

# N92-14505

## A. Stratospheric Constituent Distributions From Balloon-Based Limb Thermal Emission Measurements

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## C. Research Objectives

This research task deals with an analysis of infrared thermal emission observations of the earth's atmosphere for determination of trace constituent distributions. Infrared limb thermal emission spectra in the 700–2000  $\text{cm}^{-1}$  region were obtained with a liquid nitrogen cooled Michelson interferometer–spectrometer (SIRIS) on a balloon flight launched from Palestine, Texas, at nighttime on September 15–16, 1986. An important objective of this work is to obtain simultaneously measured vertical mixing ratio profiles of  $\text{O}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{N}_2\text{O}$ ,  $\text{NO}_2$ ,  $\text{N}_2\text{O}_5$ ,  $\text{HNO}_3$  and  $\text{C/ONO}_2$  and compare with measurements made with a variety of techniques by other groups as well as with photochemical model calculations.

## C. Summary of Progress and Results

A portion of the observed spectra obtained by SIRIS from the balloon flight on September 15–16, 1986, has been analyzed with a focus on calculation of the total nighttime odd nitrogen budget from the simultaneously measured profiles of important members of the  $\text{NO}_x$  family. The molecular spectral data employed in the calculations is based on the AFGL compilation HITRAN, 1986 (Rothman et al., 1987). The  $\text{C/ONO}_2$  parameters are taken from the database of Rinsland et al., (1985) employing laboratory crosssections of Massie et al., (1985) with normalization to measurements by Graham et al. (1977). For  $\text{N}_2\text{O}_5$ , room temperature absorption coefficients based on laboratory transmittance measurements of Massie et al. were used. The temperature profile used in the analysis was obtained from the soundings made by National Meteorological Center near the balloon track.

The measurements permit first direct determination of the nighttime total odd nitrogen concentrations  $\text{NO}_y$  and the partitioning of the important elements of the  $\text{NO}_x$  family. The total odd nitrogen concentration  $[\text{NO}_y]$  is defined here as  $[\text{NO}_y] = [\text{NO}] + [\text{NO}_2] + [\text{NO}_3] + [2\text{N}_2\text{O}_5] + [\text{HNO}_3] + [\text{HNO}_4] + [\text{C/ONO}_2]$ . NO is quickly converted into  $\text{NO}_2$  at night and its contribution to the total odd N nighttime budget can be ignored. The distributions of  $\text{NO}_3$  and  $\text{HNO}_4$  have not been made in the present set of measurements by SIRIS. In calculation of the total odd nitrogen budget, predicted profiles based on a 1-d photochemical model have been employed for both of these constituents. Comparisons of the total odd nitrogen budget are made with the daytime measurements by the ATMOS experiment, and with the predictions of the 1-d and 2-d photochemical models.

E. Publications

(1) "Measurement of nighttime stratospheric  $N_2O_5$  from infrared emission spectra", V. G. Kunde, J. C. Brasunas, W. C. Maguire, J. R. Herman, S. T. Massie, M. M. Abbas, L. W. Herath, and W. A. Shaffer, *Geophys. Res. Lett.*, 15(11), 1177-1180, 1988.

(2) "Nighttime measurements of stratospheric  $NO_x$  from balloon-borne limb thermal emission observations," M. M. Abbas, V. G. Kunde, J. C. Brasunas, W. C. Maguire, J. R. Herman, S. T. Massie, and W. A. Shaffer, *Proc. Quadrennial Ozone Symposium* (held Gottingen, Federal Republic of Germany, August 8-13, 1988).

(3) "High resolution balloon-borne emission spectroscopy of trace species in the lower stratosphere:  $N_2O_5$ ,  $HNO_3$ ," *ibid.*

