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N92-14522

RESEARCH SUMMARY

A. Title: Measurement of the Absolute Solar UV Irradiance and Variability

B. Principal Investigator: James E. Mentall
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C. Abstract:

Radiation in the wavelength interval 150-350 nm initiates chemical reactions in the lower mesosphere and the stratosphere through the photodissociation of ambient molecular species. This experiment measures the total solar irradiance, above the Earth's atmosphere, in this wavelength interval, using three spectrometers. Measurements are made from rockets on a once-a-year basis and are used with satellite observations to determine both the absolute irradiance and the long term variability of the sun in the UV. A fourth spectrometer is being added to the payload to measure the emission in the Hydrogen Lyman-α emission at 121.67 nm.

D. Summary of Progress and Results:

After the next flight, which is scheduled for mid-January of 1990, measurements will have been obtained over a complete solar cycle. Over the history of this experiment the absolute error in measuring the solar flux from has been reduced from approximately ±15% to ±5%. Data from these rocket flights have be used, along with the results from other experimenters, to determine the absolute value of the solar irradiance in the UV. Observations over the descending portion of the last solar cycle show that the long term variability of the sun is of the same order as short term variability, i.e., 15% at 150 nm and decreasing to only a few percent at 200 nm.

E. Publications:

Mentall, J. E. and D. E. Williams, "Solar Ultraviolet Irradiances on December 7, 1983 and December 10, 1984," J. Geophys Res. 93, 735, 1988.

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Sounding Rocket Studies of CO_2, N_2O, CH_4, and Other Trace Constituents in the Upper Stratosphere and Mesosphere

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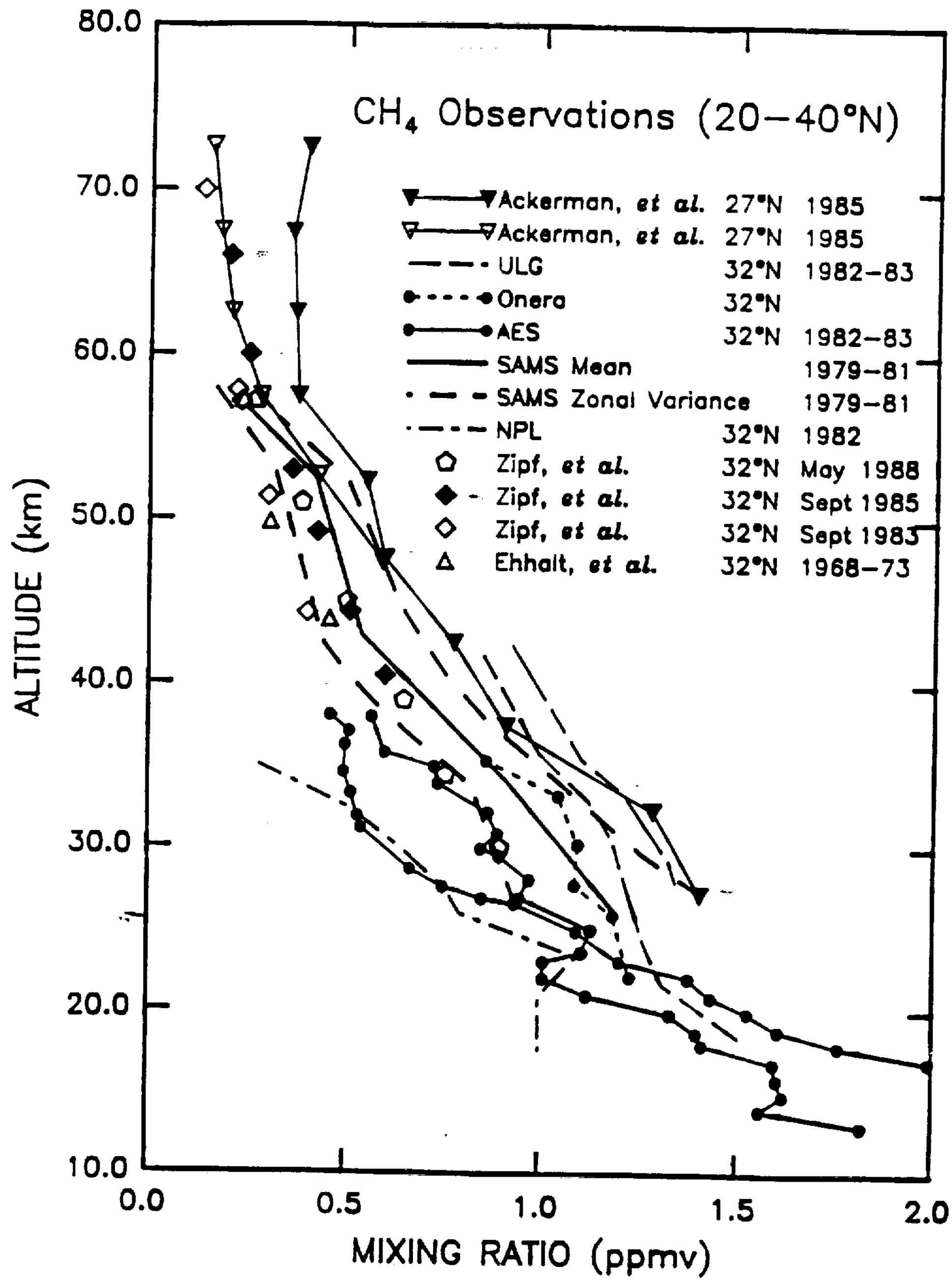
ABSTRACT

