EUROPEAN STRATOSPHERIC MONITORING STATIONS (ESMOS)

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The aim of this project is to establish coordinated measurements at two European scientific stations for stratospheric studies located in the Alps and in the Arctic. The result will be the integration of these stations into the "Global Network for Detection of Stratospheric Change" (NDSC) and the validation of advanced experimental methods which are not fully proven. The objectives are to provide the earliest detection of possible changes in stratospheric composition and structure, to understand the aeronomic processes involved in short-term variations of ozone and related species and to provide comprehensive measurements of stratospheric constituents and, thereby, to supply "ground truth" for the current and planned satellite observations.

These objectives require a comprehensive combination of experimental methods which include lidar, microwave radiometry,

UV-visible spectroscopy and IR high resolution spectroscopy. IR laser heterodyne spectroradiometry will be also investigated because of its ability to measure some important stratospheric reservoirs and other trace gases. Because of the variety of instruments spread over different locations, a major effort is needed to coordinate the various measurements to be made. Furthermore, the new techniques need to be carefully compared with proven methods before being included in a Global Network. The aim is to compare, calibrate and validate the various observations and to interpret the data in an integrated fashion. An assessment of the critical quantities of each individual technique such as stability, accuracy, precision (or repeatability) and sensitivity to perturbations due to the specific characteristics of each site will be performed.

The work programme will entail a number of sub-tasks which, of themselves, are important to the scientific community :

(i) intercomparison of the characteristics of the various observations at sites that will make up each station;

(ii) intercomparison of the different instrumental techniques and data analysis methods. As a result, methodological artifacts (instrumental, geographical, analysis method,...) will be recognized, corrected for, and a common algorithm for data retrieval and interpretation will be agreed on ;

(iii) a validation set of measured concentrations of ozone and other key stratospheric gases will be produced and archived for use by the scientific community.

The observations will be performed, for the Alpine station, at the following sites :

- the "Station Scientifique Internationale" at the Jungfraujoch (3580 m altitude, 46.5 N, 8 E, Switzerland), operated by the University of Liège (Belgium) with the "Belgian Institute for Space Aeronomy" in Brussels, where measurements of ozone and related species will be made and, if possible, vertical concentration profiles of relevant constituents. IR high resolution Fourier-transform spectroscopy (FTS) will be complemented with high and medium resolution spectroscopy in the UV and the visible;

- the "Observatoire de Haute Provence" (OHP, 44 N, 6 E, France), operated by the "Service d'Aéronomie du CNRS, where capability of lidar for the measurement of ozone vertical distribution and aerosols has been proven;
- the "Observatoire de Bordeaux" (44 N, 1 W, France) where microwave sensors will be operated to measure ozone and, in 1991, ClO. This facility will be expanded later into an appropriate site closer to the Alps;
- the "Deutsche Wetterdienst" in Hohenpeissenberg (47 N, 11 E, Germany) where the University of Bremen (Germany) will coordinate the lidar and microwave measurements of ozone;
- in various locations in Switzerland, measurements of ozone and, in 1991, water vapor and ClO will be made using microwave radiometers (University of Bern).

In addition, the National Physical Laboratory (U.K.) will experiment with an IR laser heterodyne spectrometer (LHS), and compare it to the other techniques, more particularly with the FTS at the Jungfraujoch.

The concept of the Alpine station could be disputed because of the spreading of the various observation sites. However, distances between sites of less than 500 km are acceptable provided that the measurements of various constituents are well coordinated and consideration is given to the stratospheric dynamics. This problem will carefully be adressed by coordination. In addition, it is our intention to install in all sites "portable" powerful equipment such as, for intance, the UV-visible diode array spectrometer and, when proven, the LHS, in order to have data directly comparable in accuracy and repeatability.

The Arctic station is located in Spitsbergen (79 N, 12 E, Norway) where are already being made lidar and UV-visible absorption observations. This will be supplemented with a permanent microwave sensor and with an IR Fourier-transform spectrometer. This high latitude station will therefore extend the measurements made at mid-latitude with similar stratospheric monitoring capabilities at high latitude. This will be coordinated by the University of Bremen and the "Alfred Wegener Institut".

Strong coordination between the two stations is required to obtain maximum benefit from the observations and to analyse the data relating to different stratospheric conditions.

The scientific priorities concern the measurement of :

1. Ozone total content and vertical distribution between 0 and 70 km altitude;
2. Aerosols which become important especially in polar chemistry (PSC's);
3. ClO vertical profile from 25 to 45 km altitude and HCl and halocarbons total content directly related to the stratospheric chlorine budget;
4. Nitrogen compounds including N_2O, NO_2, NO, HNO_3 and $ClONO_2$, NO_2 being directly responsible for the catalytic control of ozone;
5. Other trace species relevant to stratospheric studies like H_2O and CH_4 which are, in the stratosphere, chemically related.

The work programme for the 2 year project has been divided in three main phases :

1. Ozone measurement intercomparisons (Lidar, microwave, UV-visible spectroscopy) and LHS and FTIR measurement comparisons of ozone, $ClONO_2$, HNO_3 and HCl;
2. Comparison of retrieval method and definition of archival formats;
3. Implementation of new sensors and intercomparisons, systematic monitoring and data interpretation and validation.