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CSAGI

COMITÉ SPÉCIAL DE L'ANNÉE GÉOPHYSIQUE INTERNATIONALE
SPECIAL COMMITTEE FOR THE INTERNATIONAL GEOPHYSICAL YEAR

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THE INTERNATIONAL GEOPHYSICAL YEAR MEETINGS

Editor
M. NICOLET
(General Secretary of CSAGI)

International Council of Scientific Unions
Comité Spécial de l'Année Géophysique Internationale
(CSAGI)

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FOREWORD

FOLLOWING the initial proposal for a third International Polar Year it was suggested that this project should be extended to cover the whole of the earth and the atmosphere above it. The title was therefore changed to the International Geophysical Year (IGY) at a meeting of the Executive Board and General Assembly of the International Council of Scientific Unions (ICSU) held at Amsterdam in October 1952. The Comité Spécial de l'Année Géophysique Internationale (CSAGI) was officially constituted on the recommendation of certain Scientific Unions and Mixed Commissions, adhering to or set up by ICSU. This Special Committee is composed of representatives of ICSU itself and of certain Unions adhering thereto; the World Meteorological Organization (WMO) and, later, the Comité Consultatif International des Radiocommunications (CCIR)—both intergovernmental—were also represented on CSAGI. It was decided to invite interested Unions to set up their own organizing committees.

A preliminary meeting of some of the members of the Special Committee, L. V. BERKNER, J. COULOMB, E. HERBAYS and M. NICOLET, together with the administrative Secretary of ICSU, R. FRASER, was held at Brussels in October 1952, at which the working program of the Special Committee was considered. It was decided to send letters to the interested Unions and to the World Meteorological Organization; to renew the general appeal for the formation of International Geophysical Year Participating Committees; to propose to the Unions adhering to ICSU a moderate increase in their membership, in view of the wide scope of the enterprise; and to seek financial support from UNESCO, for a secretariat, from the beginning of 1955.

Volume I of the *Annals of the International Geophysical Year* (*IGY Annals*) gave an account of the preliminary meetings. It told of the precursors of the IGY, namely the two International Polar Years of 1882/3 and 1932/3, and also of the proposal that there should be a third polar year.

The present Volume of the *IGY Annals* provides an account of the development of the IGY by giving a series of reports of the meetings in which the plans were elaborated.

The CSAGI held its first meeting at Brussels during 30 June—3 July, 1953. The report of the meeting together with the proposals for the scientific program from various IGY Participating Committees, and the proposal made in 1951 by Mixed Commission on the Ionosphere (MCI) is given in Chapter I. A report is also included dealing with the proposal of the operation of a World Longitudes program, presented at the General Assembly of the International Astronomical Union (Rome, September, 1952).

After the first meeting of the CSAGI, the IGY Participating Committees reviewed their programs and developed detailed plans in order to permit scientific and geographic planning at the next meeting. The General Secretary issued invitations to prepare plans in the light of the provisional program drawn up in 1953. The associated international bodies represented on the CSAGI were also requested to give further consideration to the program and plans. During the summer of 1953 meetings were held by the International Union of Scientific Radio (URSI), the International Union of Geodesy and Geophysics (IUGG), and also by the Mixed Commissions on the Ionosphere (MCI) and on Radio Meteorology (MCRM).

The CSAGI held its second full meeting at Rome during 30 September—4 October 1954. By June 1953, twenty-two IGY Participating Committees had been formed and at the first plenary session in Rome the General Secretary was able to report that thirty-six Committees were participating in the IGY.

The reports of the IGY Participating Committees and the intensive preparation made by the AGI Committees of URSI and IUGG, and the resolutions of the MCI and WMO bore good fruit. These reports, and the documents, numbering slightly more than one hundred, resulting from the arduous labours of those attending the Rome meeting are reproduced in Chapter II.

In order to arrive at a more definitive program a third meeting of the CSAGI was held in Brussels from 8–14 September 1955. The general report, the report on CSAGI disciplines, and specific resolutions on CSAGI publications, World Data Centers and organization of the future work of CSAGI are given in Chapter III.

After the Brussels meeting, and as a result of the 1954–1955 CSAGI proposals, many of the IGY Participating Committees made important extentions or changes in their program; at the time of the fourth meeting of CSAGI at Barcelona (10–15 September, 1956) fifty-one Committees were participating in the IGY. Furthermore, an artificial earth satellite program had been introduced into the IGY program and the meeting provided the first opportunity to discuss the scientific aspects of the program on rockets and satellites. An account of this meeting is given in Chapter IV, which, in addition, contains reports of the URSI–AGI Committee meetings in Brussels, 29–31 August 1956, and Boulder, 29 August and 3 September 1957.

Because studies in Antarctica necessitated considerable planning the program recommended by CSAGI was discussed at four CSAGI Antarctic Conferences. Chapter V deals with the reports of these meetings, held in Paris, 6–10 July, 1955, in Brussels, 8–14 September, 1955, in Paris, 30 July—4 August, 1956, and in Paris, 13–15 June, 1957.

A CSAGI Arctic Conference was held in Stockholm, 22–25 May, 1956 and the report is the subject of Chapter VI.

Other CSAGI Regional Conferences were also arranged in various parts of the world and the reports of the CSAGI Western Hemisphere Regional Conference, Rio de Janeiro, 16–20 July 1956; the CSAGI Eastern Europe Regional Conference, Moscow, 20–25 August, 1956; the Joint CSAGI/CSA Meeting of Co-ordination for the IGY in Africa South of the Sahara, Bukavu, 11–15 February, 1957; and the CSAGI Western Pacific Regional Conference, Tokyo, 25 February—2 March, 1957 are given in Chapter VII.

The last chapter (Chapter VIII) contains the reports of four meetings, namely the meeting of the CSAGI Working Group on Oceanography at Göteborg, 15–18 January, 1957; the CSAGI Working Group on Nuclear Radiation at Utrecht, 22–26 January, 1957; the IGY World Data Centers meeting at Uccle, 1–4 April, 1957; and the CSAGI Rockets and Satellites Conference in Washington, 30 September—5 October, 1957.

The CSAGI is indebted to and thanks the countries that acted as hosts to these meetings, of, or sponsored by CSAGI, out of which the IGY plans were elaborated.

This volume of the *Annals of the IGY* shows by the official reports of the CSAGI meetings the evolution of the IGY program. The reader will find in Volume I the story of the inception and development of the IGY; Volumes III, IV, V, VI, and VII contain the manuals for the scientists participating in the IGY. Volume VIII, the geographical distribution of the IGY stations, and Volume IX, the programs of the IGY Participating Committees, may be considered as the last phase in the publication of the final IGY program.

In developing so wide a program so rapidly and completely the CSAGI owes thanks to the Unions and organizations that are represented on CSAGI, and which in their own Assemblies and by the presence and co-operation of their members at the CSAGI meetings, gave to the planning the benefit of their knowledge, experience and support. The Unions specially concerned were: the International Union of Geodesy and Geophysics, the International Scientific Radio Union and the Mixed Commission on the Ionosphere, the International Astronomical Union, the International Union for Pure and Applied Physics and its Sub-Commission on Cosmic-Ray Intensity-Time Variation. The World Meteorological Organization gave valuable aid in the planning of the meteorological program, in the application of this program, and in the assembly and reproduction of the meteorological data.

The realization of the international program is due to the efforts of scientists each in their own countries and through their representative bodies in those countries, which set up and supported the IGY Participating Committees. By their influence with their governments they were able to obtain the necessary financial grants for their programs, and to gain the interest and support of their fellow-citizens. Their delegates to the CSAGI meetings played a great part in the development of the IGY program, as well as in its execution. The IGY Participating Committees took an important share in the financial support of the central CSAGI Secretariat and in the support of the offices of the Co-ordinator at Uccle, and of the General Editor in London. The Belgian government contributed to the central secretariat by the facilities it afforded at the Department of Radiation of the Royal Meteorological Institute, Brussels, and by allowing the General Secretary to spend much official time on his CSAGI work.

The United Nations Educational, Scientific and Cultural Organization gave generous support both by direct grants to ICSU for the purposes of the central organization of the IGY, by grants towards the training of young scientists who were to take part in the observational program, and also by the UNESCO–IGY exhibition, which informed and interested a wide public in the IGY enterprise. The CSAGI expresses its gratitude for this support.

M. NICOLET

January, 1959

I—THE FIRST MEETING OF THE CSAGI

(Brussels, 30 June–3 July 1953)

1 General Report

1.1 *Introduction*

THE Special Committee of the International Geophysical Year (CSAGI) assembled on 30 June 1953 at the Palais des Académies, the rooms being generously placed at their disposal by the "Académie Royale de Belgique". Dr. L. V. BERKNER was in the chair.

At the first meeting the following members of the Special Committee were present:

International Council for Scientific Unions (ICSU):
S. CHAPMAN, E. HERBAYS

International Union of Geodesy and Geophysics (IUGG):
J. COULOMB, G. LACLAVÈRE,* V. LAURSEN

International Astronomical Union (IAU):
A. DANJON, M. NICOLET†

International Radio Scientific Union (URSI):
L. V. BERKNER, W. J. G. BEYNON‡, M. BOELLA

International Geographical Union (IGU):
J. M. WORDIE

World Meteorological Organization (WMO):
J. VAN MIEGHEM.

Dr. J. COX, the Permanent Secretary of the Académie Royale de Belgique, welcomed the members of CSAGI.

Dr. BERKNER thanked the Permanent Secretary and gave a brief history of CSAGI and of its activities since its foundation. The following agenda was presented:

1. Organization of the Committee.
   - 1.1 Election of members of the Bureau.
   - 1.2 Election of Working Groups:
     - (i) for the International Geophysical Year.
     - (ii) for the determination of longitudes.
2. Examination of the preliminary reports of the Unions and other scientific organizations.
   - 2.1 General program.
   - 2.2 Necessary observations.
   - 2.3 Standardization.
   - 2.4 Extension of international collaboration.
   - 2.5 Provisional stations and those especially necessary.

* Substitute, replacing Prof. P. TARDI, who for health reasons was unable to attend.

† Also member of the Mixed Commission for the Study of Relations between Solar and Terrestrial Phenomena.

‡ Also member of the Mixed Commission for the Ionosphere.

2.6 Accumulation, printing and distribution of results.
2.7 Collaboration with other Unions or disciplines.
3. Examination of the reports from the National Committees.
3.1 Organization of the Committees.
3.2 Proposals concerned with 2.1 and 2.6.
3.3 Proposals concerned with 2.5.
3.4 Need for new collaboration.
4. Preparation of a preliminary report to the International Council for Scientific Unions.
5. Preliminary report from the Working Group on the Determination of Longitudes: to be submitted to the Unions and the National Committees.
6. Investigation of the financial aid required.
7. Organization of a permanent secretariat (from January 1955 onwards).
8. Second official meeting of the Committee.
9. Request for information to Unions and National Committees.

Prof. CHAPMAN was unanimously elected President on a proposal of Prof. COULOMB, and began to preside over the meeting. Dr. BERKNER was then unanimously elected Vice-President following his proposal by Prof. CHAPMAN. Dr. M. NICOLET was elected General Secretary and was asked to draw up a report for the organizational framework he proposed for the Secretariat of the Special Committee.

It was decided to form a Working Group charged with the preparation of reports on the different disciplines covered by the twenty-six reports submitted by the National Committees, the Unions, and the WMO.

The IAU and the WMO were invited to intervene in discussions and to try to induce the USSR to collaborate in the IGY.

It was decided that the documents of the Committee should be produced either in the English or the French language except in those things which concerned the reports. These should be printed at the same time in English and in French; the annexes could, however, be given in either of these two languages.

The following day, 1 July, and for the rest of the meeting the following observers assisted at the meetings in addition to the members of CSAGI mentioned above:

Austria, Prof. M. TOPERCZER; France, R. P. P. LEJAY; German Fed. Rep., Prof. J. BARTELS; Netherlands, Dr. J. VELDKAMP; India, Mr. T. V. RAMANURTHI, Dr. V. SARABHAI; Japan, Dr. T. NAGATA; Norway, Prof. J. SOLBERG, Dr. L. HARANG; Sweden, Dr. N. HERLOFSON; United States, Dr. W. W. ATWOOD, Jr., Dr. J. KAPLAN.

Dr. NICOLET presented his report for the organization of the Secretariat. The Special Committee expressed its gratitude to the Belgian Government for the help promised to Dr. NICOLET and for allowing him to accept the position of General Secretary. Colonel HERBAYS was asked to continue as Secretary until 31 October 1953.

A Finance Committee composed of the President, Vice-President and General Secretary was formed.

The following recommendations were decided:

(a) To send ICSU and URSI a letter of thanks for the work performed by Colonel HERBAYS in the organization of the Committee and the meeting.

(b) To draw up a recommendation for ICSU asking ICSU to provide a sub sidy to cover the expenses of the Secretariat until November 1954, after which it was hoped to obtain a grant from UNESCO.

(c) To ask ICSU for a subsidy to cover the costs of travel and expenses for a meeting of the Special Committee in 1954.

(d) To propose to ICSU and to the National Committees a resolution for a subsidy of $20,000 in 1955–56 and for another of the same amount during the International Geophysical Year 1957–58 for the organization and operation of the program of the Secretariat.

The scientific work which consisted of the examination of the numerous reports received and in the formulation of resolutions, was then considered. To make this task simpler eleven Working Groups were formed.

1.2 *Working Groups*

The groups were as follow :

(I) World Days: Berkner, Beynon, Kaplan (Secretary).
(II) Meteorology: Chapman, Solberg, Van Mieghem (Secretary).
(III) Geomagnetism: Bartels, Coulomb (Secretary), Laursen, Nagata, Toperczer, Veldkamp.
(IV) Aurora and Airglow: Chapman, Harang, Herlofson, Kaplan (Secretary), Nicolet.
(V) Cosmic Rays: Bartels, Chapman, Herlofson, Nagata, Sarabhai (Secretary).
(VI) Solar Activity: Bartels, Beynon, Danjon, Nicolet (Secretary).
(VII) Ionosphere: Berkner, Beynon (Secretary), Harang, Lejay, Nicolet.
(VIII) Latitudes and Longitudes: Berkner, Boella, Danjon (Secretary), Laclavère, Lejay.
(IX) Study of Glaciological and Climatic Variations: Atwood (Secretary), Wordie.
(X) Oceanography: Laclavère (Secretary), Wordie.
(XI) Publications: Atwood, Herbays (Secretary), Ramanurthi, Wordie.

The proposed resolutions of the Working Groups were discussed on 2 July in the course of a short session; the texts of the resolutions adopted are given on pages 16 to 24.

On 3 July the reports and resolutions of the Working Groups were adopted. A committee for World Days consisting of Messrs. Berkner, Chapman, Lejay and Nicolet was formed to contact interested organizations.

The Committee adopted the following recommendations:

(a) National Committees should be invited to give suitable publicity, in their respective countries, to the International Geophysical Year.

(b) In each country efforts should be made to study any earlier geophysical measurements which have not yet been utilized.

The Committee examined the suggestion of the Swiss National Committee on the possibility of delaying the International Geophysical Year until 1958–59 in order to take advantage of the period of solar activity that is expected to occur in 1958.

Having considered that the maximum activity of magnetic storms had been established in 1946, the Special Committee decided to keep the International Geophysical Year in the period 1957–58.

It was decided to undertake new measures to encourage the collaboration of the USSR.

Recognizing the importance of the presence of Dr. BEYNON, Secretary of the Mixed Commission on the Ionosphere, and of M. LACLAVÈRE, General Secretary of UGGI, who had acted as assistants to the meetings, the Special Committee asked the ICSU to allow them to be present at the next meeting.

It was decided to employ the abbreviations AGI to designate the "Année Géophysique Internationale" and CSAGI to designate the "Comité Spécial de l'Année Géophysique Internationale".

1.3 *Documents concerned with the Meeting*

It was decided:

(1) To draw up in both English and French the reports and resolutions of the Working Groups.

(2) To distribute the following documents to the National Committees:

(a) A brief résumé of the activities of the Special Committee.

(b) The reports of the National Committees.

(c) The reports and resolutions of the Working Groups.

(3) A Committee composed of Dr. BEYNON, Prof. CHAPMAN, M. LACLAVÈRE and Dr. NICOLET was formed for this purpose.

(4) To publish the documents in the *Bulletin d'Information de l'UGGI.* M. LACLAVÈRE will send copies to the relevant members at the Secretariat of CSAGI.

The Bureau was given the task of deciding the place and time of the next meeting.

The following resolution was unanimously agreed upon:

"The CSAGI wishes to express its gratitude for the excellent facilities which have been made available to them by the Royal Academies of Belgium, who welcomed at the Palace of the Academies the members of the Committee and the observers from the National Committees. The Committee thanks the Academies for their generous hospitality, and also the Presidents and Permanent Secretaries for the courtesy with which they so willingly made things available."

Thanks were also given to the Royal Meteorological Institute of Belgium, which performed a major task in duplicating sufficient numbers of copies of the resolutions of the Working Groups in an extremely short time.

2 Reports on CSAGI Disciplines

I. World Days

(1) The *Regular World Days*, i.e. 2 days at new moon and 1 day at full moon, will be defined in advance, circulated by the World Meteorological Organization (WMO) and reminders will be issued by the Warning System before each occasion.

(2) In addition there will be *IGY Special World Days*, on the average two per month, chosen at shorter notice, to coincide with:

(i) Expected unusual magnetic, ionospheric or auroral activity.
(ii) Expected intervals of extreme magnetic quiet days.
(iii) Launching of rockets.
(iv) Days of solar eclipses.
(v) Unusual meteor showers.

These five types of day are given in order of their priority, (iv) and (v) can be foretold, but could be omitted as World Days if too great a number of such days appeared in the same month. It is recommended that the organization to define the above special World Days shall be designated by the Ursigram Committee of URSI.

(3) The Warning System will be operated through WWV, WWVH, Ursigrams, extended time system and any other channels. Warning elements to be considered are (i) optical observations of the sun; (ii) solar radioelectric observations; (iii) visible magnetic recording; (iv) fade outs; (v) cosmic rays; (vi) beginning of a brilliant aurora. It is recommended that the warning code be established by the Ursigram Committee of URSI in consultation with the World Meteorological Organization.

II. Meteorology

1. *Program*

(1) *The general circulation of the atmosphere.* The determination on a planetary scale, and as a function of the epoch in the year, of the distribution of winds, air temperature and water vapor content.

Study of the distribution, sources and interchanges of momentum, of the various forms of energy, of entropy and of vorticity in the atmosphere.

Study of the influence of friction and of the earth's surface relief on the air movements and of the dissipation of the kinetic energy of the air, including the hydrodynamic effects of mountain masses, and the tangential forces exerted by winds upon the ocean surface.

Investigations along vertical sections of the atmosphere both along meridians from pole to pole, and along zones of latitude. The proposed meridian sections are:

(a) Along the meridians 10° E, 140° E and 75° W, as suggested by several national committees and as recommended also by the programs in geomagnetism and ionospheric physics.

(b) Along a line from the Arctic across the Aleutians, Midway and Fiji, New Zealand and the islands to the south.

(c) Along a line crossing western Greenland, eastern Canada and U.S.A., the Antilles and eastern South America to the southern part of Argentina.

(d) Along a line from the northern station in Perryland, crossing the north-east of Greenland, Jan Mayen, Great Britain, France, Spain and West Africa to Cape Town.

(e) Along lines outside of the continents where the jet stream is often divided.

Note.—On at least one of these meridians (e.g. that of 10° or 15° E) the radiosonde temperature and wind measurements should be made at 6 hr intervals, from points 300–400 km apart; and also from stations along a parallel line 500–1000 km distant, to determine the orders of magnitude of the space and time derivatives of these meteorological variables.

As regards the zonal observations, the equator and the parallels of 15°, 30° and 60° are proposed.

Study of the relations in the tropical zone between the fields of flow and of pressure as functions of the latitude (to examine the degree of validity of the quasi-geostrophic approximation as the equator is approached, and the dependence of the vertical gradient of wind on latitude and height).

Dynamical study of the equatorial atmosphere, the interchanges of mass between the two hemispheres and the relations between their general circulations.

Study of the interdependence between the geophysical phenomena of the high atmosphere and the meteorological phenomena of the low atmosphere, in relation to long period variations of weather and climate.

(2) *Synoptic aerology.* Detailed synoptic analysis of atmospheric situations with the aid of upper air soundings at short intervals over extensive regions in order:

To study in detail the dynamic and thermodynamic processes occurring in the atmosphere and to re-examine the extent to which they can be represented, described or explained by the classical conceptions of air masses and fronts.

To study tropical cyclones systematically (especially in their initial stages), and also extratropical cyclones, and the large-scale perturbations associated with zonal currents in the free atmosphere.

To study jet streams.

To make a critical comparative study of atmospheric models used in numerical forecasting.

(3) *Physical meteorology.* The physics of clouds and precipitation, including the conditions in which rain can be formed in clouds situated above freezing level, the determination of the marine salt content at different heights above sea level, and the regional morphology of clouds.

Study of atmospheric ozone in relation to general circulation and atmospheric variations.

Study of the terms in the thermal balance at the earth's surface in relation to the general circulation; new determination of the solar constant and study of the atmospheric turbidity.

Study of (radio) atmospherics and of the atmospheric electricity in relation to weather distribution. Study of the thunderstorm activity and of its seasonal fluctuations. Study of the contribution of an individual storm to the maintenance of the earth's electric field. Study of the global daily variation of the earth-air current, and of the daily and seasonal fluctuations of the potential difference between the earth and the high atmosphere.

Study of clear-weather turbulence.

2. *Elements to be observed*

(1) *Synoptic surface observations.* In addition to the usual observations made at a synoptic station, improved and more detailed observations of clouds and hydrometeors, especially at tropical stations, in order to advance our knowledge of the

macrophysics of clouds and precipitation and to determine cloud movements (indirect aerology); precise wind measurements at the ocean surface made at stations on Pacific atolls; the daily extremes of temperature; and the daily rainfall.

(2) *Synoptic observations in the free air.* At every station in the aerological network, and in order of priority: the wind at least up to 50 mb level (or to 25 km in low latitudes); temperature T and pressure p up to the same level; the relative humidity up to the level of the isotherm $-30°$ C.

At a choice of aerological stations and on special *International Aerological Days*: the wind to the highest attainable level (it is hoped to reach the level 10 mb as often as possible); T and p to the same level; the water vapor content to the level of the tropopause and in the stratosphere, with the aid of special instruments (frost point hygrometers, absorption spectrographs, . . .) borne on pressurized aircraft; and the turbulence at high levels, as shown by the accelerations of sounding balloons, measured from the ground level (or possibly by accelerometers carried on radiosonde balloons).

(3) *Special observations at selected stations distributed over the globe.* Solar radiation.

The terms of the thermal balance of the earth's surface and particularly nocturnal radiation.

Atmospheric ozone and its vertical distribution with the aid of radiosondes and rockets.

Remark: The above special observations should be made daily at selected stations along at least one of the meridians mentioned on p. 5.

Atmospherics and the quantities involved in the study of the earth's electric field; frequent measures of the potential gradient and electric conductivity in the free air by radiosondes.

3. *Observational network*

It is necessary to compare the registering "sondes" used with a standard sonde of a type chosen in advance.

It is necessary to increase the number of radio wind observing stations.

It is necessary to increase the heights attained by sounding balloons.

It is necessary to augment the density of aerological stations in the southern hemisphere.

It is necessary to increase the number of oceanic stations during the IGY. It has been suggested: (a) to set up sounding stations on islands, (b) to establish an additional weather ship in the North Atlantic or North Pacific and (c) to equip a certain number of selected ships for air sounding.

It is necessary to fill the gaps in the existing network in connection with the meridional and zonal sections (see p. 5).

It is necessary to increase the number of aerological stations in low latitudes. According to Prof. C. E. PALMER, consideration should be given to the following principles in the establishment of the aerological network in the tropical zone:

(a) The new stations should be set up so that, together with the old stations, there will be a reasonable distribution along certain meridians between the latitudes 20° N and 20° S.

(b) As far as possible, these meridian series in low latitudes must be in the proportions of those which will be set up in higher latitudes.

(c) In the tropical meridian sections, the stations must be set up as near as possible to the equator and to the latitudes 5°, 10° and 20° N and S (in each case) along the same meridian.

(d) It is desirable that the oceanic and continental sections shall be nearly equal in number (one across the Caribbean must be regarded as continental, while one across N. Australia and New Guinea must be considered oceanic).

(e) An ideal distribution of the tropical sections of the aerological network is as follows:

Africa, 3; America, 3; S.E. Asia, 1; Pacific Ocean, 3; Indian Ocean, 3; Atlantic Ocean, 1, that is, fourteen sections in all, or ninety-eight stations (seven per section).

Prof. PALMER notes that the Pacific Ocean needs four sections but that it is very difficult to equip a section in the eastern part of this ocean, also that, among all the tropical regions, the Pacific zone has been so far the best explored.

(f) In general, the aerological stations must be set up on land, because the cost of a single weather ship would suffice to set up many stations on islands and atolls. Other things being equal, it is better to set up an oceanic station on a low lying island or atoll.

The number of daily balloon ascents must be at least two for temperature and at least four for wind; for the higher levels (25–30 km) two per week, on World Days fixed in advance.

It is necessary to increase the frequency of balloon ascents in the regions, and on the borders of the regions, where the density of aerological stations is too low (at least four ascents for temperature per day), and at the stations that observe in the aerological network.

It is necessary to press for more frequent soundings as part of a special effort for improved exploration of the high atmosphere.

The installation during the International Geophysical Year of a closer network of aerological stations in a region containing a high and extensive mountain mass.

Provision of special equipment at a number of selected stations: actinometric instruments (including instruments to measure thermal radiation); spectrographs for ozone and water vapor measurement (especially between the latitudes 15° and 40° N, to the east and west of the subtropical anticyclones); frost point hygrometers; recorders of atmospherics (the Swiss have proposed a permanent polar station, and would hope to be able to collaborate actively in setting up a radio-meteorological polar station, especially by the provision of technical equipment); radar for the exploration of showers; radiosondes for ozone measurements; atmospheric electric instruments to measure air conductivity, the field, the air-earth current, the rate of ion-production, number of large ions and Aitken nuclei, . . .; radiosondes to measure the electric field and the air conductivity.

4. *Subsidiary program*

The geophysical cycle for substances (NO_3, NH_4, NO_2, Cl, P) transported by the air, the oceans, lakes and rivers and across the earth.

Rainfall measurements on weather ships and other selected ships.

Measures of the heights of the base and summit of Cu and Cb clouds in connection with studies of precipitation and electric discharges.

Temperature measurements at the summits of cumuliform clouds.

Synoptic cloud charts.

III. Geomagnetism

1. *Problems recommended for study*

CSAGI considers the two principal problems to be:

(a) The changing morphology of magnetic storms and activity including bays and pulsations.

(b) The daily variation of the three magnetic elements in the zone containing the magnetic and geographic equator.

These problems should be studied in combination with the associated ionospheric problems.

When expeditions are made to regions rarely visited, such as most of Greenland, it is recommended that the magnetic elements shall be measured, particularly, in the case of stations where such measurements have been made previously, to determine the secular variation.

Magnetic measurements at sea are recommended in the case of oceanographic expeditions made mainly for other purposes.

2. *Rocket magnetic observations*

The intense magnetic disturbances that often prevail in high latitudes may reasonably be attributed to electric currents flowing in the ionosphere. Hitherto our knowledge of the approximate location and total intensity of these currents has been based on magnetic observations made at the earth's surface. It is very difficult, however, to determine from such observations the detailed structure and intensity distribution of these currents. It is highly desirable to penetrate the region of current flow by rockets carrying a magnetometer or magnetometers, which can show whether or not at times of intense auroras the currents are specially localized along the auroral sheets or arcs. Measurements of the total magnetic intensity alone, without directional data (valuable as these would be), would give valuable indications on this point.

3. *Ionospheric magnetic measurements*

It is to be hoped that radio scientists will be able to develop radio methods of determining the magnetic intensity in different parts of the ionosphere during powerful magnetic disturbances.

IV. Airglow and Aurora

1. *General remarks*

The following report deals with those types of airglow and aurora which clearly require co-operation between observers on a global scale. The preliminary program outlined should be supplemented with more detailed investigations according to the facilities available at each observatory or station.

The material in this report has, in great part, been obtained from the reports of the various national committees, associations, commissions and unions. Included among committees which contributed to these topics are Australia, Belgium, Denmark, Finland, France, India, Japan, Norway, Sweden, the United Kingdom and the United States.

2. *Auroral observations*

(1) *Synoptic studies of world-wide great displays.* The purpose of this study is to improve our knowledge of the connection between geomagnetic storms and typical features of the aurora. In particular, it is desirable to relate the time of appearance of the aurora to the sudden commencement of the geomagnetic storm, and to observe possible auroral difference between the first phase and the main phase of a storm.

A continuous, or nearly continuous, watch would overtax the resources of nearly any observatory. It is therefore suggested that telegraphic warnings of expected auroral displays, or of displays already begun, should be sent out through a central organization, possibly in co-operation with a solar observatory, and the auroral observatories in Alaska and Tromsö. All observing stations should then be ready to start work at once after sunset and take frequent observations, according to a plan, and using a log-book, prepared before the International Geophysical Year. This warning system of World Days fixed at short notice should be used on about two days per month during the International Geophysical Year, and on each occasion of successful prediction, or timely warning of great aurora begun, the observers should, if possible, be ready to continue to watch on a few succeeding nights.

(2) *The auroral zones during periods of unusual magnetic calm.* A few observations are on record which suggest that during magnetically very quiet periods there may be one or more homogeneous arcs well inside the polar cap enclosed by the auroral zone. Observation of these quiet phenomena may be as useful for the advancement of auroral theory as the spectacular displays, which are so exceedingly complex.

Occasional observations also indicate that the position and direction of the arcs may vary in a systematic manner during the night.

The quiet arcs should be observed regularly from stations, in or inside the normal auroral zones by visual or photographic means. These stations should preferably be grouped along magnetic meridian sections across the auroral zones. Time-resolved spectra should be obtained in the case of quiet arcs.

The co-operation of air lines operating near the auroral zones would be particularly valuable.

(3) *Improvement of Fritz's chart.* Owing to the variation of auroral frequency from year to year, especially in association with the sunspot cycle, even the most complete auroral observations during the International Geophysical Year cannot suffice for the improvement of VESTINE's revision of Fritz's chart. They will, however, be a guide and a valuable contribution towards later elaborations of isochasmic charts relating to particular features, instead of (as in Fritz's chart) auroras as a whole.

For this purpose a more continuous auroral watch is desirable than private observers are likely to be able to keep, valuable as their efforts are; it may be possible, however, for groups of watchers to arrange to observe throughout the nights of the special World Days, according to a pre-arranged schedule. Hence there should be a number of auroral observatories equipped with automatic photographic, photo-electric and spectrographic recorders.

(4) *Construction of an isoauroral chart.* For the theoretical study of geomagnetic and ionospheric storms and auroras it is desirable to construct a new kind of auroral chart, which may be called "isoauroral", showing the frequency of occurrence of auroras at (above) each place, instead of (as with the isochasmic chart) the frequency of *visibility from* each place. Observations of *overhead* occurrence of auroras directly contribute to this purpose, without any knowledge or assumption concerning the *height* of the auroras; but only a little less valuable are observations of auroral occurrence anywhere within 30° of the zenith of the observer as the uncertainty as to the true geographical location of the aurora (if the true height is not known) is then small.

The "isoauroral" lines on the isoauroral chart may be expected to agree in form with the Fritz isochasms, but will be graduated differently. A first attempt at this re-graduation may be based on the study of past auroras over many decades; but improved future auroral observations will gradually provide a more exact basis.

(5) *Observations in the southern hemisphere.* More auroral observations from the southern hemisphere are badly needed. An effort should be made to correlate them in time with observations from the northern hemisphere. To some extent the warning system outlined in 2. (1) would promote this purpose.

(6) *International planning and reduction of observations.* A standardization of log-books well before the IGY is highly desirable for the synoptic studies of the aurora. If possible, both the log-books and the warning system for auroras should be tried out in the years before 1957.

It is suggested that Mr. J. Paton, Dr. C. T. Elvey and Prof. C. W. Gartlein should be approached and asked to undertake the planning of the observations in co-operation with other interested researchers in this field.

A microfilm of all log-books should be deposited immediately after the International Geophysical Year with a central agency, which should be responsible for making copies available on request.

3. *Spectrographic studies*

(1) *Auroras.* In the spectrographic problems of the aurora, the world-wide effects are important. Data should be obtained on Hα in both the northern and southern auroral zones, and for a considerable arc of longitude in the northern zone.

Since information concerning the broad features of the auroral spectrum is sufficient, more attention should be paid during the International Geophysical Year to spectral investigations of major significance (absolute calibrations, rapid fluctuations, . . .).

As the main spectral contributions to the *light* of the aurora are now known, the *color* of the aurora may serve to indicate the approximate ratios of these contributions at any particular part of an aurora and at any instant of observation. The usual verbal descriptions of auroral colour are not adequate for this purpose: a finer discrimination and nomenclature are desirable, such as only colorimetric observations can provide. In London, Prof. W. D. WRIGHT is developing a colorimeter designed for such observations of auroras and other sky phenomena when sufficiently bright; this apparatus will be tested in use by observers of Mr. J. PATON's group, and if it proves successful, it may be a means of adding much to our knowledge of the spectral variations of the auroral light in the hands of discriminating observers, and therefore usefully supplement the knowledge provided by spectrographs.

(2) *Airglow.* Systematic photometric and spectrographic observations of the airglow should be made at a number of stations in both hemispheres. For this purpose:

Spectrographs should be used in conjunction with photometers, so that identification and absolute calibrations are available.

Observations should be continuous throughout good photometric nights, in order to study diurnal variations.

A coverage both in latitude and longitude should be established in order to determine seasonal and geographical variations.

Equatorial stations are desirable in order to separate auroral effects from the airglow emissions.

Complete sky coverage should be achieved in photometric observations so as to make morphological studies and to determine rapid fluctuations, which may be related to hydrodynamic or electromagnetic effects in the high atmosphere.

4. *Rocket observations for auroral and airglow observation*

Rocket firings for airglow observation in New Mexico and Australia are very desirable, and arrangements should also be made for firings from ships which could go into polar regions. Information obtained in this way at specific places and times regarding temperature and density, as well as other atmospheric properties, such as luminosity, could be collated with other less direct observations that are more widely available in space and time.

V. Ionosphere

1. *General remarks*

Sixteen of the National Committee reports submitted to CSAGI refer to ionospheric studies during the International Geophysical Year. This represents a considerable world distribution of effort, but no reports have as yet been received from a number of nations, in particular USSR, New Zealand, Italy, Canada, Peru (the last named is of especial concern since it involves the Huancayo magnetic and ionospheric observatory). An immediate effort should be made to stimulate interest in the IGY in all countries which have not yet responded.

2. *Priority for measurements*

CSAGI has considered the world distribution of ionospheric observatories, and following the lines of a resolution first made in 1950 by the Mixed Commission on the Ionosphere, recommends first that in siting new stations prior consideration be given to stations along three lines of longitude, in the auroral zone and in equatorial regions. Details of these proposals are given in the formal resolutions. CSAGI has considered the priority which should be given to various types of ionospheric measurements and suggests the following order of priority:

(1) *Normal incidence (P′f) recording.* In general it is considered that hourly observations will be adequate but that on the Special World Days such observations should be made at quarter-hourly intervals. It is suggested that where adequate sender power is available "back scatter" observations might also be associated with normal incidence measurements. This technique may provide useful information about the ionosphere in remote parts of the world at which the conventional vertical incidence sounding is not possible.

(2) *Vertical incidence.* Ionospheric absorption measurements should be given second priority and with these should be coupled (*P′t*) type recording. The use of some simple auxiliary equipment for recording "off vertical" echoes is also recommended, particularly at polar stations. It is recommended that galactic noise sources should be observed during the International Geophysical Year in order to measure ionospheric absorption, and that the methods be used if possible in the auroral region during polar blackouts. It is recommended that absorption measurements be made at least every day at local noon, and that throughout the Regular and Special World Days absorption measurements be made at frequent intervals.

The National Committee reports contain many references to details within the above general program (such as scaling and accuracy of recording). CSAGI recommends that these details be studied by the relevant commissions of URSI. It is hoped that at the next meeting of CSAGI the National Committees will submit full particulars of the localities to be occupied and of the equipment which will be employed, so that a proper assessment of the adequacy of the world program can be made. Meanwhile, CSAGI invites comments and further suggestions regarding this program from the URSI and National Committees for the International Geophysical Year.

VI. Solar Activity

It is important to present all the results on solar activity during the IGY in a publication which would be helpful for geophysical studies. Considerable attention should be given to the form of this publication.

It is important to observe and publish detailed data on sunspots. It is desirable to discuss how best to represent the quantitative measurements.

Not all chromospheric flares are observed at the present time, in spite of about twenty co-operating observatories. It is therefore very desirable that during the IGY very close co-operation be arranged between the owners of spectroheliographs and Lyot-Hα filters with automatic cameras. The continuous records should be standardized so as to yield comparable quantitative information. Finally, objective photometry of faculae and flares should be started before 1957.

The daily photometry of the solar corona should no longer be made by visual procedures but with instruments such as the polarizing spectrophotometer of Lyot.

Attention is drawn to the program of the International Association of Terrestrial Magnetism and Electricity for the continuous measurement of the intensity of corpuscular solar radiation as inferred from geomagnetic time-variations. A homogeneous series of planetary indices *Kp* for each three-hour interval is available, covering the period since 1937, and is being continued by monthly reports. An extension to hourly values is planned for the IGY.

Further information on corpuscular radiation and solar activity may be obtainable from cometary observations and also from time-variations of cosmic-ray intensity.

Rocket observations of the solar ultraviolet emission are of very great value and should be included in the IGY program.

VII. Cosmic Rays

The study of the intensity-time variations in the cosmic radiations may have important consequences for the knowledge of geophysical and solar processes:

A solar daily variation, and a twenty-seven day recurrence tendency are observed in the cosmic radiations, which are related to solar or geophysical phenomena.

At present, it is believed that some of the variations are due to solar modulating mechanisms, and some to variations in cosmic-ray production (such as intensity increases associated with solar flares).

Changes of cosmic-ray intensity are also possibly associated with geomagnetic and heliomagnetic effects.

Atmospheric effects produce variations in cosmic-ray intensity. The existence of contributions of atmospheric mass absorption and of changes in the mean height of meson production due to temperature effects, is generally accepted.

However, the positive temperature effect, believed to be connected with density changes of the air near the levels of meson production, presents many difficulties. The effects of solar and lunar tides in the atmosphere on the variation of meson intensity require further study.

In order to study solar and geophysical phenomena related to cosmic-ray intensity variations it is necessary to establish a world-wide program of cosmic-ray measurements.

Hence cosmic-ray studies must be included in the program for the IGY.

The following countries have indicated special interest in the IGY cosmic-ray program:

(1) Australia; (2) Denmark; (3) German Fed. Rep.; (4) Great Britain; (5) India; (6) Japan; (7) Netherlands; (8) Sweden; (9) Switzerland and (10) U.S.A.

VIII. Longitudes and Latitudes

The object of this part of the International Geophysical Year enterprise is the more precise determination of the astronomical co-ordinates of the participating observatories, and the study of the variations of these co-ordinates. The results of the study will lead in the future to a more exact knowledge of the instantaneous coordinates of the observatories, from which will follow: (a) an improvement in terrestrial time determination; (b) a more precise determination of the irregularities in the rate of the earth's rotation; and (c) an improvement of star catalogs.

The determination of longitude is affected by errors of the following kinds: (a) instrumental errors of observation; (b) fluctuations of the instantaneous axis of rotation of the earth; (c) fluctuations in the direction of the vertical at the place of observation, due to (i) lunisolar gravity, (ii) terrestrial phenomena, both periodic and non-periodic, especially thermal effects, (iii) changes deep within the earth; (d) uncertainties in the rate of propagation of time signals between transmitting and receiving stations; (e) errors in star catalogs; (f) abnormalities of refraction.

IX. Glaciology

Tentative proposals for the International Geophysical Year prepared by the United States National Committee include several projects calling for observation and measurement of glaciers, sea ice and snow cover in so far as these relate to long-range climatic changes. The National Committee of Switzerland proposes observations on the amount and character of snow-fall as related to meteorological conditions. Although not stated in the preliminary program submitted by the British National Committee, it is understood that British glaciologists will plan glaciological studies to be conducted at Arctic and Antarctic stations when these stations have been chosen.

In view of the limited interest in glaciological studies revealed in the current proposals of National Committees, it is doubtful whether any extensive program should be undertaken in this field. However, it is believed desirable to defer decision on this question until participating countries have reviewed their programs once more; a real interest may exist in six or eight countries, in which case a worthwhile program could be undertaken.

To determine the extent of interest and ability to participate in a glaciological program, the following proposal is included for consideration by National Committees:

It is proposed to obtain additional data on the character and distribution of glacier ice, sea ice and snow cover in so far as these relate to long-range climatic changes. An important by-product of this program will be the establishment of base points for future comparative observations. Elements of the program include the following:

(a) Aerial reconnaissance of the extent of representative glaciers;

(b) Periodic aerial reconnaissance of the extent of snow cover over continents and ice pack over oceans by aircraft flying on regularly scheduled routes;

(c) Measurement of temperature gradients in icecaps in northern and southern regions.

X. Oceanography

Oceanography proposals have been made from a limited number of countries, six in all. Some of these (e.g. those from Sweden) are not purely oceanographic. Others do not necessarily demand simultaneous international observations.

The German Federal Republic is prepared to send a ship to East Greenland waters. The U.K. would make a research ship available for certain purposes. It does not appear that oceanographic observations are likely to be actively pursued unless additional countries are prepared to participate.

The CSAGI refers the proposals made by the different countries to the International Association of Physical Oceanography for consideration and further reports.

Ships engaged in oceanographic research during the IGY might be asked to cooperate in other geophysical research, such as ocean magnetic surveys.

3 Resolutions

II. Meteorology

(1) CSAGI emphasizes that the special meteorological effort during the International Geophysical Year should be devoted mainly to the upper regions of the atmosphere.

The Committee commends the following order of priority:

(i) Problems of atmospheric dynamics.
(ii) Problems of the thermal exchanges.
(iii) Problems of water vapor and ozone.

The Committee draws the attention of meteorological services to the importance of physical meteorology and hopes that during the International Geophysical Year special efforts will be devoted to problems (ii and iii) related to (1).

(2) CSAGI endorses the Australian proposals to set up observing stations in the Antarctic and on Macquarie and Heard Islands, particularly in relation to any stations situated on the longitudes of about 10° E, 140° E and 75° W. It draws special attention to the interest of ozone measurements in southern latitudes. In reply to the question put by the Australian National Committee, CSAGI considers that priority should be given to radiosonde observations of temperature.

(3) CSAGI has noted the program outlined by URSI Commission II, and hopes to be informed of the nature, quality, frequency and density of the meteorological observations desired by the radio workers on that program.

III. Geomagnetism

1. *Methods of observation and reduction*

(1) CSAGI stresses the value attaching to measurements, during the International Geophysical Year, of the magnetic gradients, by means of additional observatories auxiliary to main observatories, particularly near the auroral zone; but it does not make this a general recommendation for all participating nations.

(2) CSAGI recommends that all the magnetic instruments used during the International Geophysical Year shall be compared with those of one or other important observatory whose instruments have already been compared with others elsewhere as part of the international scheme of comparisons.

(3) CSAGI stresses the need for good time-marking of magnetograms, to an accuracy of 1 sec where possible; it recommends that the corrections needed to convert the time marks on the sheets to UT (Universal time) shall be inscribed on the magnetic sheets.

(4) CSAGI requests IATME (the International Association for Terrestrial Magnetism and Electricity) to begin an immediate enquiry into the methods of registering variations of period between a second and a minute; the results of such an enquiry will serve to formulate further recommendations. CSAGI does not consider it possible at present to invite international co-operation in the study of variations of still shorter period.

(5) CSAGI recommends that a microfilm copy of all the magnetograms obtained during the International Geophysical Year, and of all the tables of hourly values taken from them, in cases where the publication of these tables are not assured, be deposited with the archives of the second International Polar Year 1932–1933 now kept at the Danish Meteorological Institute. Copies from these films could later be supplied on reciprocal conditions to institutes that request them.

(6) CSAGI recommends that magnetograms on an extended time scale be obtained, if possible, on the World Days.

2. *Projects to be recommended*

(7) The following proposals are endorsed by CSAGI and are to be communicated in the form of Resolutions to the nations concerned:

(i) The Japanese National IGY Committee's proposal to operate stations on some Pacific islands in low latitudes, subject to the consent of the U.S.A.
(ii) A magnetic station to be set up by U.S.A. on Jarvis Island.
(iii) Austrian participation in the establishment of a magnetic station in Africa near the magnetic equator.
(iv) Establishment of a Swedish magnetic station in Ethiopia.
(v) Establishment by the Netherlands of magnetic stations at Paramaribo (Surinam) and Hollandia (New Guinea).
(vi) Equipment by Brazil of a new magnetic observatory at Tatuoca.
(vii) Establishment by Spain of magnetic stations in Spanish Guinea and the Canary Isles.
(viii) Further development by the French government of the magnetic stations of Tamanrasset and Bangui; and possibility of a station at Tahiti and of a variation station in the Kerguelen Isles.
(ix) Establishment by the government of Iceland of a magnetic station equipped to register rapid variations.
(x) Establishment of magnetic stations at Bunia and Lwiro in the Belgian Congo, particularly for the study of the variations.
(xi) Recommencement of operation of the magnetic observatory of Hong Kong.
(xii) Establishment of a magnetic station at Khartoum.

(8) CSAGI recommends the establishment of a magnetic station on Spitzbergen, and invites Norway and Sweden to consider the best way of providing for the operation of such a station.

(9) CSAGI recommends that the network of magnetic stations operated in the Arctic region during the International Geophysical Year should be at least as complete as during the Second International Polar Year 1932–1933. Attention is drawn

to the desirability of re-establishing the following stations which operated then: Julianehaab, Jan Mayen, Scoresby Sound.

IV. Aurora and Airglow

CSAGI: (1) Resolves that visual observations of auroras should be made over as wide an area as possible—ideally so that the survey becomes completely circumpolar and transpolar—and that the co-operation of civil air lines, ocean-going vessels and weather-ships be sought; in addition that suitably situated countries should co-operate in organizing a network of voluntary observers as well as by requesting their professional meteorological observers to record auroras at each night observing hour. Observations on the appearance of the hydrogen lines in auroras should be made and efforts should be directed to determine whether or not the lines show up simultaneously over the two auroral zones.

(2) Resolves that regional centres should be established to organize visual observations and synthesize the results. In the U.S.A., Prof. C. W. GARTLEIN and Prof. C. T. ELVEY should be approached, in Europe Mr. J. PATON, and in the Southern hemisphere a center should be established by co-operation between Australia, New Zealand and other interested countries.

(3) Resolves that the warning system for world-wide observations (World Days at short notice) should select a small number of extremely quiet days in addition to the very disturbed days, and observing stations should then be particularly requested to report a possible complete absence of aurora under conditions of clear sky.

(4) Resolves that when strong auroras appear after sunset, it is very important to warn observers in the sunlit regions further west. The appropriate national authorities and the meteorological organizations should be approached with a request to secure the assistance of broadcasting systems and meteorological teleprinter systems for this purpose.

(5) Resolves that spectrographic and photometric work on the auroras should be undertaken particularly in the regions where auroras occur fairly often, and that in lower latitudes astronomical observatories and high-altitude stations be urged to prepare for the occasional use of their equipment for the same purposes, especially at times indicated in advance by the general warning system.

(6) Resolves that a possible correlation between aurora at both ends of the same magnetic field line should be investigated by simultaneous observations according to a predetermined scheme. College, Alaska and Macquarie Island are examples of stations which appear to be connected by a field line, and a careful check on this and other possible pairs of stations should be carried out at an early date.

(7) Resolves that a world-wide coverage of radio observations of auroras be attempted by creating a ring of observing stations placed within the optimum observing belt of geomagnetic colatitude 29°–32°. Such a ring of observing stations is scarcely possible in the southern hemisphere but should be attempted as far as geographical circumstances permit. Three methods of investigation are recommended, i.e. (a) the radio echo technique in which reflection or scattering of radio waves from

auroral formations is observed, (b) techniques involving the reception of radio waves from the radio stars, with particular reference to the effect of auroras on the scintillation of the radio stars, (c) observation of radio noise emitted by the auroras.

(8) Resolves that a number of stations, including equatorial regions and the southern hemisphere, should study the temporal variations of the main spectral features of the airglow. Accurate determinations of temperature (from the rotational structure of the bands) would be especially valuable if carried out at various stations.

(9) Recommends that the development of observing techniques and the institution of improved observing programs be begun at the earliest possible date, so as to be in good order and readiness for the International Geophysical Year.

(10) Resolves that early plans be made for the development of the most effective instrumentation for the visual, photographic, photometric and spectrographic studies of nightglow and aurora. As far as practicable, these instruments should be similar and carefully compared. It further resolves that a special sub-committee on instrumentation be set up by the Association of Terrestrial Magnetism and Electricity.

(11) Resolves that there be an expanded use of rockets for direct measurements of the properties of the upper atmosphere during the IGY. The aim should be the utmost available variety of firings in space and time.

V. Ionosphere

CSAGI: (1) Following the lines of a resolution made by the Mixed Commission on the Ionosphere in 1950, recommends that in siting new ionospheric stations, priority be given to stations in or near three zones of longitude centered on 75° W, 10° E and 140° E. In each case, a zone width of approximately $\pm 10°$ is suggested for the polar regions, with wider limits for temperate and equatorial regions.

(2) Recommends that there should be a close concentration of ionospheric observatories in the auroral zones along the above lines of longitude with one auxiliary line of concentration near Fairbanks, Alaska. CSAGI would also welcome other Arctic and Antarctic ionospheric expeditions, whether or not such expeditions fall within the specified longitude zones.

(3) Recommends that for these three lines of longitude there should be an increased concentration of observatories in equatorial latitudes, and in particular that an ionospheric station be established in Eastern Brazil, if possible at or near the proposed magnetic station at Tatuoca.

(4) Recommends that URSI should devise an adequate system of scaling and representation of polar ionospheric phenomena, and produce an instruction manual which would include illustrative examples.

(5) Recommends that URSI should carefully consider the classification of sporadic *E* phenomena and devise methods of scaling and representation for the various classes.

(6) Recommends that the Permanent Ursigram Committee of URSI be charged with the duty of ensuring that the need for rapid interchange of information on many geophysical topics is adequately met during the International Geophysical Year, and of developing codes for the special IGY warning system.

(7) Having formulated an outline of the ionospheric program for the International Geophysical Year in relation to other geophysical programs, recommends that the International Geophysical Year Committee of URSI should develop the proposed ionosphere program in further detail, including standards of measurement and operative procedures.

(8) Requests URSI to devise standard methods of measuring absolute ionospheric absorption at vertical incidence.

(9) Endorses the following resolutions of the Mixed Commission on the Ionosphere concerning work during the International Geophysical Year.

(i) *Reduction and analysis of records*

The Commission recommends that organizations be set up before the International Geophysical Year, to pursue energetically the analysis of geophysical records accumulated during the past, and in the case of ionospheric records that some of the best $h'f$ records should be analyzed in detail to determine the way in which the electron density depends on height.

(ii) *Geophysical work in southern latitudes*

The Commission notes with satisfaction the valuable geophysical work now in progress at Macquarie Island, Campbell Island, Kerguelen Island and Heard Island, and urges that such studies should be continued and expanded during the International Geophysical Year. The Commission also draws attention to the desirability of establishing a station on the mainland of Antarctica.

(10) Recommends that every effort be made to maintain continuous observation of the sun both on radio frequencies and visually during the International Geophysical Year, and with this in view, advantage should be taken of polar expeditions.

(11) Recommends that observations of winds in the ionosphere be undertaken wherever possible. Various techniques may be employed including fading methods, measurement of Doppler shift in meteor trail reflections, scintillation of radio stars, or employing data from three suitably spaced vertical incidence recorders. Special attention should be given to such wind observations on World Days.

(12) Emphasizes the special interest attaching to studies of ionospheric storms, and contemplates that such studies will be possible within the framework of the program sketched above.

(13) Recommends that observations of "whistlers" be made using a sensitive audio amplifier. It is suggested that at least six stations be equipped for making such observations, one near the north magnetic pole, one in the Antarctic, two at intermediate latitudes, and one in the southern hemisphere at a point conjugate with respect to a line of magnetic force with one of the intermediate latitude stations in the northern hemisphere.

(14) Recommends that in localities where "Giant Magnetic Pulsations" may be anticipated, magnetic recorders and ($P't$) ionospheric recorders with good height resolution should be operated simultaneously. A frequency likely to give echoes from the E layer should be used for this purpose.

VII. Cosmic Rays

CSAGI recommends: (1) That the program in cosmic rays during the International Geophysical Year should cover:

(i) A study of the relationship of cosmic-ray intensity with solar activity and with geomagnetism. This would also involve an examination of the correlation with possible associated phenomena such as ionospheric changes, solar radio noise, aurorae and ozone in the atmosphere.
(ii) A study of the anisotropy of the primary cosmic relation.
(iii) The geomagnetic field, which acts on cosmic rays; as a convenient mass or momentum spectrometer, this makes it possible to select particles according to energy or magnetic rigidity.

(2) That the observing stations should be distributed over a range of latitude as well as longitude. Since cosmic-ray intensity increases with altitude, some high-altitude stations are desirable. At present equatorial and polar latitudes are poorly covered. In the central latitudes there are few stations which provide data that can be intercompared. The location of neutron monitors and directional counter telescopes should be planned on a world-wide basis, and where possible should be at places where magnetic and ionospheric data are available.

It may be advantageous to set up such new apparatus alongside the existing ionization chambers at the Carnegie Institution stations, where almost continuous data are available since 1938.

For (1) (ii) more elaborate directional studies are required over a wide range of latitudes covering both the northern and the southern hemispheres.

(3) That world-wide studies during the IGY be conducted with apparatus of a standardized design. Uniform procedure for collecting, tabulating and reducing the data should be established.

The co-operation of the International Union of Pure and Applied Physics is invited in relation to the above studies, particularly as regards:

(i) The design of apparatus (type of radiation to be measured, solid angle, etc.).
(ii) The places where the observations could be conveniently conducted. It is desirable to have widespread distribution of a rugged equipment, while more intensive studies requiring greater attention and skill could be conducted at fewer stations, where cosmic-ray laboratories already exist.

(4) That extended co-operation over a longer period is required for world-wide studies of geophysical interest in cosmic rays, in addition to the program during the IGY. It is recommended that the International Association for Terrestrial Magnetism and Electricity should organize such work on a permanent basis. Informal co-operation between the International Union of Pure and Applied Physics and the International Association of Terrestrial Magnetism and Electricity could be achieved by each body extending an invitation to the other to send one or more delegates to their meetings.

(5) That since many cosmic-ray intensity variations are related to solar or geophysical processes it is important that cosmic-ray stations should receive the standard disturbed day-warnings for solar (optical and radio-electric), auroral,

magnetic and ionospheric activity. Also the principal cosmic-ray groups should receive data of magnetic disturbance as soon as possible.

VIII. Longitudes and Latitudes

The CSAGI recommends:

(1) (i) That special astronomical observations be made during the IGY by all the observatories associated with the Bureau International de l'Heure (BIH);

(ii) That a number of first order stations be established for the IGY in parts of the world where there are no existing observatories of category (i), and especially in the southern hemisphere.

(2) (i) That each of these observatories, 1 (i) and (ii), shall make concurrent observations of time and latitude;

(ii) That these observations shall extend over an interval covering at least one Chandler period;

(iii) That all these observations shall be referred to the same fundamental star catalog, whatever the instrument used.

(3) (i) That, in conformity with the recommendations of Sir HAROLD SPENCER JONES, instruments of differing types shall be used: small transit instruments, photographic zenith telescopes, impersonal astrolabes and so on;

(ii) That in all cases preference shall be given to instruments that simultaneously measure time and latitude;

(iii) That when the instrument used is a zenith telescope, auxiliary observations of the fundamental stars shall be made with another instrument closely adjacent to it, so as to correct for any errors in the local catalog, and particularly for errors depending on right ascension, which if uncorrected would imply a spurious annual variation.

(4) (i) That two-way intercommunication of time signals shall be arranged during the IGY, for the precise determination of the transmission time of the signals and of the variations of this transmission time;

(ii) That measurements of the transmission time of signals between certain stations shall be made with the utmost precision, and as far as possible ionospheric measurements should be made at points along the transmission path, in order to have the fullest knowledge of the conditions affecting the propagation of the radio signals;

(iii) That URSI shall send the following communication to the organizations concerned:

CSAGI, considering (a) the necessity to ensure the utmost precision of international longitude measurements during the IGY; (b) the advantages afforded for the interchange of time between astronomical observatories, by the emission at frequent intervals of time signals capable of being received over the entire surface of the earth, including the southern hemisphere, draws the attention of the responsible organizations, and especially of CCIR and URSI, to the importance of organizing a world system of emission of time signals during the IGY, and asks that this shall be established and in working order before the IGY begins.

(5) (i) That in order later to take account of the annual and irregular variations of refraction, the meteorological services participating in the International Geophysical Year shall determine the distribution of motion and of temperature of the atmosphere up to 30 km;

(ii) That in order later to take account of the lunisolar influence upon the vertical, this correction shall be calculated for the period 1951 to 1958;

(iii) That in order to assess the importance of the corrections 5(i) and (ii), the BIH shall from now, if possible, apply them to the determinations of longitude made since the beginning of 1951;

(iv) That the International Association of Geodesy shall as soon as possible proceed, through its appropriate section, to the study of the methods suitable for determining with all available precision at a given station, the daily, seasonal, annual and irregular variations of the vertical direction;

(v) That at the next Assembly of the International Association of Geodesy in 1954, the Director of the International Latitude Service shall propose a program of work for the best possible determination of the polhode;

(vi) That the International Astronomical Union shall continue to support the revision by Prof. Kopff of the Fundamental Catalog FK3, and the revision by Dr. Melchior of the International Latitude Service star catalog;

(vii) That for longitude determinations observations shall be made by the method of Dr. Markowitz at a number of fundamental stations, and that the International Association of Geodesy shall, through its appropriate section, study the corrections required in order to refer the determinations to a common system of reference;

(viii) That the ten-member commission appointed by the International Astronomical Union for the IGY longitude operation shall meet at Rome in 1954 on the occasion of the General Assembly of UGGI, instead of waiting for the General Assembly of the International Astronomical Union in 1955;

(ix) That the reduction of the latitude and longitude observations shall be centralized, and for this purpose referred to the appropriate organization of the International Astronomical Union and UGGI, namely Bureau International de l'Heure and International Latitude Service, and that these shall receive the necessary subventions for the purpose.

IX. Glaciology

Whereas the first set of proposals for the International Geophysical Year did not suggest the inclusion of glaciological and climatological projects and, whereas a degree of interest in such projects has been indicated by the United States, the United Kingdom, India and Switzerland:
CSAGI resolves that the U.S. proposals be distributed to all participating countries and invites the National Committees to submit proposals in the fields of glaciology for consideration by the Special Committee at its next meeting.

General Resolutions

(1) CSAGI expresses its deep appreciation of the great facilities afforded to it by the Royal Belgian Academies in welcoming CSAGI and its associates, the national observers, to the Palace of the Academies, and for the generous hospitality otherwise accorded to them by the Academies: and wishes to thank also the Presidents and Permanent Secretaries for their personal courtesies.

(2) CSAGI, in recognition of the valuable services rendered to it by Col. HERBAYS, its Convener and Provisional Secretary, especially in connection with the arrangements for its first meeting, records its gratitude to him and resolves to communicate this resolution to the International Council of Scientific Unions and to the International Radio Scientific Union.

(3) CSAGI expresses its cordial gratitude to the Director and the staff of the Royal Meteorological Institute of Belgium and to the staff of the URSI secretariat for the assistance they have afforded to the Committee.

(4) CSAGI in recognition of the valuable help rendered at its first meeting by the Secretary of the Mixed Commission of the Ionosphere, Dr. BEYNON, and the General Secretaries of the International Union of Geodesy and Geophysics, M. LACLAVÈRE, and of the International Association of Terrestrial Magnetism and Electricity, Dr. LAURSEN, who attended as alternate members, urges that the International Council of Scientific Unions shall authorize their continued attendance at its meetings.

(5) CSAGI requests the International Council of Scientific Unions to use its influence with UNESCO National Delegations for assistance to CSAGI for the organization of its secretariat and for the realization of the programs of work, in the sum of $10,000 for the year 1954–1955 and $20,000 for each of the years 1955–1956 and 1956–1957.

(6) CSAGI at its first plenary meeting held at Brussels in July 1953, having regard to the scientific importance of the proposed observations during the International Geophysical Year and of the necessity for careful and complete preparation for these observations, requests the National Committees of the International Geophysical Year already constituted, or hereafter constituted, to urge their National UNESCO Delegations to support the proposals for UNESCO financial aid to CSAGI.

After ratification of general resolution (4) of CSAGI by the International Council of Scientific Unions, the composition of the CSAGI is as follows:

President: Prof. S. CHAPMAN
Vice-President: Dr. L. V. BERKNER
General Secretary: Dr. M. NICOLET
Representing the International Council of Scientific Unions: Col. E. HERBAYS
Representing the International Astronomical Union: Prof. A. DANJON, Sir HAROLD SPENCER JONES
Representing the International Union of Geodesy and Geophysics: Prof. J. COULOMB, Dr. V. LAURSEN, M. G. LACLAVÈRE, Prof. P. TARDI
Representing the International Geographical Union: Mr. J. M. WORDIE
Representing the International Scientific Radio Union: Dr. W. J. G. BEYNON, Prof. M. BOELLA.

4 Publications

4.1 *Introduction*

While regarding it as premature to lay down strict rules at this time for the publication of the varied results to be obtained in the International Geophysical Year, CSAGI considers it advisable already to give some general directives to help the various organizations concerned to take the necessary preliminary steps relative to the International Geophysical Year publications.

4.2 *Publication of results*

The responsibility for the reduction of the observational data shall rest with the IGY National Committees of the countries that make the observations.

The Unions and the World Meteorological Organization are invited to consider whether it is possible to recommend a uniform presentation of the IGY results obtained in the varied scientific domains, and to inform the General Secretary of the International Geophysical Year of their proposals as soon as possible.

CSAGI will examine the possibility of obtaining financial support for certain publications.

With reference to the above the different domains are assigned as follows:

Meteorology: World Meteorological Organization and International Association of Meteorology (U.G.G.I.).

Geomagnetism: International Association of Terrestrial Magnetism and Electricity (U.G.G.I.).

Aurora and Airglow: International Association of Terrestrial Magnetism and Electricity (U.G.G.I.).

Ionosphere: Radio Scientific Union and Mixed Commission on the Ionosphere.

Solar activity: International Astronomical Union and Mixed Commission for the Study of Solar Terrestrial Relationships.

Cosmic rays: International Association of Terrestrial Magnetism and Electricity (U.G.G.I.).

Longitudes and Latitudes: International Astronomical Union and International Association of Geodesy (U.G.G.I.).

Glaciology: International Association of Hydrology (U.G.G.I.).

Oceanography: International Association of Physical Oceanography (U.G.G.I.) and the Mixed Commission for Oceanography.

CSAGI will prepare and publish a Final Co-ordinated Report giving the conclusions based on the results of the International Geophysical Year.

4.3 *Bibliography*

CSAGI will form a bibliography of all the articles published in connection with the International Geophysical Year, grouped according to the scientific domain and by the region or country.

Each article mentioned shall be followed by a short abstract.

This bibliography shall be published annually from the end of 1958 and if possible will end after 5 years.

The National Committees of the International Geophysical Year are asked to invite the scientific periodicals published in their countries to add to any article published in a language other than English and French, an abstract in each of these languages.

The General Secretary of CSAGI is asked to arrange for the preparation of this bibliography with ICSU Abstracting Board of the International Council of Scientific Unions.

The National Committees of the International Geophysical Year are asked to give active co-operation in the preparation of this bibliography.

4.4 *Special CSAGI Publications*

The communications, reports and directives issued by CSAGI relative to the organization of the International Geophysical Year observations and researches, and sent to the various participating organizations, shall be given in English and in French, and the General Secretary is charged with their distribution.

5 Proposals for the Scientific Program

5.1 *Belgium*

5.1.1 *Observations photométriques et spectroscopiques de l'émission atmosphérique*

Il y aurait lieu d'étudier, à l'échelle mondiale, l'émission atmosphérique en effectuant des observations depuis le pôle jusqu'à l'équateur afin de pouvoir examiner en fonction des latitudes géographiques et géomagnétiques, les phénomènes auroraux, ceux du ciel nocturne et ceux du crépuscule. L'analyse des observations en particulier au voisinage de l'équateur, permettrait peut-être une investigation des effets de la distribution différente des équateurs magnétique et géographique. Il serait souhaitable que des observations spectrales crépusculaires et nocturnes des radiations de l'oxygène atomique, du sodium et des bandes moléculaires de OH et O_2 soient effectuées simultanément par les procédés photoélectriques et spectroscopiques dans les régions équatoriales.

5.1.2 *Observations solaires*

1. *Observations optiques.* Aux observations classiques des taches solaires, il y aurait lieu d'ajouter l'observation continue des phénomènes chromosphériques en lumière monochromatique $H\alpha$. En outre, il serait très utile de procéder à des observations quantitatives des phénomènes chromosphériques et coronaux.

2. *Observations radio-électriques.* Il est nécessaire de procéder à des observations continues dans une gamme de fréquences suffisamment large afin de couvrir tout le domaine chromosphérique et coronal. De plus, il y aurait grand intérêt à répartir les stations à la surface du Globe afin de posséder des observations pendant 24 heures.

En bref, l'ensemble des observations solaires doit donner l'image la plus complète de l'activité solaire.

3. *Observations cométaires.* Comme il existe des relations étroites entre l'activité solaire et les phénomènes cométaires, un effort pourrait être fait pour obtenir de bonnes observations photographiques, photométriques et spectroscopiques de comètes. La Commission 15 de l'Union Astronomique Internationale pourrait être chargée d'organiser le programme.

5.1.3 *Observations météorologiques*

Il est recommandé que des études de la structure de la troposphère (pression, température, humidité, vent, gradient du potentiel électrique) jusqu'à 30–35 km soient effectuées à l'aide de sondes très précises et de radars ou théodolites de grande précision. Il y a lieu d'appuyer les suggestions formulées dans le programme de l'O.M.M. pour l'Année Géophysique Internationale.

Il est recommandé que les sondages effectués au cours de l'Année Géophysique Internationale comportent un nombre important de mesures de gradient de potentiel par le dispositif Koenigsfeld-Piraux.

De même, il serait utile que des mesures continues du gradient soient effectuées (à certaines dates) à une hauteur fixe au moyen d'appareils attachés à un ballon captif.

5.1.4 *Troisième opération mondiale des longitudes*

Les recommandations relatives à l'exécution de la campagne d'observations adressées par Sir HAROLD SPENCER JONES au Professeur NØRDLUND devraient être adoptées.

Les recommandations suivantes sont encore soumises au Comité Spécial:

(1) Il y aurait lieu, dès à présent, pour les observatoires intéressés d'échanger des informations sur leurs méthodes d'observations et de réductions, sur leur manière d'enregistrer les signaux horaires et de mesurer les retards à l'enregistrement. Des suggestions précises pourraient ainsi être faites en temps utile aux Observatoires participant à la campagne (feuilles-types de réductions, etc.).

(2) L'observation simultanée en un même lieu, à plusieurs tubes zénithaux, suggérée par Sir HAROLD SPENCER JONES, pour déceler des erreurs systématiques éventuelles, devrait être étendue à d'autres types d'instruments de passage.

(3) Dans le cas d'observations aux grands instruments, difficilement retournables, il est suggéré de diviser les séances en deux parties, faites respectivement en position directe et en position inverse.

(4) Dans le cas d'observations visuelles, il faudrait envisager en cours de programme l'échange d'observateurs de pays voisins en vue de permettre l'étude des équations personnelles. Cette manière de faire serait particulièrement utile pour les observatoires ne disposant pas de machines à mesurer les équations personnelles.

(5) Pour améliorer la précision des observations, dans les stations secondaires non munies d'horloges à quartz, il serait souhaitable de voir augmenter le nombre d'émissions permanentes du type WWV, de manière à ce qu'elles soient accessibles 24 heures sur 24, dans toutes les régions du Globe.

(6) En ce qui concerne les méthodes de mesures des retards à l'enregistrement des signaux horaires, d'application délicate dans le cas des grandes ondes, il y aurait lieu de généraliser l'emploi d'un générateur hétérodyne à faible puissance dont le schéma détaillé serait mis à la disposition des différents Observatoires.

(7) Il y aurait lieu, conformément à la recommandation de la Commission 31 de l'Union Astronomique Internationale lors de l'Assemblée Générale de Rome en septembre 1952, d'envisager la création d'un Service de l'Heure de haute précision dans une région équatoriale.

5.2 *Finland*

The proposed scientific program for the International Geophysical Year has been discussed by a temporary Commission, and the following suggestions were made:

5.2.1 *Meteorology and aerology*

1. *Special radiosonde and wind observations for a better knowledge of the structure of the atmosphere and the flow pattern* (proposed by Prof. E. PALMÉN). In spite of the growing network of aerological stations, our knowledge of the mean structure and circulation of the atmosphere in the tropical belt and in the southern hemisphere is still rather fragmentary. An important task for the International Geophysical Year should be to establish a suitable number of additional aerological stations along selected meridians in the tropical zone and in the southern hemisphere in order to fill some of the gaps in the international aerological network. The meridians should be selected approximately along the belts 0–30° E, 120–150° E and 80°–60° W; thus it would be possible to utilize a large number of stations already existing on continents and islands. In addition to these meridional cross sections, the possibility of getting dense aerological data along the equator and the parallels 15° N and 30° N should be investigated. Due to the difficulty in using the geostrophic balance for computing winds in the tropical zone, strong emphasis must here be put on wind observations (with radar or radio direction finder). In the meridional cross sections the mutual distance between stations should not considerably exceed 300–400 km. At least in the northern hemisphere, such a spacing between the stations could relatively easily be obtained.

2. *Radiation measurements at the aerological stations.* (Proposed by Prof. M. FRANSSILA). The aerological observations proposed in the foregoing point should offer valuable material for the study of the general circulation. For the solution of the problem of the general circulation it would be important to know the radiation balance at the earth's surface. Therefore it is proposed that net radiation measurements in large quantities should be made on the meridional cross sections mentioned above. The radiation measurements could be made in most cases at the aerological stations, where suitable personnel are available. If the position of the aerological

station is not suitable, the radiation measurements could be made at a near-by situated meteorological station, where the environment is appropriate.

3. *Radiosonde and wind observations on board ships in regular traffic.* (Proposed by Prof. V. VÄISÄLA and Dr. L. A. VUORELA). In order to improve the knowledge of the structure of the atmosphere especially in the tropical regions, aerological observations should be made during the International Geophysical Year on board ships making regular ocean voyages. The possibility of organizing such observations in the Atlantic, Indian and Pacific Oceans should be investigated. Freighters with relatively low speed are particularly suitable for this purpose.

Finland could possibly arrange one ship station on board a freighter of the Finnish South American Line between England and Buenos Aires. Six cross sections of the atmosphere with about sixty soundings in each could be made during a year.

5.2.2 *Oceanography* (Proposed by Dr. G. GRANQVIST)

1. *Determinations of trace metals in the sea water.* The composition of river water is influenced by the regions from which it originates, and the matter it contains can be found in the sea it runs into. Among this material, the amounts of so-called trace metals (which are probably important for the sea as a production area) is almost unknown. The following proposals are suggested:

A methodical analysis of the sea water in the vicinity of larger river mouths should be made in order to determine the amount of trace metals within these areas. In this connection, samples should also be taken in order to obtain the overall composition of the sea water.

2. *Temperature conditions in the sea.* The temperature conditions in the sea are subject to general variations from year to year. From the biological, physical and climatological points of view, the water temperature is especially important in areas with low surface temperatures which vary considerably with the seasons. It would moreover be important for future research on fluctuations of long period, or periods of a continuous character in a definite direction to determine as exactly as possible the temperature conditions during a whole year. The following proposal is suggested:

During the IGY, special attention should be paid to the surface temperature of the sea, particularly within the cold areas.

3. *Observations of the* CO_2 *partial tension in the air and sea.* From the biological and meteorological points of view, the amount of CO_2 in the atmosphere and hydrosphere is very important. As the CO_2-balance between air and sea has been very sparingly studied at present, in spite of the fact that the method for the investigation of the problem is clear, the following proposal is suggested:

Within all sea areas systematic research should be carried out with simultaneous observations of the CO_2 partial tension in air and sea in order to establish the amount and direction of the CO_2 flux.

5.2.3 *Geodesy and gravimetry* (Proposed by Prof. U. PESONEN)

Gravimetry measurements at sea. Measurements should be carried out on as large a scale as possible with the aid of submarines, in order to investigate the consistence of the earth's crust and the shape of the geoid.

5.2.4 *Terrestrial magnetism and electricity* (Proposed by Dr. E. SUCKSDORFF).

1. *Geomagnetism.* It is recommended that all the La Cour quick-run recorders now available should be put in operation during the IGY and distributed in a suitable manner over the globe, so that accurate determinations of the times of various geomagnetic occurrences can be made, in connection with ionospheric observations.

For the general geomagnetic research work it is very desirable that the Greenland observatories Godthaab and Julianehaab should be reoccupied during the IGY.

2. *Earth currents.* It is proposed that earth current recording stations should be set up around the globe at several places free from artificial disturbing factors and with a homogeneous soil structure.

3. *Observations of auroral forms.* A systematic study of the auroral displays near the Auroral Zone during many years shows, according to the experiences obtained in Sodankylä, that the aurora appears chiefly in three various and distinct forms, namely as

(1) homogeneous quiet arcs,
(2) moving forms (with rays, occasionally with corona), and
(3) flaming.

As a result of these observations, it is suggested that the following points should be studied.

(a) Whether the above-mentioned classification of the auroral forms corresponds to the actual circumstances, and
(b) Whether a quiet auroral arc can appear also during wholly quiet magnetic conditions.

In addition, the following points should be studied:

(c) The diurnal variation of the occurrence of the different auroral forms.
(d) The direction of the flaming aurora and its change with the time of the day and of the year.
(e) When spectral or radiotechnical investigations of the auroras are carried out, account must be taken of the different types of the auroras in question, because their origin can be different.

5.3 *France*

(1) En ce qui concerne l'Année Géophysique Internationale proprement dite, le Comité Francais considère que l'étude de la haute atmosphère doit avoir la priorité. Dans cet esprit prenant pour base les propositions de la Commission Mixte de l'Ionosphère, il propose de leur ajouter l'étude spectroscopique et photoélectrique du ciel nocturne et crépusculaire et l'étude des parasites atmosphériques, considérés comme pouvant apporter des informations sur la propagation des ondes longues.

L'observation des pulsations, demandée par la Commission Mixte de l'Ionosphère, devrait être concertée internationalement; elle comporterait des enregistrements magnétiques et telluriques simultanés.

Les observations météorologiques classiques devraient être développées seulement dans la mesure où elles seraient indispensables au dépouillement des expériences concernant les couches supérieures, parmi lesquelles le comité français juge particulièrement intéressants les sondages acoustiques de la "thermosphère". Ni la climatologie, ni l'actinométrie ne devraient être l'objet de recommandations internationales, étant bien entendu que tous les pays restent libres de les inclure dans leurs projets.

Enfin les recommandations de l'UGGI (Bruxelles 1951) concernant les jours internationaux devront être appliquées strictement.

Une dernière remarque s'adresse aux pays qui entreprendraient au cours de l'AGI une expédition magnétique dans des régions écartées; il serait bon de leur recommander la visite de toutes les stations de la région, où des mesures magnétiques auraient déjà été faites antérieurement, afin d'y déterminer la variation séculaire.

(2) En ce qui concerne les Opérations de Longitudes, les voeux du Comité National Français de l'Année Géophysique Internationale sont les suivants:

(1) Les observations devront se référer à un même et unique catalogue fondamental.

(2) Il paraît souhaitable de distinguer deux sortes de stations participant à l'opération: les stations de premier ordre, formant un réseau principal, seraient, en assez petit nombre, celles qui sont particulièrement bien équipées pour les mesures horaires, qui possèdent un personnel entraîné, c'est-à-dire pratiquement les stations qui ont un service horaire développé et permanent.

Les stations de deuxième ordre, plus ou moins bien équipées ou provisoirement établies pour l'occasion et désirant profiter des opérations pour se rattacher au réseau fondamental seraient considérées à part.

Seules les premières entreraient dans une discussion générale dont la conduite devrait être confiée à un organisme unique centralisateur.

(3) Il serait souhaitable que des observations de latitude soient poursuivies en même temps que les mesures horaires, en vue notamment de suivre le mouvement de Pôle pendant la durée des observations.

(4) La durée de propagation des signaux horaires devrait être mesurée avec toute la précision possible : on suggère l'organisation de nombreuses liaisons en duplex, rattachées aux stations de premier ordre.

(5) En vue d'améliorer les résultats du programme prévu au paragraphe 3, on insiste sur l'importance de l'établissement de stations dans l'hémisphère sud particulièrement démuni d'observatoires.

5.4 *India*

5.4.1 *Ionosphere*

(1) A program of high-power pulse transmissions in the short-wave band from some of the broadcasting centers in the participating countries. (Observations of such pulses at the ionospheric stations will add greatly to our knowledge of the oblique modes of transmission, and also of ionospheric characteristics.)

(2) Studies on scattering of very high-frequency radio waves with special reference to propagation.

(3) Study of the upper part of the F region with the help of galactic radiation.

(4) Collection of data on sporadic *E* echoes, which will be available from the routine records of ionospheric stations.
(5) Study of ionospheric absorption.
(6) An extensive study of the airglow spectrum, particularly of the OH-bands is suggested. It is suggested that during the International Geophysical Year, a special effort may be made to distribute ozone stations between 15° N and 40° N with a view to study the changes in subtropical transition regions where the tropical tropopause changes into temperate latitude tropopause. It would be desirable to have ozone stations both on the western and eastern sides of one of the major permanent anticyclones.

5.4.2 *Need for more extensive observations of stratospheric wind, and temperature observations in tropical regions. High-level humidity observations in sub-tropics.*

Meteorological organizations of countries should be requested to establish an open network of stations where regular upper wind and temperature data are obtained daily up to at least 20 km (or 50 mb). It will be very valuable if such stations can be established two or more years before the International Geophysical Year. Countries in subtropical regions may be requested to acquire and instal a few such instruments in high-flying aeroplanes for obtaining data of atmospheric humidity over the semi-permanent anticyclones.

5.4.3 *Proposal for a world-wide study of the variations of cosmic-ray intensity* (by Dr. V. SARABHAI)

(1) Organization, through international co-operation, of a world-wide study of the variations of cosmic-ray intensity could promote an understanding of two types of problems. They refer to:

(a) The anisotropy of the primary particles. This requires a study of the daily variation of directional cosmic-ray intensity at various latitudes and at different elevations above sea level. Valuable information concerning the origin of cosmic radiation is likely to result from such a study.

(b) The solar and terrestrial relationships of cosmic rays in comparison with ionospheric disturbances, aurora polaris, geomagnetic disturbances and high-frequency radio noise. This requires a study of non-periodic world-wide changes of short duration as well as the long-term changes in the nature of the daily variation produced in cosmic-ray intensity.

(2) The main studies made in recent times with comparable apparatus at more than one station are:

(a) The Carnegie Institution (LANGE and FORBUSH 1948) studies at:

Huancayo (12° S, 75° W,	Geomagn. Lat. 1° S, 3350 m)
Cheltenham (39° S, 77° W	,, ,, 50° N, sea level)
Christchurch (43° S, 173° E	,, ,, 49° S, ,, ,,)
Godhavn (69° N, 53° W	,, ,, 80° N, ,, ,,).

The ionization chambers of standard design have been in almost continuous operation at all these stations since 1938. Very valuable data have been collected. While the apparatus is sensitive in detecting changes in general cosmic-ray intensity such as are associated with magnetic disturbances and the occurrence of some solar flares, it is not very suitable for measurement of the daily variation, from which the anisotropy of the primaries and its changes can be inferred. The stations operated by the Carnegie Institution are not distributed over the world in any regular way but give a preponderance to the western hemisphere.

(b) The studies of SIMPSON *et al* (1952) with neutron monitors at Climax (39° N, 106° W, Geomagnetic Latitude 48° N, 3500 m), Chicago, Sacramento and Peak (N.M.).

SIMPSON has shown that the neutron intensity is a very sensitive index of changes in intensity of primary cosmic rays. Very valuable data concerning solar and terrestrial relationships can therefore be gained. However, the neutron monitor being essentially an omni-directional detector of radiation suffers from the same disadvantages as an ionization chamber for studying the anisotropy of primaries. All stations operated by SIMPSON lie exclusively in the western hemisphere.

(c) The studies of SARABHAI *et al.* (1953a, 1953b) at:

Ahmedabad	(23°·5 N, 72°·5 W	Geomagn. Lat.	13° N, 50 m)
Kodaikanal	(10°·2 N, 77°·5 W	,, ,,	1° N, 2340 m)
Trivandrum	(8°·5 N, 77°·0 W	,, ,,	1° N, sea level).

In these, the apparatus consists of geiger-counter telescopes of limited solid angle. Results collected over the last two years at Ahmedabad and Kodaikanal have elucidated some of the meteorological and extra-terrestrial causes of the daily variation of meson intensity. This has permitted the barometric pressure corrected meson variation to be ascribed to continuous solar emission of cosmic rays. World-wide changes in the amplitude and hour of maximum of the diurnal component of the daily variation of meson intensity have been reported by this group. The diurnal variation is therefore a sensitive index of changes in the anisotropic component of the primary cosmic radiation. Experiments at the Physical Research Laboratory have also revealed that by improving the geometry of telescopes, within limits, the increase in the amplitude of the variation can more than compensate the loss of statistics due to a lower counting rate. The studies conducted by the Physical Research Laboratory are confined exclusively to India.

(3) Reviewing the work mentioned under (2) (a), (b) and (c) in terms of the objectives stated under (1) (a) and (b), it would appear that future studies should be planned on the following basis:

(a) For a study of the anisotropic component of cosmic radiation as well as the location of its origin in the sun and the galaxy, work requires to be done with narrow angle counter telescopes at stations covering a wide range of latitudes. A range of longitudes is not important for this purpose. The directional studies should include not only the vertical but the east, west, north and south directions (ALFVÉN and MALMFORS 1943; ELLIOT and DOLBEAR 1950). The experimental set-up would be moderately complicated and it would be difficult to set up many stations for this work. Latitudes 0°–30° N could be covered satisfactorily in India with two high-level (Kodaikanal and the Northwest Himalayas) and two low-level stations (Ahmedabad and Trivandrum). Latitudes 30° N–50° N could be covered satisfactorily in the United States, and the work can perhaps be taken over by the Chicago group. Latitudes 50° N to 80° N could be covered in Europe by the Manchester and the

Stockholm groups. Latitudes 20° S–50° S could be covered by the Australians in collaboration with the New Zealand scientists. It would be useful to thus have stations separated by 15°–20° of latitude from 50° S–70° N or 80° N.

(b) For a study of solar and terrestrial relationships, it is necessary to cover a wide range of latitudes as well as longitudes. The apparatus should thus be less complicated and be more rugged than that designed for 3 (a) above. The apparatus could consist of a neutron monitor, of the type developed by SIMPSON, working alongside duplicate vertical triple coincidence geiger-counter telescopes of moderate solid angle. It would be advantageous to locate these units at stations where there are ionospheric units operating. One could thus ensure availability of electricity and facilities for supervision and servicing by men trained in electronics. It would be desirable to have a group of two stations for about every 90° of longitude. Equatorial and high latitudes would be more interesting than intermediate latitudes from 30°–60°. Tentatively the organization of stations along the Greenwich meridian could be undertaken by the Manchester group, at 80° E by the Physical Research Laboratory group at Ahmedabad, at 140° to 180° E by the Japanese and Australian groups, and at 90° W by the Chicago or the Carnegie groups. It would be advantageous to include the four Carnegie Institution stations where cosmic-ray data is available for almost 15 years.

5.5 *Japan*

(1) It is desirable that the Special Committee of the International Geophysica Year provisionally decide as soon as possible on an ideal plan concerning the principal forms of observation to be undertaken and their distribution over the world, in order to permit all the adhering organizations to set up their budgets to cover the cost of preliminary work that would be incurred during the fiscal year 1953–54.

(2) In view of the experience gained during the Second Polar Year, it would be desirable that:

(a) The level and scope of activities of the Special Committee for the IGY be raised and extended as compared to that of the previous organization, and that it maintain close and continuous connection with all adhering national committees throughout the three periods of preparation, observation and arrangement of results.

(b) The Special Committee be permitted to determine the standard scales of accuracy for various kinds of observation (also with respect to latitude if necessary), and request every observatory to make efforts to aim at attaining standards as close as possible to these scales. The need for this is emphasized in respect to accuracy in the observations and the timing of the magnetographs and the specifications for the instruments used in ionosphere observations.

(c) Stations for geomagnetic and ionospheric observations be set up in greater numbers also in the intermediate regions of the Asiatic, African and South American Continents, apart from those destined to be established in the polar and equatorial areas.

(3) In addition to the objectives proposed by the Joint Commission of the Ionosphere, we should like to propose that the following observations be undertaken, to be carried out on a world-wide scale:

(a) Night sky light (with common wave-lengths).
(b) Solar and terrestrial radiations in the troposphere.
(c) Solar radio waves (with common frequencies).

(4) The undertaking of a world-wide magnetic survey over both land and ocean is strongly recommended.

(5) Japan owns no territory within the polar and equatorial regions. If required, we might consider the organization of an expedition to islands across the magnetic equator in the Pacific Ocean during the Third International Year to carry out measurements on geomagnetism, observations on the ionosphere and other related surveys.

(6) The Japanese National Committee suggests the addition of the following program of observations, to be carried out with appropriate international co-ordination:

(a) For radio observations:
  (i) continuous observation of the critical frequency and minimum virtual height of the ionosphere by several selected stations;
  (ii) continuous observations of the field intensity of HF and VHF radio-waves through selected circuits so distributed as to cover the whole globe;
  (iii) systematic observation of atmospherics with appropriate international co-ordination;
(b) For magnetic work, magnetic surveys on land and sea.
(c) For auroral observations:
  recording of the intensity change of a few selected lines of the night sky.
(d) For tropospheric observation:
  observation of solar and nocturnal radiation.
(e) For solar observation:
  continuous observation, with appropriate networks, of solar radio waves at various frequencies.

(7) Based on the experience of the International Polar Year 1932–1933 the Japanese National Committee has its attention drawn to the following points:

(a) For magnetic work:
  (i) Error in time-keeping for the ordinary magnetograms to be of necessity less than one minute.
  (ii) Network of magnetic observation stations to be set up at distances in so far as practicable, roughly every 30° from each other with respect to longitude on the continents and on the islands in the middle and lower latitudes.
(b) For ionospheric work:
  (i) Desirability of the use to the widest possible extent by ionospheric stations of automatic observing equipment, mentioned in the resolution of the 1948 Plenary Assembly of CCIR, and of holding under 1 min the

deviation of the starting point of each measurement from the observation time assigned in the proposed schedule.

(ii) Desirability of having the ionospheric stations distributed in so far as practicable throughout the continents and islands in the middle and lower latitudes.

(iii) Designating 30 min or some shorter interval as the standard time between succeeding observations of the ionosphere.

(c) For meteorological work:

Advisability of having the upper air observation stations distributed as uniformly as possible, to cover the whole globe.

(d) For cosmic-ray work:

Desirability of making continuous observations of cosmic-ray intensity, at least, at several stations distributed nearly uniformly along a latitude circle in the middle or lower latitudes.

(8) The Japanese National Committee is specially interested in systematic observations of magnetic and ionospheric variations along the magnetic equator, and hopes that some appropriate scheme for this particular purpose might be planned to be carried out under international agreement.

5.6 *Netherlands*

1. *Cosmic radiation.* It is felt desirable to combine cosmic radiation measurements with aerological observations in order to obtain data both at great altitude and at high latitude. It is recommended that measurements by means of ionization chambers are made.

2. *Solar radio noise.* Routine measurements of solar radio noise are desirable, specially with a view to the localization of active regions on the sun. Our country will be glad to co-operate in such a program.

5.7 *Norway*

5.7.1 *Meteorology*

(1) The Committee proposes that a net of aerological stations shall be organized and maintained along the line of longitude: Gardermoen—Ostersund—Tromsö—Bear Island—Spitzbergen. Of these stations, the two Arctic stations Bear Island and Spitzbergen must be erected especially for the IGY.

(2) The two stations Tromsö and Jan Mayen ought to be supplied with instrumental equipments for determination of *wind* by *radar methods.* It is also desirable that other stations in the Arctic region should be supplied with similar equipment.

5.7.2 *Physics of the upper atmosphere*

Two ozone measurement stations will be maintained in Norway: Tromsö, and a second station in Southern Norway. Dobson spectrographs (photoelectric) will be used. We will, however, stress the importance of similar measurements being made at other Arctic stations: Jan Mayen, Spitzbergen and Greenland.

5.8 *Pakistan*

Suggestions are made that the following problems be included in the program:

(1) Establishment of similarities and differences of continental layers in the seismic areas of the world.
(2) Solution of the problems connected with the onset of the shear phases.
(3) Solution of the multiple compressional phases.
(4) Mapping of major dynamic faults.
(5) Determination of focal depths more accurately.

5.9 *Spain*

Nous nous permettons de vous faire quelques suggestions de peu d'importance, mais qui, de notre avis, ne manqueraient pas d'intérêt:

(1) Il est à souhaiter que les observations systématiques des baies magnétiques et des pulsations ne se limitent pas aux composantes H et Z, mais qu'elles soient étendues aux trois composantes magnétiques et s'il est possible aux courants telluriques et aux observations ionosphériques.

(2) Il est aussi à souhaiter que, dans les données des baies magnétiques, on ne se limite pas à celles à commencement brusque, mais qu'on donne les données de toutes et dans tous les observatoires. Pour les dénommer facilement on pourrait peut-être employer la nomenclature proposée au Mémoire n° 10 de l'Observatoire de l'Ebre "Balnas Geomagnéticas" de J. M. PRINCEP.

(3) Il est aussi à souhaiter que les Observatoires, soit définitifs, soit temporaires, que l'on organise à l'occasion de l'Année Géophysique Internationale, soient installés dans les régions dépourvues d'observatoires, à variation séculaire irrégulière ou rapide, surtout de l'hémisphère sud (Afrique et Amérique Latine).

5.10 *Sweden*

The Swedish suggestions are described in the following memoranda, which cover the subjects of Meteorology, Oceanography and Physical Geography, Ionosphere, Gravity, Geomagnetism, Aurora, Cosmic Radiation and Radio Noise. The Swedish National Commission will attempt to establish contact with corresponding committees in neighboring countries to explore the possibilities of common projects on a regional base.

5.10.1 *Meteorology, oceanography and physical geography* (Edited by Dr. B. BOLIN, Stockholm)

The following proposals have been made:

1. *The geophysical cycle of various substances as they are transported through the atmosphere, the oceans, the soil of the earth, lakes and rivers.* In very few cases this problem has been discussed from such a general viewpoint and it is very likely that a large amount of new information might be obtained if a real co-operation between scientists in various fields of geophysics could be established. It is interesting to notice that all proposers have included one or several investigations that have a bearing upon this problem. We shall here list these various investigations:

(1) *Certain aspects of the geochemistry of the hydrosphere and the atmosphere.* (Proposed by Dr. O. ARRHENIUS, Grödinge and Professor C. G. ROSSBY, Stockholm).

The geochemistry of the soil is fairly well known, while few studies have been made of the hydrosphere and the atmosphere. Similarly, we know more about the chemistry of the oceans than of the rivers and lakes.

For a study of the budget of various chemicals we need a considerably better knowledge of the chemical composition of the atmosphere. It is of special interest to know the content of the so-called cyclic substances (i.e. Cl, NO_3 and NH_4) and to see whether they really go through a complete cycle, or if losses occur in some stages of this cycle. Furthermore, a better knowledge of the geophysical importance of various biochemical processes is needed (nitrogen, phosphorus).

The following proposals are made:

(a) *During one year regular observations should be made of the chemical composition of the water in the rivers all over the world. These samples should be sent to certain central laboratories, where analysis should be made. In particular the content of* NO_3, NH_4, NO_2, Cl, P *should be determined. It would be of special value to obtain such determinations from Russia, Asia and Africa, where very few observations have been made.*

(b) *Regular observations of the chemical composition of rain-water. Again, the analysis should be made at certain central laboratories.*

(c) *Chemical composition of impurities of the air and in particular the vertical gradient of these substances.*

The samples under (a) and (b) might be taken at some of the best ordinary meteorological and hydrological stations, while (c) probably could only be investigated at observatories and by expeditions.

(2) *Investigation of the amount and composition of dust in the precipitation reaching the ocean surface.* (Proposed by Professor H. PETTERSSON, Göteborg and Professor H. KÖHLER, Uppsala.)

It is of great interest to know the contributions from the atmosphere to the sedimentation on the deep ocean beds. It is possible that some cosmic dust also is brought into the oceans with the precipitation, which might explain the relatively high content of nickel that recently has been found in those sediments that have been deposited most slowly. Recent investigations in U.S.A. seem to indicate that the amount of dust brought into the atmosphere by meteors is many times larger than was believed earlier. *It is proposed that regular observations of the content of dust in the precipitation be carried out at selected places all over the world both in high and low latitudes. It would be of particular interest if the terrestrial and extra-terrestrial components could be determined separately.*

(3) *Visual observations of dust in the atmosphere.* (Proposed by Professor T. BERGERON, Uppsala.)

At certain selected stations the amount of dust in the atmosphere should be determined visually through a careful determination of the visibility (both the range of sight of the contors and the details of certain objects). Determinations with the aid of some aspiration method should be made where it is possible. Thus we might obtain a better knowledge of the content and transport of lithospheric dust in the atmosphere.

(4) *Determination of the content of impurities in the atmosphere by actinometric measurements.* (Proposed by Dr. A. ÅNGSTRÖM, Stockholm.)

A detailed account of these measurements is given in 2.

(5) *Measurements of the transport of sediments in rivers.* (Proposed by Professor F. HJULSTRÖM, Uppsala.)

It has recently been shown that the drainage of the soil is very different in different climatic and geological regions. Thus an investigation from the area around Paris proves that practically all water that does not evaporate reaches the rivers as underground water. It is quite clear that the erosion of the soil to a large extent depends upon how the drainage takes place. Thus it has been shown (HARZ) that the erosion is considerable, even if only a few per cent of the precipitation reaches the rivers along the surface of the earth.

We know very little about the drainage and erosion at present. *It is therefore proposed that the transport of sediments with the rivers be determined during one year in different geological and climatic regions. It would be of great interest to try to obtain a regional description of the erosion.*

2. *Actinometric measurements.* (Proposed by Dr. A. ÅNGSTRÖM, Stockholm.) *It is proposed that actinometric measurements should be carried out during the IGY* 1957–58 *to a larger extent than has been made previously. This should be done in accordance with the recommendations from WMO.*

It would be of great interest to study the outgoing radiation more closely. *It is proposed that such measurements in particular should be carried out at stations where regular radiosonde observations are made, in order to have simultaneous observations of temperature and humidity conditions.*

It is finally requested that the various countries propose at which stations regular actinometry measurements should be made.

3. *The physics of clouds and precipitation.*

(1) *A regional investigation of the appearance of sea salt in the atmosphere.* (Proposed by Professor H. KÖHLER, Uppsala.)

Details of this investigation will be given later. It should merely be stressed here that it would be of great importance to determine the content of sea salt at different levels above sea-level. Electron-microscope observations should be made when it is possible.

(2) *A regional determination of cloud forms.* (Proposed by Professor H. KÖHLER, Uppsala.)

This investigation should be carried out at selected weather stations. The observations should include a short description of the clouds and in particular whether the boundaries are sharp or diffuse, as well as how the sun and moon appear behind the clouds. These observations are of great importance for our knowledge of the character of the clouds and the cloud particles.

(3) *Observations of clouds and precipitation over the whole world according to more definite principles than at present.* (Proposed by Professor T. BERGERON, Uppsala.)

It is suggested that the Special Committee for the International Geophysical Year contacts the subcommission in WMO, which is dealing with these problems.

4. *Observations of electrical discharges.* (Proposed by Professor T. BERGERON, Uppsala.) *It is proposed that regular acoustic-optic observations of electrical discharges (thunder, lightning strokes, St. Elmo fire, etc.) be made on a global scale.* It is important to select representative stations on islands and ships. In this way, we might get a better knowledge of the regional distribution of these phenomena as well as the variations during the day and the year.

5. *Special radiosonde observations for a better knowledge of the structure of the flow pattern in the atmosphere.* (Proposed by Dr. B. BOLIN, Stockholm.) *It is proposed to try to establish observations along one meridian over Europe from, for example, Spitzbergen to Central Africa along long.* 10° *E. These observations should be made at* 6 *hr intervals, the stations should not be separated by more than* 300–400 *km and observations should include pressure, temperature, humidity and wind.* From a dynamic point of view it would be still more desirable if observations could be made along two such lines parallel to each other and 500–1000 km apart. In that way both time and space derivatives might be obtained.

5.10.2 *Ionosphere and radio-wave propagation* (Proposed by Professor O. E. H. RYDBECK, Göteborg)

1. *Systematic studies of "polar blackouts" using high-power, fast multi-frequency or panoramic methods.*

A chain of class A stations should co-operate by continuous measurements, preferably in the auroral zone. It is very important that the stations suggested operate with high power, if possible 200 kW pulse, with highest possible received sensitivity, and with separate recording CR-tubes for the upper and for the lower ionosphere. The echo-sensitivity of the various stations should also be almost the same so that individual recording can always be compared. Low-power, unsensitive equipment will not be adequate. With such equipment, one runs the risk of classifying moderate increase in ionospheric absorption as blackouts.

Preferably, co-operation should be arranged with stations operating in the southern auroral zone in order to find out whether polar blackouts occur simultaneously in the two zones or not.

Standard polar blackout studies should make use of vertical incidence recording. However, if long-base recordings could be maintained at the same time, for example, through the auroral zone from Kiruna to Iceland, no doubt very interesting and valuable material could be collected.

All co-operating ionospheric stations ought to remain at least in weekly contact during the IGY.

2. *Systematic studies of radio-wave back scatter from the aurora.*

Such studies preferably are undertaken with recording systems using a sufficiently short wavelength, about 9 m or less, with a rotating antenna having a sufficiently narrow beam. It would be extremely interesting to study long-distance auroral back scatter. These measurements should be made with equipment using receiver input stages with minimum noise factor, so that the recorded noise background would be cosmic noise.

The measurements referred to should, like the regular ionospheric measurements, be organized in close contact with the auroral research.

3. *Regular recording, if it can be arranged, of radio noise from auroral displays.*

4. *Systematic studies, if they can be organized, of the nature and frequency of ionospheric triple split phenomena as functions of the geomagnetic latitude.*

5.10.3 *Other measurements*

1. *Gravity measurements at sea.* (Proposed by Professor L. ASPLUND, Stockholm.) With rapidly working gravity meters now available for land use, it has been possible to perform gravity measurements on land in a short time and with great density. A great number of nations have started and in several cases already completed gravity measurements of their countries. In Sweden, more than 2000 gravity stations have been occupied during the years 1941–48, uniformly spread out over the country except for some mountain regions.

To make full use of the results of these measurements for geodetic purposes, it is necessary to know the main character of the gravity field over an extended surrounding area. In Scandinavia, difficulties arise because of the surrounding water, where gravity measurements still are lacking. Even a sparse measurement of the gravity at sea in these areas would be of great value in this respect.

On the whole, gravity measurements at sea have, up till now, been performed only to a very limited extent. It seems natural that measurements of this kind should be carried out by international co-operation, and it ought to be possible and desirable to carry through a certain program in this respect during the IGY. It might be convenient to plan such undertakings regionally, and the waters surrounding the Scandinavian peninsula might be treated as one region.

Gravity measurements at sea have hitherto been carried out mainly by special pendulum apparatus in submarines. However, some new constructions designed for measurements from the surface of the sea are being considered, and if successful, they may facilitate the work considerably. It may, therefore, not be advisable to make too detailed plans now for gravity measurements at sea during the IGY. The development in this field during the next 2–3 years will be decisive for the methods to be used and the arrangements to be made.

2. *Geomagnetic measurements.* (Proposed by Dr. N. AMBOLT, Stockholm.) Measurements should be carried out at stations which have already been selected for the study of secular variations.

3. *Aurora observations.* (Proposed by Dr. N. HERLOFSON, Stockholm.) At the present stage in auroral theory, there is little hope of interpreting in detail the spectacular curtains and rays observed during great aurora displays, but it seems likely that useful information can be gained from a study of the position and direction of quiet aurora arcs during minor disturbances. Observations made during the First Polar Year (CARLHEIM-GYLLENSKIÖLD 1886) indicate that the polar distance of

quiet arcs varies in a systematic way during the night. Considered on a planetary scale, this variation is consistent with the view that the auroral zone is eccentric and remains in a fixed orientation relative to the direction towards the sun. Similar effects also appear in geomagnetic data (ALFVÉN 1950).

The range of the displacement is of the order of 500 kilometers measured along the meridian, and the position of arcs should therefore be studied along several sections spaced at intervals along the auroral zones. One section might go from Isfjord on Svalbard, via Hopen and Björnöya to Tromsö or Kiruna. A second section might include Scoresbysund and Angmagsalik on Greenland and Isafjördur and Reykjavik on Iceland. A third section might follow the west coast of Greenland preferably right up to the geomagnetic pole near Thule. Further sections might be placed north of the American continent, and at Franz Joseph's Land. A section across the auroral zone at about 160° E would be of great interest in order to complete the survey of the auroral zone.

If it is desirable, the Swedish National Committee will consider undertaking the reduction and working up of observations of the position and direction of auroral arcs on a planetary scale.

For a comparison with auroral theory, a possible correlation between auroras in the northern and southern auroral zones should be investigated by simultaneous observations from stations located on, or near, the end points of the same geomagnetic field line. When more is known about the location of observing stations during the IGY, it will be necessary to compute the periods during which both ends of the same field line are in darkness at the same time.

4. *Cosmic radiation.* (Proposed by Professor H. ALFVÉN, Stockholm.) Measurements of the fluctuations in cosmic radiation are important not only for the theory of the origin of cosmic radiation but also because of their connection with geomagnetic phenomena such as magnetic storms and auroras.

Two different types of variations are especially interesting:

(1) The diurnal variation.

(2) The magnetic storm variation.

Although measurements of the integrated cosmic radiation are not without interest, it is particularly important to measure the variation of cosmic rays of specified energy arriving within a specified solid angle.

It is therefore recommended that measurements should be made with coincidence counters situated at selected latitudes and longitudes and directed towards selected parts of the sky. A standardization of the apparatus, especially of the solid angle, is highly desirable. There is a possibility that the scintillation counters will soon be so developed that such counters should be preferred to Geiger-Müller counters. Corrections for the deflection of cosmic rays in the geomagnetic field have been calculated by an analog computing machine (scale model experiment) by BRUNBERG, and corrections of this kind can be supplied for all registrations made on an international basis.

5. *Lightning discharges in Arctic regions.* (Proposed by Professor H. NORINDER, Uppsala.) The electromagnetic field of individual atmospherics, originating in Arctic

regions, should be investigated by cathode-ray oscillographs. The technique is described in a paper by H. Norinder (1949).

5.11 *Switzerland*

1. *Radiométéorologie.* Le développement du réseau radiométéorologique mondial en voie de réalisation par l'OMM et intéressant très vivement l'OACI et le CCIR, devrait être sérieusement pris en considération dans le programme général de l'Année Géophysique Internationale.

A cette fin, le Comité Suisse propose de collaborer activement à l'établissement d'une station radiométéorologique polaire très élevée en latitude, qui pourrait être établie en commun par plusieurs états.

Il faut remarquer que l'enregistrement des parasites atmosphériques dans les régions polaires, vu les expériences faites pendant l'Année Polaire 1932–1933, peut par les longs effets crépusculaires à l'entrée et à la sortie de la nuit polaire, contribuer grandement à nos connaissances des couches D et E de l'ionosphère.

2. *Rayons cosmiques, tritium.* Co-ordination internationale des mesures de rayons cosmiques effectuées dans plusieurs pays et ayant pour objet la dépendance entre l'activité solaire et les rayons cosmiques.

Mesurer en différents points de la terre le contenu de tritium dans l'atmosphère et l'hydrosphère, ceci permettant de tirer d'importantes conclusions sur le cycle de l'eau.

3. *Date de l'Année Géophysique Internationale.* Vu que le maximum d'activité solaire se produira probablement une année après l'AGI 1957–1958, le Comité Suisse suggère que l'on renvoie la date de l'AGI à 1958–1959.

4. *Dépouillement des observations et publication.* Les expériences des deux Années Polaires Internationales précédentes ont montré qu'une quantité considérable de publications ou même des observations non publiées ne purent produire tout leur effet, vu le manque de synthèse ou de co-ordination dans la recherche de solution à des problèmes scientifiques impliquant un travail de cabinet purement international.

L'attention devrait être attirée sur la nécessité de définir par avance un nombre restreint de problèmes avec précision, attendu que chaque participant cherchera à apporter sa contribution expérimentale individuelle aux dits problèmes. Cela sera fait par la procédure ordinaire des recommandations.

Avant même d'aborder un problème et de mettre en marche l'immense appareil mondial des mesures ou d'expériences, qu'il nécessite, il faudrait désigner un ou un groupe de savants responsables pour collationner, dépouiller et élaborer le matériel recueilli.

Ce "rapporteur général", dont le nom devra être en vue, sera connu de tous les intéressés d'avance. Il devrait connaître les facilités financières et de personnel qui lui seront accordées à la fin de l'Année Géophysique pour rédiger l'Acte Final concernant le problème posé.

Il est évident que toute latitude sera laissée à chaque opérateur pour le dépouillement individuel, expérimental et théorique. Nonobstant, ces publications individuelles devraient faire l'objet d'une synthèse qui n'aura pas seulement un caractère bibliographique, mais un caractère théorique ou même la forme d'une critique fixant objectivement des états de faits reconnus par l'expérience.

5.12 *United Kingdom*

The following recommendations are made by the United Kingdom National Committee for the International Geophysical Year:

5.12.1 *Meteorology*

That observations be made with the object of obtaining a more complete knowledge of the general circulation of the atmosphere over the globe at all levels and throughout the year. This could be done by radiosonde or rawind observations at a number of upper air stations and supplemented by measurement of frost-point up to the 15 km level at airfields and by ozone observations. It is proposed that observations be made along three meridional cross-sections (or four with USSR co-operation), viz., along lines running from Spitzbergen to Cape Town, from N. Canada to Falkland Islands, from Japan to Macquarie Island, and through USSR between longitudes 70° and 80° E from the far north to the equator. The sites of stations to supplement the existing permanent stations would have to be determined largely by the places where facilities could be organized, and might include weather ships or passenger boats on regular routes or whaling ships. Should it not be possible to achieve the above program in its entirety, it is strongly recommended that observations be concentrated in the tropical belt where information is particularly needed. The observational program should aim at: (a) a minimum of two observations of wind and also of temperature and humidity daily at each station to at least 15 km, with ascents (say) twice a week to 30 km on pre-selected "international" days, (b) a series of observations of frost-point to 15 km at any available airfields once or twice a week, (c) daily ozone observations at a series of stations on one at least of the meridional sections.

1. *Subsidiary program in meteorology.* The following meteorological observations are suggested as particularly appropriate to an International Geophysical Year and would offer scope to those countries unable to participate in the main program outlined above. They are essentially subsidiary, in specialized effort and capital cost, to a major investigation such as the determination of rather complete meridional sections of wind and temperature:

(1) *The measurement of precipitation at sea by "reporting" and "weather" ships.* Precipitation on land may be very unrepresentative of the true global pattern on account of topography and differential heating. Yet the global pattern must be determined in order to appraise the energy and water-vapor transfer problems of the general circulation. This is also important in oceanography. Observations of precipitation at sea to an accuracy of 10 per cent would be very acceptable and should be possible without serious technical complication. The International Geophysical Year might well be the spur to the realization of a "network" of observations which could be specially valuable in association with an augmented program of observations of upper winds, temperatures and humidities in 1957–58. Once realized, the network would naturally continue beyond the International Geophysical Year itself.

(2) *Temperatures (heights) of tops of precipitation in Cumulus (Cu) clouds.* Stations might be selected to provide information, on a global basis, on the relative frequency of precipitation from Cu clouds whose tops are above or below the 0° C level. Heights of cloud tops could be estimated, or theodolite observations taken. Radiosonde stations and ships at sea are particularly appropriate.

(3) *Synoptic maps of clouds.* All aircraft operating within a given area of some size (e.g. Europe) might be asked to make detailed observations on clouds by flight-path sections, etc. on pre-selected "international" days. Large-scale synoptic maps of cloud systems and their sequences could thereby be achieved.

(4) *Characteristics of thunderclouds.* A world-wide survey (supplementary to (2) above) of the temperatures (heights) of thundercloud bases and tops would provide information of value for practical and theoretical purposes. Radar stations observing the heights of echo tops would be appropriately incorporated.

5.12.2 *Observations of auroras*

(1) That visual observations of auroras should be made over as wide an area as possible—ideally so that the survey becomes completely circumpolar and transpolar—and that the co-operation of civil air lines, ocean-going vessels and weather-ships be sought; in addition that suitably situated countries might co-operate in organizing a network of voluntary observers as well as by requesting their professional meteorological observers to record auroras at each night-observing hour. Observations on appearance of the hydrogen lines in auroras would be useful and might reveal whether or not the lines showed up simultaneously over the two auroral zones.

(2) That spectrographic and photometric work on the auroras should be undertaken particularly in the regions where auroras occur fairly often, and that astronomers be urged to prepare to use their equipment for the same purposes on occasions when the aurora is seen outside its usual latitudes.

(3) *Night study of airglow*: That a number of observatories, including at least one in the southern hemisphere, should study the temporal variations of the main spectral features of the airglow and the movements of patchiness. Accurate determinations (from the rotational structure of the bands) would be especially valuable if carried out at various stations.

(4) *Radio observations of auroras*: That a world-wide coverage of radio observations on auroras be attempted by creating a ring of observing stations, placed within the optimum belt of geomagnetic co-latitude 29° to 32°. Ideally, a similar ring of observation stations should be established in the southern hemisphere. Three methods of investigation are recommended, i.e. (i) the radio echo technique in which the reflection or scattering of radio waves from auroral formations is observed, (ii) techniques involving the reception of radio waves from the radio stars, with particular reference to the effect of auroras on the scintillation of the radio stars, (iii) observation of radio noise emitted by the auroras.

5.12.3 *Radio observations*

1. *Observations on the ionosphere and its characteristics by radio methods*
   (a) That ordinary routine observations and records at ionospheric observatories should be speeded up on World Days to quarter-hour intervals if

possible, or at least half-hourly, during the International Geophysical Year.

(b) That during the International Geophysical Year, special attention be given, in daily routine recording, to characteristics of the *E* region: and that, if possible, there should be continuous *h′t* recording on a frequency in the neighborhood of 2·5 Mc/s.

(c) That all ionospheric observatories should do everything in their power between now and the International Geophysical Year to improve their records of observations with a view to facilitating analysis.

(d) That the study of ionospheric characteristics at oblique incidence by back scatter technique, whose development was expected to continue, should be used to supplement other information gained during the International Geophysical Year.

(e) It is hoped to submit before the end of 1953 a recommendation on the subject of measurement of atmospheric temperature and pressure by radio-echo observations of meteors.

(f) That observations of scintillation of radio stars be encouraged and if possible, continuous observations recorded at polar, equatorial and southern hemisphere observatories.

(g) That the sun be continuously observed both on radio frequencies and visually, and if possible, photographically during the International Geophysical Year, and with this in view, advantage be taken of polar expeditions, attention being drawn to the resolution of Commission V of URSI IXth General Assembly, and visual observation of the sun undertaken with special reference to the maximum number of flares and to the real sources responsible for ionospheric regions.

(h) That observations of winds in the ionosphere by Mitra fading methods be continued and that this be undertaken in Britain and by at least one other station in the auroral region, e.g. in Alaska or Norway, and that observations of scintillation of the radio stars should, at some sites, be carried on with three separated receivers so that winds in the higher *F2* region can be measured; also that observations of winds in region *F2* at present being carried out in this country using three spaced vertical incidence *h′f* recorders, be continued: and that special attention to this recording be paid during World Days when observations should be made every half-hour.

(i) That the stations equipped for measuring ionospheric wind using the Doppler effect on ionized meteor trails should be encouraged to carry out observations during the International Geophysical Year, particularly in the *E* region.

(j) That direct study of meteors by radio technique be carried out as far as possible by a world chain of stations in the northern and southern hemispheres.

(k) That the study of absorption in the ionosphere by direct sounding methods be carried out.

(l) That preparation be made for observations of absorption in the ionosphere by using galactic noise sources during the International Geophysical Year, and that the method be used if possible in the auroral region during polar blackout.