A rocket-borne, cryogenic whole-air sampler [CWAS] is used to investigate the sources and sinks of CO_2, N_2O, NO, CH_4 and other minor constituents in the middle atmosphere from 30-80 km. The atmospheric samples are collected on gold-plated surfaces maintained at ~15°K by on-board CTI-8 closed-cycle helium refrigerators. The cold fingers are located in specially prepared stainless steel canisters and are exposed to the atmosphere through pneumatically actuated UHV valves. The CWAS payload collects samples on the upleg of the flight in the ram position. The large samples collected in this manner (~2-15 std-liters) are concentrated further after recovery so that the density of the final samples analyzed by optical, mass spectrometer, and gas chromatographic techniques is ~10^5 times the ambient values. Mixing ratio values with a precision better than ±1% can be obtained by this technique over the entire altitude range with a resolution, Δz, varying from 0.5-3 km. CO_2, CH_4 and N_2O mixing ratio profiles and data on the altitude variation of the $^{12}C/^{13}C$, $^{18}O/^{16}O$, and $^{18}O/^{17}O$ isotope ratios in the middle atmosphere have been obtained from Nike-Orion flights launched from the White Sands Missile Range (WSMR) (32°N) and from Churchill Research Range (CRR), Churchill, Manitoba (58°N). During this summary period [1988-1989], the operational range of the CWAS payload was extended down to 30 km in order to overlap the observation range of high-altitude balloons and to permit careful cross-comparison measurements. Trace constituent data in the arctic air mass above CRR following the major solar flare during March 1989 were also obtained as part of NASA's CAMPAIGN 89.

PROGRESS REPORT

The CWAS payload was originally designed to provide trace constituent data in the altitude range 40-80 km. In-situ tests were actually carried out up to 110 km in order to determine how high in the atmosphere this technique would provide high accuracy mixing ratio data. 80 km now appears to be a working upper limit for the skimmers (diameter 3.5 cm presently being used). The lowest practical sampling altitude depends, in a complex way, on vehicle, nose cone, and cooling-power constraints. During May 1988, two successful launches of the CWAS payload from the White Sands Missile Range [WSMR] demonstrated that very large samples (~15 std liters) could be obtained readily at altitudes as low as 28 km. A large number of fluorocarbon compounds have been detected in these low altitude samples in addition to the other minor constituents (CO_2, CH_4, NO, and N_2O) that have been the focus of the higher altitude CWAS measurements. The large size of the samples has permitted a detailed study of the isotope ratios of the principal atmospheric constituents as well as the measurement of the $^{12}C/^{13}C$ ratio for CO_2 and CH_4.

The samples from ten CWAS launches have now been analyzed in detail. Some of the methane results are shown in the figure where they are compared with the body of CH_4 data obtained at mid-latitudes by earlier balloon, shuttle, and satellite experiments.



The CWAS results for CH_4, N_2O, and CO_2 will be published in the near future.