SMM Mesospheric Ozone Measurements

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Research Objectives

The primary objective of this research is to understand the secular and seasonal behavior of ozone in the lower mesosphere, 50 to 70 km. This altitude region is important in understanding the factors which determine ozone behavior. It represents the transition from ozone photochemistry heavily influenced by chlorine compounds and nitrogen oxides to a situation where only hydrogen oxygen reactions are important. Ozone is measured by the technique of solar occultation utilizing the ultraviolet spectrometer polarimeter on the SMM spacecraft. Resulting ozone profiles are used in conjunction with temperature and solar flux data from other experiments to compare predicted ozone variations with observations.

A secondary objective is the investigation of stratospheric ozone in the polar regions. Use is made of results from the SBUV satellite-borne instrument. In the Arctic the interaction between chlorine compounds and low molecular weight hydrocarbons is investigated.

Summary of Progress

More than 30,000 profiles have been obtained using the UVSP instrument on the SMM spacecraft. From mid 1985 through the summer of 1989 several orbits of ozone data per day have been obtained allowing study of the current rise in solar activity from the minimum in mid-1986 until the present. Figure 1 illustrates the observed behavior at sunset within three latitude zones a) $20^{\circ}N \pm 5^{\circ}$, b) $0^{\circ} \pm 5^{\circ}$, and c) $20^{\circ} \pm 5^{\circ}$. At the equator there is a strong annual minimum in January and semiannual maximum associated with the equinoxes. This pattern is reproduced in an assymetric manner and to a lesser degree at $\pm 20^{\circ}$. There is no secular trend at the equator. At $20^{\circ}N$ there is an upward trend in ozone. Both sunrise and sunset profiles are obtained with larger differences between sunrise and sunset with increasing altitude. There is a seasonal behavior associated with these differences.

Analysis of Nimbus 7 SBUV data in Antarctic spring indicates that ozone is depleted within the polar vortex relative to ozone outside the vortex. This depletion confirms the picture of ozone loss at altitudes where polar stratospheric clouds exist. In addition there is ozone loss above the cloud level indicating that there is another mechanism in addition to ozone loss initiated by heterogeneous chlorine reactions on cloud particles.

Publications

Aikin, A. C. and R. D. McPeters, The three-dimensional morphology of the Antarctic ozone minimum, Geophys. Res. Lett., 15, 413-416, 1988.

Aikin, A. C., Ozone mimimum occurs in Antarctic in the springtime, Earth in Space, 1, No. 8, 3-5, 1989.

Aikin, A. C., D. Kendig, and H. J. P. Smith, An intercomparison of mesospheric ozone profiles determined by the UVSP and SAGE II solar occultation experiments, Planet. Space Sci., 37, 97-104, 1989.

Aikin, A. C., Mesospheric ozone behavior determined from satellite data, Proceedings of the Biennial Ozone Symposium Gottingen, W. Germany, 1989.

Aikin, A. C., W. Henze, R. Nakatsuku, D. Kendig, and H. J. P. Smith, Variations of mesospheric equatorial ozone as observed by the Solar Maximum Mission, submitted to Geophys. Res. Lett., 1989.

Presentations

Aikin, A. C., D. Kendig, and W. Henze, Mesospheric ozone behavior determined from the ultraviolet spectrometer and polarimeter on the SMM spacecraft, EOS, 69, 1068, 1988.

Kendig, D. and A. C. Aikin, Sunrise/sunset mesospheric ozone differences observed with the ultraviolet spectrometer on SMM, EOS, 70, ,300, 1989.

Aikin, A. C., Nonmethane hydrocarbon influence on the chlorine-induced depletion of Arctic ozone, EOS, 70, 299, 1989.
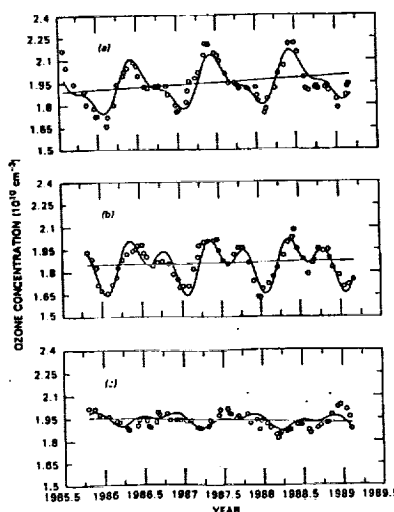
Fig. 1   Sunset ozone concentrations at 55 km measured by the SMM/UVSP instrument (open circles) as a function of time for (a) 20 degrees north, (b) the equator, and (c) 20 degrees south. For clarity of presentation, smoothed weekly means are displayed. Also shown are the fits to the raw data, and the linear trends from the fits.