(m) That there should be one forecasting authority, e.g. Washington, to give warning of ionospheric storms and to choose World Days at short notice; and that on an average there should be not more than five World Days chosen per month including those fixed at long notice. Each country should give wide publicity to this forecasting in their own regions.

2. *Atmospheric disturbances in relation to radio phenomena*:

(a) That Britain should continue its own subjective method with regard to measurement of strength of noise field, extended to low frequencies at certain stations, and that the coverage should be as wide as possible, with extension into the auroral zone, and that at some stations there should be overlap with the objective method of measuring.

(b) That support be given to the proposal made by the WMO to equip observatories with specially designed counters for measurement of strength of noise field created by atmospheric disturbance.

(c) That other countries equip their stations as far as possible with direction-finding apparatus for the location of sources of atmospheric disturbances, and set up stations to make observations.

(d) That other countries, particularly in Europe and North America, should be invited to collaborate in investigating the dependence of the wave-form of atmospherics on type of storm and on the distance and direction of transmission.

5.12.4 *Terrestrial magnetism*

That a study of electric-current systems by the measurement of magnetic space gradients be made.

5.12.5 *Cosmic rays*

(1) That records of the general ionizing flux be made at high mountain altitudes at moderate latitudes e.g. Jungfraujoch or the Pic-du-Midi.

(2) That recording of the atmospheric neutron flux be made. (In both (1) and (2) here records from high geomagnetic latitudes would be particularly valuable.)

5.12.6 *Physical oceanography*

(1) That a study be made of problems associated with the generation, nature and propagation of surges and long waves due to the effects of changes of barometric pressure and the influence of wind on the sea. Countries could be asked to instal tide gauges in critical positions and to ensure the best possible records from present sites. A program is also suggested for the measurement of surface oscillations of all periods over a wide network.

(2) That there should be early co-operation in the development and trial of a practical method for the actual measurement of the slow deep-water movements and

a plan should be made for simultaneous measurements all over the world in 1957–58. Measurements should be accompanied by simultaneous information about the vertical distribution of temperature and salinity. The possibility of making carbon 14 isotope determinations on CO_2 in the water at the same time as measuring the water circulation should be explored.

(3) That there should be international co-operation to obtain an approximately synoptic picture of the distribution of temperature and salinity, and speed and direction of drift in the continuation of the Gulf Stream across the North Atlantic Ocean. In the Eastern North Atlantic Ocean where the current boundaries are not well defined, it would involve some fairly long traverses across the principal direction of the drift. Co-operation of weather ships should be sought through ICAO.

5.12.7 *General*

(a) That the Special Committee consider what advantage could be taken of the situation of Huancayo on the magnetic equator in connection with many of the projects proposed in connection with the International Geophysical Year.

(b) That the attention of the Special Committee be drawn to the importance of the prompt publication of the results obtained from the investigations pursued during the International Geophysical Year.

5.13 *United States of America*

5.13.1 *Meteorology*

Many of the suggestions contained in this meteorological program conform with those made by the various WMO technical and regional commissions to Prof. VAN MIEGHEM in his capacity as chairman of a WMO Working Group for the International Geophysical Year. While the items which follow are not listed in order of priority, it is felt that items 1 and 2 are the most important.

1. *Meridional line of stations.* In order to construct vertical cross sections along a meridian from pole to pole, some additional meteorological stations must be established along the meridians finally adopted. Prof. VAN MIEGHEM has emphasized the construction of vertical cross sections along 15° E through the co-operation of European and African countries. In addition, it is recommended that cross sections be constructed for the longitudes of 80° W and 140° E, with a tolerance of ± 20° in longitude. While a very good station coverage exists in North America along 80° W, rather large gaps appear in South America, particularly insofar as regular radiosonde observations are concerned. Along 140° E, station coverage seems fairly good. It is recommended that terminal meteorological stations for the meridional lines of stations be established in Antarctica.

2. *Latitudinal line of stations.* A latitudinal line of stations would permit the construction of vertical cross sections along a given latitudinal circle. A vertical section along 30° N ± 10° would have fair to good station coverage in the United States, over portions of the Atlantic and Pacific Oceans, and in India; however, the coverage would be poor elsewhere over the globe. The selection of 30° N as the latitude for study has the great advantage that it is located at the mid-point of the

northern hemispheric air mass, and is also the latitude of maximum poleward flux of angular momentum.

The information acquired from a study of the longitudinal and meridional vertical sections would be helpful in investigating various transport problems (e.g., heat, momentum, energy and water vapor); of determining the location, strength, and movement of the various jet streams; in studying the possible interdependence of circulations of both hemispheres; and in shedding further light on southern hemispheric circulation. The observations mentioned above may be co-ordinated with those listed in Atmospheric Electricity (see p. 52).

3. *Aerological Days.* Inauguration of International Aerological Days during the IGY to obtain more frequent and higher soundings by use of larger than average balloons (1,000 g or more). This would enable the drawing of meteorological maps at the 50 mb (22 km) level and higher as a background for the study of wind conditions aloft, and shed light on proposed theories relating solar disturbances and terrestrial weather anomalies. (See also 5.13.3, Atmospheric Electricity.)

4. *Clear air turbulence.* Establishment of International Clear Air Turbulence Days is proposed similar to those conducted in the United States in March 1953, which proved to be extraordinarily successful in obtaining information on turbulence from commercial and military pilots. More than 600 completed data-cards were received in a three-day period as compared to a slightly smaller number received over a two-year period when no special turbulence days were in effect. These International Clear Air Turbulence Days might well coincide with International Aerological Days, and it is proposed to equip some of the radiosonde stations with NACA gustsondes to obtain the vertical distribution of turbulence, such as was done recently at six Weather Bureau radiosonde stations.

5. *Increased soundings over the oceans.* To fill large gaps in the existing oceanic network of aerological stations, it is proposed to provide equipment and observers to a number of merchant vessels to take regular radiosonde observations along sparsely travelled ship routes not covered by a fixed network of ocean weather vessels. It has been shown possible to release radiosonde balloons from the stern of merchant vessels under extreme conditions of wind and weather found during a winter crossing of the North Atlantic. Such increased coverage will assist not only the various meridional and latitudinal vertical sections, but also will provide additional data for study of genesis, structure and movement of severe oceanic storms, such as typhoons and hurricanes.

6. *Snow and ice cover reconnaissance.* Institute periodic aerial reconnaissance of the extent of the snow cover over continents and ice pack over oceans. More and more attention is being paid by meteorologists to the importance of the underlying surface on air mass modification. It should be a relatively simple matter for aircraft flying on regularly scheduled routes in appropriate areas to keep regular check on the extent of the snow and ice cover. (See also 5.13.2, Climatic Studies, p. 50.)

7. *Mountain observatory.* At Mauna Loa in Hawai (elevation 14,000 feet), located only 25 miles from the ocean, the U.S. has set up facilities for unmanned weather observing. With little additional expenditure facilities could be established to permit observers to be stationed at or just below the summit to take regular

observations not only of the usual meteorological elements but also of solar radiation, ozone, airglow, and other geophysical properties.

8. *Ozone observations.* Equipments to measure the total ozone content in the vertical column are or have been in operation at various locations over the globe. Surface ozone content measurements, determined by a chemical method, are now made at two stations in the U.S. It is proposed to augment the ozone network so that ozone distribution charts can be drawn and compared with meteorological charts. It is hoped to have available by 1957 relatively inexpensive (approx. $500) ozone-measuring apparatus to give good coverage over North America. It is of particular importance to devise an accurate method of measuring total ozone content using the moon or stars as a light source, so that measurements might be made in the Arctic night to verify the existence of the ozone "gap" thought to exist at high latitudes after the winter solstice, and followed by a sharp increase, within a month or so, to values higher than those found anywhere else in the northern hemisphere. Observations of the total and surface ozone content are important not only as indicators of vertical and horizontal motions in the atmosphere, but also as a possibly important natural oxidizing agent in biological and commercial processes.

9. *Stratospheric water content.* The meager amount of data available from British airplane soundings which barely penetrated the stratosphere, and from the four higher U.S. balloon soundings, show enough discrepancy in stratospheric moisture content to warrant further investigation in this field. The data will be of assistance, for example, in stratospheric cloud and contrail forecasting, stratospheric heat balance and exchange of air between stratosphere and troposphere. Some of the U.S. measurements showed interesting increases with height of the water-vapor mixing ratio above 20 km. Work in developing an improved dew-point hygrometer capable of measuring very low water-vapor content is now in progress at several locations in the U.S. This work should be accelerated to provide sufficient and reliable instruments to provide for a skeleton network.

10. *General remarks.* Upper atmosphere rockets and constant level balloons have been employed successfully in recent years in obtaining extreme high-altitude meteorological data and long-distance air trajectories, respectively. However, on account of their high cost and special facilities required for launching and tracking, rocket probing techniques have not been included in this meteorological program. It is hoped nevertheless that these facilities will still be available in 1957–58.

Within reasonable weight limitation, it is possible that weather reconnaissance aircraft can be equipped to make special observations such as auroras, radiation, cloud and dust samples.

5.13.2 *Climatic studies*

There is increasing evidence that the earth is undergoing a significant climatic cycle change advancing from cooler to warmer conditions. This current warming cycle apparently began about 1900. Based upon results of studies by or inspired by H. AHLMANN, and other data, S. PETTERSON has suggested that if the climatic trend continues as at the current rate, it is conceivable that the North Pole basin might be an ice-free ocean in midsummer within another 50 years. That such a situation could happen is plausible as indicated by interglacial epochs that were warmer than at present. Within historic times broad cyclic changes have been observed with significant climate changes from one century to another.

Present knowledge is still imperfect as to the exact cause of long-term climatic changes and thus our ability to predict long-range change is still essentially lacking. The answer to this problem may be forthcoming as studies of the sun, the ionic layers and the ozone layer increase.

An attack upon the problem of the rate of change need not await clarification of causation, but can be approached through collection of resulting evidence. The rate of change can be employed to forecast major climatic trends until the reversal of the trend can be identified.

The significance of major climatic changes within the next few decades to our modern civilization is not to be taken lightly. Not only does the potentiality of Arctic commerce suggest itself but the resultant changes to existing climatic belts (especially in the transition zones) would be expected to alter the whole economy of extensive regions and, in some cases, whole nations. Changes of climate resulting in redistribution of precipitation patterns might in some cases create new famine belts, while other areas now unarable might become productive. Excessive melting of the great snowfields of Antarctica and Greenland, plus lesser glaciers could seriously menace many major low-lying coastal cities of the world by raising sea levels.

Thus, recognizing the potential far-reaching nature of climatic changes now in progress, it appears a worthy goal of the International Geophysical Year to make an intensive review of current observable facts to provide a base line for further assessment of the current rate of long-range climatic changes.

From its very nature, a program in climatic changes is hardly one to be accomplished solely by intense international co-operation during a single geophysical year. Any climatic program which is evolved must utilize studies made during a series of geophysical years to determine the long-term changes which are affecting the earth. In essence, these investigations should be considered as epochal studies, which have increasing value when compared from geophysical year to geophysical year (assuming that geophysical years will be planned each 25–50 years). Some of the studies mentioned below will establish datum levels which will serve as a base for future comparative studies.

It is also realized that some of the projects listed below are continuing efforts, to be made year after year. Their proposal at this time represents an effort to stimulate activity and if possible to initiate new continuing projects for studying long-term climatic trends.

Because of the foregoing reasons, implementation of the following projects is recommended:

1. *Glacial studies.* The measurements on glacial changes (initiated by H. AHLMANN) should be continued and extended to other geographic sites. Once initiated at new sites, measurements should be made not only during the International Geophysical Year of 1957–58, but as a continuing annual effort through succeeding geophysical years. Special attention should be directed towards the heat budget of the glacier measured in calories. Consideration should also be given to the influence on the glacier of all factors involving heat transfer on the melting of ice. In the past,

major emphasis has been placed on the determination of the temperature and the amount of precipitation. It would be highly desirable in connection with glacial studies if standards could be established. In this connection direct measurements might be made on the rate of water loss from standard blocks of ice.

2. *Ice cover and glacial atlas.* It would be extremely worth while to undertake periodic observations during the International Geophysical Year of complete ice-fields, including (a) the complete extent of representative glaciers; (b) sea-ice; (c) lake-ice; and (d) river-ice. In this fashion, a glacier and ice atlas would be developed which would provide information relative to glacial changes, ice characteristics, duration of ice cover, etc. This study would yield information regarding relationships of ice cover and glacial extent to meteorological and climatic factors, and would be of value to ice forecasting and navigation. In addition to maps showing distribution of ice cover, a series of maps could be prepared showing snow distribution. These would be of value for forecasting snow cover and weather conditions. It is recognized that observations taken during any one year will be inadequate to establish an average condition, but it is believed that periodic co-ordinated observations (perhaps during succeeding IGYs) of the type indicated are desirable. (See also 5.13.1, p. 48.)

3. *Ice-cap temperature changes.* Temperature gradients within ice caps in the northern and southern polar regions should be determined periodically, but at least during each International Geophysical Year. In the northern hemisphere, temperature gradients in the Greenland Ice Cap may be compared with the early observations made there by WEGENER.

Evidence of former climatic cycles exists and it is believed that additional temperature gradient observations may reveal valuable information regarding climatic variations. It is suggested that reference markers be placed at selected ice-cap stations in such a way that the position of the surface can be readily identified in future profiles. (See also 5.13.1, Meteorology.)

4. *Oceanic heat balance.* Because of their large mass and high specific heat, the oceans' response to small time variations in the heat budget may cause no change in oceanic temperatures; a long-term continuing warming up or cooling off of the earth would reveal itself by small but persistent changes in the temperature of the oceans. One means of measuring such changes would be by an infra-red "temperature mapper" flown over given oceanic zones from the tropics to the polar regions. The integrated temperature values which are thus obtained (without disturbing the local sea temperature) could be compared from epoch to epoch (i.e. from IGY to IGY). As the ocean is one of the largest heat reservoirs of the earth, even small changes in temperature, which indicate a change in the energy content of the oceans, would be significant in determining long-term climatic trends.

5.13.3 *Atmospheric electricity*

Of the various problems in atmospheric electricity which can best be pursued through international co-operation, the problem of global diurnal variation in air-earth current density is probably the most important. Substantial progress has been made during the last few months in demonstrating that the atmospheric electrical air-earth current density, measured during fair weather conditions on mountain tops at altitudes above 2000 m, resembles in phase and relative amplitude the *mean* diurnal variation of the air-earth current density found at sea. In essence, it seems that a means is being found for measuring a quantity which is proportional to the potential difference between the earth and the high atmosphere. If a global network were established during the International Geophysical Year, it would be possible for the first time to obtain a reliable measure of the diurnal and seasonal trends of the potential difference between the earth and the high atmosphere. A minimum of six stations is recommended. The measurements are of great importance in determining the true cause of the earth's electric field, which is now generally believed to be due to currents produced by thunderstorms.

If the thunderstorm hypothesis were fully established, the atmospheric electrical measurements would serve to give a continuous record of integrated thunderstorm activity over the earth and probably would also give some indication of the thunderstorm distribution by continents. Furthermore, if it proves possible to measure the global variation of the atmospheric electrical field on an hour-to-hour basis (as distinguished from weekly averages) an improved study could be made of the local effects produced by meteorological fronts as they approached the recording station.

Associated with the above program of atmospheric electricity determinations, a more accurate measurement of the global thunderstorm activity is necessary. These observations may be made in co-operation with the various National Weather Services, through the establishment of networks of spherics stations, or by both means. A sufficient number of observers are already available in the United States and Europe to permit the establishment of such networks. However, a minimum total number of six to ten additional stations in South America, India, Japan and the East Indies is also recommended.

Prior to the beginning of the International Geophysical Year, the proposed spherics network must be effectively calibrated in order to insure that thunderstorm activity is measured in a quantitative manner.

The stations which are selected for the measurement of atmospheric electricity should be as free as possible from local electrical effects; in this way global effects would be relatively enhanced. In general, the sites should be well removed from regions of industrial activity. At each station, measurements would be made of the (a) positive conductivity, (b) negative conductivity, (c) electric field, (d) air-earth current, (e) rate of ion production, (f) concentration of large ions, (g) large ion mobility spectrum, (h) concentration of Aitken nuclei, and (i) temperature, pressure and relative humidity.

In addition to ground observations, it is also recommended that a selected number of balloon flights be made simultaneously from various sites. If possible, measurements should be made to altitudes of 25–30 km. During balloon flights, data on the positive and negative conductivity, electric field, and temperature, pressure and relative humidity should be obtained. These measurements, of course, should be co-ordinated with those listed in the program in meteorology and the program in ionospheric, auroral and high-altitude physics.

5.13.4 *Geomagnetism*

The suggestions which appear below are intended to outline general objectives that would benefit particularly by international co-operation, and to avoid those that are highly specialized, that lack wide-spread interest, and that do not require synoptic treatment. It is recommended that the following be achieved insofar as possible:

(1) Utmost care should be employed in magnetic observatory operation, with international comparison of national instrumental standards, and with full and immediate publication of results.

(2) Operation of rapid-run magnetographs (approximately 100 mm/hr) should be made wherever possible at northern hemisphere observatories, to produce data on magnetic and ionospheric storms, and other disturbances peculiar to polar regions, bays and giant pulsations, and micro-pulsations.

(3) Operation of five to ten closely-spaced rapid-run (approximately 100 mm/hr) observatories should be established (possibly of portable or temporary type) in a line crossing the north auroral zone. Possible locations of these stations are limited to a line through Fairbanks, Alaska, one somewhere near Hudson Bay, Canada, or one in the northern extremity of Siberia.

(4) Observatories in equatorial regions should be established and integrated to provide a basis for the study of geomagnetic variations as a function of longitude. Existing observatories, augmented by proposed ones at Belem and Bogota, provide fairly uniform distribution about the world. Special efforts should be made to establish at least a portable magnetograph at Jarvis Island, near the conjunction of the geomagnetic and geographic equators.

(5) Observatories of portable or temporary type (for the period of the International Geophysical Year) should be established in east-west chains of four or more, spaced at intervals of several hundred miles. The data from these chains could be correlated with weather data. At least one chain should be in a fairly low latitude. These stations should coincide with meteorological (particularly radiosonde) stations.

(6) Magnetic observatories should be established in Antarctica, in conjunction with any expeditions which may be operated.

(7) All possible rocket tests, wherever made, should be employed for the collection of high-altitude magnetic field data.

(8) Simultaneous geomagnetic data should be collected at selected times on high-frequency magnetic fluctuations (up to 10,000 c/s) by operation of induction magnetometers recording at very rapid rates.

5.13.5 *Solid earth investigations*

It is recommended that special efforts be made to secure much needed data on crustal temperature gradients in undisturbed areas, and, if possible, under ocean basins.

5.13.6 *Ionospheric, auroral and high-altitude physics*

1. *The geographical location of the auroral zone and its variations.* It is proposed that during the IGY, auroral observations be systematically made every 15 min beginning on the hour, on the strip across the sky representing the magnetic meridian. Recordings should be made of:

(a) Zenith distance of lower edge of aurora.

(b) Auroral form according to the international classification.

(c) Estimate of intensity on a scale of 1–5.
(d) Motion and its direction.
(e) Pulsations and frequency.
(f) Color.
(g) Additional data for those off meridian (loops, isolated rays, spirals, diffuse surfaces).
(h) Degree of cloudiness.

Data should be taken in as simple a form as possible so that they may be readily tabulated, or preferably transferred to a punched card (see Annex A, p. 60).

The main bulk of the data should be provided by (a) amateurs who are already organized in astronomical societies and (b) meteorological observers. Where a group can work together, a fixed installation should be made. For individuals, a portable sighting protractor can be made available at moderate total cost. Certain selected sites, manned by meteorologists, ionosphericists, etc., could employ wide-angle cameras or possibly sequence cameras. A danger, however, with automatic equipment is that large amounts of data may be collected which cannot be measured, reduced and published.

2. *The determination of intensities of the rotation-vibration bands in the airglow spectrum on a global basis for study in conjunction with meteorological observations of the high atmosphere.* It is proposed to record the intensity of the infra-red OH bands in the airglow spectrum throughout each clear moonless night for a selected set of meteorological stations, using a simplified automatic recording photo-electric photometer. (See Annex B, p. 61.)

3. *Regular ionospheric sounding stations.* Analysis of records from regular ionospheric sounding stations can make an important contribution to understanding sudden ionospheric disturbances, magnetic storms, auroral disturbances, antipodal relationships, etc.

It is proposed that regular ionospheric sounding stations, using equipment such as the C3, be operated during the International Geophysical Year substantially as usual, but with much more increased emphasis on the reduction and analysis of the records obtained. The usual practice of reducing one record every hour might be replaced by reduction of one record every 15 min. Greater effort could be devoted, however, to the accuracy of scaling records, particularly with regard to height (see Annex C, p. 62). More especially there should be greatly increased emphasis on the analysis of the results obtained, and on collation of records from stations distributed over the world.

Special attention should be paid to analysis of records from polar stations, and in this connection, careful thought should be given before the IGY to the interpretation of polar ionospheric records. It is doubtful whether the quantities scaled at polar stations always have the same interpretation as at lower latitudes. The questions of what quantities to scale from polar records and what are their physical interpretations should be settled if possible before the IGY and standards for scaling established.

Off-vertical echoes are thought to be common at polar ionospheric stations and a simple antenna system (perhaps a vertical rod) should be installed so as to check when echoes are seriously off-vertical. In view of the fact that the appearance of sporadic echoes on ionospheric records often depends on the power of the transmitter and the gain of the receiver, groups of records should be taken in quick succession with different calibrated gain settings. During the IGY, ionospheric stations that are in the hands of "operators" should be frequently inspected by scientific personnel.

In establishing new ionospheric stations, attention should be paid to arranging them roughly in lines convenient for studying the behavior of the ionosphere. Longitude lines of stations possibly along the meridians 20° E, 75° W, and 140° E should be considered. (See also 5.13.1, Program in Meteorology.) There are obvious gaps at the present time in South America. A ring of stations beneath the northern auroral zone is also very desirable, and here results could be achieved by arranging for complete interchange of information between all of the countries concerned.

4. *Scatter sounding.* Where possible, ionospheric sounders should be equipped with beam antennas for looking roughly horizontally in various directions, in addition to the usual antennas for looking upwards. These might take the form of rhombic antennas. With this arrangement, it is possible to obtain back-scattering from the earth mirrored in the ionosphere. Frequency-sweep records taken in various directions in this way permit an ionospheric sounder to monitor ionospheric behavior over a considerable region around it. In particular, it is possible to make deductions about the geographical distribution of sporadic ionization (see Annex D, p. 63).

An alternative arrangement is to use one or two fixed frequencies together with rotating directional antennas (see Annex E, p. 65). Experience between now and the IGY will probably determine the best technique to be utilized at that time. Frequencies to perhaps 50 Mc/s should be considered.

5. *VHF ionospheric investigation by radar techniques.* It is quite likely that, between now and the IGY, VHF ionospheric sounding will have developed to the point where at least one installation of this type should be made in polar regions. The frequency that would be appropriate would be in the region 30–100 Mc/s, and 50 Mc/s might be a good choice. Preliminary investigation before the International Geophysical Year would, however, be required in order to determine details. Such a sounder could be used in conjunction with a vertically-looking antenna to obtain echoes at vertical incidence. It is quite likely that echoes at VHF could be obtained at all times, even during HF polar "black-outs". The sounder could also be used in conjunction with a moderate-gain steerable antenna to obtain echoes from meteoric ionization. Likewise, the sounder could be used in conjunction with a high-gain horizontally-looking rotating antenna for detection of ionospheric scattering regions presumed to be associated with the aurora. Alternatively, an omnidirectional antenna might be used in conjunction with a number of distant receiving sites equipped with rotatable directional antennas. The most appropriate arrangements would have to be the subject of investigation between now and the IGY.

6. *Ionospheric winds.* It would be very desirable to take advantage of the IGY to obtain, if possible, a clearer idea of the world-wide distribution of the ionospheric

movements commonly interpreted as ionospheric winds. This could be done by installing at ionospheric sounding stations, triplets of spaced receivers for comparing the fading obtained from ionospheric echoes on one or two fixed high frequencies. Equipment would be necessary for evaluating the correlation coefficients between the fading at three receivers and interpreting these as a "wind" in magnitude and direction. Observations should be such as to provide the diurnal, seasonal and geographical distribution of the winds (see Annex E, p. 64).

For ionospheric winds high in the *F2* region, see Section 7.

7. *Study of the ionic layers by extraterrestrial radio waves.* The various ways in which the extraterrestrial radiations may be utilized to provide information on the ionosphere involve such measurements as those of ionospheric absorption of cosmic noise during normal times as well as during sudden ionospheric disturbances, of ionospheric refraction of radiations coming from discrete sources preferably at two frequencies, and of radio scintillations made simultaneously by at least two, and preferably three, suitable separated stations (separated by a few km) employing nearly identical receiving equipment to investigate wind motions in the upper part of the *F2* region. Of these various methods, the ones which might be profitably used during the IGY are:

(a) Measurements of ionospheric absorption, using preferably the cosmic noise at frequencies near the critical frequency of the *F2* layer, for normal times as well as during sudden ionospheric disturbances (see Annex *F*, p. 65).

(b) Measurement of ionospheric winds high in the *F* region by using the radiation from a discrete source (see Annex G, p. 66).

8. *Solar observations.* To facilitate studies in solar terrestrial relationships and radio-optical solar conditions, it is suggested:

(a) That special emphasis be placed on the careful timing of outstanding phenomena of solar activity, both in terms of seconds and hours of time.

(b) That, in addition to the usual descriptive tables of solar activity phenomena, small-scale reproductions of the solar radio patrol records (tapes) from the world chain of solar radio observatories be interchanged among solar, magnetic, ionospheric and other types of laboratories which need solar activity data for the interpretation of their own observations.

(c) That, for the period of the IGY, the URSIgram program be expanded to provide solar and geomagnetic activity data on a short-time schedule, both by electrical means and by air mail, to the principal laboratories involved in the program of the IGY.

9. *Additional studies suggested but not examined in detail*

(a) Annual variation of intensity of Na-D lines in airglow spectrum for the southern hemisphere to compare with that observed in the northern hemisphere. There is a maximum in December–January which is five to six times the minimum intensity observed in July–August.

(b) Visual observations of luminous clouds and bands not apparently associated with magnetic activity. This may be a part of the program for the visual observation of auroras by groups of amateurs but with extension of the observations to equatorial regions. Attempts should be made to distinguish auroral and noctilucent clouds from the luminous clouds and bands.

(c) Use of rockets for direct measurements of the properties of the upper atmosphere. A number of firings might take place in New Mexico and Australia, and arrangements might be made for firings from ships which could go into polar regions. Information obtained in this way at specific places and times would have to be collated with other less direct observations that are more widely available in space and time.

(d) World-wide measurements concerned with radio meteorology.

(e) World-wide measurements of terrestrial radio noise.

(f) Measurements of low frequency "swishes" or "whistlers" to verify the theory of RATCLIFFE and STOREY reported at the Xth Assembly of URSI. This theory is potentially important in revealing the state of ionization above the F region out to several earth's radii. According to the theory, there should be an important variation in the properties of "whistlers" with latitude. From this the correctness of the theory could be further verified and additional deductions could be made about ionization above the F region (see Annex H, p. 67).

(g) Measurements of the direction of arrival of ionospheric echoes using the four-loop method of ECKERSLEY.

(h) Measurement of collisional frequency by wave interaction techniques (see Annex I).

(i) Oblique incidence field-strength measurements on paths at different distances from the auroral zone. For example, measurements of WWV at College, Alaska, Anchorage, Alaska, Kodiac, Alaska, etc.

(j) World distribution of ionospheric absorption using CW reflections at nearly vertical incidence.

(k) Oblique incidence pulse studies in the Arctic involving reception by one ionospheric station of pulses from another. It would be desirable so to arrange the experiment that there is a third ionospheric station near the midpoint of the path.

(l) Observation of meteors at a frequency of about 12 Mc/s during polar blackouts. Low meteor trails might be observable and high ones unobservable thereby giving information on the height of the absorbing layer.

(m) Meteor counts by radio methods are needed from one or two places in the northern *and* in the southern hemispheres, both for their astronomical interest and for correlation studies with *Es* observations by vertical and oblique soundings. The methods employed by LOVELL's group would seem appropriate.

(n) It is noted that a solar eclipse will occur in June 1958 in the western Pacific and there should therefore be an opportunity with little added effort to obtain ionospheric and radio propagation observations of great potential value.

5.13.7 *Cosmic rays*

During the International Geophysical Year, emphasis should be given to cosmic-ray investigations near both geomagnetic poles, and at high latitudes in the southern hemisphere. In addition to measurement of the soft and hard components of cosmic rays, some effort should also be given at selected stations to the measurement of neutron densities. Balloon studies and high altitude cosmic-ray observatories in both polar regions would be invaluable.

Some attempts should be made to correlate the variations in intensity of cosmic rays or neutrons with other geophysical effects, such as meteorological changes and occurrence of intense auroras.

5.13.8 *Geodetics*

The program in geodetics is confined to the measurement of the geodetic distance between continents, the size and shape of the earth, and variations in the earth's speed of rotation.

1. *Introduction.* The determination of the size and shape of the earth and the geodetic distances between continents has been greatly hampered by the difficulty of extending triangulation nets across the oceans. During recent years, it has become possible to use the moon as a triangulation point for the extension of existing surveys all over the world; this has been due to advances in precision of observation and in our knowledge of the motion of the moon. The attempts so far made have consisted of observing total solar eclipses and selected occultations of stars by the moon, and the rarity of these phenomena has prevented much progress.

During the past 20 years it has been realized that the moon can also be used for another purpose: as a clock to measure variations in the speed of rotation of the earth. BROUWER has shown that observations during the past century establish seven or eight changes larger than 10^{-8}, each of which is probably due to the accumulation of smaller changes taking place successively in the same direction. The magnitude and frequency of the smaller changes is unknown, but statistical considerations suggest that they may be as large as 10^{-9}, and may occur more frequently than once a year. They are probably associated with motions in the core (or at least below the mantle) of the earth, in such a way as to conserve the total angular momentum.

2. *Proposed technique.* The recent development by MARKOWITZ of a new photographic technique, which makes it possible to observe the moon with the necessary precision whenever it can be seen at night, gives the possibility of accomplishing as much in a single year as could be done in a century by the older methods, provided the co-operation of a sufficient number of observatories well distributed geographically can be obtained. The observational technique, soon to be published in detail, consists of direct photography of the moon, the camera being specially devised to hold the image of the moon stationary among the stars while the exposure is being made. The probable error of a single observation is about 0·5 sec of arc, corresponding in general to about 900 ft on the earth. Thus, 200 observations at each of two stations should give the distance between them with a probable error of about 90 ft. The mutual adjustment of observations at several stations should reduce the uncertainty materially, but the presence of systematic errors will tend to increase it; it is certain that the results will be of value but no precise estimate of the final uncertainty is possible at present.

The new technique adds greatly to the precision with which changes in the speed of rotation of the earth can be measured, and the observational material obtained for the geodetic program may be expected to shed new light on the inner constitution of the earth.

3. *Equipment.* At each station there is required an equatorially mounted refracting telescope of moderate size, say of aperture 10 in. or more and focal length 10–20 ft. The telescopes already existing at various observatories are probably sufficient in number and distribution. Also needed is a special camera, and means of timing the exposures. The Superintendent of the Naval Observatory is authorized to say that the Observatory is prepared to furnish plans and drawings, and in fact to procure the cameras themselves if necessary funds (estimated at about $3700 each) are provided.

Annex A. Suggested instructions for auroral observers

The detailed instructions for the auroral observations must remain tentative until contacts can be made with other groups which are also conducting systematic observations. At that time, a final set of instructions may be written. Two of the groups which are well known are the Auroral Section of the British Astronomical Association under the leadership of Mr. PATON, and the auroral observers of the American Association of Variable Star Observers under the direction of Professor C. W. GARTLEIN at Cornell University.

Condensed instructions for recording auroral observations as prepared for the observers in the Auroral Society of Alaska are as follows:

(1) Enter the date and observer's name. The date should be given as the double date; for example, January 4–5, which indicates observations on the night on which January 4 ended and January 5 began.

(2) The location of the observer's station is to be noted. The co-ordinates of the station will be entered at Society headquarters. If the observer is not in a town, he should give the direction and distance from the nearest town.

(3) Enter weather conditions in the column "weather".

N—North section of sky.
E—East section of sky.
S—South section of sky.
W—West section of sky.
Z—Zenith (overhead) of sky.

Note whether cloudy, partially cloudy, or clear (for different sectors).

(4) Record the time of the observation, giving it on a 24-hr scale, local standard time. For example, 2300 AST, denoting 11 p.m., Alaska Standard Time.

(5) List in order the altitude of each auroral form crossing the magnetic meridian, starting with the north horizon. Angles in the north are to be preceded by N, those in the south by S. Measure all angles upwards from the horizon to the zenith. (Thus we might have forms at N30, N60, S85, S60.)

(6) Check the appropriate column under *form* for each aurora noted in the altitude column.

(7) Check the corresponding intensity for each form.

(8) If the form shows movement of the rays, check the motion column; E–W signifies general east to west movement of the rays along the form, W–E signifies general west to east motion. If the rays seem to be moving in both directions simultaneously, check both the E–W and W–E columns. Check Z whenever motion

is toward the magnetic zenith (as for flaming aurora or some types of pulsating arcs).

(9) Check the appropriate color. N indicates normal; R–B, red lower borders; and R, red over the entire form. Careful observations should be made of any form exhibiting a red coloration over its entire vertical extent.

(10) Observations are to be made on the quarter-hour divisions.

For observations at fixed stations, a large sighting protractor is set up in the plane of the magnetic meridian, and altitudes can be measured easily to one degree. Also, for individual observers, a pocket-sized sighting protractor has been designed.

Annex B. Suggested methods for observing the OH bands in the airglow spectrum

The program of observing the intensity variations of the OH bands in the airglow spectrum on a world-wide basis is practical only if a simple system of automatic recording is developed. The system must be one that will operate with the minimum of attention and which presents data in a form so that extensive processing, such as the scaling of long photographic or ink tracings is not required before the data are ready for analysis. Equipment to meet such specification, to our knowledge, is not now available, but it seems reasonable that a comparatively short engineering development can produce suitable instruments.

In 1941, photoelectric photometers using cesium oxide photocells and negative feed-back amplifiers had sufficient signal to noise ratio to permit satisfactory manual measuring and recording the intensity variations of the infra-red portion of the spectrum of the night sky, now known to be the OH bands of the airglow. The improved techniques in electronics will increase the signal-to-noise ratio and will provide sufficiently stable circuits to integrate the photoelectric current to produce pulses of equal energy. The pulses can be counted over a period of say, 5 min, thus giving a measure of the integrated intensity over that interval, and can be recorded by an electrically operated printing counter which also prints the date and time of the observation. It is believed that a standard source of light can be incorporated in the instrument so that compensation for the instrumental variations may be done automatically or, at least, will supply data in recorded form so that the corrections can be made.

The data from the proposed instrument will need to be corrected for atmospheric transmission and scattering, since the main objective of the program is to compare the intensities of the OH bands in the airglow for various geographical positions. However, this correction is small in comparison with the variation of intensity which is being sought if the usual precautions for making photometric observations are observed. The correction can be determined for a few selected but widely different atmospheric conditions and then interpolations made for the intermediate atmospheric conditions. It is anticipated that the stations for the photometric observations will be located near the meteorological stations, hence, observations of atmospheric conditions can be made on an objective basis.

The distribution of the photometric stations should be selected to coincide with the meridional line of stations chosen for the meteorological program, specially that part concerned with the circulation of the upper atmosphere. A minimum of one meridional line of stations should be established: and a preliminary estimate is that the spacing should be about 10° of latitude. However, prior to the final selection of the stations, a study should be made of the more probable geographical regions at which the water vapor is transported to the upper atmosphere and of any circulation patterns of the motions of ozone in the upper atmosphere. Theory indicates that the excitation of the OH bands is a collisional reaction between hydrogen atoms from the dissociation of water vapor, and ozone molecules; consequently, the observing stations should be more numerous at the areas where changes of collisional frequency between the hydrogen and ozone are to be expected.

Annex C. Note on uniform interpretation of results of ionospheric soundings

Comparing the results of ionospheric soundings at many different observing sites is possible in the practical sense only if there are uniform standards of interpretation. The quantity of data is very large in ordinary times; if during the IGY there are new stations in operation or special observations or extra reductions, the quantity becomes tremendous. Investigations involving data during the IGY from many stations should be planned in advance so that the needed characteristics are scaled at the field stations, and special measures taken that the scaling practices at the various stations are uniform.

At the present time, the routine analysis of ionospheric sounding records involves scaling twelve different characteristics. The common practice is to reduce one record each hour, so that there are 288 values per day, or about 10^5 per year per station.

More important than the size of the mass of material is the appropriateness of the characteristics scaled to the problems under investigation. The international scheme (*URSI Proc.* 1950; *URSI Inf. Bull.* 1952) for reducing ionospheric sounding records calls for scaling critical frequencies and minimum virtual heights of the regularly occurring layers *E*, *F1* and *F2*, and also transmission factors for standard distances. Other characteristics commonly scaled are the "top" frequency and minimum virtual height of *Es* reflections, and the lowest frequency at which any ionospheric echo is observed with the sounding equipment. A number of other characteristics are recognized internationally and are scaled at some stations. There is a complicated system of descriptive symbols to be used to describe the appearance of the sounding record or to explain the absence of measurement. For consistency of interpretation, the field depends upon a few remarks in the international documents, on informal interchanges among laboratories and on a few instruction manuals (MEEK and MCKERROW, 1951).

This reduction scheme has been found fairly satisfactory for studies of some slowly varying characteristics of the ionosphere in middle and low latitudes. The routine hourly reductions have made possible extensive work on the gross ionospheric characteristics important to radio communications, and their prediction. For other characteristics and studies, for example f_0F1 or fEs, there have been important differences of interpretation at the various stations, and the world-wide data are far from homogeneous. There should be available, by the time of the IGY, a more comprehensive manual of interpretation, well illustrated, for observations at middle and low latitudes.

Ionospheric sounding observations from near and inside the auroral zone present more serious reduction problems. At present the records are interpreted according to the same scheme employed at lower latitudes. The results are not completely satisfactory because short time changes are common and because of the prevalence of scattered reflections, *Es* clouds, auroral echoes and other anomalies. The success of any IGY investigations involving ionospheric soundings from high latitudes will depend on the prior development of improved schemes for interpreting these soundings. URSI Commission IIIb has this matter under study.

Annex D. Technique of scatter sounding using variable frequency

Observations of back-scatter with the sweep-frequency technique (SILBERSTEIN 1951) offer the following advantages over observations by the fixed frequency technique:

(a) As frequency increases and the regular *h'f* curves are traced, the scatter echoes are seen to develop, often out of the second order echoes. Thus information is revealed as to the origin of the scatter.

(b) The diurnal behavior of a continuous spectrum of frequencies can be observed.

(c) In studying the relation of the scatter range to the maximum usable frequency (MUF) for a fixed distance, a large number of samples are obtainable in any given day, since, for a given distance, there is usually one frequency in each sweep which is the maximum frequency for that distance.

Output powers of the order of 30 kW from a modified conventional ionosphere recorder such as the U.S. National Bureau of Standards Model C3 will afford fair daytime scatter records on a large rhombic antenna with a pulse length of 100 μsec, sweeping the 2–25 Mc range in 12 min. It may not be possible to receive scatter during a large part of the night without higher power, however, because the skip distance for the lower frequencies is long, requiring low wave angles, which may not be favored by the rhombic antenna. Pulse lengths greater than 100 μsec can be used with potential increase in signal-to-noise ratio but with sacrifice of fine detail.

Receiving should also be done with a large rhombic antenna. Because received signals will be weak, narrower bandwidths should be used than with the usual vertical-incidence recorder, with some sacrifice of fast rise and fall times. A rough, non-critical value is:

$$B = \frac{1200}{t}$$

where B = bandwidth in kc/sec
t = pulse length in μsec.

Reception of powerful interfering stations as the frequency is swept will cause shifts of the video reference voltage in the oscilloscope circuits which may obliterate the weak scatter signals unless very good clamping is used. Also, differentiation suitable for ordinary vertical-incidence work may be too much with the high receiver gains necessary in scatter reception.

A test of origin of short-distance *F2* or *F1*-layer-propagated back-scatter is the tangent test (DIEMINGER, 1951; DIEMINGER, 1952; PETERSON, 1951). With the *h'f* sweeps plotted on a linear scale, a straight line is drawn from the origin so that it falls tangent to the second-order *F2* or *F1* trace and continues onward. If the scatter is from the ground, it will fall along this line, but if it is from the top of a lower ionosphere layer, such as the E layer, it will fall along a similar line starting at about the layer height below the first one at the ordinary wave critical frequency.

To test the origin of backscatter at intermediate and long distances, a two-way synchronized sweep frequency pulse reception test (FERGUSON and SULZER, 1952) is best, so that MUF and travel time can be compared with back-scatter delay time. Much can be learned, however, by orienting the back-scatter antennas along the great circle path to a vertical-incidence ionosphere station at a distance of 1500 km or less and comparing data. The origin of scatter propagated by the $F2$ and $F1$ layers can be deduced by comparing the MUF for an oblique path for a given layer with the frequency at which the delay time for the scattered echo to return is correct for the path length, assuming scatter from the ground or from the top of a lower layer. A comparison of travel times and MUF for obliques poradic-E propagation should yield information on various types of sporadic-E-propagated scatter.

It should be possible to track ionospheric disturbances by noting changes in long-distance scatter patterns (HARTSFIELD and SILBERSTEIN, 1951; 1952).

Annex E. The technique of measuring ionospheric winds by means of the fading of radio echoes from the ionosphere

The basic requirements of a system for determining ionospheric winds by the fading method have been described by MITRA (1949) and by KRAUTKRÄMER (1950). Pulses of radio energy reflected from the ionosphere are received at three receiving antennas spaced on the order of a wavelength apart at the corners of a right triangle. Comparisons of the fading of the echo amplitudes at pairs of the antennas then lead to a value of the speed and the direction at which the diffraction pattern produced by ionospheric roughness is drifting over the ground. The speed of the ionospheric wind is taken to be half of the speed of drift of the ground pattern (BRIGGS *et al.*, 1950).

1. *Equipment.* A pulse transmitter operating at a fixed frequency is required. The transmitter of a conventional ionospheric sounding unit may be employed. Since fading observations over a 5- or 10-min period are sufficient for a determination of the wind vector, these observations might be made between scheduled ionospheric sounding observations.

A separate receiver may be employed for each antenna, or a single receiver may be switched electronically between the three receiving antennas in synchronism with the transmitter pulses in such a way that the echo of every third pulse is received on the same antenna. An electronic gate of variable delay time is provided to keep the receiver insensitive except during a brief interval when the echo is received.

The output of the receiver may be applied directly to a cathode-ray oscilloscope and photographed on moving film in the manner described by MITRA (1949), PHILLIPS (1952) or CHAPMAN (1953), or the envelopes of the pulse amplitudes may be detected and recorded on paper tapes (SALZBERG and GREENSTONE, 1951). If a single receiver is used, the output must, of course, be switched in synchronism with the input.

2. *Antennas.* The receiving antennas may be dipoles or loops, and spacings of the order of one to one-and-a-half wavelengths afford sufficient time resolution for

satisfactory determination of the time delays. Care should be taken to avoid excessive pickup by long transmission lines, especially if relatively inefficient antennas such as loops are employed. CHAPMAN (1953) used preamplifiers at the base of each antenna.

Best results are obtained if the fading is not complicated by interference between successive reflections of the wave or between the two magneto-ionic components of the wave. A single reflection is isolated by gating the receivers. But as a rule, the magneto-ionic components cannot be separated by gating. In daytime, the extraordinary mode is considerably more attenuated than the ordinary, but at night this is not always the case. The interference can be eliminated by suitably polarizing either the transmitting antenna or the receiving antenna or both. In moderately high latitudes, circular polarization gives adequate discrimination.

3. *Operating Frequency.* Relatively long series of observations have been made at 2·3 Mc/s by the U.S. National Bureau of Standards (CHAPMAN, 1953), at 2·4 Mc/s by the Cavendish Laboratory (PHILLIPS, 1952), and at various frequencies by CHAPMAN, 1953). Such frequencies are reflected by the *E* layer in the daytime and, except when reflected by sporadic *E*, by the *F2* layer at night. A frequency well above the *E* layer critical frequency, say 4 Mc/s or higher, would be necessary to study reflections from above the *E* layer during the day.

Wind measurements at a low frequency (150 kc/s) have been made at Pennsylvania State College (MILLMAN, 1951).

4. *Observation schedules.* For several years, observations at the Cavendish Laboratory, at the National Bureau of Standards, to some extent those by CHAPMAN in Canada, and possibly also by other workers, have been made at half-hour intervals during 3 days near the middle of each calendar month.

5. *Determination of the wind vector from the fading records.* Methods of determining the wind vector from the fading records are discussed in references. In each case, a time interval is determined for each pair of antennas which is related to drift speed of the diffraction pattern. The values of the time interval depend upon the operating frequency and upon the antenna spacing as well as the wind speed. At 2·3 Mc/s and a spacing of 130 m (1—$\frac{1}{2}$ wavelengths (SALZBERG and GREENSTONE, 1951)), the time intervals range from 0–3 or 4 sec. The fading rate varies from perhaps 6–60 fades/min.

Annex F. Measurement of ionospheric attenuation using cosmic noise

1. *Normal absorption.* MITRA and SHAIN (unpublished) have already investigated the possibility of measuring ionospheric absorption by using cosmic noise at 18·3 Mc/s with a narrow-beam aerial of thirty dipoles and conventional receiving and recording equipments. The records obtained had much less fluctuations than in the terrestrial method of ionospheric absorption. The accuracy of estimation of absorption was limited primarily by the accuracy of reading a mean value of the fluctuating intensity and, in general, under good conditions the equivalent aerial temperature could be estimated to about 1 per cent.

The variations in the observed radiation involve those of the incoming radiation as the sky moves over the aerial as well as those caused by variations in ionospheric absorption. The first depends on sidereal time, the second on solar time. By comparing observations over a whole year, it was possible to separate the two types of variations.

MITRA and SHAIN have carried out some detailed analysis on the data obtained by the above technique over a year. The essential conclusions are that the total absorption during summer noon is some 1·4 db, that absorption during the daytime in winter is larger than in the equinoxial period, that about 25 per cent of total absorption is contributed by the *F2* region, that *F2* absorption increases much more rapidly with f_0F2 than a Chapman layer would allow, and that the absorption due to *D* and *E* layers shows a pronounced asymmetry round noon. Further, there was evidence of a nocturnal source of absorption caused presumably by irregularities occurring in the *F2* region.

The most interesting point in the method is the consistency of the results obtained and the fact that reliable conclusions could be made from only a year's data, whereas in the ordinary terrestrial method, a number of years' data are necessary to get even rough conclusions.

2. *Absorption during sudden ionospheric disturbances.* Useful studies of solar flares and their effects on the ionosphere may be made by measuring the intensity of cosmic noise at the time of the solar flare. The effect appears as an excess absorption and is easily distinguishable from the effects of atmospherics or man-made noises which appear as an *increase* in the intensity of the received radiation. SHAIN and MITRA (unpublished) have investigated, by the same technique as outlined above, all such effects observed during a year. It was found that the method is highly sensitive and indicated a larger number of flares than were visually observed. In fact, the method was found to be as sensitive as the "sudden phase anomalies" method discussed by BRACEWELL and STRAKER, while at the same time, the equipment is simple and does not suffer from the sporadic gaps of transmission from which measurements of long-wave transmitting stations suffer. Statistical analysis regarding occurrence, duration and growth of the effects, made along the same lines as those of BRACEWELL and STRAKER, gave identical results. Further, strong evidence was found for appreciable corpuscular absorption beginning 18 hr after the occurrence of the solar flare and reaching a maximum at about 26 hr.

Study of ionospheric absorption by the method outlined above does not involve equipment that is too elaborate, and a number of ionospheric stations might conceivably be equipped before the IGY.

Annex G. Measurement of ionospheric winds high in the F *region*

Estimates regarding the velocity of ionospheric winds in the *F2* region may be made by comparing the scintillation patterns of a single discrete source simultaneously at two or more stations. Such measurements are now being made in England at Cambridge and Manchester. (See, for example, LITTLE and MAXWELL, 1952 and HEWISH, 1952). The separation between the stations should be of the order of a few kilometers. A frequency far removed from the critical frequency of the *F2* layer should be used, so that there is no appreciable absorption by the irregularities in the *F2* layer.

As this method involves elaborate antennas, there would be a severe restriction on the number of laboratories which could carry on such measurements during the IGY. For those stations which already have some radio astronomical equipment for measuring radiations from discrete sources, the necessary arrangements might be made in time.

Annex H. Measurement of "whistlers"

"Whistlers" are a most remarkable audio-frequency phenomenon first observed many years ago during studies of earth currents. They can be heard at irregular intervals on a sensitive audio amplifier (gain of order 80 db) connected to a long wire or a loop antenna. They resemble a rough, whistling tone, with varying degrees of "musical" quality, which descends in frequency from several kilocycles to a few hundred cycles in an interval of about 1 sec. Whistlers are frequently preceded by clicks caused by lightning discharges.

A theory of whistlers was described by RATCLIFFE at the Xth Assembly of URSI. It is based on the idea that the VLF energy radiated from a lightning discharge may travel through the ionosphere as an extraordinary ray in the magneto-ionic longitudinal mode of propagation. This requires that the path of propagation be in the direction of the earth's magnetic field and that there be sufficient ionization along the path to sustain the longitudinal mode. The energy follows the field lines into the opposite hemisphere, is reflected from the earth's surface and returns to the starting point. The dispersion is such that $1/\sqrt{f}$ varies linearly with time, where f is the instantaneous frequency of the whistler. Since lines of the earth's field originating in areas where whistlers have been observed pass far beyond the maximum of the $F2$ layer, the theory is potentially useful in studying that part of the ionosphere above the F region.

Although several features of the theory are in agreement with experiment, certain other predictions of the theory must be checked before final acceptance is possible. According to the theory, there should be a pronounced variation in occurrence of whistlers with latitude. From this, the correctness of the theory could be further verified and additional deductions could be made about the ionization above the F region. Furthermore, the variation of whistler frequency with time (i.e., dispersion) can be expected to show latitude dependence.

Information on whistler occurrence is easily obtained using a sensitive audio amplifier connected to a long horizontal wire or loop antenna. The characteristics of whistlers can be recorded permanently on magnetic tape. Accurate timing is highly desirable.

One simple method for doing this is to use a dual-channel tape recorder, recording whistlers on one channel and WWV timing signals on the other. Stations should be located not more than about 1000 km away from reasonably active thunderstorm areas. It would be desirable to set up at least one pair of "conjugate" listening stations; that is, stations located on the same geomagnetic meridian and equidistant from the geomagnetic equator. Only one member of such a pair would have to be near a thunderstorm area. Other stations should be established near the geomagnetic equator and the geomagnetic poles. It is suggested that at least five stations be set up; one near the geomagnetic equator, one near the north geomagnetic pole, two at intermediate latitudes, and one in the southern hemisphere at a point conjugate to one of the intermediate-latitude stations in the northern hemisphere.

Annex I. Measurement of collisional frequencies by wave interaction experiments

One method by which the collisional frequency of electrons in the ionosphere can be determined is based upon the production of heat at the level where this value is desired. On penetrating the ionosphere, an electromagnetic wave undergoes absorption which becomes a maximum usually just before the wave reaches its reflection level. This absorption manifests itself as an increase in energy or heating of the electrons in the ionic region concerned. As the temperature of the electrons increases, their velocity increases and consequently the collisional frequency of the electrons increases, resulting in an increase in their ability to absorb radio-wave energy. The time constant of this heating effect is used to determine the collision frequency of electrons in the ionosphere.

It is feasible to obtain the necessary measurements experimentally. A pulse of sufficient duration is transmitted vertically and on being absorbed in the ionosphere produces the desired local heating. This wave is then reflected from a level dependent upon the frequency of the transmitted signal. By measuring the time delay and the amplitude change of the reflected wave it is possible to determine the collisional frequency.

In practice, in carrying out this experiment, two transmitters should be employed: one for transmitting the heating pulse and the second for transmitting the probing pulses which are used for measuring the height and the time constant. The heating transmitter produces a pulse of about 50 *millisecond* duration with a peak power of about 100 kW. The probing transmitter produces pulses of 20 μsec duration with a repetition rate of 1000/sec. As there is a decrease in the amplitude of the received signal while the heating takes place, there is likewise an increase in amplitude of the signals received from the probing pulses as the region of reflection "cools off" to its normal state. By measuring the amplitudes of the received pulses of the probing rays and knowing their separation in time, a value for the collisional frequency can be determined.

The time duration of 50 msec and the 100 kW of power for the heating pulse is necessary to insure sufficient heating in the ionic layers. With a repetition rate of 1 sec for the entire process, sufficient time is allowed for the ionic region to return to its undisturbed condition before a second heating pulse is transmitted. On the other hand, the probing pulses are sufficiently short so that their heating effect on the ionosphere is practically negligible. Probing pulses of longer duration in themselves would produce some noticeable heating so that the results of the experiment would be inaccurate.

It is preferable that the same frequency be used for the heating and probing pulses in order to insure that the collisions are measured at the same height where the heating occurs. A slight difference in frequencies may nevertheless be very desirable.

The equipment used for the probing pulses may be of the conventional ionosphere recorder type. While an automatic sweep frequency transmitter-recorder could be employed, it may be better to utilize equipment in which the frequency can be adjusted manually. With this possibility, the variation of collision frequency with height can also be determined.

The desirable frequency range in which to conduct the experiments is from 0·5–1·5 Mc/s. The lower frequency represents a value at which reflections would be obtained from the lower portions of the ionosphere (about 90 km). The frequency of 1·5 Mc/s is the highest at which this experiment is practical. It is to be noted that the gyro frequency falls within this range of 0·5–1·5 Mc/s. Operation at the gyro frequency should probably be avoided even though it has the distinct advantage of being a frequency at which energy is strongly absorbed in the ionosphere. However, the heating effect is less concentrated at a specific height.

6 Proposal made in 1951 by the Mixed Commission on the Ionosphere for an International Polar Year in 1957–1958

6.1 *Resolution*

That, for the reasons attached, the Third International Polar Year be selected for 1957–58 and that, in view of the length of time necessary for adequate organization of the complex physical equipment now potentially available, an International Polar Commission be appointed in 1951 to supervise planning.

This resolution is transmitted by the Mixed Commission on the Ionosphere for the approval of the Unions affected and sponsoring this Commission, and for action by ICSU.

Some very valuable studies of the earth's atmosphere were made during the First and Second International Polar Years in 1882–83 and 1932–33 respectively. For example, during the First Polar Year, FRITZ made a remarkable study of the geographical distribution of auroras but little has been done to extend this work on the necessary world scale in more recent times; while during the Second, the first exploration of the ionosphere in Arctic regions by radio sounding methods took place.

Since the Second International Polar Year in 1932–33, there have, however, been many critical developments in the study of the earth's atmosphere from both the technical and theoretical standpoints. In 1932 there were no panoramic or multi-frequency ionospheric records. The separation between the E and F regions had been recognized but not that between regions $F1$ and $F2$. Substantially no data were available on which a world-wide study of the ionosphere could be based. High-altitude rockets were not available, nor radiosondes capable of ascending to a height of 20 km. The interest in atmospheric exploration has now progressed to the point where the co-operation that would be afforded by a Third International Polar Year could go far towards solving certain outstanding problems in ionospheric structure, of movements in the high atmosphere, of magnetic and ionospheric storms and of auroras. Because the last polar year took place at a time of sunspot minimum, it would also be beneficial if the next one were associated with a sunspot maximum. This would be achieved if an interval of 25 years were placed between the Second and Third Polar Years, one half of the interval between the First and Second. It is in this way that the year 1957–58 comes to be recommended for adoption as the Third International Polar Year.

It should perhaps be explained that the expression "polar year" in the document implies not only a year in which special observations would be made in polar regions, but also one in which observations in all latitudes would co-operate to the maximum extent so as to give as complete a picture as possible of world-wide geophysical phenomena. It is also assumed that the Antarctic region would receive its full share of attention.

6.2 *Objectives of the Third International Polar Year*

The principal objectives of the Third International Polar Year would be to provide information for understanding:

(i) The physics of magnetic and ionospheric storms and other disturbances peculiar to polar regions (such as magnetic bays and giant pulsations).
(ii) The physics of auroras.
(iii) The structure and circulation of the atmosphere in the polar regions, where absorption and radiation of the energy by the atmosphere play important roles.

There is a particular need for a complete morphology of the disturbances associated with particular storms from the ionospheric, magnetic and auroral standpoints. Really complete information about one particular disturbance from all standpoints would lead to more progress than quite a large amount of more or less random data from which only statistical conclusions can be drawn.

6.3 *Types of Observations to be made during the Third International Polar Year*

A preliminary survey suggests that the types of observations to be made shall include the following:

6.3.1 *Radio*

Ionospheric sounding by rapid multifrequency or panoramic methods. Accurate height measurements (to say 0·1 km) by special apparatus. Numerical measurements of radio-wave absorption, reflection and scattering. Tracking of moving irregularities in *Es* and *F2* regions. All aspects of storm and other anomalous phenomena, auroral echoes, frequency spectrum of auroral noise.

6.3.2 *Magnetic*

Measurements of magnetic field at great heights by rockets. Estimation of width, intensity distribution and height of current systems. Development and decay of the current systems of storms over short periods of time. Observations of pulsations and bays by equipment with sufficiently short time constants.

6.3.3 *Auroras*

Cine and still-photography of forms and movements. Total radiation and absolute intensity of optical lines. Height variation in intensity of selected lines using modern filters for isolation of the lines. Doppler shifts in selected lines. Morphology of auroral disturbances both on the average and for particular storms from a large number of stations providing highly objective data.

6.3.4 *Rockets*

Measurement of upper air winds using artificial meteor trails. Measurement of magnetic fields at high altitudes in the auroral zone during storms. Measurements of ion/electron ratios, particularly on the dark side of the earth. Detection of "windows" in the high atmosphere at optical frequencies.

6.3.5 *Ozone*

Effect of magnetic and meteorological storms on the spatial and height distribution of ozone. Observation by the Dobson method and direct observations by radiosondes.

6.3.6 *Cosmic rays*

Effect of solar flares and magnetic storms on the intensity of cosmic rays. Variation with height and with latitude near and within the auroral zone. Recording of increases associated with solar flares especially associated with polar high-altitude stations.

6.3.7 *Troposphere*

Observations of the zonal semi-diurnal pressure oscillation and any other features proposed by the Association of Meteorology of UGGI.

6.3.8 *Astronomical*

A highly organized program of solar observations will be needed to provide all possible information on associated solar phenomena during the intensive Polar Year observations.

6.4 *Recommendations*

Great advances in our understanding of the physics of the earth's atmosphere are to be expected by combining special observations in the north and south polar regions with observations of a similar nature carried out at lower latitudes. It is therefore recommended that:

(a) The year 1957–58 be designated an International Polar Year.

(b) A Commission be set up by ICSU similar to that established for previous polar years to encourage, through the various Unions and their National Committees, the establishment of a proper network of observing stations.

(c) In view of the complexities of the apparatus needed to exploit the potentialities of modern technique, the above Commission be established in 1951, so as to give at least five full years of preparation and trial.

(d) A permanent secretariat should be formed to operate during the most active period of the Commission's work, from about 2 years prior to the Polar Year until about 3 years after the Polar Year.

7 Rapport Concernant la Reprise d'une Opération de Longitudes Mondiales présenté à l'Assemblée Générale de l'Union Astronomique Internationale (Rome, septembre 1952)

On trouve dans le Volume VII des *Transactions* de l'Union Astronomique Internationale (page 179), le texte ci-après de la résolution adoptée à Zurich par la Commission des Positions Géographiques:

"Il est décidé qu'il n'y a pas lieu d'envisager *pour l'instant* le renouvellement d'une détermination mondiale des longitudes. Les méthodes de détermination des longitudes sont actuellement en pleine évolution et l'on peut escompter que l'on aboutira très prochainement à une augmentation très sensible de la précision.

"Il y aura lieu dans un *avenir relativement proche* de procéder à une nouvelle détermination d'ensemble comportant quelques stations judicieusement réparties sur le globe et particulièrement bien équipées. D'autres stations moins bien équipées seront invitées à participer à l'opération, mais une discrimination devra être faite au cours de la discussion finale en tenant compte de la précision variée des opérations.

"Il est souhaité que cette opération future suscite comme la précédente de nombreuses recherches dans des domaines variés et contribue à amener un important progrès dans le problème de la détermination des longitudes."

Un certain nombre d'Astronomes et de Géodésiens ont pensé que la date de 1958 (soit 25 ans après l'Opération de 1933) paraissait convenir pour une nouvelle opération mondiale. Si, cependant, l'UAI devait tenir sa X^e Assemblée Générale au cours de cette même année 1958, peut-être serait-il préférable de reporter l'Opération à l'année 1959.

Une telle opération doit se préparer longtemps à l'avance et il n'est certainement pas trop tôt d'en jeter les premières bases dès 1952.

Telle a été en tous cas l'opinion d'un certain nombre d'Astronomes et de Géodésiens français et une Commission préparatoire, à caractère national, a été nommée à cet effet par le Bureau des Longitudes de Paris.* C'est aux conclusions adoptées par cette Commission que se réfère plus particulièrement le présent Rapport.

(1) Il a été considéré que l'étude du temps de propagation des signaux horaires radiotélégraphiques serait indiscutablement l'une des questions essentielles dont il faudrait tenir compte pour l'organisation des opérations.

Celles-ci ne seraient plus seulement conduites grâce à une collaboration entre Astronomes et Géodésiens mais des Radio-électriciens devraient y être associés de très près.

L'Union de Radio Scientifique Internationale (URSI) tenant son Assemblée Générale à Sydney en août 1952, le Président de la Commission de la Détermination des Positions Géographiques a écrit directement au Président de cette Union (Sir Edward APPLETON) et au Secrétaire Général (Colonel HERBAYS) pour leur demander d'inscrire l'étude de cette question à l'ordre du jour de l'Assemblée Générale.†

* Cette Commission comprenait: MM. COUDER, DANJON, DECAUX, LACLAVÈRE, le R. P. LEJAY, STOYKO et TARDI.

† Le R. P. LEJAY (actuellement Président de l'URSI), présent à l'Assemblée Générale de Sydney, a bien voulu se charger d'y soutenir cette proposition.

(2) Il est proposé que toutes les questions concernant l'organisation d'une telle opération soient confiées à une *Commission Mixte Internationale*, régulièrement constituée au sein du *Conseil International des Unions Scientifiques* (ICSU), conformément aux règles qui définissent le fonctionnement de ces organismes. Trois Unions seraient intéressées au fonctionnement de cette Commission (UAI, UGGI et URSI).

Le Secrétaire Général de l'UGGI, M. G. Laclavère, veut bien se charger de porter cette question devant l'ICSU qui se réunit en Assemblée Générale à Amsterdam au début du mois d'octobre 1952, en proposant que "l'Union Mère " à laquelle se rattache la Commission mixte soit l'Union Astronomique Internationale.

(3) Au cours de la première opération (1926) il avait été envisagé de constituer un "triangle fondamental", constitué par les trois stations de même latitude de Zi-Ka-Wei, Alger et San-Diégo. Mais la considération de ce triangle n'a plus guère servi en 1933. Il est proposé de l'abandonner définitivement pour la nouvelle opération.

Il reste néanmoins nécessaire de constituer un *réseau fondamental* sur lequel viendrait se greffer un *réseau complémentaire* de stations de moindre importance. Mais il semble préférable d'admettre que ce réseau fondamental soit constitué par certaines stations appartenant au réseau normal du *Service International de l'Heure.*

(4) On pourrait objecter que les Observatoires rattachés au Bureau International de l'Heure effectuent de façon permanente des opérations qui se ramènent à des déterminations de longitude. Il semble qu'une distinction essentielle doit être établie entre ces observations journalières, de *service courant*, ayant pour but une définition continue et précise *du Temps Universel*, et l'opération internationale envisagée.

Celle-ci semble pouvoir être définie de la façon suivante:

(a) A une (ou à plusieurs) époque déterminée, un certain nombre de stations du BIH, situées à des latitudes pas trop différentes (pour pouvoir utiliser le même catalogue d'étoiles horaires) s'attacheront à multiplier et à soigner davantage leurs programmes d'observations en se rapprochant autant que possible d'un programme commun qui devra être arrêté par entente générale.

(b) Pendant cette même période un programme particulier d'émissions radiotélégraphiques sera organisé suivant des modalités qui restent à préciser après entente avec des représentants qualifiés de la radiotélégraphie scientifique. Ce programme sera conçu en vue d'éliminer, de façon aussi parfaite que possible, les *erreurs systématiques* qui se produisent indiscutablement encore dans la détermination des temps de propagation des signaux horaires. Par un phénomène de "réactions réciproques" commun à toutes les sciences expérimentales, on doit ainsi aboutir à la fois à une meilleure détermination des différences de longitudes et à une meilleure connaissance des lois de propagation des signaux horaires.

(c) Pendant cette même période également un nombre aussi grand que possible de stations secondaires, généralement moins bien équipées, participeront "de leur mieux" à l'opération organisée. Il y a un intérêt évident à ce que soient réoccupés *le plus grand nombre possible des soixante-onze Observatoires qui avaient été occupés en* 1933. Des instructions précises seront mises au point pour ces stations secondaires. Mais il ne semble pas possible (ni souhaitable) qu'un organisme central se charge comme en 1933 des calculs de réduction concernant toutes ces stations (sans la 2e guerre mondiale il aurait fallu 10 ans pour la publication des résultats. Du fait de la guerre et des décès survenus au cours des calculs, il en a fallu vingt).

(5) La question de la détermination du temps de propagation des signaux horaires radiotélégraphiques reste donc une des questions essentielles à étudier *avant* et *après* l'opération envisagée.

L'emploi exclusif de signaux émis sur *ondes longues* présenterait d'indiscutables avantages malgré le doute qui subsiste toujours dans ce cas sur la *durée d'établissement du signal*. Peut-être pourrait-on supprimer cet inconvénient en utilisant des signaux modulés? Par ailleurs l'emploi d'ondes longues nécessite l'utilisation de postes à très grande puissance.

Si l'on s'en tient à des signaux émis sur ondes courtes et particulièrement à des signaux continus du type de ceux actuellement émis par la station WWV, la question des propagations irrégulières prend une grande importance. L'emploi aux stations réceptrices d'un appareil goniométrique permettra sans doute d'éliminer ceux des signaux arrivant dans un azimut très différent de celui correspondant au poste émetteur. Des mesures particulières devront être prises pour déduire les conditions de propagation de chaque signal des indications données par les différents postes d'observation ionosphériques, avec lesquels il sera nécessaire de rester en liaison étroite.

(6) Les questions concernant les méthodes et les programmes d'observation ainsi que les instruments ne devront naturellement pas être perdues de vue pour autant et particulièrement toutes les questions concernant l'élimination des équations personnelles des observateurs.

Les mesures envisagées sont des *mesures d'homogénéisation* faites sur un plan mondial. Elles concernent par ailleurs la formation de *différences* de longitudes. Il semble donc nécessaire *a priori* que les mêmes étoiles soient observées dans les mêmes stations ou tout au moins dans les stations du réseau fondamental. Cette prescription conduirait à ne pas admettre dans ce réseau fondamental de stations uniquement équipées en instruments zénithaux à champ d'observation étroit dont le catalogue d'observation est indiscutablement très limité en déclinaisons. Par contre des instruments de hauteurs égales (analogues au nouvel astrolabe impersonnel réalisé par M. DANJON) pourraient être utilisés en limitant leurs observations aux étoiles horaires qui, si elles font partie du catalogue général adopté, seraient seulement observées avant ou après leur passage au méridien, au lieu de l'être à l'instant de ce passage.

Naturellement ces questions devront faire l'objet de discussions approfondies au sein de la Commission mixte qui sera créée.

(7) Lors de la réunion tenue à Zurich par la Commission 31* il avait été adopté un voeu tendant au rétablissement des émissions en ondes longues du poste NSS de telle sorte que des mesures précises de vitesses des ondes longues puissent être organisées de *chaque côté de l'Atlantique* (mesure des différences de temps de parcours dans les deux sens). Cette proposition doit être reprise et développée.

(8) Dans le même ordre d'idées le Comité national Japonais (MM. Y. HAGIHARA et M. MIYADI) viennent de soumettre à la Commission 18 des propositions qui

* Contenu dans le *Transactions of the International Astronomical Union*, Vol. VII, p. 329.

figurent dans le Rapport présenté à cette Commission, mais qu'il nous paraît opportun de reproduire ci-après:

"The recent advancement in the accuracy of Time has played an important role in position astronomy as well as in other fields of science, especially in the frequency science. The international time comparison should be more promoted. However, there have always been difficulties for determining accurately the time of propagation of radio waves. It is desirable to make researches from the standpoint of the precise time, and it may be also of use for ionospheric research.

"For this purpose, it is most essential to exchange the time signals bilaterally with each other, and if possible, on the same frequency and nearly at the same time. The 'standard frequency and time signal wave' may be used for this purpose.

"It is our earnest proposal that the Commission should discuss the possibility of realizing this co-operation and make some arrangements for exchange of time signals in order to determine the most accurate astronomical time, one of the most fundamental measures in our conception of the Universe. Especially, it is desirable that the Commission should recommend that the time signals from the Far East be received by observatories in other continents, in particular the JJC or JJY signals from Tokyo by Canberra, Greenwich, Paris and Washington. It is particularly recommended that two observatories in the same longitude should exchange time signals for studying the propagation of radio waves, because the two observations are free from the *unknown* longitude variation."

La proposition faite par le Comité national Japonais présente un indiscutable intérêt. Cet échange bi-latéral de signaux horaires émis à peu près à la même heure et sur des longueurs d'ondes identiques, très difficile (sinon impossible) à réaliser pour le "Service courant" du Bureau International de l'Heure, pourrait utilement être envisagée dans la cadre d'une opération mondiale, de durée limitée et comportant un réseau fondamental formé par un petit nombre des Observatoires participant habituellement au fonctionnement du Bureau International de l'Heure.

Prof. Pierre Tardi,
Directeur du Bureau Central
de l'Association Internationale de Géodésie
de l'UGGI,
Président de la Commission de la Détermination
des Positions Géographiques de l'UAI

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II—THE SECOND MEETING OF THE CSAGI

(Rome, 30 September–4 October 1954)

1 General Report

1.1 *Introduction*

THE Special Committee of the International Geophysical Year (CSAGI) met in Rome from 30 September to 4 October 1954 at the Palace of Consiglio Nazionale delle Ricerche, Piazzale delle Science, where conference rooms were put at its disposal.

The International Unions belonging to CSAGI, and the National Committees for the International Geophysical Year, were invited to send their delegates and observers. More than 100 persons took part in the plenary sessions and most of them participated in study groups. The following members took part in the first session reserved for the members of the CSAGI on 30 September at 9.0 a.m.:

S. CHAPMAN, President
L. V. BERKNER, Vice-President
M. NICOLET, Secretary-General

International Council of Scientific Unions
E. HERBAYS

International Astronomical Union
A. DANJON
Sir HAROLD SPENCER JONES

International Union of Geodesy and Geophysics
J. COULOMB
G. LACLAVÈRE
V. LAURSEN
P. TARDI

International Union of Radio Science
W. J. G. BEYNON
M. BOELLA

International Union of Pure and Applied Physics
J. A. SIMPSON

International Geographical Union
J. M. WORDIE

World Meteorological Organization
T. E. W. SCHUMANN
J. VAN MIEGHEM

The Mixed Commission on the Ionosphere and the Mixed Commission for the Study of Solar-Terrestrial Relationships are represented respectively in CSAGI by W. J. G. BEYNON and M. NICOLET. M. S. VALLARTA, representative of the IUPAP, was absent. Dr. R. FRASER, Administrative Secretary of ICSU, was present.

The President outlined the work done by the Bureau since the Brussels Meeting and referring to the problem of international participation in the International Geophysical Year 1957–58 the participation of the USSR in the International Geophysical Year was emphasized.

The President expressed his gratitude to members of CSAGI for their activities since the first plenary meeting at Brussels and recalled that the working groups appointed at Brussels had corresponding members in the CSAGI.

I World Days: L. V. BERKNER, Vice-President and a group consisting of:
S. CHAPMAN, President
M. NICOLET, Secretary-General
P. LEJAY, President of URSI

II Meteorology: J. VAN MIEGHEM
III Geomagnetism: V. LAURSEN
IV Aurora and Airglow: S. CHAPMAN
V Ionosphere: W. J. G. BEYNON
VI Solar Activity: Sir HAROLD SPENCER JONES
VII Cosmic Rays: J. A. SIMPSON
VIII Longitudes and Latitudes: A. DANJON
IX Glaciology: J. M. WORDIE
X Oceanography: G. LACLAVÈRE
XI Rockets: H. E. NEWELL, (President at Rome)
Geographical Distribution: J. COULOMB
Publications and Publicity: M. NICOLET

The Secretary-General read his report which is summarized as follows:

The Bureau (S. CHAPMAN, L. V. BERKNER and M. NICOLET) held four meetings: Washington, D.C., November 1953 and April 1954, Brussels, August 1954, and September 1954 at Rome.

The members of the Bureau have given special attention to the problem of the International Geophysical Year during visits to foreign countries.

The President visited Ireland, Yugoslavia, Greece and Turkey. He took part in a meeting of the British Committee for the International Geophysical Year, two meetings of the U.S. National Committee for the International Geophysical Year, a meeting of the U.S. Rocket Panel and a symposium on the International Geophysical Year at the National Academy of Sciences (Washington). He participated in meetings of the Mixed Commission on the Ionosphere at Brussels in August; of the URSI at The Hague also in August, and of the IUGG and its AGI Committee at Rome in September.

The Vice-President participated in meetings of the U.S.–Canadian Committees of the URSI at Ottawa in October 1953, the Symposium on the International

Geophysical Year at the National Academy of Sciences at Washington in April 1954, the U.S. National Committee of the URSI at Washington in May 1954, the Mixed Commission on the Ionosphere at Brussels in August 1954, the URSI and the AGI Committee of the URSI at The Hague, also in August 1954, the Ionospheric Conference at Cambridge, England, in September 1954, the IUGG and the AGI Committee of the IUGG at Rome in September 1954.

The Secretary-General visited Ottawa, Canada, in October 1953, Washington in November 1953 (Naval Observatory) and in February 1954 (Rocket Panel and Secretary-General of the IUGG), New York in January 1954 (Vice-President), Paris in April 1954 (Secretary-General of the IUGG), Liège in July 1954 (Executive Committee of the IAU), Manchester, England, in July 1954 (Conference on Meteor Physics). He participated in two meetings of the U.S. National Committee for the International Geophysical Year. He took part in the meetings of the Mixed Commission on the Ionosphere at Brussels, August 1954, of the URSI and AGI Committee of the URSI at The Hague, also in August 1954, of the IUGG and the AGI Committee of the IUGG at Rome in September 1954.

W. J. G. Beynon participated in meetings of the Mixed Commission on the Ionosphere (Secretary) at Brussels in August 1954, the URSI (Secretary of Commission III) and the AGI Committee of the URSI at The Hague (Secretary) also in August 1954. M. Boella participated in meetings of the URSI at The Hague in August 1954, and of the IUGG at Rome in September 1954.

A. Danjon, Sir Harold Spencer Jones, J. Coulomb, G. Laclavère, V. Laursen, P. Tardi, J. M. Wordie, J. A. Simpson, T. E. W. Schumann, J. Van Mieghem participated in the General Assembly of the IUGG and in the meeting of the AGI Committee of the IUGG at Rome in September 1954.

An article by S. Chapman (*Nature*, **172,** 327, 1953) and the Information Bulletins No. 1 and No. 2 were sent to all the national committees of the IGY by the Secretary-General of the CSAGI. Copies were also sent to all meetings relating to IGY and to certain countries which have not yet formed national committees.

By June 1953, twenty-two countries had formed national committees. Today, the following countries have national committees for the International Geophysical Year:

1. Argentina
2. Australia
3. Austria
4. Belgium
5. Brazil
6. Canada
7. Czechoslovakia
8. Denmark
9. Finland
10. France
11. Germany (Democratic Republic)
12. Germany (Federal Republic)
13. Greece
14. Iceland
15. India
16. Ireland
17. Israel
18. Italy
19. Japan
20. Mexico
21. Morocco
22. Netherlands
23. New Zealand
24. Norway
25. Pakistan
26. Peru
27. Philippines
28. Spain

29. Sweden
30. Switzerland
31. Tunisia
32. Union of South Africa
33. USSR
34. United Kingdom
35. U.S.A.
36. Yugoslavia

Other countries have expressed an interest in the program of the International Geophysical Year, but have not yet appointed national committees.

On January 1954, a letter from the Secretariat was sent to various committees for the International Geophysical Year requesting that they present national reports based on the resolutions adopted at Brussels and on the suggestions offered by the Secretary-General. At the same time, the national committees were invited to send delegates and observers to the meeting of the CSAGI at Rome. In addition, the international unions were invited to send experts to the Rome meeting.

The national committees of the following countries submitted reports at the Rome meeting:

1. Argentina
2. Austria
3. Brazil
4. Canada
5. Finland
6. France
7. Germany (Federal Republic)
8. India
9. Japan
10. Morocco
11. Netherlands
12. New Zealand
13. Norway
14. Peru
15. Spain
16. Sweden
17. Union of South Africa
18. United Kingdom
19. U.S.A.
20. Yugoslavia

Finally, the Secretary-General furnished details on the subject of preparation and organization of the plenary assembly of the CSAGI at Rome. In particular, 150 copies of Information Bulletins No. 1 and No. 2, National Reports, decisions of the Mixed Commission on the Ionosphere, of the URSI, of the Committee on World Days and of the reports of working groups of the AGI Committee of the IUGG were distributed to all participants of working groups of the AGI Committees in URSI, IUGG and CSAGI.

Subsequent to the report of the Secretary-General, the Vice-President in the name of the CSAGI Finance Committee presented the financial report, emphasizing the increased working load of the Secretariat due to the abundance of problems associated with the International Geophysical Year. Before the members of the CSAGI, he outlined recommendations made to the Secretariat of the ICSU. After discussion and approval of the report of the Vice-President, the special committee decided to ask the President to present the budgetary problem of the CSAGI Secretariat at the ICSU meeting at Naples on 5 October, considering the possibility of an increase in UNESCO assistance, since the International Geophysical Year is something exceptional in international scientific co-operation.

The session closed after the correspondents of various CSAGI working groups had presented some remarks on the subject of problems inherent in their functioning.

1.2 *The Opening Plenary Assembly*

The Plenary Assembly was opened at 11.0 a.m. by the President, who recalled briefly the conditions under which the CSAGI was established. He commended the work accomplished by URSI and the IUGG, whose committees presented their results to CSAGI. He emphasized the measures taken, on behalf of CSAGI, to obtain participation of the USSR, which on 30 September appointed a national committee for the International Geophysical Year.

The Vice-President then presented to the Assembly budgetary data requested by CSAGI and recommendations to the ICSU.

Subsequently the Secretary-General gave a short survey of the activities of the national committees, which numbered forty on 30 September 1954.

It was decided that resolutions should make special mention of the value of seismic studies and of gravity measurements in Antarctica.

1.3 *Working Groups*

The Working Groups for the Rome Assembly were organized as follows:

I World Days

Berkner (Correspondent)
Chapman, Nicolet, Lejay (Members of the Permanent Committee of World Days)
Boella (CSAGI)
Herbays (CSAGI)
Harang (Norway)
Maeda (Japan)
Shapley (U.S.A.)
Veldkamp (Netherlands)

II Meteorology

Van Mieghem (Correspondent)
Schumann (CSAGI)
Bilancini (Italy)
Doporto (Ireland)
Lugeon (Switzerland)
Montanari (Italy)
Ramanathan (India)
Solberg (Norway)
Toperczer (Austria)
Van der Elst (Belgium)
Vujevic (Yugoslavia)
Walton (United Kingdom)
Wexler (U.S.A.)
Yriberry (Argentina)

III Geomagnetism

Laursen (Correspondent)
Chapman (CSAGI)
Coulomb (CSAGI)
Bartels (German Federal Republic)
Cardus (Spain)
Giorgi (Italy)
Gulatee (India)
Herlofson (Sweden)
Herrinck (Belgium)
Madill (Canada)
Molina (Italy)
Nagata (Japan)
Nelson (U.S.A.)
Özdogan (Turkey)
Roberts (U.S.A.)
Toperczer (Austria)
Veldkamp (Netherlands)

IV *Aurora and airglow* (with sub-groups)

CHAPMAN (Correspondent)

Aurora

ELVEY (U.S.A.), Chairman
BARTELS (German Federal Republic)
DIEMINGER (German Federal Republic)
HARANG (Norway)
HERLOFSON (Sweden)
KAPLAN (U.S.A.)
MONTALBETTI (Canada)
ÖZDOGAN (Turkey)
TRYGGVASON (Iceland)

Airglow

ROACH (U.S.A.), Chairman
NICOLET (CSAGI)
GERSON (U.S.A.)
KAPLAN (U.S.A.)
MILEY (U.S.A.)
NAGATA (Japan)
RAMANANATHAN (India)

V *Ionosphere*

BEYNON (Correspondent)
BERKNER (CSAGI)
NICOLET (CSAGI)
DAVIES (Canada)
DE VOOGT (Netherlands)
DIEMINGER (German Federal Republic)
DOMINICI (Italy)
GERSON (U.S.A.)
HARANG (Norway)
HERLOFSON (Sweden)
LEJAY (France)
MADER (Austria)
MAEDA (Japan)
MARIANI (Italy)
MATSUSHITA (Japan)
RAMANATHAN (India)
RANZI (Italy)
SHAPLEY (U.S.A.)
TRYGGVASON (Iceland)
YRIBERRY (Argentina)
RAWER (Observer)

VI *Solar activity*

Sir HAROLD SPENCER JONES (Correspondent)
DANJON (CSAGI)
NICOLET (CSAGI)
ABETTI (Italy)
BARTELS (German Federal Republic)
BOBROVNIKOFF (U.S.A.)
BOURGEOIS (Belgium)
CIMINO (Italy)
DE VOOGT (Netherlands)
GOLD (United Kingdom)
HOPMANN (Austria)
NAGATA (Japan)
RAMANATHAN (India)
ROMANA (Spain)
SHAPLEY (U.S.A.)
SIMPSON (U.S.A.)

VII *Cosmic rays*

SIMPSON (Correspondent)
CHAPMAN (CSAGI)
BACHELET (Italy)
BARTELS (German Federal Republic)
CONFORTO (Italy)
GOLD (Great Britain)
KORFF (U.S.A.)
MONTALBETTI (Canada)
NAGATA (Japan)
RAMANATHAN (India)
SINGER (U.S.A.)
TRYGGVASON (Iceland)
YRIBERRY (Argentina)

VIII Longitudes and latitudes

Danjon (Correspondent)
Tardi (CSAGI), Secretary
Boella (CSAGI)
Sir Harold Spencer Jones (CSAGI)
Adkins (U.S.A.)
Bobrovnikoff (U.S.A.)
Böhm (Czechoslovakia)
Bourgeois (Belgium)
Carrasco (Spain)
Gulatee (India)
Hopmann (Austria)
Lejay (France)
Mader (Austria)
Nikolic (Yugoslavia)
Zagar (Italy)

IX Glaciology

Wordie (Correspondent)
Atwood (U.S.A.)
Davies (Canada)
Gulatee (India)
Manley (United Kingdom)
Rigsby (U.S.A.)
Tryggvason (Iceland)

X Oceanography

Laclavère (Correspondent)
Debrach (Morocco)
Davies (Canada)
Rao (India)
Roberts (U.S.A.)
Smith (U.S.A.)
Tenani (Italy)
Wexler (U.S.A.)

XI Rockets

Newell, Jr (U.S.A.) Chairman
Nicolet (CSAGI)
Debrach (Morocco)
Gerson (U.S.A.)
Gold (United Kingdom)
Montalbetti (Canada)
Ramanathan (India)
Singer (U.S.A.)
Rawer (Observer)

Geographical distribution

Coulomb (Correspondent)
Berkner (World Days and Antarctic Region)
Beynon (Ionosphere)
Chapman (Aurora and Airglow)
Danjon (Longitudes and Latitudes)
Laclavère (Oceanography)
Laursen (Geomagnetism and Equatorial Belt)
Nicolet (Publications)
Sir Harold Spencer Jones (Solar Activity)
Simpson (Cosmic Rays)
Van Mieghem (Meteorology and 10° E Meridian Line)
Wordie (Glaciology)
Elvey (Aurora and Arctic Region)
Korff (Cosmic Rays)
Nagata (140° E Meridian Line)
Newell (Rocket Stations)
Roach (Airglow)
Shapley (70°–80° Meridian Line)

Publications and publicity

NICOLET (Correspondent)
HERBAYS (CSAGI)
COULOMB (CSAGI)
LACLAVÈRE (CSAGI)
FRASER (ICSU)
ATWOOD (U.S.A.)
KAPLAN (U.S.A.)
MARTIN (United Kingdom)
RAO (India)
ROBERTS (U.S.A.)
ODISHAW (U.S.A.)

In the afternoon of the 30th of September, at 2.30, scientific work was begun with the following reports:

1. World Days: by L. V. BERKNER
2. Meteorology: by J. VAN MIEGHEM
3. Geomagnetism: by V. LAURSEN
4. Aurora and Airglow: by S. CHAPMAN
5. Ionosphere: by W. J. G. BEYNON
6. Solar Activity: by Sir HAROLD SPENCER JONES
7. Cosmic Rays: by J. A. SIMPSON
8. Longitudes and Latitudes: by A. DANJON
9. Oceanography: by G. LACLAVÈRE
10. Rockets: by H. E. NEWELL

On 1 and 2 October the 12 working groups met, simultaneously or successively, from 9 a.m. to 7 p.m. A plenary meeting took place from 9 to 10 a.m. on Saturday 2 October to hear the reports on the progress of the working groups.

J. A. SIMPSON presented a summary of the geophysical aspects of the observation of cosmic radiation. On 3 October, the working group on the ionosphere and certain sub-groups of Geographical Distribution worked from 9 a.m. to 6 p.m.

At the opening of the final plenary session (4 October), the President welcomed the USSR delegation, headed by Prof. V. V. BELOUSSOV, which participated for the first time in a meeting of the CSAGI.

The general resolutions, submitted to the Plenary Assembly, were adopted (see p. 172).

The correspondents of the CSAGI presented their reports and the resolutions of the working groups. The complete text is reproduced in reports pertaining to the various groups (see p. 93).

I World Days: by L. V. BERKNER
II Meteorology: by J. VAN MIEGHEM
III Geomagnetism: by V. LAURSEN
IV Aurora and Airglow: by C. T. ELVEY and F. E. ROACH, Chairmen of the Working Sub-Groups
V Ionosphere: by W. J. G. BEYNON
VI Solar Activity: by SIR HAROLD SPENCER JONES
VII Cosmic Rays: by J. A. SIMPSON
VIII Longitudes and Latitudes: by P. TARDI, Secretary of the Working Group
IX Glaciology: by W. W. ATWOOD (for J. M. WORDIE)

X Oceanography: by G. LACLAVÈRE

XI Rockets: by H. E. NEWELL, Chairman of the Working Group

Geographical Distribution: by C. T. ELVEY (Arctic), V. LAURSEN (Equatorial Belt), L. V. BERKNER (Antarctic), J. VAN MIEGHEM (10° E), T. NAGATA (140° E) and A. H. SHAPLEY (70–80° W).

Publications: by G. LACLAVÈRE (for M. NICOLET)

After the adoption of the resolutions, the President invited the representative of the USSR, Prof. V. V. BELOUSSOV, to speak.

The representative of the USSR announced that the Academy of Sciences of the USSR had established a national committee for the International Geophysical Year in view of the participation of his country in the International Geophysical Year.

The Academy of Sciences of the USSR considers it necessary to extend the program of the International Geophysical Year to seismology, to gravimetry and to earth currents, and believes that observations in these three branches should be made simultaneously with other proposed observations.

The Academy of Sciences of the USSR believes that countries of vast area (China, India and the USSR) should be represented in CSAGI.

The President of the CSAGI expressed his gratitude to Prof. V. V. BELOUSSOV for his speech, and emphasized that the International Geophysical Year "... has expanded beyond all expectation, and the adherence of the USSR, just noted, fulfils one of our earnest hopes, cherished from the outset of our work. At an early stage in the formation by ICSU of the Special Committee, it was hoped that we should obtain the direct participation of the USSR in our central planning, through the appointment of USSR nationals as representatives of one or both international bodies associated with CSAGI, to which the USSR already adhered—that is to say, of the International Astronomical Union and the World Meteorological Organization; but the steps taken by these bodies in this direction led to no result, and members of other nations were appointed as the representatives of these international bodies. It may be that ICSU will find it appropriate in some way to achieve that earlier objective so that USSR nationals may be added to CSAGI; but I should point out that the members of CSAGI have been chosen on a functional, not a national basis—they represent international bodies concerned with particular branches of science, and not the nations of which they are members. All the nations participating in the International Geophysical Year were invited to send one or more representatives to assist CSAGI in the central planning, and the large attendance at these meetings here in Rome has been a fine response to that invitation; their help has been invaluable. Their aid has been rendered with single-minded devotion to science and to the great objective towards which we are working; and the presence or otherwise of a fellow national on CSAGI itself has not affected the co-operation in the slightest. In this way the advice and participation of India have been freely rendered and gratefully received, and the same applies to all the other nations adhering to the International Geophysical Year, and will equally apply in future to present and prospective member nations.

"We should have been glad if it had been possible for us to receive from the USSR IGY National Committee a report on its preliminary program for study at this meeting, along with the other national reports we have received and considered in formulating our revised program; but we recognize that the formation of the USSR IGY National Committee is too recent for this to have been possible; we shall welcome a national report, however, from the USSR as soon as it can be made available, and hope that such a report can be received in time for publication along with those already received, and with the account of our proceedings at these meetings.

"Our colleagues from the USSR have now received the papers distributed today representing the fruits of the deliberation of our many working groups. From these they will see the place already accorded in our plans to the subjects specially mentioned by Prof. V. V. BELOUSSOV—seismology, gravimetry and earth currents. We shall give careful consideration at a later date to any detailed proposals that we may receive from the USSR IGY National Committee on these as on other branches of our work—such as the proposals presented by Dr. SOLOTOUKHINE to the World Meteorological Organization, which have been carefully considered by the working group on Meteorology.

"We hope that a Chinese IGY National Committee will shortly be formed and will present a national report, and any comments and proposals therein regarding the CSAGI program just adopted will be welcomed and given full consideration."

1.4 *Report by the President on the Work of the Meeting*

The President then presented a survey of the work accomplished by the CSAGI in Rome from September 30—October 4, 1954. It can be summarized as follows:

I World Days

A plan for IGY World Days has been formulated and adopted by CSAGI, and the calendar of IGY World Days has been circulated subject to final adoption at the meeting of CSAGI, September 1955.

Three Regular World Days, two at new moon and one near the quarter moon, have been specified each month, and include predictable events such as meteor showers and solar eclipses.

The Central Radio Propagation Laboratory, U.S.A., in co-operation with centers in France and Japan, will formulate predictions of geophysical disturbances. Based on solar observations of all types, the likelihood of geophysical disturbance will be notified by an "Alert" five or six days in advance. When subsequent solar activity leads to prediction of a disturbance, a Special World Interval will be declared over IGY communication networks about 12 hours in advance, to continue until terminated by the predicting agencies. Through this procedure it is hoped that detailed observation and description of the world-wide morphology of auroral, magnetic and ionospheric disturbances will be possible.

The World Meteorological Intervals of ten days each are established at each equinox and solstice during the International Geophysical Year to provide intervals for continuous concentrated meteorological observations. Each interval includes the three Regular World Days during the month in which it occurs.

Time stations and Ursigram communication networks will carry to all nations the "Alerts", announcements of Special World Days and pertinent solar and geophysical information. Each nation will inform the stations for which that nation is responsible. The WMO and CCIR have been asked to co-operate in extending this network, and their co-operation seems assured.

II Meteorology

The following points have been stressed:

(1) The necessity of making a selection from the many problems which have been suggested.
(2) The desirability of giving primary attention to problems of world-wide significance.
(3) The special need for a comprehensive study of tropical meteorology and its bearing on the general circulation.

The broad lines of the meteorological programs are the following:

(1) The redistribution on a planetary scale of momentum, vorticity, energy and entropy.
(2) The large-scale influences of the Earth's surface.
(3) The large-scale components of the radiation balance on the geographical scale of the general circulation.
(4) The vertical and horizontal distribution of ozone, especially in connection with the jet-stream.

Regarding the network of aerological stations, a selection of meridional and zonal cross-sections has been adopted. Moreover the CSAGI has recommended the adoption of six World Meteorological Intervals (WMI) of 10 consecutive days each, to occur quarterly at solstices and equinoxes during the International Geophysical Year.

The CSAGI requests the International Astronomical Union to arrange for the measurements, during the International Geophysical Year, of the earth's albedo, using Prof. Danjon's method based on the observation of the reflected earth light from the moon.

The establishment of aerological stations in the following strategic locations is strongly recommended:

Clipperton Island, Easter Island, South Sandwich Group, Tristan da Cunha Island, Gough Island, Crozet Island, St. Paul's Rocks, Bouvet Island.

The CSAGI recommends bilateral agreements to arrange for joint undertakings by different countries, during the International Geophysical Year, so as to overcome difficulties arising in certain services from the shortage of personnel and/or equipment.

III Geomagnetism

The program of observations was considered in great detail, and definite recommendations on the instrumental equipment and procedure of the observations were worked out. A new feature is the introduction of satellite stations supplementing the regular network, for the purpose of studying the gradients of magnetic fields as well as the regionally variable influence of the induced part of the geomagnetic time-variations. Without counting the USSR stations, about 100 magnetic observatories will work during the International Geophysical Year. A fundamental contribution of geomagnetic observatories to geophysics, namely the regular estimation of the intensity of solar corpuscular radiation by means of three-hourly indices for magnetic activity, will be supplemented during the International Geophysical Year by similar indices for 15-min intervals.

The CSAGI adopted twenty-four resolutions on this subject.

IV Aurora and Airglow

(1) The phenomenon of the aurora is produced by the bombardment of the atmosphere by charged particles from the sun. The investigation of the aurora is an important part of geophysical research and bears on practical problems of radio-communications.

Extensive visual, photographic, photometric and radio observations are being planned to give a synoptic view of the auroras over the globe. To facilitate the processing of data and its publication, auroral centers for several geographical areas are planned, as well as one to serve internationally.

The centers will receive the data from the observatories and field stations and prepare synoptic maps at 15-min intervals throughout both the disturbed and quiet periods. The auroral centers, also, will place the data taken throughout the period of the International Geophysical Year on punched cards for analysis.

The results will be compared with the various theories of the mechanism of the production of auroras, and attempts will be made to determine the solar source of the particles and to deduce information concerning the space between the sun and the earth.

(2) It is proposed to make systematic photometric observations of the night airglow at approximately forty stations during the International Geophysical Year. Four major chains of stations are planned: (1) Europe–Africa; (2) The Far East; (3) India–Kashmir; and (4) The Americas. The first and fourth chains will cross the maximum northern auroral zone and will thus serve to give a latitude profile of the nightglow as well as of the intensities of the aurora. All photometric observations are reducible to absolute intensities by the development of standardized methods and light sources. Three types of photometers are planned: (1) a scanning instrument to cover the entire sky, with four telescopes for four spectral regions and with a recording galvanometer; (2) a manually operated photometer with a single telescope and interchangeable filters; and (3) a visual photometer.

The American chain will be in partial operation by 1955, and it is planned to develop standardized methods for the reduction of the data, which can be further extended as the full chain of stations is developed during the International Geophysical Year.

As an example of a co-ordinated chain, the natural center for the co-ordination of the airglow data in the American chain is Boulder, Colorado. A working agreement has been made for Dr. MANRING of Sacramento Peak to monitor the stations to the south of Sacramento Peak, leaving the stations from Boulder northward to F. E. ROACH. Other areas may wish to set up similar group co-ordination.

Special observation of the airglow. Since spectral observations of the day, twilight, and night airglow should lead to important progress in aeronomy, CSAGI has recommended that a certain number of stations undertake observations which will provide valuable information on the temperature and the physical constitution of the high atmosphere. In addition, several stations should concentrate on twilight research in the northern, equatorial, and southern regions.

V Ionosphere

The CSAGI has considered the world program for ionosphere observations during the International Geophysical Year. It is expected that during the Geophysical Year regular vertical incidence soundings will be made at more than 100 stations. This compares with five or six ionospheric stations operating during the second Polar Year of 1932.

Careful consideration has been given to the world distribution of observatories and to the types of observations which should be made. The CSAGI has already recommended that first priority should be given to $P'f$ observations, and this type of measurement should be made at every station. In addition studies of ionospheric absorption, which provide valuable information as to the lowest part of the ionosphere, are expected to be made at more than twenty stations during the International Geophysical Year. The subject of movements in the ionosphere is of special interest in relation to geomagnetic problems, and also as part of a general investigation of movement in the terrestrial atmosphere. Plans are being made for extensive studies during the International Geophysical Year of such movements in the ionosphere.

If plans now being proposed are carried out, it can be expected that a fairly complete coverage will be ensured not only for temperate latitudes but also for the equatorial, arctic and antarctic zones.

VI Solar activity

The CSAGI has discussed the various aspects of solar activity which are of importance through their influence on geophysical phenomena, and has prepared a series of recommendations for the guidance of solar observers. Their aim is to encourage further observations in certain directions, and the co-ordination and standardization of data, and to ensure the rapid dissemination of information about important solar flares and radio-noise outbursts, to institutions concerned with the various fields of geophysical observation.

The CSAGI has adopted twenty-three resolutions on Solar Activity.

VII Cosmic rays

Studies of the cosmic radiation have not, until recently, made significant contributions to the development of geophysics and solar physics. At present, however, cosmic-ray research offers the promise of being able to investigate phenomena inaccessible to any other observational discipline in solar physics and geophysics.

It may well be that the coming International Geophysical Year will provide an impetus for cosmic-ray research on intensity, composition and variations with time which will parallel the dramatic development of ionospheric research which followed the last Polar Year.

The CSAGI has made several recommendations for a world-wide study of geophysical and solar problems through cosmic-ray research. Some of these recommendations are summarized as follows:

(1) That standard counter telescopes and neutron intensity monitors be operated in a world-wide network during the International Geophysical Year. To accomplish this, it is proposed that thirty-six new stations be added to the thirty-four stations now in regular operation.
(2) That three new high-altitude stations for cosmic-ray research be established.
(3) That special experiments using balloons, aircraft and rockets be undertaken during the International Geophysical Year.

VIII Longitudes and Latitudes

The program which was established in 1953 at the Brussels Meeting has been revised and extended.

It is expected that during the International Geophysical Year regular observations will be made at thirty-five principal stations. In addition a small number of temporary stations will be added.

The program of lunar observations presented by Dr. MARKOWITZ has been discussed and adopted. About twenty stations are necessary. Plans are being made for the publication of instructions to astronomers and radio electricians.

IX Glaciology

Glaciological research will be extended in the temperate and polar regions during the International Geophysical Year. The program will include detailed observations of the extent, characteristics and behavior of glaciers and the distribution of snow cover. The U.S. group, in consultation with other national groups interested, will co-ordinate the work in this field, and advise on standardizing observations and equipment needed.

Glaciological studies will be conducted at geophysical stations in Antarctica whenever feasible.

At present, the number of stations is expected to be 6–8.

X Oceanography

The United States national committee has proposed a very extensive program on oceanography. Several other countries have also shown interest in oceanographic research during the International Geophysical Year, and hope to co-operate in a world-wide program.

The following points have been stressed:

Observations of the existence, generation and propagation of long-period, non-tidal oscillations of sea-level: (*a*) seismic and storm surges; (*b*) longer changes in level such as might be caused by seasonal changes in temperature or wind.

Study of water circulation, waves, sediments and crustal structure along two extended north–south lines crossing equatorial regions.

The chief aim of this recommendation is to improve our understanding of oceanic circulation.

Investigation by oceanographic ships of the processes involved in the shifting of the boundary region between temperate and arctic waters, and in the warming of the Arctic.

At this stage it seems unlikely that observations will be made in every ocean, and the program will probably have to be restricted to the Atlantic waters and to the eastern part of the Pacific Ocean.

XI Rockets

The United States and France plan to launch upper-air research rockets during the International Geophysical Year. France proposes to launch a dozen of the Véronique rockets at Colomb Béchar, at the rate of two every two months. The United States plans to launch about three dozen Aerobees, most of them at Fort Churchill, Canada, and some in New Mexico. The U.S. program also includes the launching of about 100 small rockets at sea in the following general locations: (1) in the waters between Canada and Greenland; (2) in the Bermuda–West Indies area; (3) off the southern California coast; and (4) along some path southward from the equator to the Antarctic.

The planned programs provide a good coverage of the fields of interest in aeronomic research. They fall far short, however, of what might be desired in total number of soundings and in the geographic and temporal coverage which can be effected. In consequence it has been urged that other nations join the rockets program. With small rockets launched from balloons this can be done relatively inexpensively. It has also been recommended that both the French and U.S. programs be further expanded, if possible.

Geographical distribution

All stations proposed for occupation during the International Geophysical Year have been considered by the CSAGI with the view of:

(1) Detecting gaps in the geography of the program for the International Geophysical Year.

(2) Recommending the combination or elimination of stations where unnecessary duplication appears.

The requirements and proposals of the working groups on aurora, airglow, ionsphere, geomagnetism, oceanography, glaciology, rockets, cosmic rays and meteorology have been considered. The CSAGI did not consider the requirements for solar activity and latitudes and longitudes, since these will utilize the regular astronomical observatories, or highly specialized facilities.

The six regions to which special attention will be given in accordance with CSAGI resolutions were carefully considered. They are: Arctic: 70–80° W Meridian; Equator: 140° E Meridian; Antarctic: 10° E Meridian.

The Committee has tabulated all proposed stations and has made recommendations:

(1) To establish a limited number of extra stations to fill gaps in the world network.

(2) To modify certain arrangements, proposed in national reports, to provide the most effective location of all stations.

Appropriate resolutions have been formulated concerning all these proposals.

The CSAGI notes that only minor changes to the program proposed by individual nations are needed to provide an excellent world geophysical network. This is a measure of the co-operation provided by all nations for the successful prosecution of the International Geophysical Year.

Publications and Publicity

It has been decided to publish the resolutions of the Rome Meeting. A series of pamphlets for the guidance of observers, and for the co-ordination and standardization of data, will be prepared for the various groups of CSAGI. In order to ensure a rapid and complete dissemination of information about solar activity, a volume collecting together the solar data obtained during the International Geophysical Year will be published by the Secretariat of CSAGI as soon as possible after 1958.

Before closing the session the President invited the meeting to show its appreciation of the great service that had been and was being rendered to the organization of the International Geophysical Year by Dr. NICOLET, General Secretary of CSAGI. The Special Committee had good reason to appreciate the high value of the great amount of work done by Dr. NICOLET in the organization of this Rome meeting and of the large correspondence in which his office as General Secretary necessarily involved him—correspondence with national and international bodies and with their individual members and other scientists. It was fortunate for the progress of the plans for the International Geophysical Year that we had as General Secretary so eminent a scientist as Dr. NICOLET, with his wide knowledge and successful experience in geophysical research, and with so great a devotion to, and enthusiasm for, the world-wide project he so ably promotes. Let us thank him heartily for his great service.

The meeting warmly endorsed these thanks by the applause of all present.

When the President closed the session, Dr. T. E. W. SCHUMANN, on behalf of all the participants, delivered the following speech:

"Ladies and Gentlemen,

The Chairman has just stated that the meeting stands adjourned, but you will all agree that we cannot possibly take our departure without some expression of thanks towards the man who has so ably conducted this gathering towards it happy conclusion. The President of CSAGI can rest assured that all those gathered here have the highest regard for the excellent qualities he has displayed during our discussions.

"In many ways this has been a unique gathering, and in the annals of the development of the geophysical sciences it is bound to be regarded in due course as of great historical significance. To most of us it was indeed a revelation to find such an intense co-operative spirit among representatives of the different nations, and the President's untiring effort towards still greater and more complete co-operation was one of the outstanding features of the conference. This spirit, when translated into action, must needs lead towards a fuller and more coherent knowledge of the earth we inhabit and which is the common heritage of all humanity.

"As a representative of one of the countries of the southern hemisphere I was particularly pleased at the phenomenal interest shown on all sides in the hitherto much-neglected southernmost quarter of the globe. I have no doubt that this lively interest, and the resulting program of investigation adopted here for the International Geophysical Year, will not only be of benefit to all, but particularly to the countries of the southern hemisphere.

"The success of this gathering, and the definite prospects of fulfilling at least part of the ambitious program of investigation decided upon here in Rome, has been in great measure due to the leadership of our able President, not only as regards the way he has guided the discussions but also as regards the preparatory work which forms an essential part of any meeting or congress when something worthwhile is attained.

"I am convinced that I am expressing the unanimous feeling of this meeting when I assure the President of our warmest appreciation for his unstinting labours and our admiration for his leadership, which has made our meeting one of pleasure and inward satisfaction to everyone who has been privileged to attend it.

"Mr. President, we thank you."

2 Reports on CSAGI Disciplines

I. World Days

1. *Introduction*

1.1 A committee (L. V. Berkner, Chairman; S. Chapman; P. Lejay and M. Nicolet) on World Days was appointed consequent to the Brussels meeting of CSAGI, 30 June–3 July 1953, to formulate the calendar of World Days in accordance with the following draft resolutions:

(a) The Regular World Days, i.e. 2 days at new moon and 1 day at full moon,* will be defined in advance, and circulated by the World Meteorological Organization (WMO); reminders will be issued by the Warning System before each occasion.

(b) In addition there will be IGY Special World Days, on the average 2 per month, chosen at shorter notice, to coincide with;

(1) Expected unusual magnetic, ionospheric or auroral activity.*

(2) Expected intervals of extreme magnetic quiet days.*

(3) Launching of rockets.

(4) Days of solar eclipses.

(5) Unusual meteor showers.

These five types of day are given in order of their priority.* (4) and (5) can be foretold, but could be omitted as World Days if too great a number of such days appeared in the same month. It is recommended that the organization to define the above Special World Days shall be designated by the Ursigram Committee of URSI.

(c) The Warning System will be operated through WWV, WWVH, Ursigrams, extended time systems and any other channels. Warning elements to be considered are (1) optical observations of the sun; (2) solar radioelectric observations; (3) visible

* The 1953 plan has been modified as regards these types of days.

magnetic recording; (4) radio fade-outs; (5) cosmic rays; (6) beginning of a brilliant aurora. It is recommended that the warning code be established by the Ursigram Committee of URSI in consultation with the World Meteorological Organization.

1.2 Reports and advisory information have been received from IUGG, URSI and WMO relating to the program for World Days. Dr. G. M. CLEMENCE, U.S. Naval Observatory, has prepared data on the three eclipses during 1957–58; complete data on meteor showers during IGY have been received from Prof. A. C. B. LOVELL, University of Manchester, and Dr. PETER M. MILLMAN, Dominion Observatory, Ottawa; Mr. D. H. SADLER, Superintendent of the British Nautical Almanac Office, has supplied data regarding the moon.

1.3 A tentative calendar for Regular World Days (RWD) was selected at the Rome meeting (30 September—4 October 1954). This calendar has been subsequently modified in accordance with important suggestions received from the various interested scientific groups to include the greatest range of activity and control within the limitation of three or four RWD each month. In selecting the calendar for Regular World Days, the Committee has taken:

1.3.1 Two days each month at new moon.

1.3.2 One day near quarter moon, with the exact date adjusted to coincide with major meteoric activity. (Of these days, four—12 August 1957; 4 January, 5 May, and 27 July 1958—fall near full moon. No RWD fall near the quarter moon during October 1957 and April and October 1958, to permit an additional control day at the time of the solar eclipses).

1.3.3 Additional days of unusual meteoric activity—3 January, 9 June, 7 August 10 October, 13 December 1958; 4 January 1959—have been included.

1.3.4 An additional control day immediately following the Geminid showers has been included, 16 December 1957.

1.3.5 To prevent the interval between RWD from exceeding approximately three weeks, the following RWD have been added: 1 September 1957; 26 February, 9 June, 6 September and 4 November 1958.

1.3.6 Days of important meteoric activity that could not be included as RWD are indicated on the calendar of Table 2 for informational purposes, with the expectation that certain types of IGY activity can be concentrated upon these days in addition to the more general observational activity on the RWD.

1.4 In the place of Special World Days during intervals of predicted unusual activity, the Committee has substituted a plan for "Alerts" followed by Special World Interval (SWI) when the prediction service believes that disturbance seems probable. This modification of the initial proposal is made in order that observers may be forewarned by an "Alert" of the more than usual likelihood of the outbreak of a magnetic, auroral and ionospheric disturbance, as judged on the basis of observations of solar activity; it will enable observers to keep themselves and their instruments in special readiness for observation, and on the lookout in order to observe intensively should a disturbance begin unexpectedly without having been actually predicted. Should this happen, the loss of information owing to the absence of a definite prediction may be much reduced. When the state of the sun makes it appropriate, in the experienced judgment of the forecasting centers, to announce a Special World Interval, observations on an intensive scale will definitely be made during this Interval. The plan for "Alerts" and SWI is based on realities of prediction during the rise of solar activity anticipated during the International Geophysical Year, and follows the recommendations of the URSI. The Committee has discontinued plans for observation during anticipated intervals of extreme quiet, since such intervals cannot be predicted with sufficient reliability.

1.5 Following the recommendations of WMO, the Committee has chosen six World Meteorological Intervals (WMI) of ten consecutive days each, timed quarterly at the solstices and the equinoxes during the IGY. These WMI are chosen so as to include the Regular World Days of the same month. Hence, on three days of each WMI there will be a concentration on all forms of IGY observation.

1.6 Eclipse data from U.S. Naval Observatory.

1.6.1 Total eclipse of 23 October 1957.

The cone of umbra will touch the earth for a very short time. The eclipse center will be off the surface of the earth, the closest approach of the axis of the shadow to the surface being approximately 34km.

The eclipse will, however, be central for all three atmospheric heights of 100 km, 200 km and 300 km. Inasmuch as the axis of the shadow never touches the earth, there will be at each instant two intersections of this axis with each of the concentric "shells" at 100, 200 and 300 km, giving in each case a double central line. For observing purposes, either position is equally suitable even though the geometry of the phenomenon may appear somewhat unusual. Geocentric conjunction occurs at 23d 5h 21m 52s8 in right ascension 13h 49m 53s32, the declination of the Sun being $-11° 18' 44''\cdot 1$.

1.6.2 Annular eclipse, 19 April 1958.

In the eclipse of 19 April 1958, the geocentric conjunction will occur at 19d 03h 35m 26s9 in right ascension 1h 46m 13s72, the declination of the Sun being $+10° 58' 17''\cdot 9$.

1.6.3 Total eclipse of 12 October 1958.

In the eclipse of 12 October 1958, geocentric conjunction occurs at 21h 03m 54s41, in right ascension 13h 10m 13s92, the declination of the Sun being $-7° 27' 09''\cdot 11$.

2. *Plan for IGY World Days*

2.1 Regular World Days (RWD)

Regular World Days will be days of concentrated observation at stations of all types participating in the International Geophysical Year. The program of observation during these intervals will be specified for each branch of CSAGI investigation. When concentrated observational programs cannot be conducted on all Regular World Days, the day of new moon shall be the day of first priority.

During the International Geophysical Year, special events such as launching of rockets should be scheduled to coincide with Regular World Days, except where such observations are planned for Special World Intervals or for more general synoptic programs.

The List of Regular World Days (RWD) during the International Geophysical Year is shown in Table 1.

