MIDDLE ATMOSPHERE PROGRAM (MAP) WORKING GROUP ON SOLAR SPECTRAL IRRADIANCE MEASUREMENTS

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The photodissociation processes of atmospheric constituents in the middle atmosphere are initiated by the solar radiation of wavelengths greater than 175 nm by the Lyman α emission line and by the x rays of wavelengths less than 1 nm. In order to determine the most reliable solar irradiation flux values to be used in the photochemical models of the middle atmosphere, accurate measurements of the solar irradiances in the ultraviolet as well as their long-term variations are required. For radiation budget studies in the middle atmosphere, the spectral irradiance measurements must be extended to the visible and to the near infrared wavelength ranges of the solar spectrum in order to determine the total amount of energy available at the tropopause.

Among the most serious difficulties in determining the correct values of the solar irradiances are the uncertainties associated with each observation and the lack of intercomparison of the calibration techniques used by different experimenters.

The current position of the measurement accuracies and of the discrepancies between the different relevant observations has been extensively discussed by Simon (1978, 1979) and is summarized in Table 1. Uncertainties of the available laboratory radiometric standard sources (Madden, 1978) and the specific requirements for the future observations related to the aeronomy and the climatology at the middle atmosphere are also given.

The laboratory radiometric standards have a smaller uncertainty than the available measurements. Future observation accuracy requirements could be fulfilled if the following steps are taken:

1. A careful calibration in the laboratory should be made, allowing the transfer of the radiometric standard accuracy to the instrument with as small a degradation as possible.
2. The errors introduced by the measurements on the sun itself should be reduced by appropriate techniques, thus allowing a measure, or elimination, of the degradation of the calibration accuracy in the space environment.

Table 1. Uncertainties on Solar Ultraviolet Irradiance Measurements Related to the Middle Atmosphere and Future Needs

Δλ (nm) →	Ly α	175–210	210–240	240–330	330–400
Quoted accuracy	30%	30%– 20%	20%– 10%	10%– 4%	10%– 4%
Discrepancies between relevant observations	100%	50%	70%	60%–15%	15%
Uncertainties on available standard sources	5%	5%	5%	3%	2%
Required accuracy	10%	5%	5%	5 to 2%	
Required precision	5%	1%	1%	1 to 0.3%	

3. Observations with different experimental techniques should be made in order to eliminate the systematic errors. Intercomparisons of the calibration instrument, referring to a common standard source, should be performed before the flights, to ensure a proper intercomparison of irradiance results after the flights.

On the other hand, the solar irradiation flux variability with the 11-year cycle is very poorly known for the entire solar spectrum. The wavelength range related to the middle atmosphere aeronomy and climatology, the inadequate time coverage of reliable data during the last solar cycle, the errors associated with each available measurement, and the lack of intercomparison of calibration do not permit a quantitative conclusion of long-term solar variability.

The question of variability of solar irradiance could be solved if new observations are performed with a correct time sampling by means of repeated measurements having a very high precision. Variability measurements made from satellites will be useful only if the aging of the instrument sensitivity can be checked in orbit or if cross-calibrated observations with balloon, rocket, or shuttle-borne instruments are performed.

Clearly, future improvements in the accuracy of solar irradiance measurements require an international coordination between the different groups involved in this field. Consequently this MAP project will have the following aspects:

1. To define the measurement strategy of solar spectral irradiance and critically discuss the observational techniques.
2. To coordinate the solar irradiance measurements performed by balloons, rockets, space shuttles, and satellites in order to provide cross-calibration of the solar spectrometers and to increase the reliability of the data.
3. To promote intercomparison of radiometric calibrations in the ultraviolet, the visible, and the near infrared wavelength range.

4. To suggest long-term programs of solar irradiance monitoring and to define the related calibration strategy.
5. To compare the solar irradiance data obtained during MAP.
6. To correlate the solar spectral irradiance results with aeronomical and climate studies of the middle atmosphere based on simultaneous observations of physical parameters and of minor constituent profiles.
7. To propose tables of ultraviolet irradiances to be used in aeronomic models of the middle atmosphere.

This project is based on the following opportunities:

Solar EUV spectrometer, AE-E satellite (1976 →)
UV spectrometer, stratospheric balloons (1976 →)
SBUV spectrometer, Nimbus 7 satellite (1978 →)
UV spectrometer, rockets (1979 →)
Solar ultraviolet monitor, SME satellite (1981)
Solar spectrometer experiment, San Marco satellite (1981)
SUSIM experiment, Space Shuttle (1982, 1983, ...)
UARS (1986)
Solar spectrum experiment, Space Shuttle (1983, ...)
SBUV-2 spectrometer, NOAA F and G (1984 →)
SSBUV spectrometer, Space Shuttle (1986?)
Ultraviolet solar spectral irradiance experiment, UARS (1986).

REFERENCES

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