**Title:** Far Infrared Balloon Radiometer for OH

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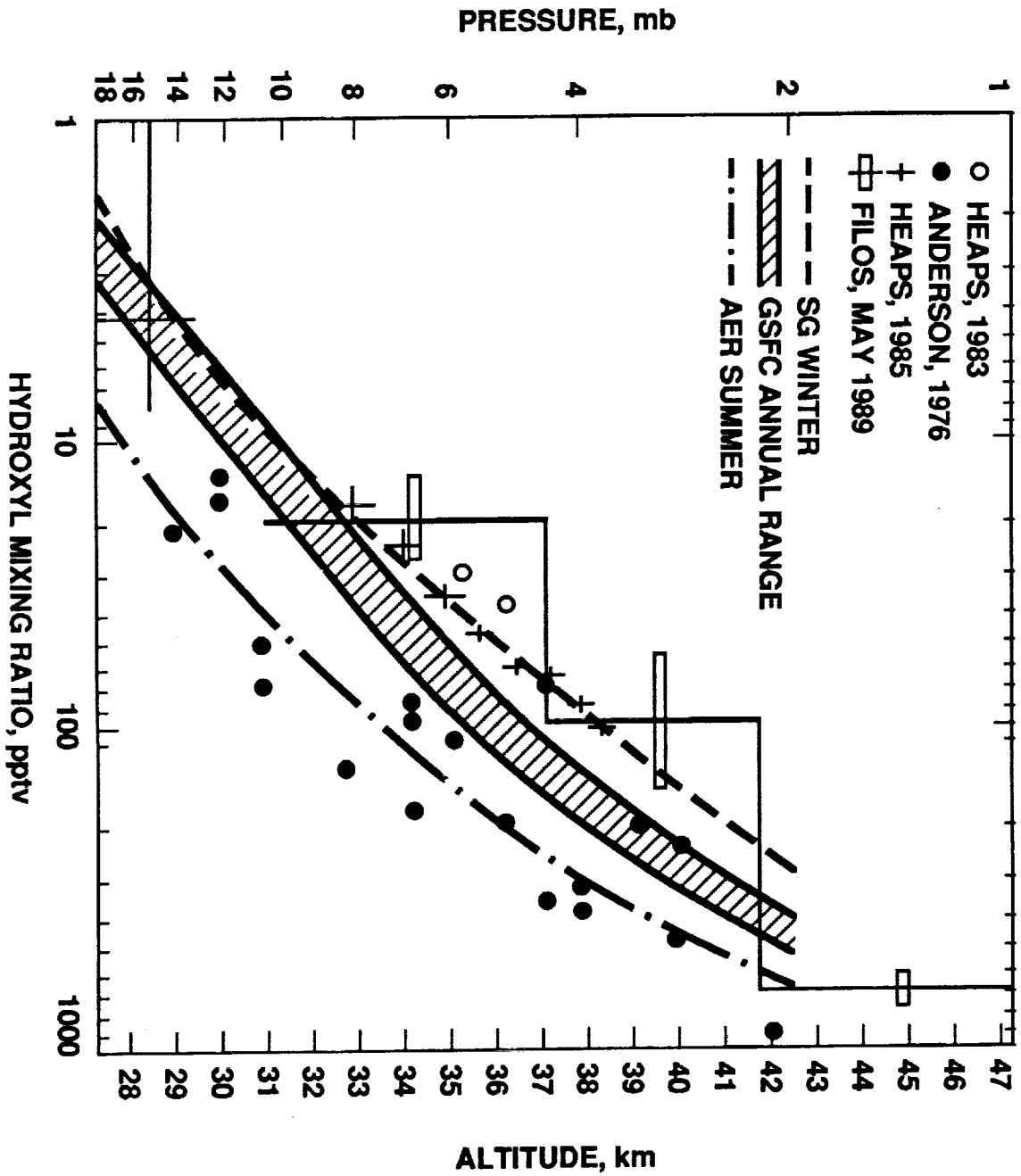
**Objectives:** A stratospheric hydroxyl radical (OH) radiometer for balloon observations in the far infrared region of the spectrum is being developed. The instrument uses three Fabry-Perot resonators to resolve stratospheric limb emission of OH at  $101\text{ cm}^{-1}$  ( $99\ \mu\text{m}$  wavelength). The spectral resolution of  $0.001\text{ cm}^{-1}$  is used to match the width of the stratospheric OH emission. The instrument is compact and designed to fly jointly with other balloon measurements. The goal of this task is to determine OH concentrations from 25-45 km with better than 10% accuracy.

**Progress and Results:** The first scientific balloon flight was made on May 15, 1989. OH radical emission from two different lines was definitely identified during the day and decayed as expected after sunset. Features due to HDO, vibrationally excited  $\text{H}_2\text{O}$ , and  $\text{O}_3$  were also identified. Provisional retrievals of the OH have shown that the OH is consistent with models for OH concentration within experimental error. In September, this instrument will fly from Ft. Sumner, NM, jointly with the Microwave Limb Sounder and with the Harvard Smithsonian Astrophysical Observatory Far Infrared Spectrometer. These joint measurements will allow comparison of OH and  $\text{O}_3$  determinations.

During the year, significant improvements in Fabry-Perot resonator performance have been made, including better flatness and more predictable performance with cooling to 4K. Test capability has been greatly enhanced through use of a high resolution FTS instrument for filter positioning and through use of a HeNe laser based Fizeau interferometer. The end-to-end performance of the instrument in the laboratory has been verified by measuring a HDO sample in emission against a liquid  $\text{N}_2$  black-body. This signal is close to the atmospheric OH signal and comparable in emission strength.

**Publications:** Publications on the instrument design and OH results will be prepared in the coming year.

# HYDROXYL PROFILE



## MULTI-SENSOR BALLOON MEASUREMENTS

147-16-01-40

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### OBJECTIVES

Continuing technical, logistical, and operational support of stratospheric balloon flights is conducted to measure the abundance and altitude distribution of key chemical constituents in the upper atmosphere. Two modular gondola systems are available to carry multi-instrument packages, consisting of several JPL remote sensing instruments and instruments from other institutions in the U. S. and abroad. The payloads are configured for a particular scientific objective. Data are obtained on the altitude profiles for a number of chemically coupled species from one or more flights in the same air mass and at the same time for the purposes of instrument intercomparison, testing of atmospheric chemical models, and validation of satellite data.

### SUMMARY OF PROGRESS AND RESULTS

The past two years have seen a marked increase in the rate of stratospheric balloon flights. In the Spring of 1988 the BLISS instrument (JPL, Webster P. I.) was launched successfully from the NSBF facility at Palestine, TX. In the fall of 1988 the BLISS and OZONE (JPL, Margitan, P. I.) instruments were successfully flown from Palestine, TX, and the BMLS (JPL, Stachnik, Waters, co-P. I.s) instrument was successfully flown from the Ft. Sumner, N. M. facility. In Spring of 1989 four instruments were launched at Palestine, including OZONE, BMLS, FILOS (JPL, Pickett, P. I.), and FIRS-2 (SAO, Traub, Chance, co-P. I.s). Fall of 1989 saw the launch at Ft. Sumner of a multi-instrument gondola carrying FIRS-2, FILOS, and BMLS, all of which operated successfully. Shortly afterward, MARK-IV (JPL, Toon, P. I.) was launched with the OZONE instrument, again from Ft. Sumner.



C. GROUND-BASED MEASUREMENTS