Table 1. List of Regular World Days (RWD) during the International Geophysical Year (July 1957–December 1958)

RWD			Moon UT	Remarks	WMI
				June 1957 (advance trial of IGY)	
Thurs.	June	27	N.M. (20:53)		June 21
Fri.	June	28			through
Sat.	June	29		*Meteors:* β Taurid max	June 30
				International Geophysical Year opens July 1, 1957	
				July 1957	
Thurs.	July	4	1st Q.	*Meteors:* β Taurid post-max	
Fri.	July	26			
Sat.	July	27	N.M. (04:28)	*Meteors:* η Aquarid max	
				August 1957	
Mon.	Aug.	12	Near F.M.	*Meteors:* ζ Perseid max	
Sun.	Aug.	25	N.M. (11:32)		
Mon.	Aug.	26			
				September 1957	
Sun.	Sept.	1	1st Q.		
Mon.	Sept.	23	N.M. (19:18)		Sept. 21
Tues.	Sept.	24			through
Mon.	Sept.	30	1st Q.		Sept. 30
				October 1957	
Tues.	Oct.	22		Pre-eclipse control	
Wed.	Oct.	23	N.M. (04:43)	Eclipse	
Thurs.	Oct.	24		Post-eclipse control	
				November 1957	
Thurs.	Nov.	14	3rd Q.		
Thurs.	Nov.	21	N.M. (16:19)		
Fri.	Nov.	22			
				December 1957	
Fri.	Dec.	13	Pre-3rd Q.	*Meteors:* Geminid max	Dec. 15
Mon.	Dec.	16		Geminid control	through
Sat.	Dec.	21	N.M. (06:12)		Dec. 24
Sun.	Dec.	22			
				January 1958	
Fri.	Jan.	3		*Meteors:* Quadrantid max	
Sat.	Jan.	4	Pre-F.M.	*Meteors:* Quadrantid max	
Sun.	Jan.	19	N.M. (22:08)		
Mon.	Jan.	20			
				February 1958	
Mon.	Feb.	10	3rd Q.		
Tues.	Feb.	18	N.M. (15:38)		
Wed.	Feb.	19			
Wed.	Feb.	26	1st Q.		
				March 1958	
Thurs.	Mar.	20	N.M. (09:50)		Mar. 20
Fri.	Mar.	21			through
Fri.	Mar.	28	1st Q.		Mar. 29

RWD	Moon UT	Remarks	WMI
		April 1958	
Fri. Apr. 18		Pre-eclipse control	
Sat. Apr. 19	N.M. (15:23)	Eclipse	
Sun. Apr. 20		Post-eclipse control	
		May 1958	
Mon. May 5	Post-F.M.	*Meteors:* η Aquarid, etc.	
Sun. May 18	N.M. (19:00)	*Meteors:* o Cetids, etc.	
Mon. May 19		*Meteors:* o Cetids, etc.	
		June 1958	
Mon. June 9	3rd Q.	*Meteors:* Arietids-Perseids	June 17
Tues. June 17	N.M. (07:59)		through
Wed. June 18			June 26
Tues. June 24	1st Q.		
		July 1958	
Wed. July 16	N.M. (18:33)		
Thurs. July 17			
Sun. July 27	Pre-F.M.	*Meteors:* δ Aquarid max	
		August 1958	
Thurs. Aug. 7	3rd Q.	*Meteors:* ζ Perseid	
Tues. Aug. 12		*Meteors:* Perseid max	
Thurs. Aug. 14		*Meteors:* Perseids	
Fri. Aug. 15	N.M. (03:33)		
		September 1958	
Sat. Sept. 6	3rd Q.		
Sat. Sept. 13	N.M. (12:02)		Sept. 13
Sun. Sept. 14			through
Sat. Sept. 20	1st Q.		Sept. 22
		October 1958	
Fri. Oct. 10		*Meteors:* Giacobinid	
Sat. Oct. 11		Pre-eclipse control	
Sun. Oct. 12	N.M. (20:52)	Eclipse	
Mon. Oct. 13		Post-eclipse control	
		November 1958	
Tues. Nov. 4	3rd Q.		
Mon. Nov. 10			
Tues. Nov. 11	N.M. (06:34)		
Tues. Nov. 18	1st Q.		
		December 1958	
Wed. Dec. 10	N.M. (17:23)	*Meteors:* Geminid	Dec. 10
Thurs. Dec. 11		*Meteors:* Geminid	through
Sat. Dec. 13		*Meteors:* Geminid max	Dec. 19
Wed. Dec. 17	1st Q.	Geminid control	
		January 1959	
Sat. Jan. 3	3rd Q.	*Meteors:* Quadrantid max	
Sun. Jan. 4		*Meteors:* Quadrantid max	
Fri. Jan. 9			
Sat. Jan. 10	N.M.		

Symbols: N.M. = New Moon; F.M. = Full Moon; Q. = Quarter.

Remarks—Provisional Days preceding the International Geophysical Year (June 1957).

Just preceding the International Geophysical Year, commencing on 21 June 1957, a provisional WMI and 3 RWD are included to provide an agreed interval for testing of procedures and final adjustment of collaborative programs.

2.2 World Meteorological Intervals (WMI)*

The following intervals of ten days at each solstice and equinox are designated as World Meteorological Intervals (WMI):

From	21 June	to 30 June 1957
	21 September	30 September 1957
	15 December	24 December 1957
	20 March	29 March 1958
	17 June	26 June 1958
	13 September	22 September 1958
	10 December	19 December 1958

*(1) Each WMI includes 3 RWD during which concentrated observations will be made in all branches of IGY work. This schedule is shown in Table 1.

(2) Throughout each WMI, special meteorological observations will be undertaken in accordance with separate recommendations of the CSAGI.

3. *Special World Intervals* (*SWI*)

3.1 Basic data

Special efforts are planned in most branches of IGY work during intervals of outstanding solar, geomagnetic, ionospheric, auroral and related activity. To ensure that such disturbance shall be as fully observed as possible, a plan for "Alerts" and Special World Intervals (SWI) has been formulated. The SWI should average about 4 days each month.

The CRPL Radio Warning Service, Box 178, Fort Belvoir, Virginia, U.S.A., is designated as the world warning agency; it will have the collaboration of the French and Japanese warning centers; the French center will act as co-ordinator for the several European forecasting groups. Using procedures specified in the report of the URSI-AGI Committee (see 3.2) and in collaboration with other regional agencies, the CRPL will formulate notices of "Alerts" and of the beginning and end of Special World Intervals (SWI).

Notice of an "Alert" will be transmitted via the IGY communication networks 4–6 days before dates on which there seems to be a special probability of a major disturbance. The "Alert" will simply provide a warning that there seems to be a special likelihood that a SWI will be declared within 4–6 days; it will call to readiness all those who would undertake special observations during a SWI.

At 05hr U.T. of the day preceding an anticipated, possibly major, disturbance, CRPL will consider the latest recommendations and evidence and make the decision whether or not to announce a SWI to begin 19 hr later at 0hr U.T. If it is decided to make such an announcement the regional centers will be at once informed and the distribution of the announcement will be made before the lapse of 7 hr. Thus the announcement will be in the hands of participating stations not less than 12 hr before the beginning of the SWI.

The SWI will continue until terminated by notification by the warning agency to be broadcast over the warning network.

Notifications of "Alerts" and declarations of SWI will be supplemented by regular broadcasts and messages of pertinent solar and geophysical data.

At the onset of very great unpredicted disturbances, the SWI will be declared *post-facto* by the predicting agency, but such *post-facto* declarations are expected only two or three times during the International Geophysical Year.

3.2 Procedures for SWI

The CSAGI endorses the following procedure, proposed by the Ursigrams Committee of URSI.

3.2.1 All the radio or geomagnetic forecasting centers are invited to participate in the choosing of SWI and the issuing of alerts. One center will be given the responsibility for the final designation. Before making a decision, this center will weigh carefully:

(a) The regular predictions of the other centers as well as its own.

(b) Any special recommendations or nominations which may be volunteered by other centers.

(c) The responses by the other centers to specific queries about proposed designations, when there is time for such consultations.

CRPL is chosen as the central agency.

3.2.2 The information will be sent by the designating center to the regional centers of the Ursigrams network and to any new IGY centers which may be designated (e.g. Australia, New Zealand, South Africa, South America, USSR). The inter-regional Ursigrams network (Paris/Darmstadt, Washington, Anchorage, Tokyo) already operates on a weekday basis and will form the core of the SWI warning network.

3.2.3 The distribution of "Alerts" and SWI designations by electrical means to IGY stations becomes the responsibility of the regional centers and subcenters. It will be the responsibility of the IGY National Committee in each country to ensure that efficient arrangements are made for the distribution to each of its stations.

3.2.4 Wherever possible the "Alerts" and SWI designations should go in a direct message to the IGY stations. For this the co-operation of the postal, telegraph, telephone and other government departments of the various nations, of private communications companies and especially of the WMO will be enlisted. (Many such agencies already co-operate on a generous scale in the distribution of geophysical information.)

3.2.5 As a supplement to this direct network, the Ursigrams Committee will make every effort to see that this information is broadcast repeatedly in each region using the facilities, for example, of TMD, JJY and WWV.

3.2.6 With rare exceptions the designating center will decide at the same Universal Time each day whether it will call for the beginning or ending of a period of Alert or the beginning or ending of a SWI. The tentative time for this decision is 05hr UT.

"Alerts" or their cancellation will take effect immediately upon receipt of the advice by the IGY station. Each SWI will begin at the next epoch 00h UT; the SWI will remain in force until further advice is received by the IGY station. Normally a SWI will be terminated after 24 hr if the expected disturbance does not occur. This draft plan is subject to modification prior to the International Geophysical Year, as may be indicated by experience during the trials preceding the International Geophysical Year.

3.2.7 The codes to be used will be worked out in detail in the coming months. In general, direct messages to IGY stations will be in plain language to reduce the possibility of confusion. The broadcast notices will be in simple code of two or three characters. All notices will be preceded by some distinctive word or code identifying them as IGY notices.

3.2.8 The relationships to be used for prediction of SWI will include the classical ones associating large magnetic storms with the meridian passage of large sunspot regions and also the relationship more recently demonstrated between flare, coronal and radio noise regions and magnetic activity; the 27-day recurrence tendency is not expected to be particularly strong in 1957–58. If an unpredicted magnetic storm occurs, a SWI will be notified only if it is an intense storm.

3.2.9 The SWI notification, where possible, should be supplemented by the provision of:

(a) Systematic forecasts of magnetic activity.
(b) Regular summary descriptions of magnetic activity observed in the immediate past.
(c) Regular summary descriptions of the degree of solar (especially solar flare) activity observed in the immediate past.
(d) Selected results of magnetic, ionospheric, solar, auroral, cosmic-ray and meteorological observations during SWI, communicated promptly to the regional centers. These results should be distributed by air mail. This information should be given the same distribution as the SWI designations. They should, however, be prepared by each of the regional centers separately and distributed once a day or as needed within their region.

3.2.10 Trials of SWI designations will be started as soon as solar activity takes a significant upswing, in order to have the scheme in full operation by July 1956, so that the methods can be revised, if necessary, on the basis of experience.

3.3 SWI Center at CRPL

3.3.1 The headquarters will be at CRPL's forecasting center at Fort Belvoir, about 20 miles from Washington. This facility is manned continuously. It is from here that short-term radio propagation forecasts are prepared and issued every six hours, and other forecasts issued once daily and twice weekly. The present equipment includes a visual magnetograph, field intensity recorders, a direction finder, and a C3 ionospheric sounder. There is also a teletype (TWX) installation and direct access to solar information. Currently the center has a staff of 11.

The basic information on which SWI selections will be made will be those now systematically collected for the radio forecasts plus whatever additional coverage is provided by the IGY program. From the North American network magnetic data come from Belvoir, Cheltenham and Anchorage, ionospheric data from about six selected U.S. and Canadian stations in middle and high latitude, radio propagation data from several monitoring or communications agencies, solar observations from all U.S. observatories with solar patrols.

Further, there is available the summary Ursigram daily from Paris, Darmstadt and, via Anchorage, from Tokyo, giving in brief summary the similar data from Europe and Japan, as well as forecasts from Europe. A moderate expansion of this up-to-the-minute data collection during the International Geophysical Year may prove useful, although the forecasters should not be overwhelmed with data.

3.3.2 The forecasting center staff includes three professional scientists with backgrounds in physics, astronomy, etc., and several years' experience in radio propagation forecasting, sun-earth relationships, etc. They operate under the general supervision of the Boulder CRPL headquarters, and their work would be monitored closely from Boulder, especially the interpretation of solar activity, inasmuch as there are many experienced solar physicists at Boulder both in CRPL and in the High Altitude Observatory.

3.3.3 The forecasters use only demonstrated methods, the practical application of correlations and analyses which have appeared in the literature; in general, this involves the assessment of the kind and degree of activity, that there will be an associated terrestrial effect when the solar region is most favorably situated with reference to the earth. A typical situation is as follows: A solar region appears at the east (oncoming) limb. From the limb observations (corona and prominences) and from the observations, during the next one or two days, of spots, flares, radio noise, plages, magnetic fields, etc., the forecasters judge the kind and degree of activity of the region and, if it is sufficiently outstanding, issue an "Alert". If the activity is maintained for the next 4–6 days as the region rotates towards the center of the visible solar disk, the forecaster (after advice from, and consultation with, his colleagues in other regional centers) may call for a SWI to begin just before the most probable time for a terrestrial effect associated with this kind of solar activity. If the terrestrial effect does occur, the forecaster will terminate the SWI two, three or four days later, after the disturbance has run its course. If there is no significant terrestrial effect, the forecaster will terminate the SWI after about 24 hr. The "Alert" will be rescinded when the solar activity subsides, or when the active region nears the west (offgoing) limb.

3.3.4 In the selection of SWI during the International Geophysical Year the forecasters will compare their own forecasts together with those received from forecasting centers in Alaska, France and Japan, and will request and encourage these centers to amplify their forecasts and make proposals for SWI to CRPL on their own initiative. The forecasters will be strongly guided by these proposals, and will be instructed to re-examine the data when these proposals differ from their own, and to resolve cases of apparently equal likelihood of disturbance in favor of the majority. When there is sufficient time, the forecasters will advise the other centers of any dilemma at the time of the regular daily teletype contact, and will ask for further opinions or reasons for nominations. Similarly, whenever possible the forecasters will initiate such consultations. It is unlikely that there will be any large difference in technique for SWI selection; the discussions are expected rather to concentrate on interpreting the basic data and resolving contradictory evidence.

3.3.5 The world warning service will be handled on a regional basis, in view of the limited broadcast facilities available. There will be three varieties of warning distributions:

(a) Regular repeated summary broadcasts (like WWV);
(b) Special IGY broadcasts;
(c) Direct multiple-address teletype messages.

(a) Broadcasts on WWV, WWVH, JJY, etc., must necessarily be very short. The quiet time on WWV, if available for this (and this is not certain), is 10 sec in each 5 min. One scheme would be to use one break for SWI announcements, and another to give forecasts of magnetic activity and a report on current activity. Each announcement should be prefaced by IGY in some distinctive tone. The announcement itself would be at most four characters. The problem of getting the announcements to the transmitters and on the air is not inconsiderable, but may be soluble in the case of WWV and WWVH. For carrying out such a scheme, the active co-operation of large communication agencies would be needed. Presumably JJY could also handle this type of announcement.

(b) Special broadcasts have been the preferred scheme for Europe and there has been discussion of increasing the number of broadcasts beyond the present two per workday. Presumably the broadcasts would give not only SWI designations and the forecasts and current state of magnetic activity, but also the short version of the Ursigram. The same might be indicated for the Americas, for the benefit of very isolated parties, such as in the Antarctic, although no arrangements have as yet been made for appropriate transmitter time.

(c) Short telegrams giving the data in (b) will be sent to at least some IGY stations which are tied in with one of the teletype (or TWX) networks. This scheme is in use now very effectively in distributing CRPL radio forecasts. The messages cannot be overlong since in many instances delivery will be by local telephone. This method gives much more flexibility than the WWV-type warnings.

3.3.6 The occurrence of an unexpected disturbance not covered by a SWI would be communicated to IGY stations in the Americas by the regular or by a special summary teletype Ursigram. Also a scheme is under consideration whereby a station would broadcast the Belvoir K-index with only 0–3 hr time lag, or alternatively broadcast whether a magnetic storm of a certain grade was in progress.

3.3.7 The SWI scheme will have its full value only if there is a supplementary distribution of important current data by mail. Scientific stations must not be burdened with any more radio schedules than is imperative for their current work. For economy of their time and convenience as well as economy of the radio spectrum, and scientific and other budgets, broadcasts and telegrams must be kept as short as possible and only include information which will be used in 48 hr at most. It is essential that details go by mail and preferably on a regular schedule. CRPL does this now once a week in plain text, and Paris and Darmstadt distribute their coded messages every week or month.

4. *Warning broadcast network*

The world warning service will be organized on a regional basis. Existing regional centers are already interconnected on a daily world teletype service. Regional warning distribution will be accomplished by four methods of distribution.

(a) Regular repeated broadcast summaries (such as WWV, MSF, JJY, etc.).
(b) Special scheduled IGY broadcasts.
(c) Direct multiple-address teletype.
(d) Local telephone and telegraph.

It will be the responsibility of the IGY National Committee in each country to ensure that efficient arrangements are made for the distribution of warnings, geophysical data and notices, and other necessary information, to each of its stations.

The URSI–AGI Committee is requested to recommend appropriate codes for transmission of warnings and geophysical data prior to 1 October 1955.

5. *Warning magnetic variographs*

There is some probability, in the present state of the art of prediction, that warnings of some really great geophysical disturbances will not be given. It is especially important that concentrated observation be initiated during such intervals. Therefore, following recommendations of URSI and IUGG, ionospheric and auroral stations should be equipped or closely related with a magnetic warning system, consisting of a magnetic variograph capable of providing instantaneous alarm arranged to give immediate notice in the event of very great disturbances.

III Geomagnetism

1. *Introduction*

The CSAGI (1953) program in geomagnetism has been further considered by the International Geophysical Year committees, both national and international (namely, that of the International Association for Geomagnetism and Aeronomy). Their recommendations have been taken into account in drawing up the revised CSAGI geomagnetic program.

2. *Studies of magnetic storms*

A major objective in geomagnetic studies during the International Geophysical Year is the further investigation of magnetic storms. Despite the important contributions to this subject made possible by the observations of the First and Second International Polar Years, there is still great need for further knowledge of the morphological facts concerning magnetic storms. Though the number of stations in the Arctic region during both Polar Years was favorable, not many complete records of big magnetic storms were obtained in those years. It is hoped that several storms will be recorded during the International Geophysical Year. It is highly desirable that the number of polar magnetic stations during that year shall not be less than during the Polar Years; the observations of magnetic storms during the IGY will be more valuable than were the observations of similar kind and scope during the

Polar Years, because of the much larger mass of associated auroral, ionospheric and solar facts that will be available in 1957–58.

The overhead electric current systems in high latitudes, especially along the auroral zones and across the enclosed polar caps, are rather complex and variable. This makes it difficult to plot the overhead currents unless magnetic data are available from many stations in this region. In any case, of course, details of the current distribution on a scale comparable with that of the height of the currents above the ground must be smoothed out in the magnetic variations recorded at observatories, however numerous these may be; to examine such detailed features of the current distribution it is necessary to get close to them, which involves the transport of magnetometers into the high atmosphere, e.g. by rockets. The existing and projected networks of magnetic observatories in high latitudes, however, are on a scale far more open than of the order 100 or 150 km apart, and suffice only to infer the broader features of the ionospheric current system. The situation can be improved by installing more magnetic observatories in the gaps between existing ones. An alternative is to operate auxiliary observatories from existing stations, the additional observatories being near enough to be serviced by the staff of the existing observatory; no regular absolute observations need be made at the auxiliary stations, whose purpose would be to determine the *space gradients* of the magnetic field at the existing stations. A note on this subject is appended to the present report. The U.S. Coast and Geodetic Survey is examining a method of determining the gradients by electrically transmitting data from the auxiliary stations to the main observatory. By this, or simpler methods, it is to be hoped that a number of Arctic and Antarctic magnetic stations may provide much more magnetic data than hitherto.

The determination of the magnetic gradients may also prove valuable near the magnetic equator, in the investigation of the electrojet, or intense laterally limited electric current that develops daily during the sunlit hours over Huancayo Observatory and in other places along the magnetic equator.

It is in such regions, both polar and equatorial, of locally intensified current flow, that rocket exploration of the earth's magnetic field promises to be most valuable. The limitation of rocket methods is the brevity of their record, a drawback that seems curable only by launching a satellite observatory that will be able to continue in motion in the atmosphere at a high level for hours or more. However, rocket exploration by methods already proved feasible can give information of great value; the rocket can traverse the auroral electrojet and record the field changes along its course. Even if rockets did not actually enter the auroral current region but only approached it closely from below, they could give important information as to the probable strength, location and regularity of distribution of the currents. The value of the results obtained will depend much on the timing of the rocket flights, which should coincide with the presence of strong magnetic disturbance and overhead electric currents above the launching site.

Rocket magnetic exploration above the magnetic equator during great magnetic storms may also serve to determine whether the currents that at such times cause a world-wide reduction in the earth's horizontal magnetic force are located in the ionosphere or in outer space (in the form of a ring current); for this purpose the magnetic measurements must extend to heights much above what is necessary in the auroral zone. These and other questions concerned with rocket magnetic exploration are discussed in the recently published work *Rocket Exploration of the Upper Atmosphere* Pergamon Press, London; Interscience Publication, New York, 1954.

Besides aiding in the solution of existing geomagnetic problems, rocket exploration may also reveal closed loops of magnetic tubes of force that do not make their presence apparent in the surface magnetic data, as suggested by E. H. VESTINE.

The intensive investigation of ionospheric storms during 1957–58 should also be of great help in the further elucidation of magnetic storms.

3. *Studies of magnetic pulsations*

Another magnetic subject to be especially studied during 1957–58 will be the rapid pulsations of the earth's field. Some of these affect only a limited region of the earth, others appear to be simultaneous and world-wide; in either case they can only begin to be understood if accurate records of them are made at numerous stations, on lines that permit proper inter-comparison and synthesis of the records.

4. *Daily magnetic variations*

The regular daily variations of the geomagnetic field, caused by the sun and the moon, seem to be better explained and understood than are magnetic storms and pulsations; but there is still much to be learnt about them, and they have also much to tell about solar radiations absorbed in the upper atmosphere, and about the motions of the air at high levels. Hence it is desirable that our knowledge of the associated electric current systems in the ionosphere be improved; one means to this end is the filling in of gaps in the network of magnetic observatories, especially in the southern hemisphere.

With these various objectives in mind, CSAGI has considered the existing provision for geomagnetic observation, and has formulated the following resolutions and proposals for further effort during 1957–58.

5. *General remarks*

In order to study the geographical distribution of the magnetic stations which are likely to be in operation during the International Geophysical Year, the Working Group on Geomagnetism has reviewed the national reports presented to the Rome Meeting of CSAGI.

It seems certain that in addition to the magnetic stations in the USSR and in the Chinese People's Republic—the co-operation of which is most urgently needed for a successful accomplishment of the geomagnetic research program of the International Geophysical Year—some 100 magnetic stations will be in world operation during 1957–58.

The number of geomagnetic stations will be the greatest that has ever been in operation at the same time; especially in the Antarctic and in the equatorial regions the number of stations will be more numerous than during any previous period in the history of geomagnetic research.

Nevertheless the Working Group has found it necessary to recommend the establishment of some additional stations, partly to fill up obvious gaps in the network of already existing or definitely planned stations, partly to ensure, whenever possible, that in regions of special interest for the geomagnetic program of the International Geophysical Year, in particular the equatorial zone and the auroral zones, the network will be sufficiently well equipped to secure maximum benefit from all the International Geophysical Year observations.

To a large extent the geomagnetic observations of the IGY will be carried out by means of instruments of types already in current use. Special equipment has been recommended for the registration of rapid magnetic variations, that is, variations having periods between, say, 1 min and 1 sec. The Committee on Instruments of the International Association of Geomagnetism and Aeronomy (IAGA) is studying technical details of the equipment.

As for instruments of the standard type, the Working Group has discussed at some length in what way two objectives can be gained which from a technical point of view are somewhat conflicting; namely, that of obtaining an adequate record of very small magnetic pulsations, and that of securing at the same time that no trace will be lost even during the most severe magnetic storms. The latter requirement can be most appropriately met through the installation of special storm-magnetographs with low sensitivity.

For the time being, special instructions to the observers seem necessary so far as registration of rapid variations is concerned. Such instructions cannot be issued, however, until more definite plans are available as to technical details of equipment.

6. *Note on the detailed exploration of the electric current systems that produce the more locally differentiated geomagnetic variations*

by S. CHAPMAN, President of CSAGI

(1) The electric currents that produce the more locally differentiated geomagnetic variations include the following:

(a) The auroral electrojet.
(b) The equatorial electrojet.
(c) The current vortices (Schmidt) that produce bays or oscillatory sequences of bays.
(d) The current vortices that produce small rapid pulsations over limited regions.
(e) The currents such as those in the English Channel that produce differences in the vertical component of the sudden magnetic storm commencements, between the two sides of the Channel.

(2) As regards (a) to (d), if the height of the currents is between 100 and 150 km, as seems not unlikely, the usual spacing of magnetic observatories, generally at least about 500 km, is too great to enable the currents to be studied in much detail.

(3) For such a study a knowledge of the magnetic space gradients would be helpful; they are nine in number, namely, in rectangular co-ordinates, $\partial X/\partial x$, $\partial Y/\partial x$, $\partial Z/\partial x$, $\partial X/\partial y$, $\partial Y/\partial y$, $\partial Z/\partial y$, $\partial X/\partial z$, $\partial Y/\partial z$, $\partial Z/\partial z$; but only five of these are independent, because the divergence and curl of the field are both zero. As it is more convenient to measure horizontal than vertical gradients, it would suffice to measure five of the first six gradients above written (taking x to the north, y to the east, and z vertical). Then $\partial Z/\partial z = -(\partial X/\partial x+\partial Y/\partial y)$, $\partial X/\partial z = \partial Z/\partial x$, $\partial Y/\partial z = \partial Z/\partial y$.

(4) There are several possible methods of measuring such horizontal gradients or their time rates of change (fluxmeters, crossed coils, astatic pairs). Possibly the simplest, cheapest and most reliable method is by measuring X, Y and Z at two stations auxiliary to any existing observatory at which it is desired to determine the *space gradients* as well as the *values* of the magnetic elements. As stated in para. 3 it is enough to measure five gradients, requiring five variometers. Namely, Z at both auxiliary stations, X at the northern and Y at the eastern station and *either* Y at the northern *or* X at the eastern station; but as a check it would seem well to record both X and Y at each station. See also (11).

(5) The value of a knowledge of the *space gradients* as well as of the *values* of the elements can be illustrated by the simple special case of a long horizontal current i flowing along a line or volume (of cylindrical cross section) at a height h vertically above the station. Immediately below the current, this will produce a horizontal perturbation $\Delta H = 2i/h$ or ΔH: the vertical gradient of this perturbation, $\partial \Delta H/\partial z$, is $2i/h^2$ or $\Delta H/h$; thus a knowledge of H and its vertical gradient will indicate the values of i and h separately. The effect of induced earth currents would, however, need consideration. In less special cases consideration of all the gradients would be necessary.

(6) In general, where the local perturbation ΔF (vectorial) can be attributed to such a current (or electrojet) i at distance $\mathscr{L}$, the components of ΔF will be of order $2i/\mathscr{L}$, and their gradients will be of order $\Delta F/\mathscr{L}$. This simplified estimate will indicate the distances desirable between the standard observatory and its auxiliary stations, in the different cases noted in (1). It will be supposed that the difference $\partial \Delta F$ between two stations, standard and auxiliary, must be as great as 10γ to be measurable to 10 per cent (that is with an accuracy of 1γ). Then 10γ must be equal to the gradient multiplied by the separation d between the stations. Thus 10γ is of order of $\frac{\Delta F}{\mathscr{L}}d$ or d must be of order $10\mathscr{L}/\Delta F$ where ΔF is expressed in γ.

(7) *Auroral electrojet*: In this case ΔF, for a station such as Lerwick or, less often, as at Eskdalemuir, may be as great as 500γ; if the electrojet is not above the station, but such that $\mathscr{L} = 500$ km, then d must be 10×500 km$/500 = 10$ km. If the standard observatory is near the auroral zone, so that $\mathscr{L}$ is less (and ΔF often greater), d may be less than 10 km.

(8) *Equatorial electrojet*: Huancayo. In this case $\Delta F = 100\gamma$ near mid-day, and if $\mathscr{L} = 100$ km, d is 10×100 km$/100 = 10$ km. This is because Huancayo seems to be almost directly under the electrojet. At stations to the north and south of Huancayo, where ΔF may be reduced to 50γ, and $\mathscr{L}$ may be 200 km, d may need to be as great as 40 km. This is probably too far for the auxiliary stations to be worked, as in the preceding cases, by the personnel of the main observatory.

(9) Similar considerations apply in cases (c) and (d) of (1), where, however, the current is probably not straight but circulates around a moving center, with a radius of perhaps 250 km. If ΔF is 50γ, the separations d may need to be of the order of 50 km, unless more sensitive variometers are used, permitting the accurate detection of $\partial \Delta F$ less than 10γ, with corresponding reduction of d.

(10) Where a standard observatory now operates two sets of magnetographs (for security against failure), one of these sets might, during the Geophysical Year, be transferred to one of the auxiliary stations, thus reducing the requirements for instruments.

(11) Other methods of determining the space gradients may be practicable or preferable, involving transmission to the main station of the X, Y, and Z values at the auxiliary stations, by some electrical method, and their subtraction from the values there, so as to record the differences; or instead of measuring the space gradients of X, Y and Z, it may be preferable, for the study of their *rapid* variations, to measure the differences, between the main and auxiliary stations, of the time rates of variation of the three elements ($\mathrm{d}X/\mathrm{d}t$, $\mathrm{d}Y/\mathrm{d}t$, $\mathrm{d}Z/\mathrm{d}t$), using coils.

IV Aurora and Airglow

1. *Introduction*

The CSAGI has considered

(1) The report by S. CHAPMAN, correspondent of the CSAGI Group on Aurora and Airglow;
(2) The national reports presented to the second CSAGI meeting;
(3) The reports by the Working Group on Auroras of the International Association of Terrestrial Magnetism and Electricity (IATME) and of the International Geophysical Year Committee of the IUGG;
(4) The reports by the Working Groups on Airglow of the IATME and IUGG-AGI Committee;

and has formulated plans for the co-ordinated observation of auroras and the airglow.

The high atmosphere emits light, observable at night and during twilight, of two distinct kinds. One of these, called the aurora polaris, is generally visible only in magnetic latitudes of about 60° and more, except during magnetic and ionospheric storms, when the aurora becomes visible in lower latitudes; the aurora often has distinct forms, such as arcs, rays and draperies, which may move, and often change their shapes during intervals of minutes. The other type of high atmosphere luminosity, called the airglow, is emitted all over the world; though it is sometimes patchy, it does not have the definite forms often shown by auroras, nor does it vary in intensity as rapidly or greatly as does the aurora. The airglow of the twilight sky is called the twilight airglow. The airglow and aurora occur also in the sunlit sky (daytime aurora and the day airglow) but are imperceptible, owing to the brightness of the sky, except at considerable heights in the atmosphere, above which the scattering of sunlight is weak compared even with the rather faint emission of the aurora and airglow.

Both these phenomena are complex. Their further investigation is an important part of fundamental aeronomic research, and bears on practical problems such as radio communication. A great effort will be made during the International Geophysical Year to study these phenomena more systematically, accurately and completely than ever before.

Observations of the airglow will necessarily include the aurora when visible; hence an airglow research program will contribute to the auroral investigation; but apart from this, the two programs are rather distinct, and, consequently, are separately considered here.

Observations of the airglow will also include the zodiacal light when visible; this light is mainly visible for an hour or more, after the end of evening twilight and before dawn, as a cone of light extending upward from the horizon along the ecliptic; the light decreases with angular distance from the sun, both along the ecliptic and perpendicular to it. The exact nature of the zodiacal light being still uncertain, additional photometric observations will be most valuable.

2. *Problem of auroral observations*

A *The auroral, subauroral and minauroral regions A, B, C.* The world may be divided, with reference to the aurora, into five regions of three different types, denoted by A, B, C and called *auroral, subauroral* and *minauroral.* The two auroral regions A extend in each hemisphere from geomagnetic latitude 60°, north or south, to the pole; they include the auroral *zones*, from which the aurora is visible on almost every clear dark night, and the enclosed auroral *caps*, within which the frequency of auroral visibility decreases towards the geomagnetic poles; they each include also a band of geomagnetic latitude outside the auroral zone, in which the aurora is often visible. The subauroral regions B, one in each hemisphere, lie between the geomagnetic latitudes 45° and 60°; in these two belts the aurora is less frequently visible than in the auroral regions, but it is expected to be seen there on several occasions during the International Geophysical Year, which is near a sunspot maximum. The minauroral belt C lies between the geomagnetic latitudes 45° north and south; few auroras are likely to be visible from this region during the International Geophysical Year, but it is most desirable that these few shall be well observed.

It is convenient, in discussing the aurora, to reserve the word *zone* for reference to the auroral zones (the zones of maximum auroral frequency), and to use the words belt or belts for the subauroral and minauroral regions B and C.

In the northern hemisphere, the auroral region A includes the Arctic islands, Alaska, most of Canada, Greenland, Iceland, part of Norway, Sweden and Finland, and part of the Arctic coast of USSR.

In the southern hemisphere, the auroral region A includes nearly the entire Antarctic continent, and extends to Macquarie Island and Heard Island.

In the northern hemisphere, the subauroral belt B includes part of southern Canada, a major part of U.S.A., all of the U.K., Ireland, Denmark, Belgium and Netherlands, much of France, Germany, Poland and Switzerland, a great area in USSR, and parts of Austria, Greece, Hungary, Italy, Portugal, Spain, Turkey, Yugoslavia and other countries.

In the southern hemisphere, the subauroral belt B includes part of Australia, Tasmania and the south island of New Zealand, and extends as far north as Cape Horn, but not so far as the Cape of Good Hope.

The minauroral belt covers the greater part of the earth, but auroras have been seen as far south as Aden (latitude 13° N geographic, 9° N geomagnetic), and as far north as Apia, Samoa (latitude 14° S geographic, 16° S geomagnetic).

B *Objective and needs.* The objective of the auroral program of observation is to record the occurrence, the changing form, the intensity, the color and the spectral composition of the luminosity, and to determine the true location—height and geographical position—of the regions in the atmosphere whence the light is emitted. The body of facts thus described is called the *morphology* of the aurora. It includes the study of the development of the aurora, over all its extent, during individual occurrences of various kinds, from those most intense and widespread (auroral storms) down to minor occurrences during otherwise very quiet periods.

Limitations on this program are imposed by geography (fewer observations are made over the sea than on land, and fewer over sparsely populated than over more densely populated regions of similar magnetic latitude); by weather (clouds prevent or restrict auroral visibility from places below them); by season (in summer the nights are shorter and brighter than in winter, and in the highest latitudes there is no real night in summer); and by human acts or characteristics (in towns where bright lights pale the aurora, observation is difficult; after midnight most people are asleep; in regions where auroras seldom occur they have in the past appeared unexpectedly, and have passed with few and poor observations; and the aurora may be so complex and changing as to render a record and description difficult to make).

Some of these limitations can be overcome or reduced. Automatic cameras can record auroras throughout clear nights. Airmen fly above the clouds and can see auroras hidden from ground observers when the sky is overcast. Radar beams, and short-wave communication signals, can detect the presence of auroras independently of ocular vision, and by day as well as by night. Astronomers, meteorologists and others on land and sea may be stimulated to improve the visual auroral watch. Special periods called "Alerts" will be announced throughout the world from a Prediction Center during the International Geophysical Year, indicating intervals (of a few days at a time) when active spots on the sun render the occurrence of a widespread aurora more than usually likely; this will make it more worthwhile for well-prepared (and well-equipped) observers in regions where auroras seldom occur to keep watch for the aurora, with greater probability that their effort will be rewarded by observations of great value—and by the sight of a natural wonder of considerable beauty, interest and rarity.

If the solar activity develops during an "Alert" period so that the probability of an imminent great magnetic storm and widespread aurora is sufficiently heightened, a *Special World Interval* will be declared by the Prediction Center, and notified throughout the world, calling for intensified auroral watch even in regions of low magnetic latitude—down to 10° or 15°.

These arrangements make it advisable for minauroral countries where auroras seldom occur, in magnetic latitudes less than 45° north and south, to organize an auroral watch, and to arrange that the observers are informed of the notification of "Alerts" and Special World Intervals. Pamphlets will be prepared giving an illustrated account of past great auroras that were seen over a large part of the globe; these pamphlets will be available to national committees for the International Geophysical Year, to arouse and maintain the interest of observers, and to indicate the nature of the phenomenon they are to observe. Instructions should be given as to the method of making and recording the observations, for observers with or without photographic or other equipment.

For subauroral countries, in magnetic latitudes between 45° and 60°, where auroras will be visible more frequently, more elaborate plans of observation are prepared, and still more so in the auroral regions of magnetic latitude greater than 60°.

The observations thus made, at many individual stations widespread over the globe, will be used to improve and extend the existing isochasmic charts, showing the geographical distribution of the frequency of auroral visibility. New (isoauroral) charts will be made, showing the geographical distribution of frequency of actual overhead occurrence of auroras; overhead observations will be of special, because direct, value in the construction of these charts, but generally auroras are not seen overhead from most stations whence they are observed, and it is necessary to combine data from different places in order to determine the geographic position of auroras. This combination of data also enables the height to be determined (from reliable simultaneous observations), and height frequency statistics may be constructed for different seasons, and different degrees of auroral intensity. This work will involve the collection of the observations at regional centers, and perhaps at a world center, where they can be compared and studied.

The photometric, spectroscopic, and colorimetric observations may be discussed at the stations where they are made, or elsewhere; they will afford information as to the nature of the process by which the auroral luminosity is produced in the atmosphere, including the identification of the types of atoms and molecules involved, and the speeds of the incoming hydrogen nuclei (and perhaps other particles) that originate those processes.

The auroral facts derived from all these observations will also be correlated with solar, magnetic, ionospheric, cosmic ray (and perhaps other) phenomena.

These auroral and associated facts can then be compared with the various physical theories of the mechanism of the production of auroras, as regards the nature of the solar agent, and its passage and changes while travelling from the sun to the earth, before reaching the earth's atmosphere; and also as regards the luminous, ionizing and other effects consequently occurring in the atmosphere.

3. *Types of observation*

The following are at present the chief types of auroral observation:

(a) Visual, with or without filters and colorimeters.
(b) Photographic and photometric.
(c) Spectroscopic and spectrophotometric.
(d) Radio observations of echoes, radio star scintillation and absorption, and auroral noise.
(e) Rocket observations of auroral ionizing particles, auroral ionization and conductivity, and (in the geomagnetic program) of the ionospheric electric currents associated with auroras.

The studies of auroral frequency by FRITZ, VESTINE and others show that, in the auroral zone, auroras occur on almost every clear dark night; well inside the polar caps enclosed by the auroral zones they may occur only a few times a month, and outside the auroral zones the frequency of occurrence falls rapidly to values of perhaps one, or at most a few, auroras a year (even during sunspot maximum) in the minauroral belt between geomagnetic latitudes 45° N and 45° S. It is therefore necessary to have different schemes of observations for different regions of the earth during the International Geophysical Year.

The polar caps enclosed by the auroral zones are rather inaccessible, and have not been extensively occupied in the past. There is some evidence, and some reason to expect, that auroras in these inner regions are associated with the earlier phases of auroral displays, and that a detailed study of events inside the auroral zones may give new information of value for auroral theory. During the International Geophysical Year there will be a number of temporary stations in these regions, and it is desirable to make full use of this unique opportunity to establish a network and keep a continuous auroral watch over as much as possible of the auroral regions above 60° geomagnetic latitude.

By means of recently developed cameras it is now, for the first time, practicable to photograph the whole sky at short intervals during all clear hours at night throughout the year. By this means, auroral observations on a global scale can now be made uniform and complete to an unprecedented degree, with the result that auroral statistics can be improved, synoptic studies of auroras over extended regions facilitated, and (in particular) detailed studies of the onset and development of auroras made possible. Such cameras should be used throughout the International Geophysical Year at a great number of stations in the auroral regions A.

An *all-sky camera* developed by C. W. GARTLEIN is briefly described in the U.S.A. National Report to the Rome Meeting of CSAGI 1954. A detailed description will be made by C. T. ELVEY, College, Alaska, and distributed in the near future to interested persons and institutions. It is estimated that a camera of this design will cost £100–150 (sterling) for stations where alternating current is available, and somewhat more for other stations. The entire sky is recorded as a circle on 16 mm film. At most stations the sky will be clear and dark during less than 2500 hr/year, and the yearly cost of film is estimated at £25 (sterling) if one picture is taken every 5 min whenever the sky is clear and dark, irrespective of whether aurora is present or not. The camera runs automatically without the attendance of a skilled operator, and it can safely be left in the charge of persons with only elementary technical and photographic knowledge.

An important feature of a widespread use of the all-sky camera is that the observational material it provides is much more uniform and complete than that provided by visual observers. Also, for each station, the all-sky camera yields material which otherwise could only be secured by teams of skilled and assiduous visual observers. Bearing in mind, furthermore, the low cost and the small demands on personnel, the all-sky camera appears to be the tool best suited to obtain systematic auroral observations on a large scale during winter nights, in high latitudes, and perhaps also elsewhere.

In region A (geomagnetic latitude 60° to 90°) CSAGI recommends as a minimum that all stations photograph the sky with all-sky cameras throughout the International Geophysical Year, whenever the sky is clear and dark, irrespective of moonlight, and irrespective of whether aurora is present or not. At least 12 exposures/hr should be made, starting at 00 min, 05 min, 10 min . . . 55 min of each hour. During the International Geophysical Year the photographs should, if possible, be supplemented by visual observations of the zenith region at 00 min, 15 min, 30 min and 45 min of each hour; this is because of certain limitations of the all-sky camera, which does not give information about the color of auroras; also its resolving power is hardly better than 1°, and moving or rayed auroral forms will often be blurred during the exposure. Hence it is useful to supplement the camera recordings with visual observations by competent observers; this may be possible at permanent observatories and at some IGY stations. Simple *grids* or *frameworks* can help visual observers to indicate positions in the sky in a systematic manner, and a detailed description of suitable grids will be made by C. T. ELVEY, College, Alaska, and distributed in the near future to interested persons and institutions.

Filters (of interference or other type), mounted in goggles, have proved valuable for visual observation of weak auroral glows, especially during twilight and moonlight. It is desirable that they should be widely used, both in regions where the aurora often appears, and in those where it is rarely seen. With a set of filters transmitting different parts of the spectrum, a visual observer can provide important data to supplement the camera record.

A *colorimeter* has been designed by W. D. WRIGHT especially for visual auroral observations, but its value for this purpose has not yet been tested. If it fulfils the hope that it can provide valuable information as to the spectral composition of the auroral luminosity, at relatively small cost, its use should be considered in many regions where spectrographic equipment will not be available. It is hoped that it can be tested during the winter of 1954–55.

Visual observers should note the special interest of auroras appearing directly overhead, which give data directly usable in the construction of isoauroral charts, and are of great value for height determination (in association with observations elsewhere).

The assistance of voluntary auroral watchers will be of great value, but usually there will be few voluntary auroral watchers for the hours after midnight. Hence the aid of those whose professional duties may render them available at such times is specially desirable; for example, astronomers and meteorologists.

One of the principal limitations of ground-based visual and photographic observations is their obscuration by clouds. Hence it is important also to obtain observations from aircraft, and in particular to try the use of wide-angle zenith cameras in aircraft flying in the regions A.

(1) *Visual auroral observations.* Recommendations as to visual auroral observations are given in the Auroral Atlas and Supplement, published by the International Association of Terrestrial Magnetism and Electricity; photographic illustrations indicate the nature of the various types and features of the auroras to be reported, with appropriate symbols; records of direction by means of stars are there recommended. Where this method of recording direction is adopted (and in some circumstances it may be the best available method), it is desirable that the astronomical references be transformed (preferably by the observer before sending in his report) into references to angular elevation and azimuth, which (unlike the astronomical references) are definite without recourse to stellar tables and consideration of the date and hour of observation. Where regular auroral observation (here called an auroral watch) is made from a fixed station, it is desirable that the visual observer should erect a simple grid or framework by reference to which he can directly record the angular

elevation and azimuth of auroral features. Proposals will be drawn up, with descriptions and illustrations, giving alternative types of grid or framework or alidade suitable for this purpose in different circumstances (e.g. for different latitudes).

At present there are different proposals for making, recording and reporting visual auroral observations, in addition to those given in the Auroral Atlas. It is hoped that discussion between the leaders of the principal groups of visual observers will before long result in the formulation of internationally agreed schemes, which will then be transmitted through the CSAGI Secretariat to National Committees for the benefit of interested institutions and persons.

To maintain the interest of observers, news letters and auroral publications will be sent to them from time to time. These will include accounts of great past auroras, giving a summary of the valuable but very deficient information available concerning them, and indicating the steps now being taken to obviate or reduce such deficiencies in future.

In the belt B (geomagnetic latitude 45°–60°) CSAGI recommends that organized observing networks be set up with the co-operation of amateur astronomers for the reporting of visible auroras.

In the belt C (geomagnetic latitude 45° N–45° S) it is anticipated that visible auroras will be very rare, but it is of great importance that observations of such occurrences, even from the general public, be collected and made available for scientific study. In order to accomplish this, CSAGI recommends that each National Committee appoint an individual to collect such data and, by means of press and radio, to encourage and instruct the public to make and send in good observations.

It is important that times of observations be noted to the nearest minute or two.

(2) *Photographic auroral observations.* Recommendations as to photographic observations, both for single stations, and for associated pairs or groups of stations, are given in the Auroral Atlas and Supplement. These envisage the stellar background as the means of determining the directions of auroral features; the use of a grid or framework, photographed at the same time as the aurora, can more conveniently afford auroral directions (angular elevations and azimuths), and is recommended where feasible.

Simultaneous photography from two or more stations, to determine the height and geographical position of auroras, as practised in Norway by C. STÖRMER over many years, is an essential part of auroral investigation. It is desirable that this be arranged in countries where the aurora is rarely visible, as well as in higher latitudes, in order that present ignorance of the height and situation of low latitude auroras may be dispelled. The system of "Alerts" and announcements of Special World Intervals should facilitate success in such plans.

The widespread use of all-sky cameras is very desirable for synoptic purposes, and still more so if it can yield photometric data. Another useful device, developed in Canada, is an all-sky scanning photoelectric instrument; Canada is willing to develop an improved prototype of this instrument, from which others can be constructed.

All-sky cameras can reasonably be recommended only for stations with fairly high auroral frequency. Particularly in the belts B and C, however, the need for more improvised equipment will often arise. It is worth noting that the aurora can be well photographed with ordinary 35 mm amateur cameras and high-sensitivity film. With a lens f/3·5, exposures of 1–2 min will often be satisfactory, and with better lenses and bright aurora the exposure can be as short as 10 sec or less. Such equipment can be valuable in places where auroras are infrequent, or when more elaborate preparations have not been made. It is necessary to note the time of observation to the nearest minute or two.

(3) *Photometry of auroras.* The photometric program of airglow observation will include auroral photometry in its scope (see Sections 7 and 8 of this Chapter). Automatically recording, and manually operated, photometers, suitable for the faint light of the airglow, will both be used. In addition a simpler photometer for visual estimation of intensities, designed by ST AMAND, is recommended for use at stations in the auroral regions A to measure the intensity of special auroral forms. The estimated cost of such a visual photometer is $400. The instrument will be thoroughly tested during the winter of 1954–55.

(4) *Spectroscopic observations of auroras.* The main aim of the spectroscopic observations will be to record the wavelengths and intensities of the atomic lines and molecular bands in the spectrum, the variation of these quantities with auroral height and type, and as a function of latitude and time of day.

As a special problem, the CSAGI recommends the study of the Doppler frequency shift, and the width and intensities, of the hydrogen lines, as a function of auroral height, type and latitude.

Spectroscopic observations will be made in Alaska, U.S.A., Canada, Norway, Ireland, Scotland, Australia and New Zealand.

An improved scanning instrument of great promise has been developed by A. B. MEINEL; it focuses on the slit a 165° arc of the sky, and when oriented in the magnetic meridian gives a spectrum of the sky from approximately 5° above the northern horizon to within 10° of the southern horizon. Its use is planned at an extensive network of stations in Alaska, Canada, Greenland and U.S.A. It is hoped that some instruments of this type will also be available for use in suitable places elsewhere. The instrument records on 16 mm film, is automatic, and its operation requires little attention.

The CSAGI recommends that one or two such instruments be used at observatories along the Scandinavian chain.

A photoelectric scanning spectrometer of great value has been developed by HUNTEN at the University of Saskatchewan, Canada.

Along the American chain a number of scanning spectrometers (3 to 4 in Canada and 2 to 3 in U.S.A. and Alaska) will be in operation; valuable results concerning latitude variations in the auroral spectrum are expected from these records.

CSAGI recommends that good spectrographic equipment should be available for observation of the rare low-latitude auroras.

(5) *Height measurements of auroras.* The CSAGI recommends that the heights of auroras be measured at several stations spread along one or more magnetic meridians, to determine any change of height of the base of an aurora with latitude; and that the height measurements be made in conjunction with spectroscopic observations. The height measurements should be made as simply as possible, probably by establishing

stations lying nearly along the same magnetic meridian and observing only auroras on the meridian.

The CSAGI recommends that in low latitudes the heights of both the bottom and top of auroras be determined, from many visual observations of altitude and azimuth made with simple measuring equipment (a grid or graduated posts, or simple alta-zimuth devices) or by locating the aurora with respect to the stars, or even by estimates of angles. Methods used for recording bright meteors and fireballs will be useful also for low latitude auroras. In the minauroral belt observing assistance should be sought from amateur astronomers, operators of weather stations, and crews of ships and aircraft. They should particularly record auroras seen within 30° of the zenith; to determine the height of auroras seen far off, at low angles of elevation, special care in measuring these angles is necessary.

(6) *Radio auroral studies.* The program of radio auroral studies will partly overlap with the general program of ionospheric research during disturbed conditions.

Radio echo sounding: the following notes refer to the measurement of radio echoes from auroras; this will be one of the chief types of radio auroral research during the International Geophysical Year.

The wavelength used should be in the range 3 to 10 meters. Transmitter power of 10 or more kW is recommended.

Aerial systems: in general, aerial beams should be narrow (less than, say, 20° in azimuth) and directed at low elevation. Where possible the aerial should rotate continuously about a vertical axis with a period of, say, one half-minute. Selected stations in the auroral region (e.g. Dr. HARANG's group) will use aerials movable in elevation; this will be useful provided the beam is sufficiently narrow (less than 20°). If fixed aerials are used, they should, in general, be inclined to the magnetic meridian to facilitate the study of apparent auroral motions, although in and near the auroral zone it may be desirable to have some aerials directed along the meridian for observation of movements in latitude.

Recording: for continuous observations an intensity modulated display with a moving film, giving a range-time record, is suitable. The PPI (plan position indicator) type of display may be employed, with narrow beam rotating aerials; at certain stations the echo structure and fading should be observed with the A-Scope type of display.

The equipment parameters should be accurately known, and should be determined in detail.

The radio echo work must be co-ordinated with the visual, photographic, spectroscopic and other observations in the vicinity. It is desirable to arrange that the same auroral structures are studied simultaneously by the various techniques. In this connection it should be noted that at moderate latitudes the radio echoes originate from structures situated several degrees nearer to the pole than the echo station. Radio echo sites should, as far as possible, be selected so that ionospheric and magnetic records are available from observers nearly below the auroral reflecting region.

Magnetograph records and (so far as possible) continuous ionosphere records should be available for use in interpreting the radio echo data.

The following are among the other principal methods of auroral research by radio measurements:

(a) The observation of *scatter* of VHF (very high frequency) waves, using several frequencies simultaneously in the band 30–100 Mc/s; the frequencies to be chosen in the near future by international agreement.

(b) *Scintillation* of radio stars when their radio waves reach the receiver after passing through an aurora: and consequent *absorption* of the waves.

(c) *Drift measurements* of ionospheric winds; in the E layer using waves in the 2–3 Mc/s band, by the Mitra method, and in the F layer, using spaced aerial reception of waves from radio stars; the methods of reduction to be adopted after consultation between the radio workers undertaking such measurements.

(7) *Rocket auroral observations.* In 1953 rockets launched from balloons, under the direction of Dr. Van Allen, afforded evidence of the presence of corpuscular* radiation penetrating the atmosphere in auroral regions down to 50 km. These observations of such radiation, as confirmed by further flights in 1954, are of great interest for auroral investigation, and should be continued and extended. Plans for such experiments are being made in the U.S.A., and it is to be hoped that such observations will be made in both hemispheres. The observations proposed include also the auroral luminosity and airglow, and the strong electric currents flowing in auroral regions. The development of rocket launching from aircraft is also being considered in the U.S.A.

(8) *Audible sound from auroras.* (These remarks, and those in 9, are inserted by the reporter on his own responsibility; the topic of auroral sounds was not discussed at the Rome Meetings of UGGI and CSAGI). As the International Geophysical Year is near a sunspot maximum, there is a chance that it may include one of the rare outstandingly great magnetic storms and auroral displays. It may, therefore, be worth-while to prepare to make an objective test of the reality of the swishing, whistling sounds often reported as heard during great auroral displays—reports of a kind which in two cases was credited by so great an auroral scientist as Prof. Störmer (1938). For this purpose sound recording devices sensitive to sounds of the kind described should be available at one or a few Arctic stations, ready to be put in action should the observers have the impression of hearing such sounds.

(9) *Atmospheric electric observations.* Hitherto no evidence has been obtained to establish a connection between auroral phenomena and electric field changes near the ground. If the reports of audible sounds during auroras ever do represent objective reality, it is possible that the sounds are associated with electric field changes. In view of the great height of auroras above the ground, and the electrical conductivity of the intervening atmosphere (due mainly to ionization by cosmic rays), such electric field changes seem improbable. But the variability of auroral height and intensity is very great, and it may still be worth-while to make provision for atmospheric electric recording during great auroral displays, at one or a few Arctic stations.

* Note added September 1958: Dr. Van Allen subsequently re-interpreted his observations as indicating the presence of X-ray photons (*Bremstrahlung* from primary auroral electrons) instead of specially penetrating primary corpuscles.

4. *Auroral observing stations*

(1) *Auroral observatories.* Stations manned by one or more full-time workers for auroral research, and at which special as well as the general observing programs are undertaken, will be called *auroral observatories.*

(2) *Auroral stations.* Places where a continuous auroral watch is to be kept during the International Geophysical Year will be called *auroral stations.* The stations should at least fulfil the minimum program for the region in question.

(3) *Gaps in the geographical distribution.* When these observatories and stations are marked on a map, several serious gaps in the geographical distribution become apparent.

The most serious deficiency would be an absence of auroral observers at Greenland. The CSAGI strongly recommends that at least all-sky cameras be provided at several stations, where persons with some technical training will be stationed for other purposes.

The next gap is in the region round Iceland. An all-sky camera in Reykjavik is strongly recommended, and observations from the meteorological weather ships in the North Atlantic are urged.

If these two gaps are filled, proper chains of observing stations will be established across the auroral zone along a range of longitude extending from Scandinavia to Davis Strait. This range should be extended by chains in the longitudes of the USSR where possible.

All-sky cameras operated at Pond Inlet and/or Lake Harbor on Baffin Land in connection with the planned observations at Resolute Bay, would be particularly valuable for the study of events inside the auroral zone, and it is hoped that Canada may be able to provide such observations, in spite of great local difficulties.

(4) *Networks of organized amateur observers.* The following networks of organized amateur observers are now established or planned.

(1) British Isles (this network is already working, with the co-operation of air pilots and meteorological officers).
(2) Northeastern U.S.A.
(3) New Zealand.
(4) Finland.
(5) Iceland.

The CSAGI strongly urges that national committees in other localities should organize networks of auroral observers, and seek the co-operation of astronomical, magnetic and ionospheric observatories, as well as of the meteorological services and airlines, in auroral observations during the International Geophysical Year.

At present the aurora is being observed from a number of permanent Arctic stations, and many more stations are already now planned for the International Geophysical Year. During the International Geophysical Year it is important to group the temporary stations, and increase their number, where necessary, so as to form an adequate network in the region A round the north geomagnetic pole. The network should consist of chains of stations crossing the auroral zone at regular intervals.

The main chains, according to present plans, are in the following localities:

(a) Spitzbergen—Scandinavia.

(b) Greenland—Iceland—British Isles.

(c) Resolute Bay—Canada—U.S.A.

(d) Alaska.

In the southern hemisphere the auroral network is expected to include all the International Geophysical Year stations in Antarctica and adjacent islands.

At most of the stations in the auroral regions, all-sky cameras will be operated, in some cases supplemented by visual observations.

Spectrographs will be operated at three groups of stations lying approximately along meridians, in (1) Alaska, (2) Canada and U.S.A., and (3) Scandinavia and countries to the south of it.

Auroral height measurements will be made in Norway, Alaska, Canada and Sweden.

Radio measurements of winds in the auroral ionosphere will be made in Alaska and Canada.

Radar measures of auroral echoes of short-wave radio beams will be made in England, Canada, U.S.A. including Alaska, Australia and perhaps Sweden and New Zealand. It is hoped that the French Antarctic expedition to Terre Adélie within the southern auroral zone will include such measurements in its work. It is hoped that radio echo meteor workers will be prepared to use their equipment for this purpose at least on special occasions when alerted; this includes workers at Stanford, U.S.A.; South Australia; and New Zealand. Dual frequency measurements may be made at some stations, in Alaska, Canada, England and Norway.

As an additional means of giving *early warnings of auroras* the CSAGI recommends that the occurrence of auroral radio echoes in the daytime be notified to one of the central agencies for the World "Alert" program, and also directly to the chains of stations to the westward. A suitable code should be drawn up for this purpose.

Observations of the scintillation and absorption of the radio waves received from radio stars will be made in Alaska, England, Norway, U.S.A. and Australia; CSAGI recommends that simultaneous radio echo and radio star measurements be made, at least at College (Alaska); Jodrell Bank (England) and Ithaca (U.S.A.).

Radio noise from auroras will be watched for by Alaskan and Canadian stations, and at present it seems unnecessary to recommend others to do likewise.

Very high frequency (VHF) scatter will be observed in Alaska, Australia, Canada, England, Norway, Sweden, and U.S.A.

Photometric auroral measurements will be made as indicated in Sections 7, 8 (see Airglow Program).

5. *Establishment of area centers and a World Auroral Center*

For proper synoptic and statistical studies it is essential that the detailed procedures of observation be identical over large areas. Experience from the earlier Polar Years shows that this is difficult to achieve without a central agency for correlating the plans of the various observers. Also the task of constructing and publishing synoptic and statistical charts is most readily carried out by one, or a few, international agencies.

The CSAGI recommends that auroral centers be established in convenient geographical areas for the processing of data, and for forwarding data to a World Auroral Center for the preparation and publication of world-wide synoptic maps of auroral displays and the analysis of statistical data. Suggested areas and auroral centers are:

(1) Alaska (possibly including the Yukon Territory of Canada)	College, Alaska
(2) Western Canada and Western U.S.A.	Saskatoon, Canada
(3) Eastern Canada and Eastern U.S.A.	Ithaca, N.Y.
(4) Western Europe, Africa and Middle East	Edinburgh
(5) USSR	—
(6) South Asia	—
(7) East Asia	—
(8) Australia	Melbourne
(9) New Zealand	—
(10) South America	—
(11) Antarctica	Each expedition

It is suggested that the Carnegie Institution of Washington and Dr. E. H. VESTINE be invited to organize the World Auroral Center.

The persons responsible for area centers are invited to consider the details of the observational procedure along the general lines discussed in the present report, and in the near future communicate their conclusions to persons or institutions responsible for auroral observations during the International Geophysical Year. The attention of National Committees in countries of region C is drawn to the importance of auroral observations in their countries.

Station records should be in standardized graphical or tabular form, depending upon the type of observations and the equipment used. The records should be in duplicate, or microfilmed, and the original data forwarded to the area auroral center where the area synoptic maps are made and the statistical data are entered on punched cards. The area center will forward maps and punched cards to the international center for analysis and publication of the statistical data and the preparation and publication of the world-wide synoptic maps of auroras.

The area centers should receive the original auroral photographs from the observers, either immediately after the International Geophysical Year or at regular intervals during the International Geophysical Year if this is possible. At the area center at least one copy should be made at once, and the original film returned to the observer for his own researches. It is suggested that the area centers and the World Auroral Center arrange by mutual agreement the final stage in the collection of data for planetary synoptic and iso-auroral charts.

If the original logbooks of visual observation are in such a form and language that they can be used directly by the area center, this material can be treated in the same way as the photographs. Otherwise, it will be better to send translated and corrected copies of logbooks and observation sheets to the area center.

After material has been recorded at the area and World Centers it may be returned to the original observers.

International investigations, such as synoptic maps and statistical studies, should be made and published by the World Auroral Center. The area centers should be responsible for providing individual researchers with copies of the regional material for their investigations.

The establishment of area centers and a World Auroral Center presents a financial problem still to be solved. It is certain, however, that the total cost of copying and reducing the observations will be considerably smaller when done at a few centers instead of at each individual observing station.

6. *Observations of the airglow*

The CSAGI considers that there must be a distinction between *standard* and *special* programs of airglow observations during the International Geophysical Year.

The standard program must include photometric observation of the principal radiations of the night airglow.

The special programs should consist of spectroscopic observations of the day, twilight and night airglow.

Although the night airglow has some radiations in common with the aurora (notably 5577 Å and 6300 Å of atomic oxygen), many of the auroral features are absent from the night airglow (especially those due to ionized molecules or to highly excited atoms or molecules) and many important airglow molecular bands (especially OH and O_2 bands) are not present in the auroral spectrum.

Since the nightglow is, in general, not visible to the eye and is too faint for short-exposure direct photography, it is necessary to make systematic and synoptic studies by means of photoelectric photometry. Such studies have shown that the nightglow varies in intensity:

(a) During the night (chiefly as a function of local time).
(b) From night to night (the range may be as much as ten-fold at a given location).
(c) Seasonally.

7. *Photometric observations of the airglow*

The indication of a geographical variation in latitude associated with the seasonal variation shows the importance of a synoptic study of the airglow during the International Geophysical Year. The night airglow program has been planned with special attention to a distribution of stations in latitude and to the proper calibration of photometers.

CSAGI strongly recommends that all photometric work during the International Geophysical Year be done with photometers calibrated to give results in absolute intensity units. In order to accomplish this, simple laboratory-type standard light sources will be developed which can be circulated among the observers all over the world.

(1) *Instrumentation.* Most of the nightglow research has been conducted at stations where the weather conditions permit a complete study of the sky to within 5° to 10° of the horizon. Under these conditions it is feasible to scan the entire sky systematically. Scanning photoelectric photometers sensitive to four or more different radiations have been developed by at least three different observers (BARBIER,

HURUHATA, ROACH). A survey of the entire sky is completed in about a half-hour. For the International Geophysical Year it is proposed to design a photometer (ROACH) which will be ten times as fast as the current instruments. With automatic programming and recording it is estimated that such an instrument will cost approximately $12,000. Because of the expense of such an instrument, and the need for excellent weather and for professional personnel in its operation, it is planned to develop a simpler photometer which can be manually oriented to any desired region of the sky. This manually operated photometer will consist of a single telescope (with interchangeable filters) and a simple meter to give the airglow intensity, instead of automatically recording it as in the scanning photometer. The estimated cost of the simpler photometer is $2,000.

(2) *The observing program.* If a multicolor scanning photometer is available, CSAGI recommends that the lines 5577 Å and 6300 Å of OI be observed in all regions.

The airglow is about as intense as the star and zodiacal light transmitted by a filter of 100 Å half width. A control filter centered at 5300 will usefully reduce this unwanted light. A fourth filter should isolate sodium D. DUNN and MANRING (New Mexico) achieve a great reduction of computing time (in allowing for astronomical light) by using a Lyot Type I birefringent filter to isolate the airglow. One such filter in one telescope can be used with a set of auxiliary filters for several different airglow emissions; the cost is then competitive with that of a four-telescope photometer, and gives great computing economy. The OH bands ($\lambda > 6600$) can be isolated by the use of photoelectric cells with a cesium-cesium oxide surface and a filter to exclude Hα and 6300, 6364 on the short-wave side. Such an isolation of OH is not practical with photomultiplier tubes now available; the systematic synoptic study of OH in the nightglow during the International Geophysical Year should be given serious attention and added to the program if possible.

In the auroral zone it is recommended that the N_2^+ band at 3914 Å should be included in the systematic observations, replacing either the control observation (during an aurora) or sodium D.

Three different spectrophotometric methods of observing are possible:

(a) The systematic scanning of the entire sky along either vertical circles or almucantars.
(b) The scanning of the sky along a single vertical circle (or a single almucantar).
(c) The observation of a single region of the sky, say, the zenith or the celestial pole.

The choice of observing procedure will depend on the instrument available and the quality of the sky. Preference should be given in the order (a), (b) and (c) above.

The absolute calibration of the observations can be accomplished in three ways:

(a) By the observation of stars of known brightness and color (see *J. Geophys. Res.* **56**, 325, 1951).
(b) By the observation of galactic clouds such as Scutam and Sagittarius (see D. BARBIER *et al.*, (1951)).
(c) By the use of fluorescent surfaces activated by radioactive material of long life. A standard of this type is being designed by ST AMAND.

(3) *The observing stations.* The observing stations at which it is hoped that synoptic nightglow photometry will be carried out are arranged in groups or chains.

In two cases the chains extend into and through the auroral zone. This is done deliberately in order to serve the double purpose of obtaining:

(a) The latitude distribution of the nightglow.

(b) An absolute measure of auroral intensities for radiations common to both airglow and aurora.

Two of the chains (India and the Far East) would be much strengthened by systematic observations northward into the USSR. Attention is called to the importance of such extensions.

It would be advantageous to extend the Far East chain southward from Australia or New Zealand to cross the auroral zone.

(4) *The reduction of spectrophotometric data and publication of results.* Two conflicting factors enter into the problem of optimum evaluation of the spectrophotometric results on the airglow to be obtained during the International Geophysical Year.

(a) The observer is best able to evaluate his own data, since he alone knows the details of his instrument and the local conditions during the observations, and he should perform at least the preliminary or summary reduction of his observations.

(b) The principal value of international programs lies in the synoptic nature of the results. This can only be realized if the data from different stations are combined and co-ordinated.

It is not yet possible to specify exactly how this co-ordination should be accomplished, but the following factors are significant:

(1) The intensities must all be expressed in, or reducible to, the same absolute units. A systematic intercomparison of instruments is essential, hence the CSAGI recommendation that standard light sources for calibration should be developed.

(2) The American chain will be in partial operation by 1955 and it is planned to develop standardized methods for the reduction of the data, which can be further extended as the full chain of stations is developed during the International Geophysical Year.

(3) As an example of a co-ordinated chain, the natural center for the co-ordination of the airglow data in the American chain is Boulder, Colorado. A working agreement has been made for Dr. MANRING of Sacramento Peak to monitor the stations to the south of Sacramento Peak, leaving the stations from Boulder northward to Dr. ROACH. Other areas may wish to set up similar group co-ordination.

8. *Spectral observations of the airglow*

Since spectral observations of the day, twilight and night airglow should lead to important progress in aeronomy, CSAGI recommends:

(1) That rocket soundings during the International Geophysical Year provide day airglow data.

(2) That a certain number of stations undertake observations on the determination of temperatures (sodium cells, Fabry-Perot interferometry, rotational structure of bands, etc.).

(3) That several stations concentrate on twilight research in the northern, equatorial and southern regions, for it is highly desirable that the study of twilight

phenomena should lead as far as possible to absolute intensities of NA–D, (OI), (NI) and N_2^+. In particular, the observations should be directed towards studies of:

(a) The variations of the intensity with the zenith distance of the sun and with the time of the year.
(b) The correlation between the different radiations at a given station.
(c) The correlation between stations.
(d) The correlation between the twilight, night airglow and other high atmosphere phenomena.

9. *Airglow and zodiacal light*

CSAGI recommends that systematic reduction of records obtained on high quality nights be made with special reference to the zodiacal light, for at low-latitude stations the scanning photometers will include the zodiacal light.

V Ionosphere

1. *Introduction*

CSAGI has considered the world program for ionospheric observations during the International Geophysical Year, the discussions being based on documents received from the national committees, the URSI–AGI Committee, and from the Mixed Commission on the Ionosphere. In some cases supplementary information has been received from national representatives present at the meeting of CSAGI.

A survey of the 1954 national committee reports indicates that there is general agreement with the broad plans prepared at the 1953 meeting of CSAGI.

2. *Distribution of ionospheric vertical incidence sounding stations*

CSAGI has given detailed consideration to the world distribution of vertical incidence ionospheric sounding stations, and recommendations are made with the object of ensuring adequate coverage in the various zones recommended for special attention. CSAGI notes with great satisfaction the recent additions to the network of ionospheric stations: Bangui, Elisabethville, Paramaribo and Talara.

The following summarizes briefly the present situation with respect to the zones and regions of the twenty-four additional stations recommended by the CSAGI:

(1) *Arctic zone.* In general, there seems every promise of a fair distribution of stations in the Arctic zone, with sixteen existing or definitely planned stations above 60° N; of these seven lie within the auroral zone (see below). No information is available yet on possible polar stations in the longitude range 30° E–170° W.

CSAGI hopes that during the International Geophysical Year adequate provision will be made by the USSR for vertical incidence ionospheric observations in this zone.

(2) *Antarctic zone.* At the present time there are no regular ionospheric soundings to the south of 65° S. It seems likely that this deficiency will be at least partially met during the International Geophysical Year. Between 50° and 64° S there are at present five stations making regular observations. During or before the International Geophysical Year the stations south of 50° S will be increased to at least ten, three of which will lie within 10° of the south pole.

CSAGI recommendations are made for locating an additional eight stations in this region if expeditions can be organized.

(3) *Equatorial zone.* Locations of stations in the tropics have been considered in relation to the geographic, geomagnetic, and dip equators. CSAGI has considered a number of north—south sections across the equatorial region at which observing stations already exist.

More specific recommendations concerning eleven additional equatorial stations are given in the formal resolutions (pp. 161–2).

(4) *Meridian* 10° *E.* The distribution of stations near this meridian is highly concentrated in Europe, but additional stations are certainly required at lower latitudes and in the southern hemisphere. CSAGI makes special recommendations for locating four additional stations along this meridian.

(5) *Meridian* 140° *E.* Near this meridian it is known that eleven stations will be in regular operation in or before the International Geophysical Year.

CSAGI makes special recommendations for the establishment of three additional stations. All these stations are located below 45° N, and it is hoped that USSR will take steps to complete the northerly section of this chain.

(6) *Meridian* 70°–80° *W.* Fourteen stations are expected to be in regular operation near the 70°–80° W meridians. In the northern hemisphere the chain is fairly satisfactory, but additional stations are certainly required in the southern hemisphere. CSAGI makes specific proposals for completing this chain.

3. *Vertical incidence ionospheric absorption measurements*

(1) *Pulse reflection methods.* At present six stations make regular ionospheric measurements using pulse reflection methods. These are Slough, Lindau/Harz, Oslo, Freiburg, Dakar, Singapore. The national committee reports contain proposals for similar measurements at eleven additional stations: Tromsö, Paris, Tamanrasset, Djibouti, Bangui, Lwiro, Tananarive, Kerguelen, Churchill, Ottawa, and Sao Paulo. Of the six nations now making regular observations, four are located in Europe and employ somewhat different techniques.

CSAGI suggests that in the immediate future (certainly before the next meeting of CSAGI), an intercomparison of results obtained by the various European groups should be made and agreement established. When this has been done it should not be difficult to ensure that the seventeen stations listed above will provide reliable and comparable absorption data. A study of the location of most of the seventeen stations shows a fair concentration near the 10° E meridian. Accordingly CSAGI feels that, in the immediate planning of additional stations for absorption observations, it would be profitable to develop this chain. It is therefore proposed that absorption measurements should be undertaken during the International Geophysical Year at the following locations: Italy, Bizerte, Gao, Ibadan, Léopoldville, and at a site near the meridian at approximately 20° S. (It is emphasized, however, that absorption experiments at any other new locations should also be encouraged). To ensure comparable results it is recommended in all cases that measurements be undertaken after consultation with one or another of the existing European groups. During the International Geophysical Year it is proposed that absorption measurements be made each day at noon and at least at hourly intervals on World Days.

CSAGI notes that the subject of ionospheric absorption measurements is being considered by a special URSI committee, and expresses the hope that the recommendations of this committee concerning measurement technique will be of such a nature as will permit routine absorption measurements at many additional stations; and it is strongly recommended that organizations responsible for groups of ionospheric stations be fully informed of the discussions of this committee.

(2) *Absorption measurements using radio star radiations.* Up to the present time only limited information is available concerning ionospheric absorption measurements using this technique, but proposals for such measurements are made in a few national committee reports.

CSAGI recommends that adequate investigations of the possibility of this technique, both for routine ionospheric absorption measurements and for the thorough study of polar blackouts, should be made in the immediate future, and, if possible, the conclusions made available within the next year.

4. *Ionospheric drift measurements*

At the present time several different methods are being used for drift measurements, and in this connection CSAGI recommends that as soon as possible an intercomparison should be made of simultaneous results obtained by these different methods. Furthermore it is also desirable to confirm that consistent results are obtained by the same method at neighboring locations. These suggestions apply to drift measurement in the case of both regions E and F.

In the light of available information CSAGI proposes that during the International Geophysical Year systematic ionospheric drift observations should be made in at least three zones, in the north and south temperate zones and the equatorial zone. If the effort is available, drift measurements near the auroral zones would also be of interest. Since only a limited number of stations appear likely to make measurements of this kind, it is considered desirable in the first instance to develop a group of observing stations in limited ranges in longitude.

In the northern hemisphere two groups of stations appear possible—one in America and one in Western Europe. Few specific proposals have been received for drift measurements in the southern hemisphere.

CSAGI suggests that consideration should be given to the possibility of such measurements being made by the Australian group of stations.

In the equatorial zone the most favorable possibility is for drift measurements to be made at existing ionospheric stations in Africa located in the area lying between approximately $\pm 25°$ of the equator and between 20° W to 30° E in longitude.

5. *Ionospheric scatter*

A *Back scatter observations.* The back scatter technique is valuable in that it will provide ionospheric observations over inaccessible localities. The technique therefore is very profitable for polar zones and large oceanic areas. Back scatter measurements at Dakar, St. John's, Paramaribo and Puerto Rico could provide useful supplementary information over the Atlantic Ocean, and soundings made at Stanford, Anchorage, and Balboa could provide data over the Pacific Ocean.

It is recommended that during the International Geophysical Year systematic back scatter observations be made at least on World Days. CSAGI strongly recommends that in the immediate future direct comparisons be made between ionospheric results obtained from back scatter observations and those obtained by vertical incidence soundings, so that the maximum possible information can be derived from IGY back scatter soundings.

B *Forward scatter soundings.* No specific information is yet available concerning forward scatter soundings during the International Geophysical Year, but CSAGI strongly endorses the proposal of URSI in this matter, and suggests that national committees forward their plans to CSAGI within the next year.

6. *Atmospheric and terrestrial noise observations*

CSAGI fully endorses the proposals made by the URSI–AGI Committee for atmospheric and terrestrial noise observations during the International Geophysical Year (see Annex 1).

7. *Other problems*

(i) Scaling and interpretation of polar ionospheric records.
(ii) Classification of *Es* phenomena.
(iii) Interchange of information and development of codes.

CSAGI notes that these problems are being considered by appropriate URSI sub-committees and expresses the hope that reports will be available before the next meeting of CSAGI.

Annex 1 *Resolutions of the Mixed Commission on the Ionosphere and URSI*

CSAGI endorses the following resolutions which were formulated by the Mixed Commission on the Ionosphere (MCI) at its meeting in Brussels, August 1954, and by URSI at its Eleventh General Assembly at The Hague, August 1954.

(1) Data on ionospheric stations.

The MCI stresses the need for a document giving full information concerning all ionospheric stations expected to be in operation during the International Geophysical Year, and invites national committees to submit such information to the Secretary General of URSI on the lines of the request already published in URSI *Information Bulletin*, No. 84.

The Secretary General of URSI and the Secretary of the MCI will then co-operate to produce a document containing all necessary information concerning ionospheric stations. The MCI recommends that the document should be published as a Special Report by URSI.

(2) Calculation of solar zenith angles.

The MCI recommends that each ionospheric station (or the responsible organization) should undertake the calculation of the solar zenith angles appropriate to its location. The calculations should be made for the 15th day of each month at hourly intervals from sunrise to sunset, due consideration being given to factors such as the equation of time and local time corrections.

(3) The ionospheric parameter f_{min} and "M" factors.

The MCI recommends every ionospheric station to make observations of "M" factors and of $f_{\min}$, and in the case of the latter to attempt to give some significance to such measurements by making adequate calibration of their equipment. (It is of course understood that the critical frequency measurements will continue to be of first priority in vertical incidence $P'f$ measurements).

(4) Publication of ionospheric data.

The MCI recommends that during the International Geophysical Year all ionospheric stations should publish both mean and median values. It is further recommended that whenever possible hourly values of the parameters should be published, and in cases where this may not be possible it is suggested that such hourly values should always be available to bona fide applicants.

(5) Back scatter observations.

The MCI recommends that ionospheric stations should be encouraged to make systematic back scatter observations during the International Geophysical Year, at least on World Days, so as to provide ionospheric information for localities not readily accessible to direct vertical incidence sounding.

(6) Ionospheric index of solar activity.

The MCI stresses the importance of developing an ionospheric index of solar activity for each day of the International Geophysical Year. It is proposed that a Sub-Committee of the MCI consisting of Dr. BARTELS (convenor), Dr. D. H. MENZEL and Prof. C. W. ALLEN should study the manner in which such indices can be derived. The MCI will inform the International Astronomical Union that it is proposing to formulate such indices and will invite the collaboration of astronomers in this work.

(7) Equatorial observations during the International Geophysical Year.

The MCI recommends that during the International Geophysical Year special attention should be given to geophysical phenomena in the equatorial belt (within about $\pm 20°$ of the geomagnetic equator).

(8) Magnetic disturbance index Kp.

The MCI strongly supports the proposal to make available during the International Geophysical Year values of the magnetic disturbance index Kp at 1/4-hourly intervals in addition to the 3-hourly values now circulated.

(9) Rocket research and the ionosphere.

The MCI strongly reaffirms its earlier resolutions on the importance of rocket research investigations of the ionosphere, and urges that the maximum possible use be made of rockets for this work during the International Geophysical Year, particularly in the zones (polar and equatorial) already recommended for special studies.

(10) Airglow observations.

The MCI recommends that co-operating countries on or near the selected meridians be invited to make systematic observations of the intensity of the spectrum of the night-time airglow and of movements of irregularities in this luminosity.

(11) Central bureau for ionospheric data of the International Geophysical Year.

The MCI recommends that consideration be given by URSI to establishing a special bureau for collecting all ionospheric data in microfilm form during the International Geophysical Year.

(12) Interchange of ionospheric data.

The MCI strongly supports the following resolution which will come before the 1954 Assembly of URSI:

"Since the effectiveness of an international program of research depends on the sharing of observational results among participants, URSI favors a free interchange of ionospheric data between countries in expectation that a similar exchange of information will be encouraged by other countries."

(13) Preparation for the program of the International Geophysical Year.

The MCI stresses the importance of getting all new equipment fully working before the International Geophysical Year, so as to ensure complete readiness when the International Geophysical Year commences. The Commission also wishes to emphasize the need of Government support now for the various national projects planned as part of the International Geophysical Year program.

URSI also adopted the following Resolutions:

(14) Study of solar radiation in the high atmosphere.

URSI recognizes the extreme importance of continuous observations from above the *E* region of extraterrestrial radiations, especially during the forthcoming International Geophysical Year.

URSI therefore draws attention to the fact that an extension of present isolated rocket observations by means of instrumented earth satellite vehicles would allow the continuous monitoring of solar ultraviolet and X-radiation intensity and its effects on the ionosphere, particularly during solar flares, thereby greatly enhancing our scientific knowledge of the thermosphere.

(15) Measurements of h_m.

URSI recommends that in future ionospheric work h_mF2 (h' for $f/fc = 0{\cdot}834$) as well as $h'F2$ shall be observed and recorded.

(16) Geomagnetic variographs.

URSI approves the proposal for the development of simple geomagnetic variographs with visible recording and a warning device, to be used for recognizing the outbreak of magnetic storms and to facilitate the scheduling of detailed ionospheric observations during periods of known disturbance.

(17) Radio star scintillations.

Observations of the scintillation of radio stars should be carried out on a world-wide basis:

(i) To determine drift motions in the upper *F* region.
(ii) To investigate the nature and origin of the diffracting screen which causes the scintillations.
(iii) As an adjunct to the study of auroras.

URSI recommends that these measurements be made in the following way:

(a) By observing the Cygnus and Cassiopeia radio sources near vertical incidence in the latitude belt between approximately N 30°–N 75°. In each locality there should be three stations separated by a few kilometers, working on a frequency in the range 40–90 Mc/s approximately. Continuous observations are desirable, otherwise the emphasis should be on the designated World Days (by continuous is meant, for example, 5-min observations every 30 min).

(b) Similar observations in the southern hemisphere near vertical incidence are very desirable.

(c) Any observations of the scintillations during the daytime either from radio stars or the sun would be of extreme interest.

It is particularly emphasized that where facilities do not exist for the three-station work, then observations should be made by one station, since this will give the data particularly needed under (ii), and will in any case give a measure of the drift speed, which is closely related to the fluctuation rate.

(18) Meteor observations.
URSI recommends:

(a) That those stations equipped for measuring winds in the 80–100 km height-range by the Doppler method applied to meteor trails should be encouraged to continue during the International Geophysical Year.

(b) That attention be drawn to the possibility of using the meteor-height technique for the measurement of scale height and density. The method yields results at least as accurate as the rocket technique and is cheap by comparison. A world-wide survey thus becomes a possibility.

(c) That continuous observations of meteor activity should be continued at Manchester (England) throughout the International Geophysical Year, and that to obtain similar data for the southern hemisphere such observations should be made either in Australia or New Zealand.

(19) Forward scatter observations.

URSI recommends that plans for the International Geophysical Year should include systematic VHF forward scatter observations with high power by both continuous wave and pulse method. Such observations should be made in many latitudes, but especially in polar latitudes and near the magnetic equator.

(20) Atmospherics and terrestrial noise observations.

URSI recommends that in the course of the International Geophysical Year the following observations be carried out:

20.1 Measurements of the atmospheric noise level should be made at as many sites as possible, and the work should be extended to both high and low latitudes and also to very low frequencies. The subjective and objective methods should be compared.

20.2 Participating nations should, as far as possible, equip their stations with goniometers permitting the location of storm centers.

20.3 Observations should be carried out at different parts of the globe to study the relationship between the enhancement of atmospherics on 27 kc/s and solar chromospheric eruptions.

20.4 Groups of observers in different parts of the world should make simultaneous recordings of the form of atmospherics produced by lightning flashes located by goniometers.

20.5 According to the theory which has been suggested to explain certain types of "whistling atmospherics", the observation of this phenomena at different latitudes should furnish data on the electron concentration at distances of some earth radii. Therefore it is recommended that during the International Geophysical Year observations should be made in many localities:

(a) For checking the theory.

(b) For studying the high atmosphere and the region beyond if the theory proves correct.

(c) For establishing whether there is a correlation between magnetic disturbance and the occurrence of "whistlers".

(d) For studying other manifestations of this type not explained by the theory. Simultaneous observations should be made near the poles, near the magnetic equator, and at two or three intermediate latitudes, with at least one pair of observers situated at the extremities of a magnetic line of force and at intermediate latitudes.

VI Solar Activity

1. *Introduction*

The sun is now (1954) near minimum activity. Several high latitude spots have appeared during recent months, so that the new cycle may be said to have already commenced. During the International Geophysical Year the activity will be somewhere near maximum. The maximum of the last cycle was unusually high, and it is not to be expected that the next maximum will be as high. However, sunspots will be numerous, and many will be associated with solar flares, accompanied by high ultraviolet emission, causing radio fade-outs. The particle emission will also be high; when spots are near the central meridian, magnetic and ionospheric disturbances are likely to occur, and bright auroral displays will be frequent. In general, however, there is no recurrence after 27 days of disturbances associated with large spots.

Because so many geophysical phenomena are related to sunspot activity it is important that the sun should be kept as far as possible under continuous observation by the various solar observatories. The normal coverage is reasonably complete, as there is a co-operative arrangement between the various observatories to watch the sun during specified hours, when weather conditions permit. But spells of cloudy weather result in the coverage being incomplete.

It is accordingly desirable that during the International Geophysical Year the normal hours of watching at each observatory should be extended. The hours of observing in Western Europe should be continued until after eastern stations in America have started observing; the western stations in America should carry on until after observations can start in Japan, Australia and New Zealand. India will provide a link between these stations and those in Western Europe.

2. *Sunspots.*

The Royal Greenwich Observatory provides in its photoheliographic results a complete record of sunspots, their positions and areas, based on photographic observations at Herstmonceux and at the Cape Observatory, supplemented for the few days that may be missing from the combined record by measurements from photographs at the Kodaikanal and Mt. Wilson Observatories. An effort should be made to publish the sunspot data for the International Geophysical Year with a minimum of delay.

Sunspot observations, photographic or visual, are made at a number of other observatories. The data from all these observatories are sent to the Zürich Observatory, where they are combined, by a process of weighting for groups of spots and for observatories, to give the Wolf sunspot numbers, which are widely adopted as a measure of sunspot activity.

3. *Magnetic fields and polarities of sunspots*

The magnetic polarities of sunspots are regularly investigated at the Mt. Wilson Observatory. The intensities of the magnetic fields of sunspots can be determined by the Zeeman splitting of the lines in sunspots spectra. BABCOCK, at Mt. Wilson, has developed a technique in which, by a process of scanning, a general picture of the intensity of the magnetic fields on the sun is obtained. The intensities both of the local fields associated with spots and of the general magnetic field can be deduced. These measurements should be made two or three times a day. It is hoped that during the International Geophysical Year a similar technique will be introduced at a few other solar observatories, so that more detailed information about changes in the fields can be obtained. Determinations of the general magnetic field have also been made at the Cambridge and Hamburg observatories. It is desirable that during the International Geophysical Year the general magnetic field should be investigated, as it may prove to be variable.

4. *Solar flares*

A number of solar observatories have obtained monochromatic polarizing filters of the Lyot type, and several others will have installed such filters before the beginning of the International Geophysical Year. With these filters a photograph of the entire disk of the sun can be obtained in $H\alpha$ light with an exposure not exceeding one second. These filters will be of special value for the observation of solar flares. Some observatories will maintain a continuous flare patrol by successive exposures on film made at short intervals automatically during the day. These observations should give reasonably complete information about the occurrence of flares, for comparison with the occurrence of short-wave radio fade-outs.

These observations require to be supplemented by more detailed observations while the flare is in progress. The spectrohelioscope is a convenient instrument for this purpose, but photographic observations with spectrographs of the spectra of the flares should be made when possible. The observations should give the UT of the beginning of the flare (when observed), the time of its peak intensity and the time of its ending. If photographic observations are not possible, the necessary observations should be made to show the precise location of the flare area with respect to associated sunspots and other features. The area of the flare should be measured on photographs or estimated by means of an eye-piece graticule.

Measurements should be made of the effective line-width of $H\alpha$ at intervals of one minute throughout the flare; of any line-of-sight motions of flare surges (active dark filaments); and of the central intensity of $H\alpha$ with a wedge photometer.

In order to obtain information as complete as possible, two spectrohelioscopes are desirable where available.

The outbreak of a flare is associated with a sudden enhancement of atmospherics

(SEA). At some observatories, recorders of SEA on frequencies of above 27 kc/s have been installed, in order to give a visual indication of the commencement of a flare where the sun is not under observation. Such records also help to give more complete information of the occurrence of flares, particularly at times when clouds prevent direct observations. The installation of SEA recorders in different longitudes is required for complete coverage.

Reports of short-wave fade-outs from radio communication organizations also serve to give information about the occurrence of flares.

5. *The solar corona*

The observation of the inner corona is possible without an eclipse at high altitude stations above the dust line. The usual procedure has been to estimate by visual methods the intensity at regular intervals of position angle round the sun's disk and at different distances from its limb. For greater accuracy it is desirable that spectrophotometric observations should be introduced to replace the visual methods, before the beginning of the International Geophysical Year. Observations should also be made of the spectrum of the corona, so that any changes in relative intensities of various lines may be detected. The corona can also be studied each year when it passes across the Taurus region of radio emission.

6. *Solar ultraviolet emission*

Rocket observations can provide valuable information (obtainable in no other way) about the solar ultraviolet emissions. It is therefore desirable that during the International Geophysical Year as many observations as possible of solar radiation in the far ultraviolet and in the soft X-ray region should be made by rocket technique in order to obtain information about the fluctuations in the radiation. In particular, there would be great interest in projecting a suitably equipped rocket during the outbreak of an intense solar flare. Because of the relatively short life of the flares, it would be necessary for a rocket to be held in readiness for projection at short notice; an intense flare is most likely to occur when there is a large active developing spot group on the sun.

7. *Solar radio emission*

The observation of solar radio emissions of both centimeter and meter wavelengths should be made at as many stations as possible. For convenience in intercomparisons of results it would be advantageous if a series of common observing wavelengths could be agreed between the various observing stations. The records should be provided with time marks to facilitate intercomparisons. Dynamic spectra covering a wide range of frequencies give additional information not obtainable from observations at definite fixed frequencies or wavelengths, and it is hoped that several stations will use this type of observation. Observations of the polarization of the radiation are also required. The location of sources of solar radio noise by the use of interferometer methods is desirable.

VII Cosmic Rays

1. *Introduction*

Studies of the cosmic radiations have not, until recently, made significant contributions to the development of geophysics and solar physics. At present, however, cosmic-ray research offers the promise of being able to investigate phenomena inaccessible to any other experimental discipline in solar physics or geophysics. It may well be that the coming International Geophysical Year will provide an impetus for cosmic-ray research in this field which will parallel the dramatic development of ionospheric research following the last Polar Year.

The International Geophysical Year is important for the development of this field of cosmic-ray research for two reasons. First, it will lead to the world-wide distribution of standardized detecting apparatus. Second, but more important, there will be available to the research scientist an unprecedented array of solar and geophysical data, enabling him to develop sound physical concepts of the electromagnetic system of the sun, earth and interplanetary space.

The principal tasks of the cosmic-ray group of CSAGI are to ensure that the capabilities of cosmic-ray research in these fields are fully realized by adequate planning for the International Geophysical Year, and that encouragement is given for all nations to join in this world-wide endeavor. The CSAGI has considered:

(1) The draft resolutions adopted by CSAGI (Brussels, July 1953);
(2) The national reports presented to the second CSAGI meeting;
(3) The reports by the Cosmic-Ray Working Groups of the International Association of Geomagnetism and Aeronomy and the IUGG–AGI Committee,

and has prepared the following report in which the principal problems, common to all National Committees, are considered, along with additional recommendations for the program of the International Geophysical Year.

2. *Standard instruments for recording cosmic-ray intensity*

Although instruments of non-standard design are important for specific studies of changes in cosmic-ray intensity, it is the opinion of the CSAGI committee on cosmic rays that some instrument designs which can readily be duplicated throughout the world should be part of the committee's minimal recommendations for establishing a world-wide distribution of measuring stations. In particular, the committee recommends a standard counter telescope design to detect the cosmic-ray intensity at relatively high energies, and recommends a standard neutron monitor pile for observations of the low energy portion of the cosmic-ray spectrum.

The CSAGI will accept the detailed plans and operating procedures for these two types of apparatus from the IUPAP sub-commission on Cosmic Rays which has already been established for this purpose.

The CSAGI also wishes to have this sub-commission assume responsibility for the technical problems which arise from time to time relating to instrument design and the program of the International Geophysical Year.

The general specifications proposed by the Cosmic-Ray sub-commission of IUPAP are as follows:

(1) *Counter telescopes*

A. Design and operation:
   (1) Cubical design.
   (2) Three trays.
   (3) 10 cm Pb or equivalent absorber between the extreme trays.

(4) Minimum normal count rate = 50,000 counts per hr.
(5) Resolution of coincidence circuit will be 3–5 μsec.
(6) Recording of data to be for 15-min intervals.
(7) Diurnal range of temperature for apparatus should not exceed 10° C.
(8) Where a roof is not being used as absorber the roof mass should be less than 20 gm/cm^2.
(9) A precision micro-barometer or micro-barograph will be used for pressure corrections.
(10) Radiosonde measurements will be used to provide atmospheric temperature corrections. These measurements should be taken near the location of the counter telescope.
(11) Two identical cubical telescopes will be operated simultaneously.
(12) A permanent electric power line should be used with adequate voltage stabilization.
(13) Details on the construction and operation of these counter telescope systems will be made available by the IUPAP sub-commission on Cosmic-Ray Studies of Intensity-Time Variations.

B. Corrections:

Temperature and pressure corrections should be carried out, whenever possible, with correction coefficients derived from the apparatus used. Only where equipment is used at a site for too short a time to derive accurately the coefficients, should coefficients derived elsewhere be used. Uncorrected data as well as data relating to meteorological factors should be published along with the corrected results.

(2) *Neutron pile monitors*

A. Design and operation:

(1) The pile geometry of the Chicago pile design is to be used with lead and paraffin.
(2) Proportional counters will be used as detectors. Boron-10 is expected to be available for this purpose.
(3) One half of the counters will be connected to an electronic pulse recording system, and the other half of the pile counters will be connected to a separate, but identical, electronic recording system.
(4) A precision micro-barometer or micro-barograph will be used for pressure corrections. Instruments reading to $\pm 0{\cdot}1$ mm Hg, or better, are required.
(5) Data are to be recorded for 15-min intervals.
(6) The number of counters to be used in the pile should be determined by the requirement that the complete system will produce 200 counts/min, or more when placed at a magnetic latitude greater than 50° at sea level.
(7) The diurnal temperature range of the pile and circuits should be less than $\pm$ 10° C. The temperature should be less than 28° C at all times.
(8) Adequate voltage regulation should be provided.
(9) Provision for keeping snow off the roof of the laboratory should be made.
(10) Roof mass should be less than 20 gm/cm^2 whenever possible.
(11) Details of the construction, maintenance and operation of neutron piles will be made available by the IUPAP sub-commission.

B. Corrections:

Correct all data to a mean atmospheric pressure for the station.

Although no standards have been established for ionization chambers, the CSAGI wishes to emphasize the importance of continuing to operate through the International Geophysical Year those ionization chambers which are now in operation.

Similarly the continuous operation of high energy shower experiments, and studies using narrow angle telescopes at inclined angles, are to be encouraged, since all of these special detectors aid in the interpretation of intensity-time variations.

3. *Locations for stations observing cosmic-ray intensity*

At the present time there are many stations in operation throughout the world. The reports on Cosmic Rays of the National Committees for the IGY programs have recommended the establishment of additional stations, and, in many cases, have indicated the locations and types of detectors they desire to use.

The CSAGI has the responsibility of encouraging the establishment of additional stations wherever they will help to complete the requirements for world-wide coverage of cosmic-ray observations.

The recommendations of CSAGI are guided by the following principles:

(1) For determination of the latitude effect of intensity variations with time, a sequence of stations should extend from above $+60°$ magnetic latitude to beyond $-60°$ magnetic latitude in a moderately narrow range of geomagnetic longitudes, i.e. a longitude band approximately 60° wide or less. There are three possible bands of longitudes on the earth where this can be accomplished:

(a) North and South America, and Antarctica.

(b) Europe, African and Antarctica.

(c) Asia, Australia, New Zealand and Antarctica.

(2) For the detection of particles associated with solar flares, and for the study of 24-hr variations, a wide distribution of stations in longitude at many latitudes, especially high latitudes, is required. Since the land area is greater and more uniformly distributed in the northern hemisphere, and since most of the present observing stations are in the northern hemisphere, the distribution of station locations in longitude can most readily be completed in this hemisphere. For problems involving symmetry between the northern and southern hemispheres there will be the three longitude bands of stations described in (a).

(3) Large networks of ionospheric, meteorological and magnetic stations exist throughout the world; CSAGI recommends that whenever possible any new cosmic-ray stations should be located at such permanent stations. This is particularly important for cosmic-ray stations using standard counter telescopes, since radiosonde data must be obtained each day to correct the cosmic-ray data.

With these principles in mind, the CSAGI recommends that the existing and proposed stations be strongly supported by their respective national governments and national committees. The success of the International Geophysical Year program in cosmic rays will depend upon their continuous operation.

Having given careful consideration to the present and proposed world distribution of cosmic-ray observing and recording stations, CSAGI notes certain major gaps where no stations exist.

In order to secure adequate world-wide coverage of observations required for the successful completion of the International Geophysical Year program, CSAGI recommends that additional stations be established in the following places: Spitzbergen; Colomb-Béchar, Algeria; Hermanus, Union of South Africa; Deception Island (Antarctica); Port Moresby, New Guinea; Lwiro, Belgian Congo; Little America, Antarctica; Kampala, Uganda; Rangoon, Burma; Azores (Portugal); Jerusalem, Israel; and Abidjan, Ivory Coast.

In the event that the Australian operation on Heard Island is discontinued, CSAGI recommends that the French Government consider the establishment of a cosmic-ray station on Kerguelen Island. The total number of stations now *operating* is thirty-four; the total number of additional stations *proposed* by National Committees is twenty-six, and ten additional stations are proposed by CSAGI.

In addition, the establishment of high altitude stations at elevations of 7000 ft or higher is strongly recommended for the following three locations: (1) the Rocky Mountains, Canada, at 58° geomagnetic or higher latitude; (2) South Island, New Zealand, at magnetic latitude greater than 52°; and (3) Gulmarg, India. It is hoped that these stations can be mainly financed by the nations in whose domains they lie, and that they will be well provided with instruments, supplies and equipment. The stations should be prepared to enter into the international high altitude observing programs in the various interested sciences, in addition to participating in cosmic-ray research. Maintenance and the provision of technical personnel should be considered and provided insofar as possible. It would be highly desirable to have the national governments build and maintain high altitude laboratories as a service for scientists.

The CSAGI considers that the establishment of additional stations will result in providing more and better data and is, therefore, to be encouraged. For example, the areas covered by the USSR, the Chinese People's Republic and several of the islands in the oceans of the southern hemisphere are important, and it is hoped that additional cosmic-ray stations will be established in these areas for the International Geophysical Year.

4. *Special experiments of interest for the International Geophysical Year*

In addition to the program of continuous intensity observations the CSAGI urges that experiments be undertaken by the participating nations, which will greatly strengthen the IGY program in cosmic rays. These experiments are outlined as follows:

(1) The determination of the composition and energy spectrum of the cosmic radiation as a function of time, both before and during the International Geophysical Year. Techniques such as moving photographic emulsions may be used to investigate the character of the heavy particle component of the cosmic radiation. Italy, Great Britain, and the United States have already indicated an interest in these studies.

(2) The determination of the momentum spectrum of the cosmic radiation. This will require high altitude observations with balloons and rockets, extending from the geomagnetic equator to the geomagnetic pole.

(3) The latitude effect of the secondary components should be measured for each of the longitude bands of fixed stations described in Section 3. This requires the use

of aircraft capable of flying at high altitudes. The United States plans to undertake measurements of this type over the United States, and it would be valuable if similar measurements could be made by the nations of Europe, over Europe and Africa, and by India and Australia over the band of fixed stations in their area.

(4) Since the magnetic equator for cosmic radiation is not precisely known, it is important to determine the position of the equator for high energy particles, and to use these measurements to correct the geomagnetic co-ordinates of the station network. This preliminary work could best be undertaken near the solar minimum.

(5) Calculations and model studies of the charged particle orbits between the sun and the earth will be particularly important in understanding the flare effects detected by the world-wide network of stations during the International Geophysical Year. It would be valuable if the Stockholm groups which have been conducting such model experiments could continue their work. Orbit calculations could be undertaken by interested groups in the German Federal Republic, United States and other nations.

5. *Facilities for very high altitude observations*

Except for the simplest types of experiment, the problems associated with cosmic-ray measurements in the high atmosphere are extremely complex. For example, the launching of plastic balloons and rockets, and the procurement of aircraft, present real problems to the scientific investigator. Therefore CSAGI recommends the establishment of facilities on a continuous basis for each nation, so that its scientists may use these devices without having to accept the responsibility for their technical operation. These facilities may be called "service groups" for the national IGY programs. Fixed locations for the balloon and rocket launching centers could be established at appropriate geomagnetic latitudes.

Since similar facilities are often used by the civilian, military and commercial organizations of many nations, CSAGI recommends that these organizations be encouraged to establish "service groups" for balloons, aircraft, and rockets during the period of the International Geophysical Year.

In some cases the use of radiosonde stations may be adequate for rubber balloon flights.

6. *Distribution and publication of cosmic-ray intensity data*

The CSAGI requests the IUPAP sub-commission to prepare and distribute samples of the forms on which neutron and meson intensity are to be recorded, including the required meteorological data. During each month of the International Geophysical Year each participating investigator should send by air mail copies of the data from his laboratory for the previous month to the other participating investigators. CSAGI and the sub-commission will co-operate in issuing a complete list of all participants and their mailing addresses, and the list will be given to each participating scientist. The sub-commission will arrange further details on the distribution of data.

The CSAGI further recommends the publication of cosmic-ray data obtained during the International Geophysical Year, and it is hoped that a permanent arrangement for publication will be established which can extend beyond the International Geophysical Year.

7. *Information and data required for cosmic-ray studies*

Each of the participating investigators in the cosmic-rays program of the International Geophysical Year will require the aid of the "Alert" and warning systems being established by the Committee on World Days.

Meteorological data are required for the cosmic-ray stations. It is particularly important that radiosonde data be made available within a few days of the time of measurement.

In addition, many of the participating observers will need *basic solar data* such as:

(1) Location and importance of special solar regions.
(2) Solar flares: their location, intensity of $H\alpha$ as a function of time; associated radio noise burst with its polarization; magnetic field intensity in the flare region.
(3) Coronal isophotal charts for the solar disk.
(4) Distribution of the magnetic field intensity and polarity over the solar disk several times each day.
(5) Solar radio noise bursts and their location; background noise intensity at several frequencies.

Geophysical data required are:

(1) Magnetic storms.
(2) Kp indices.
(3) Auroral reports.
(4) Ionospheric data and sudden ionospheric disturbances.

These data should be available in weekly reports. Outstanding solar events should be reported immediately.

8. *Measurements prior to the International Geophysical Year*

In view of the fact that cosmic-ray intensity variations will become more complex and frequent as the maximum of solar activity is approached, CSAGI strongly recommends that new cosmic-ray observing stations be placed in full-time operation well in advance of the International Geophysical Year. Special experiments to assist the program of the International Geophysical Year which may be carried out prior to the International Geophysical Year have been discussed in Section 4.

VIII Longitudes and Latitudes

1. *Introduction*

The CSAGI has considered:

(1) The draft resolutions adopted at its Brussels Meeting (30 June–3 July 1953);
(2) The national reports presented to its second Meeting, Rome, 30 September–4 October 1954 (see Annex A, Longitude Determination by photographic observations of the Moon);
(3) The communication by W. Markowitz, "The photographic Moon Position Program" (see Annex B);
(4) The resolutions adopted by the Sub-Commission IIIc of URSI (see Annex C with a communication by M. Boella);

(5) The resolutions adopted by the Working Group of Longitudes and Latitudes of the IUGG;

and has adopted a program which is planned to give a more precise determination of the astronomical co-ordinates of the participating observatories and of the variations of these co-ordinates. The results of these studies, when examined in the future, will give a more precise knowledge of the instantaneous co-ordinates of the observatories. It will result in:

(a) Improvement of the determination of terrestrial time;
(b) More precise determination of irregularities of the earth's rotation;
(c) An improvement of star catalogs.

The present method of determining longitudes is very inadequate, as it is affected by the following errors:

(a) Instrumental and observational errors.
(b) Fluctuations of the instantaneous axis of terrestrial rotation.
(c) Vertical fluctuations of observation stations due to lunar and solar tides, other periodic or non-periodic terrestrial phenomena and notably thermal effects, and important geological changes.
(d) Uncertainties as to the duration of propagation of time signals.
(e) Errors in the star catalogs.
(f) Abnormal refraction effects.

In addition to the cited astronomical observations, an auxiliary lunar observation campaign is envisaged (by the Markowitz method), which has the double aim:

(a) To improve certain tabular data on lunar movement as well as the definition of uniform time.
(b) To determine, for the observatories participating in these observations, the variation between the vertical and the normal to a conventional ellipsoidical surface.

2 *Stations and equipment*

A. *List of proposed standard astronomical stations.*

(a) Permanent observatories associated with the Bureau International de l'Heure:

Belgrade, Buenos Aires, Greenwich, Hamburg, Mount Stromlo, Moscow, Neuchatel, Ottawa, Paris, Potsdam, Rio de Janeiro, Tokyo, Uccle, Washington, Zikawei, Irkutsk, Kharkov, Leningrad, Nikolaieff, Riga, Tashkent.

Total: 21 stations.

(b) Permanent observatories which (it is hoped) will be equipped for, and participate in, the plan of observatories:

Heidelberg, Turin, Algiers, Cape of Good Hope, Tananarive, Ksara, San Fernando, Madrid, Dehra Dun, Vienna, Milan, Lwiro (Kivu, Belgian Congo) and Wellington.

Total: Thirteen stations.

Temporary observatories requiring both astronomical and radioelectric equipment:

Curaçao, San Diego, Hawaii, Amsterdam Island, Tahiti.

Total: Five stations.

Complete total: Thirty-nine stations.

B. *Equipment required for stations participating in the international plan.* Essentially:

(a) Impersonal micrometers for astronomical observations.
(b) Several good quality quartz clocks.
(c) Radiotelegraphic receiving equipment providing for quasi-continuous reception, with adequate precision of the radio emissions used by the other stations of the world network. This last condition requires the presence of an adequate staff.

In addition:

(d) Simultaneous use of many instruments.
(e) Simultaneous latitude determinations, as accurate as possible.

Naturally every national observatory that so wishes can take part in the plan, though it may not fully meet this specification. Every facility will be given, especially as regards the fixed hours of emission of hourly signals, and the determination of the most probable values of the propagation times over the relevant paths. But such stations will be regarded as operating for their own purposes, and their results will not be discussed and published along with those of the principal stations.

3. *Preparation of more precise instructions*

More precise instructions will be prepared both for the astronomical observations and for the radiotelegraphic reception. A first draft will be prepared by small committees, and submitted by correspondence to the members of the working group. The two small committees have the following members:

(a) For the astronomical observations:
Chairman: Sir Harold Spencer Jones.
Members: MM. Bourgeois and Danjon.
(b) For the radiotelegraphic reception:
Chairman: M. Decaux.
Members: MM. Boella, Lejay, Miyadi, Walgate.

Annex A. Longitude determination by photographic observations of the moon

(1) *From the British National Committee Report.* It is planned to use also the Markowitz method of direct photography of the moon and nearby stars to obtain accurate positions of the positions of the moon for comparison with the ephemeris position, in order to derive the fluctuation in the moon's motion and thence the reduction from astronomical time to a uniform Ephemeris Time. This will provide an additional check on changes in the rate of rotation of the earth.

(2) *From the U.S.A. National Committee Report.* Although extensive triangulation nets have been established on most of the populated land areas of the world, it has not been possible to make accurate maps showing the continents in their proper relation to each other, owing to the impossibility of extending triangulation nets across oceans. There are not enough islands to use as stepping-stones, nor has it been possible to connect the separate networks of longitudes and latitudes with each other more accurately than to 200 or 300 ft. The location of some islands is uncertain by as much as a mile.

The difficulty can now be overcome by means of a new observational technique, by which the moon can be used as a triangulation point whenever it is visible at night. This technique consists of direct photography of the moon, by a camera specially devised to hold the image of the moon stationary among the stars while the exposure is being made. The probable error of a single observation is about 0·15 sec of arc, corresponding to about 900 ft on the earth. Intensive application of this technique at about twenty observatories during the International Geophysical Year can be expected to reduce uncertainties in the distance between continents to a probable error of about 90 ft. The new technique adds greatly to the precision with which changes in the speed of rotation of the earth can be measured, and the observational material obtained from this geodetic program may be expected to shed new light on the inner constitution of the earth.

Astronomical longitudes and latitudes, being affected by deflections of the vertical, cannot be exclusively used for precise mapping, but their determination with all possible precision is nevertheless of great value.

Two world-wide longitude campaigns have been carried out previously (most recently in 1933), and it will be desirable to redetermine the astronomical longitudes and latitudes during the International Geophysical Year.

The United States proposes to employ the new technique for photographing the moon, and also to determine astronomical longitudes and latitudes using the new Danjon astrolabe, at three stations: Washington, San Diego and Hawaii. It will supply dual-rate cameras suitable for attachment to existing long-focus telescopes at about seventeen astronomical observatories strategically located in other countries. It will also undertake to measure approximately one-fourth of the photographic plates taken with the twenty cameras, and will supply three measuring engines of special design to observatories in other countries willing to undertake the remaining measures.

(3) *Instruments.* Uniformity in the instruments employed is desirable in order to minimize systematic errors. In particular, the measuring engines must be of identical make. In order to ensure this uniformity, the U.S. Naval Observatory is obtaining twenty Markowitz moon position cameras and four measuring engines. Any observatory may construct its own camera, but for this program only the measuring engines cited will be used.

In general the cameras will be attached to existing telescopes at permanent observatories. A telescope of simple construction has been designed for temporary stations.

(4) *Participation.* A list of possible participating observatories is given below. This list, however, must be regarded as tentative, because definite commitments have not been made in all cases. Moreover the geographical distribution may be improved by modifying the list.

(a) Permanent observatories.

(1) La Plata, Argentina	(6) Boulder, Colorado
(2) Sao Paulo, Brazil	(7) Tokyo, Japan
(3) Washington, D.C.	(8) Banaras, India
(4) Ottawa, Canada	(9) Cape, S. Africa
(5) Williams Bay, Wisc.	(10) Johannesburg, S. Africa

(11) San Fernando, Spain
(12) Athens, Greece
(13) Paris, France
(14) Greenwich, England
(15) Dublin, Ireland
(16) Lund, Sweden

(b) Temporary stations
(1) Curaçao (Netherlands), S. America
(2) San Diego, California
(3) Hawaii

In order to improve the geographical distribution it is recommended that observations be made elsewhere as follows:

Algiers, Egypt, Oslo, Stockholm, South America (latitude $-45°$), Australia and New Zealand.

The allocation of the twenty cameras should be such as will best serve the aims of the international program. The factors to be considered include geographical position, weather conditions, and availability of telescope and personnel.

(5) *Measurement.* The plates are to be measured at the following observatories: Washington, Cape (S. Africa), Paris and Greenwich. Lund is an alternative measuring center.

(6) *Reduction.* In order to obtain the maximum benefits from the program, it is essential that all co-operating observatories perform their portion of the reduction as expeditiously as possible. The observing stations will mark the stars selected for observation and make certain preliminary computations. The plates will then be forwarded to the measuring center for measurement.

The value of ΔT = Ephemeris Time—Universal Time will be published by the measuring centers. The measurements will also be forwarded promptly to the central agency, which will make the general solution. It is planned to complete the reduction of the plates in 1959 and the general solution in 1960.

Annex B. The Photographic Moon Position Program

The possibility of using the moon in the solution of problems in geodesy is well known. The basic principle is that the lunar ephemeris gives the position of the moon as it would be seen from the center of the earth, but its position as observed is affected by a parallactic displacement which depends upon the three geocentric co-ordinates of the observer. The displacement is independent of either the direction or intensity of gravity at the station.

The use of the moon for this purpose is a complex problem, for there are other factors that cause the moon to depart from the ephemeris. The constants of the moon's orbit, the lunar parallax, and the distance to the moon are subject to correction. Also the ephemeris position is given in terms of Ephemeris Time (uniform) whereas the observations are recorded in terms of Universal Time (non-uniform).

A single observation of the moon gives at most two quantities. Since we must find for each station three quantities, the geocentric co-ordinates, and also other quantities involving the moon, it is apparent that numerous observations must be made if the various unknowns are to be separated. These observations must be made with the moon in different parts of the sky and in different parts of its orbit. The possibility of making a general solution for all the unknowns has hitherto been impractical because of the lack of a method of accurately determining the position of the moon at times selected by the observer.

The dual-rate moon position camera, however, overcomes this difficulty, and allows the position of the moon to be determined at any time when the moon is clearly visible. This camera, which simultaneously photographs the moon and surrounding stars, obtains high accuracy by holding the moon fixed relative to the stars during a time exposure. The external probable error for a pair of plates is $\pm 0''\ 15$ in either co-ordinate. Limb corrections have not yet been applied.

A dark, plane-parallel filter at the center of the field reduces the intensity of the moon's image. Tilting this filter during the exposure shifts the image. The rate of tilt and axis of tilt are set so as to hold the moon fixed relative to the stars. The epoch of observation, recorded on a chronograph, is the instant when the dark filter is parallel to a fixed light-yellow filter in front of the plate. When the filters are parallel there is no shift of the moon relative to the stars.

A two-screw measuring machine is used to obtain the co-ordinates of about ten stars and thirty to forty points on the bright limb of the moon. Since only three points are needed to define the center of a circle a solution for the center is made by least squares. The measurement of the plate thus gives the position of the center of the moon relative to stars of known position.

Because of the large number of points measured the effect of limb irregularities on the position of the moon is small. The entire limb, however, must be referred to some standard datum. The lunar profiles that Dr. O. B. WATTS of the U.S. Naval Observatory is preparing are being reduced to a common datum. The probable error given above should be reduced when the limb corrections are applied.

A comprehensive world-wide moon position program is planned for the International Geophysical Year, 1957–58, and the plans are now well advanced. Thanks to the support of the Office of Naval Research twenty moon position cameras and four measuring engines of special design are now being built. The aims of the International Geophysical Year program, which are of astronomical, geophysical and geodetic interest, include the determination of the following:

(a) Changes in the speed of rotation of the earth.
(b) The size and shape of the earth, independent of gravity.
(c) Corrections to the orbital elements of the moon, the lunar parallax, and the distance to the moon.
(d) The three rectangular geocentric co-ordinates of each observatory, to about 40 meters probable error.
(e) Deflections of the vertical to about 1″ probable error.

The above data will allow geodesists to form a World Geodetic System. The size and shape of the earth determined geometrically from this program may be combined with the determinations given by the usual methods to obtain the most probable size and shape.

The twenty cameras have nearly all been assigned to observatories well distributed about the world, and will be in trial operation by 1956. The International Geophysical Year program will run from 1 July 1957 to 31 December 1958. One to three sets of plates, depending on the declination of the moon, will be taken on about 100 nights. The measures should be completed by about 1960. Observations will be made at all stations during the same lunation, but not simultaneously, as the lunar ephemeris makes this unnecessary.

The essentials of the operation are as follows:

(1) The size of the lunar orbit will be determined by pairs of base-line stations in America, Europe and Africa, whose distances apart have been determined in meters by triangulation.

(2) The fluctuation in the position of the moon due to irregular rotation of the earth will be determined for each lunation, using the results of all the stations.

(3) Corrections to the orbital constants will be derived from all the observations.

(4) The three rectangular geocentric co-ordinates of each observatory may be found from two observations of the moon, which may be made in the same night. Each observation gives a line of sight of known location with respect to the center of the earth. The intersection of the two lines determines the co-ordinates. The rectangular co-ordinates may be changed into spherical co-ordinates.

(5) The flattening of the earth will be determined by the variation with latitude of ρ, the distance of a station from the center of the earth.

(6) The variation of ρ with longitude will determine the departure of the earth from the spheroidal form.

In the reductions, use will be made of the precise lunar ephemeris produced recently by the Watson Scientific Computing Laboratory, the U.S. Nautical Almanac Office, and the British Nautical Almanac Office. New photographic star catalogs are under consideration by Dr. HECKMANN, for the northern sky, and by Dr. BROUWER and Dr. STOY, for the southern sky. It is hoped that both of these projects, which would be very useful to the moon program, will be carried out.

The moon position camera of the U.S. Naval Observatory was attached to the 12-in refractor, and has been in continuous operation since June 1952 for the purpose of determining Ephemeris Time. A description of the camera and its application is given in the *Astronomical Journal* (p. 69, March 1954). Another article is to appear in the *Bulletin Géodésique*.

10 September 1954.

W. MARKOWITZ
U.S. Naval Observatory
Washington 25, D.C.

Annex C. Resolutions adopted by Committee IIIc of URSI concerning the study of the propagation time of time signals

Members of the Committee: Messrs. BOELLA (Chairman), LEJAY, SMITH-ROSE and VORMER.

Also present: DAVIES, DECAUX, EGIDI, FLEISCHER, HEWITT, KIRBY, KOGA, KRISHNAN, SCHEIBE and VOS DE WAEL.

Resolutions Adopted:

(1) The sub-commission considers that it would be desirable to use for measurement of longitude during the International Geophysical Year transmissions of time signals of the modern type or, if these are not available, transmissions of the classical type of signals, for which the irregularities can be maintained below one millisecond.

(2) The sub-commission considers that there are large areas of the world without

a transmitter of this type and of adequate power, in particular, between Europe and Japan and in the southern hemisphere.

(3) The sub-commission, therefore, considers that it would be desirable to establish some more transmissions of the modern type or, if this is not possible, to improve the transmissions of the greatest possible number of stations emitting the classical type of signals. The sub-commission recommends particularly that such arrangements be made in Australia, South America, South Africa and India, such that measurement may be made by duplex transmission between stations of various pairs in the two hemispheres.

(4) An experimental program of measurements of the time of propagation of time signals by duplex transmissions, and lasting for one week, will be carried out (if possible before the end of 1954) between the stations WWVH, WWV, MSF, IBF, and JJY. The chairman of the sub-commission will arrange the details of this program in good time.

(5) If this experiment results in favorable conclusions, such a program will be repeated every 6 months and extended so far as practicable. The observations will be made more frequently during the International Geophysical Year, according to a program to be arranged later.

(6) The sub-commission recommends that these resolutions be communicated to IUGG, IAU and CSAGI.

It is proposed that the following delegates should be elected as permanent additional members of the sub-commission:

H. FLEISCHER (Germany); I. KOGA (Japan); K. S. KRISHNAN (India).

Circular letter from Prof. M. Boella, 22 September 1954

Dear Sir,

In view of the world-wide operation of longitudes to be held on the occasion of the 1957–58 International Geophysical Year (IGY), the opportunity for a study of the propagation time of time signals has been considered and recommended by the Special Committee of the International Geophysical Year (CSAGI) during its meeting in Brussels, July 1953.

During the last URSI General Assembly at The Hague, August 1954, the sub-commission IIIe suggested that an experimental program of measurements of propagation time of time signals should be carried out, if possible, before the end of 1954 (see above).

I propose that these experiments be carried out in the week beginning with 13 December and ending with 18 December 1954.

Determinations of mean time difference between the signals received from far stations and the signals locally emitted, averaged over a period of time of about one minute, should be undertaken at points in proximity of WWV, MSF, IBF, JJY and WWVH transmitting stations.

Determinations should if possible be made between min 50 and min 20 at every three hours UT, i.e. at 23.50–00.20, 02.50–03.20, 05.50–06.20 UT, and so on, in order to include the rest periods in the transmission from MSF (min 15–20 each hour) and from WWVH (min 00–04 each hour). This could help to discriminate between different signals on the same frequencies.

Determinations should be made on every frequency on which signals from far stations can usefully be received (5, 10, 15, 20 Mc/s).

Each determination should result from the mean of at least ten, or preferably thirty or more, observations, as far as possible for successive seconds. As shown by previous experiments undertaken by the writer, a standard deviation of $0{\cdot}15\mu$sec may be expected for the mean value of a series of ten observations. Thus we can expect, for the same case, that the deviation will exceed $0{\cdot}5\mu$sec only in 0·5 per cent of the cases.

For comparison of time signals, the use of a cathode-ray tube oscilloscope, either by visual observation or with photographic recording, seems to me to be highly preferable, in order to avoid errors produced by atmospherics, interference and variations of the amplitude of the signals. Photographic recording seems most desirable, in spite of the greater time required for the reduction of data,* in a research of the kind the present experiments are concerned with.

In order to obtain uniformity in the reduction of data, in the case of very distorted forms of received signals, I suggest that the peak-point of the first cycle whose amplitude (deviation from zero-line) is greater than one third of the maximum amplitude should conventionally be taken to be the front of the pulse.

The time difference between the signals received from far stations and the local signals should be indicated as positive when the first signals are in delay with respect to the second ones.

Station IBF will provide for special transmissions on 5 Mc/s from min 00 to min 20, at every 3 hr, beginning with 00.00 UT. IBF signals can be distinguished from the others through the different type of marking of the beginning of the minute, consisting of a series of 6 time pulses at the second 00 instead of the suppressed 59th pulse of the minute.

It is desirable that JJY station should arrange special transmissions on 5 and 10 Mc/s for the week considered, at every 3 hr; this could be done, for instance, in two periods of 15 min each (from 50 min to 20 min) respectively for 5 and 10 Mc/s if both frequencies could not be broadcast simultaneously.

The object of the present experiments should be to reveal the magnitude of the variations of the mean propagation time of signals during the day and from day to day.

The results of the determinations, in the form of values of the mean time difference between distant and local signals, averaged over a period of about 1 min at every 3 hr, should be sent to the writer (c/o Istituto Elettrotecnico Nazionale, Corso Massimo d'Azeglio, 42, Torino, Italy) in order to calculate the propagation time of signals over different circuits.

M. BOELLA

XI Rockets and Satellites

1. *Introduction*

CSAGI had no Rocket Group at its 1953 meeting in Brussels, but a group was formed at Rome, 1954, as the rocket program involves observations dealing with

* A well-trained operator can read from 30 to 60 photograms/hr, according to whether the pulse shape is more or less disturbed and distorted.

several aeronomic problems, and the rocket techniques need special discussion. The Association of Geomagnetism and Aeronomy and the IUGG Committee for the International Geophysical Year also had working groups on Rockets.

CSAGI after consideration of the reports of these working groups has adopted the following report.

2. *Rocket program*

The rocket affords a means to carry measuring instruments far above the stratosphere. It makes possible the direct observation of many geophysical and solar phenomena which cannot be observed at all from the ground or from balloons. It likewise permits improvement upon other observations, which, though possible from the ground, are very indirect in nature. As a consequence rocket soundings of the high atmosphere can play a valuable part in the program of the International Geophysical Year.

At the present time only two countries, the United States and France, appear to have definite plans for programs of rocket soundings during the International Geophysical Year. Details of these programs are set forth in Annex A and B. France plans to carry out a dozen soundings with the Véronique. The United States plans to fire roughly 36 Aerobees and about 100 balloon- (or aircraft-) launched rockets during the International Geophysical Year period. It is known that both the U.K. and Australia have an interest in the use of rockets for sounding the high atmosphere, and it is hoped that by the next meeting of CSAGI details of programs will be available from them. The techniques and rocket range for the purpose are available, and the national committees are considering plans.

The planned rocket program divides naturally into two parts:

(1) That involving small rockets launched from balloons and/or aircraft; and

(2) That using the larger Véronique and Aerobee.

As shown by the Skyhook-Deacon program carried out in the United States during the past two years, balloon-launched rockets can be used to carry 15 kg of instrumentation to 100 km. The larger rockets can carry from 50–75 kg into the thermosphere.

The small-rocket program proposed by the United States for the International Geophysical Year will be extended both geographically and temporally. The size of the program, however, is not adequate to cover satisfactorily all of the observations that could profitably be made with such rockets. The participation of other countries would add greatly to the program. The techniques have been described in publications available to all. The small-rocket firings are relatively inexpensive, making it possible for many countries to start a rocket program of upper air research on a modest basis.

The large-rocket program proposed by the United States and France involve fewer firings than does the U.S. small-rocket program. This is due largely to the greater complexity and much greater expense of the larger missiles. In view of the much greater altitudes reached by the big missiles, however, they have an important place in the study of the thermosphere, the ionosphere, and the sun. It would be of great value to have this part of the rocket-sounding program augmented by the participation of other countries.

It is important to carry out rocket observations of a given phenomenon simultaneously with other types of observation of the same phenomenon or allied events. Hence it is planned in both the United States and French programs to integrate the rocket work as closely as possible with the World Day program. Certain difficulties obstruct full success in this, and must be recognized. For the firing of an Aerobee or a Véronique, even assuming that all experimental equipment has been prepared and installed in the rocket ready for operation, at least 12 hr, and possibily a full day's alert must be provided for starting firing preparations. A final notice of about one hour before the desired firing time must subsequently be given. In the case of balloon-launched rockets, the initial alert could perhaps be no more than 5 hr before firing time. Once the balloon has carried the rocket aloft, the firing of the rocket from the stratosphere could be achieved by radio in a matter of seconds after final notice from the World Warning System. In case the launching of small rockets from aircraft is developed in time for the International Geophysical Year, such a technique may be used by the United States. This type of operation would doubtless have scheduling requirements peculiar to itself. (See Annex C for a list of advantages afforded by launching small sounding rockets from aircraft).

For many investigations it would be desirable to make observations in the high atmosphere, extending over long periods of time. In this way one could observe, for example, the emission of solar ultraviolet and X-rays and related geophysical phenomena during and after solar flares. Further important investigations concern the primary cosmic-ray spectrum and its variation with solar flares and magnetic storms; auroral particles; the magnetic field at high altitudes and its variations above the ionosphere; and many others. Such observations, extending over a period of hours or days, would be of extreme importance, particularly during the International Geophysical Year. Present rocket techniques may enable small vehicles to be installed as temporary satellites in the high atmosphere, and they could be used to make such observations.

Annex A. United States plans for rocket soundings

The United States at present plans two distinct rocket-sounding programs for the International Geophysical Year. The one program will be carried out with small rockets launched either from balloons or from aircraft. The other will employ the larger Aerobee rockets. These two programs will be discussed in turn.

1. *The small-rocket program.* It is planned to fire about 100 small rockets at various places. These rockets will be able to carry about 15 kgs to 100 km. They will be used for the study of solar ultraviolet radiation and hard X-rays, particularly during solar flares; for the measurement of exceptional fluctuations of cosmic-ray intensity; for the observation of auroral particles; for airglow studies; for the determination of atmospheric densities, pressures, and temperatures; and for the exploration of the geomagnetic field in the lower ionosphere. Some of the rockets will be fired in the Arctic; some in the Bermudas, high over the Atlantic Ocean; some in the San Diego region, high over the Pacific; and some along a path extending southward from the geomagnetic equator to Antarctic regions.

It is not possible at the present time to be much more specific about the planned locations for the small-rocket firings. Permission is now being sought from the Canadian authorities for the firing of IGY rockets at Fort Churchill, Manitoba, Canada. If the request is granted, then that location may be regarded as definitely fixed. Otherwise another Arctic site will be sought, or the firings will be made from shipboard. For the firings at other locations, the use of military vessels and aircraft will be required, and negotiations for these have not yet been completed.

2. *The Aerobee program.* Present plans envisage the firing of some three dozen Aerobees during the International Geophysical Year. If Canada permits, most of these will be fired in the Fort Churchill area, Manitoba. The remainder will be launched in New Mexico. Experiments will be performed in the following fields:

Solar radiation.
Nature of atmospheric ions.
Nature of atmospheric molecules and atoms.
Atmospheric pressure, density, and temperature.
Winds.
Charge density in the ionosphere.
Airglow.
Auroral particles.
Auroral radiations.
The earth's magnetic field.

In many cases groups of experiments will be made in a single rocket, and identical experiments will be performed in each of the four seasons. In cases in which daily variations of a parameter are of interest, an effort will be made to fly identical experiments, one in the daytime and one at night. The total number of rockets available, however, is rather small, and it will not be possible to achieve the fullest coverage.

Annex B. French plans for the use of rockets

The group at Colomb-Béchar (Sahara, Algeria), which is only beginning to work on measurements in the upper atmosphere, will endeavor to accomplish a rocket program. It is expected that twelve rockets will be fired, two on six occasions at intervals of two months.

The measurements planned at present are those of pressure and density, ionization, ultraviolet solar radiation and composition (by means of the mass spectrograph).

Annex C. Some advantages of launching small sounding rockets from aircraft

The launching of small rockets from aircraft makes use of the balloon-launched rocket principle, namely the elimination of much of the aerodynamic drag attendant upon launchings at low altitudes. In addition, however, it allows the pinpointing of firings both in place and in time, with the following advantages:

(1) It permits launching over inaccessible places, such as the polar regions.
(2) It reduces the logistics problem, of transporting balloons, helium, and launching crew.
(3) There are fewer range safety problems, so that it permits launchings closer to inhabited places.
(4) It makes possible many firings in rapid succession at one location.

(5) It makes possible time-correlated firings at more than one location.

However, there are several unsolved technical problems, and it is not yet certain that the scheme will have been reduced to practice by the time of the International Geophysical Year.

3 Resolutions

I World Days

(1) The CSAGI invites the attention of the WMO to the plans for distribution of "Alert" warnings and Special World Interval declarations during the International Geophysical Year, and asks the WMO for its co-operation in distributing the necessary information to all possible nations over the communication networks available to the WMO.

(2) The CSAGI requests the URSI to provide detailed information on the exact nature of the solar and geophysical information that will be distributed, and the proper scale of distribution by each class of Ursigram during the International Geophysical Year.

(3) The CSAGI invites the attention of the CCIR to the plans for distribution of "Alert" warnings and Special World Interval declarations, together with the need for fast communication of certain geophysical and solar information during the International Geophysical Year. The CCIR is requested to solicit the co-operation of the communication networks of the several nations to ensure fast world-wide coverage during the International Geophysical Year.

II Meteorology

The CSAGI considering

(1) That the object of an International Geophysical Year in 1957–58 is to increase our knowledge of phenomena which can be observed in low latitudes and in the upper layers at all latitudes.

(2) That, from a meteorological point of view, it is most important to investigate systematically on a global scale the upper troposphere and the lower stratosphere and to endeavor so far as possible to fill the important gaps in the tropical aerological network.

(3) That first priority must be given to problems recognized as being of a worldwide character, that is to say, problems whose solution calls for effective collaboration on an international scale.

(4) That great care must be taken during the International Geophysical Year to avoid the dispersal of effort and of means which would result from tackling problems of only limited local or regional interest.

(5) That the only problems which should be handled are those offering reasonable hope of solution as a result of a temporary increase (in fact, eighteen months) in the volume of observations.

(6) That any observing program whose purpose is not clearly defined should be left out of consideration.

(7) That the program of observations must be drawn up in accordance with the problems accepted for study.

Recommends

(1) That the International Geophysical Year should be devoted to the investigation of large-scale physical, dynamic and thermodynamic processes of the general circulation and more especially to the study of the following problems:

(a) The redistribution in the atmosphere, on a planetary scale, of momentum, absolute vorticity, entropy and all forms of energy.

(b) The large-scale influence of friction and of surface topography on the balance of momentum, of energy and of absolute vorticity and on the balance of the exchange of momentum and heat between the atmosphere on the one hand and the oceans and continents on the other.

(c) The pattern of the field of flow in low latitudes, and the interactions between the circulation of the two hemispheres and between tropical and extra-tropical circulation.

(d) The horizontal and vertical distribution of ozone and water vapor (especially water vapor content at high levels) and the distribution of precipitation (especially over the oceans) in relation to large-scale weather situations.

(e) The thermal economy of the atmosphere in relation to the general circulation.

(2) That the network of observing stations should therefore be completed so as to permit:

(2.1) The preparation of the following essential vertical sections with a tolerance of 5° longitude or latitude as the case may be:

(a) Meridional sections from pole to pole along the meridians 10° E, 75° E, 140° E, 180°, and 80° W from the North Pole to parallel 20° S and thence to the South Pole along meridian 70° W. The sections 10° E, 140° E and 80°–70° W meet the requirements of the geomagnetic, ionospheric and meteorological programs. The 75° E section is representative of continental conditions in the northern hemisphere and maritime conditions in the southern hemisphere; moreover it crosses a region where monsoons prevail. The 180° section is the only one which is oceanic from pole to pole.

(b) The meridional sections of the northern hemisphere along meridians 20° W and 110° E. The 20° W section permits systematic study of the splitting of the jet-stream when it reaches a continent—in this case, Europe. The 110° E section serves the continent of Asia in the same way as the 80° W section serves North America.

(c) The meridional sections restricted to tropical latitudes (30° N–30° S) along meridians 30° E and 110° E.

(d) The zonal sections along the equator and parallel 15° N and—insofar as possible—the partial zonal sections in the immediate neighborhood of the fifth parallel in the North Atlantic, the Southern Indian Ocean and the Western Pacific.

(e) Partial zonal section in North America along parallel 40° N and, if possible, a similar partial zonal section in South America across the Andes; the zonal section through North America and a similar section through the Andes would permit a systematic study of the hydrodynamic effects of large mountain ranges upon the general circulation.

(2.2) The organization of surface and upper air observations, especially in the zones between parallels 45° and 50° N and parallels 35° and 40° S.

(3) That, in order to determine the influence of the earth's surface, surface temperature (earth temperature, temperature of snow surface or of surface water) should be measured at as many points as possible.

(4) That, in principle, aerological stations in middle and upper latitudes along meridians and parallels should not be more than 300–400 km apart; in tropical and subtropical latitudes they should be as close as possible to latitudes 0°, 5°, 10°, 15°, 20° and 30°.

(5) That, before increasing the number of ascents at existing stations, preference should be given to increasing the number of stations, especially where there are extensive gaps in the network.

(6) That the establishment of new aerological stations, in areas where the upper air network is inadequate, should be strongly encouraged, as the need for aerological data is extremely urgent.

(7) That upper air stations should be set up for the duration of the International Geophysical Year at the following strategic points: Easter Island, Clipperton Island, South Sandwich Group, Gough Island, Crozet Islands, Bouvet Island, Tristan da Cunha, St. Paul's Rocks.

(8) That the following upper air stations should be established for the duration of the International Geophysical Year in order to fill the gaps in the meridional and zonal sections:

10° E *section*: a station in Southern Tunisia, radio-wind equipment at Kano, stations at Fernando-Poo or Muni, the coast of Angola, Walvis Bay, Alexander Bay, Bouvet Island and at Princess Astrid Coast (Antarctica).

Equator: stations on Galapagos Island, St. Paul's Rocks, Coquilhatville and Addu Atoll.

(9) That in view of the well-known inadequacy of the aerological network over the oceans and of the important role of the oceans, where most disturbances begin, maximum advantage should be taken of all possibilities offered by large or small islands for the improvement of this network.

(10) That every country with a whaling fleet should seek the co-operation of whaling companies in order that meteorologists may accompany some whaling ships with a view to making upper air soundings during the whaling season 1957–58.

(11) That automatic weather buoys should be used in the southern seas where no synoptic surface observations are available. These buoys can measure and transmit water temperature, air temperature and pressure and the wind close to the sea surface.

(12) That, in view of the great importance of wind data, the number of radio-wind stations should be increased, and that in areas where such an increase is impossible, a dense network of nephoscope observations should be organized for the International Geophysical Year.

(13) That, in low latitudes, where wind data are especially important, priority should be given to wind soundings.

(14) That the offer of the Federal German Republic to set up a radio-sounding, radio-wind and radiation station for the duration of the International Geophysical Year in the equatorial zone, preferably in the Atlantic, should be warmly accepted.

(15) That aerological soundings should attain *at least* the 50 mb level each day during the International Geophysical Year [in principle, two temperature (RT) and four wind (RW) soundings each day] and that every effort should be made to exceed this level regularly and to reach the 10 mb level (*especially in tropical latitudes*).

(16) That the Meteorological Service of each participating country should be approached with a request to take the above-mentioned action.

(17) That a period of 10 consecutive days (World Meteorological Interval, WMI) should be set aside during each season of the International Geophysical Year, during which radiosondes (RT and RW) should reach the greatest height possible four times daily.

(18) That instruments for measuring the amount of ozone and water vapor should be installed at certain upper air stations (or close to them) along selected meridians (especially 10° E and 140° E) with a tolerance of 10° longitude and, for ozone, at points to the east and west of the subtropical anticyclones between 15° and 40° N.

(19) That the horizontal and vertical distribution of ozone should be measured on both sides of the subtropical jet stream, and that at least four ozone radiosonde stations should be installed along the meridian 10° E (one station in the polar zone, one in Germany, and one on each side of the jet stream).

(20) That a comparison should be made of the vertical ozone distribution data obtained by the various methods in use, i.e. the Götz effect, radio-soundings (filters), balloon-borne spectrograph, lunar eclipse.

(21) That radiation balance components (solar, terrestrial and atmospheric radiation) should be measured, preferably at upper air stations.

In order to reach a better understanding of the atmospheric circulation, it is necessary that all components of the radiation balance of the atmosphere should be measured at a sufficiently dense network of stations. It is particularly important to determine the fluctuations of long-wave radiation energy representative of a fairly extensive area around the aerological stations (especially island stations).

(22) That measurements of the earth's albedo, obtained by observing the earth-light on the moon, should be used to determine the total quantity of solar energy absorbed by the "Earth-Atmosphere" system, and the day-to-day variations of this quantity. The extension of the radio-wind network, and improvement of the equipment of existing stations, makes it possible to consider the practicability of a fairly accurate evaluation of the total kinetic energy of the atmosphere and its day-to-day variations. It would, therefore, be particularly interesting to know with the same accuracy the total solar energy absorbed by the "Earth-Atmosphere" system and its day-to-day variations. The CSAGI therefore asks IAU to make provision during the International Geophysical Year for determining the earth's albedo, using the method of Prof. DANJON, based on the observation of the earth-light.

(23) That cloudiness should be measured accurately at upper air stations (including weather ships) and on board merchant ships (especially those which depart from the usual commercial routes) with a view to a general analysis of radiation data, on a planetary scale.

(24) That where possible visual observations be made of exceptional phenomena such as noctilucent clouds and mother-of-pearl clouds (height, movement, morphology, optical effects).

(25) That, in the course of expeditions, the oxygen content of the air over the Antarctic should be determined, and, wherever possible, the CO_2 content of the air and the chemical composition of precipitation.

(26) That, wherever the necessary equipment is available, solar UV measurements should be made at the earth's surface (especially in the spectral regions of ozone absorption).

(27) That countries with suitable radio direction-finding equipment should organize continuous spherics observations and should co-ordinate between themselves an exchange of the results in order to obtain an overall picture of the atmospherics problem.

In order to obtain a more complete idea of the structure of the atmosphere and of air movements, a detailed picture of the phenomena that accompany the weather is also needed; particular mention should be made of thunderstorms in view of their great practical and scientific significance. Hence advantage should be taken of all available means of observing weather including those based on radio direction-finding, radar, weather reconnaissance aircraft, etc. Moreover the observation of spherics has the further important advantage that it permits the long-distance detection of certain types of atmospheric disturbance in areas devoid of stations. Countries taking part in the International Geophysical Year activities, which are still without radio direction-finders, should weigh the practical and scientific advantages to be derived from spherics observations.

(28) That action should be taken without delay to standardize all the weather instruments to be used during the International Geophysical Year, and that WMO should therefore organize in good time, well in advance of the International Geophysical Year, a world-wide comparison of the radiosondes in use.

(29) That in order to simplify the analysis, publication and processing of the observational data of the International Geophysical Year, the records and forms on which the surface and upper air data are to be entered should be carefully standardized; as standardized forms are only specified for a period of 18 months, CSAGI hopes that participating countries will be able to reach agreement within a short time, through the WMO Secretariat.

(30) That codes should never be used in publishing the weather data and that the scales and units used should *always* be clearly specified.

(31) That the data should be arranged and presented in such a manner as to be easily transferable to punched cards if necessary.

(32) That the observational data (the raw data, or data assembled or converted for use) should be sent at regular intervals and as rapidly as possible to an International Center (similar to that which has been proposed within WMO)* responsible for collecting, storing and supplying these data, upon request and against payment, to scientific institutes and individual research workers, either as microcharts or as photocopies.

The International Center for Observational Data would constitute at the same time an Information Center, by publishing periodically (every 6 months for example)

* In particular by the Working Group on the International Exchange of Historical Data relating to Meteorology.

a list of available data, with an indication of the type of observation, the source and date.

(33) That copies of all scientific articles in which observations of the International Geophysical Year are mentioned or used, and of all official publications of the International Geophysical Year issued by either national or international committees affiliated to CSAGI, should be sent as rapidly as possible to an International Center for Bibliography and Documentation. The latter would undertake to publish periodically (yearly or twice yearly) a list of references and a bibliography of all literature relating in any way to the International Geophysical Year.

(34) That, five years after the International Geophysical Year (i.e. in 1963), a recapitulatory table of all literature concerning the International Geophysical Year and of all sources of raw data usable at that time should be published.

(35) That publications issued by CSAGI and all affiliated bodies should have the title *International Geophysical Year* 1957–58 clearly printed on the cover and on the flyleaf, followed by the name of the body responsible for publication and an indication of the subject (e.g. Meteorology).

(36) That in case of urgent need, staff and/or equipment be exchanged between Services concerned.

Certain Meteorological Services are considering the establishment of stations on isolated islands and in sparsely inhabited areas. However, these Services do not always have the necessary staff and technical facilities. It is therefore strongly recommended that, in order to surmount the difficulties caused by lack of staff and material, the countries concerned should come to an agreement with others and sign bilateral agreements with a view to organizing and carrying out joint programs of observations in inaccessible regions.

III Geomagnetism

(1) The CSAGI, considering the world-wide importance of the magnetic observatory of Hongkong, urges that the observatory be rapidly rebuilt and reequipped, in order that it may co-operate fully during the IGY, 1957–58.

(2) The CSAGI, considering the importance of the observatory of Tatuoca for the IGY, 1957–58, urges that its construction be actively pursued, and that the observatory be equipped and put in service as rapidly as possible.

(3) The CSAGI strongly recommends that, for the period of the IGY, a magnetic station be established in Ethiopia near Addis Ababa, which is practically on the magnetic equator and therefore of special interest for the international study of the equatorial electrojet.

(4) The CSAGI strongly recommends that, to supplement the network of observatories in equatorial Africa, the construction of the magnetic observatory at Bunia, Belgian Congo, be activated, in order to have the observatory in full operation in time for the IGY.

(5) Having considered the distribution of magnetic stations in Africa, the CSAGI recommends that at least one station in northern Algeria be operated at the highest possible standard during the IGY, with a view to full participation in the geomagnetic program of the International Geophysical Year.

(6) The CSAGI invites the Government of Pakistan to consider the possibility of establishing a magnetic station in Eastern Pakistan, at least for the period of the IGY, 1957–58, in order to complete the net of stations already existing in this part of the world.

(7) The CSAGI, considering the scarcity of geomagnetic stations in the equatorial part of the Pacific, invites the French Government to consider the possibility of establishing a magnetic station at Tahiti or somewhere in the Marquesas Islands.

(8) The CSAGI invites the French Government to consider the possibility of establishing a magnetic station at Kerguelen, which station should be in operation at least for the period of the IGY, thereby completing in the most valuable way the network of magnetic stations in that part of the world.

(9) The CSAGI invites the Danish Government to consider the possibility of establishing a magnetic station at Julianehaab, which should be in operation in ample time for the IGY. Considering the position of Julianehaab near the maximum auroral zone, this station would supplement in the most valuable way the network already planned for that part of the Arctic region.

(10) The CSAGI, recognizing the world-wide importance of the Djakarta (Kuyper) observatory, urges that every effort be made in order to have it in full operation in time for the IGY.

(11) The CSAGI invites the New Zealand Government to consider the possibility of establishing a temporary magnetic station on or near Ross Island. This should be of considerable importance during the IGY.

(12) *Whereas* the Huancayo Geophysical Institute, through the fortunate circumstances of its location, has produced geophysical data of outstanding value to the scientific world, and is certainly one of the world's most important geophysical stations:

And in view of the further fact that results of inestimable value may be expected during the International Geophysical Year, 1957–58, and that scientific information obtained in many other localities is dependent upon the availability of the Huancayo data for its proper interpretation:

And in view of the further fact that facilities at Huancayo would permit auxiliary geophysical measurements of great value in geomagnetism, thermospheric physics, airglow, cosmic rays and many other geophysical fields:

And in view of the consequent urgency of maintaining the Institute at the highest efficiency and productiveness:

The CSAGI resolves that the Government of Peru, the National Research Council of the United States of America, and interested scientific institutions of both countries be advised of the conclusion by the CSAGI that, for the effective operation of the International Geophysical Year program, every possible effort should be made in the general interest, to support and strengthen the Institute, including:

(a) More adequate funds for operation and facilities for the work;

(b) Opportunities to extend the work of the Institute to other geophysical fields;

(c) Interchange and consultation between the staff of the Institute and world-recognized authorities in geophysics.

(13) The CSAGI, having considered the unique position of the Heard Island magnetic observatory, and in particular the fundamental importance of the contributions which this newly established observatory has been able to give to the current international scheme of characterization of geomagnetic activity, and having further considered the great scientific interest of a comparison between the valuable records obtained during the present sunspot minimum with those to be expected during the IGY, recommends very strongly that the Heard Island station should be maintained in full operation for the period of the IGY.

(14) Considering the interest in the continuous recording of pulsations in the earth's magnetic field, and the necessity that results obtained in all parts of the world shall be comparable with each other, CSAGI recommends that magnetic observatories be equipped for this purpose, at least during the IGY.

As regards instrumental details, consideration will be given to these by Committee No. 8 (on Magnetic Instruments) of the International Association for Geomagnetism and Aeronomy (IAGA: formerly IATME, International Association for Terrestrial Magnetism and Electricity). This Committee will study the possibility of measuring the pulsation by "electromagnetic sondes". If this method proves inappropriate for use by most of the observatories, so that the older methods must continue to be used, then the following is recommended as the minimum equipment.

Magnetic variometers to measure the rapid variations of X and Y (or H and D) and coils and fluxmeters to measure the rapid variations of $\mathrm{d}Z/\mathrm{d}t$ and *either* $\mathrm{d}X/\mathrm{d}t$ *or* at least $\mathrm{d}H/\mathrm{d}t$. The free period of the magnet in the variometers should not exceed 3 sec, and the damping coefficient should be about 0·5. The scale value for non-polar regions should be 1γ/mm for X and Y (or H and D), and $0{\cdot}1\gamma$/sec mm for $\mathrm{d}Z/\mathrm{d}t$ and $0{\cdot}05\gamma$/sec mm for $\mathrm{d}X/\mathrm{d}t$, $\mathrm{d}Y/\mathrm{d}t$, $\mathrm{d}H/\mathrm{d}t$. The paper speed of the recorders should be standardized at 6 mm/min; the time marks should be accurate to 1 sec. The sensitivity of the instruments should be determined experimentally over the entire range of registration.

(15) The CSAGI recommends that new stations established in regions where the value of the horizontal force is lower than $10{,}000\gamma$ should be equipped to record X, Y and Z; X and Y here signify the components of the magnetic horizontal force along the *astronomical* north and east directions.

(16) The CSAGI recommends that some magnetic observatories in auroral regions should be supplemented by two satellite stations for the measurement of the horizontal space gradients of the magnetic elements: the auxiliary stations should be situated in directions from the main station that are approximately at right angles; their distances from the main station should be from 5–10 miles; the determination of the space gradients should be made in the manner most convenient to the main station, either by the method being developed by the U.S. Coast and Geodetic Survey, or otherwise. (A note on magnetic gradients has been written by the President of CSAGI, see p. 106).

(17) The CSAGI recommends that international comparisons of magnetic standards be intensified for the period of the IGY, as well as for the period immediately preceding and following the IGY.

(18) The CSAGI recommends that quick-run recording of earth-currents should be carried out at all stations able to do so.

(19) The CSAGI recommends that attention should be drawn to the procedure for examining underground inhomogeneities of conductivity in the earth's crust by means of close nets of auxiliary temporary observatories. (See FLEISCHER, U. 1954; BARTELS, J. and KERTZ, W. 1954).

(20) The CSAGI recommends that all IGY stations, permanent as well as temporary, be utilized for the reduction of such aeromagnetic surveys as can be carried out during the IGY, and that the IAGA committee on magnetic charts be charged with the selection of the oceanic areas for which an aeromagnetic survey would be of special importance.

(21) The CSAGI recommends ionospheric observatories to install a simple geomagnetic recorder with visible trace, and also, if convenient, an alarm system, in order that the observatory may learn as soon as possible when a magnetic disturbance has begun; this would usefully supplement the system of World "Alert" periods.

Such a recorder would serve mainly the purposes of ionospheric research. It would be still more valuable if ionospheric observatories were to add good standard geomagnetic recorders to their equipment. Advice on this subject may be obtained from the IAGA Committee on Magnetic Instruments through Dr. V. LAURSEN, General Secretary, IAGA.

(22) The CSAGI urges all magnetic observatories to take steps to ensure that complete records will be obtained, even during the most intense geomagnetic storms. Provision should be made for recording, with sufficient lamp brightness, deviations from the normal up to 2000γ on either side of the mean, at non-tropical stations, and up to 1200γ on either side at tropical stations. The CSAGI recommends that special storm-magnetographs be installed for that purpose. Advice may be obtained from the Instruments Committee of the IAGA.

(23) The CSAGI advises institutions that are willing to participate in geomagnetic recording, although they are situated in a region of slight artificial magnetic disturbance unsuitable for records of normal sensitivity, to consider the possibility of operating a complete storm-magnetograph, and thereby of obtaining valuable records of intense storms.

(24) The CSAGI recommends that magnetic observatories should adjust the scale-values of their variometers approximately according to the following table:

Geomag. Lat.	Scale values when observatory is operating only one normal magnetograph		
	$D(Y)$ ′/mm	$H(X)$ γ/mm	Z γ/mm
0°–30°	1	4	4
30°–50°	1	5	6
50°–60°	3	15	15
60°–90°	5	25	25

Geomag. Lat.	Scale values when observatory is operating both standard magnetograph and storm magnetograph					
	Standard magnetograph			Storm magnetograph		
	$D(Y)$ ′/mm	$H(X)$ γ/mm	Z γ/mm	$D(Y)$ ′/mm	$H(X)$ γ/mm	Z γ/mm
0°–30°	1	3	4	1	15	4
30°–50°	1	3	4	4	25	15
50°–60°	1	5	5	5	30	25
60°–90°	1	7	7	9	45	45

Geomag. Lat.	Scale values for quick-run magnetograph		
	$D(Y)$ ′/mm	$H(X)$ γ/mm	Z γ/mm
0°–30°	1	1	0·1
30°–50°	1	1	0·1
50°–60°	1	1	0·1
60°–90°	5	5	5

(25) Having considered the fact that for the purpose of the International Geophysical Year the temporary magnetic stations may be of two different categories:

(a) Absolute stations making determinations of base values, and publishing hourly values.

(b) Variation stations which would not be expected to provide base values or hourly values:

the CSAGI wishes to stress

(a) That all equatorial stations should be of the absolute type.

(b) That all stations, absolute stations as well as variation stations, should provide exact scale values, temperature records and accurate time control. For details concerning the data to be published by absolute magnetic stations, the CSAGI endorses the resolution passed by the International Association of Geomagnetism and Aeronomy, Rome 1954, that hourly values published by temporary stations should be hourly means centered on the half hour.

V Ionosphere

1. World distribution of vertical incidence sounding stations.

(1.1) The CSAGI recommends that all existing stations continue operation throughout the International Geophysical Year.

(1.2) The CSAGI endorses the plans of Belgium to install a key station on the geomagnetic equator at Bunia, Belgian Congo.

(1.3) The CSAGI recommends that every effort be made to return the Khartoum station to full operation prior to the International Geophysical Year.

(1.4) The CSAGI recommends that French authorities should consider the possibility of establishing a station at Gao as part of the proposed equatorial network.

(1.5) The CSAGI welcomes the proposal to establish a station for systematic observations in Italy, and recommends that it should be located approximately half-way between the existing station at Schwarzenburg and the proposed station near Bizerte, North Africa.

(1.6) The CSAGI calls attention to the gap in the ionospheric network in the zone 15°–23° S, 10°–20° E. This requirement could be met by a station in Angola or South-West Africa.

(1.7) The CSAGI warmly recommends the plan of India to have an additional ionospheric station at Trivandrum. The latter location will provide a useful station for studying the fine structure of equatorial ionospheric variations.

(1.8) The CSAGI strongly recommends the renewal of observations at Colombo, Ceylon, which could make a valuable contribution to equatorial zone information.

(1.9) The CSAGI strongly supports the plan of the Netherlands to install a station at Hollandia.

(1.10) The CSAGI calls attention to the gap in the world ionospheric network in the zone 0°–10° S, 100°–110° E. This deficiency could be met by a station in Java.

(1.11) The CSAGI notes that the former station at Cape York, Australia, provided very important observations over a period of about four years. The CSAGI strongly recommends that further data be obtained from this locality during the International Geophysical Year. If possible, it is highly desirable that ionospheric observations be resumed at Cape York, but if this proves impracticable, an ionospheric station should be installed in conjunction with the geomagnetic station planned for Port Moresby.

(1.12) The CSAGI strongly endorses the U.S.A. plan to install a station at Yap, on the geomagnetic equator, during the International Geophysical Year.

(1.13) The CSAGI calls attention to the desirability of establishing an ionospheric station at Palau Island, a location which with Guam and Yap would complete a closely-spaced triad across the geomagnetic equator near its most northerly extension. Since there are plans for establishing both geomagnetic and airglow observations at Palau, the usefulness of ionospheric data obtained at this site would be correspondingly enhanced.

(1.14) The CSAGI recommends that the French authorities consider the establishment of an ionospheric station in the vicinity of the Marquesas Islands. This would help to fill a large gap in the equatorial Pacific area. (It is pointed out that this location is nearly antipodal to Djibouti).

(1.15) The CSAGI notes with satisfaction the definite plans of the U.S.A. to make ionospheric observations at Palmyra during the International Geophysical Year. However, it is pointed out that a renewal of observations at Christmas Island would perhaps be of greater value as part of the equatorial network. The CSAGI recommends that consideration be given to this alternative site.

(1.16) The CSAGI recommends that strong consideration be given by the U.S.A. to renewing observations during the International Geophysical Year at a site in Florida near 30° N.

(1.17) The CSAGI strongly commends the recent installation of an ionospheric station at Talara by Peru in co-operation with the U.S.A. The CSAGI also strongly emphasizes the critical importance for the ionospheric program of the continued operation of both the Talara and Huancayo stations, and the maintenance of observations of the highest standard.

(1.18) The CSAGI calls attention to the gap in the important equatorial section (along the 75° W meridian chain) near Quito, in Ecuador, and recommends that observations be made in this locality during the International Geophysical Year.

(1.19) The CSAGI calls attention to a gap in the network of stations in the vicinity of La Paz, Bolivia (near 17° S, 68° W). This location is invaluable for equatorial ionospheric studies. The CSAGI recommends that the Bolivian authorities consider the feasibility of participating in this way in the ionospheric program of the International Geophysical Year.

(1.20) The CSAGI welcomes the plan of Argentina to operate additional stations during the International Geophysical Year, and suggests that every effort be made to install an automatic recorder at La Quiaca. The CSAGI further recommends that, as a contribution towards the geomagnetic equatorial network, Tucumàn (27° S, 65° W) be considered as the site of a second automatic ionospheric station. The CSAGI also endorses the Argentine plan for semi-automatic stations along the southern coast of Argentina, and recommends that, in siting these, every effort be made to avoid overlapping with existing stations in respect of geomagnetic latitudes. It is recommended that one of these should be at approximately 45° S.

(1.21) The CSAGI recommends the installation of a new station at or near Concepcion, Chile (37° S, 73° W).

(1.22) The CSAGI notes the important geophysical work which has been carried on in the southern hemisphere at Kerguelen, Campbell and Macquarie Islands, and strongly recommends that the responsible authorities continue the observations, including ionospheric, at least throughout the International Geophysical Year.

(1.23) The CSAGI recommends the installation of an ionospheric station on Bouvet Island (55° S, 4° E). At present no ionospheric station exists near the 10° E meridian south of latitude 35° S.

(1.24) The CSAGI strongly recommends that during the International Geophysical Year a special effort be made to obtain ionospheric data in the Antarctic. The CSAGI strongly supports the proposals which have been made to establish ionospheric stations at:

Terre Adélie	(140° E, 67° S)
Mawson	(63° E, 68° S)
Port Lockroy	(64° W, 65° S)
Marie Byrd Land (Rockefeller Plateau)	(120° W, 80° S)
Little America	(164° W, 79° S)
South Polar Plateau	(−90° S)

Furthermore, to ensure a more complete Antarctic network, the CSAGI recommends that additional stations should be established at or near the following localities:

Knox Coast	(105° E, 67° S)
Enderby Land	(62° E, 75° S)

Princess Astrid Coast	(10° E, 70° S)
Vahsel Bay	(35° W, 77° S)
Peter Island	(90° W, 68° S)

(1.25) The CSAGI recognizes that some of the recommended sites for IGY stations are in remote parts of the world or in areas where scientific activity on the scale recommended may be difficult to implement by the responsible authorities. It calls attention to the success which may be achieved through the co-operation of several nations in the establishment, equipping, or operation of such stations. Accordingly, the CSAGI recommends that consideration be given to such co-operation in establishing some of the stations listed above: for example Bouvet, Concepcion, Tucumàn, Java, etc., and expeditions to the Antarctic.

2. Vertical soundings from aircraft

The CSAGI endorses the U.S.A. plan to make ionospheric soundings from aircraft, and recommends that emphasis be placed on polar and equatorial flight paths which pass over two or more operating stations. Furthermore, whenever possible, flights should be undertaken on regular World Days or during Special World Intervals.

3. Ionospheric absorption network

(3.1) Vertical incidence sounding methods: The CSAGI recommends that in the immediate future an intercomparison should be made of absorption results obtained by different vertical incidence sounding methods.

(3.2) Absorption measurements using cosmic noise sources: The CSAGI recommends that in the immediate future careful studies should be made to explore fully the possibility of this method of measuring both normal ionospheric absorption and the abnormal absorption which occurs during polar blackouts.

(3.3) The CSAGI calls the attention of the URSI sub-committee on ionospheric absorption measurements to these resolutions.

4. Ionospheric drifts

(4.1) The CSAGI recommends that, during the International Geophysical Year, advantage be taken of the high concentration of ionospheric sounding stations in Europe for the purpose of studying large-scale movements.

(4.2) The CSAGI recommends that, in the immediate future, an intercomparison should be made of drift measurements made by different techniques, and also of simultaneous measurements undertaken by the same techniques at neighboring sites. The attention of the URSI sub-committee on ionospheric drifts is drawn to this resolution.

VI Solar Activity

(1) The CSAGI recommends that, for the co-ordination of solar and geophysical phenomena, a recurrence period of 27 days should be employed. The Carrington period will continue to be used, as hitherto, for purely astronomical purposes.

(2) The CSAGI recommends that weekly reports of the various aspects of solar activity, along the general lines of the reports issued by the Bureau of Standards and the High Altitude Observatory at Boulder, should be prepared by Western Europe,

Australia and/or Japan, to provide rapid dissemination of information of importance for various geophysical observations. The regions concerned should arrange for a center to which information should be sent and which should be responsible for the preparation of the reports. Daily telegrams should be restricted to essential and urgent information.

(3) The CSAGI recommends that the monthly reports of solar activity, at present being prepared by various centers, which contain more complete and more accurate data, should be continued and given appropriate distribution for purposes of the International Geophysical Year.

(4) The CSAGI recommends that, during the International Geophysical Year, in order to ensure as complete a coverage as possible of solar observations throughout the day, consideration should be given to the extension of normal watching periods in longitudes where stations are few. It is desirable that the hours of watching in Western Europe should be continued until after eastern stations in America have started observing, and that western stations in America should continue watching until after observations have started in Japan, Australia and New Zealand. The International Astronomical Union is requested to formulate, in co-operation with the institutions concerned, an extended program of solar activity patrol during the International Geophysical Year.

(5) The CSAGI recommends that institutions equipped with a Lyot filter should consider using the filter for the continuous observation of chromospheric flares (flare patrol), where this is not already being done. It is suggested that photographs should be obtained at intervals of 30 secs during the normal period of watch, and at intervals of 5 mins outside that period.

(6) The CSAGI recommends that, on the occurrence of a chromospheric flare, the standard observing procedure should be as follows:

(a) Estimate times (UT) of the beginning, the peak intensity, and the ending of the flare.

(b) Locate precisely, by drawing or photographs, the emission areas in relation to associated sunspots and bright hydrogen plages.

(c) Estimate, by means of an eye-piece graticule in visual observations or from measurements or photographs, the area of the emission region in millionths of the Sun's hemisphere (i.e. corrected for foreshortening).

(d) Make a series of measures of effective line-width or profile of $H\alpha$ at one-minute intervals throughout the flare, and/or

(e) Make a series of measures of central intensity of $H\alpha$ using a wedge photometer.

(f) Measure the line-of-sight velocities of flare surges (active dark filaments).

(7) The CSAGI notes with satisfaction that an improved system of flare classification is under consideration by the International Astronomical Union.

(8) The CSAGI recommends that stations using Lyot filters should arrange, where possible, for photometric calibration of the photographs. As the transmission band widths and scattered light properties of these filters are not identical, and the quantitative comparison of results from various institutions depends upon the standardization of the data, the CSAGI requests that the formulation of the procedure for such

standardization should be considered by Commission 11 of the International Astronomical Union.

(9) The CSAGI desires to emphasize the importance of improving and extending the measures of the intensity of chromospheric flares in terms of the adjacent continuous spectrum, and of such measures being made on a uniform system.

(10) The CSAGI recommends that institutions equipped for the study of chromospheric flares should consider the installation of a SEA (sudden enhancement of atmospherics) recorder, on a frequency of about 27 kc/s. Such recorders, which are simple in construction, give a visual indication of the beginning of a flare, thereby enabling the relationships between solar flares and the enhancement of atmospherics to be observed outside the normal patrol periods.

(11) The CSAGI recommends that solar prominences should be actively observed and studied during the International Geophysical Year, and considers that such observations will be of value in the search for indices of solar activity during this period.

(12) The CSAGI recommends that institutions with suitable equipment should undertake a prominence patrol during the International Geophysical Year by observations at intervals during the day, and that heliographic maps showing the positions and general structure of prominences, with indications of the prominence types, should be prepared.

(13) The CSAGI recommends that solar observatories should consider the installation of equipment for obtaining a general picture of the intensity of the magnetic fields of the sun, on the general plan of the technique developed by BABCOCK at Mt. Wilson, and that where such equipment is installed measurements should be made two or three times a day.

(14) The CSAGI recommends that institutions possessing equipment suitable for the investigation of the magnetic field of the sun by other methods should make such measurements at intervals throughout the International Geophysical Year.

(15) The CSAGI desires to emphasize the importance of the Lyot white-light polarizing photometer for the measurement of the intensity of white light at various distances from the sun's limb, and urges the extension of such observations.

(16) The CSAGI desires to draw attention to the need for the standardization of measurements of coronal intensity, and notes with satisfaction that action is being taken by the International Astronomical Union for the development of a coronal photometer for use in such standardization, in adequate time for its use before and during the International Geophysical Year.

(17) The CSAGI notes with satisfaction that consideration is being given by the Netherlands to the setting up of solar noise recorders near the ionospheric stations at Paramaribo and Hollandia. In order that a continuous record of solar radio radiation can be obtained, the establishment of a solar noise station on Hawaii or on Tahiti is to be desired. The CSAGI recommends that the possibility of establishing such a station should be considered by the National Committees of the U.S.A. and France.

(18) The CSAGI recommends that, in the formulation of plans for the observation of solar radio emissions during the International Geophysical Year, consideration should be given to the technique developed by CSIRO, Sydney, for obtaining

dynamic spectra of solar noise bursts. As this technique gives information not otherwise available, it is important that an adequate coverage in longitude to provide such observations throughout each 24 hr should be achieved.

(19) The CSAGI notes with interest that the two provisional indices for solar radio-emission proposed by URSI will be thoroughly investigated in order to be brought into use before the International Geophysical Year.

(20) The CSAGI notes with interest the program of the International Association of Geomagnetism and Aeronomy for the continuous measurement of the intensity of corpuscular solar radiation as inferred from geomagnetic time-variations, and, in particular, the plans for the preparation of a homogeneous series of activity indices for each quarter-hour interval during the International Geophysical Year.

(21) The CSAGI recommends that all observatories participating in the solar activity program during the International Geophysical Year should report promptly to the IGY network for Special World Intervals preliminary summaries of their patrol observations. The occurrence of important flares or radio noise outbursts should in addition be communicated by telephone or telegram. Summaries of other observations should be communicated as may be arranged by the observatory and the regional centers of the IGY network.

(22) The CSAGI emphasizes the great importance of increasing the number of solar patrol observations in the vicinity of 140°–160° E longitudes, in order to improve the coverage of solar activity when the sun is overhead in these longitudes; it calls this problem to the attention of the Australian National Committee.

(23) The CSAGI notes that several observatories are indicated in the National Committee reports as planning to participate in the patrol and study of solar activity during the International Geophysical Year, and expresses the hope that other observatories will also participate.

VIII Longitudes and Latitudes

The CSAGI recommendations are as follows:

1. Stations

(1.1) Astronomical observations should be intensified during the International Geophysical Year by all the observatories associated with the BIH (Bureau International de l'Heure).

(1.2) A certain number of other well-equipped stations should be organized in parts of the world where no observatories exist, and particularly near the equator and in the southern hemisphere.

2. Nature of the observations

(2.1) Each observatory (stations of 1.1 and 1.2) should proceed as far as possible simultaneously for the observations of time and latitude.

(2.2) The duration of these observations should cover a time interval at least equal to the Chandler period (about 430 days).

(2.3) Observations at all the stations should refer to the same fundamental catalog, no matter what instruments are employed.

3. Instruments

(3.1) Different types of instruments should be employed: transit instruments, zenithal photographic telescopes, impersonal astrolabes, etc.

(3.2) Nevertheless, preference should be accorded to instruments giving simultaneously the time and latitude.

(3.3) When the instrument employed for the longitude will be a zenithal telescope, observations should also be made in the immediate vicinity with another instrument in order to permit the observation of the basic stars, in such a manner as to correct the local catalog errors, and notably those errors dependent on right ascension, which can be interpreted as an apparent annual longitude fluctuation.

4. Radio transmissions

(4.1) For the longitude operation, use should be made of time signals both of the new high-precision type (WWV etc.) and the classical type, with the condition that their irregularity during each emission must be kept below 1 μsec.

(4.2) Numerous direct and precise determinations of the mean propagation time of time signals (during the period of about 1 min) should be made before and during the International Geophysical Year, using both existing emissions and special two-way circuits between suitable points. The variations of these propagation times from one region to another, as well as the variations in time itself and with wavelength, should be thoroughly studied. In every case the same frequency must be utilized in both directions in each determination.

(4.3) The experiments proposed by URSI in its attack on this subject should be encouraged, and similar efforts should later be made regularly every three months.

(4.4) Determinations requiring very high precision of propagation time of the signals should be made between certain stations, and they should be compared with results deduced from ionospheric soundings, in order to improve the knowledge of wave propagation.

(4.5) In view of the above, the importance of establishing other permanent or temporary stations emitting time signals of the new type in additional regions (in particular in the USSR, India, South Africa, Australia, New Zealand and in South America) should be called to the attention of the governments concerned, through the intermediary of the CCIR, or directly by the International Geophysical Year National Committees, or by any other means possible.

5. Reduction, centralization and discussion of observations

(5.1) In order to assure the homogeneity of results, astronomical time and latitude determinations should be reduced in a uniform manner, conforming with the instructions which will be furnished in time for the observations.

(5.2) The International Astronomical Union should maintain its support of Prof. KOPFF for the revision of FK3, as well as that of Dr. MELCHIOR for the revision of the star catalogs of the International Latitude Service.

(5.3) In order eventually to take into account annual or accidental refraction variations, the Meteorological Services participating in the International Geophysical Year should determine the configuration of winds and the distribution of the temperature and humidity up to 30 km.

(5.4) The results of astronomical observations should, after reduction, be transmitted to competent organizations common to IAU and IUGG, namely, the International Time Office and the International Latitude Service, which will undertake the discussion and will receive the necessary subsidies.

(5.5) There should be a single publication of results on latitudes, longitudes and propagation times. (This does not refer to observations and detailed calculations pertaining to individual stations).

6. Determination of longitudes by photographic observations of the moon.

(6.1) Photographic observations of the moon by the Markowitz method should be made at a certain number of stations.

(6.2) Simultaneously astronomical determinations of time and latitude should be made at the same stations.

(6.3) The base-lines for stations that belong to a network should be determined wherever possible by calculations made with the aid of homogeneous triangulations.

(6.4) It is proposed that the Naval Observatory at Washington should coordinate the lunar observations and undertake their discussion.

IX Glaciology

The CSAGI recommends that:

1. *Glaciation*

Measurements should be made on the extent, characteristics and behavior of glaciers and snow cover in all parts of the world. A simultaneous survey of world glaciation is not only vital to the science of glaciology but of great meteorological importance in the study of climatic change. A greater world coverage of glaciation will be possible during the International Geophysical Year than at any other time, because of the opportunities for observation in many isolated areas.

2. *Types of observation*

(2.1) On selected glaciers in many parts of the world, particular note should be made of ablation, accumulation, movement, change of mass, and radiation effect. The establishment of fixed survey points should be stressed in order that changes of mass may be adequately determined in future geophysical years. The melt-water discharge of glaciers having basins of known extent may comprise a useful supplementary measurement.

(2.2) In addition, where detailed work cannot be carried out, reconnaissance observations of glacier variations should be made on as many glaciers as possible. This can be accomplished either by photogrammetry or by simple terrestrial measurements. These should include the position of the terminus and height of the firn line.

(2.3) Wherever possible, records of the extent, duration depth, and other physical characteristics of the snow cover should be maintained throughout the year. The methods of measurement should be standardized. The measurements should also include areas without present glacier cover.

3. *Stations*

(3.1) If additional geophysical bases are established in Antarctica, glaciological studies should be undertaken at these stations whenever feasible.

(3.2) In addition to extensions of established programs of glaciological research in various parts of the temperate and polar regions, attention should be directed to little known areas such as tropical Africa, central Asia, and far northern Canada, particularly Ellesmere Island.

4. *Co-ordination*

(4.1) The American group, in consultation with other national groups interested, should act as co-ordinator and advisor on standardizing observations, and on the types of equipment required.

(4.2) The U.S.A. program* for glaciology should be circulated with the program of CSAGI.

X Oceanography

(1) The existence, generation and propagation of long-period, non-tidal oscillations of sea-level should be investigated, and in particular:

(a) Seismic and storm surges.

(b) Slower changes in level, such as might be caused by seasonal changes in temperature or wind.

(1.1) The CSAGI recommends acceptance of the U.S.A. plan that long-wave recorders and tide-gauges be installed on as many islands as possible as well as on continental coasts; a reasonable proportion of the measurements should be made in oceans with good meteorological cover, and some in regions where there are seasonal changes in the prevailing winds.

(1.2) The CSAGI also recommends that regular bathythermograph measurements should be made of the upper 200m of water near the recording station, as well as the usual meteorological data.

(2) The water circulation, waves, sediments and crustal structure should be investigated along two extended north–south lines crossing equatorial regions.

(2.1) The CSAGI recommends that a reasonable proportion of the effort should be devoted to the measurement of the actual water velocities, and to the heat exchange between the sea and air, as well as the usual measurements of temperature, salinity, etc.

(2.2) The CSAGI recommends that countries without adequate facilities to assist materially in the main plan should themselves, and preferably in collaboration with their neighbors, study the water circulation in seas where the results will have a bearing on the main program, or where the work will benefit from being done at the same time as the main program. The Western Mediterranean Sea and the Southern Ocean are examples of places where such work might be done.

The chief aim of recommendations 2.1 and 2.2 is to improve our understanding of oceanic circulation.

(2.3) Oceanographic ships should investigate the processes involved in the shifting of the boundary region between temperature and Arctic waters, and in the warming of the Arctic:

The CSAGI considers that much of this can be done by suitable arrangement of the existing effort.

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* The U.S.A Program was published in *Bulletin d'Information* No. 3 of CSAGI.

(3) In view of the promising development of stationary and towed electrodes for measuring water movements, the CSAGI recommends the use of this method.

(4) The CSAGI recommends that the Ocean Weather Ships be asked to assist in the studies of oceanic circulation, by making regular hydrographic and other oceanographic observations.

(5) The CSAGI recommends that during the International Geophysical Year the oceanographic ships should co-operate in the program of other fields of geophysics, as, for instance, magnetic observations at sea, provided that suitable methods and apparatus are made available.

(6) The CSAGI recommends that the following international authorities: the International Council for the Exploration of the Sea, the International Council for the North Atlantic Fisheries, the Pacific Science Council, the Pan-Indian Ocean Scientific Congress, the Scientific Council for Africa South of the Sahara, should be approached as soon as possible, and urged to intensify their work on oceanic circulation during the International Geophysical Year, and to plan the visits of research vessels to suitable regions, so that observations pertaining to the oceanographic program of the International Geophysical Year shall cover as wide an area as possible, be more synoptic, and be fruitfully worked out on an international basis.

(7) The CSAGI recommends the establishment of a standing committee of the IUGG, as follows, to implement and organize the herein listed resolutions: Dr. REVELLE; Prof. M. EWING; Dr. SMITH: Chairman, *pro tem.*; Dr. G. E. R. DEACON; Dr. BÖHNEKE, with authority to enlarge their committee as they may deem advisable. CSAGI urges the importance of an early meeting.

(8) The CSAGI recommends that detailed instructions for the use of observers and computers be prepared and published to ensure the homogeneity of the presentation of results for their further analysis.

XI Rockets and Satellites

1. *Rockets*

(1) It is urged that as many countries as possible undertake programs of small-rocket soundings, and, in addition, that currently planned small-rocket programs be expanded, but with no diminution of effort in the large-rocket programs.

The CSAGI recommends that in setting up such programs the following fields be considered:

Ultraviolet solar radiation for $\lambda > 2000$ Å.
Atmospheric ozone.
Hard solar X-rays.
Cosmic rays.
Auroral particles.
The earth's magnetic field in the auroral zone.
Air density, pressure and temperature.
And possibly also the following:
  Air composition by sampling.
  Winds.

(2) The CSAGI recommends that the nations which plan to use small rockets during the International Geophysical Year should keep one another informed.

The recommended participation of many countries in the International Geophysical Year program of small-rocket soundings is considered essential to adequate temporal and geographic coverage of the important fields listed. As pointed out on p. 148 a small-rocket program can be carried out at relatively little expense, and enables experimenters to send equipment to as high as 100 km.

(3) The CSAGI recommends that the geographic coverage of the large-rocket sounding program, now planned by the United States and France, be extended at least during the International Geophysical Year by the participation of other nations; and, in addition, it is recommended that the United States and France make every effort to expand currently planned activities in this field. In particular the following observations, which can usefully be made anywhere in the world, are recommended:

Solar radiations.
Nature of atmospheric ions.
Nature of atmospheric molecules and atoms.
Atmospheric pressure, density, temperature, and winds.
Charge density in the ionosphere.
Airglow.
Micrometeorites.
Cosmic rays.

For the auroral zone, in addition to the above, the following studies are recommended

Auroral particles.
Auroral radiations.
The earth's magnetic field.

The earth's magnetic field should also be measured in the equatorial regions.

(4) The CSAGI recommends that rocket soundings during the International Geophysical Year be made on appropriate World Days, and co-ordinated in time with each other, as far as possible. It recommends that special steps be taken to provide rocket groups as rapidly as possible with World Day announcements, and information on solar and geophysical activity. For a number of rocket experiments it will be desirable to have notice of solar and geophysical phenomena within a matter of minutes. The rocket groups should in turn keep the World Warning System informed of planned or possible firing dates.

(5) The CSAGI recommends that vertical-pulse height soundings of the ionosphere be made simultaneously with, and at the same location as, all rocket measurements of ionospheric charge density.

(6) The CSAGI recommends that the results of each individual rocket sounding be issued as soon as possible after the sounding.

2. *Satellites*

In view of the great importance of observations during extended periods of time of extraterrestrial radiations and geophysical phenomena in the upper atmosphere, and in view of the advanced state of present rocket techniques, the CSAGI recommends that thought be given to the launching of small satellite vehicles, to their scientific instrumentation, and to the new problems associated with satellite experiments, such as power supply, telemetering, and orientation of the vehicle.

General

(1) The CSAGI recommends the following resolution proposed by the International Geophysical Year Committee of the IUGG:

The basic philosophy in selection of programs for the International Geophysical Year

(a) The program of the International Geophysical Year should be selected with a view to solving specific planetary problems of the earth. To achieve such solutions, the IUGG recognizes that during the International Geophysical Year the regular scientific facilities of the world must be supplemented by additional observations suitably distributed in space and time, as needed for the solution of selected problems.

(b) Problems requiring special attention during the International Geophysical Year should be selected according to the following criteria:

(i) Problems requiring concurrent synoptic observations at many points involving co-operative observations by many stations.

(ii) Problems of branches of the geophysical sciences whose solutions will be aided by the availability of synoptic or other concentrated work in other geophysical sciences during the International Geophysical Year.

(iii) Observation of all major geophysical phenomena in relatively inaccessible regions of the earth that can be occupied during the International Geophysical Year, because of the extraordinary effort during that interval, in order to augment our basic knowledge of the earth and the solar and other influences acting upon it.

(iv) Epochal observations of slowly varying terrestrial phenomena: to establish basic information for subsequent comparison at later epochs.

(c) Where questions of priority arise, priority should be given to programs under sub-paragraph b (i), in accordance with decisions of the Brussels meeting of CSAGI, July 1953.

(2) The CSAGI requests ICSU to invite UNESCO, in view of the conformity of the International Geophysical Year with the international objectives of UNESCO, to impress upon the countries participating in the International Geophysical Year the importance of this international scientific effort in 1957–58, and suggests that UNESCO ask the government of each of these countries to give all possible assistance to their geophysical groups engaged in programs of the International Geophysical Year.

(3) The CSAGI recommends that the participating nations should incorporate the recommendations, presented in the several reports and resolutions dealing with the various geophysical fields to be investigated during the International Geophysical Year, within their respective national programs, so far as this is possible and appropriate.

(4) The CSAGI urges the several nations not now participating in the International Geophysical Year to form National Committees for the International Geophysical Year and to expedite the planning of their participation in the International Geophysical Year.

(5) The CSAGI expresses its appreciation to the nations sending delegates and

participants to the CSAGI Rome Meeting, 30 September–4 October 1954, and records its gratitude to these nations, their delegates and participants for the considerable assistance rendered to the CSAGI in the formulation of the International Geophysical Year programs, reports and resolutions.

(6) The CSAGI expresses its appreciation to the International Union of Geodesy and Geophysics for its co-operation in the formulation of the several technical programs of mutual interest to the IUGG and the CSAGI, and invites the attention of the IUGG to the results of the CSAGI Rome Meeting, at which valuable contributions of the IUGG Committee for the IGY were incorporated in the CSAGI program, reports and resolutions; it invites the further interest, advice, and aid of the IUGG in the work of the International Geophysical Year.

(7) The CSAGI expresses its appreciation to the URSI for the co-operation of its International Geophysical Year Committee in the formulation of the several technical programs of mutual interest to the URSI and CSAGI, and invites the attention of URSI to the results of the CSAGI Rome Meeting, at which the valuable contributions of the URSI-AGI Committee were incorporated in the CSAGI programs, reports and resolutions; it invites the further interest, advice and aid of URSI in the work of the International Geophysical Year.

(8) The CSAGI expresses its appreciation to the Mixed Commission on the Ionosphere, which at the Brussels Meeting, August 1954, devoted part of its program to the International Geophysical Year, and furnished a number of valuable resolutions for the guidance of CSAGI; it invites the attention of the MCI to the results of the CSAGI Rome Meeting, at which the MCI contributions were incorporated in the CSAGI program, reports and resolutions; it invites the further interest, advice, and aid of the MCI in the work of the International Geophysical Year.

(9) The CSAGI expresses its appreciation to the International Union of Pure and Applied Physics for its co-operation in the formulation of the Cosmic-Ray Program for the International Geophysical Year, and invites the attention of IUPAP to the results of the CSAGI Rome Meeting, at which the IUPAP cosmic-ray contributions were incorporated in the CSAGI cosmic-ray programs, reports and resolutions; invites the further interest, advice and aid of the IUPAP in the work of the International Geophysical Year, which is of mutual interest to IUPAP and CSAGI.

(10) The CSAGI expresses its appreciation to the World Meteorological Organization for its co-operation in the formulation of the several technical programs of mutual interest to WMO and CSAGI, and invites the attention of WMO to the results of the CSAGI Rome Meeting, at which valuable contributions of the WMO were incorporated in the CSAGI programs, reports, and resolutions; it invites the further interest, advice and aid of the WMO in the work of the International Geophysical Year.

(11) The CSAGI invites the close collaboration of the International Astronomical Union on those matters in the International Geophysical Year programs which are of mutual interest to the IAU and the CSAGI, with special reference to the results of the CSAGI Rome Meeting, 30 September—4 October 1954.

(12) The CSAGI expresses its appreciation to the National Research Council of Italy for the quarters graciously made available for the CSAGI Rome Meeting, 30 September–4 October 1954, and for the many services cordially provided by the

Council, which contributed greatly to the completion of the tasks before the CSAGI.

(13) The Secretary-General of CSAGI is authorized with respect to the several reports and resolutions of the several working groups of CSAGI:

(a) To make revisions and to edit them as may be necessary in order to provide for clarity and continuity in the final published report of the Rome Meeting; and

(b) To combine resolutions involving the same substance when this is advisable for clarity and conciseness, upon consultation with the chairman of the interested working groups or the Bureau of CSAGI.

4 Publications

(1) The CSAGI recommends that a general volume on the International Geophysical Year be prepared and published, to consist of:

(a) A history of the two International Polar Years, and of the circumstances which have led geodesists and geophysicists to plan and organize the worldwide program for 1957–58.

(b) The program for the International Geophysical Year.

(c) The list of stations, with all pertinent information conveniently assembled, for each site, its program of observations, the instruments to be used, etc.

This volume should be prepared by co-operation between the CSAGI office (for the historical section), the correspondents of the CSAGI groups (for the program) and the International Geophysical Year National Committees (for the list of stations).

The preparation of this volume, to be edited by the CSAGI Secretariat, should be completed during 1955.

(2) The CSAGI recommends that a series of observation manuals be published in connection with the different operating techniques that will be used during the International Geophysical Year. Each of these manuals should be published independently as soon as completed.

The General Secretary of CSAGI requests the correspondents of the Working Groups of CSAGI to:

(a) Prepare a list of these manuals; and

(b) Indicate the names of those who will edit the manuals.

The Publications and Publicity Group will shortly prepare instructions to be followed by the editors.

These manuals will eventually, after their publication, be collected together in one or several volumes.

(3) The CSAGI, considering the importance of the observations of solar activity for the analysis of the other IGY observations, requests the solar activity group to study the possibility and form of publication of a volume to contain the results of the solar activity observations between 1 July 1957, and 31 December 1958. This volume should be published as soon as possible after 1 January 1959.

(4) The CSAGI requests the other groups of CSAGI to prepare recommendations for the publication of the International Geophysical Year observations in their respective fields, and will submit this question for discussion at the next meeting of CSAGI.

(5) The CSAGI designates the General Secretaries of CSAGI and IUGG to enter without delay into discussions with Butterworths Scientific Publications regarding the publishing, distribution, publicity and sale of the works mentioned in paragraphs 1 and 2.

(6) The CSAGI recommends that the free distribution of each of these works be limited to one copy for each national committee, one for each member of CSAGI, one for each Secretary-General of the Unions participating in the International Geophysical Year, and one for the Secretary-General of WMO.

(7) The CSAGI requests its Bureau to prepare a general statement on the International Geophysical Year, for distribution to the International Geophysical Year National Committees, for use in discussion meetings, press releases, radio, etc. It further requests the National Committees to use every appropriate means to inform the general public concerning the International Geophysical Year.

5 Geographical Distribution

5.1 *Arctic*

5.1.1 *Introduction*

The Arctic Region for the program of the International Geophysical Year is defined as the area of geographical latitudes (ϕ) greater than N 60° and geomagnetic latitudes (Φ) greater than 60°.

In other words, the Arctic Geographical Region corresponds to the auroral region ($\Phi > 60°$) with the part of the subauroral belt that has latitudes greater than $\phi =$ 60°.

About 60 stations lie in the auroral region, and about 15 Arctic stations lie in the subauroral belt. Since the three sections of the earth's surface along the meridians of 10° E, 140° E and 80° W longitude overlap the arctic region, and, further, since these sections are relevant to the programs of meteorology, geomagnetism, airglow and aurora, and ionosphere, the reports for these longitudes and for these categories must be considered in reference to any proposed *Arctic* IGY publication. An inspection of all these data shows that they are unlikely to be sufficient for a separate publication.

It is recommended that national committees send their remarks on this subject to the Secretariat of CSAGI.

5.1.2 *Resolutions*

A complete understanding of the problem of the charged particles which originate in the sun and bombard the atmosphere, thus producing an interrelated set of phenomena—magnetic storms, ionospheric storms, and auroral displays—requires observations on a global basis with special emphasis on the auroral zones. Geographically the north auroral and subauroral zones are favorably situated for observation. Approximately 150° in longitude of the auroral and subauroral zone fall in, or immediately north of, the USSR. Therefore it is resolved by CSAGI to urge the USSR to participate in all the scientific programs of the International Geophysical Year, but especially to enter those programs for which zonal or meridional chains of stations are required, that is, the 140° E longitude section and the auroral zone stations for meteorology, aurora, airglow, ionosphere and geomagnetism. The position of Greenland with respect to the inner auroral zone is vital owing to its extension from the north geomagnetic pole to the zone of maximum of auroras. Unpublished observations of auroras made at Thule during the Second Polar Year indicate that the auroral arcs are not concentric about the geomagnetic pole, as indicated theoretically. Therefore it is resolved by CSAGI that Denmark be encouraged to emphasize auroral research in Greenland by establishing 180° auroral cameras at the following stations in order of priority: Thule, Nord, Scoresby Sund, Godhavn, Upernavik, Angmagssalik, and Julianehaab.

5.2 *Antarctic*

5.2.1 *Introduction*

During the International Geophysical Year, a total of twenty-one stations is already planned or in operation for geophysical research in Antarctica. This imposing effort represents the first really thorough world effort to uncover the geophysical secrets of this great continent. The individual efforts of great Antarctic explorers of the past have laid the foundation on which the program of the International Geophysical Year rests.

Of the twenty-one stations now planned or already in operation, eleven are on the continent proper or below the Antarctic Circle, and ten are on islands surrounding the continent and in its sphere of influence.

The CSAGI recommends five additional stations on the continent proper and three additional stations on surrounding islands, to complete the Antarctic network. The CSAGI hopes that the need for these additional stations will be recognized by their establishment by the nations of the world.

The conduct of geophysical research in Antarctica is significant for many reasons. Antarctica, one of the earth's continents, represents a major land mass with an area of about 6,000,000 square miles. It lies almost entirely within the Antarctic Circle (67° S), and by virtue of its unique position and its physical characteristics represents a region of almost unparalleled interest to the fields of geophysics and geography alike. In geophysics, Antarctica has many significant, unexplored aspects: for example, the influence of this huge ice mass on global weather; the influence of the ice mass on atmospheric and oceanographic dynamics; the nature and extent of aurora australis, for although the aurora borealis has received considerable attention in recent years, the detailed characteristics of Antarctic aurora remain largely unknown; the possibility of conducting original ionospheric experiments northward from the South Polar Plateau during the long total-night season, to determine the physical characteristics of the ionosphere during prolonged absence of sunlight. These and similar scientific considerations lead the CSAGI to recognize that Antarctica represents a most significant portion of the earth for intensive study during the International Geophysical Year.

Because studies at Antarctica involve considerable effort, the program recommended by the CSAGI is limited in station coverage to those sites of considerable importance and those needed for adequate coverage of the region. Here the following considerations are pertinent: (1) adequate coverage along the three meridional pole-to-pole lines is necessary; (2) adequate coverage over the continent of Antarctica; and (3) representative coverage in the interior of the continent, including the South Polar Plateau. For obvious scientific reasons, and in view of the fact that the incremental effort to include additional fields of technical interest becomes easier once a station has been established, the CSAGI recommends that the larger proportion of Antarctic stations assume responsibilities as primary observatories, covering all fields of interest: meteorology, geomagnetism, aurora and airglow, ionospheric physics, glaciology, cosmic rays, oceanography, seismology, gravity measurements; at other stations, in general, the principal fields of recommended effort are the following: meteorology, aurora and airglow, geomagnetism and ionospheric physics.

The following resolutions, general and specific, are made with respect to scientific aspects of Antarctic work during the International Geophysical Year.

5.2.2 *Resolutions*

Recognizing the unusual importance of Antarctica in the solution of scientific problems in almost every field of geophysics, and recognizing the paucity of our geographical and geophysical knowledge of this major land mass, the CSAGI herewith transmits the following general and specific resolutions to the various national committees and governments engaged in activities of the International Geophysical Year.

1. *General Resolutions*

The CSAGI recommends:

(1) That as many nations as possible undertake geophysical observations in Antarctica during the International Geophysical Year.

(2) That nations now operating stations continue and expand their programs of observations during the International Geophysical Year.

(3) That nations now planning stations in Antarctica proceed as promptly as possible with the execution of their plans.

(4) That all nations engaged in observations of the International Geophysical Year in Antarctica take appropriate steps so that their work there shall have priority in the planning and execution of any plans relating to Antarctic operations preceding and during the period of the International Geophysical Year.

(5) That the various nations consider recommendations to establish stations at the gap-locations, as indicated in the resolutions of the CSAGI.

2. *Specific Resolutions*

(1) The CSAGI strongly commends the efforts of South Africa in exploring the feasibility of occupying Bouvet Island during the International Geophysical Year in co-operation with the Norwegian Government, for the purpose of operating a principal geophysical observatory. Bouvet Island commands a most strategic position on the CSAGI 10° E line in the South Atlantic Ocean, relating the temperate to the Antarctic zones. The CSAGI recommends the following types of scientific observations as related to, and greatly aiding, objectives of the International Geophysical Year: meteorology, aurora and airglow, ionospheric physics, glaciology, oceano-

graphy, seismology, and gravity measurements (see *Notes* 1, 2, 3).* The CSAGI emphasizes the very great importance of these observations at this location during the International Geophysical Year.

(2) The CSAGI emphasizes the need for a principal station on the Princess Astrid Coast, at approximately 10° E, 70° S. At present no plans exist for the establishment of this station. The CSAGI urges that the various nations consider the scientific opportunity afforded by a site in this general location during the International Geophysical Year for the conduct of significant geophysical observations. This station would provide an important link in the chain of stations along the 10° E pole-to-pole line, and is favorably situated for valuable observations in several categories. The CSAGI recommends the following types of scientific observations as related to, and greatly aiding, the objectives of the International Geophysical Year: meteorology, geomagnetism, aurora and airglow, ionospheric physics, glaciology, seismology, and gravity measurements (see *Notes* 1, 2, 3). The CSAGI emphasizes the very great importance of these observations at this location during the International Geophysical Year.

(3) The CSAGI takes note of the existence of the South African station on Marion Island, and emphasizes the value of the observations that can be made from this site, located between the southern coast of Africa and Antarctica in a region largely devoid of other sites, and relating the temperate to the Antarctic zones. The CSAGI recommends that at least the following types of scientific observations be conducted there during the International Geophysical Year: meteorology, aurora and airglow, ionospheric physics, and oceanography (see *Notes* 1, 2, 3). The CSAGI emphasizes the importance of these and related geophysical observations at this location during the International Geophysical Year.

(4) The CSAGI commends the plans of the Australian Government for the establishment of a principal observatory at Mawson and of an advanced base at approximately 75° S, 62° E. The CSAGI recommends the following types of observations at Mawson as related to, and greatly aiding, the objectives of the International Geophysical Year: meteorology, geomagnetism, aurora and airglow, ionospheric physics, glaciology, seismology, and gravity measurements; similarly the CSAGI recommends the following types of observations at the advanced base: meteorology, geomagnetism, aurora and airglow, and ionospheric physics (see *Notes* 1, 2, 3). The CSAGI emphasizes the great importance of these two sites and of the observations at these locations during the International Geophysical Year.

* *Note* 1—In the course of the resolutions below (*Specific Resolutions*), reference is made to the several categories of interest during the International Geophysical Year. The fact that, often for convenience, no distinction is made between the fields of study now in effect and those recommended for establishment during the International Geophysical Year is to be interpreted as follows: (1) that current efforts in all fields of geophysics are strongly recommended for continuation during the International Geophysical Year; and (2) that fields mentioned which are not now under study are strongly recommended for establishment for the period of the International Geophysical Year.

Note 2—The fact that a particular field is not mentioned for establishment at a specific site does not preclude its incorporation: the resolutions suggest minimum activities, and the CSAGI cannot recommend too strongly the conduct of every type of geophysical study at every site.

Note 3—Although no mention is made of rocket studies in Antarctica, the CSAGI calls attention to the value of carrying out rocket experiments in the Antarctic regions for the study of such phenomena as atmospheric structure, ozone and cosmic rays, and the CSAGI strongly recommends the performance of such experiments by the various nations in the Antarctic regions.

(5) The CSAGI takes note of the existence of the French station at Kerguelen Island and emphasizes the value of the observations that can be made from this site, relating the temperate and Antarctic zones and forming a valuable link in the chain consisting of Mawson, Mawson Advance Base, Heard, and Amsterdam Island. The CSAGI recommends that the following types of observations be conducted during the International Geophysical Year: meteorology, geomagnetism, aurora and airglow, ionospheric physics, oceanography, seismology, and gravity measurements (see *Notes* 1, 2, 3). The CSAGI emphasizes the great importance of these observations at this location during the International Geophysical Year.

(6) The CSAGI takes note of the important contributions of Heard Island to the world geophysical program. The CSAGI expresses the hope that the valuable contributions from this site may be continued throughout the International Geophysical Year, provided that this can be done without affecting the Australian plans for operations directly on the continent of Antarctica. In the event of operations at Heard Island being discontinued, CSAGI urges that, through joint collaboration of the French and Australian governments, the cosmic-ray observations be transferred to Kerguelen Island.

(7) The CSAGI takes note of the existence of the French station on Amsterdam Island at approximately 37° S, 77° E and recognizes its significance, by virtue of its location in the South Indian Ocean, as relating the temperate and Antarctic zones. The CSAGI recommends the following types of observations during the International Geophysical Year: meteorology, aurora and airglow, and ionospheric physics (see *Notes* 1, 2, 3). The CSAGI emphasizes the very great importance of these observations at this location during the International Geophysical Year.

(8) The need for a principal station on the Knox Coast, at approximately 67° S, 105° E, is emphasized by CSAGI. At present no plans exist for the establishment of a station in this locality. The CSAGI urges that the various nations consider the opportunity afforded by this site, during the International Geophysical Year, for the conducting of significant geophysical observations. This station would provide an important link in the chain of circumpolar stations about Antarctica, and is favorably situated for valuable observations in several categories. The CSAGI recommends that the following types of observations be conducted there during the International Geophysical Year: meteorology, aurora and airglow, ionospheric physics, glaciology, seismology, and gravity measurements (see *Notes* 1, 2, 3). The CSAGI emphasizes the very great importance of these observations at this location during the International Geophysical Year.

(9) The CSAGI takes note of the plans of France to establish a principal observatory at Pointe Géologie on the Adélie Coast and to establish the Pointe Géologie Advance base at approximately 70° S, 140° E. Both stations represent important links along the 140° E pole-to-pole chain of stations, and both are strategically situated with respect to the conduct of several important types of observations. The CSAGI recommends that the following types of observations be conducted: at Pointe Géologie during the International Geophysical Year: meteorology, geomagnetism, aurora and airglow, ionospheric physics, glaciology, cosmic rays, oceanography, seismology and gravity measurements; at the Advance Base: meteorology,

geomagnetism, aurora and airglow, and certain aspects of ionospheric physics (see *Notes* 1, 2, 3).

(10) The CSAGI takes note of the existence of principal Australian stations at Hobart (Tasmania) and at Macquarie Island. Both stations represent important links relating to the 140° E pole-to-pole line, and both are strategically situated with respect to many geophysical events. The CSAGI recommends that at each of these sites the following types of observations be conducted during the International Geophysical Year: meteorology, aurora and airglow, ionospheric physics, seismology and gravity measurements; and oceanography, geomagnetism and cosmic rays (see *Notes* 1, 2, 3) at Macquarie Island. The CSAGI emphasizes the very great importance of these observations at these two sites during the International Geophysical Year.

(11) The CSAGI takes note of the present existence of New Zealand observatories at Christchurch, N.Z., and Campbell Island, and recognizes the value of geophysical observations for the International Geophysical Year at these important sites. The CSAGI recommends that the following types of observations be conducted during the International Geophysical Year at Christchurch: meteorology, aurora and airglow, ionospheric physics, seismology, and gravity measurements; at Campbell Island: meteorology, geomagnetism, aurora and airglow, and ionospheric physics (see *Notes* 1, 2, 3). These stations represent important links in the group of stations including Macquarie Island and stations to the southward including the South Polar Plateau station. The CSAGI emphasizes the importance of the above observations at Christchurch and Campbell Island during the International Geophysical Year.

(12) The CSAGI invites the attention of New Zealand to the very great desirability of a station at Invercargill or a similar location in the southern part of New Zealand, as affording the means for the conducting of significant geophysical observations during the International Geophysical Year, and as constituting an important link in the group of stations consisting of Christchurch, Campbell Island, Macquarie Island and stations southward to the South Polar Plateau station. The CSAGI recommends that the following types of observations be conducted during the International Geophysical Year at Invercargill (or nearby in southern New Zealand): meteorology; and continuing aurora and airglow in the vicinity of Invercargill (see *Notes* 1, 2, 3). The CSAGI further invites the attention of New Zealand to the great desirability of the establishment of a major high-altitude laboratory, engaged in cosmic-ray research, in the southern part of New Zealand. The CSAGI emphasizes the importance of these observations during the International Geophysical Year, and respectfully asks the consideration of these recommendations by the Government of New Zealand.

(13) The CSAGI invites the attention of the New Zealand Government to the very great desirability of a station at Ross Island or at a suitable site between Ross Island and Cape Adare. Such a station would represent an important link in the chain of Antarctic circumpolar stations and in the meridional chain consisting of the South Polar Plateau stations, Ross Island, Campbell Island, Macquarie Island, Invercargill and Christchurch. The CSAGI recommends that the following types of observations be conducted during the International Geophysical Year: meteorology, geomagnetism, aurora and airglow, ionospheric physics, seismology, gravity measurements, glaciology, and oceanography (see *Notes* 1, 2, 3). The CSAGI emphasizes the very

great importance of these observations during the International Geophysical Year, and respectfully asks the consideration of these recommendations by the Government of New Zealand.

(14) The CSAGI commends the plans of the United States to establish three principal observatories at Little America, Marie Byrd Land, and the South Polar Plateau. The CSAGI recommends the conduct of the following types of observations at these stations during the International Geophysical Year: meteorology, geomagnetism (except at the South Polar Plateau), aurora and airglow, ionospheric physics, cosmic rays, glaciology, seismology, and gravity measurements (see *Notes* 1, 2, 3). The CSAGI emphasizes the very great importance of these observations at these three strategically situated sites during the International Geophysical Year.

(15) The CSAGI invites the attention of the Government of Norway to the desirability of establishing a station on Peter I Island, by virtue of its position, during the International Geophysical Year. The CSAGI recommends that the following types of observations be conducted there during the International Geophysical Year: meteorology, aurora and airglow, and ionospheric physics (see *Notes*, 1, 2, 3). The CSAGI emphasizes the very great importance of these observations at Peter I Island during the International Geophysical Year, and respectfully asks the consideration of these recommendations by the Government of Norway, if appropriate in accordance with arrangements similar to those made with respect to Bouvet Island.

(16) The CSAGI takes note of the present existence of stations of Argentina at San Martin, Melchior, Decepcion Island, and South Orkneys: and recognizes the value of geophysical observations at these stations, located near the 70° W pole-to-pole line, during the International Geophysical Year. The CSAGI recommends that the Decepcion Island station constitute a principal observatory, and that the following types of observations be conducted there during the International Geophysical Year: meteorology, aurora and airglow, ionospheric physics, glaciology, cosmic rays, oceanography, seismology, and gravity measurements (see *Notes* 1, 2, 3). The CSAGI recommends that at one of the other three sites the following types of observations be conducted during the International Geophysical Year: meteorology, geomagnetism, aurora and airglow, and ionospheric physics. The CSAGI emphasizes the great importance of such observations at these sites during the International Geophysical Year.

(17) The CSAGI takes note of the existence of stations of the U.K. at Port Lockroy, Falkland Islands, and South Georgia. The former two are strategically located with respect to the 70° W pole-to-pole line, and the latter relates temperate and Antarctic zones. The CSAGI recommends that principal observatories be maintained at Port Lockroy and South Georgia during the International Geophysical Year, and that the following types of observations be conducted there during the International Geophysical Year: meteorology, geomagnetism, aurora and airglow, ionospheric physics, glaciology, oceanography, seismology, and gravity measurements (see *Notes* 1, 2, 3). At the Falkland Islands the CSAGI recommends the following types of observations: meteorology, aurora and airglow, and ionospheric physics.

(18) The need for a principal station at Vahsel Bay at approximately 77° S, 35° W is emphasized by the CSAGI. At present no plans exist for the establishment of this station. The CSAGI urges that the various nations consider the opportunity

afforded by this site, during the International Geophysical Year, for the conduct of significant geophysical observations. This station would provide an important link in the chain of Antarctic circumpolar stations, and is favorably situated for valuable observations in several categories. The CSAGI recommends that the following types of observations be conducted there during the International Geophysical Year: meteorology, aurora and airglow, ionospheric physics, glaciology, seismology, and gravity measurements (see *Notes* 1, 2, 3). The CSAGI emphasizes the very great importance of these observations at this location during the International Geophysical Year.

5.3 *Equatorial Belt*

5.3.1 *Introduction*

In accordance with the 1953 recommendation of CSAGI, consideration has been given to the equatorial belt ($\Phi < \pm 20°$) by considering stations situated between N 23° and S 23°. Basic material has been obtained from information given by CSAGI working groups II, III, IV, V and VII.

The station siting requirements differ considerably from field to field, and it is recommended that each CSAGI group consider the longitude concentration according to specific tolerances.

5.3.2 *Resolutions*

The CSAGI recommends the establishing of the following additional stations:

- II Meteorology: Fernando Poo, Diego Garcia, Minicoy, Addu Atoll, Nicobar, Biak, Merauke, Uracas, San Cristobal, St. Paul's Rocks.
- III Geomagnetism: Addis Ababa (or, in case the tentative plans for the establishment of such a station cannot be carried out, at Djibouti), Hong Kong, Hollandia, Tahiti or Marquesas Islands, Paramaribo, Kwajalein and Mogadiscio.
- IV Airglow: Belgian Congo, Kodaikanal, Calcutta, Taipei and Koror
- V Ionosphere: Bunia, Trivandrum, Colombo, Djakarta, Koror, Iwo Jima, Port Moresby, Kwajalein, Casady Fields, Marquesas Islands, Quito, La Paz, and Gao.
- VII Cosmic Rays: Lwiro, Rangoon, Abidjan and Port Moresby.

Port Moresby would fill an important gap. The joint operation of geomagnetic and ionospheric experiments at this site would make a valuable contribution to the objectives of the International Geophysical Year. The performance of cosmic-ray observations either at sea level or at high altitude in low latitudes in the Far East is highly desirable for the world-wide cosmic-ray program, and Port Moresby is an ideal site for this work.

5.4 80°–70° *W Meridian*

5.4.1 *Introduction*

In accordance with the 1953 recommendations of CSAGI, special consideration has been given to the meridional chains of stations through the Americas. The nominal meridians which best fit the continental land areas are 80° W in the northern hemisphere and south to latitude 20°, and southward along the 70° W meridian. A high density of stations has been planned or recommended in this zone. The station siting requirements differ considerably from field to field: in meteorology the longitude tolerances are strict; for ionosphere and aurora, the latitude concentration needed is greater in the vicinity of the auroral zones, and for geomagnetism and ionosphere, stations should be closely spaced in latitude near the geomagnetic equator, though the longitude requirements are loose.

Each chain has been developed as a compromise between the ideal distribution from the scientific standpoint and the practicalities of geography and economics. The stations which are in operation or are definitely planned for operation during the International Geophysical Year, when combined with the "gap" stations recommended for occupation, will in each field provide the data necessary for attacking the problems to be studied during the International Geophysical Year.

In the field of *Meteorology*, the pole-to-pole line should be spread not more than 5° from the specified meridians, if the meridional cross-section experiment is to be a success. The spacing of stations in latitude should be as close as possible, and in the existing and planned chain a spacing of 5° or less has been achieved between N 80° and N 20°, and of about 10° from N 20° to S 70°. The gaps which exist near the poles are very hard to fill: any expeditions in the Antarctic regions in the vicinity of 70° W longitude should definitely include meteorological upper air soundings, to make the pole-to-pole line experiment as complete as possible. Otherwise the line of stations will be sufficiently well filled for the purpose of the experiment if the planned stations are put into operation.

In *Geomagnetism* it is important to have stations in the western hemisphere at all representative geomagnetic latitudes, with relatively close spacing in the vicinity of the auroral zones and the geomagnetic equator. The existing and planned stations in the northern auroral zone and in the equatorial belt will give a better coverage than usual, and it is very important that the plans be carried out, although the very close-spaced experiment will have to be carried out in other longitude lines. There are no stations planned close to the 70° W meridian across the southern auroral zone; any expeditions to this area should include geomagnetic measurements in their program.

A pole-to-pole line is not a consideration of the *Auroral* program; on the other hand, synoptic *Airglow* observations should be made at all representative latitudes, and the plans call for such measurements although over a fairly wide range of longitudes. The coverage planned and recommended should result in information on the upper atmosphere of extreme importance, and it is especially important that the recommended stations in the southern hemisphere, San Juan, Comodoro Rivadavia and Decepcion, be put into operation.

The pole-to-pole line of *Ionospheric* sounding stations has been significantly strengthened as a result of the announced plans of countries participating in the International Geophysical Year, especially Argentina, Peru and the Netherlands. The chain starts along the 95th meridian from Resolute Bay to Winnipeg and continues along the 75th meridian to Huancayo, with two important gaps at Florida and Quito. South of the geomagnetic equator the coverage is less good, but could be made comparable to the subauroral northern sector by the addition of key stations at La Paz, Tucumàn and Concepcion in addition to those definitely planned by Argentina. There is more opportunity with this pole-to-pole line than with either of the other two to achieve comparable coverage in the northern and southern hemispheres. The Antarctic coverage along this line is sparse, and Port Lockroy and other points which may be occupied would make valuable additions.

The chains of *Cosmic-Ray* stations provide samples at several geomagnetic latitudes, and the existing and planned stations afford sufficient coverage.

5.4.2 *Resolutions*

The pole-to-pole lines in the various geophysical fields have the following gaps. Attention is called to the fact that the success of observations at other stations in the zone depends to a significant degree on observations from these "gap" stations, and the potentialities of the whole program will be considerably enhanced if these stations can be occupied during the International Geophysical Year. These gap stations are as follows:

IV Aurora and Airglow: Arctic Bay, Upernavik, Godhavn, Goose Bay and Gander. San Juan, Comodoro Rivadavia and Decepcion for Airglow photometers.

V Ionosphere: Cocoa, Quito, La Paz, Tucumàn, Concepcion. At Vahsel Bay and any other point on the Antarctic continent between 20° W and 100° W: Meteorology, Geomagnetism, Aurora and Airglow, and Ionospheric Physics.

5.5 10° *E Meridian*

5.5.1 *Introduction*

In accordance with the 1953 recommendations of the CSAGI, special consideration has been given to the meridional chain of stations through Africa, as the European chain has a high density of stations. It will be noticed that the longitude tolerance differs from field to field. Furthermore, the longitude requirements differ from the poles to the equator. (See general requirements in 5.4.1 for meridian lines.)

5.5.2 *Resolutions*

CSAGI recommends the establishment of:

(a) Meteorological stations at Ghadames, Tamanrasset, Walvis Bay, Alexander Bay, Capetown, Bouvet Island and on the Antarctic continent.
(b) Airglow stations in Belgian Congo, in South Africa and in the sub-auroral belt.
(c) Ionospheric stations in Algeria near Colomb Béchar, Windhoek, Marion and Bouvet Islands and on the Antarctic continent.
(d) Cosmic-ray stations in Algeria near Colomb Béchar, Abidjan, Hermanus and on the Antarctic continent.

5.6 140° *E Meridian*

5.6.1 *Introduction*

There are three first class centers of observation along the 140° E line; they are Tokyo, Sydney–Canberra and Terre Adélie; there are also three second class centers: Hokkaido and Kyushu in Japan, and Macquarie Island. Here the centers of observation are defined to be localities where a number of different subjects of observation are, or will be, carried out together.

Furthermore there are several large gaps in regard to individual subjects of observation. They are: from 10° S–37° S for geomagnetism, from 30° N–30° S for airglow, from 3° S–19° S for ionosphere and from 35° N–33° S for cosmic rays.

5.6.2 *Resolutions*

CSAGI recommends the establishment of stations in:

(a) Meteorology: Uracas, Biak, Merauke.
(b) Geomagnetism: Townsville and Base secondaire, Terre Adélie.
(c) Airglow: Taipei, Koror, Hobart.
(d) Ionosphere: Iwo Jima, Koror, Port Moresby or Cape York.
(e) Cosmic rays: Port Moresby and Terre Adélie.

6 Comments and Proposals regarding the Scientific Program

6.1 *Argentina*

Considering that during the International Geophysical Year many special observatories will be set up, which will require a great effort to provide the specialized personnel: in order to make better use of observers' time it is suggested:

(a) Separate slightly the exact hours of observations, so that, in polar stations the same observer, e.g. of meteorology, may take other readings, e.g. of electric elements.
(b) That general instructions be given for this synchronization which may be applied to individual cases.

The suggestions for fixed and special days seem to be very good.

6.2 *Canada*

V Ionosphere

It is recommended that on assigned days vertical incidence ionosonde measurements be taken simultaneously wherever possible at 15 sec intervals.

It is recommended that on assigned days wind measurements be taken simultaneously over the earth.

It is recommended that ionospheric heights should be measured simultaneously on assigned days.

It is recommended that cosmic noise measurements should be carried on simultaneously at a number of points to study the variation in the small scale structure of the ionosphere.

In addition, it is recommended that audio frequency "whistlers" be measured simultaneously near the equator, near the poles and in the auroral zone.

6.3 *Finland*

II Meteorology

The Committee begs to point out the necessity for a study of the terms connected with thermal balance at the earth's surface. Also the Committee considers it very desirable to establish over the globe a fairly dense network of atmospheric-electric stations taking continuous records of the potential gradient and of the air conductivity. Further the Committee recommends the chemical examination of the composition of precipitation, river-, lake- and sea-water all over the globe during the IGY. In these investigations Finland is ready to participate within the Arctic region.

Further the Committee wishes to put forward and support the following proposition made by Prof. K. BUCH, Helsinki:

"The modern carbon dioxide measurements in the atmosphere (average content ca. 320 ppm) show an increase from the beginning of this century of approximately 30 ppm or 10 per cent. This value corresponds fairly well to the total amount of the gas produced from fossil fuel during the same period 1900–1935 (G. S. CALLENDAR). Now 20 years have elapsed since the last measurements and further increase (at the present time to 330 ppm) can be expected until the sea is able to absorb the surplus. New series of analyses in different parts of the world seem therefore to be very desirable, not least with regard to the possible influence of the change in carbon dioxide concentration on the temperature of the atmosphere."

III Geomagnetism

The Committee wishes especially to point out the necessity of sufficiently frequent comparisons of the observatory (and field) instruments with magnetic standards of first class observatories previously selected for this purpose. Further, in the Committee's opinion, particular attention should be paid to examination of the regular directions of the variometer magnets in good time before the I.G.Y.

The parallaxes of the time marks on the La Cour quick run magnetograms should preferably be avoided.

IV Aurora

The Committee is of the opinion that in making observations for the "isoauroral" chart, note must also be taken of the *types* (homogeneous arcs, moving draperies etc., rays, corona, flaming) of the aurora in question. In our view, the homogeneous arcs are principally seen in the immediate vicinity of the auroral zone and in quiet magnetic conditions, the moving forms, on the other hand, tend to occur toward the Equator, the more so the stronger the auroral display and the magnetic disturbance. For the theoretical study of ionospheric storms and auroras it is desirable to obtain more knowledge of these circumstances.

Further the Committee wishes to stress the importance of knowing the position in space of the aurora whose spectrum is under examination, because auroral spectra should contain lines from one atmospheric level only.

6.4 *France*

X Oceanography

Pour l'Océanographie Physique, comme pour les autres branches de la géophysique, l'Année Géophysique Internationale (AGI) est une occasion d'exécuter certaines études dont l'ampleur exige une collaboration internationale organisée. Il s'agit essentiellement de phénomènes dont l'extension ou l'évolution ont un développement trop vaste pour qu'une équipe isolée puisse le suivre dans l'espace ou dans le temps; c'est dans de tels cas qu'une collaboration internationale est nécessaire et on peut citer des exemples d'opérations conduites dans cet esprit (courants de la mer du Nord, opération Cabot pour l'étude du Gulf Stream). Il est donc logique d'exclure à priori du programme océanographique de l'AGI les recherches sur les phénomènes d'allure statique, tels que la sédimentation, la morphologie sous-marine, etc. et à faire au contraire porter l'effort sur ceux qui présentent un caractère dynamique, notamment la circulation marine ou la propagation des vagues. Le fait que ces derniers sont en liaison étroite avec les mouvements de l'atmosphère dont l'étude systématique doit être également développée au cours de l'AGI constitue une raison de plus pour en préconiser l'étude pendant la période choisie.

6.5 *German Federal Republic*

In view of the high cost of maintenance of a radiosonde station, the CSAGI is asked to consider whether a connected interval of a few months might be selected to have highest priority, in which all those observations should be concentrated which, for various reasons, could not be continued throughout the entire IGY.

6.6 *Iceland*

IX Glaciology

We should welcome a decision to include glaciological and sea ice studies in the program of the International Geophysical Year, and would like to participate in such studies. Glacial changes at selected sites have been measured annually for a number of years, and a closer watch on one of the smaller glaciers has begun in accordance with the program of H. Ahlmann for studying climatic changes.

6.7 *Japan*

III Geomagnetism

(1) It will be desirable to encourage the observations of pulsations and other short period variations not only along the three meridians, 10° E, 75° W, and 140° E, but also at as many other stations as possible.

(2) It is desirable to emphasize the importance of comparison and standardization of magnetic instruments, especially of magnetic variometers.

(3) It is suggested that the special geomagnetic observations in the equatorial regions be discussed in consultation with the "Committee to promote observations of daily variations in low latitudes" of IATME, in which instrument, method, period of observations and other technical matters are discussed. The members should be increased in number so as to cover all representatives of participating observatories.

IV Aurora

(1) For the purpose of studying the horizontal movements of the nightglow phenomenon in geomagnetic latitude in addition to longitude, and of comparing the nightglow with the polar aurora, it is desirable to set up a series of observing stations from the Japanese Islands to Australia through the Caroline Islands, as nearly as possible along 140° E meridian, in addition to the lines from the magnetic pole to South America across the United States. and the line through Europe to Africa.

V Ionosphere

(1) It is desirable to keep the accuracy of time-marks in the records of continuous ionospheric observations to within an error of half a minute.

(2) It is suggested that continuous ionospheric observations be carried out at as many stations as possible throughout the world, especially in the polar regions. Methods of *h't* and *f't* observation such as have been developed in Japan might be recommended for this purpose, because of their ease for studying continuous variations in the critical frequency and the virtual minimum height of the ionosphere.

(3) It is suggested that simultaneous observations of wave forms and direction-finding of atmospherics be carried out at least for a week in every season, at several places including the equatorial and polar regions.

(4) The Japanese national committee supports recommendation 6 of Commission IV accepted by the 10th Assembly of URSI that measurements of a high standard should be made of the radio noise at as many places as possible, including the polar and auroral regions; the standard routine methods of recording should be used.

VI Solar activity

(1) It is recommended that the solar radio emission at many frequencies in a wide frequency range be observed during the IGY. It will be desirable that common observing frequencies are adopted as far as possible.

(2) In regard to the observations of the solar radio emission, the following suggestions are made:

2.1 It is recommended that timemarks are so inserted that the records may be compared with an accuracy of 0·1 min.

2.2 It is recommended that the time of smoothed maximum (or maxima) of each outstanding occurrence is reported.

2.3 Interferometer observations are desirable in order to locate the solar radio sources.

2.4 Polarization observations are advisable for making clear the mechanism of the radio emission.

2.5 Observations of dynamic spectra are advisable in order to obtain valuable data concerning the relation between the solar radio emission and geophysical phenomena.

VIII Longitudes and latitudes

(1) MARKOWITZ's proposal which was adopted at the Brussels 1953 CSAGI Meeting, is believed very interesting and promising for the possible determination of the precise geocentric position of observers.

It is known that the observation of occultations of the moon may also be used for this purpose if the observation is as accurate as that made with the photo-electric multiplier. It has been proved in the Tokyo Astronomical Observatory that the observed times of occultations, either immersion or emersion, can be obtained with an accuracy of 0·01 sec and without any sensible retardation.

It is very desirable that at least one of these observations should be carried out as frequently as possible under international collaboration at the observatories concerned during the coming World Survey.

(2) It seems there is a possibility of determining the travel time of time signals even when received by a single observatory if the signals can be so received with their multiple echoes as WWVH-signals at Tokyo. If the original signals consist of sharp impulses sufficiently far apart, for example, 50 μsec in width and 10 msec apart, the analysis may be easily made from relative arrival times between respective echoes for the numbers of hops of the echoes and the average value of the optical height of the ionosphere at that time.

For this purpose, we should propose that, if possible, a number of sharp impulses are inserted at certain spaces, superposed on a series of ordinary time signals. It is said that the CCIR has recommended that the same idea be examined for the time mark in the standard frequency wave.

6.8 *Netherlands*

I *World days*

The Netherlands National Committee is of the opinion that in general it will not be practicable to assign the same world days for the meteorological as for the other geophysical subjects. For aerological studies series of days will be needed generally, whereas for geomagnetic and ionospheric research even isolated days may be sufficient. It is thought that a number of five days per month (2 regular and 3 irregular) may be too much for those stations which will be operated by a limited staff; it would perhaps be better to limit the total number per year to, say, 35 days.

6.9 *Spain*

Le Comité National Espagnol est d'accord en lignes générales avec les résolutions provisoires adoptées par le CSAGI lors de sa réunion à Bruxelles du 30 juin au 3 juillet 1953.

Dans le cas particulier du *Géomagnétisme*, il croit très bien choisis les deux problèmes spécialement recommandés concernant les changements de forme des perturbations magnétiques au voisinage des équateurs géographique et magnétique. Pour obtenir une meilleure solution du premier de ces deux problèmes, il fait la proposition suivante:

"Il est à souhaiter que les observations systématiques des baies magnétiques et des pulsations ne soient pas limitées aux composantes H et Z, mais qu'elles soient étendues aux trois composantes magnétiques, et si possible aux courants telluriques.

"Il est aussi souhaitable que l'on communique régulièrement toutes les baies magnétiques dépassant une certaine amplitude et durée, et non pas seulement celles à début brusque.

"Pour les dénommer d'une façon courte et facile, l'on attire l'attention des intéressés sur la nomenclature proposée par J. M. PRINCEP dans le Mémoire n° 10 de l'Observatoire de l'Ebre 'Bahias Geomagnéticas' et employée, entre autres, par A. ROMANA (dans *Geofisica Pura e Applicata*, vol. XVII, pp. 148–154) et par P. ROUGERIE (dans *Annales de Géophysique*, vol. X, pp. 47–58)."

Le Comité Espagnol pense par contre qu'il est regrettable que l'on perde l'occasion offerte par l'AGI pour améliorer nos connaissances sur la variation séculaire dans des régions rarement visitées. C'est pour cela qu'il pense devoir insister sur la proposition suivante:

"Il est à souhaiter que, lorsque les autres buts peuvent être également obtenus, les observatoires, définitifs ou temporaires, que l'on établit à l'occasion de l'AGI, soient installés de préférence dans des régions à variation séculaire irrégulière ou rapide, surtout dans l'hémisphère Sud."

6.10 *United Kingdom*

I *World days*

The proposals are accepted in general, but it is recommended that an order of priority for the three regular World Days should be prescribed, so that observers who might not be able to choose the day of first priority for their observations could choose the next most important. This choice of priority might differ for different parts of the program.

Data concerning expected unusual meteor showers should be provided to all concerned. A note based on data supplied by Professor A. C. B. LOVELL, and which might be used for this purpose, is given in Annex I.

A suggested modification of the program of World Days for meteorological purpose is mentioned in Section II of this report.

II *Meteorology*

It is assumed that the WMO proposals for observations during the International Geophysical Year as set out in the General Secretary's letter supersede the draft Brussels resolutions in the meteorological program. This limitation of the program is welcomed and the following observations relate to the WMO suggestions. The Roman numerals in brackets correspond to the arabic numbering of the WMO proposals. Particular attention is drawn to (i), (vi), (viii), (ix) and (xi), where some modifications of the WMO program are proposed.

(i) That the meridians 10° E, 140° E and 75° W, with a tolerance of about 5° of longitude, would be very suitable for the establishment of vertical aerological stations; while it is hoped that aerological stations all over the world will participate in observations for the International Geophysical Year, the new stations set up should be within about 5° of the specified meridians.

(ii) That additional vertical sections are desirable in the regions of 180° (center of the Pacific) and in the northern hemisphere at 20° W and 80° E.

(iii) That in the tropics priority should be given to zonal vertical sections along the equator and along parallel 15° N.

(iv) That supplementary meridional vertical sections are also desirable in the tropics, and should be made in the neighborhood of 30° E and 110° E.

(v) That a partial zone vertical section in N. America in the neighborhood of parallel 40° N would permit the study of orographic effects.

(vi) That during the IGY the World Days in January, April, July and October be extended to periods of ten days for the study of evolutionary processes.

(vii) That aerological soundings should go to 50 mb or lower pressures at least once a day during the whole year, and during the World Days of the IGY an effort should be made to attain the highest levels.

(viii) That information about the wind is of great importance, particularly in tropical regions, and the aerological observations should be supplemented by a dense network of nephoscopic observations.

(ix) That observations are also required of (a) ozone and water vapor, (b) measurements of radiation of long and short wave lengths together with observations of roughness of the sea's surface, and (c) precipitation over the oceans. The Committee suggests, for the consideration of the International Astronomical Union, the establishment of a network of routine stations to measure the reflection of solar radiation by the earth.

(x) That in view of the great difficulties encountered in the maintenance of ocean weather ships, the utmost use should be made of small islands and of merchant vessels for the improvement of the aerological network.

(xi) That maximum attention be given to problems relating to large scale dynamic and thermodynamic processes.

(xii) That the need for aerological data according to this program is so important that strong support should be given to proposals for the establishment of supplementary stations in the regions where the aerological network is insufficient.

It is desirable that the need of radio scientific studies of tropospheric radiation should be met in the IGY program, and it is recommended:

That the resolution 3 of URSI Commission II be endorsed; that the URSI take steps to ensure that national meteorological authorities are aware that radio scientists need aerological observations: and that CSAGI be informed that the requirements would be met by observations of the variation of the refractive index at heights of at least 5,000 ft, and if possible up to 30,000 ft, three or four times a day, by balloons free or captive, or from fixed masts up to a few hundred feet as available: and that such measurements should be made reasonably near radio links (i.e. within 50 miles). In addition to observations in Britain it is hoped that similar observations will be made in other parts of the world where climatic conditions are different, i.e. in the five regions indicated in the General Secretary's letter, viz.

(1) Arctic (N. of latitude 60° N).
(2) Between N. latitudes 20° and 60° N.
(3) Equatorial, between latitudes 20° N and 20° S.
(4) Between S. latitudes 20° and 60° S.
(5) Antarctic (S. of latitude 60° S).

V Ionosphere

The following recommendations are submitted to CSAGI. Where reference is made to participation by British stations the descriptive details concerning location of stations etc. are those given in the URSI list (*URSI Bulletin*, No. 77, pp. 19–29).

(i) That attention be drawn to Sir EDWARD APPLETON's letter printed in *URSI Bulletin* No. 84, p. 12, to heads of ionospheric recording stations, and that information requested therein be sought for all ionospheric recording in addition to the information already requested by CSAGI (Annex II).

(ii) That the frequency of vertical incidence $P'f$ recording be increased to every five minutes on priority 1 Ionospheric World Days.

(iii) That the study of ionospheric characteristics at oblique incidence by back scatter technique, whose development was expected to continue, should be used to supplement other information gained during the International Geophysical Year.

(iv) That observations of vertical incidence ionospheric absorption be made.

(v) That during the International Geophysical Year special attention be given in daily routine recording to characteristics of the E region, and that, if possible, there should be continuous $h't$ recording on a suitable frequency, of sufficient accuracy to reveal any tidal movements that occur.

(vi) That the importance of ionospheric absorption measurement be urged, and that preparation be made for observations of absorption in the ionosphere by using galactic noise sources during the International Geophysical Year: and that the method be used if possible in the auroral region during polar blackout.

(vii) That observations of winds in the ionosphere by Mitra fading methods be continued and that this be undertaken in Britain, and by at least one other station in the auroral region, e.g. in Alaska or Norway, and that observations of scintillation of the radio stars should at some sites be carried on with three separated receivers, so that winds in the higher $F2$ region can be measured; also that observations of winds in region $F2$ at present being carried out in this country using three spaced vertical incidence $h'f$ recorders be continued; and that special attention to this recording be paid during World Days when observations should be made every half-hour.

(viii) That the stations equipped for measuring ionospheric wind using the Doppler effect on ionized meteor trails should be encouraged to carry out observations during the International Geophysical Year, particularly in the E region.

(ix) That on account of the importance of the phenomenon and the irregularities in the upper part of the ionosphere which are revealed by it, the scintillation of radio stars should be studied, and if possible continuous observations recorded at polar, equatorial and southern hemisphere observatories. These observations should be, in addition to the scintillation observations mentioned elsewhere, directed to the study of ionospheric winds.

(x) That direct study of meteors by radio technique be carried out as far as possible by a world chain of stations in the northern and southern hemispheres.

(xi) That attention be drawn to the publication of the Canadian Research Telecommunications Establishment Radio Physics Laboratory Report No. 2 by G. H. HANSON, E. L. HAGG, and D. FOWLE, on the interpretation of ionospheric records in connection with the CSAGI recommendation that URSI produce an instruction manual on the scaling and interpretation of polar records.

(xii) That measurements of the strength of radio noise field should be made at as many parts of the world as possible and should be extended to low frequencies. The subjective method should be compared with the objective method during the International Geophysical Year.

(xiii) That countries be invited to equip their stations as far as possible with direction-finding apparatus for the location of sources of atmospheric disturbances, and to set up stations to make observations.

(xiv) That other countries, particularly in Europe and North America, should be invited to collaborate in investigating the dependence of the wave form of atmospherics on the type of storm and on the distance and direction of transmission.

(xv) That special programs of transmissions be organized for a few transmitting stations on very low frequencies, to enable characteristics of the lower atmosphere to be studied in more detail.

VI Solar activity

Two general recommendations are submitted to CSAGI as follows:

(i) That the sun be continuously observed both on radio frequencies and visually, and if possible photographically, during the International Geophysical Year, and with this in view advantage be taken of polar expeditions. The visual observation of the sun should be undertaken with special reference to the maximum number of flares and to the real sources responsible for ionospheric regions (Annex III).

(ii) That observations should be made in various parts of the world to elucidate the relation between sudden enhancement of atmospherics as received on a frequency of about 22 Kc/s and the occurrence of solar flares.

X Oceanography

It is recommended that a study be made of problems associated with the generation, nature and propagation of surges and long waves due to the effects of changes of barometric pressure and the influence of wind on the sea. Countries could be asked to install tide gauges and seismographs in critical positions and to ensure the best possible records from present sites. A program is also suggested for the measurement of surface oscillations for all periods over a wide network.

XII Seismology

The British National Committee for the International Geophysical Year recommends adding to the International Geophysical Year program a section on Seismology, and recommends that the International Association of Seismology and Physics of the Earth's Interior be asked at the X General Assembly at Rome in 1954 to consider opportunities of establishing temporary seismological stations on the Pacific islands, in the Antarctic and elsewhere during the International Geophysical Year.

Annex I The major meteor streams

The major meteor showers are the dominant observational events in meteor astronomy. They occur when the earth sweeps through concentrations of debris in space. About a dozen major showers have been recorded visually and several recur annually, indicating that the debris is itself moving in an orbit around the sun. After a few days the earth generally moves out of the debris; hence, although the showers can be a spectacular occurrence, their contribution to the total number of meteors entering the atmosphere is somewhat less than the sporadic meteor contribution.

The meteors in a given stream travel in roughly parallel paths in the earth's atmosphere. Their apparent point or area of divergence is the radiant position. By convention, the shower takes its name from the constellation, or star, near which this position lies. If the radiant position and the velocity of the meteors in the earth's atmosphere are known, the orbit of the stream can be computed. The available information about the major showers varies a great deal. For some, the orbits are known with precision, and the association of the debris with other constituent bodies in the solar system has been established.

In many cases the showers are observed yearly with about the same intensity, indicating that the debris is fairly uniformly dispersed around the orbit. For purposes of classification we shall refer to these as permanent streams. In others the debris is localized in the orbit and the streams exhibit a marked periodicity. In one or two cases major meteor streams have completely vanished. Finally, the radio-echo techniques have revealed the existence of intense meteor streams active in the summer daytime.

The following table summarizes the major showers which are dealt with here. These all give displays (or have done in the past) with visual hourly rates exceeding 20 to 50. In addition to the showers listed there are a number of minor streams occurring at various times during the year with rates of only a few per hour. For example, the great catalog of DENNING published in 1899 lists 4,367 radiants, and the modern compilations of HOFFMEISTER and ÖPIK give attention to many more streams than those listed in the table. However, the showers described are those which are widely recognized as being of a major character, and for which information is available from a variety of sources.

Annex II Ionospheric stations

Circular letter to all Heads of Ionospheric Recording Stations throughout the world

Dear Colleague,

(1) In our Edinburgh studies of the diurnal variations of the critical frequencies of the various layers of the ionosphere, we find that the question of the precise timing of the data is of considerable importance. We should therefore be most grateful if you could furnish us with the information listed below, both for the equipment now in use and also for any previously used, at the stations which are—or have been—under your control.

(2) Information required:

- (a) Duration of sweep and frequency range covered.
- (b) Local time used (stating longitude).
- (c) Does the record start precisely at the hour stated of local time, or is it centered on the hour of stated local time?
- (d) Does the recorder start at the highest frequency employed or at the lowest frequency employed?
- (e) Could you give us any information concerning the times at which certain specified frequencies are reached relative to the time of starting the record?
- (f) Have there been any changes in the equipment or method of recording which would affect the times at which particular critical frequencies were recorded; and, if so, at what date did they come into effect?

(3) We should be greatly helped by your co-operation.

Yours very truly,
(sgd) Edward V. APPLETON
President, URSI Commission III
25 February 1954.

Information may be sent to the General Secretary of URSI, 42, rue des Minimes, Brussels, Belgium.

Annex III Solar flare observations in connection with the International Geophysical Year 1957

(1) Quantitative observations of solar flares should be based upon a standard observing procedure, as follows:

(a) Estimated times (UT) of beginning, end and peak intensity of the flare.

(b) Precise location by drawing or photograph of the emission areas in relation to associated sunspots and bright hydrogen plages.

(c) An estimate by means of an eye-piece graticule of the maximum area of the emission region in millionths of the sun's hemisphere (i.e. measured area corrected for foreshortening). This is basic for estimation of flare *importance**.

(d) A series of measures of effective line-width of $H\alpha$ at 1-min intervals through the flare, and/or

(e) A series of measures of central intensity of $H\alpha$ using a wedge photometer.

(f) Measurements of sightline velocities of flare surges (active dark filaments).

(d) and (e) are of the greatest importance for correlations with geophysical effects. Such observations need skill and experience; observers should be trained well beforehand.

(2) Even with a score of co-operating observatories, experience has shown that many flares are missed. It is therefore desirable that flares should be recorded continuously through the medium of their simultaneous (ionospheric) effects. The sudden ionospheric disturbances most easily registered are:

(a) Sudden enhancements of atmospherics (SEAs).

(b) Short-wave fadeouts (SWFs).

At Edinburgh we find, for example, that between 0900 and sunset 51 per cent of class 1 flares, 88 per cent of class 2 and *all* class 3 flares have associated SEAs. There are now sufficient 27 Kc/s recorders of SEAs in Britain, but there are none operating in America or Japan, where they are most needed to give full coverage in longitude.

M. A. ELLISON.

* An improved system of flare classification was adopted at the Dublin IAU Meeting in 1955.

Shower	Solar Long. at maximum Degrees	Date of maximum 1957	Date of maximum 1958	Co-ordinate of radiant R.A. Degrees	Dec. Degrees	Expected visible hourly rate at maximum	Remarks
QUADRANTID	282·6°	January 3	January 4	230°	+50°	50–100	Recurs regularly. Total duration about 24 hr.
LYRID	31·5	April 21–22	April 22	271	+31	10–20	Expected to recur but with low hourly rate.
η-AQUARID	44	May 4–5	May 5	336	± 0	10–20	Regular low intensity shower.
PONS WINNECKE	90	June 22	June 22	230	∓50		Last observed in 1927. Not expected to return.
δ-AQUARID	124	July 27	July 27	340	−17	40	Regular shower. Specially prominent in southern hemisphere.
SUMMER DAYTIME STREAMS. Active during the daytime in May, June and July. The following radiants are particularly intense.							
o-Cetids	54	May 15	May 15	30	− 3	Equivalent visual rate 20	Radio echo observations only.
Daytime ARIETIDS	77·5	June 8	June 8	44	+23	50–100	The most intense daytime stream. Active from May 29–June 19.
ζ-PERSEID	75–80	June 7–12	June 7–12	60	+25	50–100	Second most intense daytime stream. Active June 1–17.
β-TAURID	97	June 29	June 29	85	+20	20–30	Active from June 24 to July 5.

Shower	Solar Long. at maximum Degrees	Date of maximum 1957	Date of maximum 1958	Co-ordinate of radiant Dec.	R.A. Degrees	Expected visible hourly rate at maximum	Remarks
PERSEID	139°	August 12	August 12	47°	+57°	50–100	One of the most intense night-time streams. Active from August 1–15.
GIACOBINID	196·3	October 9–10	October 10	262	+55	Shower of great intensity and of only a few hours duration when the Earth crosses the orbit near the Comet. Not expected to recur during IGY.	
ORIONID	209	October 22	October 22	92	+15	10–20	Reliable night-time stream of low intensity.
TAURID	216 to 230	Oct. 30–Nov. 13	Oct. 30–Nov. 13	50	+15	10–20	Complex radiant system recurring regularly with low intensity and broad maximum.
BIELID	252	Nov. 30–Dec. 4	Nov. 30–Dec. 4	23	+40	Last observed with appreciable activity in 1899. Not expected to recur in the future.	
LEONID	234	Nov. 16–17	Nov. 16–17	152	+22	10–20	Periodic shower with 33-year period. Not expected to be intense during IGY.
GEMINID	260·8	Dec. 12–13	Dec. 12–13	112	+32	50–100	Regular and intense night-time stream. Active from December 8–14.
URSID	270	December 22	December 22	210	+75	10–20	Will probably return as low intensity stream during IGY.

In choosing World Days from the above data, it is suggested that priority be given to the intense meteor showers which are isolated. For example, the Quadrantid meteor shower is intense, short lived and there is no unusual activity for several days around this epoch. Similarly the maximum of the Geminid shower is well defined and intense. On the other hand the Orionid, Taurid and Leonid showers which occur in the autumn are of low intensity and the general activity at that period is very confused. On this basis priorities for World Days would be:

1. Quadrantid shower on 3 January 1957 and 4 January 1958; with control days on 1 or 5 January.
2. Geminid shower on 12–13 December 1957 and 1958; with control day on 15 December.
3. The daytime Arietids and ζ Perseids sometimes between 7 and 12 June 1957–1958. Adjacent control days are not possible because the daytime activity is very intense during this epoch.
4. Perseid shower on 12 August 1957 and 1958; with control day 15 August.
5. δ-Aquarid shower on 27 July 1957–1958; with control day 29 July. Particularly important in the southern hemisphere.

Calendar of Regular World Days (RWD) and World Meteorological Intervals (WMI) during the International Geophysical Year

The calendar of RWD and WMI during the International Geophysical Year is given in Table 2, in which the following symbols are used:
Quarterly World Meteorological Interval shown by 10 days in a box

			10	11	12	13
14	15	16	17	18	19	

*Regular world day 11

Regular world day at new moon 10

Unusual meteoric activity 8 (but not world day)

Regular world day with unusual meteoric activity 17

Day of total eclipse 12

* All regular world days are circled; other days of unusual meteor activity are marked for information only.

Table 2. Calendar of Regular World Days (RWD) and World Meteorological Intervals (WMI) during the International Geophysical Year*

June 1957 (Advance Trial)

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

* This calendar was amended in 1956 (see Report on the Fourth Meeting of the CSAGI, p. 323).

July 1957

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

August 1957

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

September 1957

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

October 1957

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

November 1957

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

December 1957

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

January 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

February 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	

March 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

April 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

May 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

June 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

July 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

August 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

September 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

October 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

November 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

December 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

January 1959

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

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III—THE THIRD MEETING OF THE CSAGI

(Brussels, 8–14 September 1955)

1 General Report

1.1 *Introduction*

THE Special Committee for the International Geophysical Year (CSAGI) held its Third Meeting at the Palais des Académies, Brussels, 8–14 September 1955, by kind invitation of the Belgian Royal Academy of Sciences.

The first meeting had been held in the same place, 30 June–3 July 1953, following a preliminary Brussels meeting of the four original members (L. V. BERKNER, J. COULOMB, M. NICOLET, and E. HERBAYS, provisional secretary) to initiate organizational procedures in October 1952; the second meeting was held in Rome, 30 September–4 October 1954.

The IGY committees of the International Union of Radio Science (URSI) and of the International Union of Geodesy and Geophysics (IUGG) also met (8–10 September) in the Palais des Académies in conjunction with the CSAGI meetings.

Thirty-three National IGY Committees presented national reports; thirty sent a delegate or delegates. In all, one hundred and seventy-two persons took part in the meetings, and co-operated in the working groups that assisted the CSAGI in planning the IGY program.

The following Presidents of International Unions were present:

Astronomy (IAU): Professor A. DANJON (member of the CSAGI).

Geodesy and Geophysics (IUGG): Professor K. R. RAMANATHAN.

Radio Science (URSI): Rev. Father P. LEJAY.

Sir Edward APPLETON attended as President of the URSI-AGI Committee, and Dr. Ronald FRASER as representative of the International Council of Scientific Unions (ICSU).

The Inaugural Meeting was held on 8 September, beginning at 10 a.m. Later CSAGI met three times in executive session, and it held four plenary sessions, which were attended also by members of the Press. The Advisory Council of the International Geophysical Year (ACIGY) held two meetings. The Bureau held nine meetings.

The time-table of the meetings was as follows:

Time-table (September 1955)

Inaugural meeting	Thursday 8th, at 10 a.m.
Executive sessions: CSAGI	Thursday 8th, at 2.30 p.m.
	Monday 12th, at 2.30 p.m.
	Wednesday 14th, at 9.30 p.m.

Plenary sessions: CSAGI	Friday 9th, at 9.30 a.m. Monday 12th, at 9.30 a.m. Tuesday 13th, at 9.30 a.m. Wednesday 14th, at 2 p.m.
Advisory Council: ACIGY	Thursday 8th, at 4 p.m. Wednesday 14th, at 11.30 a.m.
Bureau of the CSAGI	Wednesday 7th, at 10 p.m. Thursday 8th, at 11 a.m. Friday 9th, at 9 a.m. Friday 9th, at 4 p.m. Saturday 10th, at 9 p.m. Monday 12th, at 8 p.m. Tuesday 13th, at 9 a.m. Tuesday 13th, at 11 a.m. Wednesday 14th, at 8 a.m.

On Friday, 9 September, at 4.30 p.m., Dr. H. E. NEWELL gave an address on earth satellites (see p. 267). Members of the Press attended.

On Tuesday, 13 September, at 5 p.m., M. G. LACLAVÈRE gave an address on the Antarctic IGY program. Members of the Press attended.

On Sunday, 11 September participants and their families made an all-day excursion to Bruges and Ghent by invitation of the Ministère de l'Instruction Publique.

The Brussels Embassy of the Union of Soviet Socialist Republics (USSR) invited those attending the CSAGI meetings, and their ladies, to a reception on Monday, 12 September.

The Brussels Embassy of the United Kingdom of Great Britain and Northern Ireland (U.K.) invited those attending the CSAGI meetings, and their ladies, to a reception on Tuesday, 13 September.

1.2 *Inaugural Meeting*

10 a.m., Thursday, 8 September 1955

The Inaugural Meeting was attended by Professor J. F. Cox, Permanent Secretary of the Belgian Royal Academy of Sciences, who welcomed CSAGI and the delegates in the following terms:

"Monsieur le Président, très honorés Collègues,

"L'Académie Royale de Belgique a bien voulu charger son Secrétaire Perpétuel d'adresser des souhaits de bienvenue au Comité Spécial de l'Année Géophysique Internationale 1957–58.

"Je suis heureux d'être chargé de cette mission, car parmi les nombreux et passionnants problèmes dont vous allez vous occuper, il en est qui sont destinés à retenir toute l'attention des astronomes. Je pense notamment à l'étude approfondie et détaillée des trajectoires des satellites artificiels qui appellera, que l'on procède par pointés ou à l'aide du radar, d'intéressantes généralisations de méthodes de la géodésie et qui sont susceptibles d'apporter, comme ESCLANGON l'a si bien indiqué, de précieuses indications sur la manifestation d'un effet Einstein de déplacement du périgée de ces satellites.

"Je songe au problème de la détermination précise des différences de longitudes et à l'étude de la dérive des continents, aux répercussions possibles de ces phénomènes liés aux variations des latitudes, sur les fluctuations irrégulières de la rotation de notre globe. Il n'est pas jusqu'aux pertes de masse du Soleil, liées aux manifestations de l'aurore boréale qui ne soient de nature à exercer quelque influence sur le mouvement des planètes.

"Je dois m'élever ici au-dessus de ces considérations spéciales pour exprimer la joie toute particulière de l'Académie d'être associée à une grande entreprise de coopération internationale, dont il n'est guère douteux qu'elle marquera une date mémorable dans l'histoire de la pensée scientifique, date comparable en importance pour le planning scientifique international, à celle de l'année 1919 au cours de laquelle ont été fondées, ici même, les grandes unions scientifiques internationales.

"L'Académie est particulièrement heureuse de voir siéger chez elle votre illustre assemblée; elle se réjouit d'apercevoir parmi vous des chercheurs belges compétents, qui contribueront au rayonnement de la Belgique, et dont elle se doit de soutenir l'effort. Elle aime évoquer en cette circonstance le souvenir de l'expédition de la *Belgica*.

"L'Académie royale de Belgique forme les voeux les plus chaleureux et les plus sincères pour la réussite de vos importants travaux."

In reply, the President, Professor S. CHAPMAN, thanked Dr. Cox for his eloquent and cordial welcome given on behalf of the Belgian Royal Academy of Sciences, to which CSAGI was indeed grateful for having placed so large a part of the Academy premises at their disposal. He recalled with pleasure that CSAGI had held its first meeting in the rooms of the Academy in June–July 1953: "At the meeting, the twelve members of CSAGI (as then constituted) were aided by twelve 'observers' coming from nine countries; they had before them twenty-six reports from URSI, IAU, IUGG, the World Meteorological Organization (WMO), the ICSU Mixed Commission on the Ionosphere (MCI), and National IGY Committees. At that meeting the first draft of the IGY program was drawn up. These plans were improved and enlarged at the second CSAGI meeting in Rome, September–October 1954. At the present Brussels meeting, the plans will be further considered in the light of another year's studies and preparation. The program as developed at this meeting may be regarded as substantially definitive, though there will remain some possibility of later additions to the program and to the number of participating nations."

The President then extended a welcome to three new members added by the ICSU since the Rome meeting: namely, to two additional IUGG representatives, Dr. V. V. BELOUSSOV and Dr. N. V. PUSHKOV, and to a representative of the International Union for Biological Sciences (IUBS), Dr. A. F. BRUUN.

The President expressed his regret, and that of the CSAGI as a whole, at the absence, owing to illness, of Prof. J. COULOMB. He mentioned that Dr. J. A. SIMPSON and Dr. M. S. VALLARTA, who represented the International Union of Pure and Applied Physics (IUPAP) on the CSAGI, were absent in Guanajuato, Mexico, where the IUPAP was holding a symposium on Cosmic Rays. This symposium was to be followed by a meeting of cosmic-ray physicists on 14 September, also at Guanajuato, to consider the cosmic-ray portion of the IGY program; the Bureau had agreed that this meeting should be recognized as a meeting of the IGY working group on the cosmic-ray section of the IGY program; but there would be opportunity for discussion of this part of the program in Brussels if that were desired. Professor J. A. SIMPSON, reporter of the CSAGI cosmic-ray group, would prepare the report.

The President then welcomed the delegates appointed by the National IGY Committees as members of the Advisory Council (ACIGY) set up by the ICSU in March 1955. He also welcomed the officers of the International Unions, the representative of the ICSU, and the officers and members of the IGY committees of the Unions. He expressed the pleasure and satisfaction felt by the CSAGI at the presence of so many national observers who had come to join with the CSAGI in the detailed planning of the IGY program.

He added that members of the Press were free to attend the plenary sessions of the CSAGI, but that they were not invited to the other meetings of the CSAGI, of the ACIGY, or of the working groups; at 5 p.m. each day, two members of the Bureau would be available to inform the Press of the day's progress.

Finally he briefly indicated the time-table of some of the later meetings.

He then called on the Vice-President, Dr. L. V. BERKNER, to speak, and congratulated him on his election as the incoming President of the ICSU. Dr. BERKNER spoke as follows:

"It is indeed an honor and a pleasure to note the way in which plans for the International Geophysical Year have advanced since last year's meetings. There are now forty nations formally adhering or actively preparing for the International Geophysical Year. But in particular, and more important, this meeting signals the beginning of active operations of the International Geophysical Year. In two or three months the Antarctic expeditions will set off, and their equipment is now being assembled.

"I should like to invite attention to the fact that in 1950, in these rooms of the Palais des Académies, the Mixed Commission on the Ionosphere presented to the ICSU and the Unions the initial official proposal for the International Geophysical Year. With this, and the subsequent meetings of the CSAGI held in Brussels with the co-operation of the Belgian Royal Academy, the Belgian nation has contributed immeasurably to the encouragement of the IGY. Following the enthusiastic concurrence of the interested Unions to the proposal for the IGY, the ICSU formed the CSAGI, thus providing an international mechanism to organize the International Geophysical Year program. We owe a great debt of gratitude to the ICSU not only for providing the organizational mechanism, but also because last year, when the planning grew beyond the original estimates, the ICSU helped by providing additional funds. It is a source of satisfaction that the ICSU is available to help the scientists of the world to plan such a program. We must also recall the very generous support of the UNESCO; it has consistently provided funds to the ICSU for the IGY, and voted an additional $15,000 for the support of the CSAGI Secretariat for the year 1955 when the scope of the program made additional funds necessary. Therefore, the ICSU and UNESCO have demonstrated, by their recognition and support of IGY, the ability of international scientific organizations to fulfil their responsibilities. The IGY owes a great debt to these organizations."

Dr. M. NICOLET, General Secretary, then outlined the day's program. He stated that the report of the National IGY Committee of the USSR had been received, and would be available on the 9th, two copies for each national committee represented at the meeting; as soon as possible copies would be available for all present.

The leaders of all national delegations were then asked to give the list of members of their delegations to the secretariat.

The President announced that, as at the two previous CSAGI meetings, working groups would be formed for the study of the different scientific branches of the IGY program; these working groups were to serve only during the period of the CSAGI meeting.

The President stated that the subjects to be considered by separate working groups had increased by the addition of Seismology and Gravimetry. The working groups and their leaders were announced as follows: the enumeration of the groups is that used in the Rome report (see below, p. 235 regarding group I).

II Meteorology: VAN MIEGHEM.
III Geomagnetism: LAURSEN.
IV Aurora and Airglow: CHAPMAN (acting reporters during the meeting, ELVEY and ROACH).
V Ionosphere: BEYNON.
VI Solar Activity: SPENCER JONES.
VII Cosmic Rays: SIMPSON (during his absence at Guanajuato, HERLOFSON).
VIII Longitudes and Latitudes: DANJON.
IX Glaciology: WORDIE.
X Oceanography: LACLAVÈRE.
XI Rockets and Satellites: BERKNER (acting reporter during the meeting, NEWELL).
XII Seismology: BELOUSSOV
XIII Gravimetry: TARDI.

The leaders of national delegations were asked to indicate, on the lists giving their names, the working group(s) to be attended by each delegation member.

Sir Edward APPLETON, on the invitation of the President, then spoke as follows:

"The URSI naturally has a special interest in the IGY program, which has developed in such a gratifying way. As Dr. BERKNER has mentioned, it was five years ago in this room that the Mixed Commission on the Ionosphere first made the official proposal for a Third International Polar Year, a project conceived, I understand, in the fertile brain of our Vice-President, Dr. BERKNER. Now the radio people are modest, and, realizing the scope of the proposal, the URSI, which had received it from the Mixed Commission, passed it on with favorable endorsement to the ICSU, which has been responsible for its growth since 1950. It was natural for us to see the enormous scientific value of 'experiments in concert' (to quote an expression due to Francis Bacon). But I should like to remark that the proposal has additional importance in that it emphasizes the common interests rather than the differences between nations. It is my belief that the International Geophysical Year can be and will become a great instrument for fashioning the peace of the world.

"I suppose that here I am the only one of the few people in the world who went to the Arctic during the International Polar Year in 1932 to study ionospheric conditions. Today we realize also the importance of the equatorial regions. Thus we are happy that the proposal for a Third International Polar Year was transformed into one for an International Geophysical Year. We radio workers have also been glad to see the rocket developed as a research tool for the study of the upper atmosphere and the sun; the rockets have valuably supplemented the results of radio research. At first we were anxious to know whether their results would confirm the radio results, and it was gratifying to find in due course that they did; moreover they add to the radio results. We look forward now to the new atmospheric knowledge opened to us by the radio study of meteors, by radio astronomy, and by the radio study of the troposphere and of auroras."

He then invited all national observers interested in the IGY ionospheric program to join with the URSI-AGI committee, which would thus act as the CSAGI working group for this subject at the present meetings.

Dr. RAMANATHAN, President of the IUGG, spoke next: he remarked on the importance of the scientific study of the Antarctic, now being planned so vigorously; it will greatly expand our knowledge of this region, hitherto almost as inaccessible as the high atmosphere. In July the General Secretary of the IUGG, M. Laclavère, called an Antarctic conference in Paris on behalf of the CSAGI; this conference was attended by representatives of nine nations that proposed to take part in the IGY Antarctic program; they met to decide on the location of stations, and to conceive joint plans for the efficiency and safety of the various expeditions.

Dr. RAMANATHAN next expressed satisfaction at the inclusion of seismology and gravimetry in the IGY program. He also emphasized the importance of the meteorology of the equatorial region, and of studies of the tropopause.

The President thanked Sir EDWARD APPLETON and Dr. RAMANATHAN for their remarks.

The meeting was then adjourned, and the leaders of several of the working groups convened their members and began consideration of the national reports and IGY program.

1.3 *Working Groups*

I *World Days*

SHAPLEY	(Leader)
AONO	(Japan)
DIAZ	(Argentine)
KALININ	(USSR)
NUNEZ MONASTERIO	(Argentine)
MUSTEL	(USSR)
PINUS	(USSR)
PUSHKOV	(USSR)
SCHNEIDER	(Argentine)
VOROBIEV	(USSR)

II *Meteorology*

Van Mieghem	(Reporter)
Adem	(Mexico)
Aliverti	(Italy)
Bartels	(German Federal Republic)
Bleeker	(Netherlands)
Davitaya	(USSR)
Debrach	(Morocco)
Diaz	(Argentine)
Dogniaux	(Belgium)
Doporto	(Ireland)
Hasegawa	(Japan)
Kavanagh	(U.S.A.)
Kellogg	(U.S.A.)
Koenigsfeld	(Belgium)
Leipper	(U.S.A.)
Liachov	(USSR)
Lugeon	(Switzerland)
Malet	(Belgium)
Matassi	(Chile)
Nunez Monasterio	(Argentine)
Munk	(U.S.A.)
Obuchov	(USSR)
Pinus	(USSR)
Ramanathan	(India)
Romana	(Spain)
Del Rosario	(Philippines)
Schneider	(Argentine)
Schumann	(Union of South Africa)
Shelton	(Australia)
Solberg	(Norway)
Stagg	(U.K.)
Trakowski	(U.S.A.)
Vujevic	(Yugoslavia)
Wexler	(U.S.A.)
Worf	(U.S.A.)

III *Geomagnetism*

Laursen	(Reporter)
Bouska	(Czechoslovakia)
Cardus	(Spain)
Fukushima	(Japan)
Gershanik	(Argentine)
Gerson	(U.S.A.)
Herrinck	(Belgium)
Herlofson	(Sweden)

HULBURT	(U.S.A.)
JOYCE	(U.S.A.)
KALININ	(USSR)
KOENIGSFELD	(Belgium)
LAHAYE	(Belgium)
NAGATA	(Japan)
RAMANATHAN	(India)
ROBERTS	(U.S.A.)
SCHNEIDER	(Argentine)
STAGG	(U.K.)
THELLIER	(France)
TOPERCZER	(Austria)
TROITSKAYA	(USSR)
VELDKAMP	(Netherlands)
WEBSTER	(Australia)

IV *Aurora and Airglow*

CHAPMAN	(Reporter)
BARBIER	(France)
CHAMBERLAIN	(U.S.A.)
ELVEY	(U.S.A.)
GERSHANIK	(Argentine)
GERSON	(U.S.A.)
HARANG	(Norway)
HATANAKA	(Japan)
HERLOFSON	(Sweden)
KAPLAN	(U.S.A.)
KRASSOVSKY	(USSR)
PASTIELS	(Belgium)
RAMANATHAN	(India)
ROACH	(U.S.A.)
SCHNEIDER	(Argentine)
STAGG	(U.K.)
SWINGS	(Belgium)
WEBSTER	(Australia)

V *Ionosphere*

BEYNON	(Reporter)
AONO	(Japan)
APPLETON	(U.K.)
CARDUS	(Spain)
DIAZ	(Argentine)
FUKUSHIMA	(Japan)
GERSON	(U.S.A.)
HERLOFSON	(Sweden)
HERRINCK	(Belgium)

LEJAY	(France)
LEPECHINSKY	(France)
MAWDSLEY	(U.K.)
NUNEZ MONASTERIO	(Argentine)
MORGAN	(U.S.A.)
NICOLET	(Belgium)
PUSHKOV	(USSR)
RAMANATHAN	(India)
RAWER	(German Federal Republic)
SCHNEIDER	(Argentine)
SHEFFIELD	(U.K.)
SLUTZ	(U.S.A.)
VELDKAMP	(Netherlands)
DE VOOGT	(Netherlands)
VOROBIEV	(USSR)
WEBSTER	(Australia)

VI *Solar Activity*

SPENCER JONES	(Reporter)
BOBROVNIKOF	(U.S.A.)
COUTREZ	(Belgium)
GERSHANIK	(Argentine)
HATANAKA	(Japan)
LAFFINEUR	(France)
MIGEOTTE	(France)
MUSTEL	(USSR)
PAPADOPULOS	(Argentine)
ROMANA	(Spain)
SCHNEIDER	(Argentine)
SHAPLEY	(U.S.A.)
SWINGS	(Belgium)
THELLIER	(France)
DE VOOGT	(Netherlands)
WEBSTER	(Australia)

VII *Cosmic Rays*

HERLOFSON	(Acting Reporter)
CICCHINI	(Argentine)
GERSON	(U.S.A.)
HATANAKA	(Japan)
KELLOGG	(U.S.A.)
MANIFESTO	(Argentine)
MENENDEZ	(Spain)
POSADA	(Argentine)
SPENCER JONES	(U.K.)

WEBSTER	(Australia)
WORF	(U.S.A.)

VIII *Longitudes and Latitudes*

DANJON	(Reporter)
BOELLA	(Italy)
BOULANGER	(USSR)
BOURGEOIS	(Belgium)
CARRASCO	(Spain)
DECAUX	(France)
FERNANDEZ	(Spain)
GERSHANIK	(Argentine)
LETROYE	(Belgium)
LOODTS	(Belgium)
MIYADI	(Japan)
PAPADOPULOS	(Argentine)
RICE	(U.S.A.)
SHELTON	(Australia)
SILVA	(Italy)
SPENCER JONES	(U.K.)
SPIRIN	(USSR)
TARDI	(France)
VARELA	(Argentine)
VERBAANDERT	(Belgium)
WOLF	(German Federal Republic)

IX *Glaciology*

WORDIE	(Reporter)
AONO	(Japan)
ALIVERTI	(Italy)
AVSIOUK	(USSR)
BAUER	(France)
BOLIN	(Sweden)
CRARY	(U.S.A.)
DUFEK	(U.S.A.)
FIELD	(U.S.A.)
HASEGAWA	(Japan)
HATANAKA	(Japan)
KETCHUM	(U.S.A.)
LISIGNOLI	(Argentine)
NAGATA	(Japan)
PANZARINI	(Argentine)
RIGSBY	(U.S.A.)
SHELTON	(Australia)
SIPLE	(U.S.A.)
TISON	(Belgium)

X *Oceanography*

Laclavère	(Reporter)
Adkins	(U.S.A.)
Aliverti	(Italy)
Bleeker	(Netherlands)
Böhnecke	(German Federal Republic)
Bolin	(Sweden)
Bruun	(Denmark)
Capurro	(Argentine)
Deacon	(U.K.)
Debrach	(Morocco)
Dietz	(U.S.A.)
Eyries	(France)
Hasegawa	(Japan)
Hatanaka	(Japan)
Iselin	(U.S.A.)
Islam	(Pakistan)
Jockel	(Australia)
Koegel	(Chile)
Kort	(USSR)
Leipper	(U.S.A.)
Lill	(U.S.A.)
Menendez	(Spain)
Miyadi	(Japan)
Mosby	(Norway)
Munk	(U.S.A.)
Panzarini	(Argentine)
Revelle	(U.S.A.)
Shelton	(Australia)
Smith	(U.S.A.)
Somov	(USSR)
Swings	(Belgium)
Tait	(U.K.)
Tardi	(France)
Tison	(Belgium)
Webster	(Australia)

XI *Rockets and Satellites*

Berkner	(Reporter)
Aono	(Japan)
Chapman	(U.K.)
Fukushima	(Japan)
Kaplan	(U.S.A.)
Lombard	(U.S.A.)
Nagata	(Japan)
Newell	(U.S.A.)

PRIOR	(U.S.A.)
SHELTON	(Australia)
STROUD	(U.S.A.)
WYCKOFF	(U.S.A.)

XII *Seismology*

BELOUSSOV	(Reporter)
CRARY	(U.S.A.)
DEBRACH	(Morocco)
GERSHANIK	(Argentine)
HASEGAWA	(Japan)
JOYCE	(U.S.A.)
LISIGNOLI	(Argentine)
PAPADOPULOS	(Argentine)
PRIOR	(U.S.A.)
RAMANATHAN	(India)
RICE	(U.S.A.)
ROBERTS	(U.S.A.)
ROBIN	(U.K.)
ROMANA	(Spain)
ROTHÉ	(France)
SAVARENSKY	(USSR)
SCHNEIDER	(Argentine)
THELLIER	(France)
TOPERCZER	(Austria)
VARELA	(Argentine)
WEBSTER	(Australia)

XIII *Gravimetry*

TARDI	(Reporter)
BOULANGER	(USSR)
CRARY	(U.S.A.)
GERSHANIK	(Argentine)
HATANAKA	(Japan)
JOCKEL	(Australia)
JOYCE	(U.S.A.)
LEJAY	(France)
LISIGNOLI	(Italy)
PAPADOPULOS	(Argentine)
PRIOR	(U.S.A.)
RICE	(U.S.A.)
ROBERTS	(U.S.A.)
ROBIN	(U.K.)
SAVARENSKY	(USSR)
SILVA	(Italy)
VARELA	(Argentine)

1.4 *CSAGI: First Executive Meeting*

2.30 p.m., Thursday, 8 September

At this meeting, the President recalled the addition by ICSU of three new members of the CSAGI: Dr. V. V. BELOUSSOV and Dr. N. V. PUSHKOV as additional representatives of the IUGG, and Dr. A. F. BRUUN as representative of the IUBS; he also mentioned the Antarctic conference held in Paris in July.

The General Secretary then presented his report for the interval since the Rome meeting of the CSAGI.

Report of the General Secretary

Since the Rome meeting the National Committees have, in many cases, made important extensions or changes in their national program following the 1954 CSAGI proposals then laid down; in some cases budgetary action for the national programs has been taken, or the program has been modified by reason of financial considerations.

At this meeting the international program is to be reviewed in the light of these changes in previous national programs and of the new national programs to be presented by nations that have only lately decided to participate in the International Geophysical Year. Consequently those national committees which submitted reports last year were invited by a circular letter to prepare revised ones, and those National Committees which have not yet submitted their reports were asked to prepare complete and detailed plans for this meeting, together with statements of their recommendations, if any, regarding the scope and nature of the international program. All the delegates and observers will find these documents at the Secretariat.

Furthermore the Advisory Council of the International Geophysical Year (ACIGY), formed (following the ICSU recommendations) of representatives, one from each national committee, will be able to cò-ordinate programs between nations. Such co-ordination will facilitate mutual assistance between countries operating the various stations during the International Geophysical Year, and should help the work of the Secretariat.

At the Rome meeting, it was decided to prepare operation manuals for the observations during the International Geophysical Year. Some of these manuals are being prepared. At this meeting all such material must be considered. It is hoped that sufficient material will be available here to permit the final appointment of editors for each discipline, who should be able to prepare the manuals for publication by the CSAGI Secretariat soon after the Brussels meeting.

Finally, at this meeting, the problems of publication and distribution of data obtained during the International Geophysical Year must be considered. An important aspect is to get agreement on (a) exactly what data will be interchanged, (b) how and when it will be interchanged during the International Geophysical Year, and (c) the form of the data in terms of publications.

It is essential that the publication problems be considered *discipline by discipline* before final proposals are recommended by the CSAGI.

In particular the CSAGI has emphasized the desirability of having each nation report the steps it proposes to take to receive and to distribute the notices of Alerts and Special World Days.

The Bureau (President, Vice-President, and General Secretary) met in Washington, D.C., in November 1953 and April 1954, in Brussels in August 1954, and in Rome in September 1954; it has given special attention to the problems of the International Geophysical Year during visits to many countries.

The Finance Committee of the CSAGI has been appointed as follows: the Vice-President and the General Secretary of the CSAGI; a delegate of the ICSU Bureau, E. HERBAYS (who is Vice-President of ICSU); and a member of CSAGI, G. LACLAVÈRE.

The administrative office has been in Uccle at the Royal Meteorological Institute of Belgium since 1 November 1953. It was difficult for the present General Secretary, having the help of only one typist, to exercise properly the responsibilities of his post.

It is with great pleasure that the General Secretary expresses his warmest thanks to the President and Vice-President of the CSAGI for their generous help and understanding support. Their continuous aid has proved to be of great assistance in those critical moments when conditions were not favorable for efficient work by the Secretariat. It is also a source of great satisfaction to the General Secretary that there has been such happy collaboration between the members of the Bureau. The transfer of the Secretariat from the office lent by the Royal Meteorological Institute of Belgium to a private quarter nearby will properly permit a somewhat more expanded activity by the Secretariat.

Since there is every reason to believe that the expansion of the Secretariat Staff will be valuable in connection both with the administrative work in general, and with the scientific work in particular, it should be possible gradually to increase the efficiency of the Secretariat. In the past the activities of the Secretariat might have been more useful to all concerned had the publication of *Bulletins d'Information du CSAGI* Nos. 1 to 5 not been too much delayed owing largely to difficulties in obtaining consistent reports. Preparation of these requires detailed consideration which can only be accomplished with a complete staff.

It is hoped that material for future *Bulletins* will be in such a form that publication schedules can be met without difficulty.

The Chairman of the Finance Committee of the CSAGI, Dr. BERKNER, then presented the following summary.

Report of the Finance Committee

The Finance Committee of the CSAGI met in Oslo on Thursday, 11 August 1955, and examined the report of the General Secretary of the CSAGI and the proposed Budget for 1956.

The members of the Finance Committee present were:

L. V. BERKNER, Chairman.
E. HERBAYS, Vice-President of ICSU.
G. R. LACLAVÈRE, member of CSAGI.

(1) It was suggested that the Chairman of the Finance Committee discuss with the Bureau the opportunity now offered by the ICSU to have the CSAGI accounts kept by Messrs. Gimson and Son, the official auditors for ICSU.

(2) The Committee understood that the account presented to it by the Secretary General of the CSAGI represented expenditures in budget categories and would be reported by vouchers to the General Secretary of ICSU.

(3) The Committee accepted the distribution of expenditures in accordance with the recommendations adopted in Rome, with the following comments:

(a) The Committee believes it desirable to show the distribution of taxes required for payment by the Belgian Government.

(b) The Committee proposes to increase the proposed budget for 1956 to provide for essential travel of officers and members of CSAGI for the implementation of the final program, and proposes to insert an item for $3000 for publications.

This increases the projected budget from $21,540 to $27,540; this figure corresponds to the amount originally estimated by the CSAGI at its last meeting (Rome, September 1954).

(4) The Committee complimented the Secretary General of the CSAGI on the care and effectiveness with which he has established the Services of the Secretariat of the CSAGI.

The CSAGI gave power to the Bureau to decide on the best arrangements for keeping the CSAGI accounts. (The Bureau decided later to defer a conclusion on this matter till the General Secretary had had a meeting with Dr. Ronald Fraser, Administrative Secretary of the ICSU, and Mr. Gimson, Official Auditor of the ICSU.)

The President took occasion to congratulate Colonel Herbays, who was the convenor of the CSAGI when it was first appointed by the ICSU (and later Provisional Secretary), on his election as Treasurer of the ICSU from 1 October 1955, at the end of his period of service as Vice-President of the ICSU.

The Executive Committee then considered the further development of the central secretariat of the CSAGI; they had before them a proposal that regional Adjoint Secretaries be appointed to stimulate and keep watch over the execution of the IGY program in different regions; some members considered that certain parts of the program would not be best served by such a method of organization; it was decided to invite the working groups to consider and report on any addition to the central organization they may deem advisable for their part of the program.

It was understood that any Adjoint Secretaries appointed would, like the General Secretary, receive only reimbursement of expenses they incurred on behalf of the CSAGI.

The meeting was then adjourned till Monday, 12 September.

1.5 *CSAGI: First Plenary Session*

9.30 a.m., Friday, 9 September

The President pointed out that the working groups appointed to consider the various parts of the IGY program have three main tasks:

"One is to fashion *international* programs in their respective subjects, on the basis of the parts of the National Reports dealing with these subjects, and of reports from any Union-IGY committees bearing on them. A second task is to consider the collection, exchange, distribution, and publication of the data to be obtained from the execution of their programs; the appropriate plans will differ from one subject to another; CSAGI regards this second task as specially urgent, and asks the working groups to be ready to present their reports on it, stated as clearly as possible, to the Plenary Session to be held on Monday, 12 September, at 9.30 a.m. A third task is for each group to consider and report on any additions to the central secretariat that they may consider advisable, in the interest of their part of the IGY program; the CSAGI in executive session has considered a proposal to appoint regional Adjoint Secretaries, to stimulate and watch over the execution of the whole IGY program in different regions; but this may not be the most helpful plan as regards some parts of the program.

"At the CSAGI meetings in Rome it was thought useful to appoint geographical working groups to review the whole IGY program in each of a number of special regions of the globe. Since then there has been a conference called by the CSAGI in Paris in July 1955 specially to consider the Antarctic part of the IGY program; this conference was very valuable and successful. The Bureau proposes the appointment of geographical working groups also at the present meetings, and designates them and their leaders as follows:

Antarctic:	LACLAVÈRE
Arctic:	CURRIE
Equator:	HERRINCK
Meridian 10° E	HERLOFSON
Meridian 70° W	MORGAN
Meridian 110° E:	DAVITAYA
Meridian 140° E:	NAGATA

" The leaders of the national delegations are asked to give to the secretariat a list showing against the names of their members the geographical groups they wish to attend."

Some of the leaders of these groups then proposed times at which their groups would be called to meet. There was discussion regarding the difficulty for members who might wish to attend meetings of more than one geographical group, whose times overlapped. A short recess was then allowed to enable the geographical group leaders to arrange times to obviate this difficulty as far as possible.

The President then called the attention of all the groups to the circular sent in May 1955 by the General Secretary to the National Committees.

Up to this point the proceedings of the meetings had been given in both English and French; M. LACLAVÈRE was especially helpful in translating into either language. Dr. BELOUSSOV having informed the Bureau that time for translation into the Russian language was desired, such translations were thereafter made, by himself or otherwise, whenever he or other members of the Russian delegation indicated a wish for it to be done. The President asked the leaders of the working groups to follow the same practice.

The President announced that in view of the limited participation of the adhering nations in the rocket and satellite program, and in view of its great importance and of the interest of all delegates in the plan for this program, Dr. H. E. NEWELL had been asked to give a special lecture so that all delegations would be better informed of the plans for this program. This would be open also to the Press.

After announcements of the times of later meetings, the Plenary Session was adjourned until Monday, 12 September.

Working Groups, Friday, 9 September

During the remainder of Friday, 9 September, much time was devoted to meetings of the Committees of the Unions and of the many working groups, for the different subjects and the different regions concerned in the IGY program.

1.6 *CSAGI: Second Plenary Session*

9.30 a.m., Monday, 12 September

The reports of the Union-IGY committees were first received. Dr. BEYNON briefly summarized the report (which had been distributed) of the URSI-AGI committee. The first part dealt with the distribution of ionospheric stations of various kinds, and the second part with the interchange of information between stations, and other matters. As regards the production of IGY Manuals for the Ionospheric IGY Program, it had been decided that the editor should be W. J. G. BEYNON; D. LEPECHINSKY would supervise their translation into French, and N. V. PUSHKOV a translation into Russian. The URSI-AGI Committee expected to meet again about the middle of 1956, probably in Brussels.

The URSI-AGI report also recommended that, in view of the great extent and importance of the radio part of the IGY program, the URSI representation on CSAGI be strengthened by the addition of two members, and suggested that they be P. LEJAY and A. H. SHAPLEY.

Dr. BEYNON then indicated the subject of sixteen resolutions (of which the text was distributed later in the day) adopted by the URSI-AGI committee.

The President thanked Dr. Beynon for his presentation of the very full and valuable report of the URSI-AGI committee. The proposal regarding additional members of CSAGI would, he said, be considered by the CSAGI in executive session that afternoon, but in any event would be subject to final action by the ICSU.

Dr. RAMANATHAN then gave a brief summary of the work of the IUGG-IGY committee, whose report was not yet complete. The committee had considered three main aspects of the IGY program:

(a) The expansion of IGY activity; in this connection it is proposed that advantage be taken of any opportunities afforded by other IGY plans in order to secure seismic and gravimetric data in regions where these were lacking or scanty.

(b) The future form and development of the central IGY organization; its proposals on this subject were not yet ready.

(c) The availability of data; the question whether each country should publish its own data, or whether data for each distinct part of the IGY program should be collected at, and distributed from, one or more centers, was referred to the separate working groups.

After thanking Dr. Ramanathan for his report, the President announced the appointment by the Bureau of two committees, on Availability of Data and on CSAGI Publications: "The former committee has the task of collating the recommendations as to collection and distribution of data from the working groups for the different scientific disciplines, and presenting a unified report to the CSAGI. The CSAGI Publications Committee is asked to collate and review the working-group recommendations as to the IGY Manuals to be produced, and to advise as to the best method of publishing these and other documents as CSAGI publications. These committees are appointed only for the duration of the present Brussels meeting."

The President then proposed that the reports from the working groups as to additional central IGY organization be received, so far as they are ready, and studied later. P. LEJAY asked whether this included such matters as URSIgrams in connection with the announcements of World Alerts and World Special Intervals; the President said the latter was a part of the mechanism of the agreed technical IGY program, whereas he was referring to recommendations for additions to the central secretariat. G. LACLAVÈRE requested further clarification of the reference. The President replied that in connection with the Antarctic IGY program, the CSAGI had arranged an important special conference in Paris in July, of which, indeed, M. LACLAVÈRE had been the organizer on behalf of CSAGI, and the very efficient leader. The Bureau thought it would probably be desirable to appoint an Adjoint Secretary to deal with Antarctic IGY problems as they arose; he would be under the direction of the General Secretary and would keep him fully informed on all such Antarctic matters. It might be advisable that the General Secretary should have other assistance for further parts of the IGY program, or in connection with other regions of the globe. Such were among the questions of organization on which the views of the several working groups were invited.

Mr. J. M. WORDIE remarked that the working group on glaciology considered that an Adjoint Secretary for the Antarctic was certainly necessary, but did not think that there was need for such a secretary for Arctic problems. He considered that the need for an Antarctic secretary was urgent. Messrs. J. VAN MIEGHEM, V. LAURSEN, and V. V. BELOUSSOV briefly mentioned opinions of their working groups on these questions; their views would be embodied in written reports. In answer to M. P. TARDI, the President stated that full reports of the considerations taken into account by the working groups during their discussions were not necessary; a summary of their conclusions and recommendations would suffice.

He then proposed the formation of a World Days working group, with Mr. A. H. SHAPLEY as leader; there had been such a group at the two preceding meetings of the CSAGI (1953, 1954), but at the first Plenary Session last Friday its renewal was omitted, perhaps under the impression, which was found to be mistaken, that the World Days arrangements needed no further discussion. Leaders of national delegations were asked to give the General Secretary the names of their members who wished to join this working group.

He next requested the leaders of working groups to scrutinize the resolutions they were preparing for presentation, to ensure that these did not contravene the policy laid down at an earlier CSAGI meeting, that CSAGI should not propose or recommend that nation A should do IGY work on the territory of nation B. Any such arrangement should be arranged bilaterally between the two nations themselves.

The General Secretary announced that a time-table had been prepared and rooms allotted for the meetings of working groups; notices had been put up indicating how to reach the allotted rooms.

Before the meeting concluded, Dr. W. BLEEKER requested further consideration of a resolution proposed by the Netherlands National IGY Committee, regarding measurements of radioactive matter in the atmosphere; the working group on meteorology had, he said, advised against adoption of the proposal.

Dr. J. KAPLAN said the question seemed to him important, and he requested that Dr. H. WEXLER should be allowed to present a report on the subject.

Dr. H. WEXLER considered that valuable light might be thrown on some natural processes if harmless amounts of radioactive material were introduced into the atmosphere to trace the natural system of atmospheric circulation. He suggested that a group should be set up to make recommendations to CSAGI on the subject, either in time for the final plenary session or shortly thereafter.

It was agreed, on the proposal of the President, to refer the question to the Bureau, which would examine it and report without delay.

(Further information on this subject is given below, p. 224.)

1.7 *CSAGI: Second Executive Meeting*

2.30 p.m., Monday, 12 September

The CSAGI first considered the proposal by the URSI-AGI committee for the addition of two members to the CSAGI, as representatives of the URSI. The President expressed the opinion that the CSAGI would do well to support the proposal; he thought the CSAGI would be materially strengthened by the inclusion in it of the Rev. Father P. LEJAY, President of the URSI and newly-elected Vice-President of the ICSU, and Mr. A. H. SHAPLEY, who had done, and would do, so much for the IGY in connection with the World Days program. It would involve some additional cost. The decision would rest with the ICSU, as with all the appointments to membership of the CSAGI.

Dr. BEYNON explained that the proposal was made not in order to approach more closely to some ideally fair representation as between different Unions; it was made on the ground that the ionospheric IGY program was so considerable, and that radio techniques also had wide application in other parts of the IGY program.

Colonel HERBAYS supported the proposal, and indicated that if the URSI representation on CSAGI was increased as suggested, the special concerns of the four URSI members would be:

BEYNON:	Ionosphere,
LEJAY:	URSIgrams,
BOELLA:	Longitudes and Latitudes,
SHAPLEY:	World Days.

After further discussion, in which the proposal was supported by the Vice-President, Mr. WORDIE, the General Secretary, and Dr. SCHUMANN, it was agreed to recommend it to the ICSU.

On the proposal of the Vice-President it was agreed to invite Father LEJAY and Mr. SHAPLEY to attend the CSAGI meetings as observers during the 1955 Brussels meetings. On being informed, they came to attend the meeting reported here.

The President reported telegrams that had passed between the Academia Sinica, Peking, and the General Secretary, relating to the welcome decision of the Academy to participate in the IGY. The Academy had formed a National IGY Committee, but a national report had not yet been received.

The President then reported that Dr. KAPLAN and Dr. RAMANATHAN were collecting recommendations of the working groups for the Committee on Availability of Data, which was not yet ready to present its conclusions.

There followed considerable discussion concerning CSAGI publications, and the possible appointment (considered by the CSAGI Publications Committee) of an editor who would supervise all CSAGI publications, except the bulletins reporting CSAGI meetings and current IGY events; these bulletins, it was agreed, should be under the direct control of the General Secretary. Dr. BEYNON said that the URSI-IGY committee would wish to be consulted regarding any ionospheric publication to be issued by the CSAGI. M. LACLAVÈRE was appointed chairman of the Publications Committee in place of the General Secretary, who expressed a wish to be relieved of the chairmanship. The Committee was not yet ready to present its report.

The remainder of the meeting was devoted to a long discussion on the future central organization for the IGY, a matter on which the views of the working groups had been invited. Some group reports had been received, others were awaited. Different opinions were expressed as to whether the CSAGI working groups, hitherto appointed only for the duration of the CSAGI meetings, should continue in being after the close of the 1955 Brussels meeting; one view was that questions that might arise concerning the different scientific branches of the IGY program could be dealt with by the corresponding Reporters, who would keep the General Secretary informed, and who would consult where necessary with appropriate Union committees; the URSI-AGI committee had a continuing existence, and was the most appropriate group for consultation on ionospheric matters. It was suggested that the IAU and the IUGG or its Associations should set up similar committees for other separate branches of IGY work. This might involve the Unions in additional expense and some organizational difficulties, as some Union representatives on the CSAGI remarked.

The Vice-President said that the CSAGI would come to an end a few years after the close of the IGY, that is, about 1960 or not long afterwards, and during its period of existence it should not set up continuing committees that would duplicate the work of the Unions or that would tend to perpetuate the CSAGI beyond the immediate IGY operations; this might diminish the stature and weaken the authority of the Unions. He envisaged that future meetings of the CSAGI would differ in character from the series of three planning meetings so far held. The IGY program was moving from the planning to the operational phase: it was hoped that meetings such as the present one would no longer be necessary, nor would there be time during the operation of the IGY for such meetings to be useful. The CSAGI was formed by the ICSU at the request of the Unions, and it was proper to depend on the Unions for further scientific recommendations as the IGY plans went into operation.

Dr. DANJON and M. LACLAVÈRE preferred the continuance of the CSAGI working groups; Dr. BEYNON pointed to the successful work of the continuing URSI-AGI committee as an example of the ability of the Unions to function effectively. It was agreed, however, that CSAGI must be responsible for the over-all guidance of the execution of the IGY plans, and that the functions of certain members of CSAGI as Reporters for the different scientific branches of the program should continue, in order that the General Secretary should be promptly informed as to all additions or recommendations to the IGY program. In the hope of arriving at an agreed conclusion on these questions, they were referred to a Committee on Organization, consisting of BERKNER (Chairman), BELOUSSOV (alternate, BOULANGER), DANJON, LACLAVÈRE, SCHUMANN, TARDI.

Dr. SCHUMANN remarked that meteorology has a very extensive program, and many points might arise in connection with it, that could be dealt with by one man better than by a committee; there would be considerable work of this kind for one man.

Dr. BERKNER said that the Bureau considered that there was an immediate need for an Adjoint Secretary to act under the direction of the General Secretary in regard to the Antarctic IGY program.

It was agreed after brief discussion that the Bureau be authorized to expand the Secretariat by making such an appointment, and, later on, others that the Bureau might regard as necessary to lighten the burden resting on the General Secretary.

The meeting was then adjourned.

1.8 *CSAGI: Third Plenary Session*

9.30 a.m., Tuesday, 13 September

The President indicated the stage now reached in the meetings; the working groups for the different scientific branches and the different geographical regions of the IGY program were nearing the end of their studies. Some had already sent in their reports, others would do so during the day, concerning the programs, the availability of data, the recommendations as to future organization, and resolutions.

The Committee on Availability of Data had made progress in collating the sectional reports on this subject; it was agreed that centers should be set up in different countries as repositories for the collection of the IGY data to be exchanged between the nations participating in the IGY; these centers might deal with all the IGY data, or only with sections of it; they would also act as distributors of copies of the data. The Committee recommended that the data should be made available to scientific institutions and to individual scientists without any condition except repayment for the cost of reproduction and forwarding.

The Committee on Publications had not yet finished its work; it had begun by discussing the nature of the CSAGI publications to be issued. In the past the CSAGI Information Bulletins had been reprints from the *IUGG News Letter*. In future they would be issued directly from the CSAGI secretariat, and would carry the CSAGI imprint. It was proposed to adopt an International Geophysical Year symbol, which would appear on all CSAGI publications, and might also, subject to authorization by the CSAGI, be placed upon national IGY publications, and upon instruments specially made or devised for the IGY program. The CSAGI arrangements for editing and publishing remained to be examined.

In executive session the CSAGI had considered the problem of the future IGY central organization, and had appointed a *Committee on Organization*:

BERKNER (Chairman)	LACLAVÈRE
BELOUSSOV (alternate, BOULANGER)	SCHUMANN
DANJON	TARDI

to report the following day, after taking into account any recommendations made by the working groups.

In the same session the CSAGI had decided to commend to the ICSU the proposal by the URSI-AGI committee that the URSI representation on the CSAGI be increased by the addition of Father LEJAY and Mr. SHAPLEY; and they had been invited to attend the second and third CSAGI executive meetings.

Some mattters that had been referred to the CSAGI were next mentioned. UNESCO had forwarded a request from its Committee on Arid Zones that during the IGY, due attention be paid to observations in the arid regions of the latitude-belt 20°–30° N. This request had been referred to the working group on meteorology, which had recommended the inclusion of such observations in the IGY program.

The Netherlands National IGY Committee proposed that the meteorological IGY program should include measurements of the radioactivity of the air. The working group on meteorology had not supported the proposal, and as Dr. BLEEKER had the previous day requested further consideration, and the matter had been referred to the Bureau, the Bureau had asked that the proposal be presented in more detail, and a much revised form of the proposal had been communicated to them by Dr. BLEEKER and Dr. WEXLER. The Bureau after careful consideration had concluded as follows:

(a) The proposed experiments using radioactive tracers offer in principle an avenue to increased knowledge of transport and mixing in the air and the oceans.

(b) The IGY would be a specially appropriate time at which to make such experiments, because of the exceptional volume of related data, and the large number of observers during the IGY.

(c) It seems uncertain, however, whether practical plans for such experiments can be prepared in time for their execution during the IGY.

(d) The Bureau therefore suggests that the proposers of the above experiments should develop their ideas further, in quantitative detail: and that thereafter, if they see fit, they invite the Netherlands National Committee to propose plans for such experiments to one or both of the International Associations for Meteorology and for Physical Oceanography.

(e) The Bureau declares its willingness to consider any such plans that may be presented to it, before or during the IGY, by one or both of these International Associations: and, if found appropriate, to bring the plans to the attention of all National IGY Committees that seem likely to be able to include them in their programs.

The President then reported the appointment by the Bureau of a *Committee on Resolutions*:

SPENCER JONES (Chairman)	HASEGAWA	PUSHKOV
ATWOOD	HERBAYS	THELLIER
FRASER		

to review the resolutions proposed by the various working groups in consultation where necessary with the group leaders: to suggest amendments, to remove any inconsistencies or redundancies between different resolutions, and to exclude resolutions inconsistent with declared policies of the CSAGI: also to prepare suitable resolutions of thanks, and resolutions empowering the General Secretary to edit the report of the meeting.

All group resolutions were to be presented for consideration by this Committe not later than 6 p.m. on Tuesday, but the earlier the better.

A change of time-table was announced, deleting a meeting of the ACIGY originally scheduled for Tuesday afternoon, and changing the time of the ACIGY meeting on Wednesday from the afternoon to the morning; the last plenary session of the CSAGI was put in the afternoon instead of, as originally proposed, in the morning of Wednesday, 14 September, to permit time for circulation of reports.

Dr. SCHUMANN raised the question of authority for regional co-ordination and stimulation of effort for the IGY program in South Africa, where there are large territories not at present associated with the IGY. It was agreed that a general resolution on such regional co-ordination should be prepared.

Meanwhile the attention of the geographical working groups for the 10° E meridian and for the equatorial region was called to the fact mentioned by Dr. Schumann.

M. LACLAVÈRE enquired as to decisions regarding two matters raised by him in letters to the General Secretary: a proposal for the collection of meteoric dust, and some proposals from the International Association of Hydrology. It was stated that the Bureau would consider these proposals.

It was announced that at 5 p.m. on Tuesday, 13 September, M. LACLAVÈRE would expound the revised Antarctic IGY plans, at a lecture to which members of the Press were invited.

The meeting was then adjourned, and group photographs were taken shortly afterwards.

1.9 *CSAGI: Third Executive Meeting*

9.30 a.m., Wednesday, 14 September

Much of this meeting was devoted to further discussion of the draft report of the Committee on Organization.

It was stated that the CSAGI and the ACIGY would probably next meet about November 1956 in Europe. Some opinions were expressed adverse to the ICSU requirement that members of the CSAGI shall not be members of the ACIGY, but it was pointed out that the members of the CSAGI must represent the scientific interests of the various fields of the IGY.

Dr. Schumann appealed for strong efforts to be made by the Bureau to secure additional IGY participation in South Africa and the adjacent nations; M. LACLAVÈRE suggested that the Scientific Council for Africa South of Sahara might help that objective, and Dr. SCHUMANN asked that the General Secretary should report fully on the IGY program to the Commission for Technical Co-operation in Africa South of Sahara (CCTA) and Scientific Council for Africa South of the Sahara (CSA).

The reports of the Committees on Availability of Data, and on Publications, were also discussed, and approved subject to amendment by the Bureau.

Dr. BELOUSSOV stated that the USSR would arrange for translation of the CSAGI documents into Russian, at its own expense.

1.10 *CSAGI: Final Plenary Session*

2 p.m., Wednesday, 14 September

The President stated that the purpose of the session was to acquaint those present with the main outlines of the work done, and the decisions and recommendations made; there was not time for discussion, but written remarks sent in to the General Secretary after the meeting would receive consideration.

Dr. HERLOFSON summarized the conclusions of the geographical working groups (other than that for the Antarctic, as the plans for the Antarctic had been expounded the day before by M. LACLAVÈRE).

The detailed recommendations of the individual working groups will be available in future *CSAGI Bulletins*, and should be consulted in connection with the following general conclusions.

The fundamental work on geographical distributions was done in Rome 1954, and resulted in the *CSAGI Bulletin* No. 5. The precision has been greatly increased by the General Secretariat's card index of stations, copies of which have been distributed in three volumes to participants in the Brussels meeting 1955. The first task of the working groups has been to bring these cards up to date, to a large extent by personal consultations with national representatives. To make such an index really accurate requires more time than has been available during the meeting in Brussels, and representatives of several national committees have expressed the view that it might be useful some time after the Brussels meeting to send each national committee perhaps only one or two copies of the revised lists, with a request for immediate comments before a new edition of station lists is printed.

The need for a study of geographical distribution arose at a time when large areas were still poorly covered or information was lacking. During the past year this deficiency has been remedied in many places, and in some areas the gaps have now become so small that we are only left with the study of minute details.

The general impression now, seen on a planetary scale, is that the Antarctic is well covered, and so are the Arctic regions. There are in these regions no large gaps which could be readily filled.

On the other hand the equatorial belt now appears as the part which requires most attention, and a particular feature which stands out is the importance, and the need, for observing stations on several of the small isolated islands in the large oceans. As examples there can be cited the recommendations for observations in many disciplines on the islands south of India, the two islands between South Africa and the Antarctic, and the more specific recommendations for geomagnetic or ionospheric stations at islands such as Easter Island or Tahiti. Many of these small ocean islands are colonies, and the attention of the responsible nations should be drawn to this marked deficiency in the world net.

Local reconnaissance or availability of local knowledge is particularly important in order to judge whether expeditions can be sent to certain localities at all. In this connection the relevant working group has, for instance, drawn attention to the valuable local reconnaissance made by South Africa on Bouvet Island, information which is available by application to the appropriate South African authorities.

The next major item is the absence of information from the Chinese People's Republic and from the north-eastern parts of South America, which now are the two principal regions still left uncovered. It is important that the responsible national authorities or institutions should be invited to take an active part in the International Geophysical Year. Furthermore, there is a need for extended work in the belt in Africa between the Union of South Africa and the Belgian Congo; any regional initiative there would be most welcome.

Finally, in the course of their work, the various groups have seen the possibility of bringing local questions to the attention of national delegates, and in some cases bilateral negotiations are in progress. As an example Bear Island can be mentioned, where there has been a lack of ionosphere observations at an otherwise complete station. Another example is the joint observation of whistling atmospherics between northern states of the U.S.A. and Canada at one end of a geomagnetic field line and the area near or south of Cape Horn at the other end of the same field line.

In quite a few cases the resolutions of working groups on geographical distribution would run along the same lines as resolutions by groups in the various disciplines. In such cases, as far as time has permitted, the groups have tried to avoid duplication of recommendations, and have tried rather to refer to the reports for the individual disciplines.

The President thanked Dr. HERLOFSON for his clear and interesting geographical summary.

Mr. SHAPLEY then reported the position regarding the arrangements for World Alerts and World Special Intervals during the IGY. The national reports showed that the Rome plans were being followed in a generally adequate way. There had been discussion concerning the kinds of information to be distributed; the URSIgram committee would need and would receive information concerning this. The order of magnitude of the undertaking must be assessed, and enquiry sheets had been drawn up to be presented to the national committees. The World Days working group had proposed resolutions on these matters, and the establishment of World Day communication centers and associated centers was invited.

The President thanked Mr. SHAPLEY, and called on Dr. VAN MIEGHEM, who gave a brief account of the work on the meteorological program. The list of data to be exchanged through the WMO secretariat had been decided; the desirability of using microcards for distribution of the data would be examined. Manuals were planned dealing with the collection of sferics observations, on radiation, on ozone, and on several other branches of the meteorological program. Some amendments to the Rome program had been made, affecting precipitation chemistry, World Days, radiation, and atmospheric chemistry. Recommendations had been made for meteorological observations as suggested by the UNESCO Arid Zones Commission. There was need for improvement in the arrangements for radio transmission of meteorological data in the southern hemisphere; and there is a gap in the meteorological coverage on the west coast of South America: resolutions concerning these were proposed.

After thanking Dr. VAN MIEGHEM, the President called on Dr. LAURSEN, who reported that in the field of geomagnetism there had been a good response to the recommendations made at Rome for the setting-up of six new magnetic stations; five new stations were reported as being definitely planned, and a favorable report on the sixth was expected soon. Six manuals on the geomagnetic IGY program were planned (some of them very brief). Recommendations had been made regarding the interchange and distribution of data. The Rome plans had been re-examined and found satisfactory, but an additional recommendation had been made, urging full use of whatever possibilities may exist for making magnetic observations along and across the tracks of the three solar eclipses, two total and one annular, that would occur during the IGY. The whole network of AGI magnetic stations had been reviewed; the recommendations made included one for a new station in India, between 100° and 110° E, and another for the renewal of full operation of the Argentine magnetic observatory at Pilar, in time for the IGY.

Dr. LAURSEN having been thanked, Dr. ELVEY reported briefly on the auroral and airglow programs. No major changes in the Rome plans proved to be necessary, but the participation of the USSR in the IGY had greatly enhanced and substantially completed the network of auroral stations in the north auroral zone. As regards world repositories and distribution centers for auroral data, it was proposed that there should be at least two and not more than four. For the airglow observations priorities were recommended for the following spectral components:

(1) the green auroral line, (3) the red auroral lines,
(2) the Na lines, (4) the OH bands.

After thanking Dr. ELVEY, the President called on Dr. BEYNON to summarize the work of the ionospheric group. He said that much of their report had been indicated on Monday, on behalf of the URSI-AGI committee. The Rome plans had been reviewed in the light of the national reports, and it was satisfactory to find that most of the Rome recommendations had been accepted. The USSR stations brought a very valuable addition to the world coverage; the plans of the National IGY Committee organized by the Academia Sinica, Peking, were eagerly awaited. There was an important gap in the world network, which could be filled if an ionospheric station were set up on Marion Island. Detailed plans had been made for ionospheric manuals, which would appear in English, French, Russian, and Spanish. The ionospheric group recommended to the CSAGI that the publication policy for ionospheric data should be a very liberal one despite the cost.

The President thanked Dr. BEYNON for his report, and called on Sir HAROLD SPENCER JONES for an account of the work on solar activity: he reported a gratifying response to the Rome recommendations. The IAU had improved its method of flare classification, and the plans for Lyot-filter observations. It had been learned that before 1956, a newly developed coronal photometer would be completed. France had agreed to establish on Tahiti a recorder of solar radio noise, and the U.S.A. one in Hawaii. At present only the Mt. Wilson observatory scans the sun's surface magnetic field daily by the Babcock method; during the IGY, four USSR stations would add this work to their program, and two of them would also make direct Zeeman measurements of sunspot magnetic fields. Plans had been made for the distribution of solar information by telephone, telegraph, and mail: there would be regional-group weekly bulletins, showing provisional daily charts of the sun's surface, with explanatory notes; they would later be collected in a large IGY solar volume, whose contents and arrangements had been decided upon. A recommendation had been made concerning the collection and distribution centers for solar data.

The President thanked Sir Harold, and remarked that there would be no report on the cosmic-ray program at this meeting, as the cosmic-ray working group was meeting at Mexico City. A summary of their work, prepared by Dr. SIMPSON, would, however, be interpolated in the report of the meeting.

Dr. SIMPSON later reported, in writing, that thirty-five scientists from approximately twenty countries participated in the discussions and preparations of resolutions for inclusion in the CSAGI report for 1955. The cosmic-ray report as prepared at Rome is unchanged in philosophy and general emphasis on the objectives for the International Geophysical Year. However, several additions to the 1954 report have been made. The principal additions relate to special experiments using counter telescopes and unmanned satellites. In addition a number of new stations have been added to the list of those already known or proposed for the International Geophysical Year, the most notable addition being the contribution from the USSR. In addition to the recommendations for the CSAGI report, the Sub-Commission on Cosmic-Ray Intensity Variations (SCRIV) has prepared, at the request of CSAGI, the data forms for representation and exchange of basic cosmic-ray data. Prior to the official meeting on 14 September, a 3-hr preliminary meeting was held on the afternoon of 13 September, at which time the scientific programs were thoroughly discussed and sub-committees were appointed to propose resolutions related to the IGY and SCRIV research programs.

Dr. DANJON then reported that some modifications had been made in the Rome plans for the IGY program for longitudes and latitudes; the night observations should be made partly in the first and partly in the second half of the night. It was recommended that radio networks should be established to link the secondary stations of the longitudes network with the primary stations.

Thanking Dr. DANJON, the President then called on Mr. WORDIE, who reported that there was need for extended glaciological studies of the Greenland ice cap. A list of the glaciers of the world was needed, and it was recommended that the different nations should co-operatively provide the necessary information. The resolutions of the International Association of Hydrology (IAH), referred by the Bureau to the working group on glaciology, had been considered, and it was recommended that they be followed, so far as they referred to glaciology. The group proposed that after the CSAGI meeting the Reporter on glaciology should act in consultation with the Snow and Ice Commission of the IAH, which could serve as an IAH-IGY committee.

The President, having thanked Mr. WORDIE, M. LACLAVÈRE reported on the oceanographic program. In 1953 this was small, but at Rome it was discussed by a considerable group of oceanographers and much developed. The national reports on this subject indicated that during the IGY there would be many oceanographic ships combining in the program. An IGY Oceanographic manual had been planned. It was recommended that the data-collection centers should be designated by the different countries, and that there should be no world oceanography repository and distribution center.

Thanking M. LACLAVÈRE, the President called on Dr. NEWELL for a report on the

IGY rocket and satellite program. He stated that some progress had been made since 1954 towards meeting the Rome recommendations, but much remained to be done. Five additional recommendations were made, of which four detailed the data that should be published, and emphasized the importance of prompt publication; the fifth stressed the need for an expanded program of research by small rockets, particularly in the regions of the 10° and 140° meridians, and in the equatorial region.

The President thanked Dr. NEWELL, and then called on Dr. BELOUSSOV, who remarked that though a possible IGY program in seismology had been mentioned at the 1953 Brussels meeting, there had been no working group on seismology at Rome. Here in 1955 the IGY program in seismology had been thoroughly reviewed; advantage should be taken of the opportunities afforded by the IGY for seismological studies in little-visited regions such as the Antarctic, and wherever the seismic characteristics of the earth were not known; and there should be studies of microseisms in connection with the oceanographic and meteorological observations. It was learned that Chile would be able to take part in the program, and recommendations were made for some additional seismological stations, in particular for one at Easter Island.

Dr. BELOUSSOV was thanked by the President, who then called on Prof. TARDI; he stated that this 1955 meeting was the first at which there had been a working group on gravimetry. It had recommended series of measurements of two kinds. (a) Static determinations of gravity should be made, especially in remote regions, to increase the network of points at which such measurements had been made. It was essential that the results be homogeneous, which called for plans for calibration of the different instruments used. It was recommended that all the results should be sent to the International Gravimetric Bureau. (b) There should be continuous records of the changes of gravity, to determine its long and short periodicities. The data thus obtained on the earth tides should be deposited at centers in Liverpool (England), Los Angeles (U.S.A.), and Moscow (USSR).

The President thanked Prof. TARDI. He then said that the resolutions submitted by the working groups would be adopted as CSAGI resolutions, subject to their review and amendment by the Bureau, in the light of any comments received by the General Secretary after the meeting.

Dr. BERKNER then reported the conclusions reached by the Committee on Organization, on the plans for the future work of the CSAGI; its Bureau would act as an executive body during and after the operational phase of the IGY, till the time came for CSAGI to be dissolved. Keeping to established CSAGI policies, the Bureau would work with the Reporters for the thirteen disciplines of the IGY program who are now appointed in permanent status. The reporters would, when appropriate, consult with the IGY committee for these disciplines: these were, or would be, appointed by the Unions, or, if the need arose, by the CSAGI itself; though in the latter case, it was hoped that the committees would be taken over by the appropriate continuing international bodies. These IGY committees would hereafter work apart from the CSAGI meetings, which in the immediate future would not have the character of the series of three planning meetings now ending. The CSAGI had decided to hold its next meeting late in 1956, in conjunction with the ACIGY. The responsibilities of the General Secretary had been clearly defined. The National IGY

Committees would be asked to present each year a specific report on the progress of their work.

Thanking Dr. BERKNER, the President called for a summary from Dr. RAMANATHAN of the recommendations of the Committee on Availability of Data. He said that they had studied the proposals of the various working groups as to the nature of the data to be collected, the methods of processing the data, and the primary and secondary repositories and distribution centers. It was gratifying to note the full co-operation being given by many international organizations, such as the WMO, URSI, various International Associations of the IUGG, and the IAU. It had been recommended as a general principle that the IGY data approved for exchange should be available to any scientist or scientific institution at the minimum cost; and that the CSAGI should publish guides giving information that would make the data readily available, indicating the repositories and the kind of data obtainable from each. It was also recommended that, where appropriate, the data should be presented in a form suitable for machine processing.

The President thanked Dr. RAMANATHAN, and called for a summary of the report of the Publications Committee from M. LACLAVÈRE, who said that they recommended the appointment by the Bureau of a continuing Committee on Publications. This would advise the Bureau on the many questions that would be involved in the issue of the future CSAGI publications. These would include IGY reports, to be prepared by the General Secretary, giving the proceedings of the CSAGI and other IGY meetings, modifications of programs or lists of stations and current IGY news. They would also include IGY bibliographies, and a history of the IGY project and its two predecessors, the International Polar Years. Among other early publications, there would be the IGY manuals for the different branches of the IGY program. At a later stage, especially from 1959 onwards, there would be CSAGI volumes giving some of the results of the program (though the nations would publish some of their results individually). It was recommended that the CSAGI adopt an IGY symbol to be placed on all CSAGI publications, and also, subject to authorization by the Bureau, on national IGY publications, postage stamps, and on instruments or equipment devised or made for use in the IGY program; the Bureau was requested to arrange for a suitable design for a symbol.

Thanking M. LACLAVÈRE, the President said the Bureau would welcome any suggestions regarding the nature of the IGY symbol. He then called on Sir HAROLD SPENCER JONES, on behalf of the Committee on Resolutions, to present two resolutions of thanks. These were adopted by acclamation.

In concluding the meeting, the President expressed great pleasure at the spirit of harmony and goodwill that had continued to characterize this assembly of the CSAGI, as at the earlier meetings. A great deal of very valuable hard work had been done by those present, but despite the pressure and hurry of the proceedings, he believed that they had enjoyed the assembly, and had extended their circles of scientific friends. There had been inevitable clashes between simultaneous meetings that members wished to attend, and some occasional shortcomings in the proceedings, for which the Bureau apologized; but the assembly had been admirably organized by the General Secretary, and this had enabled the IGY program to be improved very materially. They had enjoyed the hospitality of the Belgian Royal Academy of

Sciences, and the receptions given by the USSR and U.K. Embassies. Special thanks were due to the assistants who had helped Dr. NICOLET in the secretariat; they had worked most devotedly and efficiently from early to late, on weekdays and on the holidays during the assembly. In the name of the Bureau, the President thanked all present for their expert and successful labors during the meetings. On his part he wished to express to the Vice-President and General Secretary his appreciation of their great and varied contributions to the work of the Bureau, and thereby to the whole IGY enterprise: and to obviate any vote of thanks to him personally, he hoped he might claim a small modicum of whatever thanks the meeting might express to the Bureau! His only regret had been that the Bureau had been so occupied with the general supervision of the business of the meetings that they had had hardly any time to give to the national and Union reports and the scientific discussion at the group meetings; in this respect, he felt that the others present had had the best share in the work of the assembly. As they all left to go on their several ways, they would remain in unison in shouldering their tasks, of bringing to fruition, each in his own country and field of work, the plans now definitely prepared, at this meeting, for the International Geophysical Year.

1.11 *ACIGY*: *First Meeting*

4 p.m., Thursday, 8 September

In opening the meeting the President recalled that the institution of the Advisory Council was recommended by the ICSU in March 1955. The purpose of the ACIGY was to advise and assist the CSAGI on general questions concerning the IGY, as distinct from the technical questions on which CSAGI was directly advised by the working groups for the different parts of the program.

For example, the ACIGY might usefully discuss problems of mutual help that the participating nations can render to each other in support of the IGY program. This help might consist of loans or gifts of instruments, of facilities for training, or of technical advice.

The IGY program might be materially helped in some respects by agreements providing that one nation should receive on its territory IGY scientists from another nation, and by offers of equipment, accommodation, or facilities for their work. However, any arrangements involving national territories should be made by bilateral discussion between the nations concerned; CSAGI is strictly non-political, and therefore it is against its policy to recommend that any specific nation should assist another by provision of funds, instruments, equipment, or personnel, or that it should do IGY work on the territory of another, or should permit or accommodate scientists of another nation on its territory. But the CSAGI would welcome information that might be presented to the ACIGY concerning any such mutual arrangements; and the ACIGY affords a convenient assembly in association with which such agreements may informally be proposed and discussed.

An Antarctic regional conference had been called by the CSAGI in Paris in July; it was composed of national representatives from the countries interested in contributing to the Antarctic part of the IGY program. It might be found useful to arrange similar conferences of national representatives in connection with other geographical regions; if so, the ACIGY provided a forum for any such proposals to be presented and discussed. The Antarctic conference had been very successful and valuable; the CSAGI was greatly indebted to M. Laclavère, who on its behalf had organized the conference and guided its work.

Another matter that might usefully be discussed by the ACIGY was the provision of archives and distribution centers for the IGY observational data that would later be made available, in accordance with the recommendations of the working group. The CSAGI would welcome offers from the participating nations to provide and maintain such centers, either for the whole IGY program, or for different parts of it; such offers might suitably be presented to the ACIGY in the first instance, and the ACIGY might discuss the conditions under which such offers should be considered by the CSAGI.

The President remarked that few, if any, members of the ACIGY would be able to present such offers at the present meetings; but the Bureau proposed to call a meeting of the CSAGI together with the ACIGY late in 1956, and he hoped that by then, such offers would be forthcoming. Proposals of other kinds might also be offered by national delegates for consideration by the ACIGY.

After brief discussion the meeting was adjourned till Wednesday, 14 September.

1.12 *ACIGY: Second (and Final) Meeting*

11.30 a.m., Wednesday, 14 September

Dr. Berkner gave a brief exposition of the report of the Committee on Organization. Dr. Ramanathan summarized the report of the Committee on Availability of Data. The President remarked that the CSAGI would be glad to receive offers from individual nations ready to set up and maintain centers for the collection and distribution of IGY data; such offers would be considered by the CSAGI and discussed at the 1956 meeting of the ACIGY. M. Laclavère summarized the report of the Publications Committee. Mr. Shapley outlined the plans for distribution of communications regarding World Alerts and Special Intervals, and Father Lejay also spoke on this subject.

1.13 *CSAGI: Bureau Meetings*

11 a.m., Friday, 9 September

The Bureau met after the first Plenary Session of the CSAGI, and appointed two committees to act during the Brussels meetings. One of them was designated to review and co-ordinate the reports of the working groups on the subjects of the collection, exchange, distribution, and publication of such IGY data as were recommended by the working groups for general distribution; this was the second task mentioned by the President at the Plenary Session held earlier in the day, to be fulfilled by the working groups. The Committee was entitled the *Committee on the Availability of Data*; its members were as follows: Chapman (chairman), Beloussov, Kaplan, Lejay, Martin, Ramanathan.

The second committee was appointed to advise the CSAGI on the method to be followed in preparing and issuing CSAGI publications. This was entitled the *Committee on CSAGI Publications*; its members were: NICOLET (chairman), FRASER, LACLAVÈRE, MARTIN.

4.30 p.m., Friday, 9 September

A lecture on "Earth Satellites" given by Dr. H. E. NEWELL, is summarized in *The U.S. Rocket-Satellite Program for the International Geophysical Year*, p. 267.

Saturday, 10 September

On this day the Bureau met at 9 a.m., and the Committees of the Unions and the working groups continued other discussions.

8.45 a.m., Tuesday, 13 September

As described in the reports of the third Plenary Session of the CSAGI, the Bureau decided to appoint two committees, on Resolutions and on Organization of the CSAGI; to change the time-table for Tuesday afternoon and Wednesday: and also considered revised proposals concerning measurements of radioactivity, submitted by Dr. BLEEKER and Dr. WEXLER.

11.30 a.m., Tuesday, 13 September

At this meeting the procedure for the ACIGY meeting and the CSAGI final plenary session was considered. It was agreed that a committee consisting of CURRIE (chairman), BOULANGER, ELVEY, HARANG, LAURSEN, and HERLOFSON should be asked to consider whether the CSAGI should take any additional steps for the organization of the Arctic IGY program, such as the appointment of an adjoint secretary or a special conference. Consideration was given to the proposals mentioned by M. LACLAVÈRE at the plenary session that morning, regarding hydrology and meteoric dust. The former were referred to the glaciology working group, the latter to the Association of Hydrology, IUGG, for preparation of more definitive proposals.

A committee on IGY geography was appointed, consisting of the leaders of the geographical working groups (except that for the Antarctic), with Dr. HERLOFSON as chairman, to co-ordinate the reports of these several groups.

1.14 *Excursion*

Sunday, 11 September

On this day many members, with their ladies, enjoyed the excursion to Ghent and Bruges offered by the Ministry of the "Instruction Publique".

Some groups and group-leaders continued their work, and the Secretariat prepared many reports from the working groups, for distribution and consideration on Monday, 12 September.

2 Reports on CSAGI Disciplines

I World Days

1 *Avant projet de diffusion des observations au cours de l'AGI*

Le Comité des Ursigrammes de l'URSI a été chargé de mettre sur pied l'organisation des transmissions des informations géophysiques et solaires pendant l'AGI.

On peut faire à ce sujet les remarques suivantes:

(1) On doit distinguer les renseignements d'utilisation instantanée, les renseignements qui peuvent être différés quelques heures, et les renseignements qui peuvent être différés une semaine. Pour chacun de ces groupes de renseignements, il convient de prévoir des modes de transmissions différents.

(2) Les observations solaires et géophysiques doivent être transmises par les observatoires, en général à des centres coordinateurs qui se chargent de faire parvenir les renseignements aux intéressés. On peut cependant envisager que certains phénomènes importants soient immédiatement et directement transmis par les observatoires aux intéressés. Ceci ne peut-être que pour des phénomènes assez rares et n'intéressant qu'un petit nombre d'institutions.

2 *Données Solaires*

Renseignements d'utilisation immédiate.

Il semble que seules les éruptions importantes (>3) et les sursauts radioélectriques de grande amplitude, précédés d'un sursaut avant-coureur, soient d'intérêt immédiat.

Les observatoires qui les enregistreraient, devraient avertir immédiatement les organismes centralisateurs et directement les observatoires qui en feraient la demande préalablement, si toutefois il leur est possible de le faire dans un délai inférieur à une demi-heure.

Les organismes centralisateurs devraient avertir les observatoires intéressés qui auraient exprimé le désir d'une telle transmission spéciale et auraient convenu avec ces organismes des conditions de ces transmissions.

Il apparaît impossible que les transmissions intercontinentales de tels phénomènes puissent être organisées.

II Meteorology

1 *Observations*

1.1 The Working Group welcomed the WMO decision to establish in the Secretariat of the Organization a center for the collection, reproduction, and distribution of IGY meteorological data.

1.2 The Working Group studied the proposal of the Technical Division of the WMO Secretariat concerning the types of observation to be filed and the forms to be used for this purpose during the IGY. It considered that the following information would be needed:

(a) Observations from surface synoptic stations included in the list of intercontinental transmissions (i.e. 2000 to 2500 continental stations, to which should be added weather ships and selected ships);

(b) All upper air observations made at stations of the world network.
(c) All observations of total ozone content.
(d) All observations on components of the radiation balance.

1.3 The Working Group proposed the following changes in the forms prepared by the Technical Division of the WMO Secretariat:

(a) Surface observations:
   (i) Insert rainfall amount under the heading "Rainfall amount during 24 hr preceding the observation at . . . . h" (provide two columns: one for the time and the other for rainfall amount);
   (ii) Print the forms with the stations grouped five at a time.

(b) Upper air observations:
Stations making only wind observations (station W):
   (i) For the layer below 1000 m, leave complete freedom to follow national practices as regards the choice of levels;
   (ii) For levels above 100 m (above M.S.L.) include the levels closest to the standard levels adopted for "pressure, temperature, and humidity" soundings.

(c) Ozone observations:
   (i) Give total ozone content;
   (ii) For special observations, such as vertical distribution of ozone, the Working Group considers that the Ozone Commission of the IMA of IUGG should prepare a suitable form.

(d) Radiation observations:
   (i) Only stations which measure at least one of the components of the radiation balance will be considered as radiation stations.
   (ii) The Working Group considers that the form used should have the following layout:

Station: . . .					Station: . . .	Station: . . .
Date	Duration of sunshine	Total radiation sun+sky	Diffuse sky radiation	Direct solar radiation		
					Ditto	Ditto

Technical characteristics of instruments used at each station and indication of scales used.

1.4 The Working Group noted with satisfaction that the USSR had offered to organize a center for the collection of data and an international bibliographical center for IGY under the auspices of the Moscow Academy of Sciences.

1.5 The Working Group welcomed the WMO proposal to publish a list of all observations made during the IGY.

2 *Handbooks*

2.1 With regard to the preparation of handbooks for use by meteorological observers during the IGY, the Working Group approved the decisions taken in Rome concerning the handbooks for ozone and radiation observers.

2.2 The Group decided to inform the Working Group on Publications and Publicity that it would like the handbooks to be published in French, English, Russian, and Spanish.

2.3 The Working Group considered it unnecessary to prepare a handbook for surface synoptic observations.

2.4 In the case of meteorological upper air observations, the Group considered that the National Services themselves should prepare the handbooks required by their observers; these handbooks would naturally differ according to the type of instrument in use.

3 *World Days*

3.1 The Working Group favored maintenance of the Rome resolutions. However, in view of the importance and interest of certain meteorological phenomena which occur in the stratosphere close to the equinoxes, the Working Group recommended that Meteorological Services make a special effort during these periods of the year to prolong the period of observation. For example, if there are sufficient stocks of radiosondes, it is recommended that launchings be continued until the change in sign of the zonal circulation of the stratosphere.

3.2 In order to avoid disturbing the telecommunications network during the IGY, *the Working Group*

Recommends that the National Committees provide as soon as possible the lists of new observing stations which they intend to set up and state the minimum height which they wish upper air soundings to attain during the IGY, especially during the World Days.

4 *Changes in the program drawn up at Rome** (*CSAGI*, 1954)

The Working Group considered it necessary to make the following changes in the program prepared in Rome:

4.1 3.II. 2.1(b) to be worded as follows:

"The organization of surface and upper air observations, especially in the zones between parallels 45° and 50° N, parallels 35° and 40° S, parallels 20° and 30° N, and parallels 20° and 30° S."

This addition meets the wish expressed in the recommendation of the Consultative Committee on the Arid Zone (9th session, Socorro, New Mexico, May 1955) and Recommendation 5 of the Arid Lands Conference of the American Association for the Advancement of Science (April 1955).

4.2 3.III.3 to be worded as follows:

"That in order to determine the thermal influence of the earth's surface on certain meteorological phenomena, the temperature at various depths below the ground surface, as well as the temperatures of the snow surface and the water surface should be measured at as many points as possible; these measurements should be sufficiently frequent to be representative."

* See pp. 151–156.

4.3 Add the following note between paras. 3 and 4:
"Observing station means any station making synoptic observations at the earth's surface. Such stations include continental low-level and mountain stations, coastal stations, stations on islands, weather ships, and selected ships."

4.4 Delete the reference to St. Paul's Rock in paras. 7 and 8.

4.5 Add the following sentence to para. 10:
"Moreover it is greatly to be desired that weather observations be made on whaling ships during the whaling season 1957–1958."

4.6 Para. 16 to read as follows:
"That the Meteorological Service of each participating country should be urged to take appropriate action to comply with the requirements of para. 15."

4.7 Add the following text to para. 21:

"(a) Measurements to be carried out:

(i) Continuous recording (possibly using a totalizing method) of the total radiation of the sun and the sky over a horizontal surface;
(ii) Measurement of the effective long-wave radiation;
(iii) Measurement of the radiation balance of the earth and its various components, or else effective radiation of a black surface;
(iv) Regular measurement of direct solar radiation, both total radiation and that of selected spectral regions;
(v) Measurement of u.v. radiation from the sun and sky;
(vi) Recording of sunshine duration.

(b) Technical directives from the Radiation Commission of the IMA and the CIMO Working Group on Actinometry would be very useful for settling questions about instruments and scales.

(c) It should also be noted that in order to determine the components of the thermal balance at the earth's surface, it is imperative to measure the gradients of air temperature, air humidity and wind close to the surface, as well as the temperature and moisture content of the soil. In this connection evaporation is an essential factor."

4.8 Para. 25 should read as follows:

"(a) That in the course of expeditions the oxygen content of the air should be determined;

(b) That wherever possible the CO_2 content of the air and the chemical composition of precipitation (S, Cl, NO_3—N, NH_3—N, Na, K, Mg, Ca, etc.) should be measured, at least by means of monthly samplings."

4.9 With regard to para. 27, *the Working Group*,

Recognizing that there is a lack of co-ordination between the activities of countries in which atmospherics are observed,

Recommends that the Working Group on Atmospherics of the WMO Commission for Aerology study the creation of international centers for the collection and analysis of sferics data; that this Working Group consider what forms should be used for collecting such data during the IGY.

4.10 The Working Group adopted the recommendation of the Joint Commission on Atmospheric Electricity (IUGG) concerning the measurement of atmospheric electricity during the IGY.

Point 1 of this recommendation is covered by para. 27 of the Rome program.

The Working Group considered that point 2 should be worded as follows:

"It is recommended:

(a) That soundings of potential gradient and air conductivity be carried out by radiosonde or aircraft, at least during the "World Days", at the largest possible number of stations (several countries are already able to carry out these soundings);

(b) That these measurements be compared one with another;

(c) That surface measurements of potential gradient and conductivity at places not disturbed by accidental and local factors be compared one with another, as well as data from soundings of the electric field."

4.11 Para. 28 to be modified so as to read as follows:

"That action should be taken without delay to check all the meteorological instruments to be used during the IGY against national standards, and that WMO organize in good time, well in advance of the IGY, a world-wide comparison of the radiosondes in use."

4.12 Modify para. 29 to read as follows:

"That in order to simplify the analysis, processing and reproduction of the IGY observational data, the records and forms on which the surface and upper air data are to be entered should be strictly standardized."

4.13 Modify para. 30 to read as follows:

"That codes should never be used in publishing the meteorological data except for surface synoptic observations, and that the scales and units used should *always* be clearly specified."

4.14 With regard to para. 32, *the Working Group*,

Noting that most countries, particularly those which have a large number of weather stations, reproduce their observational data on punch cards and carry out tabulations on the basis of the latter, and

Recognizing the advantages of the 'microcard' system for the presentation of data in a form both compact and easy to handle,

Recommends that WMO study the most efficient and economical mechanographical means of transferring data from punch-cards to the forms recommended by CSAGI and to the microcards, and that the results of this study be transmitted to all countries participating in the IGY.

5 *World charts*

5.1 *The Working Group*, considering that surface and upper air (500 mb) hemisphere charts are at present published by the U.S.A. for the Northern Hemisphere,

Recommends that such publication continue during the IGY.

5.2 *The Working Group*, considering that hemisphere surface charts are at present prepared by South Africa,

Recommends that these charts be published during the IGY.

5.3 *The Working Group*, considering that charts for the equatorial zone are not yet available but are of considerable interest,

Recommends that CSAGI invite the German Federal Republic to publish such charts.

5.4 *The Working Group* recommends that the three countries which will be publishing world charts consult one another regarding scales, type of projection, and any other technical details which might lead to a uniform presentation of these charts.

6 *Miscellaneous*

6.1 *The Working Group* recommends that WMO contact the Governments of Member countries in order to obtain customs facilities to accelerate the return to their base laboratories of instruments launched during the preparatory period for the IGY and during the IGY.

6.2 *The Working Group* recommends that WMO take appropriate action with the authorities concerned in order to solve the question of the intensity of the meteorological broadcasts by Pretoria, Rio de Janeiro, Nandi, and Nairobi, and in order to arrange that Canberra and Rio de Janeiro retransmit by radio the meteorological data from Wellington and Melchior respectively.

6.3 *The Working Group*, recognizing the existence of large gaps in the upper air network of the Pacific and Atlantic Oceans off the coast of South America,

Recommends that the islands of Juan Fernandez, Easter, Trinidad (Brazil), and Saint Helena be provided with surface and upper air observing stations measuring pressure, temperature, humidity, and wind.

6.4 The IGY Committee of URSI has asked that the Working Group on Meteorology prepare a list of stations at which the index of refraction of the lower atmosphere will be measured during the IGY using radio techniques, or that such stations be indicated by a special sign in existing lists.

The Working Group considered that stations measuring the index of refraction are better known by radio specialists than by meteorologists, and that the former are therefore better able to prepare the required list.

6.5 In reply to a question raised in a letter from the Arid Zone Commission of UNESCO, the Working Group considered that there would not be sufficient time prior to the beginning of the IGY to set up a network of stations at which observations of hygroscopic nuclei could be carried out.

6.6 The Working Group on Meteorology of CSAGI did not consider it necessary to set up a Meteorological Bureau within CSAGI. In its opinion, future planning and co-ordination could be carried out successfully, as in the past, by the existing Working Group of CSAGI and the WMO Working Group.

6.7 The Working Group did not feel that it should support the Netherland's proposal that measurements of the radioactivity of the air and precipitation be carried out during the IGY.

6.8 The Working Group did not consider it necessary to create Secretarial posts within CSAGI except, perhaps, in the case of the Antarctic.

The use of harmless radioactive tracer materials for the study of circulation and mixing in the atmosphere and ocean†

(1) The Netherlands National IGY Committee in March 1955 submitted the following proposal to CSAGI:

"The Netherlands National Committee proposes that *measurements of the radioactivity of the air* be taken up in the program for Meteorology during the International Geophysical Year 1957–1958.

"It is probable that the amount of radioactive particles in the air increases by the thermonuclear reactions, which take place from time to time in various countries. As the pollution of the air by radioactive matter may, in the long run, become a serious menace to health, and might even influence meteorological phenomena, it seems highly desirable to know the basic value of the radioactivity. Measurements during the International Geophysical Year at many places may be of great value for the investigation and determination of normal and possibly abnormal values.

"Reference is made to Resolution 10 (EC-V) adopted at the fifth session of the Executive Committee of the WMO."

(2) The WMO resolution mentioned by the Netherlands Committee was as follows:

Influence of atomic explosions upon the weather. The Executive Committee, considering that

(a) there is a widespread tendency among the people in different parts of the world to associate apparently exceptional meteorological conditions with trial explosions of hydrogen bombs, and that

(b) the influence of such explosions on the weather is very little understood, charges the General Secretary of WMO to collect all available information bearing on the relation between atomic explosions and the weather, and to produce and in due course publish a WMO Technical Note on the subject: and invites the Members of WMO to assist the General Secretary to collect such information.

(3) The General Secretary of CSAGI invited the comments of other National Committees and of the WMO on the Netherlands proposal, with the following result.

(a) The following thirteen National Committees approved the proposal:

Argentine*	German Fed. Rep.	Norway
Australia	India*	Spain
Belgium*	Ireland	U.S.A.*
Canada*	Italy*	Yugoslavia
Finland		

The Committees indicated by * added the following comments:

Argentine: May not be able to collaborate in the plan.

Belgium: Will make such measurements, and hopes that other countries will contribute to a wide network of such measurements.

† By the Bureau of the CSAGI.

Canada: The Canadian program is already so extensive that it cannot be enlarged to include such measurements.

India: Such measurements are already being made, and will be continued during the IGY.

Ireland: Some members of the National Committee consider that the measurements should begin earlier (e.g. in 1956–1957), in view of the urgency of the matter and its importance to the whole of mankind.

Italy: Will undertake such observations according to the plan proposed by the Netherlands.

U.S.A: Will examine the possibility of collaboration; desires more information as to the precise nature and scope of the program, the number and location of measurement stations, and types and methods of measurement.

(b) The reply from the U.K. was adverse: "There would be little point in making measurements in any simple sense, as these would not provide information of much value. An important part of the radioactivity due to nuclear fission is at present in the high levels of the atmosphere, and to investigate it would require extensive specialized resources."

(c) The reply from the WMO was also adverse; because the proposal falls outside the scope of the meteorological program for IGY, which deals with the large-scale physical, dynamical and thermodynamic processes of the general circulation of the atmosphere; because the biological effects of radioactivity concern the International Health Organization, not the WMO; because there is at present no evidence of even slight modification of major atmospheric processes by radioactive atmospheric pollution; and because the success of the proposals would require measurements (and their publication) by all the nations participating in the IGY.

(d) South Africa asked for more information about methods and instruments before deciding to join in the program.

(4) The Netherlands proposal and the above replies were considered at the 1955 CSAGI meeting, when the working group on meteorology decided that it was unable to support the inclusion in the IGY program of measurements of the radioactivity of the air and of precipitations.

(5) At the ACIGY meeting on 12 September 1955, Dr. BLEEKER, on behalf of the Netherlands delegation, requested further consideration of their proposal. At the suggestion of the President, it was agreed to refer the matter to the Bureau.

(6) On behalf of the Bureau, the President invited the Netherlands delegation, in conjunction with others interested in their proposal, to present it in more detail. Consequently the Netherlands' delegates J. VELDKAMP and W. BLEEKER had a meeting with the U.S.A. delegates E. O. HULBURT, G. M. KAVANAGH, W. W. KELLOGG, R. REVELLE, E. B. ROBERTS, E. H. SMITH, H. WEXLER, and D. L. WORF; after considering suggestions by D. F. LEIPPER (U.S.A.) and K. R. RAMANATHAN (India), revised proposals were presented to the Bureau.

These made no mention of radioactivity due to bomb explosions; they dealt with the use of artificial radioactive tracer materials as research tools in meteorology and oceanography, and mentioned the following three problems that could be studied if an adequate supply of tritium or other suitable radioactive materials could be obtained and released in the atmosphere or ocean (tritium was singled out especially because of its known low toxicity in the concentrations likely to be measured, but it was suggested that the question of toxicity might be referred to the IUBS for further advice).

(a) *The change of air between Antarctica and the rest of the atmosphere.* During the U.S.A.'s 1939–41 Antarctic expedition, LOCKHART and COURT measured an oxygen deficiency over the Antarctic (at Little America), which was taken as evidence that Antarctic air masses do not mix rapidly with the rest of the atmosphere. This conclusion requires further study, and it is suggested that the release of adequate amounts of tritium instantaneously from some point over the Antarctic continent in the form of water vapor might contribute to the elucidation of this problem. To measure the spread of this "heavy water vapor" to lower latitudes, precipitation samples should be obtained from a number of stations in the southern hemisphere, and also in the northern hemisphere, to note the interchange of air between the two hemispheres.

(b) *Vertical transport of air in the neighborhood of the jet stream.* It is surmised that in the neighborhood of the jet stream there are large vertical components of air motion whose distribution relative to the axis of the jet stream is still largely unknown.

Since the polar front jet stream occurs close to one of the principal gaps in the tropopause, there is likely to be a rather important exchange of air between troposphere and stratosphere in this region as a result of the vertical motion. An artificial source of tritium placed near the axis of the jet stream in the form of heavy water vapor would make its presence felt ultimately in rainfall collected at the ground, and would thus throw some light on which latitudinal zones are favored by the downward spread of the tracer material.

(c) *Vertical diffusion and lateral transport of air in the stratosphere.* The atmosphere is known to be well mixed in the troposphere, and the fact that the composition of the atmosphere is uniform in the stratosphere and mesosphere indicates that a certain degree of vertical mixing must also occur up to at least 70 or 80 km. However, the rate of this vertical diffusion in the stable stratosphere is not known. The release of a sample of tritium in the form of heavy water vapor in the stratosphere, and the subsequent measurement of its lateral and vertical distribution, would throw light on the speed of the vertical and horizontal transport in this region.

It should be mentioned that in order to perform this experiment, specially equipped aircraft and balloons would be required for taking air samples at sufficiently high altitudes (up to 30 km).

(d) *Study of current motion and lateral diffusion in the ocean.* The ocean is analogous in many ways to the atmosphere, and the use of tracers to study its motions seems attractive. The motions and the vertical mixing rates vary greatly between the surface layer and deeper layers and in different parts of the ocean.

(It may be noted that ICSU at its seventh General Assembly at Oslo, in August 1955, took action to promote the study of the biological and other effects of nuclear radiations.)

(7) These proposals were considered by the Bureau of CSAGI, and at the plenary session on 13 September, the President reported the following conclusions:

(a) The proposed experiments using radioactive tracers offer in principle an avenue to increased knowledge of transport and mixing in the air and the oceans.

(b) The IGY would be a specially appropriate time at which to make such experiments, because of the exceptional volume of related data, and the large number of observers during the IGY.

(c) It seems uncertain, however, whether practical plans for such experiments can be prepared in time for their execution during the IGY.

(d) The Bureau therefore suggests that the proposers of the above experiments should develop their ideas further, in quantitative detail: and that thereafter, if they see fit, they invite the Netherlands National Committee to propose plans for such experiments to one or both of the International Associations for Meteorology and for Physical Oceanography.

(e) The Bureau declares its willingness to consider any such plans that may be presented to it, before or during the IGY, by one or both of these International Associations: and, if found appropriate, to bring the plans to the attention of all National IGY Committees that seem likely to be able to include them in their IGY programs.

III Geomagnetism

During three meetings on 9 and 10 September 1955 the Working Group on Geomagnetism studied the items of the following agenda:

(1) The CSAGI resolutions on geomagnetism, Rome 1954, reviewed in the light of the national reports presented to the Brussels meeting 1955.

(2) Operation manuals on geomagnetism which it would seem desirable to have included in the planned CSAGI series of such manuals.

(3) Means and methods for making the geomagnetic results of the IGY readily available to research workers.

(4) The observational program.

(5) The actual geographical distribution of magnetic stations in the IGY project.

1 *Rome resolutions*

The resolutions on geomagnetism which were passed by the CSAGI in Rome 1954 were reviewed in the light of the national reports presented to the present meeting, and the Working Group was happy to note that the response to the recommendations made in Rome had so far been remarkably good. Out of six additional magnetic stations recommended in Rome, five were now reported as planned, namely:

Dacca (East Pakistan), by Pakistan:
Tahiti, by France;
Kerguelen, by France;
Julianehaab, by Denmark;
McMurdo Sound, by New Zealand;

and it was stated at the meeting that a favorable report concerning the sixth, Addis Ababa, might be expected before long.

The plans for the establishment of a station at Kerguelen had become of particular importance in view of the fact that it had proved impossible for the Australian Government to comply with the Rome recommendation concerning a continuation of the station at Heard Island.

2 *Operating manuals*

This question was thoroughly discussed, and the Working Group finally made the recommendations given in Annex A.

The Working Group urged that all makers of magnetic instruments intended for use at IGY stations provide with the instruments detailed instructions as to the correct setting up and maintenance of the equipment.

The Working Group noted with great appreciation that upon request the U.S. Coast and Geodetic Survey would be willing to provide IGY magnetic stations with copies of the Magnetic Observatory Manual which had been prepared by H. E. McComb and published by the Survey.

3 *Availability of data*

The Working Group drew up a definite proposal concerning the collection, distribution and publication of geomagnetic data from the IGY. This proposal is given in Annex B.

4 *The observational program*

The program for the geomagnetic observations of the IGY had been outlined in the resolutions of the CSAGI meeting in Rome 1954, and no essential modifications of this program were deemed necessary.

The Working Group supported a suggestion made by the Association of Geomagnetism and Aeronomy, IUGG, that the Association Committee on Observatories be charged with the preparation of a list of all geomagnetic stations; such a list to contain detailed information as to the instrumental equipment and the availability of data at each station. The list should be available in time for the IGY.

The Working Group recommended that every effort be made to secure magnetic observations near the paths of the solar eclipses, two total and one annular, occurring during the IGY.

Although magnetic observations at sea do not appear as a special point in the IGY program, the Working Group drew attention to the fact that the great number of land stations to be in operation during the IGY will provide quite exceptional possibilities for a reliable reduction of sea observations made during the same period.

It seems desirable that in addition to the IAGA scheme of intercomparisons of magnetic standards for horizontal force by means of the QHM-instrument, a similar scheme be adopted for the intercomparison of standards of vertical force, and it is hoped that appropriate instrumental equipment for such intercomparisons will be designed in time for the IGY.

The Working Group discussed the difficulty that may arise in some countries with regard to the recruiting of qualified observers for the operation of the magnetic stations. The opinion was expressed that for the purpose of the IGY, during which the scientific research work performed at the individual stations may, to some extent, be subordinated to the procurement of data for the general research program, well-trained technical personnel may in many cases prove adequate.

5 *The geographical distribution of magnetic stations*

In studying the actual geographic distribution of IGY magnetic stations, the maps prepared for the Brussels meeting by the General Secretary of the CSAGI had proved very useful. It had been a privilege for the Working Group to complete these maps by plotting on them the magnetic stations mentioned in the USSR national report, and it was the general opinion of the Group that with this extremely important supplement to the net of stations already reported as operating or planned, the distribution of magnetic stations over the earth's surface might be considered fairly adequate.

Additional stations would, however, be desirable in south-eastern Asia, and it was sincerely hoped that the magnetic work at the Hongkong Observatory could be resumed in time for the IGY, as recommended by the CSAGI in Rome 1954. The Working Group further submitted to the CSAGI a resolution recommending the establishment of a magnetic station near the equator in longitude 100° to 110° E.

From the national report presented by Chile, the Working Group noted with the greatest interest the plans for the establishment of either two or three magnetic IGY stations on Chilean territory, and seeing that Easter Island was among the sites suggested, the Group recommended that first priority be given to this locality, in view of its unique situation in the Pacific.

The Working Group also noted the plans for the establishment by Egypt of a magnetic station in the equatorial region near the 30° E meridian. Such a station would complete in an excellent way the net of already existing or planned stations in Equatorial Africa, and in view of the fact that the recommended station at Addis Ababa would be situated approximately on the magnetic equator, it seemed desirable that the Egyptian station be placed 3 to 4 degrees to the north of this equator.

Annex A. Recommendations concerning manuals to be published. The Working Group on Geomagnetism thoroughly discussed the question of operation manuals which it would seem desirable to have included in the planned CSAGI series of such manuals, and recommended that the following manuals be considered for publication:

(1) An introductory note concerning general problems involved in the operation of standard recording equipment in different parts of the world.

(2) A manual on instrumental equipment for the recording of rapid magnetic variations.

(3) A manual on instrumental equipment for the recording of space gradients of the magnetic elements.

(4) A manual on instrumental equipment for quick-run recording of earth currents.

(5) A manual on the technical principles for the scaling of magnetic activity indices.

(6) A manual on the preparation of the film reproductions of magnetograms which are to be sent to the proposed IGY documentation centers.

Annex B. Recommendations concerning the availability of data. The Working Group on Geomagnetism discussed in detail how the IGY geomagnetic data should be made available to investigators, and finally made the following recommendations:

(1) The Permanent Service on geomagnetic activity indices, established by the IUGG and directed by the International Association of Geomagnetism and Aeronomy, should continue the collection and publication of these indices for the period of the IGY. During the IGY the lists of indices for each station should, if possible, be sent to the Bureau of the Permanent Service twice a month.

(2) All other data should be published nationally, and Services responsible for geomagnetic stations operated during the IGY should be requested to arrange for speedy publication of the results.

(3) As for the data to be published, reference was made to the recommendation adopted by the International Association of Terrestrial Magnetism and Electricity, IUGG, at its Rome Meeting, 1954. This recommendation, Resolution No. 22, is quoted here for reference:

"The International Association of Terrestrial Magnetism and Electricity recommends the publication by magnetic observatories, through the media of year books or other publications, of the following data, in order of importance:

"3.1 *Primary importance*:

"3.1.1 Hourly values of three elements, with notations regarding interpolated values. If mean values are scaled, they should be centered upon the half-hour.

"3.1.2 Monthly and yearly means, each as soon as possible.

"3.1.3 *K*-indices, also *C*-figures and descriptions of magnetic activity if previously reported.

"3.1.4 An account of the standard equipment, and of the past records available for the station, and information bearing on the reliability of the values; this information refers, for example, to absolute observations or consequent base-line determinations, scale-value determinations, the performance of the absolute and variation instruments, the orientation and interaction of magnets, the temperature coefficients, and the calibration of the instruments used for absolute observations.

"3.1.5 Reproductions of the magnetograms for all days, or, failing this, reproductions of selected magnetograms.

"3.1.6 Daily sums and daily means of hourly values, and sums and means by hours for each whole month, and the corresponding means for the selected five quiet and five disturbed days thereof.

"3.1.7 The time of sudden commencements of magnetic disturbance, and, as far as practicable, of crochets, pulsations, giant pulsations, and of similar changes and other remarkable phenomena, together with the magnitude and sense in each magnetic element.

"3.2 *Desirable additional data*:

"3.2.1 Composite daily variation or hour-by-hour departures of the general and selected-day means for each month, for Lloyd's three seasons (Nov.–Feb., May–August, and the remaining four months, denoted by *d* for December solstitial group, *j* for June solstitial group, and *e* for equinoctial group of months), and for each year, including also noncyclic changes as appropriate.

"3.2.2 Individual daily maxima and minima and ranges.

"3.2.3 Accounts of special equipment, and statements of intervals for which special records were obtained, such as rapid-run magnetograms, rate-of-change records, etc. . . ."

(4) There should be established four regional documentation centers for geomagnetism, and it is tentatively suggested that each of the following institutions be requested by CSAGI to be responsible for one of these centers:

4.1 The U.S. Coast and Geodetic Survey, Washington, D.C.
4.2 The Danish Meteorological Institute, Charlottenlund.
4.3 The Institute of Terrestrial Magnetism, Moscow.
4.4 The Bureau of Mineral Resources, Melbourne.

(5) Each magnetic station should send to at least one of these centers (if practicable to all of them):

5.1 A complete collection of microfilm copies of magnetograms obtained by means of:

(i) Magnetographs recording at ordinary speed.
(ii) Quick-run magnetographs of the La Cour type or a similar type, recording at a speed of about 180 or 360 mm per hour; all films to contain sufficient indications as to instrumental constants, temperature, and timing, so as to allow a complete evaluation of the curves.

5.2 Microfilm copies of tables of hourly values as soon as such tables have been prepared in their final, even if handwritten, form. In order to make the geomagnetic results of the IGY available to investigators with the shortest delay possible, such immediate copies are requested also of any other tables which will later be printed.

(6) Each of the centers which receive such documentation should arrange for copies to be sent immediately to the other centers, unless these have already received the same material, and all the centers will, upon request, make the material available to those who need it for their research work.

(7) The documentation centers mentioned above should collect also earth current data obtained during the IGY, and stations making earth current observations are requested to make their data available in a form similar to that just outlined for geomagnetic material.

(8) Stations which for the purpose of studying rapid variations of the geomagnetic field or earth currents are operating recording equipments with a very wide time-scale are not requested to provide complete copies of their records. Such stations should examine their own curves, and then send to a central office, namely the Committee on Rapid Variations and Earth Currents of the International Association of Geomagnetism and Aeronomy, IUGG, a list of such intervals which they

would suggest for general reproduction. The central office, having examined the suggestions received, would then make a proposal as to what intervals should be selected for general reproduction, and all the stations concerned would be requested to provide the documentation centers with copies of the records obtained during these selected intervals.

V Ionosphere

The URSI-AGI Committee, meeting under the chairmanship of Sir EDWARD APPLETON, set up two main Working Parties. The first considered the world distribution of IGY ionospheric stations and also discussed matters concerning other types of ionospheric observation, such as absorption, drifts, terrestrial noise, etc.

The Committee notes with satisfaction the world pattern of IGY ionospheric stations—there will be at least 150 vertical incidence sounding stations, including twenty to be operated by the USSR. At the meeting, maps and lists originally prepared by the Working Party at the Rome meeting of CSAGI have been revised and brought up to date in the light of the latest information contained in National Committees' reports. A comprehensive list of all ionospheric stations with full details of co-ordinates, operating characteristics, etc. is being compiled by the Secretary of URSI and the Secretary of the MCI, and will be made available to CSAGI at the earliest possible date. Absorption measurements will be made during the International Geophysical Year at some twenty-five to thirty stations, and drift measurements at fifteen to twenty stations. It would be desirable to have measurements of the latter kind at many more stations, and it is to be hoped that further stations will be established during the IGY. Various other ionospheric studies will be made at a smaller number of stations. The Committee notes that definitive information is still lacking concerning possible ionospheric stations in the People's Republic of China, and hopes that ICSU or CSAGI will be able to obtain information soon on the situation in this part of the world.

The second working party under Mr. SHAPLEY and Dr. RAWER considered procedure for the uniform scaling of records, the interchange of data and the publication of ionospheric characteristics during the IGY.

1 *Preparation of instruction manuals*

In accordance with decisions taken at earlier meetings, arrangements are being made for the production, within the next few months, of instruction manuals covering all the principal IGY ionospheric studies.

The first manual will deal with vertical incidence $h'f$ recordings. Subsidiary manuals will deal with more specialized studies such as ionospheric absorption, drifts, back scatter, terrestrial atmospheric noise measurements and the observations on "whistler"-type atmospherics. Authors have been proposed and the CSAGI ionospheric Reporter has been invited to act as General Editor. M. LEPECHINSKY has been invited to deal with the preparation of a French translation, and Dr. PUSHKOV has undertaken to arrange that a Russian translation will be made in the Soviet Union.

It is understood that the cost of publication of these manuals in English and French will be borne by CSAGI.

2 *Publication of IGY data*

In considering the question of publication of IGY observations, the URSI-AGI Committee has naturally been impressed with the magnitude of the task and the volume of the material. Nevertheless, having regard to the fact that the principal objective in the work of the IGY is to gain physical insight into natural phenomena, the actual observations being only a means to that end, it urges on CSAGI, the adoption of a most liberal publication policy, in spite of the considerable cost, in order that this corpus of unique material may be readily available to scholars everywhere.

3 *Future of URSI-AGI Committee*

It is proposed to maintain the URSI-AGI Committee in being during the foreseeable future to co-ordinate all IGY activities in the radio field.

4 *URSI representation on CSAGI*

Having regard (i) to the vital importance of radio communication during the IGY, (ii) to the need for rapid distribution of geophysical data, (iii) to the wide ambit of radio geophysical studies, the URSI-AGI Committee strongly feels that URSI should have two additional representatives on CSAGI. Accordingly the Committee recommends that, subject to the agreement of the ICSU Bureau, Father P. LEJAY and Mr. A. H. SHAPLEY be immediately added to the CSAGI membership.

VI Solar Activity

(1) The resolutions* relating to various aspects of solar activity adopted by the CSAGI at its second meeting have been considered at a joint meeting of the solar commissions during the general Assembly of the IAU in Dublin, 29 August–5 September 1955.

(2) Action has been taken on several of these resolutions, as follows:

2.1 *Rome Resolution* 4

Plans have been prepared for securing a continuous photographic patrol of the solar chromosphere during the International Geophysical Year. The observing hours recommended to different observatories have been selected with a view to observations being obtained at the times of day when the seeing is normally the best.

2.2 *Rome Resolution* 5

This was accepted with the modification that the interval between consecutive photographs should not exceed 3 min. Observatories remain free to take photographs at shorter intervals if desired.

2.3 *Rome Resolution* 7

An improved system of flare classification has been prepared by Commission Eleven. Details are given in the report of this Commission approved at the Dublin meeting.

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* See pp. 166–168.

2.4 *Rome Resolution* 8

The formulation of the procedure for the standardization of the photometric data obtained with the Lyot filters will be undertaken by a working group consisting of Dr. Roberts (Chairman), Miss Dodson, and MM. Coutrez, d'Azambuja, and Kiepenheuer.

2.5 *Rome Resolution* 9

The question whether the intensity of chromospheric flares should be related to the adjacent continuous spectrum or to the continuous spectrum at the center of the disk was discussed. It was agreed that the intensity should be related to the adjacent continuous spectrum.

2.6 *Rome Resolution* 15

The procedure for the standardization of the observations with the Lyot white-light polarizing photometer will be developed at the Meudon Observatory.

2.7 *Rome Resolution* 16

The development of the coronal photometer is in hand and will be completed by the end of 1955. Standardization of measurements of coronal intensity made during the International Geophysical Year will thereby be ensured.

The other resolutions, in so far as they concerned the International Astronomical Union, were approved.

(3) The Working Group has learnt with satisfaction, with reference to the Rome Resolution 17, that France will establish a solar noise station on Tahiti, and notes the statement in the United States program that an effort will be made to establish a 200 Mc/s patrol station in Hawaii.

(4) With reference to the Rome Resolution 13, the Working Group has learnt with interest that observations of solar magnetic fields by the Babcock method, will be made in the USSR at the Central Astronomical Observatory, Rilxovo; at the Kislovodsk Mountain Station; at the Research Institute of Terrestrial Magnetism, Moscow, and at the Crimean Astrophysical Observatory. In addition, measurements of magnetic fields of sunspots, using the Zeeman effect, will be made at the second and fourth of these stations.

(5) The Working Group recommends that indices of solar activity should be based on the total area of the calcium plages, and be given at 6-hr intervals on the scale $0, \frac{1}{2}$, 1, 2, 3, 4. Co-operating observatories are requested to make measurements of plage areas twice daily, at an interval of approximately 6 hr, and to send the data to Arcetri, for the preparation of the 6-hourly indices.

(6) *Reporting of information on solar activity*

The following procedure is recommended:

6.1 The occurrence of large flares (3+) and large radio outbursts should be communicated to reporting centers immediately, by telephone or telegram.

6.2 Daily reports of solar activity should be sent to World Day Centers, to provide them with the data required for fixing Special World Intervals.

6.3 Material for the weekly reports on solar activity, to be prepared regionally for current use, should be sent by mail.

(7) *Weekly reports on solar activity* (*vide* Rome Resolution 2 of the Second meeting of the CSAGI)

It is recommended that weekly reports of solar activity should be prepared on a regional basis, to provide rapid dissemination of information of importance for various geophysical observations. Such weekly reports should contain a solar map for each day, showing approximate positions of spots, flares, dark filaments, prominences, and coronal isophotes, together with explanatory notes.

These reports would be of ephemeral value, so that great accuracy in the details shown on the charts is not necessary. It is important that they should be prepared and distributed with the minimum of delay. It is suggested that the reports for the U.S.A. should be prepared at the High Altitude Observatory, Boulder; for western Europe at the Meudon or Uccle Observatory; and for Japan, Australia, and New Zealand at the Tokyo Observatory.

(8) *Publications*

The publications which summarize solar data of various kinds, such as the

Zürich Quarterly Bulletin of Solar Activity,
Meudon Synoptic Charts,
Greenwich Photoheliographic Results,

will continue to provide similar data for the IGY. It is urged that the data for the period of the IGY should be published with the minimum of delay, and should be given priority over any unpublished data for earlier periods.

(9) *Final publication*

The CSAGI has requested the solar activity group to study the possibility and forms of publication of a volume to contain the results of the Solar Activity observations between 1 July 1957 and 31 December 1958, this volume to be published as soon as possible after 1 January 1959.

The Working Group has discussed the contents of such a publication and considers that it should include the following data:

9.1 Daily sunspot areas (uncorrected and corrected for foreshortening). Wolf daily sunspot figures.

9.2 Approximate positions of all spot groups with areas exceeding 500 millionths of the Sun's visible hemisphere.

9.3 Six-hourly indices of solar activity.

9.4 Daily charts of the Sun's surface, showing sunspots and their polarities, dark filaments, calcium plages, positions of flares, prominences. The Zürich type of each spot group should be indicated on these charts.

9.5 Coronal isophotes for each day for the green line 5303 Å, and for the red line, 6374 Å.

9.6 Babcock pictures for each day of the general and localized magnetic fields.

9.7 Details of observations of flares and of bright and dark surges.

9.8 Prominence and filament data, including information about rapid changes of prominences and filaments.

9.9 Special observations of interest, such as observations of the yellow coronal line.

9.10 Averaged values of the intensity of solar radio noise for the 3-hourly periods, 0 hr–3 hr; 3 hr–6 hr; 6 hr–9 hr; . . . UT, for each frequency of observation, the unit of intensity being 10^{-24} watts per square meter of receiving area per cycle-per-second band width.

9.11 An index of variability for each frequency, expressed (as for flares) by designation 0, 1, 2 or 3. These designations will have a different meaning for each frequency. The index of variability is to be formulated by Commission 5 of URSI.

9.12 Positions of radio-emitting areas on the disk.

9.13 Details of solar noise bursts, including information about the dynamic spectra and polarization of bursts.

It is recommended that various centers should undertake the responsibility for the collection and co-ordination of data to be included in this publication:

(United States)	Sunspot data, including investigation (if possible) of changes during the day.
Ebro or Arcetri	Solar plage activity indices.
Mount Wilson	Solar magnetic fields; sunspot fields and polarities.
Zürich	Wolf sunspot numbers.
Meudon	Flare data and filament data.
Crimea	Flare and plage indices, based on photometric measurement of total intensity.
Boulder	Coronal isophotes and data.
CSIRO–Sydney	Radio noise.
Meudon or Fraunhofer Institute	Daily charts.

The Working Group is of the opinion that an Editor of this publication will be needed, who will be responsible for collecting the data, preparing copy for press, and settling all editorial details.

VII Cosmic Rays

1 *Introduction*

Studies of the cosmic radiations have not, until recently, made significant contributions to the development of geophysics and solar physics. At present, however, cosmic-ray research offers the promise of being able to investigate phenomena inaccessible to any other experimental discipline in solar physics or geophysics. It may well be that the coming International Geophysical Year will provide an impetus for cosmic-ray research in this field which will parallel the dramatic development of ionospheric research following the last Polar Year.

The International Geophysical Year is important for the development of this field of cosmic-ray research for two reasons. First, it will lead to the world-wide distribution of standardized detecting apparatus. Second, but more important, there will be available to the research scientist an unprecedented array of solar and geophysical data, enabling him to develop sound physical concepts of the electromagnetic system of the sun, earth, and interplanetary space.

The principal tasks of the cosmic-ray group of the CSAGI are to ensure that the capabilities of cosmic-ray research in these fields are fully realized by adequate planning for the International Geophysical Year, and that encouragement is given for all nations to join in this world-wide endeavor. The CSAGI has considered:

(1) The draft resolutions adopted by CSAGI (Brussels, July 1953),
(2) The national reports presented to the second CSAGI meeting,
(3) The reports by the Cosmic-Ray Working Group of the International Association of Geomagnetism and Aeronomy and IUGG-IGY Committee,
(4) The report of the Cosmic-Ray Group of the CSAGI meeting at Guanajuato, Mexico, 14 September 1955,

and has prepared the following report in which the principal problems, common to all National Committees, are considered, along with additional recommendations for the program of the International Geophysical Year.

2 *Standard instruments for recording cosmic-ray intensity*

Although instruments of non-standard design are important for specific studies of changes in cosmic-ray intensity, it is the opinion of the CSAGI Committee on Cosmic Rays that some instrument designs which can readily be duplicated throughout the world should be part of the committee's minimal recommendations for establishing a world-wide distribution of measuring stations. In particular the committee recommends a standard counter telescope design to detect the cosmic-ray intensity at relatively high energies, and recommends a standard neutron monitor pile for observations of the low energy portion of the cosmic-ray spectrum.

The CSAGI has accepted the detailed plans and operating procedures for these two types of apparatus from the IUPAP Sub-Commission on Cosmic-Ray Intensity Variations (SCRIV). The SCRIV will assume responsibility for technical problems which arise from time to time relating to the instrument design and the program of the International Geophysical Year.

The general specifications proposed by the SCRIV are as follows:

Counter telescopes

A. Design and operation:
(1) Cubical design.
(2) Three trays.
(3) 10 cm Pb or equivalent absorber between the extreme trays.
(4) Minimum normal count rate $\doteq$ 50,000 counts per hour.
(5) Resolution of coincidence circuit will be 3–5 μsec.
(6) Recording of data to be for 15-min intervals and reported bi-hourly.
(7) Diurnal range of temperature for apparatus should not exceed 10° C.
(8) Where a roof is not being used as absorber, the roof mass should be less than 10 g/cm^2.
(9) A precision micro-barometer or micro-barograph will be used for pressure corrections.
(10) Radiosonde measurements will be used to provide atmospheric temperature corrections. These measurements should be taken near the location of the counter telescope.
(11) Two identical cubical telescopes will be operated simultaneously.

(12) A permanent electric power line should be used with adequate voltage stabilization.

(13) Details on the construction and operation of these counter telescope systems are available from SCRIV (see *Annals of the IGY* **4**, pp. 374–393).

B. Corrections:

Temperature and pressure corrections should be carried out, whenever possible, with correction coefficients derived from the apparatus used. Only where equipment is used at a site for too short a time to derive accurately the coefficients, should coefficients derived elsewhere be used. Uncorrected data, as well as data relating to meteorological factors, should be published. The SCRIV has prepared recommended forms (see Section 5) and has recommended the way in which cosmic-ray and meteorological data should be prepared for distribution.

Neutron pile monitors

A. Design and operation:

(1) The pile geometry of the University of Chicago pile design is to be used with lead and paraffin.

(2) Proportional counters will be used as detectors. Boron-10 is available for this purpose.

(3) One-half of the counters will be connected to an electronic pulse recording system, and the other half of the pile counters will be connected to a separate but identical electronic recording system.

(4) A precision micro-barometer or micro-barograph will be used for pressure corrections. Instruments reading to $\pm 0{\cdot}1$ mm Hg, or better, are required.

(5) Data are to be recorded for 15-min intervals and reported bi-hourly.

(6) The number of counters to be used in the pile should be determined by the requirements that the complete system will produce 200 counts/min, or more when placed at a magnetic latitude greater than 50° at sea level.

(7) The diurnal temperature range of the pile and circuits should be less than $\pm 10°$ C. The temperature should be less than 28° C at all times.

(8) Adequate voltage regulation should be provided.

(9) Provision for keeping snow off the roof of the laboratory should be made.

(10) Roof mass should be less than 20 g/cm^2 whenever possible.

(11) Details for the design, construction, maintenance, and operation of neutron piles are available from SCRIV (see *Annals of the IGY* **4**, pp. 351–373).

B. Corrections:

Correct all data to a mean atmospheric pressure for the station.

3 *Locations for stations observing cosmic-ray intensity*

(1) There are at least four convenient bands of longitudes on the earth where this may be accomplished:

(a) North and South America, and Antarctica.

(b) Europe, Africa, and Antarctica.

(c) USSR, India, Kerguelen Island (France), and Antarctica.

(d) USSR, Chinese People's Republic, Japan, New Guinea, Australia, New Zealand, and Antarctica.

In order to secure adequate world-wide coverage of observations required for the successful completion of the International Geophysical Year program, CSAGI recommends that additional stations be established in the following places: Colomb-Bèchar, Algeria; Lwiro, Belgian Congo; Bouvet Island; Rangoon, Burma; Azores (Portugal); Jerusalem, Israel; and Abidjan, Ivory Coast; Norway, Sweden, USSR, and the Chinese People's Republic.

The total number of stations now operating is forty-six; the total number of additional stations proposed by National Committees is fifty-four, and eight additional stations are recommended by CSAGI.

In addition the establishment of a high-altitude station at an elevation of 2150 m or higher is strongly recommended on South Island, New Zealand, at a geomagnetic latitude greater than 52°. However, it is not now possible for the New Zealand National Committee to consider the establishment of such a station. It is hoped that high-altitude stations can be mainly financed by the nations in whose domains they lie, and that they will be well provided with instruments, supplies, and equipment. The stations should be prepared to enter into the international high-altitude observing program in the various interested sciences, in addition to participating in cosmic-ray research. Maintenance and the provision of technical personnel should be considered and provided in so far as possible. It would be highly desirable to have the national governments build and maintain high-altitude laboratories as a service for scientists.

The CSAGI considers that the establishment of additional stations will result in providing more and better data and is, therefore, to be encouraged. CSAGI welcomes the establishment of the proposed stations in the USSR.

4 *Special experiments of interest for the International Geophysical Year*

In addition to the program of continuous intensity observations, the CSAGI urges that experiments be undertaken by the participating nations which will greatly strengthen the CSAGI program in cosmic rays. The measurements are divided into three categories as follows:

(1) The nature of the primary spectrum and the secondary cosmic-ray components.

(a) The determination of the composition and energy spectrum of the cosmic radiation as a function of time, both before and during the International Geophysical Year.

(b) The determination of the momentum spectrum of the cosmic radiation. This will require high-altitude observations with balloons, rockets, and unmanned satellites, with measurements extending from the geomagnetic poles to the geomagnetic equator.

(c) To determine the response of intensity monitors, the latitude effect of the secondary components, especially neutron intensity, should be measured for each of the longitude bands of stations described in Section 3. This requires the use of aircraft capable of flying at high altitudes at constant atmospheric pressure. The U.S.A. plans to continue measurements of this type in the U.S.A., and it is strongly recommended that similar measurements be made over Europe, particularly along a longitude line extending through the U.K., and longitude lines running through

Italy, Germany, and the Scandinavian countries. It is also recommended that these measurements be made over India and Australia to cover these bands of stations.

(d) It is expected that unmanned satellites capable of carrying cosmic-ray instruments will be available during the International Geophysical Year. The CSAGI wishes to encourage measurements using these satellites which will reveal the nature of the primary particle spectrum. The analysis can most readily be made if the satellite follows a pole-to-pole orbit. The CSAGI wishes to encourage the launching of satellites by several nations during the International Geophysical Year for the purpose of studying the primary cosmic radiations.

(2) Measurements to determine the appropriate geomagnetic co-ordinates to be used for measuring cosmic-ray particle rigidities, and measurements to investigate the motion of charged particles in the earth's field.

(a) Since the geomagnetic co-ordinates for defining the magnetic rigidity of incoming particles are not precisely known, it is important to determine the position of the equator for cosmic-ray particles, as well as to determine appropriate geomagnetic co-ordinates at high latitudes. The CSAGI recommends that neutron intensity detectors be used to establish the position of the cosmic-ray equator, and that measurements of alpha particle energies in photographic emulsions be used to determine the correct geomagnetic cutoffs at intermediate and high latitudes. At the present time this is particularly important throughout Europe, especially in the U.K., France, Italy, Germany, Netherlands, Norway, Sweden, and in Eastern Europe and in Asia, India, the USSR, and Australia and Japan. It is hoped that most of these countries will be able to undertake these measurements.

(b) Calculations and model studies of the charged particle orbits between the sun and the earth will be particularly important for understanding the flare effects detected by the world-wide network of stations during the International Geophysical Year. It would be valuable if the Stockholm group, which has been conducting such model experiments, could continue their work, especially using the real, non-dipole model for the earth such as suggested by Vestine. Orbit calculations could be undertaken by interested groups in Germany, the United States, and other nations.

(3) Continuous observations of intensity changes with time.

(a) In order to investigate possible solar-related intensity variations at moderately high primary energies, CSAGI recommends that measurements be made underground using counter telescopes. The observations should be made at depths not less than 30 m and, wherever possible, at a depth of about 60 m, with a suitably designed telescope giving not less than 10,000 counts/hr, using at least three identical counter trays in a rectangular telescope geometry (details of standards for the underground measurements are available from SCRIV). It is hoped that at least the observing stations at Moscow and Iakutska (USSR), Mina Aguilar (Argentina), Hobart (Tasmania), and Haifa (Israel) will be continued throughout the International Geophysical Year.

(b) The CSAGI recommends that special observations be conducted at stations in the geomagnetic latitude range $\pm 50°$ with meson telescopes having the following characteristics: triple coincidence telescopes with semi-angles of 10° in the East–West and North–South planes, using 10 cm lead absorber. It is the purpose of these observations to investigate the anisotropy of primary cosmic radiations. (Further details of a standard design for narrow-angle telescopes may be obtained from SCRIV.)

5 *Distribution and publication of cosmic-ray intensity data*

At the request of CSAGI, the Sub-Commission of IUPAP (SCRIV) has prepared sample forms for the distribution of neutron, meson, and ionization chamber intensity data for distribution to interested investigators. The SCRIV recommends that during the International Geophysical Year those stations participating in the International Geophysical Year program prepare and distribute data approximately one month, and not later than three months, after the recording of the data. Each participating investigator will send by air mail copies of data from his laboratory to those participating investigators who have requested such information. CSAGI and SCRIV will co-operate in issuing a complete list of all participants and their mailing addresses, and the list will be given to each participating scientist.

The CSAGI further recommends the publication of cosmic-ray data obtained during the International Geophysical Year, and recommends that all data obtained during the International Geophysical Year be in publishable form not later than one year after the conclusion of the International Geophysical Year.

Standard Form for Presentation of Neutron Intensity Monitor Data

Name of Institution reporting..

Name of Station..

Month, day, and year.............................. Mean Station Pressure..................

Scaling Factor .... Barometer Coefficient ....

(Prepare one sheet for each month of C.R. Data, giving the sum of the A and B sections of neutron counting rate, plus one sheet of Pressure Data.*)

* Pressure readings are the *mean* bi-hourly values. (Rapid pressure changes within any bi-hourly period carefully averaged, using 15-min intervals. Indicate such averaging with a symbol on Pressure Data sheet.)

Days	Hours bi-hourly	GMT values	→	

Standard form for presentation of Ion Chamber Data. In the case of Ionization Chamber Data, the form employed by Dr. S. E. FORBUSH is to be used. This form appears in Publication 175, Carnegie Institution of Washington, '*Cosmic-Ray Results from Huancayo Observatory, Peru, June* 1936–*December* 1946', 1948.

Standard form for presentation of data obtained with cubical telescopes

A. Cosmic-ray data:

(1) GMT should be used.
(2) Bi-hourly values should be given, starting from 00 hr.
(3) The data to be given are the uncorrected values.
(4) Only the sum of both telescopes is required.
(5) In addition to bi-hourly values, the daily sum should also be given, from 00 hr to 00 hr.
(6) The actual numbers to be given are the scaled readings, the scaling factor being given.
(7) In order to reduce the number of digits, a constant number may be subtracted from the tabulated numbers.
This subtracted number must be clearly indicated, and, in any case, the first column on each sheet should also contain the full values.
(8) Monthly sheets are recommended (one for C.R. Data, one for Station Pressures, one for Radiosonde Data), with the hours tabulated horizontally and the days vertically.
.................................hours GMT.
Days

B. Equipment failures and missing data:

(1) If only one recorder fails, the true sum of both recorders should be estimated from the recorder in operation, using an experimentally determined conversion factor, and be listed in the tables. The values so obtained should be marked with an asterisk, with a footnote explanation.
(2) Except for the case under (1), the rule is that whenever data are missing or are unreliable, the corresponding position should be left blank (see, however, (4) below). No interpolation should be attempted even if the total number of counts for the period in question is known.
(3) Daily sums may be known even if some individual bi-hourly values are unknown, and the daily sum should therefore be given whenever it is known. If the break in bi-hourly values extends from one day to another, the total number of counts in this period should be given in a footnote if it is known.
(4) Missing data may be due to:
(a) Counter failure, in which case the symbol c.f. should be inserted in the appropriate blank spaces.
(b) Recording failure (electronics, power, etc.), in which case the symbol r.f. should be used.

C. Unusual events:

Such events should be pointed out in footnotes, and more detailed information should be given in an appendix.

D. Meteorological data:

(1) Bi-hourly values or bi-hourly averages of barometric pressure should be given and prescribed in the same form as the cosmic-ray data. Times of barometric readings must be given. Any convenient unit may be used. The accuracy should be 0·5 mb or better (readings to be given to the nearest mb or better). (Any unusual changes in pressure or other events which may effect the quality of barometric corrections, such as passages of fronts, etc., should be pointed out in footnotes, using appropriately defined symbols.)

(2) The height of the nearest standard pressure level which is always above the station, and the heights of the 700 mb, 500 mb, 300 mb, 200 mb, 100 mb, and 50 mb levels should be given for each individual flight, together with the time of the flight. (The levels from 200 mb upwards are probably the most important ones.)

E. Additional information:

(1) The position of the station in geographic co-ordinates.

(2) The altitude of the station.

(3) The most appropriate *total barometer coefficient* and, if possible, also the best values of the partial barometer coefficient and the decay coefficient.

(4) Location of the radiosonde station relative to the meson intensity recorder.

X Oceanography

After an informal meeting beginning at 9.30 a.m. the first session was opened at 11 a.m. Dr. E. H. SMITH was elected Chairman and Dr. G. E. R. DEACON, Secretary. The agenda, circulated by M. G. R. LACLAVÈRE, CSAGI Reporter for Oceanography, with his report, was adopted. The Working Group thanked M. LACLAVÈRE for his report, and noted his further information that Messrs. Butterworth were prepared to produce the IGY Oceanographic Manual if invited to do so, and that ICSU was disposed to give favorable consideration to oceanographic programs that were not incorporated in the IGY, or that arose from it.

1 *The Oceanographic Program as agreed up to September* 1955

(a) *Long-wave recording*

(i) It was agreed that the main object of the work is to improve our understanding of the 5- to 60-minute non-tidal oscillations of sea level which affect harbours and shipping and occasionally cause coastal floods and other damage.

(ii) It was decided that observations on oceanic islands are likely to be most productive. Along the continental shelves a number of factors, not yet understood, make the interpretation of the records more difficult; it was agreed, however, that the results obtained would justify the work. It was agreed that an attempt should be made to measure long waves of 1000 sec period to an accuracy of 1 mm.

(iii) In view of probable associations between air and water oscillations it was decided that supplementary recording with a microbarograph with similar pressure response was desirable. It was not considered necessary to ask for quick-run magnetograph records at all stations, though it was felt they might be useful where they were obtainable.

(iv) Several probable national contributions were reported and the Working Group urged all the contributors to do their best to have as many studies as possible in operation for the period 1 July 1957 to 31 December 1958.

(b) *Sea-level recording*

(i) It was agreed that the main objects were to further our understanding of non-tidal changes of sea-level of longer duration than the semi-diurnal and diurnal tides, and of oceanic tides.

(ii) It was emphasized that the study of this subject has been difficult because a sufficiently wide network of tide gauges was not continuously operated so that there were gaps in the information available. The accuracy required was that laid down in the principal manuals on tides.

(iii) It was noted that there were a number of portable or semi-portable tide gauges which gave this accuracy.

(iv) In view of the finding that most of the long-period changes in sea-level can be explained by the changes in density of the water column, it was decided that everything possible should be done to obtain sufficient vertical series of temperature and salinity measurements near each tide gauge to show the seasonal changes in density of the water column, down to 1000 m if necessary. It was considered that the measurements would be needed at least once a month, that salinity measurements were more likely to be important in high latitudes than in the tropics, and that observations within 100 miles of the gauge would sometimes be adequate.

It was emphasized that the usual meteorological observations and records were also required fairly close to the gauge.

(v) Several probable national contributions were reported, and the Working Group urged all the contributors to install, and maintain the accuracy of as many of the gauges as possible from 1 July 1957 to 31 December 1958.

(c) *Deep water circulation*

(i) In the Atlantic Ocean the main objects of the work are to discover what changes have taken place in the layering, and the physical and chemical properties of the water during the 25–30 years which have elapsed since detailed surveys were made by the *Meteor* and other vessels, and to use all possible means available to obtain more information about the rate of movement and transport of the subsurface and deep water masses. In the Pacific Ocean the object is to make the same kind of detailed survey to obtain a realistic picture of the deep water circulation of the ocean, paying particular attention to the observations which it is desirable to repeat in a subsequent geophysical year.

(ii) Observations of temperature, salinity and dissolved oxygen, are regarded as essential; it was emphasized that they should be continued to the bottom and that the vertical spacing of the observations in the deep and bottom layers should be as close as possible.

It was also considered essential to make some measurements of velocities in subsurface and deep water layers and to use radioactive tracer and other methods to estimate water transport. It was recognized that ships taking part in these programs would also make the biological, geological and chemical observations in which their parent laboratories are interested. The Working Group asked for wave measurements, geomorphological and geological studies.

(iii) In the Atlantic Ocean it was agreed that Canada, the U.S.A. and Argentina should co-operate in repeating the section down the West Atlantic basin which WÜST used as one of his main longitudinal sections 25 years ago. (Although no Canadian representative was present, there are assurances of Canada's highly desirable co-operation.) The U.K. would repeat the corresponding section down the East Atlantic basin as far as the Equator. This would be continued as far as 35°S by the U.S.A. and it was agreed that South Africa should be urged to continue it farther south.

It was recognized that the program made insufficient allowance for detailed work in the equatorial region, the importance of which was stressed by the International Association of Physical Oceanography; the possibility that Norway could send a vessel there was welcomed. It was also noted that the proposed USSR voyages down the eastern side of the Atlantic Ocean represented a substantial addition to to the Atlantic program.

In the Pacific Ocean, the U.S.A. with the co-operation of Canada, Peru and Chile would work two longitudinal sections in the eastern part of the ocean, east and west of Easter Island, and with the help of Japan and the USSR another complete line of observations would be obtained in the western part of the ocean.

The Working Group noted with regret the insufficiency of the program in the Indian Ocean and wished to do everything possible to support the Pakistan proposal to survey the ocean north of 20°N. The Group placed particular emphasis on the need for observations designed to show how quickly the density distribution in the subsurface and deep layers adjusted itself after the change caused by the monsoon.

(d) *Polar front survey*

It was agreed that the North Atlantic Polar Front Survey could best be organized by the International Council for the Exploration of the Sea with the help of the International Council for the North West Atlantic Fisheries, and it was decided that these organizations should be asked to undertake the detailed arrangements. It was considered that emphasis should be placed on the need for observations of temperature, salinity and dissolved oxygen in the deep and bottom layers and for detailed knowledge of the bottom topography. It was felt that the attention of the International Council for the Exploration of the Sea should be called to the intensive USSR contribution proposed for the Norwegian and Greenland seas and the North Atlantic Ocean.

It was considered that the Polar Front survey in the North Pacific Ocean would have to be arranged by a small group appointed by the National Committees of the U.S.A., Canada, USSR and Japan.

(e) *Multiple ship current measurements*

It was agreed that the main purpose of this work is to use and to test the reliability of new methods of measuring water velocities and water transport in the subsurface and deep layers of the ocean. It was decided that the work should be done where the resulting information would be most useful.

It was decided that the work in the Atlantic Ocean should be done in the area which was studied in great detail by the International Gulf Stream Investigation of 1938, and that at least the *Atlantis* and *Discovery II* would take part. It was suggested that if the project looked very promising by 1957–1958 it might be advisable to ask Norway to supply a third ship for this project instead of doing the work in the equatorial region.

It was considered that the work in the Pacific Ocean would be most useful in the equatorial region and it is expected that three ships will collaborate in the east, and at least three in the west.

At the second session on Friday 9 September, the Chairman appointed the following sub-committee to consider the long-wave and tide-gauge measurements in greater detail: Messrs. CAPURRO, DEACON, EYRIES, KORT, MATTASSI, MENENDEZ, MUNK, and REVELLE.

Oceanographic Working Party

It was agreed that the meetings were doing much to strengthen the program and to further its execution, and it was considered very desirable that the Working Group should meet again about six months before the start of the IGY.

The need for smaller Working Groups to make arrangements in particular regions or to supervise particular items in the program, was discussed. The general opinion was that the work could best be done by informal correspondence between national representatives.

Oceanographic Handbook

After considerable discussion it was agreed that there was little hope or need to achieve complete standardization of methods and techniques. Some laboratories would find one method better suited to their facilities and personnel, while others could work more efficiently using an alternative. It was strongly argued that the draft handbook prepared by the U.S.A. Oceanographic panel afforded a useful guide to any laboratory requiring help, and that the task of attempting to reach any general agreement on a text to cover all possible alternatives was likely to be unproductive.

Nevertheless it was finally decided to invite all the national delegations to examine the draft and to send any alternatives which they considered really important to the secretary of the Working Group before 31 December 1955. These suggestions would be considered by a small committee consisting of representatives of the USSR, U.S.A. and U.K. meeting in London in January, 1956. The small committee is free to seek the advice of other experts on the subject.

In the meantime the question of publication would be discussed with Messrs. Butterworth.

Publication of Results

The Working Group emphasized that data collected in the IGY program should be freely available to all.

It was agreed that the observations and records made must be treated in two ways, the following (as many as are obtained) should be published, or given wide circulation in mimeographed form, as soon as possible, and not later than one year after collection:

(a) Position of observation to nearest minute of latitude and longitude;
(b) Date and time of observation to nearest minute when practicable;
(c) Sea state, height and period of waves and swell;
(d) Standard meteorological observations as near as possible to the time of observation;
(e) Depth of observation as accurately as it can be determined, planning to use the standard depths recommended by the International Association of Physical Oceanography but with samples taken at intervals of not more than 500 m below 1500 m and one as near the bottom as possible;
(f) Temperature, salinity, color, transparency;
(g) Electrical conductivity;
(h) Extinction coefficient;
(i) Direct current observations including depth, duration, method of measurement and other essential details:
(j) Chemical determination of O_2, SiO_2, PO_4, NO_2, NO_3, H_2S, CO_2, Cl, NH_2, H_2BO_3, ^{14}C, D_2O, T_2O, pH, titratable base, radioactivity, and other measurements:

The following information on tides should also be published as soon as possible:

(k) Reference datum, latitude and longitude of station to nearest minute, zone time;
(l) Mean monthly sea-level averages computed from the average of hourly heights;
(m) Six-hourly meteorological data, particularly barometer and wind;
(n) Salinity and temperature data for adjacent ocean areas down to a depth of 1000 m.

Oceanographical publications should also indicate what observations had been made in submarine geology, submarine geophysics, echo sounding and marine biology so that readers can ask for more detailed information if they need it. Ice observations should be reported according to the International Code.

It was decided that long-wave records should not be reproduced in full because the parts of the records in which investigators would be most interested are likely to be only a small fraction of the whole. It was agreed that each national organization should be responsible for the care of its own records and be ready to reproduce any part of a record with all the relevant data when a request was made for it. It was agreed that a similar procedure be adopted for echo-sounding records. A statement by the CSAGI Reporter for Oceanography that the USSR would be prepared to compile a bibliography to be published by CSAGI, to show where the oceanographic data and results of research were published, was warmly welcomed by the Working Group.

Additions to the Oceanographic Program

(a) *Spectrochemical determination of trace elements in sea water*

It was agreed that the IGY represents a unique opportunity to study the distribution of certain substances present in very small concentrations in the oceans using such powerful tools as spectrochemical analysis. The group was addressed on this subject by Prof. P. SWINGS. Examples of specific problems are:

The concentration of beryllium in sea water: The radioisotopes ^{7}Be and ^{10}Be are believed to be produced by cosmic radiation in the upper atmosphere. ^{10}Be with a half-life of the order of 10^6 years may accumulate in the deep sea sediments, and if so, it may afford a useful method of dating the sediments. Variations with depth in the sediment, after corrections for radioactive decay, may tell something about variations in intensity of cosmic radiation with time. To be able to search intelligently for ^{10}Be in the sediments we must know about the concentration of non-radioactive beryllium in the sea water, the contained organisms and the sediments.

The concentration of elements from the middle part of the periodic table: The radioactive isotopes of these elements are produced by nuclear fission. Large-scale development of atomic energy for peaceful purposes will raise questions about the disposal of such products at sea. The concentration of the non-radioactive isotopes in the sea is an important datum which will be needed in answering these questions.

Variations in concentration of trace elements with depth: Wherever a marked depth variation is found the element must be important in the metabolism of marine organisms. Our knowledge of the role of trace elements in determining biological productivity is very inadequate. The suggested measurements combined with laboratory experiments are likely to help the elucidation of such problems.

Use of trace elements to study diffusion: Different rivers, because they erode different geological areas, have distinctive concentrations of minor elements, and advantage of this fact can be taken in following their waters and sediments into the ocean. This affords a powerful method for studying the problems of lateral and vertical diffusion in the oceans.

(b) *Studies of flow of water through straits between large seas and oceans*

The Working Group considered that a more detailed understanding of the flow of water in and out between the Mediterranean Sea and the Atlantic Ocean is vital to the study of the general circulation of water in the Atlantic Ocean, and the group was impressed by the preparations of Spain and France to tackle the problem. Both countries were urged to make as many direct measurements of water velocities as possible, particularly with the idea of studying the exchanges between the Mediterranean Sea and the Atlantic Ocean during periods of E and W winds. The group thought that German oceanographers might help with such measurements. It was also suggested that some trial measurements should be made of the variations in the e.m.f. induced between the two sides of the strait by the flow of water if use of a submarine cable can be obtained.

The group gave a similar welcome to USSR proposals to study the variations in water transport through the Behring Strait.

Antarctic Oceanography

The Working Group expressed strong appreciation of the extensive USSR proposals for oceanographic work in the Antarctic Ocean during the IGY and noted with particular interest that the studies would concentrate on the study of the water circulation and energy exchange between the ocean and atmosphere. Such work is very desirable at a time when there is to be so much activity in the Atlantic and Pacific Oceans. It was regretted that little assistance could be given to the USSR program except by Argentina, Chile and France. It was mentioned that most of the exploring vessels visiting Antarctica are not fitted for oceanographic research and would only attempt observations on the basis that they did not interfere with the exploring. It was strongly urged that such expeditions be asked to engage in the relatively simple but profitable study of the CO_2 balance between sea and atmosphere. The group suggested that Dr. KORT act as oceanography representative on the Antarctic Working Group.

Operating Plans for Ships

It was noted that some 48 ships would be engaged in oceanographic work in the Atlantic Ocean and 25 in the Pacific Ocean, and that a list and maps to indicate their proposed activities were being prepared for inclusion in the report of this meeting.

The group welcomed an appeal by Dr. BRUUN that ships working in little-frequented areas and depths would do what they could to collect and study the habits of deep sea life.

The Working Group held their final meeting on Saturday 10 September.

The Working Group agreed that an exchange of scientists between ships engaged in the IGY program would lead to improvements in techniques and to a higher general standard of oceanographical research.

The Working Group felt that the regional secretaries proposed by the IGY Executive Committee might not be able to do much to help the planning and execution of the oceanographical programs unless some of them were made responsible for particular oceans. The group hoped, however, that the needs of oceanography would be borne in mind.

The Japanese member, Dr. HASEGAWA, summarized the hoped-for Japanese participation in the oceanographic program. The group considered it highly desirable that Japanese ships should be able to take part together with ships of USSR in the planned oceanographic operations in the Western Pacific both in the equatorial zone and in the area of the polar front. The group also welcomed the long-wave and sea-level stations, the latter to be combined with regular observations of temperature and salinity down to several hundred meters.

The Chairman regretted that the delegate from the Union of South Africa was not able to be present. The group considers it highly desirable that the Union of South Africa participate in the oceanographic program, and it hopes that the oceanographic ships *Protea* and *Africana II* will join in the deep-sea operations planned in the eastern South Atlantic.

The Chairman emphasized that although this is the final meeting of the Oceanographic Working Group of the Brussels Conference 1955, all members and other participants are urged to communicate from time to time with the Secretary of the Working Group, Dr. G. E. R. DEACON, whenever developments occur which it is felt should have the Secretary's attention.

XI Rockets and Satellites

*The U.S. rocket-satellite program for the International Geophysical Year**

At the second CSAGI Conference held in Rome last year a proposal was made that the development of an artificial satellite be considered for launching during the International Geophysical Year. Since then the United States National Committee for the International Geophysical Year has considered this recommendation carefully.

In evaluating the possibility of an IGY satellite, the USNC, with its advisors, examined very thoroughly the two important aspects of feasibility and worth. It was considered essential that the launching of an IGY satellite should lead to worthwhile scientific results and not reduce to a mere stunt. As a result of the Committee study it was concluded that a modest artificial earth satellite could be built and launched for the IGY. It was also concluded that a number of valuable geophysical and solar researches could be carried out in such a vehicle. The Committee recommended, therefore, that the United States undertake the construction and launching of artificial earth satellites for research purposes during the IGY. This recommendation involving a scientific satellite program, was presented by the Academy to the U.S. Government and was accepted by the Government in terms of fiscal and operational support.

The first announcements of the intent to create an artificial earth satellite quite naturally created excitement. The philosophical implications of such an achievement, if brought about, are tremendous. Even those, or perhaps especially those, who expect to be closely associated with the project feel the excitement. It is natural for both the scientist and layman to let the imagination roam, and there has been much spoken and written speculation relative to the announced project. It should, however, be kept in mind that the undertaking is based on scientific objectives, and will necessarily be only a modest effort compared to some of the schemes which have been aired.

I should like in this talk to turn attention away from the spectacular aspects toward a sober consideration of what the satellite might do during the IGY, and how it might fit into the overall IGY program.

The USNC has consistently regarded the satellite project as simply an extension of the conventional rocket program, which in turn has been thought of as an integral part and natural extension of the overall IGY effort. Sir EDWARD APPLETON's remarks to the effect that rocket ionosphere observations *supplement* but do not *supplant* other ionospheric study techniques have a parallel in the case of the satellite project. Studies with a satellite vehicle will complement those made with the conventional rocket technique, but will not replace them. This becomes quite obvious when one considers what the satellite actually does. Remaining in its orbit above the atmosphere, the satellite permits one to obtain a picture of conditions outside the atmosphere over extended periods of time. But conventional rockets are still needed to give a vertical picture of the atmosphere at a specified time.

For example the amount of solar energy entering the earth's atmosphere, and

* Talk given on 9 September 1955 by H. E. NEWELL, Jr.

the time-variations therein, can be studied in a satellite vehicle, whereas the conventional rocket is needed to learn at what altitudes the different wavelengths are absorbed. As a second example, the measurement of the vertical distribution of ionospheric charge densities will probably be very difficult, if at all possible, in a satellite, while in the conventional rockets such measurements have been and are being made with relative ease. It is plain that each technique has its advantages and disadvantages, depending on the application intended.

Since the satellite program is to be regarded as an extension of the regular rocket program, it is worth while to review briefly the plans for the conventional rocket studies. The fields covered by the vertical-rocket program are well known to all, so that there is no need to go into detail. Pressure, temperatures, densities, winds, atmospheric molecular and ionic composition, charge densities in the ionosphere, the earth's magnetic field, cosmic rays, sunlight, aurora, and airglow are included in the roster of rocket studies.

The proposed rocket observations are simply a continuation of the U.S. rocket upper air research program which began in 1945, since which time about 200 sounding rockets have been fired. It should be noted, however, that in spite of the number of years since the beginning of the rocket program, and in spite of the large number of missiles fired, only roughly 10 hr of actual observing time have been involved. The principal feature of the rocket technique, its over-riding "selling" feature, is its usefulness in getting equipment up to high altitudes. Because of this feature the rocket makes possible direct observations of many quantities which cannot otherwise be observed at all, and makes possible direct observation of many quantities which can otherwise be determined only in very indirect fashion by inference from observations made at or near the surface of the earth.

The rocket provides a powerful means of calibrating, so to speak, ground-based techniques for measuring high atmosphere parameters, while the ground-based techniques provide a relatively economical means for collecting large quantities of data and for making synoptic or long-term studies. In partnership, then, the sounding rocket and various ground-based methods should provide an effective means for solving problems associated with the high atmosphere and with solar-terrestrial relationships. It is important, therefore, to make this partnership as effective as possible, by organizing the rocket program so as to provide as complete a coverage as possible.

Timewise this will be done by spreading the firings throughout the IGY, correlating the rocket firings with measurements in other programs by participating as fully as possible in the World Days–World Intervals program. But there is a gap here in that there is as yet only one extensive program planned, that of the United States. Even the U.S. program could be extended profitably. The French, British, Australian, and Japanese plans are not fully known, but it is expected and hoped that these efforts will augment the U.S. scientific efforts.

The IGY rocket program will also be spread out geographically. In the case of the United States program there will be firings in the Arctic, at Ft. Churchill in Canada, off the Virginia coast, off the California coast near San Diego, and along a path (probably in the Pacific) from the equator south to the Antarctic. This will provide a reasonably good coverage of a meridional belt in the western hemisphere.

Elsewhere in the world the geographical coverage of the rocket programs will not be so good. If Britain does fire rockets from Aberporth, on the west coast of Britain, and if France does fire rockets in the Sahara, then this will provide some rocket activity for the (roughly) 10 degrees east meridian. But the coverage would be incomplete, and it would be desirable to extend it. Likewise if Japan and Australia fire rockets in Northern Japan and at Woomera respectively, then there will be some coverage for the 140 degrees east meridian, but again it would be desirable to extend the activity.

Finally, the coverage provided by the rocket program can be extended by the use of artificial earth satellites as research vehicles. The remainder of this talk will be concerned with the use of artificial satellites for geophysical research. It should be emphasized at this point, however, that the following discussion will not be a statement of actual plans, which are in fact still in the formative stage. It is intended simply to review some of the possibilities which might be considered in formulating final plans.

In its thinking and planning the U.S. National Committee has considered the possibility of from six to ten satellite vehicles. How they would get into their orbits would be the concern of the U.S. Department of Defense, for these are logistics problems for which only this Department has adequate facilities at the present time. It is sometimes convenient to separate the project this way into two parts, one concerning the launching and the other concerning the research; but such a separation greatly over-simplifies things. To ensure success the researchers and the launching group will have to work closely together from start to finish. In this sense the U.S. National Committee's plans for the satellite program are similar to the Committee's plans for the "conventional" rocket and the Antarctic programs in IGY: the Committee has developed the plans and the budget; the Committee directs and executes the programs; the Committee has requested logistics assistance in each area from the Department of Defense—for example, ships from the Navy for the Antarctic program.

In order to be useful a satellite must be trackable. On this basis one concludes that a vehicle weighing only one pound would probably not be useful. On the other hand, calculations show that a vehicle weighing on the order of ten pounds probably could be made observable. Calculations by R. Tousey, for example, indicate that a 20-in. sphere of proper reflective properties should be observable at favorable times, sometimes with the naked eye, at other times with binoculars. To translate this theoretical possibility into actual accomplishment, however, will be a very difficult problem.

Carrying the above thoughts one step further, it is probable that construction of a satellite weighing on the order of 100 lb is more than can be expected *for the International Geophysical Year*. Thus if it is true that only six to ten vehicles are to be launched, then the total weight-carrying capacity will be quite limited. Careful planning will be required to make the utmost of what will be available. Naturally it would be nice to extend the satellite program, but here economics, the size of the job, and its impact upon other programs and activities must be taken into account.

For the IGY satellite program an advisable approach is to consider what can be done within the scope of techniques already developed for conventional rocket research. There will be problems of power supplies, telemetering, tracking, and lightweight construction, in addition to those of the primary research instrumentation itself. All of these have been worked on intensively over the past decade in connection with rocket sounding. As a result it is certain that appreciable work can be done with the modest payloads characteristic of small rockets like the Deacon; such payloads may well be representative of those that will be available in the early satellites.

Some of the research possibilities are:

(1) *Geodetic measurements.* Such studies can be made with a "passive", i.e. uninstrumented, satellite. It is thought by some that more accurate measurements of distances along the earth's surface and of the shape of the earth can be made with the artificial satellite than are now possible with the moon. Whether or not this is possible remains to be seen. Certainly the task is quite difficult, involving careful observational and computational work. Since the basic data will be obtained from observation of the satellite, this admits of international co-operation, and it is planned to make information on the orbit of the vehicle available so that those who wish to do so can track the satellite.

(2) *Air density measurements.* The fact that the artificial satellite will be moving in a resisting medium will make its use for geodetic studies more difficult than would otherwise be the case. On the other hand the effect of air drag upon the orbit can be used to determine the density of the resisting atmosphere. Here again, since the basic data are to be obtained by observation of the satellite's motion, international participation will be possible.

(3) *Solar ultra-violet and X-rays.* These can be measured with customary rocket techniques using photon counters and radio telemetering. It will be possible in the case of the satellite observations to look for fluctuations in the solar intensities as a function of time. Particular interest will attach to what happens when a solar flare occurs.

(4) *Earth's magnetic field.* There are lightweight magnetometers which have been developed for rocket-sounding studies which can be used to measure the earth's magnetic field above the ionosphere. By measuring the field at high altitude while simultaneously observing the field at the surface of the earth it should be possible to detect the presence of the Chapman–Stormer current ring, and to measure variations in its intensity for correlation with solar and magnetic activity.

(5) *Cosmic rays.* The primary cosmic radiation reaching the vicinity of the earth can be studied with the usual counter techniques. Particular interest attaches to the lower energy end of the cosmic-ray spectrum, since these rays do not penetrate the atmosphere and so are not observed at the earth's surface, and since, moreover, fluctuations in the radiation are more pronounced at this end of the spectrum. For the cosmic-ray studies one would want to have the satellite encircle the earth in a polar orbit, so as to make use of the earth's geomagnetic field as a rigidity spectrometer for differentiating the rigidity spectrum of the incoming radiation.

(6) *Micrometeorites.* Electrostatic analyzers and impact detectors of various types can be used for observing tiny meteoritic particles impinging upon the satellite. In this way the density of dust in interplanetary space may be measurable, and the frequency of occurrence of fast-moving micrometeorites may be determined.

(7) *Hydrogen density in space.* One of the most fascinating experiments possible with artificial satellites has been proposed by H. Friedman and co-workers. The plan is to observe the Lyman-alpha radiation directly from the sun, using relatively insensitive photon counters. Simultaneously the Lyman-alpha radiation coming from space will be measured with sensitive counters looking out at an angle to the direction to the sun. Comparing the two Lyman-alpha curves should make it possible to determine the density in space of both hydrogen atoms and hydrogen ions.

Some of the things which have been suggested for the satellite vehicle are not for the immediate present, but are rather to be considered as future possibilities. Many of them will come with the development of better propulsion techniques, and better power supply techniques—as, for example, silicon-boron strips for solar batteries. It may be that such solar batteries will be available for use during the IGY, but there are many who feel that there is still too much engineering involved in their use for satellite experiments to warrant planning on them.

Specific future possibilities are:

(a) Photography.
(b) Anything requiring recovery of the satellite.
(c) Television.
(d) Radio relay.
(e) Telescope.

Photography of the earth, for instance, is an experiment requiring physical recovery of film, and this would plunge one directly into a whole series of problems an order of magnitude more difficult than one would want to attempt in the first satellite projects. Use of television in the early satellite work is precluded because the equipment is too complex and the power supply requirement too great. For similar reasons the use of satellite stations for radio relay purposes is to be considered for some of the later work. For the IGY, telescope experiments are probably too much to attempt, because the equipment would be too heavy and the transmission to earth of the information obtained from them would be an exceedingly difficult undertaking.

As always, the question of manned space flight comes to mind when discussing artificial earth satellites. This is something for the far distant future.

For the present, as the discussion above shows, there is much of scientific value that can be done on a relatively modest basis. It is such that is proposed for the International Geophysical Year. But above and beyond the scientific work that may be done for the IGY, the launching of the first satellite will be intrinsically important in and of itself, for it will signal the opening of a new frontier for exploration. It is such considerations that have led to the development of the satellite program in the United States by the National Academy of Sciences.

*XIII Gravimetry**

Le Groupe XIII a été tout nouvellement constitué. A la réunion de Rome de 1954, malgré une intervention des délégués des États-Unis, l'Association Internationale de Géodésie avait adopté un Voeu, transmis officiellement à toutes les organisations

* Rapport préalable établi par P. Tardi, Président du Groupe XIII, Gravimétrie, lors de la réunion de Bruxelles.

adhérentes et aux Gouvernements, et demandant seulement que des observations gravimétriques soient exécutées chaque fois que sera organisée une expédition *spéciale* dans des terres lointaines (continents arctique et antarctique, îles isolées, etc.). *D'une façon générale*, l'Association Internationale de Géodésie avait considéré que les déterminations gravimétriques ne correspondaient pas exactement à *l'esprit* dans lequel était conçue l'Année Géophysique Internationale: les opérations entreprises à propos de cette dernière doivent avoir un caractère de *simultanéité* correspondant au fait que les quantités mesurées sont variables avec le temps. Tel n'est pas, *en première approximation*, le cas de l'accélération de la pesanteur.

A la demande de plusieurs délégations ou personnalités, le problème a été repris en ce qui concerne les *variations* de l'accélération de la pesanteur—et c'est plus particulièrement ce point qui sera examiné ici.

Analyse sommaire des communications et propositions reçues

Le Président du Groupe XIII a reçu sur cette question un certain nombre de communications dont les principales sont résumées ci-après.

(1) Le R. P. LEJAY, Directeur du *Bureau Gravimétrique International*, dans un Rapport (Annexe 1), insiste sur l'oeuvre déjà réalisée par cet organisme, lequel est prêt à donner toutes les indications aux observateurs de l'Antarctique en vue d'assurer l'homogénéité des mesures qui seront faites dans les régions polaires, dans le but de les rattacher correctement au réseau mondial pré-existant. Il insiste particulièrement sur les précautions à prendre en vue d'assurer un étalonnage correct des instruments.

Soulignant l'importance considérable des mesures en mer, le R. P. LEJAY déplore que les résultats des travaux récents exécutés dans ced omaine soient difficilement accessibles et soient considérés comme "secrets" par certaines des nations ou certains organismes qui les ont exécutés.

Il évoque enfin l'intérêt de mesures des variations de g avec le temps, tout en insistant sur le fait que l'organisation de telles observations ne saurait être faite à la légère et devrait faire l'objet de consultations entre spécialistes dans ce domaine.

(2) C'est ce dernier problème qui est plus spécialement évoqué par M. A. GOUGENHEIM, qui est un des meilleurs spécialistes français de la question (Annexe 2). M. GOUGENHEIM souhaiterait que des opérations soient faites en un *nombre restreint* de stations, mais avec une très haute précision. Cette précision est difficile à atteindre du fait que les instruments sont utilisés à l'extrême limite de leur précision. Il préconise l'emploi de gravimètres permettant *l'enregistrement continu* des variations de g à quelques microgals près. Les résultats obtenus en ces stations pourraient être comparés à ceux obtenus avec des pendules horizontaux et qui concernent les variations de direction de la pesanteur, bien que ces dernières soient d'une interprétation extrêmement difficile du fait des nombreuses causes de perturbations.

(3) Le Prof. C. MORELLI (Italie), après avoir souligné l'intérêt des déterminations en mer, pose l'ensemble du problème de la variation de g avec le temps (Annexe 3).

Il préconise, comme M. GOUGENHEIM, l'emploi d'instruments enregistreurs. En cas de lecture directe, il préconise une lecture toutes les 2 heures (précision 0,01 mgal). Il propose, en cas d'observations ne durant pas toute l'AGI, des observations *simultanées*, qui pourraient être organisées par exemple à raison d'un mois par saison ou une semaine par mois. La première de ces solutions paraît préférable du fait de l'influence lunaire. Ces stations seraient à installer plus particulièrement dans des régions présentant actuellement d'importants mouvements tectoniques (régions volcaniques en activité plus spécialement).

En vue de l'étude des *variations séculaires,* il préconise l'établissement de chaînes gravimétriques de très haute précision, qu'il voit plus spécialement dirigées suivant des méridiens—et où des observations devraient être reprises plus tard . . . lors d'une seconde année géophysique.

Suivent certaines recommandations d'ordre *général,* ayant trait à la valeur de Potsdam et à l'établissement des réseaux fondamentaux. Ces questions d'ordre général, nous l'avons dit plus haut, quel que soit leur extrême intérêt, ne doivent pas être rigidement liées à la question de l'Année Géophysique Internationale.

(4) *La proposition présentée par la délégation soviétique* (Annexe 4), à propos des observations faites à l'aide de gravimètres enregistreurs et de pendules horizontaux, rapelle que l'on connaîtra beaucoup mieux au cours de l'Année Géophysique Internationale certaines données relatives aux marées océaniques et aux variations de la pression atmosphérique. Les perturbations correspondantes pourront ainsi être mieux connues.

La délégation soviétique indique qu'elle aura la possibilité d'installer deux stations de haute précision avec gravimètres enregistreurs dans les environs de Léningrad et de Moscou.

(5) *Le rapport national des États-Unis* reprend avec plus de détails les propositions présentées à Rome en 1954 (Annexe 5). Tout un programme est envisagé, comportant:

des mesures au pendule en quartz de la Gulf C°;
des mesures aux gravimètres;
des mesures par gravimètres immergés;
des mesures gravimétriques en sous-marin, comportant la mise au point d'un appareil nouveau;
des mesures des marées terrestres;
des mesures gravimétriques dans l'Antarctique.

L'ensemble en est considérable et ne comporte pas moins de cinquante-trois stations, en même temps que l'exploration de vastes aires telles que l'Océan Indien, l'Océan Atlantique, l'Océan Pacifique Sud, etc., où aucun nombre de stations ne peut être fixé.

Annexe 1

Rapport présenté par le R. P. P. LEJAY. *Gravimétrie.* Des propositions ont été faites au CSAGI, lors de la réunion de Rome, en vue d'étendre à la Gravimétrie le programme de l'Année Géophysique Internationale. De la discussion de ce sujet à Rome, il est ressorti que le but général de l'AGI étant principalement d'obtenir des données sur les phénomènes géophysiques à l'échelle planétaire dans des domaines où ces données sont actuellement déficientes, par une concentration des observations dans le temps, les mesures gravimétriques ne rentraient pas immédiatement dans le programme. En première approximation en effet, la pesanteur à la surface du globe ne varie pas avec le temps. Aucune raison impérieuse ne pousse à obtenir par conséquent ces données en 1957–1958 plutôt qu'à toute autre époque.

Certes, il est possible qu'en certains pays, un effort supplémentaire dans ce domaine pourrait être obtenu à l'occasion de l'AGI par suite du choc psychologique produit par l'annonce des travaux géophysiques spéciaux qui seront exécutés. Mais ceci ne peut être étendu aux nations qui, depuis quelques décades, fournissent un effort considérable en gravimétrie. Aussi le CSAGI a-t-il seulement décidé de recommander l'exécution des mesures gravimétriques au cours des expéditions lointaines, dans les régions du Globe qui ne sont pas encore prospectées et, tout particulièrement, sur les continents arctique et antarctique.

Il serait également d'un très grand intérêt si pour la raison énoncée plus haut des mesures en mer étaient exécutées à cette occasion.

Avant d'examiner les actions que peut prendre le CSAGI à ce sujet, il convient de rappeler l'état d'avancement des travaux dans ce domaine.

Depuis de nombreuses années, l'Association Internationale de Géodésie se préoccupe de l'établissement de cartes gravimétriques mondiales homogènes. Elle a discuté des conditions d'établissement de telles cartes par une coordination des efforts des nations intéressées, puis, après avoir précisé les problèmes au cours de ses Assemblées Générales, elle a constitué un organisme permanent, le *Bureau Gravimétrique International*, qui, sous le contrôle d'une *Commission* comportant un représentant de chaque Nation, est précisément chargé de coordonner les travaux gravimétriques de caractère scientifique exécutés dans le monde entier.

L'oeuvre déjà accomplie par cette organisation est considérable. Les réseaux gravimétriques ont été reliés entre eux avec une extrême précision. Un réseau de premier ordre, comportant une trentaine de stations, a été formé; la cohésion de ce réseau déjà presque parfaite se vérifie d'année en année par de nouvelles liaisons entre les diverses stations qui le constituent. Les bases nationales ont été reliées au réseau de premier ordre. Pour assurer l'homogénéité des étalonnages des gravimètres, des "bases", comportant un grand nombre de chaînes de stations s'étendant des hautes aux basses latitudes, ont été créées en Europe et en Amérique, tandis que des liaisons directes entre les stations de ces deux bases ont été multipliées. Les travaux à ce sujet se poursuivent avec activité.

Entre-temps, sur les continents encore inexplorés il y a seulement quelques années, les réseaux gravimétriques se multiplient. Une grande partie de l'Afrique est maintenant prospectée, tandis que l'Amérique du Sud se trouve déjà fortement entamée. Le Groënland a été traversé et des chaînes de stations établies tant au nord qu'au sud de ce continent.

La Commission Gravimétrique Internationale s'est réunie à Paris en 1953; elle a pris toutes les mesures utiles pour assurer le développement des travaux et leur coordination dans les meilleures conditions possible. Elle doit se réunir de nouveau en 1956 pour examiner les travaux considérables qui ont été exécutés dans les dernières années et prendre de nouvelles dispositions répondant à l'avancement des questions.

La Commission Internationale apprendra donc avec satisfaction que les expéditions polaires, en particulier, ont inscrit à leur programme l'exécution de mesures gravimétriques sur le continent antarctique, où il n'a été occupé jusqu'ici qu'une seule station. L'AGI est en effet une occasion unique d'étendre les travaux gravimétriques à cette portion de la planète.

Le Bureau Gravimétrique est disposé à donner toutes les indications aux observateurs de l'Antarctique en vue d'assurer l'homogénéité des mesures qui seront faites dans les régions polaires et leur rattachement au réseau mondial.

Comme il a été signalé à la Conférence antarctique internationale, qui a été provoquée par le CSAGI en juillet dernier, il serait important que les expéditions antarctiques assurent leurs valeurs du départ en des stations de haute latitude, soit aussi proches que possible de l'Antarctique, soit situées dans l'extrême Nord de l'Europe ou de l'Amérique (avec transport rapide d'un hémisphère à l'autre) avant le départ. Il serait indispensable que les gravimètres soient soigneusement étalonnés et parfaitement étudiés avant et après chaque expédition, et que les observateurs aient une connaissance poussée de leurs instruments. Les plus grandes précautions doivent être prises pour assurer la rectitude des observations qui devraient être publiées en détail afin d'en permettre une discussion approfondie. Il serait en effet désastreux de risquer d'introduire des valeurs erronnées, invérifiables dans la suite, dans un réseau mondial qui présente aujourd'hui toute sécurité.

Il est inutile de faire ressortir la grande importance des mesures en mer. Les travaux déjà accomplis représentent également un effort considérable; malheureusement les résultats des travaux récents sont presque tous inaccessibles, les organismes qui les ont exécutés les considérant confidentiels. Une résolution du CSAGI, en vue de multiplier les mesures en mer, serait donc inefficace si les pays qui disposent des moyens ne sont pas prêts à publier les résultats.

En résumé, le CSAGI pourrait confirmer la résolution de Rome en encourageant les travaux gravimétriques au cours des expéditions lointaines dans les pays non prospectés. Le CSAGI pourrait également recommander l'exécution de travaux gravimétriques en mer et insister pour la publication rapide des résultats. Les résolutions devraient faire ressortir l'importance de contacts entre les observateurs et le Bureau Gravimétrique International par le canal du délégué de la nation intéressée à la Commission Gravimétrique Internationale. Ces contacts devraient être établis avant la prochaine réunion de la Commission (septembre 1956), afin que celle-ci puisse prendre les mesures spéciales nécessaires à une conduite rationnelle des travaux.

L'intérêt que pourrait prendre l'exécution des mesures coordonnées des variations périodiques de la pesanteur (effet luni-solaire et marées de l'écorce) mériterait d'être discuté. Il serait tout indiqué que l'Association Internationale de Géodésie entreprenne une enquête auprès des spécialistes de cette question, afin de déterminer les conditions expérimentales, à la lumière des travaux antérieurs dans ce domaine, susceptibles d'apporter des résultats intéressants. Ce problème ne peut être traité à la légère; il demande une étude en Sections IV et V (Gravimétrie et Géoïde) de l'Association Internationale de Géodésie.

Annexe 2

Communication présentée par M. A. GOUGENHEIM. *Étude des variations périodiques de la verticale et de la pesanteur.* Il serait avantageux de profiter de l'Année Géophysique Internationale pour effectuer en divers points du globe des déterminations simultanées de l'effet luni-solaire sur la *direction de la verticale* et sur *l'intensité de la pesanteur*. Cette action est à l'origine des marées terrestres; des observations continues en plusieurs stations contribueraient à améliorer la connaissance de la réaction élastique du globe et permettraient à l'occasion de mettre en évidence des singularités de ce phénomène.

Comme les mesures sont toujours faites à l'extrême limite de la précision des instruments, il y a intérêt à n'envisager *qu'un petit nombre de stations* et à faire porter l'effort sur la *qualité de leur équipement*, pendules horizontaux d'une part, gravimètres de haute précision d'autre part.

En particulier pour la gravimétrie, il convient d'employer seulement des appareils permettant d'enregistrer de façon continue les variations de la pesanteur à quelques microgals près. De tels appareils, mis en service récemment à titre d'essai, ont fait apparaître dans les variations de la pesanteur certaines singularités qui n'ont encore été ni confirmées ni expliquées; un programme de recherches à l'aide de ces appareils aurait le double avantage d'en activer la mise au point et de faire progresser l'étude du phénomène en cause et de ses anomalies éventuelles.

L'étude des variations périodiques de la verticale à l'aide de pendules horizontaux ne peut être conçue tout à fait de la même façon, car le phénomène ne se dégage que de longues séries de moyennes, étant masqué par des effets perturbateurs beaucoup plus importants que lui (déformation de la surface du globe sous l'effet du rayonnement solaire et aussi de la charge variable des marées océaniques, effet gravitationnel des marées océaniques); par suite les anomalies de courte durée n'apparaissent pas; par contre des effets élastiques différents ont été signalés suivant le méridien et dans la direction perpendiculaire. La comparaison des résultats obtenus dans un petit nombre de stations bien équipées, opérant simultanément, serait à coup sûr très instructive.

Il y aurait enfin intérêt, pour la recherche et la confirmation de singularités locales éventuelles, à ce que les stations de gravimétrie soient effectuées au voisinage de celles où l'on mesurera les déviations de la verticale.

Annexe 3

(1) *Report by* Professor CARLO MORELLI. *Gravity*. Professor C. MORELLI recommends the adoption of the Swedish proposal on "Gravity Measurements at Sea", proposed by Professor L. ASPLUND, Stockholm (see p. 41), at least around all possible continental shelves:

"With rapidly working gravity meters now available for land use, it has been possible to perform gravity measurements on land in a short time and with great density. A large number of nations have started, and in several cases already completed, gravity measurements of their countries. In Sweden more than 2000 gravity measurements have been performed during the years 1941–48, uniformly spread out over the country except for some mountain regions.

"To make full use of the results of these measurements for geodetic purposes it is necessary to know the main character of the gravity field over an extended surrounding area. In Scandinavia, difficulties arise because of the surrounding water, where gravity measurements still are lacking. Even a sparse measurement of the gravity at sea in these areas would be of great value in this respect.

"On the whole, gravity measurements at sea have until now been performed only to a very limited extent. It seems natural that measurements of this kind should be carried out in international co-operation, and it ought to be possible and desirable to carry through a certain program in this respect during the International Geophysical Year. It might be convenient to plan such undertakings regionally, and the waters surrounding the Scandinavian peninsula might be treated as one region.

"Gravity measurements at sea have hitherto been carried out mainly by special pendulum apparatus in submarines. However, some new constructions designed for measurements from the surface of the sea are being considered, and if successful they may facilitate the work considerably. It may, therefore, not be advisable now to make too detailed plans for gravity measurements at sea during the IGY. The development in this field during the next 2–3 years will be decisive for the methods to be used and the arrangements to be made."

Professor MORELLI proposes the following additional resolutions.

(2) *Gravity variations with time.* Owing to the great interest in the study of tectonic processes, also in connection with terrestrial magnetism and telluric currents, for the evolution of the interior of the Earth, for the problem of the Earth's elasticity and of the gravitational skin effect (Maiorana's hypothesis), the CSAGI considers that every effort should be made:

(a) *To establish during the IGY the most complete net all over the world for the registration of gravity variations with time.*

This can be obtained with torsion (bifilar or trifilar) gravity meters, or easily reached with modern Western, North American or Askania gravity meters. Where registration is not possible, direct readings at regular intervals (for instance, every 2 hr) could be established. Maximum accuracy is recommended ($\pm 0{\cdot}01$ mgals).

Registration is recommended throughout the IGY; but since not all gravity meters will be available for such a long period, shorter periods should be fixed for more extensive work; for instance 1 month every season, or 1 week every month.

Closer nets should be established in regions of strong actual tectonic movements (high seismicity, high reliefs, isostatic adjustments, etc.) and especially in present volcanic areas (to follow the effects of eventual mass movements).

(b) *To obtain data on secular variation.*

It is recommended that a gravity net of the highest accuracy be established over the most interesting regions (young tectonic areas, connected with old ones for reference), to be repeated at least every International Geophysical Year, to begin the study of the secular variation of gravity.

Special chains, with the lowest possible closure errors, should be established for this purpose also, as far as possible, along meridians. At least three of these chains are recommended:

in Europe, from Norway to Sicily, possibly extended to Africa;
in America, from North to South so far as possible;
in Asia, through Japan, Philippines, and Indonesia.

Modern gravity meters and pendulums provide measurements of the necessary accuracy.

(3) *Reference value for g.* Owing to the necessity of replacing the actual reference value of g (Potsdam: $g = 981{\cdot}274$), certainly wrong, by a more accurate one, the CSAGI recommends that new absolute gravity measurements should be recommended and concluded for the next IGY.

(4) *First-order world gravity net.* To complete the first-order gravity net all around the world it is recommended that during the IGY every expedition should make also gravity measurements, and that every effort should be made to complete the first-order world gravity net.

(5) *Gravity measurements on Geoid Sections.* To complete the geophysical results obtainable from Sections of the Geoid, it is recommended that systematic gravity measurements should accompany every Geoid Section.

Annexe 4 Supplements and remarks on the study of the elastic properties of the Earth

Report of the Academy of Sciences of the USSR. Observations of tidal deformations of the earth with the aid of high-precision stationary gravimeters and horizontal pendulums.

Throughout the period of the International Geophysical Year there will be at our disposal unprecedented and complete data on ocean tides and on the changes of atmospheric pressure. This will make it possible to take into account the deformations caused by the variable load on the earth's crust, and to distinguish more distinctly the tidal deformation of the earth. On the one hand, they determine the earth's total elastic properties (particularly the elastic characteristics of the nucleus) and on the other hand, permit a detailed study of the regional particularities of the upper strata of the shell and of the elastic properties of the earth's crust with relation to its geological structure.

It would be desirable to organize such observations at various continental and ocean blocks.

The USSR may participate in this work by organizing at two stations (near Leningrad and Moscow) observations of tidal gravity changes with the aid of high-precision stationary quartz gravimeters with continuous recording.

Annexe 5

U.S.A. program. Gravity measurements are of fundamental importance to an understanding of the physics of the "solid" earth and are basic to the determination of the absolute deflection of the vertical, and of the size and shape of the earth. Practical implications of gravity measurements affect mapping and exploring for minerals and petroleum. The International Geophysical Year affords an unusual opportunity for extending in a significant way our knowledge of the earth's gravimetric field, the placing of gravity data now available on a common ground, and ensuring that future gravimetric work will have the same standard of reference. Six research activities are contemplated: (1) Pendulum Measurements; (2) Gravimeter Measurements; (3) Under-water Gravimeter Measurements; (4) Submarine Pendulum Gravity Measurements, including the development and construction of an improved submarine gravimeter apparatus; (5) Earth Tide Studies; and (6) Antarctic Gravimeter Observations.

(1) *Pendulum measurements.* Pendulum measurements are needed to complete the establishment of a common gravity standard throughout the world. The Gulf quartz pendulums have, until now, been used to establish a gravity calibration line from Fairbanks, Alaska, to Mexico City, Mexico, and from Oslo, Norway, to Tripoli, Libya. This program can be extended as far as present air transportation is available. Air transport is essential for the gravimeter program in that the gravimeter readings change with time, and for that reason the time element must be kept to a minimum and also frequent closures obtained. To extend these calibration lines to Cape Horn in South America, Capetown in South Africa, and into Australia, it will be necessary to get an airplane assigned specifically for this work, since an operation using scheduled flights of commercial airlines is impractical and rarely possible at all.
(2) *Gravimeter measurements.* Gravimeter measurements are essential for tying together international networks and extending the present global network of bases to the Antarctic and other areas where no measurements have been made up to the present time. In particular it is proposed to take advantage of the transportation facilities of other projects operating in the Antarctic or other remote areas during the IGY. It is intended to ride the re-supply flights serving these remote sites as was done in obtaining gravity observations at the advanced weather stations in the Arctic. It will thus be possible to make observations and to obtain gravimetric data from areas that have in the past been inaccessible.
(3) *Under-water gravimeter measurements.* Under-water gravimeter measurements are needed for developing gravity information in the continental shelf areas, particularly in the zone from the coast out to about the 50-fathom line. In order to evaluate submarine gravity values (other than port stations) at sea, as well as to build up knowledge concerning the nature of the transition in crustal structure in passing from the continents to the oceans, it will be necessary to obtain data over the continental shelves. By using surface vessels and under-water gravimeters placed on the ocean bottom, both objectives of this part of the program can be accomplished. It will be necessary to have the use of a seagoing boat capable of operating out to at least 50 miles off shore. The operational area would include some work off the East Coast of the United States, the Gulf of Mexico, and the West Coast. It is desirable that measurements should be made where there are submarine gravity measurements.
(4) *Submarine pendulum gravity measurements.* Gravity measurements at sea provide an evaluation of gravity and indirectly geology for the "normal" 64 per cent of the earth covered by water deeper than 2000 fathoms: provide means to study the structure and tectonics of continental margins, island arcs, and ocean island areas: provide a basis to assist in evaluation of the absolute deflections of the vertical, and provide a primary means to determine the size and shape of the earth.

Four hundred submarine days are planned to permit 100,000 miles of track with about 2000 gravity observations. These will be placed on approximately five east–west lines across the southern Atlantic Ocean, three east–west lines across the Indian Ocean, and six east–west lines across the southern Pacific Ocean, with approximately 20 per cent of the time available for detailed investigation of continental margins, oceanic islands, island arcs, ocean depths, and earthquake epicenter regions.

There is need for the development of a compact gravity apparatus that can be used with greater ease than pendulums and which can be installed on modern-type submarines which do not have space available for pendulums. A project is planned to develop a direct or quick-reading gravimeter for submarine use. The possession of an instrument of this type will make possible a continuing series of gravity surveys at sea.

(5) *Earth tide studies*. The objective of this project is an improved determination of the rigidity of the earth at the tidal periods of approximately 12 and 24 hours. It is desired to observe the gravitational solar-lunar tide with two special LaCost-Romberg gravimeters, which provide a sensitivity about ten times greater than that previously available. Each set of observations will extend throughout a one-month interval, and about ten representative stations will be occupied around the earth. In so far as local conditions will permit, it is also planned to take corresponding tidal tilt observations at the same station. The gravimeters will be modified to be relatively insensitive to the high level of microseisms encountered at island stations in mid-ocean. These gravity and tilt observations will be of special value if taken during the IGY, because observations both of ocean tides and of meteorological conditions will be more extensive during this period. Accordingly corrections and correlations involving these conditions (especially the ocean tides) can be more effectively made.

Measurements will be taken at stations well distributed around the earth. The measurements will be undertaken by observers who transport their equipment by air between different observation sites and gather data at individual spot locations.

(6) *Antarctic gravimeter observations*. Gravity measurements in Antarctica are of importance in deducing the exact figure of the earth. Gravimetric data from the Antarctic will be an essential part of the world-wide measurement program of the earth's gravimetric field, and basic to geodetics and seismology. This knowledge is helpful not only to science, in that it helps to chart sub-ice topography, but also to cartographers, for whom exact knowledge of the earth's figure is very important in map making.

Gravimeters will be used to tie fixed bases in Antarctica with pendulum stations at adjacent points in the southern hemisphere. Gravity observations will also be made in conjunction with seismic and glacial studies by field expeditions. On these traverses, gravimeters will be employed: (1) to determine the approximate ice thickness in support of seismic measurements; and (2) to study problems of isostatic compensation of Antarctica as a whole and the regions of varied topographic relief.

3 Resolutions

I World Days

(1) The CSAGI invites offers for the establishment of World Day Centers and World Day Associate Centers in countries in a position to undertake the centralization of distribution of *Alert* and *Special World Intervals* (SWI) information and of short-time data summaries. In general, however, the network to be arranged by the

URSIgram Committee should be such that any center must be in regular communication with not more than three other centers.

(2) The CSAGI notes that the plan for Alerts and SWI reported to the Rome meeting seems to meet with general agreement. It is recognized that the plans for announcing the beginning of SWI 19 hr in advance may have to be revised by the IGY World Warning Agency on the basis of trials of prediction methods and of the actual efficiency of the communication network. In particular it may prove desirable to shorten the advance notice interval to less than 19 hr.

(3) The CSAGI notes that the schedule of World Meteorological Intervals (WMI) included in the report of the Rome meeting seems generally acceptable, with the qualification that some meteorological measurements should be continued beyond WMI by stations in a position to do so, in the event that the expected stratospheric changes have not occurred by the end of the stated WMI interval.

(4) The CSAGI notes that the calendar of Regular World Days (RWD) included in the report of the Rome meeting appears to be generally acceptable.

(5) The CSAGI endorses the principles in the report prepared by the Chairman of the URSIgram Committee on the type of data to comprise the various grades of URSIgrams, and notes especially the principle that these distributions should fill evident needs.

(6) The CSAGI repeats its previous recommendation that each National IGY Committee shall assume responsibility for arranging for efficient distribution to its IGY stations of World Day information and any data summaries which may be requested, and invites the close co-operation of National Committees with the URSIgram Committee in arranging the IGY warning network.

II Meteorology

(1) The CSAGI endorses the recommendation of the Working Group on Meteorology relating to the centralization and presentation of observations, as detailed in the report of the Working Group, and instructs the General Secretary to forward these recommendations to the WMO.

(2) The CSAGI notes with satisfaction the decision of the WMO to publish a list of all the observations made during the IGY as part of the meteorological program.

(3) The CSAGI endorses the changes proposed by the Working Group in the program prepared in Rome.

III Geomagnetism

(1) The CSAGI endorses the suggestion of the International Association of Geomagnetism and Aeronomy (IAGA) that the Association Committee on Observatories be charged with the preparation of a list of all IGY magnetic stations, with detailed information as to instrumental equipment and availability of data at each station.

(2) The CSAGI emphasizes the great scientific interest of magnetic observations from stations near the paths of the solar eclipses occurring during the IGY, two total and one annular, and recommends that efforts be made to secure all possible observations of this kind.

(3) The CSAGI recommends that ionospheric observatories install simple geomagnetic recorders with visible trace, and also, if convenient, alarm systems, in order to learn as soon as possible of the beginning of magnetic disturbances, as a useful supplement to the system of World Alert periods. This would serve mainly the purposes of ionospheric research. More valuable results would be obtained from good standard geomagnetic recorders. Advice on this subject is available from the IAGA Committee on Magnetic Instruments, through Dr. V. LAURSEN, General Secretary, IAGA.

(4) The CSAGI urges National Committees to approach their Governments in the interest of protecting geomagnetic observatories from disturbances by direct current lines, for instance those used for electric railways.

(5) The CSAGI recommends the Argentine Government to resume a complete operating program of geophysical work at Pilar Observatory before the start of the IGY, because of its location near the 70° W meridian, and of its most valuable work in the earth sciences during the past half century, and because of the special value of a long record as nearly continuous as possible.

(6) The CSAGI recommends that, to amplify the network of magnetic stations in Equatorial Asia, the nations concerned consider the possibility of establishing an equatorial magnetic station near meridian 100° E or 110° E.

(7) The CSAGI recommends the Government of Brazil to establish full operation of the Tatuoca Observatory as soon as possible, in view of the great geomagnetic importance of its location upon the equator.

(8) The CSAGI, in view of the Chilean proposal to install two magnetic observatories at Santiago and Punta Arenas, and possibly one at Easter Island, in time for the IGY, expresses its view that Easter Island is much the most important location for geomagnetic research, and therefore recommends that first priority be given to that location.

IV Aurora and Airglow

(1) The CSAGI resolves that the Area Centers proposed on pp. 119–121 of this volume be adopted and that, instead of one World Center as proposed there, not more than four World Centers or Archives be established, one in the USSR, another in the U.S.A., and the remainder to be decided by the CSAGI from among the applicants.

(2) The CSAGI resolves that photographs of the sky during the nights of all World Days and Special World Intervals be taken if possible at intervals of 1 min, but in any case, at intervals of not more than 5 min, using exposures sufficiently long to give a detectable image of the sky when free from auroras; that the exposures be started at 0 sec of the interval; that adequate observing records be made in duplicate; that the date and times be registered on the films; and that photometric standards be placed on each reel of film.

Resolves further that the original film and copies of observing records be sent to the area center, which will be responsible for the following:

(a) Copying the film and returning the originals to the investigator or institution concerned;

(b) Scaling the film and preparing maps showing distribution of auroras at 00, 15, 30, 45 min of each hr GMT for World Days and Special World Intervals for the area under the cognizance of the center;
(c) Making microfilm copy of the maps; and
(d) Forwarding to at least one World Center or Archive copies of the original film, the observing record, and the microfilm of the maps.

Resolves further that each World Center will copy all records and data for distribution to the other established World Centers and that each of the World Centers will make any of the data available to investigators.

(3) The CSAGI resolves that, in view of the existing nets of stations making visual observations in the U.K., Scandinavia, USSR and New Zealand, a manual for the visual observation of auroras be prepared by mutual agreement among PATON (U.K.), GARTLEIN (U.S.A.), ISAEV (USSR), and THOMSEN (New Zealand), using as a basis a report prepared by C. W. GARTLEIN, "Simplified Punch Card Reporting of Visual Auroras", and

Resolves further that the visual observations of auroras be forwarded to the area centers for punching cards and for assisting in preparing maps of the distribution of auroras, and forwarding to the World Centers or Archives.

(4) The CSAGI, considering that many of the spectroscopic studies will be distributed as scientific papers, recommends that with a view to the study of latitude effects the following spectroscopic data be forwarded to the Area and World Centers:

(a) Relative intensities of lines and bands emitted from different auroral forms.
(b) Absolute intensities of the green auroral line 5577 Å.
(c) The profiles of $H\alpha$ and $H\beta$ at different magnetic zenith distances.

(5) The CSAGI, considering that the manual for observation in ionospheric physics will include sections on radio and radar observations of auroras, resolves that observations of auroras using radio and radar techniques follow the procedures adopted by Group V, Ionosphere.

(6) The CSAGI, considering the preceding recommendations and the national reports, resolves that photometric observations of the airglow emissions shall be made with the following priority:

(i) λ 5577, (ii) λ 5893, (iii) λ 6300, (iv) OH bands:

that, from the many observations made, a selection for general distribution shall be made in the form of intensities of the night airglow for each hour on the hour (universal time), that the provisional observations which are reported shall be referred to the zenith, and that all night airglow intensities shall be in the unit:

megaquanta/cm^2 column second.

V Ionosphere

The CSAGI endorses the resolutions adopted by the URSI-AGI Committee as follows:

1 *World network of ionospheric stations*

The URSI-AGI Committee notes with satisfaction the proposed network of IGY sounding stations, but calls attention to the fact that many are still in the planning stage, and it strongly recommends that these shall be put into operation as far in advance of the IGY as possible.

2 *Proposed station at Bogota, Colombia*

The URSI-AGI Committee strongly supports the proposal to establish an ionospheric station at Bogota, Colombia, as an alternative to Quito, Ecuador. Such a station would fill an important gap in the 75° W meridian chain and could make a valuable contribution to equatorial ionospheric studies.

3 *Ionospheric station at Marion Island*

The URSI-AGI Committee strongly recommends the South African National Committee to establish an ionospheric station at Marion Island. Measurements at this site would materially help to fill the almost complete absence of ionospheric data for this part of the world.

4 *Ionospheric station in Java*

The URSI-AGI Committee again calls attention to the resolution of the Rome Meeting of the CSAGI concerning the need for an ionospheric station in Java.

5 *Ionospheric observations near the auroral zone*

The URSI-AGI Committee strongly endorses the Canadian plan for ionospheric soundings at new locations near the auroral zone.

6 *Ionospheric measurements in the longitude zone* 60°–120° *E*

The URSI-AGI Committee notes with satisfaction the network of vertical-sounding ionospheric stations operated or planned by the USSR in the longitude zone 60–120°E, but calls attention to the need for additional ionospheric studies in this zone, and expresses the hope that the USSR and Chinese People's Republic will consider undertaking measurements of ionospheric drift, absorption, atmospheric noise, and radio auroral studies in this zone.

7 *Information on ionospheric stations in the Chinese People's Republic*

The URSI-AGI Committee notes the participation of the Chinese People's Republic in the IGY and expresses the hope that definitive information as to its IGY ionospheric program will be available in the near future.

8 *Ionospheric drift observations*

The URSI-AGI Committee notes that ionospheric drift measurements are planned at a number of stations, but emphasizes that drift observations at additional stations are needed if adequate world coverage is to be achieved. The Committee again stresses the need for intercomparison studies between neighboring stations and between different methods before the commencement of the IGY.

9 *Intercomparison of absorption measurements*

The URSI-AGI Committe notes that an intercomparison of ionospheric absorption measurements at European stations has recently been carried out, and endorses the plan for further experiments in the near future.

10 *Atmospheric noise measurements*

The URSI-AGI Committee notes that only a few equatorial stations propose atmospheric noise measurements during the IGY, and the Committee strongly recommends that additional stations consider making this type of measurement.

11 *Radio observation of auroras*

The URSI-AGI Committee has discussed radio reflection observations of the auroras, and recommends that such observations should always be made on two or more frequencies and, furthermore, that in reporting the results of such measurements the polar diagrams of the aerials used for this work should be specified.

12 *Whistler-type atmospherics*

(i) The URSI-AGI Committee recommends that attempts be made to study the polarization of whistler-type atmospherics, since measurements of this kind might be valuable in checking the theory of such atmospherics.

The Committee also calls the attention of workers in this field to other naturally occurring audio frequency radio phenomena, and recommends that work on these phenomena be pursued during the IGY.

(ii) The URSI-AGI Committee strongly recommends that stations suitably placed in Europe, the USSR, Australia, and Japan should collaborate in experiments on whistlers.

(iii) The URSI-AGI Committee strongly supports the French proposal for experiments on whistlers at Poitiers and Kerguelen.

13 *Calculation of solar zenith angles*

The URSI-AGI Committee recommends that CSAGI invite one or more central computing bodies to undertake the calculation of the solar zenith angle χ for IGY ionospheric stations, as recommended in the resolution in Annex 1 (2) p. 127 of the Rome Meeting of CSAGI.

14 *Accuracy of ionospheric measurements*

The URSI-AGI Committee urges on all IGY ionospheric stations the need for ensuring maximum accuracy in all measurements; in particular it is recommended that the timing of measurements such as vertical-incidence critical frequencies should be accurate to within 1 min.

15 *Report on scaling of high-latitude ionograms*

The URSI-AGI Committee endorses the proposals contained in the report of the URSI Special Committee on high-latitude ionograms, and recommends the adoption at the beginning of 1956 of the proposals by the ionospheric stations concerned, so as to ensure that adequate experience is gained in the uniform interpretation of such records before the start of the IGY.

16 *Propagation time of signals*

The URSI-AGI Committee recommends that experiments on the propagation time of radio signals commenced in December 1954 should continue, so that adequate data can be accumulated concerning the actual possibilities of comparing, during the IGY, the time standards established in different countries.

17 *Ionospheric observations from aircraft*

The URSI-AGI Committee is gratified to learn of progress made in the U.S.A. with ionospheric soundings from aircraft. It is strongly recommended that, as soon as possible, details of these experiments be made available to other workers.

It recommends too that attention be given to the possible use of aircraft for calibrating and standardizing equipment used for vertical-incidence absorption studies.

18 *Publication of IGY data*

In considering the question of publication of IGY observations the URSI-AGI Committee has naturally been impressed with the magnitude of the task and the volume of the material. Nevertheless, having regard to the fact that the principal objective in the work of the IGY is to gain physical insight into natural phenomena, the actual observations only being a means to that end, it urges on CSAGI the adoption of a most liberal publication policy, in spite of the considerable cost, in order that this corpus of unique material may be readily available to scholars everywhere.

19 *Publication and circulation of IGY ionosphere characteristics*

The URSI-AGI Committee proposes that the publication and circulation of IGY ionospheric data be carried out according to the scheme outlined at the meeting held on 8–10 September 1955.

20 *Ionospheric IGY Manuals*

The URSI-AGI Committee proposes the preparation and publication of a series of CSAGI manuals for use in the ionospheric IGY program. The suggested manuals will relate to:

(a) Vertical-incidence high-frequency recordings;

(b) More specialized studies such as ionospheric absorption, drift, back-scatter, terrestrial atmospheric noise, etc.

The Committee proposes that W. J. G. BEYNON be the General Editor of these manuals.

VI Solar Activity

(1) The CSAGI recommends that indices of solar activity should be based on the total area of the calcium plages and given at 6-hr intervals on the scale 0, $\frac{1}{2}$, 1, 2, 3, 4. Co-operating observatories are requested to make measurements of plage areas twice daily at an interval of approximately 6 hr, and to send the data to Arcetri, for the preparation of the 6-hourly indices.

(2) The CSAGI recommends the following procedure for reporting information on solar activity:

(a) The occurrence of large flares (3+) and large radio outbursts should be communicated to reporting centers immediately, by telephone or telegram.

(b) Daily reports of solar activity should be sent to World Day centers, to provide them with the data required for fixing Special World Intervals.

(c) Material for the weekly reports on solar activity, to be prepared regionally for current use, should be sent by mail.

(3) The CSAGI recommends that weekly reports of solar activity should be prepared on a regional basis, to provide dissemination of information of importance for various geophysical observations. Such weekly reports should contain a solar map for each day, showing approximate positions of spots, flares, dark filaments, prominences, and coronal isophotes, together with explanatory notes.

These reports would be of ephemeral value, so that great accuracy in the details shown on the charts is not necessary. It is important that they should be prepared and distributed with the minimum of delay. It is suggested that the reports for the U.S.A. should be prepared at the High Altitude Observatory, Boulder; for Western Europe at the Meudon or Uccle Observatory; and for Japan, Australia, New Zealand, and other countries in the same longitude, at the Tokyo Observatory.

VII Cosmic Rays

The CSAGI endorses the resolutions in the Cosmic-Ray Report (pp. 253–260) written, after the CSAGI Cosmic-Ray Meeting at Guanajuato, Mexico, on 14 September 1955, by Professor J. A. SIMPSON, member of the CSAGI and reporter for cosmic rays.

VIII Longitudes and Latitudes

(1) The CSAGI confirms the resolutions adopted by the Second CSAGI Conference held at Rome in 1954. It also makes the following additional recommendation:

2.4 "Regardless of the instrument used, at least two series of observations should be made during the night, one before, and one after, midnight."

Likewise it completes resolution 4.2 by adding the following paragraph:

"The CSAGI emphasizes that resumption, for the IGY, of the time signals formerly transmitted by Annapolis NSS would be of fundamental importance. Moreover such transmissions have been requested repeatedly by the URSI and the IAU, in particular at the Dublin meeting."

(2) *Fundamental catalog* (*Rome Resolution* 2.3). The CSAGI confirms that, in accordance with the recommendations of the IAU, the fundamental catalog is the FK3 with the corrections whose values will be furnished in sufficient time by Professor KOPFF.

Stars borrowed from other catalogs will be related to the FK3 catalog by special observations.

(3) *The lunar observational program* (*Rome Resolution* 6). The CSAGI expresses the wish that observations by the Markowitz method be extended to include sites within the territory of the USSR.

(4) *List of participating observatories* (2A, p. 140). The CSAGI expresses the wish that the definitive list of participating observatories be considered complete according to the information furnished by the various organizations concerning their equipment. The attention of other observatories is directed to the final paragraph of 2B, p. 141.

IX Glaciology

(1) The CSAGI recommends that all national committees having glaciers which fall within their national purview be asked to submit complete lists of their glaciers by the end of the International Geophysical Year.

(2) The CSAGI resolves that at the conclusion of the International Geophysical Year there be published as complete a list as possible of all known glaciers, recording as a minimum:

(i) Location and elevation;
(ii) Name;
(iii) Area (approximate);
(iv) Volume (estimated);

further, if possible:

(v) Photograph,
(vi) Measurements of activity,
(vii) Other observations of glaciological and meteorological value.

(3) The CSAGI recognizes the desirability of further glaciological studies in Greenland with scientific objectives indicated by the Commission on Snow and Ice of the International Association of Scientific Hydrology, IUGG.

XI Rockets and Satellites

(1) The CSAGI reaffirms the resolutions adopted at its second meeting held in Rome in 1954.

(2) In order that the national program for rocket firings may be integrated into a truly international program, the CSAGI urges each National Committee sponsoring a rocket program to provide the CSAGI with the following detailed information:

(i) Individual experiments to be performed.
(ii) Planned schedule of firings, giving geographic location, proposed date of launching, and time of day.
(iii) Type of vehicle to be used.

In addition it is recommended that each National Committee sponsoring a rocket program be prepared to furnish to all interested parties upon request the following further details of each experiment to be performed:

(i) Objective.
(ii) Method.
(iii) Theoretical basis.
(iv) Instruments to be used.
(v) Accuracies expected.
(vi) Altitude range of the experiment.

(3) The CSAGI wishes to place particular stress on the Rome recommendation that the small-rocket program be expanded, and to point out that by this means it may be possible to fill currently existing gaps in the geographic distribution of IGY rocket soundings.

The National Committees should take note of the fact that there is a great need for additional firings along the 10° E and 140° E meridians and along the equatorial belt.

(4) The CSAGI urges prompt publication in the open literature of all scientific data obtained by rockets and artificial earth satellites during the IGY, whether or not the data were obtained under the auspices of the individual National Committees.

(5) The CSAGI recommends that one or more World Information Centers for geophysical and astrophysical scientific data obtained by rockets and satellite vehicles be established, to function as a directory and reference agency for pending and completed experiments.

(6) The CSAGI recommends the following publication policy for the rocket-satellite programs:

(i) That each operating agency report to its National Committee, within one week, the accomplishment of each firing and an estimate of its scientific results, and that the National Committee forward this information on a continuing basis to the World Information Center.

(ii) That final results be published as promptly as possible in established journals of widespread circulation throughout the world.

(iii) That each operating agency maintain a file of original data, register the original data with the appropriate World Information Center, and make it available upon request for examination by interested agencies.

(7) The CSAGI gratefully receives the offer of the United States National Committee to undertake the establishment of a Rocket-Satellite World Information Center referred to in Resolution 5 above, without prejudice to the acceptance of possible additional World Centers.

XII Seismology

(1) The CSAGI recommends that seismic studies made in connection with the IGY program be directed and co-ordinated by the International Association of Seismology and Physics of the Earth's Interior. Consequently the Bureau of this Association is invited to form a commission as soon as possible consisting of representatives of the nations participating in seismic studies during the IGY.

(2) The CSAGI recommends the following general seismic considerations for the IGY:

A. The study of seismicity in regions of the world not easily accessible, principally in the Antarctic in connection with the IGY expeditions.

B. The study of seismicity of the regions not sufficiently studied at present from the seismological point of view.

C. The study of microseisms in connection with meteorological phenomena such as hurricanes, typhoons, etc.

The CSAGI in addition recommends that special studies of the earth's crust be carried out as fully as possible.

(3) The CSAGI recommends that seismological stations operating in the IGY program be equipped with the most efficient apparatus for the determination of position of hypocenters of near and distant earthquakes, their mechanism of origin and their energy.

(4) The CSAGI puts special emphasis on the seismological program in the Antarctic, which is included in the complex program of the Antarctic expeditions. The

CSAGI approves as a whole the plans of the location of seismological stations in the Antarctic as proposed by several countries (U.S.A., USSR, France, U.K., Argentina and New Zealand), but wishes to recommend the following:

A. That Australia organize seismological stations on Macquarie Island and on Mawson Land.

B. That, if possible, the results of the seismological stations be broadcast in one of the existing codes and that this be included in the special radio broadcasting programs of the Antarctic Stations; and that the data be included in the *International Seismological Bulletin.*

(5) The CSAGI approves the program of the USSR to organize three new seismological stations in the Arctic Zone, and recommends that other countries with stations in the Arctic Zone intensify their activities and improve their equipment.

The CSAGI recommends that Norway establish a seismological station in Spitzbergen.

(6) The CSAGI recommends that, in connection with the IGY, new seismological stations be organized and existing stations improved in the equatorial and south tropical zones (South and Central America, Africa, Indonesia and the Islands of Pacific and Indian Oceans). For those countries which have no seismological stations, it is recommended that at least one station be organized during the IGY. If the country is unable to do so, it is recommended that the help of other countries be utilized. In connection with this, the CSAGI welcomes the readiness of U.S.A. and USSR to help set up these stations.

(7) The CSAGI welcomes the intention to study microseisms during the IGY expressed by India, Ireland, Japan, Mexico, Argentina, France, Morocco, Union of South Africa, U.S.A. and USSR, and recommends that the reading of microseisms be made four times a day (0, 6, 12, 18 UT) according to decisions of the conference at Rome, and also at the time of the greatest amplitudes of microseismic storms. These readings must contain information about amplitudes and periods. It is recommended that the data be published in the *Monthly Bulletin of Stations.* If this cannot be fulfilled it is recommended that times of beginning, of maximum amplitude, and of ending of microseismic storms be read. During and especially after IGY more detailed data (seismogram copies and more detailed readings) should be made available for special periods of meteorological and oceanographic activity. It is recommended that results of these detailed studies be published in national bulletins and also in the *Bulletin of the International Seismological Bureau* for general distribution. This concentration of data should not hinder a direct exchange between stations, groups of stations, etc.

The CSAGI recommends that during IGY the greatest possible number of tripartite stations be operated and results published in national bulletins, and also in special bulletins of the International Seismological Bureau.

(8) The CSAGI calls upon all countries wherever possible to conduct special seismological studies. It welcomes the intentions of the U.S.A. in the special studies of the earth's crust, and recommends to the USSR that they initiate such studies in the area of the north western Pacific Ocean.

(9) The CSAGI recommends that the results of the interpretation of microseisms and copies of seismograms obtained during the IGY be collected, not only in the

International Seismological Bureau, but also in international centers in which the meteorological and other observations of the IGY are collected. These centers must, on request of the National Committees, obtain from the stations the copies of necessary seismograms and distribute them in the form of microfilms or photocopies. After the IGY copies of all station seismograms operating during the International Geophysical Year must be collected in the International Seismological Bureau.

XIII Gravity Measurements

1 The CSAGI:

1.1 Endorses the view stated at Rome in 1954 by the International Association of Geodesy that gravimetric determinations properly so called (carried out at sea or on land by means of pendulums or gravimeters) are not directly a part of the essential program of the IGY, because of the fact that, to a first approximation, g is considered as constant at a given location; this removes all interest in simultaneous determinations at different places on the earth.

1.2 Notes with great satisfaction, nevertheless, the observational program presented by the U.S.A. and other nations, which, taking advantage of the impetus given to all the terrestrial measurements through organization of the IGY, offer further to develop the present world network, more especially in the southern hemisphere, for the calibration of gravimeters to be used for distant expeditions.

1.3 Recommends that all nations organizing distant expeditions (polar regions, isolated islands) avail themselves of the opportunity to add to their observational programs gravity determinations which are, unfortunately, lacking for such regions at this time: the positions determined will have to be related to other more easily accessible positions (in the case of expeditions departing a long time in advance).

1.4 Insists particularly that all gravimetric determinations which are to be made be carried out under strict agreement with the *International Gravimetric Bureau,* which is a permanent service of the International Association of Geodesy. This agreement must cover at one and the same time calibration data, discussion of results, and the inclusion of results in the world gravimetric network.

It is requested in particular that the delegates of each nation participating at the meeting of the International Gravimetric Commission to be held in Paris 10–15 September 1956 be able to specify in detail conditions of this collaboration with the International Gravimetric Bureau.

2 The CSAGI:

2.1 Recommends strongly that measurements of variations in gravitational acceleration be carried out *simultaneously* during the IGY at different locations on the earth.

A precision of 0·01 mgal is to be sought at these stations; this corresponds to the limit of sensitivity of instruments actually extant.

The observations must preferably be made with recording instruments capable of continuous registration—with instruments for direct observation it is necessary that observations be made at least every two hours (if possible every hour).

In case observations cannot be carried out at certain locations throughout the whole IGY, it is recommended that they be made (at these locations) during the first month of each quarter in such a way that a correct harmonic analysis of the results can be carried through.

2.2 Appoints the following commission, limited to three members, for the formulation of technical instruction for such observations:

Walter D. LAMBERT (U.S.A.), former President of the International Association of Geodesy,

Professor BOULANGER, delegate from the USSR,

Dr. MELCHIOR, General Reporter to the International Association of Geodesy on all questions concerning tides of the earth's crust.

3 The CSAGI:

Invites all adhering nations to make known their programs concerning this field of activity as soon as possible—it notes with satisfaction the programs presented by the U.S.A. (ten stations occupied successively with two instruments) and by the USSR (two stations). It desires to have these programs extended as much as possible.

4 The CSAGI:

Wishes to have the results of observations concerning variations of the acceleration due to gravity collected and analyzed at different centers (Moscow, Los Angeles, Liverpool). The results of the analyses will be transmitted to Dr. MELCHOIR.

General Resolutions

(1) The CSAGI expresses its appreciation to the Belgian Royal Academy for the quarters so graciously made available for the organization of the Third Plenary Conference of the CSAGI.

The Committee asks Professor Cox, Permanent Secretary of the Belgian Royal Academy, to transmit this expression of appreciation to the Academic authorities, and to accept for himself and his collaborators the deep gratitude of the CSAGI.

(2) The CSAGI expresses its appreciation to the Minister of Public Instruction for the generous assistance which permitted the organization of a tour to the two beautiful cities of Ghent and Bruges.

(3) The Special Committee for the International Geophysical Year of the International Council of Scientific Unions, having met in plenary session at Brussels, 12 September 1955, and having been informed that the Secretariat of UNESCO proposes to make the International Geophysical Year the theme of the UNESCO Traveling Exhibition for 1957, conveys to the Director General of the UNESCO its warm appreciation of this plan, expresses the hope that the Executive Board of the UNESCO, at its 42nd Session in November 1955, will endorse the inclusion of the project in the Draft Program of the Department of Natural Sciences for 1957–1958 which will be submitted to the Ninth General Conference of the UNESCO at New Delhi in 1956, and offers such information concerning the technical program for the IGY as may be needed for carrying out the plan.

(4) The CSAGI declares that the operations of the International Geophysical Year will commence at 0 hr UT on 1 July 1957 and will continue for 18 months, terminating at 24 hr UT on 31 December 1958. A ten-day test interval, commencing 0 hr UT on 20 June 1957, will precede the beginning of the IGY.

(5) The CSAGI suggests that National IGY Committees should consider the advisability of arranging discussions or regional conferences with neighboring countries to promote the more successful execution of the IGY program; it requests information concerning any such discussions or conferences that may be arranged, and concerning their results.

(6) The CSAGI recommends that the participating nations should incorporate the recommendations, presented in the several reports and resolutions dealing with the various geophysical fields to be investigated during the IGY, within their respective national programs, so far as this is possible and appropriate.

(7) The CSAGI urges the several nations not now participating in the International Geophysical Year to form IGY National Committees and to expedite the planning of their participation in the International Geophysical Year.

(8) The CSAGI expresses its appreciation to the national committees sending delegates and participants to the CSAGI Brussels Meeting, 8–14 September 1955, and records its gratitude to these committees, their delegates and participants, for the considerable assistance rendered to the CSAGI in the formulation of the IGY programs, reports, and resolutions.

(9) The CSAGI expresses its appreciation to the International Union of Geodesy and Geophysics for its co-operation in the formulation of the several technical programs of mutual interest to the IUGG and the CSAGI, and invites the attention of the IUGG to the results of the CSAGI Brussels Meeting, at which valuable contributions of the IUGG Committee for the IGY were incorporated in the CSAGI program, reports, and resolutions, and invites the further interest, advice, and aid of the IUGG in the IGY work.

(10) The CSAGI expresses its appreciation to the URSI for the co-operation of its IGY Committee in the formulation of the several technical programs of mutual interest to the URSI and CSAGI, and invites the attention of URSI to the results of the CSAGI Brussels Meeting, at which the valuable contributions of the URSI-AGI Committee were incorporated in the CSAGI programs, reports, and resolutions, and invites the further interest, advice, and aid of URSI in the IGY work.

(11) The CSAGI expresses its appreciation to the Sub-Commission on Cosmic-Ray Intensity Variations of the International Union of Pure and Applied Physics for its co-operation in the formulation of the IGY Cosmic-Ray program, and invites the further interest, advice, and aid of the IUPAP in the work of the IGY, which is of mutual interest to the IUPAP and the CSAGI.

(12) The CSAGI expresses its appreciation to the World Meteorological Organization for its co-operation in the formulation of the several technical programs of mutual interest to the WMO and the CSAGI, and invites the attention of the WMO to the results of the CSAGI Brussels meeting, at which valuable contributions of the WMO were incorporated in the CSAGI programs, reports, and resolutions, and invites the further interest, advice, and aid of the WMO in the IGY work.

(13) The Secretary General of CSAGI is authorized with respect to the several reports and resolutions of the several working groups of CSAGI:

(a) To make revisions and to edit as necessary in order to provide for clarity and continuity in the final published report of the Brussels Meeting; and

(b) To combine resolutions involving the same substance when this is advisable for clarity and conciseness, upon consultation with the Reporters of the interested working groups or the Bureau of CSAGI.

Resolutions on CSAGI Publications

(1) The CSAGI authorizes the Bureau to appoint a continuing Publications Committee, to advise the Bureau on questions concerning the CSAGI publications.

(2) The CSAGI resolves to issue series of publications, and authorizes the Bureau to make all necessary arrangements involved in their editing, translation, and publication. Any part(s) of this work may be delegated to appropriate agencies. The contents of such publications would include the following:

(a) The IGY program and stations, and a history of the two International Polar Years and of the IGY project.

(b) Instruction Manuals, at least one for each branch (I to XIII) of the IGY program: their editing and translation to be arranged in conjunction with the corresponding CSAGI Reporter.

(c) Current IGY information, to be issued by the General Secretary at such intervals as he deems appropriate.

(d) A guide to the availability of IGY data, to enable those who wish to obtain or use IGY data to know whence and how they may be obtained.

(e) Bibliographies of IGY data.

Later a series of volumes recording salient IGY results will be published.

(3) The CSAGI authorizes the Bureau to arrange that the CSAGI Reporters shall co-opt editors for the CSAGI Instruction Manuals, and for necessary translation from English into French or vice versa.

(4) The CSAGI resolves that its publications shall bear a distinctive symbol, which, with the authorization of the CSAGI, may also be used on IGY publications issued by other bodies, on letter heads, postage stamps, and on instruments and equipment devised or used for the IGY program. The CSAGI authorizes the Bureau to arrange for the design and preparation of the IGY symbol.*

(5) The CSAGI requests the National IGY Committees to deposit observational and other documents in accordance with the resolutions on World Data Centers (see (1) below), and to inform the General Secretary of such depositions, in order that he may keep watch over, and when advisable make generally known, the progress of the processes by which the IGY data are made generally available.

Resolutions on World Data Centers

(1) The CSAGI resolves that all observational data to be exchanged in accordance with the IGY program shall be available to scientists and scientific institutions in all countries. The CSAGI will designate a number of World Archives at which the data relating to different subjects will be assembled and from which copies can be obtained, on payment of cost of reproduction if necessary.

(2) The CSAGI will publish in appropriate form information as to the data to be contributed by National Committees to the World Archives.

* It is desirable to register the IGY Symbol for protection against unauthorized use.

(3) The CSAGI will issue a series of notes reporting on the progress of national IGY plans, and giving accounts of difficulties encountered and solved or to be solved, and other technical information of value to the IGY.

(4) The CSAGI recommends that, so far as appropriate, tabular IGY data should be arranged for handling by machines.

(5) The CSAGI will publish a guide to the availability of IGY data, and will issue periodically bibliographies of IGY publications and discussions of IGY data.

4 Organization of the Future Work of the CSAGI

The CSAGI recognizes that the work of planning the program of the IGY 1957–1958 will be substantially completed at the end of this, its Third General Assembly, although some additions may be found desirable even after the publication of the report of this Assembly. Henceforward the efforts of the CSAGI must be devoted mainly to promoting the execution of the program, and to planning the most effective ways of publishing, distributing and analyzing the IGY data during and after 1957–1958. These purposes will require the continuance of the CSAGI for some few years after 1958, and then it should be dissolved.

The CSAGI authorizes the Bureau to promote the execution and, if need arises, the extension of the IGY program, by acts and decisions currently required.

Reporters

The CSAGI appoints Reporters as follows from among its own members, to advise the Bureau on matters that arise concerning the various parts of the IGY program:

I	World Days	Mr. Shapley
II	Meteorology	Professeur Van Mieghem
III	Geomagnetism	Dr. Laursen
IV	Aurora and Airglow	Professor Chapman
V	Ionosphere	Dr. Beynon
VI	Solar Activity	Sir Harold Spencer Jones
VII	Cosmic Rays	Professor Simpson
VIII	Longitudes and Latitudes	Professor Danjon
IX	Glaciology and Climatology	Mr. Wordie
X	Oceanography	M. Laclavère
XI	Rockets and Satellites	Dr. Berkner
XII	Seismology	Dr. Beloussov
XIII	Gravimetry	Father Lejay

Advisory IGY Committees

The working groups that have advised the CSAGI during its three planning Assemblies have been appointed on each occasion only for the duration of each assembly. The International Unions have permanent functions extending indefinitely beyond the time when the CSAGI will be dissolved; the CSAGI regards them as best fitted to provide continuing IGY committees to assist the CSAGI in regard to the various branches of the IGY program, and to be available for consultation by the corresponding Reporters. Valuable aid of this kind has been received from the Union-IGY committees appointed by URSI and IUGG. The Unions and International Associations are invited to set up or to maintain such advisory IGY committees for each branch of the IGY program. Each such committee is invited to keep the corresponding Reporter and the General Secretary of the CSAGI informed of its work, and of any recommendations it may wish to make, and also to invite them to any meetings the committee may hold. The General Secretary will acquaint the National IGY committees of such recommendations when the Bureau considers this appropriate. The Unions and International Associations may find it desirable to continue such IGY committees for some time after the CSAGI is dissolved, to promote the availability and analysis of the IGY data.

Where some branch of the IGY program needs consideration by such an advisory committee, but no Union or Association has appointed an appropriate committee, the corresponding Reporter, with the approval of the Bureau, may arrange the formation and meetings of an *ad hoc* committee; but the CSAGI hopes that any such committee will be absorbed by the appropriate Union or Association as soon thereafter as feasible.

Collection and Distribution of IGY News

National IGY Committees are asked to send annual reports to the General Secretary during the years 1956–7–8, indicating the stages reached in the execution of their program; they are also invited to send current IGY news to the General Secretary at other times when they deem this appropriate. The General Secretary will publish such reports and news subject to the approval of the Bureau. The General Secretary is authorized to request information from the National IGY Committees and to transmit recommendations to them.

Exceptional Developments

Until the completion of the IGY the Reporters and the CSAGI as a whole are requested to keep watch for any exceptional scientific developments within the scope of the IGY, and to take any consequent steps to exploit these developments for the benefit of the whole program.

Adjoint Secretaries

The General Secretary, with the approval of the Bureau and the Finance Committee of the CSAGI, may delegate any part of his responsibilities to Adjoint Secretaries.

Further Meetings

The Bureau may arrange further meetings of the CSAGI and the ACIGY as may prove desirable. The Bureau is authorized at its discretion to invite observers or to organize working groups or committees in connection with such meetings.

IV—THE FOURTH MEETING OF THE CSAGI

(Barcelona, 10–15 September, 1956)

1 General Report

1.1 *Introduction*

The Special Committee for the International Geophysical Year (CSAGI) held its Fourth Assembly at the "Consejo Superior de Investigaciones Cientificas" in Barcelona, 10–15 September 1956, through the kind invitation of the Spanish National Committee for the IGY. The Advisory Council for the International Geophysical Year (ACIGY) also convened in Barcelona as a part of the same Assembly. A number of associated scientific and executive working groups met or were formed during the meeting to consider specific questions relating to the IGY program.

The inaugural plenary session was held in the Barcelona City Hall graciously made available by the civic authorities.

The first three meetings of CSAGI had been held in Brussels in 1953, Rome in 1954, and again in Brussels in 1955, as described in Chapters I-III. Thirty-eight national reports were received at Barcelona from the National Committees participating in the IGY.

The inaugural plenary session was held at 10.00 a.m. on the morning of Tuesday, 11 September. The remainder of the day was devoted to a conference and symposium on satellites planned for launching during the IGY. The final plenary session was held at 12.00 on Saturday, 15 September. In addition to these sessions, the CSAGI met four times in executive session and once in joint session with the ACIGY, which itself met separately three times during the course of the conference.

The Bureau held meetings each day in the period beginning 5 September and extending through the final day of the conference, 15 September. The Adjoint Secretaries joined in session with the Bureau on the morning of 7 September; in the afternoon, the Editor and the Chairman of the Publications Committee met with the Bureau. The Publications Committee met throughout the day on 8 September, and the Finance Committee and Bureau convened together on the afternoon of the eighth. Working groups for the IGY scientific disciplines represented at the conference convened on the afternoon of Wednesday, 12 September and on Thursday, 13 September.

The timetable of the meetings was as follows:

Timetable (September 1956)

Inaugural Plenary Session:	Tuesday, 11th, at 10.00 a.m.
Final Plenary Session:	Saturday, 15th, at 12.00 noon.
CSAGI Sessions:	Monday, 10th at 10.00 a.m. and 3.45 p.m.
	Thursday, 13th, at 11.30 a.m.
	Saturday, 15th, at 10.30 a.m.

CSAGI and ACIGY Joint Session:	Wednesday, 12th, at 10.00 a.m.
ACIGY Sessions:	Wednesday, 12th, at 5.30 p.m.
	Thursday, 13th, at 3.30 p.m.
	Saturday, 15th, at 10.00 a.m.
Discipline Working Group Meetings:	Wednesday, 12th.
	Thursday, 13th.
Satellite Conference:	Tuesday, 11th, 3.30 p.m.

Members of the press were invited to attend the inaugural and final plenary sessions, and a series of press conferences were held by the Bureau during the meeting.

On the evening of Thursday, 13 September, the participants and the press were privileged to view a feature-length documentary color film on the activities of the Soviet IGY Antarctic expedition during the Antarctic summer of 1955–56.

Mr. P. LAW showed colored slides of Antarctica, and the Australian base at Mawson which had been established in the 1954 season.

On Tuesday evening, 11 September, the participants and their families were entertained at a Folklore Festival held in the Pueblo Espagnol in Barcelona. The participants' ladies were taken on two sightseeing trips within the city of Barcelona on Wednesday and Thursday, 12 and 13 September. All these activities were provided through the hospitality of the Barcelona city authorities.

The participants and their ladies enjoyed a very pleasant all-day excursion to Montserrat on Friday, 14 September. On Sunday, 16 September, following the close of the Conference, the participants and their families made a most enjoyable all-day excursion to Tarragon and the observatory at Tortosa.

1.2 *CSAGI Inaugural Plenary Session*

10.00 a.m., Tuesday, 11 September 1956

1.2.1 *Opening addresses*

Admiral RAFAEL ESTRADA, Chairman of the Spanish National Committee for the IGY, opened the Inaugural Plenary Session with the following words of welcome:
"Excellences, Mesdames, Messieurs,

"Comme Président du Comité National de l'Année Géophysique Internationale, je me fais un plaisir de souhaiter la bienvenue aux assistants de ces importantes réunions plénières qui ont commencé à Bruxelles et se sont continuées à Rome. A cette sincère expression de bienvenue, j'ajoute l'admiration de notre Comité pour le très grand labeur de MM. le Président, le Secrétaire et les honorables membres du Comité Spécial qui, selon leurs sages indications et instructions, ont organisé une des plus grandes entreprises que les hommes de science puissent projeter et mettre à exécution.

"L'entreprise est grande dans tous les sens, car son ampleur couvre le monde entier. C'est la mobilisation générale de l'homme pour découvrir les mystères que la Nature cache: dans la couche gazeuse qui entoure la terre; à la surface et au sein de celle-ci et dans l'Astre-Roi qui nous domine et nous dirige. Ce soleil, adoré par les anciens, nous conduit à travers l'immense espace stellaire, dans un voyage vertigineux et imperceptible aux sens de l'homme, vers une limite et un objectif inconnus, sans but et portée apparents, mais qui doit avoir un terme comme la vie sur terre et celle des astres qui peuplent l'immensité de l'Univers.

"L'entreprise qui nous réunit aujourd'hui est grande, parce que son objectif est celui de la paix authentique et du progrès dans le futur de l'homme; parce qu'elle demande le concours de toutes les nations, l'union confiante de tous les hommes de bonne volonté.

"Vraiment cette attitude est nécessaire pour pouvoir supporter les rigueurs du climat dans des régions qui, il n'y a pas longtemps, étaient encore interdites à l'être humain. Des lieux glacés du pôle à ceux torrides de l'équateur, il faut étudier toute espèce de phénomènes: météorologiques, magnétiques, électriques, luminescents, etc. . . ., etc. . . ., et l'observation simultanée, sur terre et dans la mer, nous donnera les moyens de capter quelque chose en plus de ce nous savons, de ce que Dieu nous cache pour que nous le découvrions par le grand effort de l'union de tous. Il ne s'agit pas d'une audace similaire à celle de Babel, c'est l'union étendue aux différents endroits de la planète.

"Les observateurs au pôle verront se lever devant leurs instruments les beaux fantômes lumineux des ondulantes aurores dans la nuit continuelle et tragique de l'hiver polaire, ainsi qu'un radieux soleil en été, pendant le jour sans fin, sans que les crépuscules meurent ni les neiges se fondent. Les observateurs à l'équateur, enveloppés dans une dense et chaude atmosphère, et menacés des dangers qui entourent les hommes là-bas, prendront note, comme ceux du pôle, de tout ce qui se passe dans le ciel et sur la terre. Tous les observatoires du monde, aux mêmes instants précis, décidés d'avance, enregistreront les courants telluriques, les palpitations du sol, les perçants rayons cosmiques et d'autres phénomènes d'intérêt scientifique. Quelque part, là où les ballons et fusées n'arrivent pas, entourant la terre dans la haute atmosphère, surgira dans un vol terriblement rapide, inconnu jusqu'à présent, un tout petit frère de notre lune mélancolique, un satellite créé par les hommes : astre artificiel, sporadique, essai génial, qui pourrait être le précurseur minuscule et avancé, de la conquête de cette astronautique que, réellement, si nous voulons être sincères, nous voyons très lointaine et enveloppée d'une brume tellement dense, qu'il nous paraît impossible de percevoir les claires lumières qui augurent du triomphe rêvé.

"Dans ce grand concert des nations du monde, l'Espagne a contribué par tout ce qu'elle possède. Elle a apprêté ses observatoires en vue de faciliter avec leurs renseignements l'ample statistique exigée par l'Année Géophysique Internationale et nos hommes de science seront à Fernando Poo et aux Iles Canaries, pour apporter leur collaboration souhaitée par le Comité Spécial.

"Pour arriver à un tel but, nous qui faisons partie du Comité National, avons eu recours, en premier lieu, à S.E. le Chef d'Etat et, trouvant l'appui auquel nous nous attendions, avec le stimulant conséquent, nous avons obtenu l'aide nécessaire dans les différents Ministères. Celui de la Présidence, non seulement en nous donnant les moyens de développer l'Institut Géographique et Statistique avec ses Observatoires et autres établissements scientifiques, mais aussi par l'aide que nous sollicitions de l'ensemble des départements d'autres Ministères. Celui de l'Education Nationale, en nous procurant les moyens de compléter les installations de l'Observatoire de l'Ebre, entité qui participe à l'AGI avec le zèle et l'efficience proverbiaux avec lesquels les

RR. PP. Jésuites ont organisé cette Assemblée. Le Ministère de l'Air avec son Service Météorologique et celui de la Marine avec son Observatoire de San Fernando et ses Instituts Océanographique et Hydrographique, ont également prêté leur puissant concours. Pour finir, nous ne pouvons pas oublier l'aide apportée à cette énorme entreprise géophysique par le Ministère des Finances par son assistance financière. Ayant dû s'absenter, le Ministre DON LUIS CARRERO n'a pu présider cette session comme il l'aurait désiré.

"L'Espagne a été très honorée d'être choisie par le Comité Spécial comme siège d'une de ses plus intéressantes réunions, et Barcelone, avec son hospitalité coutumière, a accepté avec plaisir la demande du Comité National. Je me permets donc de présenter également nos remerciements aux dignes autorités de la Cité Comtale; car nous savons que vous tous, illustres professeurs des pays ici représentés, emporterez un bon souvenir de votre séjour dans cette ville qui, il y a quatre siècles et demi, a reçu en triomphe, en présence des Rois Catholiques, notre Premier Amiral des Indes, le découvreur du grand mystère géographique continental, qui a dévoilé les ténèbres océaniques.

"Le Comité National de l'Année Géophysique Internationale salue fraternellement tous les Comités représentés en cette réunion plénière à laquelle, il est inutile de le dire, il souhaite un succès complet."

President CHAPMAN replied that it was a great pleasure to respond in the name of the CSAGI and the ACIGY to the welcome extended by Admiral ESTRADA, President of the Spanish National Committee for the IGY. He further remarked that those attending the meetings were especially glad to meet in Spain, which has long shown great interest and eminence in geophysical research as demonstrated by the many institutions which are represented on its National Committee and which are contributing to the IGY program. President CHAPMAN noted that the initiative for holding the Conference at Barcelona came from Fathers ROMANA and CARDUS of the Observatory at Tortosa, which has a long record of contribution in geophysics and has been represented at meetings of the IUGG for many years. The General Secretary had visited Tortosa to make preliminary arrangements for the Conference and had told of their labors for the Conference in the service of science. President CHAPMAN regretted that the President of the Spanish Council of National Research and other Spanish officials would not be present to receive thanks for the conference rooms made available and the services rendered the CSAGI. Finally, he referred specifically to the observatories, institutes, societies, services and academies which are represented on the Spanish National Committee, and which give evidence of the great interest in geophysical research in Spain.

After President CHAPMAN's response, Mr. D. ANTONIO MA SIMARRO, the Mayor of Barcelona, extended the city's greetings in a speech of welcome. President CHAPMAN thanked the mayor and the civic authorities of the city of Barcelona for use of the splendid hall in which the inaugural plenary session was held, for the entertainment planned for the delegates that evening, and for the ladies' excursions through the city.

1.2.2 *Conference on rocket and satellite observations*

Dr. L. V. BERKNER, in his capacity as CSAGI Reporter for Rockets and Satellites, opened the Conference by tracing very briefly the development of experimental techniques for studying the high atmosphere, beginning with indirect experiments and now including the more recent rocket techniques. He noted that both the URSI and IUGG meetings of 1954 had recommended that the feasibility of satellite launchings be considered, and he expressed the wish that still other countries would be able to participate in the IGY rocket and satellite programs.

Dr. BERKNER announced that the first part of the program would be devoted to statements by representatives of National Committees who would describe their rocket-satellite programs. In the afternoon session, more detailed technical information on the satellite would be presented. Complete technical information would be given so that all countries could join in making satellite observations.

Dr. BERKNER then introduced the first of the National Committee representatives, Dr. J. KAPLAN, chairman of the U.S. National Committee, to describe the rocket-satellite programs. This presentation was followed by statements from representatives of the National Committees of the USSR, United Kingdom, France, Japan, Canada, and Australia.

A *The U.S. IGY rocket and satellite program.* (a) *Introduction.* The satellite program for the International Geophysical Year represents a new departure in man's continuing effort to increase his knowledge of the physical universe. Its significance for science, in permitting man to reach into the upper atmosphere to gather data needed for an understanding of his environment, cannot be over-stressed. It is one of the boldest, most imaginative steps taken by man, and it represents the first stage in his acquisition of direct knowledge of the universe far beyond the earth's surface and far beyond the scope of aircraft, balloons, and even conventional research rockets.

The primary objective of the program is, then, the acquisition of knowledge about the outer atmosphere and the particles and radiations impinging upon it from the sun, the stars, and the interplanetary medium. For centuries man was limited in his exploration of outer space to the observations he could make from the surface of the earth. The envelope of atmosphere surrounding the earth has seriously restricted man in his understanding of particles and radiations. Direct observations are needed; but direct observations can only be obtained by actually reaching out beyond the lower, dense portions of the atmosphere.

Rockets are tools to reach directly into the outer atmosphere, providing data not only of great intrinsic value, but information that can be correlated with the vast quantities of ground-based observations.

The U.S. rocketry program calls for the firing of some 200 research rockets during the IGY, with about twenty additional test rockets to be fired before the IGY begins. The types of rockets to be used will include the Aerobee, the Nike-Cajun, the Nike-Deacon and Rockoons. This program, since it does not represent a separate discipline, has been designed to complement various studies. Thus there will be experiments in atmospheric composition, radiation studies, particle studies, and ionospheric and geomagnetic measurements.

Many rockets will carry out several experiments, so that the total number of rockets that will be fired does not give an accurate picture of the scientific importance of this project. For example, there will be three types of experiments from shipboard rockoon launchings from the Arctic to the Antarctic. Rockoons carrying cosmic-ray equipment will be launched about every five degrees of latitude to provide a cross-section of cosmic-ray intensity at various geomagnetic latitudes. The second experiment involves sending rockoons into the ionosphere in the region of the geomagnetic equator to make direct observations of the presumed equatorial current. The third group of experiments involves the study of so-called soft radiation above 50 km in the southern auroral zone. This last group will be co-ordinated with simultaneous observations in the northern auroral zone.

To promote inter-discipline and international co-operation, the details of the U.S. rocket-sounding program have been published in the proposed program of the U.S. National Committee. We have also published as firm a schedule of rocket firings as it is possible to make. These firings are scheduled for Regular World Days whenever possible. There will, as well, be an effort to perform suitable rocket experiments during Meteorological and Special Intervals. Rockets are limited, however, to a narrow zone of the atmosphere, ascending and descending almost vertically, and to short intervals of time. In spite of these limitations, research rockets continue to represent a valuable and unique tool, particularly within the region between the maximum range of sounding balloons—about 100,000 ft (30 km)—and the minimum altitude that can sustain satellite flights—roughly 200 miles (320 km). The advantages of satellites are that they provide a vehicle for carrying instruments above the major portion of the atmosphere for an appreciable length of time, and that they can traverse a broad expanse of the high atmosphere.

The IGY satellite program thus affords an unusual opportunity for the world's geophysicists to acquire information about the upper atmosphere. As in other IGY programs this opportunity is a broad one: the nations of the world will not only observe the satellite but will participate in the scientific program. Extensive international participation will yield maximum advantage from the endeavor. Observations by radio or optical instruments permit the conduct of important experiments relating to outer atmosphere air density, composition of the earth's crust, and various geodetic determinations.

A preliminary list of advantageous satellite observation and measurement sites has been made by the U.S. National Committee, calling for some thirteen optical observation stations and some ten radio observation stations forming a picket line along the 75° meridian. Emphasis has been placed on a north-south line of stations, in view of the launching aspect, with some added stations to provide longitudinal coverage. These are but suggestive. It is hoped that many more stations will be established by the nations participating in the IGY.

I should like, in these remarks, to summarize the salient aspects of the satellite. First, the development of the program through CSAGI deliberations and actions. Second, the subsequent development of the U.S. National Committee's satellite program and aspects of its present status. Third, the scientific program relating to ground-station observation and measurements, including some proposed station sites. I should like as well to mention some of the types of experiments that can be conducted by the instrumentation within the satellite. What I have to say is, therefore, in the nature of a progress report, outlining what has been done and pointing out some of the things that still remain to be accomplished.

(b) *Development of satellite program.* The satellite program is not one which has sprung up overnight. Its origins go back to the development of rockets, to which scientists and engineers of many nations have contributed during the last three decades. Particularly important, of course, has been the use of rockets for upper-atmosphere research. Almost a decade of upper-atmosphere research with Aerobees and Vikings in the United States and with similar devices in other countries lay behind the CSAGI at the time that a satellite program was considered. As a matter of fact, the satellite program is so much an extension of the upper-atmosphere rocket-research program that I designated our own program as the LPR—the long-playing rocket.

It is gratifying that the IGY satellite program has been established as a civilian program of broad base, resting upon the contributions of many investigators of many nations. And it is most fitting that the results of these investigations now make possible, during the IGY, the accomplishment of this long-desired objective, providing a tool that will permit us to measure directly, over long periods of time and over an appreciable expanse of the outer atmosphere, those phenomena about which man needs to know so much more. And it is fitting that we meet here to discuss the further collaboration of the many scientists of many nations, at what is probably the last meeting of the CSAGI before the IGY formally commences, in an effort to maximize the possibilities in this great, pioneering program.

Interest in earth-circling research satellites for the IGY began with the adoption of resolutions, during the summer and early fall of 1954, regarding the desirability of such vehicles. These resolutions were adopted by three international scientific bodies: The International Scientific Radio Union, the International Union of Geodesy and Geophysics, and the Special Committee for IGY of the International Council of Scientific Unions (CSAGI). The resolution of most immediate interest is the one adopted on 4 October 1954 by the CSAGI:

"In view of the great importance of observations during extended periods of time of extra-terrestrial radiations and geophysical phenomena in the upper atmosphere, and in view of the advanced state of present rocket techniques, CSAGI recommends that thought be given to the launching of small satellite vehicles, to their scientific instrumentation, and to the new problems associated with satellite experiments, such as power supply, telemetering, and orientation of the vehicle."

In view of these international recommendations, the U.S. National Committee for the IGY (USNC-IGY) studied the possibility of constructing, launching and observing an instrumented IGY satellite. These studies led to the conclusion that an instrumented satellite program not only was of scientific importance but was feasible. On 14 March 1955, accordingly the Committee transmitted its general recommendation for its IGY Satellite program to the President of the National Academy of Sciences and the Director of the National Science Foundation.

Meanwhile the scientific and technical studies of the Committee's special satellite group continued. By the early part of May, a preliminary program had been developed, and the Committee directed its chairman to transmit the proposed program to the Government. This was done on 6 May 1955.

Late in July the Government's approval of the satellite program permitted the chairman of the USNC to notify the CSAGI of our plans. In my letter of 26 July 1955 to Professor SYDNEY CHAPMAN, President of CSAGI, I said:

"The Committee on behalf of the National Academy of Sciences wishes to inform you at this time that, in response to the CSAGI resolution, the program of the United States for the International Geophysical Year now includes definite plans for the launching of small satellites during the International Geophysical Year.

"The United States National Committee believes that significant scientific data may be gathered as a result of this program in such fields as geodesy, atmospheric physics, auroral physics, ionospheric physics, and solar radiation. The participation of other nations engaged in the International Geophysical Year is invited, and to this end we shall provide full scientific information on the orbiting vehicle, so that other nations may monitor the device and make appropriate observations. The United States National Committee looks forward to the interest and co-operation of other nations in what it hopes will be one of the great scientific achievements of our time."

On 29 July 1955, Professor CHAPMAN released this letter to the public at Brussels through CSAGI's Secretary General, Dr. M. NICOLET. A few minutes later, the President's endorsement of the program was made public in the United States at the White House by the President's press secretary:

"On behalf of the President, I am announcing that the President has approved plans by this country for going ahead with the launching of small, unmanned, earth-circling satellites as part of the United States participation in the International Geophysical Year, which takes place between July 1957 and December 1958. This program will, for the first time in history, enable scientists throughout the world to make sustained observations in the regions beyond the earth's atmosphere.

"The President expressed personal gratification that the American program will provide scientists of all nations this important and unique opportunity for the advancement of science."

Professor CHAPMAN replied to me on 3 August 1955. I should like to quote three paragraphs from Professor CHAPMAN's letter:

"On behalf of the CSAGI, I wish to express great satisfaction that it was in consequence of the CSAGI resolution you quote, that your National Committee arranged for a study of the possibilities and value of the construction of a satellite vehicle for upper atmosphere and other scientific exploration.

"I am glad to know that this study was so successful that your Committee felt able to resolve to construct and launch small satellites as a part of the United States contribution to the International Geophysical Year and to announce these plans publicly. The long experience of your scientists in rocket launching and construction, and the brilliant scientific use they have made of rockets for upper-atmospheric and solar exploration, gives confidence that the plans so announced will be fulfilled.

"This will indeed be one of the great scientific achievements of our time, and will give occasion and opportunity for the co-operation of other nations in this outstanding part of the great enterprise, the International Geophysical Year."

These, then, were the early steps in the development of the Academy's IGY satellite program.

(c) *World-wide co-operation.* As in all of the IGY, the co-operative nature of the satellite program is particularly important if the full scientific value of the project is to be realized. Only with the co-operation of scientists throughout the world can this program, or indeed any of the other programs of the IGY, yield their full potential. In this connection I should like to mention some relevant resolutions passed by the Western Hemisphere IGY Regional Conference held at Rio de Janeiro, 16–20 July. The conference recognized the need for an expanded communications network among the IGY nations, relaying orbital and other satellite data quickly and broadly.

It was also recommended at the conference that the countries planning earth-satellite programs as a part of the IGY make available as soon as possible to all National Committees detailed information on radio and optical stations for satellite observation, in order to facilitate the establishment of satellite observing stations in many countries throughout the world, and thereby to provide the accurate and widespread observation of the satellite which is necessary for the full realization of its scientific capability. The U.S. National Committee will continue, as in the past, to provide CSAGI with all available details on the satellite program, so that this information will be available to any interested country.

The Western Hemisphere IGY Regional Conference also called the attention of the CSAGI to the desirability of recommending that the maximum feasible number of artificial earth-satellite vehicles be launched and that these vehicles be designed to carry the maximum payload of instruments. It is recommended as well that the orbits of the vehicles cover as wide a range of latitudes as possible, and that as many nations as possible consider the contributions which they can make to the program, especially in making observations on the vehicles in flight. For this purpose it was recommended that consideration be given to the establishment of ground observing stations. The conference adopted this resolution in consideration of the great importance of the observations to be made with the satellite and the many kinds of data that can be obtained only in such a scientific experiment.

In still another resolution the conference recommended that the CSAGI invite the National Committees of all countries participating in the IGY to appoint satellite committees or reporters, so as to channel the exchange of information on earth-satellite programs among the participating countries.

(d) *Organization of U.S. effort.* Within the United States, broad participation of American scientists in this endeavor is being effected by the National Academy of Sciences, which established the U.S. National Committee for the IGY. This Committe, with its subcommittees and panels, is charged with responsibilities for planning, directing, and executing the U.S.-IGY effort, embracing every discipline and area of our IGY participation. The Government has co-operated extensively in the realization of the program, both program-wise and fiscally.

In the development of the satellite program and assignment of responsibilities, the National Academy's Committee recognized that there were two major areas of activity. First, there were the engineering problems associated with the design and construction of the propelling rocket vehicles, their launching, and associated logistics problems. Second, there were the problems of the scientific program, and here we had in mind, first, the radio and optical ground observation and measurement programs, and, second, the various experiments, both ground based or contained within the satellite itself, which might most profitably be conducted in the interests of the IGY and science.

In recent years significant scientific studies of the upper atmosphere have been conducted by the civilian laboratories of the Department of Defense and their industrial and university contractors, using research sounding rockets. The experience and competence of these groups led the Committee to request of the Government that this talent be utilized in the design, construction, and launching of the rockets. This responsibility has been assigned to the Naval Research Laboratory, which is in charge of the contributions of the three military services and various industrial contractors.

The high-precision optical observation program in the United States has been assigned by the Committee to the Astrophysical Observatory of the Smithsonian Institution. The precision radio observation program has similarly been assigned to the Naval Research Laboratory, which has developed the system and the equipment. Plans have been developed for participation of a number of private and public laboratories for the development and design of experiments and instruments.

(e) *Satellite rocketry and launching.* Present plans call for the satellite to be launched from the east coast of Florida at Cape Canaveral. A three-stage rocket will be used to place it in orbit. The rocket will be about 72 ft (22 m) long and will have a maximum width of 45 in. (115 cm). It will be finless, using internal controls for guidance.

The first stage will have a thrust of 27,000 lb. (12,250 kg). It will propel the system upwards, gradually tilting, until at burnout the vehicle will be moving at an inclination of approximately 45°. The first stage will be discarded at burnout and the second stage will take over.

The second stage will include the control systems for all three stages: guidance during the flight of the first two stages, guidance during the coasting of the second stage, and the start of the third stage.

The second-stage motor will drive the vehicle to an altitude of about 140 miles (225 km), and then coast some 700 miles (1130 km) to attain a desired altitude of between 250 and 300 miles (400–485 km). At this altitude, after the nose cone has been ejected, the third and final stage will have begun. The second stage will be discarded and the third stage will quickly consume its solid fuel in impelling the satellite into its orbit with the necessary orbital velocity of 18,000 miles per hour (28,900 km/hr).

(f) *Physical description and orbit.* The first satellite will be spherical in shape, about 20 in. (50·8 cm) in diameter, and will weigh approximately 21·5 lb. (9·8 kg). About half of this weight will be required for the instrument itself; the other half will be left for the various instruments, including the telemetering system.

The satellite's orbit will permit it to revolve about the earth in an apparent latitude range of about 40° on either side of the equator. As it revolves about the earth once in slightly more than an hour and a half, the earth will rotate beneath. Since the earth rotates about its axis once every 24 hr, it will have made about one-sixteenth of a revolution each time the satellite orbits once completely. If the orbit of the satellite were circular, one-sixteenth of a revolution, or 22·5° would be approximately accurate. The orbit will be elliptical, however, so that more than one-sixteenth of a revolution will be made by the earth during one revolution of the satellite:

the displacement will be about 25°. Thus after one revolution the satellite will appear about 25° west of its launching site, 50° on its second passage, and so on.

In this orbit between 40° N–40° S of the equator, the satellite's instruments will be able to record observations over an appreciably broad expanse of the high atmosphere. This 80° coverage will permit many scientists of a large number of nations to take measurements and to make observations. The U.S. National Committee hopes that some satellites, after the initial ones, may be placed in other orbits so as to permit scientists of additional nations to participate in the study.

Once placed in its orbit, the satellite becomes in effect a celestial body. As such, the first problem becomes its acquisition—those initial observations which not only establish its celestial existence but which provide data for preliminary calculations of its orbit in order that ephemerides may be made. These predictions will permit, first, the concentration of ground stations on the preliminary orbit, and, second, the subsequent acquisition of more extensive data on the basis of which the various studies can be conducted.

Precision in determination of the orbit of the satellite as it moves in its elliptical path from between 200–300 to perhaps 800–1500 miles (320–485 to 1300–2400 km) from the earth is necessary, therefore, to the achievement of the planned experiments. Plans call for tracking, observation, and measurements using both optical and radio methods. One of the difficulties in the initial optical acquisition of the satellite is the problem of atmospheric conditions. Extensive cloud cover, for example, would minimize the chance of optical acquisition. Here the radio system can play an important part.

(g) *Radio observations and measurements.* Radio observations will employ a system developed by the Naval Research Laboratory. It is a precision, several-component system known as Minitrack. Ground stations using the Minitrack will include a precision multiple antenna array and an extensive electronics installation, requiring an operating staff of several technicians. The expected precision of observations is about 3′ of arc under normal conditions, with improvement to a precision of 20″ of arc for observations at small zenith angles, or for night-time operation. The USNC plans to install a limited number of stations with this type of equipment.

A second radio tracking system, called the Mark II Minitrack, is of lower precision, but still of great value because of its adaptability to extensive use. A broad network of such stations would contribute appreciably to the program, particularly in the acquisition and tracking of the satellite.

In terms of minimum north-south chain of stations, intended to insure radio observations, and in terms of necessary spacing (taking economic factors into account), the Committee believes that the following station sites would be desirable: Santiago, Chile; Antofagasta, Chile (with optical observation station); Panama; Antigua, British West Indies; Havana, Cuba; Jacksonville, Florida, U.S.A.; Washington, D.C., U.S.A.; San Diego, California, U.S.A. Plans for the co-operative establishment of these stations are under way. Additional stations are desirable, and it is hoped that many nations will participate in the radio tracking program, using both the Minitrack and the Mark II Minitrack systems.

(h) *Optical observations and measurements.* Optical observations of the satellite can be effected by three types of programs. The most precise optical observations will be made using a modified Schmidt camera developed at the Smithsonian Astrophysical Observatory. Continuous strip film will simplify the problem associated with following the satellite. To provide accurate timing, crystal clocks calibrated against WWV will give a signal for photography simultaneously with the satellite. Time must be read to the millisecond. Before the Schmidt cameras can be employed, however, the path of the satellite must be known to a precision of about 3°.

Some of the ourrently proposed photographic stations are along the 75° meridian, as are most of the radio stations, while others extend east-west toward the northern end of the satellite's band-width, where visibility conditions appear more favorable.

On the basis of visibility and other technical considerations, the U.S. National Committee feels that some desirable locations for the optical observation stations include the following: White Sands, New Mexico, U.S.A.; Cocoa Beach, Florida, U.S.A.; Venezuela or Netherlands Antilles; Quito, Ecuador (with radio observations); Antofagasta, Chile (also with radio observations); Cordoba, Argentina; Bloemfontein, South Africa; Australia; Maui, Hawaii; Southern Japan; India or Pakistan; Egypt or east edge of Mediterranean; Southern Spain or Morocco. Because conditions of visibility will restrict optical observations to brief morning and evening twilight periods, additional stations distributed in both latitude and longitude would be desirable, and it is hoped that many nations will establish such optical observing stations.

The Schmidt camera system requires that the path of the satellite be initially known to a precision of 3° so that preliminary sighting positions can be established. The radio tracking system will provide this information, but to provide for the remote chance of radio failure in the satellite, a network of organized volunteer observers will be used.

In this connection I should also like to mention that the U.S. National Committee has developed plans for obervers not directly associated with the IGY to make a scientific contribution in the fields of ionospheric physics and aurora, similar to that which is being developed for the satellite itself.

Returning to the volunteer visual observers satellite program: although a particular individual will obviously have difficulty in viewing the satellite, trained teams of observers can undertake a satellite acquisition program. By placing binoculars on fixed mounts and employing a group of such installations disposed so as to cover a large region of the heavens, with good data as to position of the installation, timing of observations, and critical review of the observations by scientists, a major contribution to the overall program is possible.

In the United States such organizations as the American Association of Variable Star Observers are organizing their members to serve as teams of observers. These groups will receive their instructions from the Smithsonian Astrophysical Observatory, and the data gathered by them will be collated by that institution.

Valuable work can be done by astronomical observatories and the physics departments of universities throughout the world. Using wide-field astronomical equipment which can be adjusted to follow the movement of the satellite, the observatories could undertake significant observation programs. Such institutions could, for example, establish interesting programs combining, say, optical and Mark II Minitrack equipment and entering into the analyses of data. I am sure that most useful and stimulating programs of this type will be developed by scientists at universities and astronomical observatories. One must bear in mind that the whole satellite program is new and that there has been little time to consider the many potentialities of ground station programs. But we can be sure that the many scientists of many nations, bringing to play their imaginations, cannot but extend our concepts of valuable studies of the kind I have so briefly outlined.

(j) *Ground station experiments.* One of the most important sets of experiments in the earth-satellite program, as I have suggested, relates to observations, measurements, and calculations which can be made from ground stations. Here both radio and optical observation stations play significant roles. The following are three areas of study that can be conducted:

(1) Air Density: Very little is presently known about the density of the upper atmosphere. From the geometry of the satellite's course and observations of its flight, calculations can be made of the air density.

(2) Composition of the Earth's Crust: The satellite orbit will have a basic periodicity with perturbations dependent upon local non-uniformities in the gravitational field. Careful observations of the orbit and its variations will permit calculations of mass-distribution in the earth. This, in turn, should yield information about the composition of the crust.

(3) Geodetic Determinations: Determinations similar to those noted above will provide data about the oblateness of the earth. Synchronized observations may permit improvements in determinations of longitude and latitude. These observations would supplement the observations that are planned in the IGY Longitudes and Latitudes Program.

(k) *Satellite-borne experiments.* In addition to the experiments described above, the satellite affords an unique tool for observations of atmospheric and cosmic phenomena not directly susceptible to measurements on the earth—and phenomena which in many instances are masked by the earth's atmosphere. It is expected, within the payload limitations of the satellite, that research experiments can be conducted. Many valuable ideas for possible satellite experiments have been presented, and the National Committee will use many University and Government laboratories to develop these suggestions. The following are examples of such typical experiments under consideration:

(1) Temperatures: Measurements of temperatures within the satellite and at its surface will be made. The heat within the satellite is derived from solar radiation, the power supplies, thermal radiation emitted by the earth, and a very small amount from friction.

(2) Pressures: The satellite shell will be airtight and may contain an inert gas. Pressure gauges will be used to measure pressures during the satellite's life, in order to check on leakages and in connection with possible meteoric effects.

(3) Meteoritic Particles: Small meteoritic particles, a few thousandths of an inch in diameter, are constantly impinging upon the earth's atmosphere. Estimates as to the quantity reaching the earth's surface vary. These micro-meteorites are believed to contribute a measurable amount to ionizing the atmosphere in the

E-region (about 60–90 miles above the earth). With the use of simple impact detectors these micro-meteorites can be observed. Moreover measurements of pressure within the satellite will reveal meteorite penetration and some information on size.

(4) Ultraviolet Radiation: Much of the radiation from the sun is masked from the earth by the atmosphere. This is particularly true of the ultraviolet radiations in the Lyman-alpha region. The satellite offers an opportunity to observe this radiation on a long-term basis and thereby to determine the influence of solar flares on its emission from the sun.

(5) Cosmic Rays: Cosmic rays have high energies and there are variations in their energy content. Because the earth's magnetic field deflects these particles, only those with the highest energies penetrate the mid-latitudes. Many of the low-energy particles are absorbed in the earth's atmosphere, and observations of cosmic rays are generally of "secondaries". The satellite will permit direct studies of primary cosmic rays above the masking atmosphere.

It is fitting that this conference and its working groups are met to discuss our co-operation in the satellite program. I have tried in these remarks to outline our progress to date. Much has been accomplished. Much more remains to be done, not only in the scientific problems of placing the satellite in orbit, but also in making certain that its full potential is realized. I hope that our discussions here will lead to man's fullest utilization of this new tool, even in these first steps.

At the present time some fifty nations are formally participating in the IGY program, and additional nations are expected to participate or to co-operate in the world-wide effort during 1957–58. The IGY satellite program is one part of this unprecedented, co-operative, international effort. But the earth satellite is unique in one sense: all the other disciplines to be investigated during the IGY represent, in one form or another, extensions of existing work. They are unprecedented in scope and intensity; the results to be achieved may well extend man's knowledge of the physical universe immeasurably. The satellite program, however, is revolutionary. Nothing like it has ever happened before. The initial step that it represents, limited though it may be in terms of man's aspirations, is a historic event without parallel in terms of man's relationship to his cosmic environment. The fact that man can make a satellite and set it in an orbit about the earth is a monumental step forward in man's continuing search for knowledge of his physical environment. Perhaps even more auspicious is the fact that men are taking this historic step jointly under the aegis of the IGY, that unprecendented, co-operative exploration of our physical environment.

B *The USSR rocket and satellite program.* On the request of the General Secretary of the CSAGI, Dr. M. NICOLET, inquiring about the possibility of the Soviet Union's participation in the Rocket-Satellite program, the Soviet National Committee announced that:

(1) In addition to the USSR program already presented to the Barcelona meeting, the Rocket-Satellite program will be presented at a later time.

(2) The USSR intends to launch a satellite by means of which measurements of atmospheric pressure and temperature, as well as observations of cosmic rays,

micro-meteorites, the geomagnetic field and solar radiation will be conducted. The preparations for launching the satellite are presently being made.

(3) Meteorological observations at high altitudes will be conducted by means of rockets.

(4) Since the question of USSR participation in the IGY Rocket-Satellite observations was decided quite recently, the detailed program of these investigations is not yet elaborated.

This program will be presented as soon as possible to the General Secretary of the CSAGI.

C *The United Kingdom program.* The program of upper-atmosphere research using rocket-borne instruments which is proceeding in the United Kingdom has been made possible through collaboration between the Ministry of Supply (and particularly the Royal Aircraft Establishment, Farnborough) and a number of British Universities, the whole being co-ordinated through the Royal Society. The rockets will be fired, at least in the first instance, at the Woomera range in South Australia. This is only possible through the co-operation of the Australian Government.

The vehicle to be used is a single-stage rocket with solid-fuel motor. It will be fired from a launcher which could also be used with an Aerobee rocket. In the first instance an altitude of about 150 km is expected to be attained, with a payload (involving instruments and telemetry) of about 150 lb. The final design is expected to reach 200 km or so.

The first tests of the vehicle will be carried out before the end of 1956. Flights with instruments to investigate the following are planned to take place during IGY in numbers sufficient to give significant results:

(a) Study of pressure and density using standard gauges.

(b) Study of temperature and wind distribution using the grenade sound-ranging technique. Temperature will also be determined from the line widths of sodium lines from an ejected sodium cloud. The motion of the cloud will also give information about winds, and these will be further studied by radar tracking of suitable ejected objects.

(c) Study of micrometeorites by impact microphones.

(d) Study of airglow and atmospheric photochemical phenomena.

(e) Investigation of the nature of the ionization in the D and lower E regions.

Work has also been initiated on pulse methods for studying electron density, but it is not likely that measurements will be made during IGY. The same applies to the study of solar radiation.

Participation of the United Kingdom in the satellite-tracking program will be limited by the inadequacy of resources now available and also by the fact that up to the present, we have no information about any planned satellite orbit which will pass within easy range of radio or optical stations in the U.K. It is hoped, nevertheless, that the discussions which will take place at this conference will show how the United Kingdom can assist in this Program.

D *The French program.* Le Comité National Français pour l'AGI avait envisagé un programme très complet de lancement de fusées de différents types au Sahara.

Une section du Comité avait arrêté les différents types de mesures à exécuter. Les observations classiques de pression et de température devaient être faites au moyen de fusées à poudre montant à une altitude de 30–40 km. Pour des problèmes spéciaux de spectrographie ultraviolette, et pour l'étude de l'ionosphère, il était prévu l'emploi de la fusée Véronique qui atteint l'altitude de 165 km. Mais devant l'importance des efforts nécessaires le Gouvernement français a décidé de constituer une organisation spéciale, indépendante du Comité de l'Année Géophysique Internationale, pour prendre en mains toutes les questions scientifiques liées à l'emploi des fusées. Cette organisation s'efforcera de reprendre pour l'Année Géophysique le programme initialement fixé par le Comité National Français, mais elle continuera à jouer un rôle après la fin de l'Année Géophysique Internationale.

Les premiers lancements d'essai au Sahara ont eu lieu l'année dernière suivis d'autres en 1956. Ils ont été couronnés de succès. Nous espérons que l'équipement scientifique en cours de mise au point apportera de nouvelles données qui pourront être exploitées en liaison avec celles d'autres pays.

E *The Japanese program.* Sounding rockets will be launched at the Akita Rocket Base in Japan during IGY. The rocket to be used, called the "Kappa", has dimensions approximately the same as those of the U.S. "Aerobee" rocket. It will be a three-stage rocket, or in the worst case a two-stage rocket. The expected maximum altitude of flight of the three-stage rocket will be about 110–120 km, while that of the two-stage one will be about 80 km.

The types of observations to be made by these rockets are:

(a) Atmospheric pressure.
(b) Solar radiation.
(c) Cosmic rays.
(d) Ionic density in the ionosphere.

It might also be possible to carry out measurements of atmospheric temperature and winds.

Owing to a limited budget only ten firings, or twelve at the most, are expected during IGY. In order to strengthen our rocket program, we have now started to examine practically the possibility of launching "Rockoon"-type rockets in Japan also.

Finally it may be worthwhile to mention that the Japanese National Committee for IGY is ready to co-operate with the U.S. satellite programs by observing optically the satellites' orbits.

F *Remarks on the rocket program in Canada.* The Canadian Committee for IGY, though not initiating a program of rocket measurements, is very happy to co-operate in part of the extensive program of rocket measurements planned by the United States.

At present some 500 men are completing the launching site at Fort Churchill on the west coast of Hudson Bay, and installing the auxiliary observational facilities.

Canadian participation includes the provision of accommodation and messing, laboratory facilities, and the addition of three scientists to the United States instrumentation team.

Measurements of ionospheric, magnetic, and auroral variations will be made by Canadian observers at the times of rocket flights in order to provide comparative data.

Canadian observers will also make altitude measurements of the aurora at the times when rocket flights are made in the dark hours.

It is expected that the preparations will be completed and several test rockets fired during October and November of 1956.

G *The Australian rocket program.* The Australian National Committee has informed the CSAGI that Australia will be able to assist the U.S. Satellite project. The Weapons Research Establishment will provide men, equipment and facilities at Woomera for tracking the satellite (assuming that U.S.A. will provide the Schmidt camera necessary for optical tracking) and the Commonwealth Observatory at Mt. Stromlo, Canberra, will assist where necessary.

On Tuesday afternoon, 11 September, the Conference on Rocket and Satellite Observations continued with a technical session in which the speakers were Messrs. Newell, Van Allen, Hagen and Whipple. Prof. Massey joined them for a panel discussion and question session with which the Conference concluded.

1.3 *First CSAGI Session*

10.00 a.m., Monday, 10 September 1956

President Chapman opened the first CSAGI session with the following words:

"This Fourth General Meeting of CSAGI is our last general reunion before the IGY begins next July. At this time it is tempting to review the great developments in our brief history, since the year 1950 in which our Vice-President first proposed that 1957–58 should be a third International Polar Year. But we *must* review the events of the year since our 1955 Brussels meeting, take stock of our present position, and develop our future plans; and that will fully occupy our available time.

"This meeting will have two parts—the first will be a review of our various activities during the past year, by those who have led them. Discussion on these reports, and of future plans, will occupy the second part of our meeting.

There have been some changes in our own membership. This is appointed by ICSU, of which our Vice-President has, during the year, become President. As recommended by the URSI-AGI Committee, ICSU added R. F. Lejay and Mr. Shapley to our number; ICSU also appointed Drs. Van der Pol and Van der Mark as representatives of CCIR on CSAGI. To our regret we have lost our colleague Sir Harold Spencer Jones as a member of CSAGI, though he will continue to serve the IGY still more fully in his new capacity as Editor of the CSAGI Publications. The ICSU on the nomination of IAU has appointed Dr. Y. Öhman to take his place on CSAGI. We welcome here those of our new members who are present.

"During the past year five new National Committees have joined in the IGY. Their co-operation, and the development of the plans of the already adhering National Committees, has notably improved the prospects of our great enterprise.

"Last year the Bureau was given power to appoint Adjoint Secretaries and other officers, as might seem advisable for the advancement of our work. Accordingly five Adjoint Secretaries were appointed:

Dr. N. HERLOFSON to organize an Arctic Regional Conference.
Dr. E. O. HULBURT to organize a Western Hemisphere Regional Conference.
M. G. LACLAVÈRE to organize an Antarctic Regional Conference, a successor to two earlier Antarctic Regional Conferences which he organized and led, at the request of CSAGI, with conspicuous success.
Dr. J. BOULANGER to organize an Eastern Europe Regional Conference.
Dr. T. E. W. SCHUMANN to organize co-operation in the IGY work of Southern Africa.

"The Regional Conferences organized by the Adjoint Secretaries have resulted in decided improvements in our overall program.

"The Bureau has also appointed two officers to serve under the General Secretary, the chief executive officer of CSAGI. One of these officers, appointed at the request of our Publications Committee, is the Editor, Sir HAROLD SPENCER JONES; his function is to assist the CSAGI by supervising the CSAGI publications in accordance with the policy of the Publications Committee. The other officer is Admiral Sir ARCHIBALD DAY, who will act as Co-ordinator of Operations. His function is to fulfil many organizational tasks that cannot be met by the part-time work of the honorary officers who form the Bureau of CSAGI. He has already begun his very important duties, on which he will briefly report at this meeting. I am sure that the work of these two officers will prove of great advantage to our whole enterprise.

"The CSAGI Reporters for the different branches of our IGY program have presented written reports on the present state of the plans in each subject; they will briefly summarize them at this meeting. M. G. LACLAVÈRE will then present the report of the Publications Committee, and that of the Finance Committee will be given by our Vice-President.

"After thus reviewing the stage we have now reached, our business is to carry our plans still further forward. Our program has gaps that must be filled in, and it can be improved in other ways. We must do all we can in these directions at this meeting and provide for other sectional meetings later as may prove necessary.

"Our *main* task at this meeting is to look ahead to the time when the results of the IGY program will begin to be garnered. We must make suitable arrangements for the collection of the great mass of data that will be accumulated. The data must be concentrated in World Data Centers, where they will be accessible either directly, or by copies, for the use of scientific bodies and individual workers who will study and interpret them.

"It is the opinion of the Bureau that the Unions represented on CSAGI should increasingly undertake the oversight of the IGY program and the discussion of the results of its different parts. The URSI is the Union that has most completely assumed this responsibility, with great success, in its own sphere. As I may be allowed to recall, it was at my suggestion at its 1952 Australian meeting that it appointed the URSI-AGI Committee. This has functioned also as the CSAGI Working Group on this subject. The IUPAP has likewise taken a large part in the planning of the Cosmic-Rays program. More recently, when seismology and gravity came to be included in the IGY program, the IUGG Associations of Seismology and the Physics of the Earth's Interior, and of Geodesy, have undertaken the planning of the corresponding parts of the IGY program. Our CSAGI Reporters for these four subjects, Drs. Beynon, Simpson, Beloussov and Lejay, have intimate links with these Union Committees. The Bureau hopes that the IAU and the IUGG, through its other Associations also, will take like responsibilities for the remaining parts of our program, keeping in close touch with our CSAGI reporters, so long as CSAGI exists. But the need for the supervision of the Unions and Associations over the treatment of the IGY data will persist after CSAGI itself is dissolved. It is very desirable that the formal arrangements for such supervision in all branches be made at an early date. The IUGG Executive Council meeting in Paris in April took important steps to facilitate this action in the spheres of its own Associations. Hence, in the name of CSAGI, I appeal to the Unions and their Associations and Commissions to act promptly to create the necessary committees to act as CSAGI working groups. These groups, like the URSI-AGI Committee, can then meet under Union sponsorship, and hold Symposia aided where necessary by the financial support of ICSU.

"This mention of finance leads me to bring to your notice the need for additional support of the central organization for the IGY. Hitherto ICSU and UNESCO have borne the cost of the CSAGI operations out of their normal budgets. But the increased funds that will be needed during the years 1957 and 1958 for the central organization and administration of the IGY exceed the limits of the generous provision hitherto made by ICSU and UNESCO. To meet urgent immediate needs during the past year, ICSU requested additional aid from two member nations, U.S.A. and U.K. They responded liberally with contributions of twenty thousand and seven thousand dollars respectively, and an indication of further substantial special IGY grants to ICSU in 1957 and 1958. But even with these additions to the expected provision by ICSU and UNESCO, there will remain a substantial deficit in the budget drawn up by our Finance Committee; this estimates the future needs of the CSAGI, according to the plans now proposed, including the support of some IGY symposia sponsored by the Unions and Associations. To cover this deficit the ICSU has invited CSAGI to ask its other adhering nations to make special IGY contributions to ICSU in the years 1957 and 1958. If a majority of our adhering nations agree to do so, the contributions needed will be of only moderate amount.

"The CSAGI officer on whom falls the greatest burden of all is our General Secretary. We members of CSAGI, as well as the Secretaries of National IGY Committees, and innumerable other correspondents throughout the world, have some understanding of the great labors he is undertaking on behalf of the IGY. Though we cannot fully appraise their extent, we all have personal experience of the highly efficient and courteous way in which he carries out his duties. With these inadequate words of appreciation, I now have pleasure in calling on him to present his report for the past year."

1.3.1 *Report of the General Secretary*

(i) *Membership and organization of CSAGI.* As the President has indicated, a number of organizational changes have been made since the Brussels 1955 meeting of the CSAGI. The present membership is therefore reviewed briefly below. The CSAGI members and their sponsoring bodies are as follows:

ICSU	L. V. BERKNER
	S. CHAPMAN
	E. HERBAYS
	M. NICOLET
IAU	A. DANJON
	Y. ÖHMAN
IUGG	V. V. BELOUSSOV
	J. COULOMB
	G. LACLAVÈRE
	V. LAURSEN
	N. V. PUSHKOV
	P. TARDI
URSI	W. J. G. BEYNON
	M. BOELLA
	P. LEJAY (R.F.)
	A. H. SHAPLEY
IUPAP	J. A. SIMPSON
	S. VALLARTA
IGU	J. M. WORDIE
IUBS	F. BRUUN
WMO	T. E. W. SCHUMANN
	J. VAN MIEGHEM
CCIR	J. VAN DER MARK
	B. VAN DER POL

The Bureau of CSAGI is composed of: S. CHAPMAN, President; L. V. BERKNER, Vice-President; and M. NICOLET, General Secretary.*

The Finance Committee is composed of L. V. BERKNER, Chairman; E. HERBAYS; G. LACLAVÈRE and M. NICOLET.

The Publications Committee consists of G. LACLAVÈRE, Chairman; W. W. ATWOOD; V. V. BELOUSSOV; R. F. J. O. CARDUS; D. C. MARTIN and M. NICOLET.

The Adjoint Secretaries are given in the President's report (p. 314). The CSAGI Reporters for each IGY scientific discipline are:

I	World Days	A. H. SHAPLEY
II	Meteorology	J. VAN MIEGHEM
III	Geomagnetism	V. LAURSEN
IV	Aurora and Airglow	S. CHAPMAN
V	Ionosphere	W. J. G. BEYNON
VI	Solar Activity	Y. ÖHMAN
VII	Cosmic Rays	J. A. SIMPSON
VIII	Longitudes and Latitudes	A. DANJON
IX	Glaciology	J. M. WORDIE
X	Oceanography	G. LACLAVÈRE

* The Bureau was enlarged later in 1956 by the addition of V. V. BELOUSSOV and J. COULOMB.

XI	Rockets and Satellites	L. V. Berkner
XII	Seismology	V. V. Beloussov
XIII	Gravity	P. Lejay (R. F.)

The services of Sir Harold Spencer Jones have been obtained to act as General Editor of CSAGI, and Sir Archibald Day has been appointed CSAGI Co-ordinator of Operations.

(ii) *National Committees.* The number of committees participating in the IGY has increased to fifty-one, and are as follows:

Argentine	Egypt	Ireland	Rumania
Australia	Ethiopia	Israel	Spain
Austria	Finland	Italy	Sweden
Belgium	France	Japan	Switzerland
Bolivia	German Democratic Republic	Mexico	Tunisia
Brazil		Morocco	USSR
Bulgaria	German Federal Republic	Netherlands	Union of South Africa
Canada		New Zealand	United Kingdom
Chile	Greece	Norway	U.S.A.
Chinese People's Republic	Hungary	Pakistan	Uruguay
	Iceland	Peru	Venezuela
Colombia	India	Philippines	Yugoslavia
Czechoslovakia	Indonesia	Poland	
Denmark	Iran	Portugal	

(iii) *Meetings of the Bureau.* In the year preceding the Barcelona Conference the Bureau has held seven meetings, with the following locations and dates:

New York	September	1955
London	January	1956
Brussels	May	1956
Stockholm	May	1956
Bagnères-de-Bigorre	July	1956
Boston	July	1956
Brussels	August	1956

To further IGY planning, the President attended the Arctic Regional Conference in Stockholm and the Western Hemisphere Regional Conference in Rio de Janeiro. He addressed the British Association for the Advancement of Science on the subject of the IGY at their annual meeting in Sheffield, England.

In addition to attending the meetings of the Bureau, the Vice-President participated in the URSI-AGI Committee in Brussels in August 1956.

The General Secretary travelled to meetings of the Bureau at London, Stockholm, Bagnères-de-Bigorre and Boston. In addition he gave a talk to the Swiss National Committee in Berne, visited London for a meeting of the Publications Committee, had discussions with UNESCO in Paris in June on the subject of the UNESCO Exhibition on the IGY, and in July on the subject of the UNESCO IGY Fellowships. He also went to Barcelona in July for the organization of the Fourth CSAGI Meeting, and attended the Arctic and Antarctic Conferences.

(iv) *Regional Conferences and Adjoint Secretaries.* The Bureau of CSAGI found it desirable to organize a series of Regional Conferences in order to allow careful consideration of the regional plans during the IGY. The principal purpose of these conferences was to fill gaps in the observational program and to promote intimate operational co-operation among stations of each geographic region. The Regional Conferences were organized under the direction of Adjoint Secretaries, who, as the President said, were appointed from the region concerned. In each case the Regional Conferences were held after the need for them had been expressed by National Committees in these regions.

These conferences have proved very valuable for the development of CSAGI plans, and the reports of National Committees submitted for circulation at the Barcelona Conference demonstrated that gaps in the program have been filled as a result of discussions and recommendations from these regional meetings.

Dr. T. E. W. SCHUMANN has been appointed Adjoint Secretary for Africa South of the Sahara. He will conduct a survey of the programs in that region through visits to the National Committees concerned.

(v) *Publications Committee.* The Publications Committee held three meetings in 1956 with M. G. LACLAVÈRE as Chairman; in London in January and April, and in Barcelona in September. The Committee paid particular attention to the general problem of the production of manuals and associated CSAGI publications, on a schedule designed to meet the requirements of IGY operations. The Publications Committee made strong representations to the Bureau that an Editor be appointed to organize drafts of the manuals in suitable form and in accordance with the time schedule. In addition the Publications Committee has considered the policies under which CSAGI publications should be issued.

(vi) *CSAGI Editor.* Following the recommendation of the Publications Committee, the Bureau authorized the appointment of Sir HAROLD SPENCER JONES as Editor of CSAGI. Sir HAROLD's office is in London and he has been organizing the draft manuals for final publication. A number of copies of these manuals were reproduced in time for distribution before the departure of the Antarctic expeditions. In addition the Editor has the task of planning printing of major manuals for CSAGI in accordance with the policies recommended by the Publications Committee.

(vii) *Co-ordinator of Operations.* With the approach of the operating phase of the International Geophysical Year, it became evident to the Bureau that many measures involved in the actual operations were far beyond the capabilities and facilities available to it. The officers of the Bureau can serve the CSAGI on a part-time basis only. After consultation with a number of National Committees and members of CSAGI, it was decided that a Co-ordinator of Operations should be appointed to ensure the achievement of the aims of the CSAGI during the IGY. Accordingly the Bureau asked Vice-Admiral Sir ARCHIBALD DAY to serve as Co-ordinator of Operations. He assumed this post with an office in Brussels established in close relation with the office of the General Secretary. The Co-ordinator of Operations attended the Western Hemisphere and Antarctic Regional Conferences and represented the Bureau at the Eastern Europe Regional Conference.

The Co-ordinator's activities include the frequent publication of an operational progress report, a continuous review of the performance of the world-wide communications network required by the IGY, the dissemination of important or unexpected results obtained during the IGY which might result in amendments to the program, and the promulgation of data regarding the flight of the earth satellites. He will act as an intermediary to promote mutual arrangements between National Committees to overcome shortages of instruments or personnel. In particular the Co-ordinator will act to ensure that arrangements for transmittal of CSAGI scientific information to and between World Centers will proceed smoothly.

(viii) *Finance Committee.* The CSAGI finances were previously met by generous contributions from ICSU and UNESCO. The rapidly expanding activities of the CSAGI required a critical review of the costs of organization and administration of the organization. Increases in cost were occasioned by the appointment of the Editor and the Co-ordinator of Operations and the establishment of their offices, by the need for duplication at a very early date of a number of copies of the Manuals, by the increase in the membership of CSAGI as authorized by the ICSU, and by the organization of the regional conferences. Accordingly the Finance Committee made new estimates for the cost of operations and communicated these requirements to the ICSU for its consideration.* In order to meet the immediate requirements for these needs the ICSU asked two member nations to contribute to the ICSU funds for these purposes. As the result of preliminary requests, the U.S. has made a contribution of $20,000 and the United Kingdom one of $7,000, in each case with the indication of substantial contributions in future if other national contributions were forthcoming. In reviewing the requirements for CSAGI, at its meeting at Bagnères-de-Bigorre in June 1956 the ICSU noted that the CSAGI budget would involve a deficit (September 1956), calculated then to be about $13,000 for 1956 and about $30,000 per year for 1957 and 1958. Accordingly the Executive Board of the ICSU authorized the CSAGI to ask its member nations to make contributions to the ICSU for the purposes of administration of the International Geophysical Year organization. Therefore the member National Committees are to be asked to make individual contributions toward the financial requirements of the CSAGI during the ensuing interval.

(ix) *UNESCO-IGY fellowship program.* In recognition of the need for trained specialists in many countries during the operations of the IGY, the UNESCO generously organized a fellowship program, in collaboration with the General Secretary of the CSAGI, to provide for the training of geophysical observers. Scientists were trained under this program as follows:

Origin of Fellow	*Place of Training*
Argentina	U.S. Weather Bureau, Washington, U.S.A.
Bolivia	Imperial College of Science and Technology, London, U.K.
Chile	U.S. Coast and Geodetic Survey, Carnegie Inst. of Washington, U.S.A.
Egypt	Institute of Meteorology, Charlottenlund, Denmark.

* These requests are separately reported in the Report of the Finance Committee (p. 331).

Pakistan	Californian Institute of Technology, U.S.A.
Peru	National Bureau of Standards, University of Colorado, Boulder, U.S.A.
Thailand	University of Chicago, U.S.A.
Yugoslavia	U.S. Coast and Geodetic Survey, Carnegie Inst. of Washington, U.S.A.

This program has now been completed. The training of these observers will add substantially to the effectiveness of the IGY.

(x) *Station lists.* A list of all stations participating in the IGY has been assembled in accordance with previous resolutions of CSAGI. This list provides the geographic and geomagnetic latitudes and longitudes of each station and an indication of the geophysical subjects to be investigated at each station. It is a consistent list for all interested in the CSAGI operations. After circulation to the National Committees for final correction, the list will be published in the future in the *Annals of the IGY*. In addition detailed maps are in preparation to show the world-wide distribution of stations in accordance with specified activities.

(xi) *CSAGI Bulletins.* Bulletin No. 6, reporting the conclusions of the third meeting of the CSAGI, was published by the Office of the General Secretary, and circulated to all national committees in the quantities requested.

(xii) *CSAGI News Letter.* An earlier resolution of the CSAGI requested the publication of a *News Letter* to provide National Committees with an authoritative source of useful information concerning the development of the plans and actual operations of the IGY. It was not possible to undertake publication of such a *News Letter* until the Co-ordinator assumed his duties. The Office of the General Secretary requested all National Committees to provide all appropriate information concerning their operations to the Co-ordinator of Operations in order that the *CSAGI News Letter* could be circulated at regular intervals, commencing in the immediate future.

(xiii) *Office of the CSAGI Secretariat.* In August 1956 the General Secretary moved his office to the Department of Radiation of the Royal Meteorological Institute of Belgium, Uccle.

1.3.2 *Summaries of reports by the Adjoint Secretaries*

Professor CHAPMAN then called for presentation of summary reports by the Adjoint Secretaries and CSAGI Reporters. Short summaries of the reports are given below.

(i) *CSAGI Arctic Conference, Stockholm,* 22–25 *May* 1956, *N. HERLOFSON.* The Arctic Conference was attended by sixty-one delegates from all twelve countries planning Arctic IGY observations. National reports on plans for Arctic research were presented, and were published as part of the proceedings. Representatives of Denmark, Finland, Iceland, Norway and Sweden had met in Stockholm some time before the conference, and these countries presented a joint North European report.

The conference was opened by four invited speakers, who gave introductory surveys on Arctic research in the following IGY disciplines: Prof. S. CHAPMAN on auroras, Prof. J. BARTELS on geomagnetism, Mr. A. H. SHAPLEY on the ionosphere, and Dr. F. F. DAVITAYA on meteorology.

The delegates met regularly in seven working groups for different disciplines. The introductory lectures, the reports by the working groups and the final resolutions are published in the proceedings of the conference.

During the conference the list of Arctic stations was revised. The number of Arctic stations is satisfactory. Minor rearrangements were agreed upon, particularly for Spitzbergen.

Arrangements for joint transport and mutual rescue were discussed. In general these questions appear not to be of the same importance in the Arctic as in the Antarctic. Satisfactory arrangements were made for some isolated stations, e.g. Murchison Bay on the North East Land at Spitzbergen, where the service by Soviet helicopters may be valuable.

The system of telecommunications in the Arctic can still be improved. A continuing working group on Arctic IGY communications was established, with representatives from Canada, Iceland, Sweden, USSR, U.K. and U.S.A., with Mr. S. GEJER as chairman. This group will endeavor to solve the difficulties of Arctic communications, and pay attention to the need for improved communications between the Arctic stations and stations in temperate latitudes. The group is requested to keep CSAGI advised of its work.

Questions related to publications and data centers were discussed. It was the opinion of the conference that all Arctic data should be collected in the planned World Data centers, and should not be separated from other data. But the conference recommended that the CSAGI Publications Committee be asked to consider the feasibility of publishing one or more CSAGI volumes on the results of the IGY Arctic operations.

(ii) *CSAGI Western Hemisphere Regional Conference, Rio de Janeiro,* 16–20 *July* 1956, E. O. HULBURT. The Western Hemisphere IGY Conference at Rio de Janeiro was held under the joint auspices of CSAGI and the IGY Committee (CPAGI) of the Pan American Institute of Geography and History. About seventy persons, representing twelve countries, attended. The IGY programs of each country were discussed in lectures and working groups dealing with each scientific subject. The integrated programs gave fair scientific coverage for the entire Western Hemisphere. Various necessities for improvement were brought to focus in several resolutions.

Public and private communication agencies were asked to help in IGY communications. A world-wide preliminary test of communications was urgently recommended. More upper-air balloons, radiosonde and upper-wind stations were needed. Satisfaction was expressed that magnetic observatories were to be built at Easter Island and Santiago, Chile, and hope was given that the famous observatory at Pilar would resume operation. PAIGH should appoint an auroral reporter for Central and South America, and each nation a national auroral reporter. Many all-sky cameras should be operated. Ionosphere stations at Recife and at Quito or Pasta should be installed to fill an equatorial gap. The solar coronograph planned by Peru would be the only one in the southern hemisphere. In oceanography, salinity and temperature should be measured to a depth of 300 meters, and water samples should be analyzed for carbon dioxide. Reporters in each nation for the artificial satellites should be appointed. Bulletins of recent seismological data should be published quarterly. All gravity instruments should be standardized to the highest accuracy.

(iii) *Third CSAGI Antarctic Conference, Paris,* 30 *July*–3 *August* 1956, *G. Laclavère.* Une 3e Conférence Antarctique s'est tenue à Paris du 30 juillet au 3 août 1956 avec la présence de soixante-neuf délégués représentant les onze nations participant aux opérations antarctiques de l'AGI, le CSAGI et l'Organisation Météorologique Mondiale.

Des comptes rendus présentés par les délégations, il résulte que cinquante-huit stations fonctionneront dans l'Antarctique pendant l'AGI (vingt-quatre sur le continent antarctique proprement dit, vingt sur la péninsule antarctique et quatorze dans la zone subantarctique. Toutes les disciplines de l'AGI seront observées dans l'antarctique et les réseaux séismique et gravimétrique sont suffisamment denses pour permettre d'espérer à la fin de l'AGI une connaissance satisfaisante de la séismicité et des anomalies gravimétriques de ce continent.

La 3e Conférence Antarctique s'est attachée à résoudre le problème des transmissions radio dont le bon fonctionnement est essentiel pour le succès des opérations antarctiques de l'AGI (transmission des messages scientifiques, météorologiques et de détresse), problème difficile en raison de la zone aurorale, de l'absence de bonnes prises de terre aux stations établies sur la glace, etc. Bien que des progrès considérables aient été faits, il a été reconnu qu'il était essentiel de réunir le groupe de travail des Liaisons Radio de l'Antarctique une dernière fois avant le début de l'AGI.

La Conférence a décidé de publier un manuel radio destiné aux opérateurs de l'AGI dans l'Antarctique et a recommandé que les Manuels du CSAGI puissent être reproduits à temps pour être distribués aux expéditions avant leur départ de leur dernier port de relâche.

La question de l'établissement d'une station de l'AGI sur l'Ile Bouvet n'a pu être résolue et un petit comité a été chargé de poursuivre son étude.

Une extension du programme océanographique de l'AGI pour couvrir les eaux antarctiques a été proposée par la délégation soviétique et sera examinée par le groupe de travail d'Océanographie.

(iv) *CSAGI Eastern Europe Regional Conference, Moscow,* 20–25 *August* 1956, *J. D. Boulanger,* At the request of the CSAGI, a Regional Conference of Eastern European countries was convened in Moscow during the period 20–25 August 1956. (The participating countries were: Bulgaria, German Democratic Republic, Poland, Rumania, Hungary, Czechoslovakia, Yugoslavia.) Representatives of the Chinese and Mongolian Peoples' Republics also participated in the work of the conference. Altogether forty delegates were present. The CSAGI Co-ordinator represented the CSAGI Bureau. Except for Albania all the invited countries sent representatives to this conference.

As a result of discussions of national programs, resolutions were elaborated specifying the programs with greater precision and urging the intensification of some planned and some new observations.

The questions of co-ordination and of mutual support were discussed as well. The report on this conference and the resolutions adopted were presented to the Special Committee and have been distributed to the members of this conference.

It is hoped that the Eastern Europe Regional Conference will serve to activate the preparation for the IGY in the above-mentioned countries.

Since the materials of the Conference have already been distributed, only the main conclusions of the Conference will be mentioned. For instance, the Conference noted that it is important to organize at least two Documentation Centers for IGY data, and it gave appreciation for the efforts of the USSR in constructing a special building for one of these centers.

The Regional Conference called the attention of the CSAGI to the desirability of urgent determination of dates and standardized forms for publication of the results of the IGY observations. The conference took note of the necessity for convoking some international Working Groups before the commencement of the IGY in order to discuss some questions of methods and techniques. In connection with this, the conference recommended the enhancement of the activity of the international scientific organizations including some of the international Working Groups.

(v) *IGY Co-operation in Southern Africa, T. E. W. Schumann.* The National Committee of the Union of South Africa has formulated and published its program of proposed activities during the IGY, and the necessary funds for carrying out this program have been voted by the Union Government.

Similar programs by most other countries of Southern Africa are not as yet available, although it is known that they are willing to co-operate in the IGY program to a greater or lesser extent.

During September and the first part of October these countries, with the possible exception of Madagascar, will be visited by Dr. S. P. Jackson, Editor-in-Chief of the Climatic Atlas of Africa, and member of the South African National Committee. On behalf of the Adjoint Secretary for Southern Africa, he will discuss and obtain first-hand information concerning the proposed activities of the various countries, the main purpose being to achieve the best possible networks of observing stations for the various disciplines. After his return, towards the end of October, a general survey of the IGY program for the whole of Southern Africa will be submitted to the Secretariat of CSAGI.

If, in the light of this general report, it should be deemed necessary to call a regional meeting for Southern Africa, every effort will be made to convene such a meeting before the end of 1956 or early in 1957.

1.3.3 *Summary reports on CSAGI discipline by the reporters*

I World Days and Communications

The calendar of Regular World Days remains unchanged. However, the WMO has requested adjustments in the dates of World Meteorological Intervals so that they will fall exactly on the pentades, or five-day intervals, recently adopted as standard for reporting meteorological observations. There seems to be general agreement to this change, but the calendar approved by CSAGI, Barcelona, should be the FINAL calendar and conspicuously so marked whenever published. (The Final Calendar of Regular World Days and World Meteorological Intervals is given on p. 373.)

Alerts and SWI will be declared by the IGY World Warning Agency at the fixed time of 16 hr Universal Time (instead of 05 hr as planned previously). Advice regarding declarations will be sent by forecasting organizations. Trials of these declarations were started in May 1956 and are continuing. Arrangements for Auroral Warnings, Geomagnetic Forecasts and Current Data Summaries are proceeding among the organizations concerned. Use of the IGY World Day communications arrangements for distributing and collecting certain information in the satellite program is anticipated.

The World Days and Communication Centers are in operation or being established. Information on telegraphic addresses is still incomplete for many National Centers or National Contacts. Arrangements are almost complete to use meteorological teletype networks and WWV and some other standard frequency broadcasting stations for notifications of Alerts and Special World Intervals. The regional centers are in the process of ascertaining requirements of countries and IGY stations for prompt current data summaries. They should also proceed with arrangements for the rapid collection of certain current data, especially from new solar patrol stations.

It will be proposed to CSAGI that beginning January 1957 there be *Trial Weeks* of IGY communication arrangements, with new station and new communication links participating on at least a token basis as soon as they are ready.

A draft *Operations Manual* is planned to be ready 1 October, with supplements supplied at intervals even during the IGY itself.

II Meteorology

Le Secrétariat du CSAGI ayant publié de larges extraits de mon rapport général, établi à la date du 15 juillet 1956, sur l'état des travaux du groupe météorologie, je me bornerai à indiquer ce qui a été fait depuis la dernière réunion du CSAGI.

(i) Le Bureau du CSAGI a demandé au rapporteur de la météorologie d'envisager l'inclusion d'une partie du programme hydrologique, proposé par l'UGGI, dans le programme météorologique de l'AGI, à savoir:

d'un programme de mesures de l'évaporation et de l'évapo-transpiration. C'est chose faite : voir Resolution 11 (CE–VIII) du Comité exécutif de l'OMM.

(ii) La création à la date du 1 janvier 1957 d'un Centre des données météorologiques de l'AGI, chargé du rassemblement, de la reproduction et de la distribution des données d'observation de l'AGI. Ce Centre sera établi au Secrétariat Général de l'OMM à Genève.

(iii) Etablissement d'un plan pour la diffusion de déclarations et d'alertes et de messages SWI à l'aide des réseaux de transmissions de l'OMM.

(iv) Questions pendantes:

(a) *avec le groupe des Publications*: répertoire de toutes les observations météorologiques effectuées pendant l'AGI;

(b) *avec le groupe des Journées Mondiales*: modification du calendrier du WMI (voir rapport de Mr. SHAPLEY);

(c) *avec le groupe des Aurores*: instructions pour l'observation des aurores dans les stations météorologiques;

(d) *avec l'UAI* : mesure de la lumière cendrée de la Lune en vue de la détermination de l'albedo de la Terre;

(v) Questions de météorologie en suspens :

(a) *Radioactivité de l'air* : Comme le Bureau du CSAGI a proposé la création d'un groupe de Radioactivité, je propose que cette question soit inscrite à l'ordre du jour de ce nouveau groupe et que le Secrétaire Général organise l'horaire de nos travaux de telle manière que les délégués du groupe météorologie puissent assister aux travaux du groupe Radioactivité.

(b) Récupération des instruments météorologiques : examen de la proposition de M. A. VIAUT, présenté par le Comité National Français.

(c) Examen des rapports nationaux déposés sur le bureau de la Conférence de Barcelone.

III Geomagnetism

In geomagnetism, the instrumentation and the methods of observation to be used during the IGY will, to a large extent, be based on classical principles. One of the primary concerns of the CSAGI has been an extension of the existing network of stations in order to secure an adequate coverage of the earth as a whole, and an increased number of stations in regions where the geomagnetic field and its variations are of particular interest in connection with the IGY project. Among these regions will be the two polar caps (including the auroral zones) and the equatorial belt. During the last year remarkable progress has been made in the implementation of the geomagnetic program. Many stations which have so far been listed as planned are now in operation or under construction, while a number of stations previously listed as recommended must now be considered as definitely planned. At the same time the list itself is continuously growing by the addition of new important stations, and it has recently been announced that in some regions also magnetic observations at sea will be carried out in connection with the IGY program.

At the request of the CSAGI, the International Association of Geomagnetism and Aeronomy is devoting part of its activity to the IGY project. A complete list of all the magnetic stations with details of their instrumental equipment is being established, and a program of international comparisons of magnetic standards has been initiated.

IV Aurora and Airglow

In the Arctic auroral region a promising network of all-sky camera stations has been provided by the northern nations in Alaska, Canada, the Arctic islands, northern Europe and Siberia. The network was improved as a result of the Arctic Regional Conference. There is still scope for more visual auroral stations in this region.

In the northern subauroral region there are well-planned organizations for visual auroral observation on land, sea and in the air, based on Canada, U.S.A., U.K., Scandinavia, and USSR. In the southern subauroral region such organizations have been or are being created in New Zealand, Australia and Tasmania.

In the minauroral belt, extending over more than 70 per cent of the earth's surface, between 45° N and S geomagnetic latitudes, few nations have any auroral program. There is urgent need to institute visual observation there. Following on the

Western Hemisphere Regional Conference, such work will be organized in Latin America, both Central and Southern. The auroral manual will contain a chapter (already available) indicating the need for such work, and other chapters will describe suitable methods.

Photometric, spectrographic, radio, radar, and rocket studies will make important contributions to the auroral program. It is desirable to institute some atmospheric electric and auroral sound-recording stations in the auroral zone.

The airglow program is concentrated mainly on four meridional chains, Europe-Africa, USSR-India, Japan-Australia and the Americas. It is more extensive in the northern than in the southern hemisphere. The instruments chiefly to be used are complicated and expensive; the production of the simpler instruments earlier projected, that would have permitted a wider geographical coverage, has not been organized.

V Ionosphere

The present state of preparations for the IGY ionospheric program was reviewed at a recent meeting of the special IGY Committee of the International Scientific Radio Union (URSI). The discussion at the meeting showed that in general these preparations are well advanced.

In fact ionospheric studies will have many branches. The major part of these studies will come from frequent vertical incidence soundings using the latest type of radio sounding equipment, and reports indicate that at least 150 stations will regularly make these observations. (This number is to be compared with the two or three stations which undertook very limited similar measurements during the Polar Year of 1932–33.) New types of ionospheric measurement, not made in 1932–33, will include measurement of ionospheric absorption, of ionospheric drifts, of terrestrial atmospheric noise, echo observation of auroras and of whistler-type atmospherics. IGY studies in these various fields will ensure that an additional eighty or a hundred stations will contribute to the sum total of ionospheric studies. Detailed programs for all these various studies have now been drafted, together with proposals for the uniform presentation of results. Preparations are also well in hand for the production of ionospheric instruction manuals covering all these ionospheric programs.

Dr. BEYNON also referred to the report (see p. 375) made to CSAGI by the URSI-IGY Committee after its meeting in August 1956. He noted that the question of ionospheric World Data Centers had been considered, and that Japan was to provide such a center. The functions of such centers had been discussed but no change in the statement made a year earlier was recommended.

VI Solar Activity

Since the last meeting Commission 11a of the International Astronomical Union has done very valuable work in recommending a careful study of the best procedure for a photographic $H\alpha$ patrol of the solar disk.

According to information at hand, about fifty different observatories will be engaged in solar work during the International Geophysical Year, and about thirty birefringent filters will be in operation. Among new devices which seem specially well fitted for observations planned for the International Geophysical Year is a birefringent filter for the lines H or K, with a pass band of 2Å.

During this meeting the Solar Activity Working Group will present a detailed plan for observations of bright and dark surges, sudden disappearances of prominences, regions with sunspot active prominences, etc. The Working Group will discuss the question of improving the suggested activity index based on areas of calcium plages by considering their intensities as well. This seems possible with the new calcium H or K, line filter.

The Working Group will investigate the possibility of using similar forms to report the observations of the many different solar observatories participating in the general solar patrol. This would help provide standardization of the methods of observation and facilitate the final synthesis of results.

VII Cosmic Rays

The program of cosmic-ray observations throughout the world is already in operation, with several new cosmic-ray laboratories coming into operation during the months leading up to the beginning of the IGY. Already international co-operation on an informal basis shows that these world-wide observations will lead to important new knowledge of interplanetary magnetic fields, production of high-energy particles at the sun, and the properties of the earth's magnetic field extending far into interplanetary space. For example, during the past year a gigantic solar outburst of radiation produced cosmic radiation which has been extensively studied by many of the nations in the IGY. This event has revealed the existence of several new phenomena.

The operation of cosmic-ray stations up to the present, as well as the study of events such as the giant flare, have led to further recommendations to be adopted by the CSAGI in cosmic rays, and new supporting observations in solar physics and ionospheric observations. The continual revision and improvement of the observational programs in these fields will greatly extend our understanding of solar-terrestrial effects far beyond our earlier expectations.

VIII Longitudes and Latitudes

(1) *Stations*: La liste des stations comprend actuellement trente-trois services horaires permanents et treize nouveaux services.

(2) *Manuels*. Le texte de quatre manuels a été remis au Secrétaire Général. M. Decaux achèvera la rédaction des instructions sur l'emploi de la radioélectricité dès son retour de Varsovie où siège le CCIR.

(3) *Catalogue fondamental*. Selon les recommandations de l'UAI, la réduction courante des observations se fera à l'aide du FK3R dont le Dr. Fricke vient d'annoncer l'achèvement pour le milieu de 1957. La réduction finale, confiée au B.I.H., sera rapportée au FK4.

MM. Mikhailov, Zverev, Pavlov et Nemiro ont proposé d'appliquer au FK3R, pour les réduction courantes, une correction de la forme :

$$\frac{1}{2}(\mathrm{Pul}+\mathrm{N30})-\mathrm{FK3},$$

mais les autres spécialistes consultés ont conclu que les avantages de cette correction ne compenseraient pas le surcroît de travail qu'elle entraînerait. Ils recommandent de s'en tenir au FK3R.

(4) *Durée des opérations.* On peut craindre que toutes les stations participantes ne soient pas prêtes pour le 1er juillet 1957, et que certaines d'entre elles aient besoin de quelques mois supplémentaires pour la mise au point du matériel et la formation des observateurs. Or, il a été demandé que l'opération couvre un peu plus d'une période de Chandler, ce qui peut nécessiter la prolongation des observations au delà du 31 décembre 1958. L'Union Astronomique Internationale pourrait être invitée par le CSAGI à suivre le développement de l'opération et à prendre toutes les dispositions qui lui paraîtraient utiles pour assurer son plein succès.

IX Glaciology

Sir JAMES WORDIE noted that glaciologists were not then planning preparation of a special manual for the IGY.

X Oceanography

Il y a peu à dire de nouveau depuis la dernière assemblée générale du CSAGI sur le programme d'Océanographie. Ce ne sera que dans quelques mois que ce programme sera définitivement arrêté quant à la nature des phénomènes à étudier, quant aux méthodes et instruments d'observation et quant aux stations et régions des océans où les observations seront faites. En effet diverses réunions d'organisations internationales sont prévues au cours des mois à venir où sera discuté et mis au point le programme d'océanographie de l'AGI. Citons l'*ICES* et le *PIOSA* en octobre. En conséquence il a été décidé de tenir une dernière réunion du Groupe de Travail d'Océanographie en janvier 1957, sans doute à Göteborg.*

Si dans l'hémisphère Nord et dans les régions équatoriales la surface des océans sera largement explorée pendant l'AGI, on ne peut en dire autant des eaux australes. Le prof. KORT (URSS) a établi un programme pour les mers antarctiques qui fera l'objet d'un examen prochain.

Signalons que l'importante question de la teneur en CO_2 de l'atmosphère dans toutes ses couches et des mers fait l'objet d'études activement poussées, aux Etats-Unis et ailleurs. Diverses méthodes pour la détermination de la teneur en CO_2 et de la composition isotopique (carbone et oxygène) sont envisagées. Il est très probable qu'un certain nombre de centres seront établis où les prélèvements recueillis par les diverses nations pourront être analysés.

Au cours de la réunion de Barcelone, un projet présenté par le Prof. ZENKEVITCH de l'Académie des Sciences de l'URSS relatif à des observations biologiques sera examiné.

XI Rockets and Satellites

The rocket program provides direct access to the outer atmosphere in making cross-section observations involving physics of the upper atmosphere, cosmic rays and other phenomena that relate the earth to its surrounding environment. Measurements made by rockets not only supplement other types of observation but also are capable

* See Chapter VIII.

of unique and very significant direct and independent observations through the atmosphere.

Proposals for various types of rocket research have been made by a number of nations at previous meetings. Australia, Canada, France, Japan, USSR, U.K., and the U.S.A. have all indicated their interest in this program. Plans have now proceeded to the point where a final systematic world program can be organized at this meeting. Moreover it is hoped that other nations will be able to announce their participation in the rocket program as a result of development of plans over the past year.

The significance of scientific observation during the IGY with an instrumented earth satellite was pointed out in resolutions adopted in 1954 by the General Assemblies of URSI at the Hague, and of IUGG at Rome. As a consequence of these resolutions, the CSAGI at its second meeting in Rome in October 1954 asked the nations to consider launching such a satellite for scientific observations during the IGY. As announced in July 1955, and discussed in more detail at the third meeting of CSAGI at Brussels last year, the U.S. National Committee for IGY agreed to undertake an IGY Earth Satellite program.

Because the satellite program was introduced late in the IGY plan, and because of its complexity, this meeting at Barcelona provides the first opportunity to discuss the scientific aspects of the program in detail. In particular it is now appropriate to examine the significance of the collaborative effort of the IGY nations in this program. Accordingly a special Rocket and Satellite Conference has been arranged to precede the work of the Working Groups, so that full understanding of the problems and experiments can provide a foundation for the work of these working groups. Emphasis will be given to problems of ground observation. In this all nations within view of the satellite orbit can participate. These problems will include initial acquisition, accurate observation of position and timing along its track, formation of the ephemeris, and determination of the precise orbit and perturbations in that orbit. These determinations, in themselves, will produce very important scientific information concerning atmospheric density, and bearing on geodetic problems such as figure and rigidity of the earth and perhaps crustal mass distributions. Reference will also be made to the other experiments to be carried out in the satellite.

As our experience with the instrumented earth-satellite vehicles is acquired, we will eventually be able to perform some of the most significant fundamental experiments that can be devised concerning the earth and its environment. Such experiments hold promise of very greatly advancing our knowledge of the earth.

It is hoped that other national IGY committees with advanced techniques for rocket technology at their disposal can also undertake programs for instrumented IGY satellites.

XII Seismology

Une commission permanente a été constituée au sein de l'Association Internationale de Séismologie pour diriger les travaux séismologiques prévus pour l'Année Géophysique Internationale. A sa demande, les Comités Nationaux ont mis à la disposition de la Commission les informations concernant leurs programmes séismologiques. En se basant sur ces informations, il a été possible de rédiger une liste de stations séismologiques; cette liste est maintenant presque complète. Lorsque quelques corrections que nous avons à apporter lors de cette conférence auront été faites, une partie de notre tâche sera accomplie. Néanmoins cette liste de stations doit encore être corrigée au point de vue suivant : il faut éliminer les stations permanentes du type général qui ne sont pas en rapport direct avec le programme de l'AGI.

On peut remarquer que nous avons inclu les stations générales construites spécialement pour l'AGI et les stations spéciales pour les études des microséismes et des ondes longues. Les stations microséismiques tripartites présenteront un grand intérêt.

Quelques Comités Nationaux ont prévu d'exécuter des profils séismologiques afin d'étudier la structure de l'écorce terrestre.

Lors des conférences régionales arctique et antarctique, on a pu constater que les régions polaires seront suffisamment couvertes par les observations séismologiques. On ne peut pas dire la même chose concernant la zone équatoriale, où les stations n'existent pas en nombre suffisant. Peut-être serait-il possible de pallier à cette carence.

Des instructions ont été préparées à l'intention des observateurs. Elles sont maintenant à la disposition de l'Editeur. Le groupe de travail discutera les méthodes d'observations microséismiques, la forme sous laquelle les données des observations devraient être remises aux Centres Mondiaux, les méthodes d'étude du mécanisme des foyers. Précisons que plusieurs Comités Nationaux ont montré un vif intérêt pour la proposition faite par quelques savants soviétiques d'inclure dans le programme de l'AGI ce dernier problème.

Il est probable que pour résoudre toutes ces questions de programme et de méthodes d'investigations, il serait nécessaire de réunir la commission au début de l'année prochaine.

XIII Gravimetry

Le programme "Gravité" de l'Année Géophysique comporte:

(a) l'établissement des réseaux gravimétriques dans les régions inaccessibles en temps normal, principalement l'Antarctique et l'Arctique

(b) l'exécution des mesures de variations périodiques de la pesanteur

(c) les problèmes discutés au cours de la conférence de l'Antarctique à Paris et de l'Arctique à Stockholm.

Des mesures ont été prises pour établir le plus grand nombre possible d'interconnexions entre les réseaux des diverses expéditions. La liste des stations internationales les plus sûres, voisines de l'Antarctique, a été établie par le Bureau Gravimétrique International de Paris et diffusée auprès de toutes les missions antarctiques.

Il a été recommandé au cours de la réunion de la Commission Gravimétrique à Paris que les réseaux gravimétriques de l'Arctique soient reliés à Thule.

(d) Le Groupe de Travail réuni à Paris le 7 septembre 1956 a fixé les conditions d'emploi des gravimètres et les modalités d'observations pour la coordination des mesures en vue de la détermination des marées de l'écorce terrestre.

Des mesures ont été prises pour parer aux difficultés dues à la pénurie d'instruments convenables (circulation d'appareils en divers pays).

1.3.4 *Report of the Finance Committee*

After the discipline reports from each Reporter, Dr. BERKNER, as chairman of the Finance Committee, reported on its deliberations:

(1) Because of the increasing responsibilities of the CSAGI and the corresponding increases in the financial demands on it, the budget of the CSAGI has been considerably enlarged in the past year. To meet the requirements of these enlarged expenditures, the Finance Committee has cast the budget in accordance with seven categories as follows:

I Office of the CSAGI Secretariat.
II Office of the Editor of CSAGI.
III Office of the Co-ordinator of Operations.
IV Travel and per diem of the Bureau of the CSAGI.
V Support of Regional Conferences and meetings.
VI Meetings of CSAGI for other than members of the Bureau.
VII Other.

(2) Budget requirements. The Finance Committee finds the budget requirements for the functioning of the CSAGI for the ICSU financial years 1956, 1957 and 1958 as follows:

		1956	1957	1958
I	Office of the CSAGI Secretariat	\$24,000	\$24,000	\$24,000
II	Office of the Editor	13,500	20,000	20,000
III	Office of the Co-ordinator	12,000	21,000	21,000
IV	Travel and per diem	5,000	7,500	8,000
V	Support of Regional meetings	4,000	10,500	10,500
VI	Meetings of CSAGI	7,000	8,500	9,500
VII	Other	4,300		
		\$69,800	\$92,000	\$93,500

The budget figures listed above have been examined by the Finance Committee and are believed to be a good estimate of the requirements for actual functioning of the offices concerned.

(3) The income anticipated to the CSAGI over this same interval is listed below:

Income to CSAGI	1956	1957	1958
ICSU	\$14,500	\$15,000	\$15,000
UNESCO	15,000	15,000	15,000
U.S. National Committee	20,000	25,000	25,000
U.K. National Committee	7,000	7,000	7,000
	\$56,500	\$62,000	\$62,000
Deficit	\$13,000	\$30,000	\$31,000

(4) The additional costs leading to the deficit listed above have occurred for a number of reasons, e.g.:

(a) The immediate need for publication of the manuals and certain other CSAGI documents that were essential to the success of the IGY plan required the establishment of the Office of the Editor.

(b) The need for exchanging information and for providing for fast flow of information involving the launching of the satellite, and other imperative requirements beyond the capacity of the members of the Bureau to carry on within the limits of their part-time service, required the establishment of the Office of Co-ordinator of Operations.

(c) Requirements of national committees for co-ordination of their programs within regions required the convention of regional conferences.

(d) The urgent need for pre-publication of the manuals by fast methods of publication to provide for the departure of the Antarctic expeditions and the distribution of the manuals for other purposes involved additional expenditures to the office of the CSAGI Secretariat.

(e) The expansion of the membership of the CSAGI itself has involved additional costs of travel and subsistence.

The Finance Committee has presented this problem to the Executive Board of the ICSU, which has reviewed the problem of financing the functions of the CSAGI and has invited the CSAGI to apply to its National Committees for voluntary contributions to finance this deficit.

The Finance Committee therefore recommends that the CSAGI urge National Committees constituting the ACIGY to provide voluntary contributions to finance the deficit, estimated as a total of $75,000, for the operations during financial years 1956, 1957 and 1958.

Control

Because of the increase in the budget requirements of the CSAGI the Finance Committee deems it necessary to institute additional measures of control in the expenditures of the CSAGI, and has recommended that the following control procedures be adopted.

The CSAGI will look to the Treasurer of ICSU to maintain control of CSAGI expenditures against the authorized budget. To effectuate this control, the following procedures are adopted.

(1) Financial commitments in excess of $300 made by the Offices of the CSAGI should be communicated to the General Secretary of CSAGI and to the Treasurer of ICSU.

(2) At the beginning of each financial year a suitable advance should be made to each of the Offices of CSAGI, which should apply through the General Secretary for reconstitution when needed.

(3) At the beginning of each quarter or other suitable interval the salaries and rent for the offices of CSAGI for the following period should be paid to each of them on claims of the General Secretary.

(4) Subsistence allowance and transportation expenses should be reimbursed according to the custom followed by ICSU, i.e. the claims should come to the Treasurer of ICSU, who would authorize the reimbursement.

(5) The Treasurer of ICSU is asked to make advances against Budget Categories IV (Travel and per diem), V (Support of regional meetings), VI (Meetings of CSAGI) and VII upon the request of the General Secretary of CSAGI. Funds so advanced shall be vouched and accounted for in accordance with ICSU practice. Such accounts shall be subject to the certification of the General Secretary that the funds have been expended for general purposes of the CSAGI.

(6) Commitments for expenditures of CSAGI funds, other than those of the Offices of CSAGI specified above, can be made only within the limits of advance authorization by the General Secretary of CSAGI.

The Finance Committee will continue to review the budgets of the CSAGI from time to time as appropriate.

Georges Laclavère
Marcel Nicolet
Ronald Fraser (co-opted)
Lloyd V. Berkner, Chairman

1.3.5 *Report on the meetings of the Publications Committee*, 8 September 1956

Present: M. G. Laclavère (Chairman), Dr. W. Atwood, Prof. V. Beloussov, Father J. O. Cardus, Dr. D. C. Martin, Dr. M. Nicolet. Vice-Admiral Sir Archibald Day (CSAGI Co-ordinator) and Sir Harold Spencer Jones (General Editor) attended by invitation.

Morning Session

(i) *Status of the Publications of the IGY*—(a) *Present status of the Introductory Volume*. The Introductory Volume will consist of: an account of the First International Polar Year; an account of the Second International Polar Year; an account of the planning of the International Geophysical Year; the IGY program; the list of IGY stations.

It was reported that a draft list of IGY stations had been circulated to all National Committees in June 1956, but that as many corrections were required, it had been decided to defer the typesetting of the list because of the expense involved in making the corrections in proof. So it was decided that the draft list should be corrected with the information received up to 1 October 1956, and should then be forwarded to the General Editor for printing. Any corrections received subsequently would be circulated at a later date.

The meteorological stations included in the list will be those that will make aerological measurements, and the seismological stations listed will be those specifically set up for the IGY period. In order not to prejudice the relations existing between CSAGI and the publishers it was decided that any further draft lists of stations to be circulated by the General Secretary should be restricted to two per National Committee, one being for return and the other for retention. It was stated that the new draft list would be ready by 31 October 1956.

It was reported that the account of the First Polar Year, which was being prepared by Dr. Armitage and Mr. Heathcote of University College, London, had been expected by 31 August 1956, and the General Editor was confident that he would receive the manuscript in the very near future. It had been hoped that the account of the Second Polar Year might be based on the introduction to the bibliography of the Second Polar Year written by Dr. V. LAURSEN, but this dealt only with the organization of the program. Accordingly the General Editor planned to prepare a summary of the achievements of the Second Polar Year. In this connexion Dr. W. ATWOOD offered to search through some papers formerly in the possession of Dr. JOHN FLEMING to look for useful material.

It was reported that the General Secretary had prepared maps illustrating the distribution of IGY stations. They consisted of a general map of stations, maps showing stations in different regions of the globe, and the stations making observations in the different disciplines. The General Editor stated that he would inspect these maps, and advise the Publications Committee before the end of the Barcelona meeting of his selection to be included in the Introductory Volume, bearing in mind that it would probably be necessary to have them redrawn.

It was decided that the Introductory Volume should be published in the form of a single volume, and it was stated that the manuscript should be complete by 31 December 1956 except for the list of stations, and that the publication date would probably be 15 April 1957. The General Editor was instructed to ensure that references to various national enterprises in the Second Polar Year were in line with current CSAGI usage.

(b) *Present status of the Instruction Manuals.* There are at present thirteen working groups, and with the possibility that Atmospheric Nuclear Radiation study may be added to the IGY program, there may be fourteen different disciplines to consider. It was reported that two Cosmic-Ray instruction manuals had been circulated by the General Secretary, and that no further action concerning them was required by the General Editor; that the Longitudes and Latitudes and Seismology Manuals had been sent for reproduction. Messrs. Beck will be issuing manuals to cover the Dobson Ozone Spectrophotometer, and a manual on the computation of ozone measurements will be published by the Ozone Commission. The manual on Solar Radiation Measurements will be published by CSAGI. The World Days Manual will be handed to the General Editor by 1 October 1956, but it may be necessary to issue supplements during the IGY.

It was reported that some manuals had been sent to the Publications Office in English and some in French. When time had permitted, the latter had been translated into English and only the second version sent to the printers. It was decided to have the sections of the Geomagnetic Manual which were written in French, translated into English.

Prof. BELOUSSOV requested that microfilm or photocopy versions of the manuals should be sent to the USSR at the earliest possible moment after the conclusion of their editing, so that translation and reproduction in Russian could be completed in the USSR before the IGY began.

(c) *Publication of the Introductory Volume.* It was reported that Messrs. BUTTERWORTHS were still interested in this item as a commercial venture. Members had been asked for their comments on the draft contract, but it had not yet been signed as it also contained clauses relating to the manuals.

(d) *Publication of the Instruction Manuals.* It was reported that Messrs. Butterworths had written to all National Committees asking for an estimate of the sales in their own countries of the IGY Instruction Manuals. Not many replies had been received, but it appeared that the requirements of the National Committees were much smaller than had been expected. Butterworths were also shown small Seismological and Longitudes and Latitudes Manuals. They had decided that they were unable to undertake the publication of the manuals as a commercial venture. The Third Antarctic Conference had urged that the manuals should be ready in time for the departure of the Antarctic expeditions by late October 1956; this had necessitated their reproduction by offset printing, which would reduce the market for the letterpress version.

Some manuals will prove to be of permanent value, such as those on the Ionosphere and on Geomagnetism. It was decided that the present negotiations with Butterworths should be dropped, and that the publication in letterpress form of some of the more important manuals should be reconsidered in a year or so.

A letter from the President of CSAGI concerning the manuals was considered.

The arrangements for the translation of the manuals into the Russian language had been considered at earlier meetings. The translation into Spanish was discussed and Father Cardus undertook to investigate the possibility of the translation, reproduction and distribution being done in Spain. The use in Spain of the original blocks for the photographs and drawings was also considered.

The press order for the English version of the manuals was considered, and it was decided that the General Secretary should inform the General Editor of the number of stations in each discipline, so that an estimate can be made of the number of manuals likely to be required.

(ii) *The bibliographic record.* It was reported that National Committees had been sent a circular letter NC.CIR 10 567/11 on 11 July 1956, and that more than 4000 bibliographical cards had been distributed: only two of these had so far been returned.

It was reported that no action had yet been taken with regard to the offers of USSR and the Centre de Documentation du Centre National de la Recherche Scientifique as proposed at the London Meeting on 9 April 1956. It was decided to request CSAGI to insist that all National Committees return the bibliographical cards as requested, and to raise the matter at the forthcoming meeting of the ACIGY.

(iii) *Antarctic Radio Communications Manual.* It was decided that the projected Antarctic Radio Communications Manual is to be a CSAGI publication.

(iv) *Lugeon's crepuscular tables.* These tables were originally published before the Second World War, in Poland, but the type has since been destroyed. The President of CSAGI was of the opinion that the tables could be used by many people, and members supported this view. Very few copies of the original 500 are believed to be in existence. It was decided that the Chairman and the General Secretary should prepare a note on the use of the tables for the General Editor, who was instructed to seek a publisher who would be prepared to publish the tables, with a warranty on sales, probably using photo-lithographic methods. It was also decided to refer the matter to the ACIGY for their advice.

AFTERNOON SESSION

The Chairman reported on his financial discussions with the Vice-President of CSAGI, who then attended the meeting whilst the problems were resolved.

(v) *Publication of scientific results or data by CSAGI.* The London Meeting of the Committee recommended that, in collaboration with the General Secretary, the General Editor should write to all the correspondents of the Working Groups requesting information concerning the type of publication of results that they would wish to be undertaken by CSAGI. It appeared that this matter would be discussed by the Working Groups during the coming week. It was considered that it might be useful if a summary of the interesting phenomena occurring during the IGY were to be published.

(vi) *Recommendations of regional conferences.* The reommendations of the Arctic, Antarctic, and East European IGY Regional Conferences were considered. The committee decided to postpone any action concerning the special marks to be accorded to Arctic data in the bibliographic record until such a time as it was necessary to deal with the production of the final volume. The Committee endorsed the resolution concerning the direct exchange of material, reprint collections, and the interchange of periodic résumés, etc. The Committee did not endorse the Arctic resolution concerning the limiting of the number of journals in which papers were to be published, and they postponed any action on the subject of special volumes to summarize Arctic and also Antarctic operations.

(vii) *Argentine Antarctic Atlas.* The Committee noted with interest the plans of the Instituto Antarctico Argentino to compile an Antarctic atlas.

(viii) *CSAGI Bureau resolutions.* The Committee noted the CSAGI Bureau draft resolutions concerning the early delivery of the manuscripts for the instruction manuals, and the regulations governing the use of the IGY symbol.

1.3.6 *Report of the CSAGI Co-ordinator*

The first session of the CSAGI concluded with the presentation of the Co-ordinator's report, given in summary as follows:

His appointment took effect in time for him to attend the Western Hemisphere and Antarctic Conferences, and to represent CSAGI at the Eastern Conference in Moscow. These gave him valuable personal contacts and background information. In consultation with the General Secretary, an office near his in Brussels has been arranged.

His tasks include producing an operational progress letter, ensuring the transmission of data to and between World Data Centers, disseminating important or unexpected results obtained during IGY, promulgating data on satellites, and acting as intermediary between National Committees to overcome instrument shortages. Close liaison will be maintained with the General Secretary.

The Co-ordinator concluded by mentioning that the operational progress letter (*News Letter*) would be a frequent issue in loose-leaf quarto size to be contained in a standard type folder. Numbers of copies could be issued but National Committees needing more than one folder would be expected to purchase them.

1.4 *Second CSAGI Session*

3.45 p.m., Monday, 10 September 1956

In the afternoon session a draft resolution was presented for consideration in which the function and management of IGY World Data Centers and the arrangements for supply of data to them were very briefly delineated. The discussion concerned the problems of locations and kinds of data centers, their operation costs and storage facilities, the flow of data itself, and the need for monitoring such flow. The relation between existing international scientific permanent services and the centers themselves was cited as another problem. A committee of Messrs. Beloussov, Berkner, Beynon, Laclavère, and Van Mieghem, with the Co-ordinator as convener, was appointed to examine these questions and report recommendations for action to the CSAGI.

The six resolutions adopted by the CSAGI Publications Committee were approved as CSAGI Resolutions. These resolutions provide for prompt distribution of a station list by the General Secretary, and rapid reproduction of limited editions of the manuals for Antarctic use. They also recommend bibliographic procedures, provide for the early publication of an Antarctic Radio Communications Manual, pertain to publication of IGY data after the IGY, and request the Editor to consider publication of certain mathematical tables.

The Special Committee discussed a proposed resolution which would request National Committees to contribute funds to meet CSAGI expenses, and requested that it be sent back for further revision. It further considered how the responsibility for scientific activity in a given discipline might best be shared between the interested Union, or the WMO, and the CSAGI. CSAGI approved the circulation of an IGY *News Letter* by the Co-ordinator, and passed two resolutions to ensure that the General Secretary was kept informed of correspondence and published material essential to the operation of his office. The General Secretary was directed to circulate an IGY station list, and the CSAGI Reporter for Cosmic Rays was asked to establish a Working Group at the meeting, to advise on the use of radioactive tracers in geophysical problems. National IGY Committees were authorized to permit use of the IGY symbol. A resolution of thanks was addressed to the Belgian Government for its provision of the services of the General Secretary and of the premises of the Secretariat.

1.5 *ACIGY-CSAGI Joint Session*

10.00 a.m., Wednesday, 12 September 1956

Professor Chapman opened the session by outlining organizational changes which had been made during the previous year. Profs. Van der Mark and Van der Pol had been appointed members of the CSAGI as representatives of the CCIR, Dr. Öhman had been asked to serve as member of the CSAGI and Reporter for Solar Activity, Father Lejay had become a member of CSAGI and Reporter for Gravimetry, and Mr. Shapley was now serving as a member of CSAGI and Reporter for World Days. The Adjoint Secretaries, Editor and Co-ordinator of Operations had also been appointed to carry out the organizational tasks which the part-time officers of the Bureau could not undertake.

It was noted that on Monday the CSAGI had considered a plan for the establishment of at least three World Data Centers for each discipline, to be located one in the U.S.A., one in the USSR, and a third center in other locations to be decided later. The CSAGI had referred the specific proposal to a committee for study, but meanwhile it was indicated that offers in writing from the National Committees to establish World Data Centers C would be gratefully received by the Co-ordinator.

Professor CHAPMAN also referred to the resolution passed by the CSAGI in its session of Monday, 10 September, asking for increased Union participation in the guidance of scientific discipline programs.

The General Secretary gave a résumé of his written report and the Report of the Finance Committee was distributed. The extent to which responsibility for formulation of IGY financial policy should be shared between the CSAGI and the ACIGY was discussed, as were the general purposes and functions of the two bodies. It was decided that the ACIGY would meet during the afternoons of 12 and 13 September, while the CSAGI would meet on the morning of 13 September, to consider the general questions which had been raised.

The session concluded with the establishment of Working Groups for the various disciplines represented. The Working Groups met in the afternoon and on Thursday, 13 September, to consider the implementation of planning in the various IGY disciplines.

Working Groups

I *World Days*

SHAPLEY (Reporter)
AONO (Japan)
CHU (Chinese People's Rep.)
EYRIES (France)
GIORGI (Italy)
GRUNWALDT (Argentine)
HASSANEIN (Egypt)
JOYCE (U.S.A.)
LAW (Australia)
McNICOL (Australia)
MINNIS (U.K.)
PUSHKOV (USSR)
SOLBERG (Norway)
SUNDARAM (Switzerland)

II *Meteorology*

VAN MIEGHEM (Reporter)
BLEEKER (Netherlands)
BOLIN (Sweden)
BRUNT (U.K.)
CENTKIEWICZ (Poland)
CHU (Chinese People's Rep.)
FACY (France)
FEA (Italy)
GRUNWALDT (Argentine)
HASSANEIN (Egypt)
KAPLAN (U.S.A.)
LUGEON (Switzerland)
MACHTA (U.S.A.)
MINNETT (Australia)
PHILIPPS (Germ. Dem. Rep.)
SCHUMANN (Union of S. Africa)
TOLSTIKOV (USSR)

III *Geomagnetism*

LAURSEN (Reporter)

Bartels (Germ. Fed. Rep.)
Cardus (Spain)
Chen (Chinese People's Rep.)
Giorgi (Italy)
Gouin (Ethiopia)
Haubert (Morocco)
Nagata (Japan)

IV *Aurora*

Chapman (Reporter)
Blamont (UNESCO)
Chu (Chinese People's Rep.)
Harang (Norway)
Herlofson (Sweden)
Hoffmeister (Germ. Dem. Rep.)
Hulburt (U.S.A.)
Law (Australia)
McNicol (Australia)
Moore (U.K.)
Nagata (Japan)
Peavey (U.S.A.)
Picha (Czechoslovakia)
Pushkov (USSR)

VI *Solar Activity*

Öhman (Reporter)
Bartels (Germ. Fed. Rep.)
Bobrovnikoff (U.S.A.)
Danjon (France)
Hachenberg (Germ. Dem. Rep.)
Nagata (Japan)
Picha (Czechoslovakia)
Piddington (Australia)
Pushkov (USSR)
Roberts (U.S.A.)
Romana (Spain)
Shapley (U.S.A.)
de Voogt (Netherlands)

VII *Cosmic Rays and Radioactivity*

Simpson (Reporter)
Aono (Japan)
Balta (Spain)
Bleeker (Netherlands)
Bolin (Sweden)
Brunt (U.K.)
Chu (Chinese People's Rep.)
Facy (France)
Harang (Norway)
Herlofson (Sweden)
Law (Australia)
Massey (U.K.)
Minnett (Australia)
Picha (Czechoslovakia)
Pushkov (USSR)
Solberg (Norway)
de Voogt (Netherlands)
Worf (U.S.A.)

VIII *Longitudes and Latitudes*

Danjon (Reporter)
Blaser (Switzerland)
Bobrovnikoff (U.S.A.)
Boulanger (France)
Carrasco (Spain)
Chen (Chinese People's Rep.)
Dore (Italy)
O'Dwyer (Argentine)
Krzeminski (Poland)
McNicol (Australia)
Tardi (France)
Whipple (U.S.A.)

X *Oceanography*

Laclavère (Reporter)
Armstrong (New Zealand)
Atwood (U.S.A.)
Bruun (Denmark)
Capurro (Argentine)
Chen (Chinese People's Rep.)
Debrach (Morocco)

HIDE (Union of S. Africa)
KULLENBERG (Sweden)
LAW (Australia)
MARTIN (U.K.)
MENENDEZ (Spain)
TOLSTIKOV (USSR)

XI *Rockets and Satellites*

BERKNER (Reporter)
BARDIN (USSR)
BEYNON (U.K.)
BLAMONT (UNESCO)
BLASER (Switzerland)
BLASSEL (France)
CHU (Chinese People's Rep.)
HAGEN (U.S.A.)
KAPLAN (U.S.A.)
LAW (Australia)
LU (Chinese People's Rep.)
MASSEY (U.K.)
MORENO (Argentine)
NAGATA (Japan)
NEWELL (U.S.A.)
ODISHAW (U.S.A.)
PIDDINGTON (Australia)
SLAVIN (U.S.A.)
TOUSEY (U.S.A.)
VAN ALLEN (U.S.A.)
VAN ROOY (Union of S. Africa)
WHIPPLE (U.S.A.)

XII *Seismology*

BELOUSSOV (Reporter)
BONELLI (Spain)
CHEN (Chinese People's Rep.)
COULOMB (France)
DEBRACH (Morocco)
O'DWYER (Argentine)
HULBURT (U.S.A.)
JOYCE (U.S.A.)
KRZEMINSKI (Poland)
MOORE (U.K.)
NAGATA (Japan)

1.6 *First ACIGY Session*

5.45 p.m., Wednesday, 12 September 1956

President CHAPMAN convened the meeting and called upon Dr. L. V. BERKNER, as Chairman of the Finance Committee, to review the development of the IGY organization and its financial requirements. The rapidly expanding program had entailed so much greater responsibility for the unpaid part-time executive officers of the CSAGI that it was felt necessary to provide for the appointment of Adjoint Secretaries, an Editor, and a Co-ordinator. An additional heavy expense item was the cost of publishing IGY manuals.

Because there were insufficient funds to support this expanded activity the Bureau consulted the officers of ICSU, who advised that they felt it necessary for CSAGI to fulfil its responsibilities for the IGY programs, especially in view of the large commitments already made by the National Committees, at their own expense. Thus it was agreed to approach two National Committees to ask for supplementary funds, with the understanding that if a favorable response was received and if the ICSU Executive Board, meeting in the spring of 1956 in Bagnères-de-Bigorre, approved of this procedure, all the participating IGY National Committees would be asked to contribute in support of the CSAGI central organization. The United States and the United Kingdom National Committees made initial contributions as indicated in the report of the Finance Committee, and promised additional support in ensuing years if other National Committees would respond favorably to a call for funds. The ICSU Executive Board in turn endorsed this procedure at its meeting in Bagnères-de-Bigorre. A draft resolution had consequently been presented to the CSAGI at a session on Monday afternoon, 10 September, requesting National Committees to provide funds in support of the central organization, but action on it was deferred.

Several schemes were proposed to guide National Committees in deciding the size of contribution appropriate. However, it was agreed that the General Secretary should work out the precise scheme for contributions, and a general resolution was adopted endorsing the principle that each National Committee should contribute to meet the estimated deficit of $75,000 for the years 1956, 1957, and 1958.

There was a short discussion of the necessity for the creation of the office of the Co-ordinator of Operations.

1.7 *Third CSAGI Session*

11.30 a.m., Thursday, 13 September 1956

On Thursday morning, the CSAGI met to consider the arrangements for financing the activities of the international IGY organization.

A number of opinions were expressed as to how best the CSAGI might resolve the problem of insufficient funds for the support of the international IGY central organization. After lengthy discussion it was voted to endorse the resolution passed by the ACIGY on Wednesday, 12 September, in which approval was given to the idea that each National Committee should be asked to provide a contribution to meet the estimated deficit for the years 1956, 1957, and 1958.

After the discussion, Dr. M. Nicolet announced that he was tendering his resignation as General Secretary of the CSAGI. He then left the room. There were immediate expressions of regret at the prospect of losing the service of so faithful a General Secretary, and the following resolution was passed unanimously for transmission to him:

> "Le CSAGI exprime à l'unanimité sa confiance envers le Secrétaire Général, le Dr. Nicolet, qui a accompli en toute conscience une tâche considérable et lui demande de retirer sa démission."

1.8 *Second ACIGY Session*

3.30 p.m., Thursday afternoon, 13 September 1956

Professor Chapman opened the meeting by stating that it was felt that certain criticisms expressed in the morning session of the CSAGI had been pushed to unreasonable lengths; moreover these had led to the resignation of the General Secretary. Numerous speakers rose to urge that the General Secretary reconsider his decision, and further indicated that the resignation of the General Secretary could well have serious consequences, not only in disrupting the IGY administration, but also in destroying national confidence in the organization of the IGY. By unanimous vote the ACIGY associated itself with the resolution expressing confidence in the General Secretary. In reply the General Secretary noted that, as originally stated, his resignation would not take effect until 1 November, and that he would, of course, continue to serve the IGY until then.

On the President's initiative, the Co-ordinator was asked to present the draft resolution for IGY World Data Centers as prepared by an *ad hoc* committee designated at the CSAGI afternoon session of Monday, 10 September. After discussion it was endorsed as a general guide by the ACIGY without modification and without dissent.

Finally a resolution providing guidance for the Co-ordinator was adopted as follows:

> "Dans le but de faciliter l'établissement des Centres C, l'ACIGY fait confiance au Co-ordinateur et le charge en accord avec les Unions Scientifiques de dresser la liste des Centres Internationaux de diffusion déjà existant ou dont la création est envisagée.
>
> Dans cette deuxième hypothèse, demande au Co-ordinateur d'apporter à ces centres en formation, concernant des disciplines nouvelles, tout l'appui et toutes les facilités que l'ACIGY serait susceptible d'apporter."

1.9 *Third ACIGY Session*

10.0 a.m. Saturday morning, 15 September 1956

The ACIGY convened to consider the future IGY organization and unanimously adopted the following resolutions:

(1) The Advisory Council for the IGY expresses confidence in the present Bureau, which has made it possible for such a great enterprise as the IGY now envisaged to develop.

(2) The ACIGY reaffirms its confidence in Dr. MARCEL NICOLET, and expresses its thanks to him and the other members of the Bureau.

(3) The ACIGY is confident that the Bureau will recognize the rapidly changing picture of the IGY, and that it will adapt its central organization accordingly at any time.

(4) The ACIGY urges that all National Committees by correspondence with the Bureau and its officers make known their views and requests for the future organizational work.

The ACIGY expresses its complete confidence in the whole of the CSAGI Bureau, and at the same time expresses the conviction that the Bureau will find satisfactory ways leading to the successful fulfilment of the IGY operation.

1.10 *Fourth CSAGI Session*

10.30 a.m. Saturday, 15 September 1956

The CSAGI in turn, meeting to consider the future organization of the IGY, after lengthy discussion adopted the following resolutions:

(1) The CSAGI expresses confidence in the present Bureau, which has made it possible for such a great enterprise as the IGY program now envisaged to develop.

(2) The CSAGI reaffirms its confidence in Dr. MARCEL NICOLET, and expresses its thanks to him and the other members of the Bureau.

(3) The CSAGI is confident that the Bureau will recognize the rapidly changing picture of the IGY, and that it will adapt its central organization accordingly at any time.

(4) The CSAGI urges that all members of CSAGI, by correspondence with the Bureau and its officers, make known their views and requests for the future organizational work.

1.11 *Final Plenary Session*

12.0 noon, Saturday, 15 September 1956

In the first portion of the final plenary session the resolutions adopted and the planning accomplished were described. Sir HAROLD SPENCER JONES presented the general resolutions, and the Reporters gave short résumés of the planning and resolutions in each of the disciplines.

President CHAPMAN concluded the Conference with the following remarks:

"Formal but heartfelt thanks are due to our hosts in Spain who have done so much to make our stay agreeable. I should like to propose three resolutions (see p. 371).

"There are many other thanks which need to be given to others who have worked hard at the meetings to bring the program to a further stage of perfection: to the chairmen and each member of the working groups, and to the chairman of the Resolutions Committee and his colleagues, who battled with a very large number o resolutions. I am sure that we wish to give thanks to one and all who have contributed to the great progress in the scientific program in our meeting, and in formulating further stages in our work.

"I would like, at this point, to draw attention to the extraordinary services which Col. LACLAVÈRE has rendered to the IGY program in so many aspects. He has borne the usual amount of work of any CSAGI Reporter in attending meetings and discussing papers as the CSAGI Reporter for Oceanography. He also undertook the responsibility of acting as Adjoint Secretary for the Antarctic, and did this work for two years before the name for the office was devised. He organized two successful conferences for the Antarctic before the last conference in the present year. In addition he is the chairman of the Publications Committee and a most valuable member of the Finance Committee, and you all know what efforts he has made at the meetings themselves in translating very long statements so skilfully. This has been a great strain on him, and we hope by the use of translators to relieve him of some of that strain in the future.

"In conclusion I shall now briefly refer to some of the highlights in the progress we have made at this meeting. First of all there is the announcement by the leader of the USSR delegation that the USSR will launch rockets and satellites for the IGY program. There is also the excellent news that co-operation has been arranged in the satellite program so that certain standards will be adopted in the satellites of the two countries, thus making possible standardization of the equipment needed to observe satellites. I think this first announcement of a new satellite program and of this international co-operation is of the highest importance for the IGY program.

" As the beginning of the IGY approaches and final preparations are made, the work of the central organization must necessarily change. Important changes have been made by the Bureau, acting on the authority given it at the Brussels meeting, by the appointment of an Editor and Co-ordinator. We must expect that further changes in the organization will be needed during the coming year. For this purpose proposals are invited from the National Committees and Unions, which are asked to send in constructive suggestions. We are glad to see that both the ACIGY and CSAGI itself have expressed confidence in the Bureau, and especially in its General Secretary, in placing in his hands the review of these proposals and their preparation for submission to the parent body ICSU. We have also to recall the generosity shown by members of the Advisory Council in endorsing the invitation by ICSU that National Committees should be invited to contribute, according to their ability, to the CSAGI funds, to cover the deficit in the budget laid down by the Finance Committee in view of the needs of the central organization during the present year and two coming years.

"Another important addition to our program which has been decided upon, as a result of discussions which began last year at the Brussels meeting, is the program of nuclear radiation in the atmosphere.

"Important progress in our work is shown in the advanced stage of preparation of the manuals for the different scientific disciplines of the IGY. There will be manuals of guidance and instruction for each part of the program except for Glaciology. They have been prepared by many hands in the Working Groups, and will have great importance for the success of our work; I believe they will be of permanent value after the IGY. The manuals will be produced under the guidance of the Publications Committee, whose chairman is Col. LACLAVÈRE.

"A new stage in the organization of World Data Centers has been reached. This is a vital part of the work. There is much agreement, and many of the detailed decisions have been made here. In this respect the Co-ordinator of Operations has a task of great importance, just as has the Editor in the production of the manuals.

"And finally, I should like to extend thanks for the wonderful pictures of the Antarctic shown by the Russian delegation on one of the evenings of the meeting. It is hoped that these will become a part of a collection of films on the IGY Antarctic enterprise, which will come before the public at a later stage."

2 Resolutions on CSAGI Disciplines

I World Days

(1) The CSAGI, considering the request received from the WMO that the dates of the WMIs be adjusted to coincide exactly with two "pentades" to facilitate the grouping of the meteorological observations made during World Days, and noting that the advantages and convenience of selecting the WMIs to correspond to integral pentades are overwhelming, resolves that the dates of the WMIs be readjusted as follows:

1957	June	20–29	(advance Trial WMI)
	Sept.	18–27	
	Dec.	12–21	

1958	March	17–26
	June	15–24
	Sept.	13–22
	Dec.	12–21

(2) The CSAGI, considering that:

(i) Different versions of the Calendar for IGY Regular World Days and WMIs appear to be in circulation; and

(ii) It is imperative for the success of the IGY disciplines that there should be no confusion or ambiguity with regard to the Calendar, resolves that the final calendar of RWDs and WMIs should be titled as follows:

FINAL Calendar of Regular World Days (RWD) and World Meteorological Intervals (WMI) during the International Geophysical Year 1957–1958

and requests all Organizations, National Committees and other bodies which have circulated previous versions of the Calendar to reissue this final version, drawing special attention to its title.

(3) The CSAGI resolves that a special telegraphic auroral warning system is not required.

(4) The CSAGI requests all National Committees in the subauroral and min-auroral belts to approach their local broadcasting services with a view to announcing in their programs in the later part of the evening the local appearance of auroral displays near the zenith in geomagnetic latitudes 55° or less, in those periods not covered by an SWI Alert.

(5) The CSAGI, considering that the trial month (June 1957) designated for the whole IGY program is too short for establishing the final and reliable communication arrangements resolves that:

(i) Trial weeks of the IGY Communications shall be held each month from January to May 1957; and

(ii) The plans for these trial weeks shall be as follows:

(i) The trial weeks shall be from the 10th to the 16th (both days inclusive) of January, February, March, April and May 1957.

(ii) The trial is only to test the efficiency of the communication arrangements; and therefore, during these trial weeks, IGY stations are not expected to make any special observations or try out their observing programs planned for periods of Alerts and SWIs.

(iii) IGY stations that are expected to make regular reports to Regional World Day Centers during the IGY should send at least token messages based on whatever observations are available. These messages should be sent at the same time of the day as envisaged for the IGY.

(iv) *Regional Centers* should interchange data on the schedules envisaged for the IGY: distribute data by direct messages or broadcasts exactly in the same way as during the IGY (in many cases these may be only token messages, since the amount of data available will be limited): and send advice regarding declarations of Alert and SWI to the World Warning Agency in a full schedule. Other organizations planning to give their opinion regarding the declarations should similarly send them to Regional Centers.

(v) *The IGY World Warning Agency* will issue notifications of Alerts and SWIs as decided on the basis of advice received. In order to ensure that messages will be available for the trial of this part of the IGY communications, the IGY World Warning Agency may have to reduce the minimum standards for declarations below those intended for the IGY itself. These messages for the trials will begin "AGI Geophysical Year Test Warning No. . . .."

(vi) All National Committees (or their representatives responsible for World Days) will report immediately after each trial week, to their respective Regional World Day Centers, with a copy to the CSAGI Secretariat, the times of receipt of each message, with any comments which will help to improve the communication arrangements, so that remedial action can be taken where necessary.

(vii) Observing stations and communication links which are in the process of being established should join the trials as soon as they are able to do so. Similarly as new instruments which will contribute to the World Day Program are put into operation, reports of their observations should be added to the data reports. In these ways the volume of data and messages handled under the World Day Program will gradually build up to the level to be handled during the IGY proper.

(6) The CSAGI recommends that continuous short notifications be transmitted by stations broadcasting on standard frequencies in accordance with alerts issued by the World Warning Agency. Such transmissions should be broadcast twice hourly.

It is recommended that the following code be used:

Message	*Meaning*
AGI AAAAA	State of Alert SWI will begin
AGI SSSSS	SWI will begin at 0001 UT (GMT) following
AGI — — —	SWI continues
AGI TTTTT	SWI will end at 0001 UT (GMT) following
AGI EEEEE	No state of Alert

(7) The CSAGI recommends: in order to implement the program of World Days for the IGY, that those countries that have not already done so designate as soon as possible a specific person who will be responsible for that portion of the communications scheme that applies to his particular country, and to whom operation manuals should be sent. There should also be provided both postal and telegraphic addresses of the organization concerned, and since it is planned to begin trial operations in January 1957 in order to assure an effective system by 1 July, it is urgent that this information be received not later than 1 November 1956. It should be sent to the CSAGI Secretariat.

(8) The CSAGI strongly urges all regional centers for World Days and Communications and all National Committees to keep the CSAGI Reporter and the IGY Coordinator continually informed of practical details of the communication arrangements for the IGY program, such as addresses of responsible organizations, including cable addresses, as well as schedules of regular transmissions and broadcasts, frequencies in use, codes employed in data interchange or international dissemination, and all other information suitable for supplements to the *World Day Operations Manual*, and, in particular, of any changes in arrangements or details. CSAGI further

directs that supplements to the *Manual* be issued at frequent intervals as required, extending even towards the end of 1958.

(9) The CSAGI recognizes the difficulty of establishing sets of codes for summaries of current data which will be suitable alike for data collection, data interchange, and data dissemination to all types of users, and notes that the Ursigram Committee has made progress but has not arrived at a final conclusion on this question. It therefore directs the CSAGI reporter to make a temporary decision on the interchange codes to be published in the *Manual*, and urges the World Day Centers to use these codes in their mutual interchange of current data until the Ursigram Committee comes to a decision. CSAGI further directs that all codes proposed to be used by World Day Centers for data collection or data dissemination be published in the *Manual*, and that all changes appear in the periodic supplements to the *Manual*. CSAGI endorses the principle that codes be simple and particularly suited to the convenience of the recipients of data messages.

(10) The CSAGI considering (i) the unprecedented scope of the scientific effort represented by the IGY, and (ii) the wide-spread participation of amateur observers in the various IGY scientific disciplines: and recognizing the significant scientific contributions that radio amateurs throughout the world can make to the IGY programs:

resolves that:

(i) The National Committees should invite:

(a) Their respective administrations to afford all reasonable facilities to their radio amateurs to co-operate in this scientific effort and exchange purely scientific information relating to the IGY programs; and

(b) The radio amateurs of their countries through the appropriate bodies to co-operate, as far as their resources permit, in the various scientific programs of the IGY; and

(ii) This resolution be transmitted to the International Telecommunication Union, with the request that it be circulated to all its members, inviting their whole-hearted co-operation in giving effect to this resolution.

(11) The CSAGI, noting:

(i) The texts of Alert warnings and SWI messages developed by the Ursigram Committee of the URSI (Paris 1955), and

(ii) The suggestion received from the WMO regarding identifying the individual messages,

resolves that

The standard texts of the Alert warnings and SWI messages shall be as given in the annex to this resolution; and

requests

All the organizations concerned and the National Committees to circulate these texts to all their stations participating in the IGY program, so as to familiarize them thoroughly with the texts of these messages and their meaning.

Annex—Warnings

Text of messages	*Meaning*
AGI Geophysical Year Warning No. . . .: Alert starts immediately 02/1600.	A state of Alert commences from 1600 hr UT of the 2nd of the month.
AGI Geophysical Year Warning No. . . .: Special World Interval starts at 30/0001.	A Special World Interval is declared and becomes operative from 0001 hr UT of the 30th of the month.
AGI Geophysical Year Warning No. . . .: Alert SWI Continues 31/1600	A state of Alert or the duration of a SWI, as appropriate, continues. The message notifying the continuation has been originated at 1600 hr UT on the 31st day of the month.
AGI Geophysical Year Warning No. . . .: Alert finishes immediately 03/1600.	A state of Alert finishes immediately. The message notifying the finish has been originated at 1600 hr UT on the 3rd day of the month.
AGI Geophysical Year Warning No. . . .: SWI finishes at 05/2359.	A Special World Interval that has been current will finish at 2359 hr UT on the 5th day of the month.

Remarks:

(i) All times given in the warning messages are UT.

(ii) Occasions may arise when there will be no interval between the ALERT warning and the declaration of the SWI. In such cases the ALERT warning and the declaration of the SWI will be combined in the message issued at 1600 UT (GMT) as follows:
"AGI Geophysical Year Warning . . . . . .: Alert starts immediately 02/1600; and Special World Interval starts at 03/0001"

(iii) Similarly occasions may arise when a SWI will finish but the Alert will continue for some days after the finish of the SWI. In such cases also a combined message will be issued as follows:
"AGI Geophysical Year Warning . . . . .: SWI finishes at 05/2359; Alert continues."

(12) The CSAGI, noting the resolutions adopted by the CSAGI Eastern Europe and Western Hemisphere conferences regarding the importance of observatory data, particularly those from solar observation, being available at Regional World Day Centers as quickly as possible,
resolves that

National Committees should forward to their respective Regional Center, before 31 December 1956, a list of observatories and institutions which can communicate their observational data very quickly to the Regional World Day Centers.

(13) The CSAGI recommends that the reporter for World Days assemble a list assigning all countries participating in the IGY to specific Regional World Day Centers for communication purposes. These provisional assignments will be sent to

National Committees for their approval or alternative suggestions. On the basis of the amended lists final assignments will be made.

(14) The CSAGI recommends that in April or May 1957 a meeting be held at each Regional World Day Center, to be attended by suitably qualified representatives from all countries assigned to the center. The purpose of these meetings will be to discuss deficiencies in the communication system which have appeared during the test periods, and to suggest remedial actions.

These regional meetings should be followed by a meeting of suitable qualified representatives from each Regional World Day Center to collate results and again to suggest possible remedial actions on the basis of the world network.

(15) The CSAGI notes with much satisfaction the response of the WMO to the resolution of the second meeting of CSAGI requesting co-operation in distributing the necessary information on Alerts and Special World Intervals over the communication network available to WMO: and particularly recognizes the value of the circular describing the plan which the General Secretariat of WMO has drafted. CSAGI is confident that the direct and indirect advantages to meteorological science from the observation by the IGY stations of many disciplines during periods of Alerts and Special World Intervals will be considerable.

(16) The CSAGI notes with much satisfaction that a World Day Center has been established for Eurasia, and recognizes that the full participation of this center in the interchange of current data summaries and advice to the IGY World Warning Agency on declaration of Alerts and SWI will help greatly the full realization of the World Day Plan.

(17) The CSAGI notes and approves the actions of the Ursigram Committee contained in the report of its September 1955 meeting (*URSI Information Bulletin* No. 94) which concerns particularly the plan for the IGY program, noting that the center for Eurasia has since been established, and noting that the standard texts for Alert and SWI notifications have been further developed at the present meeting of CSAGI.

(18) The CSAGI recognizes that there will be a potential problem of mutual interference at some Antarctic stations between communication services and the sweep frequency ionospheric experiments. It is further recognized, however, that most ionospheric equipments under conditions of good maintenance may cause interference on any given frequency for only a few seconds. It appears therefore that stations should be able to work out suitable arrangements, and that the important objectives of the ionospheric program can be achieved on the prescribed schedules without the communications services suffering.

(19) The CSAGI notes that an exchange of data summaries more extensive than the usual exchange between the hemisphere regional center and the various national centers may be required on particular occasions at the time of observations of an unusual nature, such as cosmic-ray showers: and in such cases endorses the direct interchange of data summaries by individual stations within the region, such as may facilitate the observation and interpretation of such phenomena.

(20) The CSAGI recommends that the participating countries adopt and register

a standardized form of cable address for their respective IGY communications offices, with the address denoting the program and the city in which the office is located, in the following form, AGI Buenos Aires, AGI Lima, AGI Sao Paulo, etc.

II Meteorology

(1) Le CSAGI recommande que des mesures synoptiques systématiques du champ électrique, de la conductibilité de l'air et, autant que possible, du courant vertical soient entreprises pendant l'AGI à des stations continentales et maritimes et suggère, en particulier, que les navires météorologiques stationnaires de l'Atlantique Nord soient équipés afin de leur permettre d'effectuer ces mesures, et que des cartes mondiales d'orages donnant la répartition des foyers orageux et les variations interdiurnes et saisonnières de leurs activités soient préparées à l'aide des observations d'orages effectuées pendant l'AGI à l'aide de tous les moyens techniques existants à ce jour (nombre, intensité et forme des décharges).

(2) The CSAGI noting the relative sparseness of upper-air stations in South and Central America, recommends that those countries having suitable geographical conditions establish and maintain at high altitudes pilot balloon stations to complement the proposed network of radiosonde stations, and also recommends that the pilot balloon observations at high-altitude stations be made with two theodolites for the duration of the IGY.

(3) The CSAGI notes the need for information on atmospheric circulation in equatorial regions, which lack adequate networks of radiosonde and radio wind stations, and urges that the equatorial countries of the western hemisphere install and maintain a full network of radiosonde and radio wind stations for the duration of the IGY.

(4) The CSAGI urges that countries of the western hemisphere publish all as yet unpublished meteorological data in their possession at an early date, so that these data may be used in conjunction with those obtained during the IGY.

(5) The CSAGI urges that efforts be given to the achievement of the highest accuracy in the meteorological observations taken by participating countries, and to this end recommends that meteorological instruments used at stations included in the IGY networks be periodically intercompared in accordance with the specifications of the World Meteorological Organization, and also recommends that the participating countries carry out regional comparisons between the standard instruments of each country, and recommends that CSAGI obtain through the World Meteorological Organization a list of all standard meteorological instruments in use in each western hemisphere country so that advisory co-ordination can be provided for programming the recommended comparisons.

(6) The CSAGI urges that atmospheric carbon dioxide measurements be made whenever possible during the IGY with the object of obtaining an accurate assay of the total carbon dioxide content of the earth's atmosphere and the rates of interchange among atmosphere, oceans, and soil, and notes that measurements are especially needed over the oceans, at coastal stations away from cities, and at high-altitude stations, with particular attention to the carbon dioxide content of different air masses.

(7) The CSAGI recommends that selective meteorological observing stations throughout the western hemisphere should, whenever possible, measure the chemical constituents of precipitation during the IGY and that efforts should be made to enlist the interest of chemists in this program, especially since the Working Group on Meteorology at the Brussels Meeting of CSAGI, 1955, emphasized the desirability of measuring sulphur, chlorine, sodium, potassium, magnesium, calcium, etc.

(8) The CSAGI recommends that countries of the western hemisphere engaging in studies of atmospheric chemistry during the IGY exchange detailed information on the methods used, and further recommends that duplicate samples be analyzed at different measurement centers to insure the possibility of intercomparison of results.

(9) The CSAGI recommends that National Committees in western hemisphere countries give consideration to the installation and operation of radiosonde stations adjacent to those stations operating cubical meson telescopes, in view of the fact that the existing and presently proposed network of radiosonde stations is lacking in stations so located, and since it is of great importance for the studies of cosmic rays and particularly for those made with the cubical meson telescopes, that there be also obtained complete meteorological information from the higher layers of the atmosphere, especially the region between the pressure levels of 50 and 100 millibars.

(10) The CSAGI strongly recommends the establishment of an aerological and actinometric station on the Greenland ice cap.

(11) The CSAGI, recognizing the importance of Arctic meteorological phenomena to the northern hemisphere weather and perhaps to world weather, and noting with satisfaction that the preparation of northern hemisphere weather charts will be undertaken by U.S.A. during the IGY, recommends that during the IGY these charts be prepared from meteorological data which the participating nations will make available at the IGY Meteorological Data Centre.

It would be desirable also to include in the published map series daily weather charts for 50 mb for the northern hemisphere and as much of the equatorial region as data permit.

(12) The CSAGI notes with great satisfaction that during the IGY the Scandinavian countries Denmark, Finland, Norway and Sweden are planning to organize a Working Group stationed at the Norwegian Weather Service in Oslo. The organization of this group will make it possible:

(a) to extend and intensify weather forecasting in the Arctic region for which Norway is responsible according to WMO resolution;

(b) to evaluate on a current basis the synoptic observational material in meteorology which will be assembled.

(13) The CSAGI emphasizes the importance of reporting sea ice conditions according to the international WMO code through the established channels to the Weather Central.

(14) The CSAGI, considering that (i) there are large ocean areas in the southern hemisphere particularly the South Atlantic and the South Pacific, with no meteorological coverage and (ii) that everything must be done during the IGY to cover this

gap in the interest of world meteorology, and noting that South Africa and Australia receive observations from whaling ships in these areas and rebroadcast them in their collectives, omitting the names of the ships; and taking into account that under a scheme organized by the WMO

(i) all efforts should be made by countries participating in the Antarctic operations so that their radio stations in the Antarctic receive the observations from whaling ships when rebroadcast by South Africa and Australia.

(ii) at least the mother stations and the Weather Central in the Antarctic be supplied with the necessary information to enable them to identify the positions and names of the ships, and that countries receiving observations from voluntary observation ships provide adequate facilities for retransmission of the observations in their collectives.

(15) The CSAGI recommends that Weather Central should broadcast information concerning the probability of adverse radio propagation conditions and that operators of Antarctic IGY Stations be urged to record carefully the time of onset of disturbances to radio transmission.

(16) The CSAGI notes with satisfaction the intention of several countries to maintain or establish ozone stations at latitude 65° or higher between longitudes 19°E (Tromsö) westwards to 148°W (College) in the northern hemisphere and between longitudes 40°E to 140°E in the southern hemisphere and urges that every effort be made to establish ozone stations at similar high northern latitudes from 19°E eastwards to 148°W and at high southern latitudes from 40°E westwards to 140°E.

(17) The CSAGI noting the vital importance of following world weather on a current basis during the IGY, urges that every effort be made to improve the quality and quantity of radio transmission of synoptic meteorological observations from the Arctic and Antarctic regions.

(18) The CSAGI urges that particular attention be given to transmission of the aerological observations from altitudes as high as possible.

(19) The CSAGI, recognizing the importance of actinometric measurements in the Arctic and Antarctic, recommends that each country planning such measurements examine with great care the results of the comparisons of radiation instruments made in Hamburg in September 1955 and May 1956 under the auspices of the Radiation Commission of the International Association of Meteorology (UGGI).

(20) The CSAGI, recognizing the importance of ozone measurements in the Arctic and Antarctic, especially during the polar night, urges that the sensitivity of the ozone measuring instruments be increased to allow measurements to be made using moonlight.

(21) The CSAGI urges that a standard method of measuring the ozone content of surface air be developed and adopted so that extensive networks in the Arctic and Antarctic could be established. Recommendations of the Ozone Commission of the International Association of Meteorology (IUGG) should be requested for the measurements of surface ozone and vertical ozone distribution.

(22) The CSAGI invites the Radiation Commission of the International Association of Meteorology (IUGG) to designate two or three standard instruments, from among the sixteen actinometric instruments which were intercompared at Hamburg,

in order that, on a regional basis, the comparison of instruments not yet calibrated could be carried out with those which have been compared in Hamburg in September 1955 and May 1956.

(23) The CSAGI recommends that close co-ordination be established between oceanographical and meteorological operations so that oceanographical surveys planned for the South Atlantic and South Pacific Oceans during the IGY can have maximum effectiveness in providing maximum frequency, duration, and type of meteorological data in areas not usually under observation: and strongly urges that semi-permanent ocean stations be established in strategic locations in the southern hemisphere and where large gaps now exist,—either by individual countries or by several in co-operation: and recommends that all countries which are in a position to carry out such oceanic programs, in one way or another, inform the CSAGI Secretariat of the plans which are to be carried out during the IGY.

(24) The CSAGI notes with appreciation the valuable assistance which has been given by whaling ships to the National Meteorological Service by sending meteorological reports to Australia and the Union of South Africa during the whaling season, and recommends

(i) that each National IGY Committee should approach the whaling companies operating from its own country, acquaint them with the aims of the IGY, and request their continued co-operation during the IGY, at least on the same scale as before,

(ii) that the CSAGI Bureau convey a similar message to the International Commission and the Whaling Association and other appropriate bodies.

(25) The CSAGI supports the resolution of the WMO concerning meteorological observations to be carried out on board naval vessels, especially when they are in waters infrequently visited by merchant ships. More generally the Conference earnestly desires that IGY national committees make strong representations not only to the navies of their respective countries, but also to commercial navigation companies, in order to augment the number of supplementary and auxiliary ships selected for the IGY. It furthermore insists that all meteorological observations made at sea, on no matter what ship, be ultimately transmitted to the IGY Center for meteorological data by not later than 1959.

(26) The CSAGI requests that national committees investigate the possibility of organizing surface and altitude observations not only from oceanographic vessels, but also on board all ships which will participate in the IGY maritime operations, as, for example, on ships traveling to and from the Antarctic.

(27) The CSAGI recommends that a ship of light tonnage be placed in service to make synoptic observations while circumnavigating the earth between the parallels of 45 and 55°S whose costs of operation would be supported jointly by several nations.

The CSAGI, considering (i) the very great importance of synoptic surface observations at sea, and (ii) the desirability of obtaining during the IGY as many observations as possible from ships not only in the Antarctic waters but also from ships in the Arctic Ocean, supports the resolutions of the CSAGI Antarctic Conference (Paris, 1956) on ship observations in the southern seas; and urges the countries whose ships are liable to operate in the Arctic waters to co-operate to their fullest extent.

III Geomagnetism

(1) The CSAGI notes with satisfaction that Chile is installing magnetic variographs at Antofagasta, Easter Island, Concepcion and Punta Arenas and that a La Cour magnetograph will be set up at Santiago. Attention is drawn to the Brussels resolution III, 8, 1955, by which Chile was requested to give a high priority to the Easter Island project.

(2) The CSAGI recommends that discussions be held by appropriate representatives of Argentina and Chile to establish a co-ordinated program of priorities for their respective establishment of permanent magnetic observatories in the Antarctic.

(3) The CSAGI requests the International Association of Geomagnetism and Aeronomy to take immediate and appropriate steps in order to bring about a standardization and clarification of Spanish terminology in the field of geomagnetism.

(4) The CSAGI draws the attention of all geomagnetic observatories to the urgent necessity of obtaining in quick-run recording of rapid variations in geomagnetism and earth-currents an absolute time-accuracy of one second or preferably better.

(5) The CSAGI endorses the continuing efforts of the International Association of Geomagnetism and Aeronomy to secure maximum benefit from the registration during the IGY of rapid variations in geomagnetism and earth currents. The IAGA is considering a meeting early in 1957 of its Special Committee on Rapid Variations and Earth Currents.* This meeting will take appropriate steps to assure uniformity in the classification of the variations observed. The IAGA further hopes to be able to arrange a symposium on rapid variations some time during 1959, when all the observational data of the IGY will be at hand.

(6) The CSAGI notes with satisfaction that the USSR is planning for the IGY a broad program of comparisons of standards of magnetic observatories by means of the non-magnetic ship *Zarya*, and that this program will be linked up with the comparison program of the International Association of Geomagnetism and Aeronomy.

(7) The CSAGI recommends that in each country at least one magnetic station should be provided with equipment for the study of the microstructure of the geomagnetic field.

(8) The CSAGI endorses the recommendation of the CSAGI Eastern Europe Regional Conference to the National Committee of the Chinese People's Republic that a station equipped with fluxmeter installation should be established in the south-east of the Republic. It notes that the National Committee of the USSR will investigate the possibility of providing such equipment.

(9) The CSAGI notes with pleasure the activities of the USSR in recording earth currents at several locations within the Soviet Union, and the plans for continuing this work during the IGY.

(10) The CSAGI strongly recommends to the National Committees concerned to consider the possibility of installing storm magnetographs at the following stations:

Danish Committee: at Scoresby Sund
Canadian Committee: in Labrador
Norwegian Committee: on Jan Mayen
USSR Committee: at Kap Schmidt.

* Copenhagen 9–11 April 1957.

(11) The CSAGI recommends that an additional measure of geomagnetic activity at polar stations should be introduced in the manner of the proposed Q-index.

(12) The CSAGI recommends that the IGY program should be completed by a World Magnetic Survey to be made after the end of 1958, and desires that the time and organization of that survey should be considered by IAGA.

IV Aurora and Airglow

(1) The CSAGI invites each National Committee to appoint a National Auroral Reporter to fulfil the following duties in association with the Regional Auroral Reporter (if any):

To organize visual auroral observations within his country, to enlist visual observers in his country and inform and instruct them concerning the auroral observations that are likely to be most valuable, to see that they are made aware of World Alerts so that adequate watches may be kept, and to see that their observations of aurora and other unusual luminosities are transmitted to the Regional Auroral Reporter or World Data Center.

(2) The CSAGI expresses the hope that in each country the records will be searched for great auroras of the past. Information should be available from journals and newspapers for the following periods, which cover some of the greatest magnetic storms and auroral displays in the past hundred years: 1 September 1859, 4 February 1872, 17 and 20 November 1882, 31 October 1903, 25 September 1909, 13 May 1921, 25 January 1938, 16 April 1938, 24 March 1940, 1 March 1941, 18 September 1941, 28 March 1946 and 21 September 1946.

(3) The CSAGI urges the National Auroral Reporters to use all available means to inform the public of events on the sun and of the possibilities and ways of observing auroras, especially during the international periods of Alerts and Special World Intervals.

(4) The CSAGI endorses the resolution by the CSAGI Western Hemisphere Regional Conference which recommends the use of all-sky cameras in high southern latitudes.

(5) The CSAGI recommends the use of special filters and pocket spectroscopes as an additional aid to visual observations in accordance with the auroral plan, as outlined in the Rome meeting of CSAGI 1954.

(6) The CSAGI endorses the resolution by the CSAGI Eastern Europe Regional Conference requesting countries of that region to develop auroral atlases and uniform instructions, and to provide mutual aid for the construction of photoelectric photometers, together with standard instructions and data recording sheets.

(7) The CSAGI notes with pleasure the offer of the Australian National Committee to establish a regional center for auroral research, and invites observers in the southern hemisphere to deposit copies of their records at this center.

(8) The CSAGI invites the WMO to ask all Meteorological Services to make visual observations of the aurora at least every three hours at 0,3,6,.... Universal Time, although hourly observations would be preferable. Such observations should commence as soon as possible, and not later than 1 January 1957.

The WMO is asked to encourage arrangements, especially in the minauroral belt where the aurora is very rare, to inform the meteorological observers of the announcement of Alerts and Special World Intervals.

(9) The CSAGI invites National Auroral Reporters to summarize the visual observations made in their country on a given night in the form of a chart when possible, and to send a copy of this chart to a World Data Center.

(10) The CSAGI recommends that copies of occasional photographic observations made at independent stations shall not automatically be forwarded to the World Data Center. The CSAGI requests the Auroral Committee of IAGA to decide at suitable intervals during the IGY the dates of those displays which merit further investigation. It is recommended that occasional photographs taken at independent stations on these dates be sent to a World Data Center.

(11) The CSAGI recommends that copies of simultaneous auroral photographs taken at two or more stations for the purpose of height determination shall not be sent to the World Data Centers, but that copies of the logbook only shall be deposited in the World Data Centers. This restriction does not refer to all-sky camera films.

(12) The CSAGI recommends that only those photographs taken by all-sky cameras during periods of Special World Intervals shall in the first instance be sent to World Data Centers for copying and return, in the manner described in resolutions of Brussels CSAGI Meeting, 1955.

(13) The CSAGI requests the Auroral Committee of the IAGA to determine, at suitable intervals during the IGY, the dates of those displays which merit further investigation, and requests that all-sky camera records for those displays also be forwarded to the World Data Centers for copying and return.

(14) The CSAGI is of the opinion that copies of other forms of auroral data are in general not required by World Data Centers.

(15) The CSAGI resolves that a special telegraphic auroral warning system is not required.

(16) The CSAGI requests all National Committees in the subauroral and minauroral belts to approach their local broadcasting services with a view to announcing in their programs in the later part of the evening the local appearance of auroral displays near the zenith in geomagnetic latitude 55° or less, in those periods not covered by an SWI Alert.

(17) The CSAGI notes with pleasure the offer of the Swedish National Committee in conjunction with the U.K. National Committee to establish a World Auroral Data Center.

*V Ionosphere**

(1) The CSAGI notes that in the network of vertical sounding stations distributed along the geomagnetic equator an important gap exists between Huancayo, Peru, and Africa, and recommends that one additional station for vertical incidence sounding be installed in eastern Brazil, with location at or near Recife or Natal.

(2) The CSAGI recommends that stations proposing to make absorption measurements endeavor to standardize their measurement methods through consultation with experts in the field and with organizations making similar observations.

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* See 49., URSI–AGI Committee, p. 375.

(3) The CSAGI urges that the National Committees of the countries within the western hemisphere work through their respective amateur radio organizations to establish a program of forward scatter observations co-ordinated with the United States program for a trans-equatorial scatter propagation experiment.

(4) The CSAGI recommends that the transmitter to be operated at Antofagasta, Chile, on about 50 Mc/s for forward scatter experiments should also be beamed eastward for operation in conjunction with additional receiving stations, one near Clorinda, Argentina, and another near Sao Paulo, Brazil.

(5) The CSAGI urges that a station for recording radio star scintillations be operated at low latitude, near Huancayo, Peru, or Sao Paulo, Brazil, for providing observations which can be correlated with spread F occurrences as observed by vertical soundings.

(6) The CSAGI recommends that a station for vertical incidence sounding be installed at Quito, Ecuador, or Pasto, Colombia.

(7) The CSAGI recommends that the proposed program of observations at Ushuaia, Argentina, be extended to include radio noise measurements and vertical incidence soundings, so as to fill the gap between Trelew and Deception Islands.

(8) The CSAGI recommends that two additional vertical incidence sounding stations be installed near Huancayo, Peru, with a spacing of approximately 3° in latitude, in order to provide coverage adequate for the study of the midday trough in F layer critical frequencies near the geomagnetic equator. Possible sites: Chiclayo and Chimbote.

(9) The CSAGI recommends that personnel operating ionospheric stations in South America visit the station at Huancayo, Peru during the IGY, for the purpose of maintaining standard procedures of observation and interpretation.

(10) The CSAGI strongly recommends the South African National Committee to establish a vertical sounding station at Marion Island. The South African Committee is also strongly encouraged to undertake whistler observations at this site, since the location is geomagnetically conjugate to certain stations in Europe.

(11) The CSAGI recommends that additional attempts should be made to observe whistlers at the geomagnetic equator, to check the negative results predicted theoretically for such locations. For this purpose it is strongly recommended that standard IGY whistler stations be established at Huancayo, Peru and at Ibadan, Nigeria.

(12) The CSAGI strongly recommends that ionospheric drift observations should be made at Huancayo, and that the European group of observing stations be extended by the addition of a station in Southern Italy.

(13) The CSAGI, taking into account the presently available estimates of direction and rate of drift of the several drifting stations in the Arctic Sea planned to be equipped for ionospheric vertical soundings, observes that the distribution of stations would be more uniform and more suitable for the ionospheric program if the sounding station proposed for U.S.A. Ice Floe Station A could instead be put on U.S.A. Ice Floe Station B.

(14) The CSAGI recommends that all possibilities be explored towards completing the ionospheric vertical sounding network as follows:

(i) There is a gap of 7° in geomagnetic latitude between the line of stations along the 10°E meridian headed by Murmansk and Tromsö (67°N) and the station planned at Longyeartown, Spitzbergen (74°N). As this gap includes the maximum of the auroral zone, a station on Bear Island (71°N) would be a very important addition to this chain.

(ii) The chain of stations along the auroral zone maximum itself would be greatly improved by an additional station in the large longitude gap to the west of about 150°W. In this connection the Arctic Conference feels that possible locations which would help to fill the gap between sub-auroral stations and stations well within the auroral zone in these longitudes are either (a) the vicinity of Wrangel Island (or alternatively Cape Schmidt) or (b) the region of Taymir.

(15) The CSAGI calls the attention of National Committees to the importance of additional cosmic radio noise absorption observations being made from any location near the auroral zone; the cosmic radio noise technique seems better suited for a study of auroral zone absorption than the pulse reflection method. Further it is well adapted for operation at small observing stations as an auxiliary experiment to vertical soundings. It would be of special value if the chain of such absorption stations in Alaska could be duplicated at other geomagnetic longitudes.

(16) The CSAGI draws attention to the fact that a considerable exchange of ionospheric vertical incidence data has been taking place, on an international basis, for many years, with great benefit both to the accuracy of ionospheric predictions and ionospheric research generally: such a network of exchanges has not, however, included all operating stations the world over: and recommends that all nations should join in this international exchange of ionospheric data as from 1 January 1957, that is, in advance of the IGY. As other stations come into operation they could then join an existing network of interchange. It is considered that such interchange will greatly encourage and assist ionospheric studies in a way which will render the work of the IGY more fruitful.

(17) The CSAGI strongly recommends that existing international regulations be relaxed for the period of the IGY, so as to permit amateur radio stations to transmit IGY scientific data. It is recognized that such stations could, in this way, materially contribute to the success of the IGY program, especially in the transmission of geophysical data from isolated observing stations.

(This resolution has been forwarded to the International Radio Consultative Committee (CCIR), meeting at Warsaw, August 1956.)

(18) In view of the important ionospheric information which can be obtained from observations on very long waves, CSAGI strongly urges the British Post Office to make available one and the same long wave station (GBR or GBZ) on Regular World Days and Special World Intervals during the IGY.

(19) The CSAGI recognizes the value of locating pairs of certain types of stations in the Arctic and Antarctic at both ends of the same geomagnetic field line. As, however, the location of Antarctic stations has been fixed, the addition of relatively inexpensive equipment to certain favorably located stations may provide for the acquirement of useful data on whistling atmospherics and their correlation with the aurora borealis and the aurora australis. The CSAGI considers that minor changes in location or the establishment of secondary stations in the Arctic which are provided

with the necessary equipment may be the most practicable means of realizing the desired conjugate configurations.

VI Solar Activity

(1) The CSAGI desires to emphasize the importance of applying the rules for the classification of solar flares, as adopted at the Dublin meeting of the International Astronomical Union, 1955.

(2) The CSAGI recommends that the report made by the working group of Commission 11A of the IAU for the photographic solar patrol be used as a guide.

(3) The CSAGI recommends that the following classification of solar surges should be adopted:

Importance class	Apparent length (per cent of solar radius)
1	5–10
2	10–20
3	20–40
3+	>40

(4) The CSAGI recommends that a classification of sudden disappearances of prominences should be introduced according to the greatest apparent extension of the filament, and that the apparent length be expressed as a percentage of the solar radius as follows:

Importance class	Apparent length
1	10–20
2	20–40
3	40–80
3+	>80

(5) The CSAGI recommends that observatories planning work on calcium plages should consider the possibility of using spectroheliograms of small dispersion, or birefringent filters for the H or K lines with passbands of the order of 2Å.

(6) The CSAGI desires to emphasize again the great importance of standardization in the measurement of coronal line intensities.

(7) The CSAGI desires to draw attention to peculiar solar phenomena such as the "Ellerman bombs" and a probably related small size flare phenomenon, discovered recently by SEVERNY, showing polarized continuous emission. A patrol of the solar disc in white light using polarigraphic equipment of high resolving power seems desirable for observing such phenomena.

(8) The CSAGI recommends that limb prominences of active region character should be classified, preferably from cinematographs, according to their intensity of activity, and degree of concentration to a centre of activity, as follows:

Importance class	Character
1	1–3 downflowing streamers or knots visible at one time
2	4–6 downflowing streamers or knots visible at one time

Importance class	Character
3	many (more than six) downflowing streamers or knots visible at one time.

(9) The CSAGI recommends that the questions of centralizing solar data for final publication, and of the final form of the reports of solar data be referred for decision to a committee, composed of the Presidents of the Solar Commissions Nos. 10, 11, 11A, 12 and 40 of the IAU, and expresses the hope that this committee will be convened as soon as possible.

(10) The CSAGI recommends that during the IGY solar radio observations of the following types should be undertaken:

(i) 200 Mc/s intensity-time observations.

(ii) Swept frequency observations of radio noise bursts over the widest possible frequency range.

(11) The CSAGI calls attention to the great advantages of carrying on optical or radio patrols of solar activity from sites at very high latitudes, thus affording the possibility for continuous 24-hour watch of the sun for many summer months. The Arctic Conference notes with satisfaction the plans of Canada for this kind of observations at Alert.

(12) The CSAGI recommends to the National Committee of Hungary that observations of the sun should be undertaken, and invites the Academy of Sciences of the People's Republic of Hungary to assist the National Committee in organizing these observations.

(13) The CSAGI recommends that the People's Republic of Mongolia should undertake observations of the sun with a photoheliograph of the Macsoutov type.

(14) The CSAGI, noting the proposed co-operative project for the installation of a coronograph in Peru, recommends that the project be given all possible support, in view of the importance of coronograph observations being undertaken in the southern hemisphere.

(15) The CSAGI, noting that solar observatories equipped with Lyot filters are planned to be established at San Miguel, Argentine; at Sao Paulo, Brazil; and at Tonanzintla, Mexico, recommends that these projects be given the continued support necessary for their completion.

(16) The CSAGI notes with satisfaction the plans for the installation of a solar observatory at a site in Brazil, to be operated jointly by Brazil and Norway as a co-operative project.

(17) The CSAGI recommends that the normal observations of sunspots (positions, areas, etc.) should be extended, where possible, to observations, by visual or photographic methods, of rapid changes in complicated sunspot groups, and that such groups should be photographed, where possible, by automatic methods with a time interval of one minute.

(18) The CSAGI, noting that there are few solar observatories in the Far East, desires to emphasize the importance of the active participation of the Chinese People's Republic in such observations, and recommends that a solar telescope, equipped with a Lyot monochromatic filter, should be installed in one of its observatories.

VII Cosmic Rays

The CSAGI recommends that:

(1) All stations participating in the IGY program for measuring cosmic-ray intensity variations should provide a count rate meter or other suitable device capable of recording the onset time of temporary increases of cosmic-ray intensity (e.g. solar flare effect) to a precision of $\pm 0{\cdot}5$ min for events reaching a maximum intensity of $\geqslant 10$ per cent at the detector. This recording device should be installed as an addition —and not a substitute for—the 15 min registration devices used to collect data in accordance with CSAGI recommendations. An adequate time standard should be available to relate all intensity observations throughout the world to a precision of ± 1 min.

(2) Wherever possible, all radiosonde stations which are expected to provide data for cosmic-ray stations should schedule not less than four (and preferably six) radiosonde flights per 24 hr throughout the period of the IGY. Where this schedule is not feasible the radiosonde flights should be increased to six per day for all World Days.

(3) Radiosonde stations should be located whenever possible, within a radius of 25 km from the cosmic-ray stations which measure either meson intensity or total ionization.

(4) Radiosonde observations intended for use by cosmic-ray stations should not only measure the heights of the pressure levels but also measure air temperature at each of these pressure levels to an accuracy of 1°C. These observations make it possible to correct for atmospheric temperature effects according to the methods developed by DORMAN and FEINBERG, OLBERT, or MAEDA and WADA.

(5) Measurements of magnetic field intensity over the visible disc of the sun should be attempted using the techniques developed by BABCOCK. The entire surface of the sun should be mapped at one-hour intervals during World Days of the IGY.

(6) Measurements of radio frequency bursts associated with solar flares should be made continuously at approximately 200 Mc/sec.

(7) Since several of the most important cosmic-ray observations require balloon, aircraft or rocket flights at the time of special solar events, it is essential to provide immediate notification of the solar event to the interested research workers without using radio networks. It is important to warn cosmic-ray observers of changes in balloon, rocket and satellite launching times, preferably by an international teletype system.

(8) To extend the study of changes in the low energy cosmic radiation spectrum with time and position in the geomagnetic field, the measurement of cosmic radiation should include observations from aircraft flights extending from low to high southern latitudes as well as transpolar flights in the northern hemisphere at several longitudes.

VIII Longitudes and Latitudes

Le CSAGI considérant que toutes les stations participant à l'opération des Longitudes et Latitudes n'auront peut-être pas achevé leurs préparatifs pour le 1 Juillet 1957, ce que pourrait conduire à prolonger les observations au delà du terme prématurément fixé, considérant d'autre part que, en tout état de cause, il y aurait intérêt à poursuivre pendant plus de 18 mois les observations lunaires par la Méthode de Markowitz, émet le voeu: que l'Union Astronomique Internationale surveille les progrès de l'opération des Longitudes et Latitudes—qu'elle prenne toutes dispositions pour en assurer le succès et, le moment venu, fixer la date de clôture des observations se rapportant à chacune des parties de son programme.

IX Glaciology

(1) The CSAGI takes note of the resolutions pertaining to glaciology adopted by the CSAGI Arctic Conference at Stockholm and the CSAGI Antarctic Conferences at Paris and recommends (a) as much standardization of instruments as possible, and (b) mutual exchange of information.

(2) The CSAGI recommends that IGY stations be encouraged to include among their observations (related to glaciology and meteorology) a study of the morphology of sastrugi which develop in response to changing meteorological conditions.

It is recognized that a study of sastrugi will contribute to the science of snow mechanics and to the development of an increased capability to interpret meteorological information from aerial photographs of regions of the Antarctic remote from meteorological observation points.

(3) The CSAGI recommends that the Participating Committees of the western hemisphere interchange reports and scientific personnel in the field of glaciology.

(4) The CSAGI recommends that each IGY Committee in the western hemisphere should publish a report, however brief, on glaciological studies carried out prior to the IGY, with an explanation of the glacial morphology of its zones.

(5) The CSAGI recommends that the Pan American Institute of Geography and History study the possibility of centralizing in one institution photogrammetric material pertinent to the glacial zone of America, with a view to the publication in a co-ordinated form of data on glaciology acquired during the IGY.

(6) The CSAGI recommends that the proposed German glaciological program in Spitzbergen take place in the Koldeway Bay area, as recommended by the CSAGI Arctic Conference.

(7) The CSAGI recommends that regular aerial photographic traverses of the Arctic Basin be carried out with the object of securing comprehensive data on sea-ice distribution, lead patterns and degrees of ice concentration.

(8) The CSAGI notes with satisfaction the arrangements made for the interchange of specifications of instruments and, where possible, for the exchange of instruments themselves.

(9) Le CSAGI recommande d'élargir le programme des recherches glaciologiques de l'Union Soviétique en Antarctique en organisant des groupes glaciologiques sur les vaisseaux longeant les côtes de l'Antarctide pour reconnaître certaines parties du littoral de l'Antarctique au point de vue glaciologique et géomorphologique.

(10) Le CSAGI estime désirable qu'en effectuant des recherches glaciologiques, on fixe l'attention sur le rassemblement des données nécessaires aux prochains calculs de tout le massif glaciaire y compris les massifs séculaires.

(11) Le CSAGI recommande d'utiliser la proposition du représentant de la

République Démocratique Allemande relative à l'acquisition en République Démocratique Allemande du nouvel appareillage destiné à assurer, si possible, la réalisation des travaux de recherches glaciologiques.

(12) Le CSAGI recommande aux comités nationaux de l'URSS et de la République Démocratique Allemande d'examiner la question de la participation des glaciologues de la République Démocratique Allemande aux travaux glaciologiques de l'URSS.

(13) Le CSAGI prie le Comité National de Bulgarie d'examiner la question de l'insertion dans le programme de l'AGI de recherches glaciologiques dans la région de la ville de Pirine et attire son attention sur la grande importance de la résolution de ces problèmes.

X Oceanography

(1) The CSAGI, noting tidal gauges are scarce or lacking in certain regions, such as the Indian Ocean, recommends that the Regional Organizations interested in the relevant parts of the world be asked to invite the countries in their area to establish tide gauges where needed.

(2) The CSAGI strongly recommends an exchange of scientists on oceanographic vessels of different countries, to promote uniformity of methods.

The CSAGI, noting that Argentina, Australia, Chile, France, and the Union of South Africa will carry out observations in high southern latitudes, recommends that vessels going to and from the Antarctic collect air and near surface water samples to be analysed for CO_2 contents, and, further, large deep water samples (50 l.) for radioactive dating, from the bottom, and from depths of 4,000 m, 3,000 m and 2,000 m.

The CSAGI recommends that permanent World Data Centers for oceanographic data be organized. Two such centers should be sufficient, taking into account that some regional centers already exist.

XI Rockets and Satellites

(1) In view of the need for frequent and urgent communications with isolated stations engaged in IGY Rocket and Satellite work, the CSAGI resolves that URSI be requested to take steps toward securing relaxation of existing international regulations for the period of the IGY, in order to permit amateur radio stations to transmit such essential information.

(2) The CSAGI resolves that the National Committees of countries having satellite programs be requested to provide to CSAGI, or directly to any country requesting it, full technical information on optical and radio tracking equipment—and on telemetry equipment as appropriate.

(3) In view of the essential requirement for satellite tracking stations in addition to those presently planned by the U.S. National Committee, the CSAGI resolves that the attention of other National Committees be drawn to the need for the establishment of further suitably placed optical and radio tracking stations. It is further resolved that consideration be given to the establishment of additional telemetering receiving stations, as appropriate.

(4) The CSAGI resolves that the National Committees of countries having

satellite programs be requested to provide to CSAGI, or to any country requesting it, such scheduling and planning information as is essential for the preparation for, and execution of optical and radio observations.

(5) Attention is drawn to resolution XI. 2 (Ch. VIII) of the CSAGI Western Hemisphere Conference of May 1956 adopted by CSAGI; the CSAGI recommends that each interested National Committee hasten to appoint such a committee or reporter; and that these appointments be communicated immediately to CSAGI and to National Committees concerned.

(6) The CSAGI resolves that each of the National Satellite Committees, or reporters, investigate at the earliest possible moment the feasibility of an organization in its country for visual and amateur radio satellite tracking and report to CSAGI.

(7) The CSAGI recommends that for all IGY satellites the radio systems employed for tracking and telemetering be compatible with those which have been announced at the current CSAGI meeting, in order that the same ground-based receiving equipment can be used throughout.

XII Seismology

Le CSAGI recommande que

(1) le correspondant du CSAGI corrige la liste des stations séismologiques dans le plus bref délai, détermine les lacunes dans la répartition des stations dans les régions les plus intéressantes du point de vue du programme de l'AGI, et se mette en contact direct avec les Comités Nationaux responsables pour examiner les possibilités d'éliminer les lacunes.

(2) une réunion des séismologues qui seront engagés dans les études microséismiques pendant l'AGI soit convoquée avant le début de l'AGI, ayant pour objet la discussion des méthodes et des installations destinées aux observations microséismiques.

(3) les questions des méthodes d'investigations du mécanisme des foyers soient discutées à l'Assemblée Générale de l'UGGI à Toronto en 1957.

(4) le correspondant du CSAGI en collaboration avec le Bureau Séismologique International et en consultation avec les Comités Nationaux envisage le contenu et la forme des données séismiques destinées à être déposées aux Centres Mondiaux, élabore le système de rassemblement, conservation et distribution des données et transmette ses propositions au CSAGI le plus rapidement possible.

XIV Nuclear Radiation

(1) The CSAGI approves the following report:

The Netherlands National IGY Committee in March 1955 submitted a proposal to CSAGI that measurements of nuclear radiation be taken up in the program for meteorology during the Geophysical Year 1957–58. During the third CSAGI meeting (1955) a study group was formed, which considered specific experiments in relation to the Netherlands proposal. At the plenary session on September 13 the President of CSAGI reported the following conclusions:

(a) The proposed experiments using radioactive tracers offer in principle an avenue to increased knowledge of transport and mixing in the air and the oceans.

(b) The IGY would be a specially appropriate time at which to make such experiments, because of the exceptional volume of related data, and the large number of observers during the IGY.

Since the Brussels conference the World Meteorological Organization has paid considerable attention to problems related to nuclear radiation. Furthermore the CSAGI Western Hemisphere Conference in Rio de Janeiro adopted the following resolution:

"The CSAGI Western Hemisphere Conference recognizes that a study of the radioactivity of the atmosphere is being made by the Netherlands National Committee on behalf of CSAGI and notes with approval that several countries of the western hemisphere have begun investigations in this field to continue during the IGY, and particularly in view of the value of such data for study of the transport and mixing of air and ocean masses, urges that CSAGI establish an appropriate working group charged with the co-ordination of a world-wide network of radioactivity measuring stations during the IGY."

Several countries have performed and reported work in the field of nuclear radiation since the Brussels conference, from which it is obvious that useful geophysical information can be obtained from measurements of nuclear radiation. (See U.S. Atomic Energy Commission Report entitled: *Annoted bibliography on the Transport and Deposition of Atomic Debris.*)

Nuclear radiation in the solid earth, the oceans and the atmosphere originates from three sources:

(i) From naturally occurring radioactive nuclides.
(ii) From within the atmosphere as a result of the bombardment by cosmic rays.
(iii) From man's activity in the field of nuclear physics.

Each of these sources of radiation contains radionuclides suitable for use in tracer studies of geophysical processes.

Numerous complicated techniques and expensive specialized instrumentation have been developed in the field of nuclear radiation. However, an IGY program in this field will aim at undertaking a simple collection and analysis program which will yield important geophysical data. It is therefore suggested that the principal effort in this program be measurements of the gross radioactivity of the air and precipitation at the surface of the earth and of solid particles deposited on the ground. The sampling techniques for this purpose are simple, and analyses can be performed by existing physical laboratories.

There are several links between this kind of simple program and the existing IGY meteorological program.

(i) The meteorological program for the IGY is in particular aimed at obtaining a better understanding of the general circulation. Measurements of the nuclear radiation would make it possible to identify and follow air masses. It would also be possible to make estimates of the storage time of particulates and water vapor, having important bearings on large-scale vertical exchange processes in the atmosphere.

(ii) The part of the meteorological program for the IGY dealing with the chemical composition of air and precipitation, as developed during the Rome meeting of CSAGI, 1954, would be greatly enhanced by measurements of the nuclear radiation.

(iii) A better knowledge of the nuclear radiation of the atmosphere has important applications to atmospheric electricity, which at the Brussels Conference, 1955, has been introduced as an item in the IGY program.

The above program will in addition establish the present level of nuclear radiation.

A program of this kind constitutes a minimum program, which in some countries, where facilities and trained personnel are available, will be supplemented by experiments as

(i) Analysis of samples for such long-lived radionuclides as tritium, ^{90}Se and ^{137}Cs at the ground and at upper levels.

(ii) Analyses of short-lived natural radionuclides such as radon and thoron.

(2) The CSAGI recommends that the nuclear radiation of air and precipitation at the earth's surface and of solid particles deposited on the ground be measured on a world-wide basis during the IGY.

(3) The CSAGI recommends that National Committees combine their resources in order to facilitate the analysis of the collected samples.

(4) The CSAGI recommends that an interim committee be set up to arrange for the establishment of a network of stations and the standardization of methods for observation and analysis.

3 Resolutions on Publications

(1) Le CSAGI reconnaissant, d'une part, l'importance de publier aussitôt que possible le volume d'Introduction aux Opérations de l'Année Géophysique Internationale et, d'autre part, la difficulté d'établir une liste exacte et à jour des stations de l'Année Géophysique Internationale, recommande que la liste en cause soit établie en tenant compte des éléments reçus par le Secrétaire Général du CSAGI jusqu'à la date du 1er octobre 1956.

(2) Le CSAGI constatant, d'une part, le retard dans la rédaction de certains manuels de l'Année Géophysique Internationale et, d'autre part, que certains de ces manuels n'ont qu'un intérêt opérationnel tandis que d'autres ont une valeur permanente, reconnaissant qu'il est indispensable de publier ces manuels dans un délai très court et en tous cas avant le départ des expéditions antarctiques, recommande que les dispositions suivantes soient prises:

(i) L'Éditeur Général du CSAGI fera reproduire les manuels par un procédé rapide et fera procéder à un tirage limité. Le chiffre de tirage de chaque manuel et la distribution aux différents pays participant aux opérations de l'Année Géophysique Internationale seront basés sur le nombre de stations de chaque pays pour la discipline visée par le manuel. Ce tirage limité portera l'indication "Édition provisoire".

(ii) Lorsque tous les manuels auront été édités sous cette forme expédiée, le Comité des Publications du CSAGI fera le choix de ceux qui présentent un intérêt permanent et entrera en relation avec un éditeur en vue de la publication de ces manuels, réunis en un ou plusieurs volumes. Cette édition typographique portera l'indication "Édition définitive".

(3) Le CSAGI attire l'attention des Comités Nationaux sur la nécessité d'adresser rapidement et régulièrement leurs fiches bibliographiques à l'Éditeur Général du CSAGI en vue de la publication des Comptes Rendus Bibliographiques de l'Année Géophysique Internationale, et décide que dans ces Comptes Rendus Bibliographiques aucune indication ne soit portée signalant que telle publication se réfère à l'Arctique, à l'Antarctique ou à une autre région particulière.

(4) Le CSAGI recommande que le Comité des Publications du CSAGI examine l'intérêt et, le cas échéant la façon de signaler dans la Bibliographie Générale de l'Année Géophysique Internationale que tel article se rapporte à une région particulière du globe.

(5) Le CSAGI recommande que dans les Comptes Rendus Bibliographiques et ultérieurement dans la Bibliographie Générale de l'Année Géophysique Internationale, les articles soient classés par discipline de l'Année Géophysique Internationale.

(6) Le CSAGI considérant qu'il est urgent qu'un manuel pour les opérations radio dans l'Antarctique pendant l'Année Géophysique Internationale soit publié et distribué avant le départ des expéditions pour l'Antarctique, recommande que l'Éditeur Général du CSAGI prenne les dispositions nécessaires pour la publication de ce manuel.

(7) Le CSAGI recommande que les Correspondants des Groupes de Travail du CSAGI fassent connaître dans les meilleurs délais à l'Éditeur Général du CSAGI les résultats qui devraient faire l'objet d'une publication du CSAGI dans les quelques années qui suivront la fin de l'Année Géophysique Internationale.

(8) Le CSAGI recommande que le Comité des Publications du CSAGI étudie la publication d'un ou plusieurs volumes sur les opérations de l'Année Géophysique Internationale dans l'Arctique et dans l'Antarctique.

(9) Le CSAGI considérant l'intérêt pour les opérations de l'Année Géophysique Internationale des Tables Crépusculaires de Lugeon actuellement épuisées, recommande que l'Éditeur Général du CSAGI étudie les conditions dans lesquelles ces tables pourraient être réimprimées assez rapidement pour pouvoir être mises à la disposition des usagers avant le début de l'Année Géophysique Internationale.

4 IGY World Data Centers

The CSAGI authorizes the establishment of at least three IGY World Data Centers, of which one will consist of a number of parts. Each Center will be international in the sense that it will be at the service of all countries and scientific bodies. It is however intended that the existing arrangements for the interchange of geophysical observations shall not be disturbed.

4.1 *Functions*

Each IGY World Data Center will be the repository of the originals or copies of IGY records, observations, and preliminary tabulations as specified by CSAGI in each and every branch of the IGY program. Each IGY World Data Center will contain a central catalog and index of all the material in its charge; it will make this catalog and index available to each participating National IGY Committee and to other responsible national and international scientific bodies and to scientific investigators sponsored by such bodies. Each IGY World Data Center will provide access to its data to such organizations and investigators. It will also provide them with copies of the data in its charge at a cost not exceeding that of the reproduction and transmission of the data requested, by the most efficient and economical method.

4.2 *Management of World Data Centers*

In accordance with offers received from two national committees there will be established:

IGY World Data Center A by U.S.A.

IGY World Data Center B by USSR

IGY World Data Center C will in fact be a number of centers in different countries, which will collect data by disciplines, and include certain established International Centers. Appreciating that such established Centers must continue to receive data during the IGY, but that they may not have the finance and facilities to handle the increased amount of data in full, C Centers must be established on a different basis. This will cover the particular needs of established international Bureaux and Centers. The CSAGI authorizes the Co-ordinator to negotiate with each of these to establish the best arrangements, and to report his conclusions to CSAGI. He will provide CSAGI and National Committees with a guide giving all particulars.

4.3 *Supply of Data to IGY World Data Centers*

Each national IGY Committee participating in the IGY program is under obligation to supply at its own cost, and in accordance with a time schedule established by the CSAGI, all its IGY data as specified above to at least one of the IGY World Data Centers. It will inform CSAGI to which IGY World Data Centers it will supply its data. World Data Center A or B receiving such data shall supply copies at its own cost to the others. Data Centers C will supply data in accordance with the guide issued by the Co-ordinator.

4.4 *List of C Centers*

The list of C Centers has not yet been fully formulated, and it is realized that it cannot be finalized until the Unions concerned have been consulted on the proper locations, and until the National Committees of the countries concerned have agreement from their Governments in respect of the finance involved. The existing WMO at Geneva will continue to be the meteorological repository.

To finalize this list before producing the guide the Co-ordinator will write to Unions for their recommendations, with copies to the appropriate Reporter and also to the relevant National Committees.

Where concise information regarding the type of data to be collected in each discipline has not yet been agreed by CSAGI the reporters for such disciplines must supply the Co-ordinator with information for co-ordination with the National Committees.

A further meeting of those concerned with organizing procedures in Centers will then be discussed.

Meanwhile National Committees will approach their Governments to ensure that exchange procedures can be carried out, the Co-ordinator acting as intermediary in finalizing these agreements and the date when they shall be given effect.

4.5 *ACIGY Resolution*

In order to facilitate the establishment of World Data Centers C the ACIGY places confidence in the Co-ordinator and asks him, in agreement with the Scientific Unions, to prepare a list of World Data Centers already existing or in process of formation. In the latter case it requests the Co-ordinator to render to these proposed centers in the new disciplines all the support and facilities that the ACIGY is capable of giving.

5 Resolutions on the Arctic and Antarctic

(1) The CSAGI adopts the resolutions made in the Arctic and Antarctic Conferences that there should be no special center for the collection of Arctic and Antarctic Data. The procedure adopted for collecting such data should not result in a division of the data or in delays in their assembly: and in order that all countries interested in Arctic or Antarctic matters should receive full documentation, direct exchanges should be established between these countries.

(2) The CSAGI recommends that the 5-letter international code (INTCO) be accepted by all IGY members.

(3) The CSAGI recognizes that there will be a potential problem of mutual interference at some Antarctic stations between communication services and the sweep frequency ionospheric experiments, but that most ionospheric equipments under conditions of good maintenance may cause interference on any given frequency for only a few seconds. It appears therefore that stations should be able to work out suitable arrangements, and that the important objectives of the ionospheric program can be achieved on the prescribed schedules without the communications services suffering.

(4) The CSAGI desires that a further meeting of the Working Group on Radio Transmissions should be held not later than June 1957, in order that the results of radio working may be surveyed and amendments to the proposed radio manual considered.

(5) The CSAGI recommends that Norway, the Union of South Africa and the USSR should jointly investigate the possibilities of organizing a station on Bouvet Island on an international basis during the IGY, and, if possible, take practical measures for the establishment and maintenance of the station.

6 Resolutions Relating to CSAGI Secretariat

(1) The CSAGI decides that the National IGY Committees may authorize the use of the IGY symbol (of which the copyright is reserved) on publications, personnel and equipment concerned with the IGY. A formal authorization in each case should be given by the National IGY Committee concerned, and the General Secretary of CSAGI should be informed thereof. No modification of the IGY symbol may be made, except that any National IGY Committee may substitute for either the English or French words in the symbol a translation of these words in its own language. The central device in the symbol may be used without the border.

(2) The CSAGI, recognizing that various nations or institutions have offered to give or to loan to other nations or institutions scientific equipment for use in various programs of the IGY: and that, on the other hand, these offers have in some instances been declined because of the high duties levied by the customs authorities on the importation of such equipment: recommends that the General Secretary of CSAGI should make representations to the Governments of the countries concerned, urging that the facilities for the importation of scientific equipment which have already been granted under certain conditions, following negotiation by UNESCO, should be extended to instruments required for carrying out the programs of the IGY.

(3) The CSAGI resolves that National Committees that establish additional IGY stations, too late to be included in the formal list (1956) of IGY stations, should have the opportunity of having such stations and their activities included in the IGY program, subject to their giving the necessary information to the General Secretary of CSAGI, and to their compliance with the policies of CSAGI.

The General Secretary is instructed to circulate to all National Committees at an early date a complete list of participating IGY stations, showing geographical and geomagnetic location, and the character of the observations to be made at each.

(4) The CSAGI requests its Reporters and others who prepare matter for publication in the name of CSAGI to send the material in draft in good time to the General Secretary, for the purpose of ensuring that the draft is in accordance with the general policy and principles of CSAGI.

(5) The CSAGI requests that copies of IGY international correspondence be sent promptly to the General Secretary of CSAGI, so that he may be kept aware of the progress of all international IGY activities and plans; only thus can he fulfil his duty to keep CSAGI and the appropriate bodies informed as to the progress of the IGY program.

Likewise members of National IGY Committees should forward copies of their international IGY correspondence to the Secretaries of the National IGY Committees concerned.

(6) The Co-ordinator of Operations for the IGY will circulate an IGY News Bulletin monthly or oftener. It will be based on information supplied by the Secretary General, the National Committees, members of CSAGI and other sources.

The CSAGI requests the National Committees and CSAGI Reporters to supply promptly to the Co-ordinator suitable items of information concerning their operations for announcement in the IGY News Bulletin.

(7) The ACIGY approves in principle the idea that each National IGY Committee shall provide, in accordance with its resources, a contribution to meet the deficit of $75,000 as estimated by the Finance Committee for the years 1956, 1957 and 1958.

7 General Resolutions

(1) The CSAGI expresses its grateful thanks to the Presidium of the Academy of Sciences of the USSR and to Academician I. P. BARDIN, Vice-President of the Academy, for the organization of the CSAGI Eastern Europe Regional Conference, which has contributed greatly to the establishment of close relations between the geophysicists of the countries in this region, their relations being of great value for the preparation and realization of the programs of the IGY.

(2) The CSAGI expresses its grateful thanks to the Swedish National Committees of the IUGG, URSI and IAU, to the Swedish National Committee for the IGY, and to Dr N. HERLOFSON, Adjoint Secretary for the Arctic Region, for the organization of the CSAGI Arctic Conference in Stockholm.

(3) The CSAGI expresses its grateful thanks to the Pan American Institute of Geography and History (PAIGH) for its able work in organizing the National IGY Committees in the nations of the western hemisphere, and for its enthusiastic cooperation with CSAGI toward making the world-wide scientific IGY programs of the greatest effectiveness and value.

(4) The CSAGI notes with appreciation and thanks the draft scheme developed by the WMO for the dissemination of ALERT warnings and SWI messages over the meteorological telecommunication networks, and invites the WMO to circulate the final version of the scheme to the National Committees for the IGY through the CSAGI Secretariat, to enable them to incorporate it in their national operational program.

(5) The CSAGI and the nations associated together in the Advisory Council of the International Geophysical Year wish to place on record the very valuable aid afforded to the organization of the International Geophysical Year by the Belgian Government through their provision for the services of the General Secretary of CSAGI and official premises for the CSAGI Office. They wish to express their most grateful appreciation to the Belgian authorities concerned, and in particular to the Minister of Public Instruction and to the Director of the Royal Meteorological Institute of Belgium, for this generous aid.

(6) The CSAGI and Advisory Council express their appreciation to the City Council of Barcelona, which in putting at their disposal its magnificent Gothic hall added to the inaugural session a solemnity worthy of the great enterprise of the IGY. The CSAGI and Advisory Council also express their thanks to the City Council for the hospitable entertainment given at Pueblo Espanol in an atmosphere of needed relaxation from their labors. The members greatly enjoyed the festival of music and Spanish dancing, with a deep appreciation of its high artistic value. The CSAGI and Advisory Council also thank the City Council for the gracious hospitality shown to the guests accompanying their members.

(7) The CSAGI and Advisory Council express their thanks to the Superior Council of Scientific Investigations for generously making the premises of the Council available for the fourth general IGY meetings.

(8) The CSAGI and Advisory Council express their great appreciation to the National IGY Committee of Spain for their invitation to hold the fourth general IGY meeting in their country, and especially wish to acknowledge with gratitude the many courtesies and the great assistance rendered by Admiral RAFAEL ESTRADA, President of the National Committee, and by Father ROMANA and Father CARDUS.

8 Final Calendar of Regular World Days (RWD) and World Meteorological Intervals (WMI) during the International Geophysical Year 1957–1958*

Calendar of Regular World Days (RWD) and World Meteorological Intervals (WMI) during the International Geophysical Year 1957-1958

(Adopted by CSAGI, September 1956 and edited by CSAGI SECRETARIAT - 3, AVENUE CIRCULAIRE, UCCLE-BELGIUM)

World Meteorological Interval 20 21 22
23 24 25 26 27 28 29

Regular world day 11
Regular world day at new moon 10
Unusual meteoric activity 8 (but not world day)
Regular world day with unusual meteoric activity 17
Day of total eclipse 12

June 1957 (Advance Trial)

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

July 1957

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

August 1957

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25	26	27	28	29	30	31

September 1957

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29	30					

October 1957

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November 1957

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December 1957

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January 1958

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February 1958

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March 1958

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April 1958

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27	28	29	30			

May 1958

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June 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
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July 1958

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August 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
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17	18	19	20	21	22	23
24/31	25	26	27	28	29	30

September 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

October 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

November 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23/30	24	25	26	27	28	29

December 1958

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

January 1959

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
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9 URSI–AGI Committee

9.1 *Brussels Meeting*, 29–31 *August* 1956

The present state of preparations for the IGY ionosphere program was considered in some detail at the URSI-AGI Committee meeting in Brussels on 29–31 August 1956. This report is a summary of the proceedings at that meeting.

A. *Report and resolutions of the* 1955 *meeting of the Committee*

The report and resolutions of the 1955 meeting of the Committee were considered and the following points noted:

(a) *Proposed station at Bogota, Colombia*
Plans for this station are now in hand in accordance with the resolution of the last meeting.

(b) *Ionospheric station at Marion Island*
This recommendation is still under consideration by the South African National Committee.

(c) *Ionospheric station in Java*
It appears unlikely that this station will be established.

(d) *Ionospheric stations in Chinese People's Republic*
Five ionospheric stations will be operating during the IGY.

(e) *Atmospheric noise measurements*
A number of equatorial stations are likely to be in operation.

(*f*) *Calculation of solar zenith angles*
The Secretary of the Committee has circulated all ionospheric observers inviting co-operation in this work, and has reported very satisfactory progress in the completion of a complete set of tabulations (see section F below).

B. *World network of ionospheric stations*

The Committee considered certain aspects of the world network of ionospheric stations, and recommendations on this subject are contained in K. Resolutions K (1) (2) (3) and (9).

C. *Preparation of IGY ionosphere instruction manuals*

The General Editor (W. J. G. Beynon) reported on progress in the preparation of the IGY Instruction Manuals. Four manuals were now proposed as follows:

Manual I. "Vertical Incidence *h'f* recordings".
Manual II. "The measurement of ionospheric absorption".
Manual III. "The measurement of ionospheric drifts".
Manual IV. "Radio Atmospheric Noise".
"Back-Scatter Measurements".
"Whistlers".
"Radio detection of aurorae".

Manuscripts had been prepared and received on nearly all the above topics. The editing of Manuals I and II was practically completed, but certain parts of Manual III might need revision. Three of the four sections of Manual IV had been submitted but were awaiting editing. Copies of contents lists and of the main parts of the texts of Manuals I, II and III were available at the meeting, and comments on these were invited.

The Chairman of the URSI Sub-Committee on Vertical Soundings reported that an atlas of ionograms was in preparation. This will be in the nature of a supplement to Manual I, and it was hoped that the CSAGI would undertake publication.

The Committee decided to include in Manual IV an additional section on "Forward Scatter Observations".

D. *Regional centers for IGY ionospheric data*

At the 1955 meeting proposals were drafted for four Regional Centers for IGY Ionospheric Data, in the longitudes of America, Western Europe, Russia and Japan/Australia. Definite offers to establish Centers had been received from U.S.A., U.K., and Japan, and the Committee agreed to support proposals that three of the four Centers be respectively at Boulder, Tokyo and Slough. (Australia had communicated her agreement that the Ionospheric Center for that longitude be in Japan. No formal offer had yet been received from the USSR, but it was assumed that a Center would be established there.)

The proposals drafted by the Committee in 1955 for the functions of these Centers were the subject of a Working Party discussion. There was a degree of disagreement between members of the Working Party on these proposals, particularly in respect of the detailed data to be assembled and handled by the Centers and in associated financial problems. After much discussion the Committee decided to endorse the proposals of last year, subject to certain minor modifications, and also to establish a Committee, consisting of representatives of the four Centers, together with representatives of ionospheric organizations, to review the actual operation of the proposals for Regional Centers. The nomination of the latter representatives was entrusted to the Chairman of the URSI-AGI Committee. A copy of the modified proposals is given in Section L of this report. See also Resolution K6.

E. *IGY ionospheric studies*

(i) *Vertical incidence soundings*

The URSI Sub-Committee on vertical incidence soundings submitted a very detailed report on this subject. Considerable progress was reported in the detailed preparations for IGY Vertical Incidence Soundings, including the schedule of observations, characteristics to be scaled and interchanged, list of symbols, etc. An abstract of the report is given in Section P.

(ii) *Absorption, drift and whistler meausrements*

Detailed programs for IGY ionospheric absorption, drift and whistler measurements have been formulated and are given in Sections M, N and O.

F. *List of ionospheric stations, tables of solar and lunar data*

It was reported that considerable progress had been made with the collection of tables of solar zenith angle for all ionospheric stations, and the Committee decided to invite URSI to publish in a single volume a list of ionospheric stations together with the tables of solar zenith angles and relevant lunar data.

G. *Interchange of ionospheric data*

Considerable discussion took place on the existing interchange of ionospheric data and on the need for extending this interchange before the IGY commences, in respect of both the actual amount of data interchanged and the countries involved in the interchange network. (See Resolution K (4)).

H. *Amateur radio transmitting stations and the IGY*

The Committee discussed the question of seeking the co-operation of amateur radio transmitting stations for the communication of IGY scientific data, and formulated Resolution 7 on this subject. The following cablegram was also sent to the International Radio Consultative Committee (CCIR) currently meeting at Warsaw.

"The question of permitting amateur radio stations to transmit scientific data during the IGY has been discussed at this meeting of the URSI-AGI Committee. Apparently under existing international regulations this is not permitted, and this Committee strongly urges the CCIR to make efforts to get this regulation relaxed for the period of the IGY. The problem arises particularly in cases where isolated stations wish to send geophysical data back to the parent organization. The co-operation of all amateurs is being sought for the period of the IGY, and it is felt that they could materially contribute to the scientific program in the above manner if the regulations were relaxed."

J. *Long wave transmissions during the IGY*

A Working Party of the Committee discussed the great value of long-wave radio transmissions for certain IGY ionospheric studies, and formulated Resolution K 8.

K. *Resolutions*

(1) The URSI-AGI Committee reaffirms its Resolution 3 of last year, and strongly recommends the South African National Committee to establish a vertical sounding station. The South African Committee is also strongly encouraged to undertake whistler observations at this site (Marion Island), since the location is geomagnetically conjugate to certain stations in Europe.

(2) The URSI-AGI Committee recommends that additional attempts should be made to observe whistlers at the geomagnetic equator, to check the negative results predicted theoretically for such locations. For this purpose it is strongly recommended that standard IGY whistler stations be established at Huancayo, Peru and at Ibadan, Nigeria.

(3) The URSI-AGI Committee endorses the resolutions of the recent CSAGI Arctic Conference (May 1956), and especially calls the attention of ACIGY to the following:

(a) The CSAGI Arctic Conference, taking into account the presently available estimates of direction and rate of drift of the several drifting stations in the Arctic Sea planned to be equipped for ionospheric vertical soundings, observes that the distribution of stations would be more uniform and more suitable for the ionospheric program if the sounding station proposed for U.S.A. Ice Floe Station A could instead be put on U.S.A. Ice Floe Station B.

(b) The CSAGI Arctic Conference recommends that all possibilities be explored towards completing the ionospheric vertical sounding network as follows:

(1) There is a gap of 7° in geomagnetic latitude between the line of stations along the 10°E meridian headed by Murmansk and Trömso (67°N) and the station planned at Longyeartown, Spitzbergen (74°N). As this gap includes the maximum of the auroral zone, a station on Bear Island (71°N) would be a very important addition to this chain.

(2) The chain of stations along the auroral maximum zone itself would be greatly improved by an additional station in the large longitude gap to the west of about 150°W. In this connection the Arctic Conference feels that possible locations which would help to fill the gap between sub-auroral stations and stations well within the auroral zone in these longitudes are either (a) the vicinity of Wrangel Island (or alternatively Cape Schmidt) or (b) the region of Taymir.

(c) The CSAGI Arctic Conference calls the attention of National Committees to the following remarks in the report of its working group on the Ionosphere: "Additional cosmic radio noise absorption observations would be very desirable from any location near the auroral zone. The cosmic radio noise technique seems better suited for a study of auroral zone absorption than the pulse reflection method. Further, it is well adapted for operation at small observing stations as an *auxiliary experiment* to vertical soundings. It would be of especial value if the chain of such absorption stations in Alaska could be duplicated at other geomagnetic longitudes."

The URSI-AGI Committee suggests that such chains might be established in Western Europe and in the USSR.

(4) The URSI-AGI Committee draws attention to the fact that a considerable exchange of ionospheric vertical incidence data has been taking place, on an international basis, for many years, with great benefit both to the accuracy of ionospheric predictions and ionospheric research generally. Such a network of exchanges has not, however, included all operating stations the world over.

The Committee therefore recommends to CSAGI that all nations should join in this international exchange of ionospheric data as from 1 January 1957, that is, in advance of the IGY. As other stations come into operation they could then join an existing network of interchange. It is considered that such interchange will greatly encourage and assist ionospheric studies in a way which will render the work of the IGY more fruitful.

(5) The URSI-AGI Committee notes with satisfaction that CSAGI has endorsed its proposal that a series of CSAGI Manuals should be produced as guides to IGY radio operating station procedure. Drafts of these Manuals have therefore been prepared and are now in an advanced stage, as follows:

Manual I. "Vertical Incidence Ionospheric Recording".

Manual II. "The Measurement of Ionospheric Absorption.

Manual III. "The Measurement of Ionospheric Drifts.

Manual IV. "Atmospheric Radio Noise, Whistlers, Ionospheric Scatter and the Radio Detection of Aurorae".

The Committee wishes to stress the urgent need for these manuals to be available in printed or other form, in order that their distribution to distant parts of the world can be ensured well in advance of the beginning of the IGY.

(6) The URSI-AGI Committee has had many valuable discussions on the interchange of IGY ionospheric data and on the functioning of the IGY Regional Centers. It finds the plans prepared by the Committee in 1955 (URSI *Inf. Bull.* 94, p. 29, Appendix I) to be quite satisfactory, subject to minor clarifying changes as indicated in the minutes of the 1956 meeting. It is recognized that certain problems still exist, especially regarding the financial details of the plan, but the Committee believes that these problems can be solved and should not affect the overall objectives of the IGY plan.

(7) The URSI-AGI Committee strongly recommends that existing international regulations be relaxed for the period of the IGY so as to permit amateur radio stations to transmit IGY scientific data. It is recognized that such stations could, in this way, materially contribute to the success of the IGY program especially in the transmission of geophysical data from isolated observing stations.

This resolution has also been forwarded to the International Radio Consultative Committee (CCIR) Meeting at Warsaw, August 1956. Attention is also drawn to Resolutions V.4–V.8 of the CSAGI Arctic Conference (see Ch. VI).

(8) In view of the important ionospheric information which can be obtained from observations on very long waves the URSI-AGI Committee strongly urges the British Post Office to make available one and the same long wave station (GBR or GBZ) on Regular World Days and Special World Intervals during the IGY.

(9) The URSI-AGI Committee strongly recommends that Ionospheric Drift Observations should be made at Huancayo, and that the European group of observing stations be extended by the addition of a station in Southern Italy.

L. *Proposals for IGY ionosphere regional centers**

(1) Four Regional Centers shall be established by CSAGI at Boulder, Tokyo and Slough and at a location to be specified in the USSR. The principal functions of these Centers will be:

(i) to collect all IGY ionospheric tabulations, graphs and copies of selected ionograms (see 4 below); these will be available to research workers at the Centers;

(ii) to meet requests from bona-fide users for purchasing microfilm copies of tabulations or ionograms;

(iii) to maintain a complete index of all IGY ionospheric data.

(2) Organizations responsible for ionospheric stations should make adequate arrangements beforehand for ensuring that there is regular preliminary publication of all tabulations from each station from the start of the IGY. To this end it is recommended that organizations appoint the necessary staff before the IGY commences.

(3) Each organization should prepare for each of its stations monthly tables of hourly values, and summaries, and where appropriate graphs, containing all the IGY vertical incidence $h'f$ ionospheric data and within two months make these available

* Revised at URSI-AGI Committee, Brussels, 1956.

to its Regional Center, and if possible to all other groups, on the lines of the existing reciprocal exchange basis.

(4) Each organization should regularly send to its Regional Center microfilm reproductions at least of all ionograms taken on Regular World Days, during Special World Intervals, and during such intervals as may later be specified by the World Day Organization. The Regional Center concerned will be responsible for supplying copies to the other three Centers. Requests for copies for other days can be forwarded through the Regional Center concerned.

(5) Tabulations of ionospheric data should be made in a standard form. This standard form, together with full details of the ionospheric parameters required, will be presented in the ionospheric instruction manuals.

(6) The final publication will be based on the preliminary reports, as may be organized by CSAGI.

(7) CSAGI shall designate the specific Regional Centers and work out with the organizations concerned the details of initiating the data exchange. It is strongly recommended that exchange of tabular data be started as far in advance of the IGY as feasible.

(8) The above proposals refer specifically to vertical incidence $h'f$ data. Such data form the major part of ionospheric work. It is recommended that the above Regional Centers, or Sub-Centers of these, be also the Centers for other ionospheric measurements, such as absorption, drifts, atmospheric noise, back-scatter, etc.

(9) The operation of the Ionospheric Regional Centers shall be reviewed, when necessary, by a Committee consisting of representatives of the four Centers, together with representatives of ionospheric organizations as nominated by the Chairman of the URSI-AGI Committee.

M. *IGY ionospheric absorption measurements: vertical incidence pulse method*

1 *Program*

(i) *Choice of frequencies*

It is recommended that as a *minimum* program all stations should make measurements on two frequencies. One of these is to be $2{\cdot}2 \pm 0{\cdot}2$ Mc/s. If possible measurements should be made on a second E-layer frequency, but if circumstances make it necessary for the second frequency to be an F-layer reflection, then it is recommended that this second frequency be chosen to be near that of $h'f$ (the minimum equivalent height of the region).

It is emphasized that the above represents a basic minimum requirement, and that stations which normally operate a multifrequency program should continue to do so during the IGY.

(ii) *Measurements*

(a) *Noon observation*

First priority should be given to measurements at noon. It is recommended that throughout the IGY each station should publish indices of ionospheric absorption for each day. These indices are to be near-noon measurements centered on 1230 LMT, and for stations which can undertake the work, a minimum measuring period of one to two hours is recommended. Indices should be given for each $\frac{1}{4}$-hr period defined by 00 to 15, 15 to 30, etc., minutes past each hour.

(b) *Diurnal variation*

Second priority should be given to measurement of the diurnal variation in absorption. For this purpose it is recommended that stations make hourly observations on Regular World Days, at least over the daylight period. The observations should be made in the interval 00 to 15 minutes past each hour.

(c) *Measurements at constant solar zenith angle*

Third priority should be given to measurements at constant solar zenith angle. It is recommended that each station makes measurements over a period of $\frac{1}{2}$ hr each day throughout the IGY, under conditions of constant solar zenith angle. It is suggested that when possible stations should use frequency 1 in the forenoon and frequency 2 in the afternoon, and vice versa, on successive days. The selected solar zenith angle should be the local noon value.

2 *Calibration of equipment*

The importance of making every effort to obtain an accurate calibration of the measuring equipment and for checking its constancy is stressed. It is recommended that each station makes calibration measurements on one night per week. The measurements should be of one hour's duration within the period 2 hr after sunset to 2 hr before sunrise. It is emphasized that calibration measurements should be made during an interference-free period, and that the echo reflections should not be scattered or spread. These calibration measurements are of basic importance to all absorption work, and should be accorded equal priority with those made at noon. It is recommended that these night measurements be published together with an indication of the number of multiples present at the time of the observation. With each absorption measurement the value of the calibration constant used in calculating the value should be given.

3 *Stations above latitude* 60°

For stations above about 60° latitude the solar control appears to be markedly diminished or even absent. High latitude absorption shows definite correlation with magnetic and auroral activity, and experiments have to be planned in this light. For these stations the following amended program is recommended:

(i) Noon observations on all days, and hourly observations on Regular World Days, as given in 1(ii) (a) and (b) above.

(ii) It is suggested that hourly observations be made at night on as many World Days as possible, to study the incidence of corpuscular radiation.

(iii) No constant solar zenith angle observations are recommended.

4 *Presentation of results*

(i) *Symbols*

Letter symbols A, B, C, etc., as defined for vertical incidence soundings (9.1 P, Section 3), are to be used in presenting absorption results.

Additional agreed symbols for absorption work are:

ρ The apparent reflection coefficient of the ionosphere. This is defined as the ratio of the amplitude actually observed to the amplitude which would have been observed if there had been no collisional losses along the wave trajectory.

ρ_g The apparent reflection coefficient of the ground.

L The ionospheric absorption measured in decibels at a particular frequency.

(ii) *Means and Medians*

Medians of all routine absorption measurements should be circulated. The provision of means in addition is optional.

B, D, fE, fF1 are treated as high absorption values in computing medians.

F, G and values qualified by X are ignored when computing averages.

Non-numerical observations (e.g., B, D and G) are ignored in computing means.

(iii) *Accuracy*

(a) *Heights.* The equivalent height of reflection should always be measured and the value given with each absorption measurement. The height will usually be the average of that at the beginning and end of the observation and may change during it. Where heights have been measured by techniques involving no systematic error and with an accuracy better than ± 2 km they should be given to the nearest km. Otherwise heights are rounded off to the nearest 5 km.

(b) *Amplitudes—sampling error.* An index of sampling error should be included in every absorption measurement. For manual measurements this index is to be the number of individual samples of amplitude made. For continuous measurements this index is to be the number of seconds of recording time divided by five.

(c) *Amplitudes—systematic error.* An index of systematic error is to be included with each sequence of observations (e.g., diurnal or monthly sequence). This index is to be the number of *independent* determinations of the unabsorbed field parameter used in calibrating the equipment.

N. *IGY ionospheric drift measurements*

Spaced receiver fading method.

1 *Program*

(i) Observations should be made on the *E* layer and the *F* layer.

(ii) $2{\cdot}2 \pm 0{\cdot}2$ Mc/s should be preferred for use on the *E* layer (as agreed for work on absorption). For the *F* layer the frequency will be chosen to suit local conditions. That corresponding to the minimum virtual height is suggested as suitable.

(iii) Observations should be made on the following days in order of preference:

(a) Regular World Days.

(b) Special World Intervals.
(c) World Meteorological Intervals.
(d) Three consecutive days for the middle of each month, according to a program to be included in the Drifts Manual.

(iv) Observations should be made during periods of 15-min intervals starting at the following *Universal Times*:

For RWDs and SWIs	00, 01, 02, . . . 23
For days listed under (iii) (c) and (d)	00, 03, 06, . . . 21

The observations should extend, if possible, over the whole of the 15 min, but at places where other observations have to be made the total recording time may be shorter.

2 *Symbols*

In presenting the results of drift observations the symbols to be used are those recommended by the URSI-AGI Sub-Committee on Vertical Soundings. (See 9.1 P, Section 3.)

O. *IGY whistler measurements*

Program. Minimum and complete programs will be outlined in the IGY Manual on Whistlers.

The observing schedule is to be 2 min per hr commencing at 35 min past each hr UT. On World Days, additional 2-min schedules commencing at 5 min past each hour are to be made.

The Manual will describe and recommend for IGY use a method of subjective recording developed in the U.S.A. It is recommended that the subjective reports obtained by listening to all recordings made, and copies of these recordings, be made available to the appropriate World Data Center upon request. All recordings made during the IGY on regularly established schedules are to be preserved.

P. *Abstract of Report of URSI-AGI Sub-Committee on world-wide ionospheric soundings*

1 *Introduction.* The Sub-Committee on World-Wide Ionospheric Soundings was appointed in September 1955, by the URSI-AGI Committee. The report which has been prepared is based on very lengthy discussions at two meetings held in Brussels in 1955 and 1956, together with considerable correspondence between members and consultants. During the meetings the opinions of about fifty stations were directly or indirectly available, and members of the Committee have been in touch with the opinions of more than 100 stations. The considerations of the Committee therefore have a very broad base. Only a brief abstract of the report is given here, and the full report should be consulted for complete details of the proposals.

The changes in procedure listed in the report (see *URSI Inf. Bull.* 99 p. 48) become effective on 1 January 1957.

2 *Summary of changes of procedures for ionospheric sounding stations.* The principal changes and decisions are summarized below:

2.1 *Routine work*

(a) The minimum schedule for making soundings is four per hour, whether to obtain representative hourly data or for studies of details.
(b) The *f*-plot is considered the best practical and economical way for

the basic reduction of 15-min soundings, and has been adopted as the standard method for interchange of these types of data.

(c) Some of the characteristics to be scaled have been modified for the purposes of clarity or to provide more nearly homogeneous data.
  (i) *h'F*, or the minimum virtual height of the *F* region, is to be scaled throughout the 24 hr.
  (ii) It has been decided to make the *Es* data more homogeneous by the application of simple selection rules, including the distinction between the components.
  (iii) As a separate project, the occurrence of several types of *Es* is to be noted in a way much like that given in the High Latitude Report. The types given are appropriate for the whole range of latitudes.
  (iv) M3000 is considered to be the most advantageous parameter for the representative height of the *F1* and *F2* layers, as well as being a transmission factor.

(d) The accuracy to which measurements should be expressed is given for frequency and height characteristics, in summary, as follows:
  0·1 Mc and 5 km for the *F* region,
  0·05 Mc and 2 km for the normal *E* region,
  0·1 Mc and 2 (or 5) km for *Es*,
  0·1 Mc for *f-min*.

  M-factors are given in units of 0·05.

(e) The latter symbols have had their definitions altered for uniformity and clarity, and so that they may apply as well to absorption and drift work. Certain symbols have been dropped and the definition of others extended (see 3 below).

2.2 *Special work—World Days*

(a) The minimum schedule of soundings for World Days for fast sounders is 5 min, to be increased when unusual phenomena are noticed to have begun. The schedule for slow sounders should exceed that for routine work as may be practical at the station.

(b) The first use of these additional soundings on World Days is the timing of discontinuities, such as storm beginnings or phases, SID, etc.

(c) Reduction and presentation of special work should generally be by *f*-plot. The *h*-plot (heights) and *E*-plot (*E* region structure) are for presentation of auxiliary data. Copies of original reduction sheets, but not summary tables, may also be appropriate.

3 *Symbols*. Minor changes in definitions have been made in order to provide one set of standard symbols for virtual soundings, absorption and drift measurements. Other changes are:

(a) Four symbols are dropped: K, M, P, Q.
(b) The definitions of three symbols have been extended: C, G, N.
(c) New definitions are given for two symbols: T, U.

Three symbols have been added: I, O, X.

The following is the revised complete list of symbols:

A Measurement influenced by, or impossible because of, the presence of a lower thin layer, for example *Es*.

B Measurement influenced by, or impossible because of, absorption in the vicinity of *f*-min.

C Measurement influenced by, or impossible because of, any non-ionospheric reason.

D (a) (Preceding a numerical value) *greater than*. . . .
(b) (As a descriptive symbol) Measurement influenced by, or impossible because of, the upper limit of the normal frequency range.

E (a) (Preceding a numerical value) *less than* . . .
(b) (As a descriptive symbol) Measurement influenced by, or impossible because of, the lower limit of the normal frequency range.

F Measurement influenced by, or impossible because of, the presence of spread echoes.

G Measurement influenced or impossible because the ionization density of the layer is too small to enable it to be made accurately.

(This symbol applies, for example, to the case of $foF2$ near to or less than f_0F1, or of f_0Es near to or less than f_0E. Do not use this symbol in cases where the lower frequency limit of the recorder gives the limitation; in these cases "*E*" should be used.)

H Measurement influenced by, or impossible because of, the presence of a stratification.

I (Preceding a numerical value) Missing value has been replaced by an interpolated value.

J Ordinary component characteristic deduced from the extraordinary component.

L Measurement influenced or impossible because the trace has no sufficiently definite cusp between layers.

N Conditions are such that the measurement cannot readily be interpreted, for example, in the presence of oblique echoes.

O Measurement refers to the ordinary component.

R Measurement influenced by, or impossible because of, absorption in the vicinity of a critical frequency.

S Measurement influenced by, or impossible because of, interference or atmospherics.

T Value determined by a sequence of observations, the actual observation being inconsistent or doubtful.

U (Preceding a numerical value) Uncertain or doubtful numerical value.

V Forked trace which may influence the measurement.

W Measurement influenced or impossible because the echo lies outside the height range recorded.

X Measurement refers to the extraordinary component.

Y Intermittent trace.

Z Third magneto-ionic component present.

9.2 *Boulder Meeting,* 29 *August and* 3 *September* 1957

Two meetings of the URSI-AGI Committee (Chairman Sir EDWARD APPLETON) were held at Boulder (on 29 August and 3 September 1957).

A. *Publication*

(i) *Publications concerned with IGY radio studies* (see also minute C below). The Committee agreed that a policy of undirected publication of IGY results should be encouraged. It would appear that publication of IGY radio studies could be considered in three categories:

(a) The planning activities—these were contained in the reports on the proceedings of the URSI-AGI Committee and had been published in the *URSI Information Bulletin.* It was agreed that, for record purposes, these might be reprinted in the appropriate volume of the CSAGI *Annals of the IGY.*

(b) Publication of volumes of selected ionospheric data—the Committee noted that a preliminary proposal for printing about three volumes of basic ionospheric data had been made by the CSAGI Working Group of Ionospheric Data Centers, and agreed to endorse this proposal.

(c) Publication of "Interpretative Volumes"—the Committee agreed to sponsor the preparation by suitable authors, within a period of about three years after the conclusion of the IGY, of volumes of an interpretative character in which a connected survey might be given of published IGY results in the radio field.

(ii) *Bibliography of IGY radio publications.* The Committee discussed the question of URSI preparing and publishing a bibliography of IGY radio publications, but it was felt that this would be adequately covered by the CSAGI Publications Committee and no further action was taken.

(iii) *Report on the IGY day-meeting during the URSI Assembly.* The Chairman reported on the great success of the meeting on the IGY held at Boulder on 27 August, and the Committee agreed to recommend to the Executive Committee that the morning proceedings of this meeting be published in the Proceedings of the XIIth General Assembly.

B. *URSI-AGI Sub-Committee on World-Wide Ionospheric Soundings*

The Chairman of this Committee (Mr A. H. SHAPLEY) reported on the recent activities of this Sub-Committee. It was stressed that during the IGY, in order to safeguard the homogeneity of ionospheric data, it is essential for the World-Wide Soundings Committee to maintain direct contact with operating stations, and it was agreed that for the duration of the IGY National Committees should be urged to permit such direct contact.

It was brought to the notice of the Committee that certain IGY ionospheric stations are not operating according to the agreed plan, and the URSI-AGI Committee agreed, as a matter of urgency, to call the attention of National Committees to the need for ensuring that all stations are placed in full operation as soon as possible.

It was agreed that the World-Wide Soundings Sub-Committee should continue in being until the reconstitution of URSI Sub-Commission IIIA, probably at the next URSI Assembly. It was further agreed that the membership of the Sub-Committee should consist of National Committee nominees, that powers of co-option should be given to the Chairman, and that it should have an Executive Committee with the following membership: SHAPLEY, RAWER, AONO, PIGGOTT, TURNER, MEDNICOVA.

C. *Co-operation in certain IGY ionospheric studies*

The question of URSI support for groups of IGY workers wishing to co-operate in certain studies (e.g. ionospheric drift measurements) was discussed, and it was agreed that the URSI-AGI Committee should encourage such co-operation. Furthermore should any difficulties arise over the publication of the results of such co-operative studies, then the Committee agreed to recommend that URSI should publish these results in the form of an URSI Special Report.

D. *URSI compendium of ionospheric stations*

The Secretary reported on the present position of this volume, and it was agreed that publication should be pressed forward as early as possible. It was suggested that at a later date, information on magnetic dip at altitudes of 100, 200 and 300 km should be included in the Compendium, but that publication should not be delayed on this account.

E. *IGY research scholarships*

The Committee discussed the possibility of Educational Trusts and Foundations establishing IGY Scholarships to enable workers to undertake the analysis of IGY data. The following recommendation was adopted by the Committee:

"The URSI-AGI Committee is well aware of the plans already formulated in many institutions throughout the world for the scientific elucidation of IGY radio observations by way of theoretical study. Nevertheless, in view of the vast and unique opportunity for geophysical comprehension which such observations provide, the Committee invites all bodies which sponsor scientific research to consider the possibility of instituting special IGY Fellowships and Studentships—of all ranges of seniority, from professorial downwards—for the prosecution of such theoretical research in IGY World Data Centers, Universities and similar institutions on an individual or group basis."

The Committee warmly commends the action of UNESCO in instituting special studentships for the operational phase of the IGY, and trusts that the same body will continue to support individual scholars, in the same way, during the post-IGY stages of scientific elucidation.

F. *IGY Terminating Committee*

The Committee received the ICSU proposals for establishing a Terminating Committee for the International Geophysical Year. This Terminating Committee will come into being on the dissolution of the CSAGI in July 1959. The Committee agreed to recommend to the URSI Executive Committee that Dr. W. J. G. BEYNON be the URSI representative on this Terminating Committee.

G. *Future of URSI-AGI Committee*

It was agreed that the URSI-AGI Committee should continue in being to deal with all radio matters pertaining to IGY studies and the subsequent analysis of results. The next meeting will be held in Brussels in July 1958. The following revised membership was proposed, and subsequently endorsed by the URSI General Assembly:

Sir EDWARD APPLETON (Chairman), Dr. L. V. BERKNER (Vice-Chairman), Dr. H. G. BOOKER, *Dr. N. PUSHKOV, *Dr. FUKUSHIMA, Dr. W. DIEMINGER, *Dr. R. L. SMITH-ROSE, Mr. J. A. RATCLIFFE, Mr. A. H. SHAPLEY, *Dr. R. J. SLUTZ, Dr. D. F. MARTYN, Dr. M. NICOLET, Father P. LEJAY, Mr. D. LEPECHINSKY, Colonel E. HERBAYS, Dr. W. J. G. BEYNON (Secretary).

In proposing this revised membership the Committee has in mind the future greater relative importance of the World Data Centers, and accordingly the names marked with an asterisk are proposed as representatives of the four World Data Centers.

10 CSAGI Working Group on Oceanography

10.1 *Barcelona Meeting, September* 1956

A. *Introduction*

M. LACLAVÈRE gave a brief summary of what had been happening since the last meeting of the Working Group on Oceanography which was held in Brussels, 8–10 September 1955. He expressed the wish to be kept informed of the developments of the oceanographic program in the various countries in order to be able to distribute periodic progress reports. He then reported that he had received requests from Prof. PETTERSSON, Dr. ZENKEVITCH and Dr. KORT, and he had had the opportunity of examining them with Dr. REVELLE who gave his views thereon. These matters will be discussed later at the meeting. He agreed to circulate the national oceanographic reports sent to him, and asked that newcomers to the Working Group give him their addresses.

B. *Professor Pettersson's project*

M. LACLAVÈRE reported that two years ago Dr. PETTERSSON approached him in Paris with a proposal for an investigation on the amount of meteoric fragments and dust settling down from the atmosphere. He proposed that collecting stations for magnetic particles and dust be established on various oceanic islands in the course of the International Geophysical Year. M. LACLAVÈRE promised Dr. PETTERSSON to present his proposal at the next meeting of CSAGI in Brussels, and requested him to send documentation on his project; from this he made out the following memorandum in which he presented some details of the project and also stressed the support it had already received from various scientists.

"Through investigations on the cosmic material present in deep-sea cores collected by the 'Swedish Deep Sea Expedition', the importance of the so-called 'cosmic spherules' discovered in deep-sea sediments in 1876 by Sir JOHN MURRAY has been greatly enhanced. Using a powerful electromagnetic extractor it has become possible to extract completely the magnetic particles present in sediments from the Western Pacific Ocean and from the Mediterranean. By counting the magnetic spherules of diameters between 30–60 μ, their number has been found to be from tens to hundreds of times larger than those found by MURRAY, who only used a hand magnet. Moreover the numbers found show conspicuous variations with the depth below the sediment surface, i.e. with the age of the sediment. These variations appear to some extent to be due to changes in the rate of sedimentation, but perhaps still more to the changes in the frequency of meteors, which are presumably of world-wide extension.

"A new incitement to studies of meteoric dust is given by the theory recently published by Dr. E. G. BOWEN, Director of the Radiophysics Laboratory of the CSIRO, Australia, that one of the most important factors controlling rain formation is the meteoric dust floating down through the earth's atmosphere, the meteoric particles acting as nuclei on which raindrops condense.

"As regards the frequency of meteors entering the earth's atmosphere the use of new methods of investigation, especially of radar, has given results much higher than those earlier obtained from visual observations alone. On the other hand, the few attempts hitherto made to estimate the amount of meteoric dust brought down by rain and snow have given divergent results, largely due to the inefficient technique used for collecting the dust.

"Various scientists have shown a deep interest in Prof. PETTERSSON's project, such as Prof. HAROLD UREY, of the Institute for Nuclear Physics at the University of Chicago and Prof. FRED WHIPPLE, Director of the Smithsonian Observatory at Harvard University. Prof. B. PETERS of the Tata Institute of Fundamental Research in Bombay, has also promised co-operation for sampling meteoric dust settling over a Himalayan snowfield, at a station he has established for collecting the beryllium isotopes generated in the upper atmosphere by the impact of cosmic rays."

Owing to the fact that this project was not presented to the CSAGI by a National Committee it could not be considered by the Bureau of the CSAGI unless it were introduced by a Union. M. LACLAVÈRE therefore submitted Prof. PETTERSSON's proposal to the members of the IUGG Committee for the International Geophysical Year by a circular letter dated 20 February 1956, asking them for their comments about the advisability of undertaking the proposed collection of magnetic spherules during the IGY. Out of twelve members of that Committee, nine gave an answer; and the general feeling was that in spite of the great interest of Prof. PETTERSSON's proposal it was already too late to make plans to implement it as part of the IGY program.

M. LACLAVÈRE proposed therefore that no further attempt be made for the inclusion of PETTERSSON's project in the IGY program, but proposed that the research involved in it be deferred to another body, for example the Special Committee on Oceanic Research (SCOR) now in the course of establishment under ICSU. This was agreed by the meeting, and M. LACLAVÈRE accepted to write a letter to the President of SCOR, Dr. R. REVELLE, and to submit the project to him.

C. *Dr. Zenkevitch's proposal*

It was reported that Dr. ZENKEVITCH proposed to take the opportunity of the International Geophysical Year to carry out some investigations on marine biology, and he formulated a proposal in that sense which he sent to UNESCO, considering that they were not the appropriate body to deal with this matter UNESCO transferred the request to the ICSU, which handed it to M. LACLAVÈRE.

The investigations proposed by Dr. ZENKEVITCH may be summarized as follows:

(1) Seasonal changes in the composition and distribution (qualitative and quantitative) of phyto- and zooplankton.
(2) Quantitative expression of the photosynthetic action of phytoplankton.
(3) Biologic particularities of the photosynthetic action of plankton.
(4) Composition and distribution of benthos.
(5) Medium factors.

M. LACLAVÈRE took up the question and exchanged correspondence with the Department of Natural Science of UNESCO, with the IUBS and with several scientists, and in March 1956 sent out a circular letter to the members of the Executive Committee of the IAPO (with copy to the Bureau of CSAGI and other interested persons) giving a report on Dr. ZENKEVITCH's proposal and asking for comments. Only a few answers were received. M. LACLAVÈRE stated that Dr. ZENKEVITCH was invited to come to the Barcelona Meeting but that he had other commitments which prevented him from coming, but that he wrote a letter asking M. LACLAVÈRE to present his proposal and to do his best for a successful issue.

M. LACLAVÈRE then reported to the Working Group an exchange of correspondence he had recently had with Dr. DEACON from which the following may be gathered:

CSAGI is certainly aware of the possibilities offered by the world-wide oceanographic program of the IGY to increase our knowledge of the plant and animal populations of the sea. Moreover it is clear that in some important aspects of that program, namely, the exchange of CO_2 between the sea and the air, and the movement of water masses, the behavior and distribution of marine organisms would be of great value in elucidating the geophysical problems.

It was reported that on many of the ships taking part in the IGY program it would be possible to provide space and facilities for marine biologists or technicians who could take systematic collections of the phyto- and zooplankton and observe the distribution of fishes and other animals. Systematic plankton collections at regular intervals near the islands and coastal stations planned for the sea-level and long-wave programs would also appear possible, using simple, relatively inexpensive equipment.

It was intimated that if the results are to be of maximum value the equipment and methods used should be carefully intercompared and, if feasible, should be uniform at all stations. And in that respect the Working Group on Oceanography should be requested, in collaboration with other interested oceanographic organizations concerned with marine biology, such as the Special Committee on Oceanic Research on Marine Sciences, to make recommendations concerning equipment and methods.

A resolution on this subject was prepared* but M. LACLAVÈRE said that he was not sure that the resolution would be endorsed by the CSAGI, which was reluctant to make any new addition to the program. However, if it were negatived, M. LACLAVÈRE proposed to take further action outside the CSAGI in order to implement to some extent Dr. ZENKEVITCH's proposal. This was agreed by the meeting.

* The CSAGI Resolutions Committee, of which M. LACLAVÈRE was a member, did not retain the resolution.

D. *Dr. Kort's program in Antarctic waters*

It was reported that at the Third Antarctic Conference held in Paris (30 July -3 August 1956), Dr. Kort had proposed that other countries should supplement the oceanographic program of the Soviet Antarctic Expedition. The following program was proposed to be submitted to the other interested countries, and M. Laclavère distributed on 20 August a circular letter which reads as follows:

"At the 3rd Antarctic Conference held in Paris, 30 July–3 August, 1956, Prof. Kort (USSR) stressed the importance of the study of the exchange of heat between the waters of the Antarctic Ocean and the adjacent oceans and the atmosphere. Research in that field will lead to a better knowledge of the atmospheric circulation. The Antarctic Conference recognized the importance of oceanographic observations in the southern waters during the IGY."

M. Laclavère was directed to circulate the following proposals, drafted by Prof. Kort, which he presented to the meeting.

"(1) In addition to the complex program of the Soviet Antarctic Expedition in the Indian Ocean which will be carried out during the period from January to May 1957, it seems desirable that the other countries participate in oceanographic observations in the following areas:

"*Argentina.* In Drake's Straits and the Weddell Sea.

"*Union of South Africa.* Along sections crossing the Angola and Moçambique currents.

"*Australia.* Along a section from Tasmania across the Davis Sea.

"*France.* Along the path of the expedition ship across the Indian Ocean.

"*U.S.A.* In the South Pacific Ocean and particularly along the New Zealand shelf and along two meridian sections between the Ross and the Bellingshausen Seas.

"(2) In order to establish a better planning of oceanographical researches in the Antarctic waters and to permit a better understanding of the fundamental problems of the IGY, it seems desirable that the results of the observations made in the Antarctic waters since the 2nd World War be published as soon as possible, giving priority to such data as will help the solution of geophysical problems.

"(3) In order to have a better knowledge of the variation of sea-level in the Antarctic, which is of interest for several problems, it is recommended that tide-gauges be established at all coastal stations of the Antarctic, as far as local conditions permit."

It was also recognized, at the Third Antarctic Conference, that it would be desirable to discuss the matter as early as possible owing to the departure of the ships sailing for Antarctica by the end of 1956. Barcelona seemed a very good place to hold the meeting. (However, M. Laclavère received on 21 August a telegram from Prof. Beloussov stating that Soviet oceanographers could not participate in the Barcelona Meeting.) This seemed to be a very timely proposal since the study of this ocean and the air above it should be more effective than much of the land exploration in increasing the understanding of world-wide geophysical problems. The proposal had been discussed at the Meeting of the Working Group on Oceanography at Brussels.

It was reported that some assistance could be given to the USSR program by Argentina, Australia, Chile, France and South Africa, which have already made plans in this respect. It was mentioned that most of the ships visiting Antarctica to land parties on that continent are not fitted for oceanographic research, and would only attempt observations which would not interfere with the business of getting to land and back. In Brussels the Working Group strongly urged that such vessels should at least be used to study the balance of carbon dioxide between ocean and atmosphere, but even this may prove difficult.

M. LACLAVÈRE made the following comments:

Oceanographic work in the Antarctic will not be really profitable till it can achieve much more in extent or detail than has already been done by the Discovery Committee and the U.K. National Institute of Oceanography, from 1924 to 1951. This seems very unlikely just yet. More temperature and salinity profiles will tell us little until we can make actual measurements of water movements at all depths; more biological collections will tell us little till we can make them at the precise places, depths and times needed to answer some well-defined problems in the study of the life-history of one or other of the plankton forms in relation to their environment. In a few years time these critical observations will be possible; till then it is far better to develop new techniques and to study the existing "Discovery" collections. Most of the "Discovery" physical data are published and the post-war data are in the press; some papers on plankton distribution have been published, but most of the analysis of the biological collection is still to be done.

The Russian plan to study the exchange of heat between the waters of the Antarctic Ocean with the adjacent oceans and the atmosphere is very useful, but its success seems to require a dense coverage of marine meteorological observations to be made by many ships over many years, or a detailed knowledge of rates of water transport with many measurements of actual water velocities in the subsurface and deep layers, or very practical methods of making simultaneous measurements of temperature and velocity profiles in the water, and temperature, humidity and wind profiles in the air. This does not seem feasible at the moment.

The Russian appeal for more measurements of sea level, and recommendation that tide-gauges be established at all coastal stations in the Antarctic as far as local conditions permit, is very commendable. A resolution should be adopted by CSAGI in support of it. However, it is a difficult problem, many of the stations are established on the ice, waters are not shallow and pressure gauges cannot be used. Gravity variations will not give good results for the study of sea-level variations.

After a short discussion a resolution was drafted and later adopted by CSAGI.

E. *World Data Centers*

M. LACLAVÈRE reported that the Bureau of CSAGI will submit to CSAGI a recommendation proposing to establish World Organizations for collecting and handling IGY data. There will be two World Centers, one in U.S.A. and the other in USSR, with headquarters at Washington and near Moscow, in accordance with offers received from the National Committees of these countries. There will be also *Discipline Centers* set up by the various disciplines on a regional basis.

Each World Center will be the repository of a complete set of originals or copies of data in all disciplines as specified by CSAGI, whereas each discipline center will be responsible for data in that discipline only. Each World or Discipline Center will maintain an indexed catalog of data and make it available to participating National IGY Committees and to responsible scientific institutions or individuals. It will also provide access to its data and provide copies at a cost not exceeding that of reproduction and transmission. Each National Committee of the IGY program will be under obligation to supply at its own cost and in accordance with a time schedule established by CSAGI all its IGY data to one of the World Centers or to one of the Discipline Centers. They will report to CSAGI the Center(s) to which material will be regularly sent. The Center receiving this original data will make copies and transmit them in one case from one World Center to the other and to the appropriate Discipline Center(s), and in the other case from a Discipline Center to the two World Centers and to other regional discipline centers where such exist. These copies will be made and sent at the cost of the center receiving the original supply. It is, however, not intended that any established and satisfactory arrangements such as exist in the WMO should be disturbed, and it may be that the financial arrangements at a Discipline Center should be discussed with the Union or Association concerned.

M. LACLAVÈRE said that such centers would only keep data collected during the IGY, and that they will therefore be of rather limited interest to the oceanographers. It was reported that the plans of the U.S.A. were to use a center where data are already collected on a permanent basis. After a short discussion the following resolution was drafted and was later adopted by CSAGI.

"The CSAGI recommends that *permanent* World Data Centers for oceanographic data be organized. Two such centers should be enough, taking into account that some regional centers already exist."

F. *Oceanographic Manuals*

M. LACLAVÈRE reported that various documents had been sent to him for inclusion in a prospective IGY Manual on Oceanography, but as the U.S. Hydrographic Office was expected to publish in the near future a Manual on Oceanographic Observations, he would wait until it has been published to see which documents should later be incorporated in the projected IGY Manual.

G. *Customs Duties*

On Dr. REVELLE'S behalf a recommendation on this subject was presented by M. LACLAVÈRE (see p. 394).

The meeting adopted this resolution, which was later adopted by CSAGI.

H. *Exchange of scientists*

As to the exchange of scientists on oceanographic ships and observing stations during the IGY, it was recognized that in several aspects of the program, newly developed techniques and instruments must be employed aboard oceanographic ships, particularly (1) in attempting to measure the deep circulation directly by special meters, floats, buoys, electrical and chemical methods, (2) in multiple ship operations to follow the movement of the water, (3) in measurements of the heat flow through the sea floor, (4) in seismic studies of the bottom.

In order to achieve maximum results it appears necessary that the new techniques and instruments should be intercompared. This can best be done if scientists of the different countries can gain personal experience of the methods used by others. It was therefore urged that scientists of different countries be exchanged for sufficiently long period on the ships and observing stations to enable them to gain adequate experience with the new methods to be used in the oceanographic programs. In this respect, the CSAGI has adopted the proposed recommendation: (K(3) below).

I. *Special Committee on Oceanic Research and International Association of Physical Oceanography*

M. LACLAVÈRE reported on the Special Committee on Oceanic Research (SCOR), the establishment of which was approved by the International Council of Scientific Unions. He said that during the IGY the national and international oceanographic programs will be intensified, but that it will take much more than the eighteen months of the IGY to investigate the problems of the oceans. It seemed therefore that the SCOR and the IAPO should endeavor to continue the program of the IGY when this period of intense scientific investigations has ended. It therefore appeared advisable to have a meeting of SCOR and of the Executive Committee of the IAPO, at the same time as the next meeting of the Working Group on Oceanography, to discuss the future. This view was shared by the meeting, and M. LACLAVÈRE was invited to arrange for a joint meeting of the three bodies in the near future.

Accepting the kind invitation of the Institute of Oceanography of Göteborg, Sweden, presented by Dr. B. KULLENBERG, it was agreed to hold the next meeting of the Working Group in Göteborg on 15–17 January 1957.

M. LACLAVÈRE presented two maps established by the Scripps Institution of Oceanography showing the tide gauges and long-wave recording stations. It appeared that there was a deficiency of such stations along the coast of Angola, the South Atlantic coast of Africa and the Indian Sea; it was therefore decided to prepare a recommendation so that the countries interested in these regions could take action to fill this gap. A recommendation was then formulated and later adopted by the CSAGI.

K. *Resolutions of the CSAGI Working Group on Oceanography (WGO)*

(1) "The CSAGI WGO is aware that several countries intend to carry out biological investigations during their oceanographic program for IGY, and invites the different countries taking part in the oceanographic program of the IGY to consider whether they will be able to add biological observations, especially regarding the productivity of the sea, to the program already planned."

(2) "The CSAGI WGO, noting that Argentina, Australia, Chile; France and the Union of South Africa will carry out observations in high southern latitudes, recommends that vessels going to and from the Antarctic collect air and near-surface water samples to be analyzed for CO_2 content, and also large deep-water samples (50 l), for radioactive dating, from the bottom and from depths of 4,000 m, 3,000 m and 2,000 m."

(3) "The CSAGI WGO, recognizing that various nations or institutions have offered to give or to loan to other nations or institutions scientific equipment for use

in various programs of the IGY, and that, on the other hand, these offers have in some instances been declined because of the high duties levied by the customs authorities on the importation of such equipment, recommends that the Secretary General of CSAGI should make representations to the Governments of the countries concerned, urging that the facilities for the importation of scientific equipment, which have already been granted under certain conditions following negotiations by UNESCO, should be extended to instruments required for carrying out the programs of the IGY."

(4) "The CSAGI WGO strongly recommends an exchange of scientists on oceanographic vessels of different countries to further uniformity of methods."

(5) "The CSAGI WGO, noting that tidal gauges are scarce or lacking in certain regions, such as the Indian Ocean recommends that the International Organizations interested in the relevant parts of the world be asked to invite the countries in their areas to establish tide gauges where needed."

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