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ATMOSPHERIC TRACE MOLECULE SPECTROSCOPY (ATMOS) (N009)

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The Atmospheric Trace Molecule Spectroscopy (ATMOS) experiment is a space-borne investigation designed to obtain fundamental information related to the chemistry and physics of the Earth's upper atmosphere (20 to 120 km altitude). The instrument, a high resolution (0.01 cm^{-1}) interferometric spectrometer, measures the atmospheric absorption of solar radiation over the wavelength range from 2 to 16 micrometers, a spectral band which encompasses active transitions of all of the molecular species of current importance in upper atmospheric studies. There are two major aspects to the experiment: the first is the determination of the detailed compositional structure of the stratosphere and mesosphere, and its global, seasonal, and long-term variability. The second is the study of the partitioning of absorbed solar energy at levels in the atmosphere characterized by dissociation of many of the constituents and by the break-down of thermodynamic equilibrium. An added bonus in obtaining the spectra from space at the ATMOS resolution is the ability to extend the frontiers of infrared studies of the photosphere of the Sun.

Since the instrument operates in the absorption mode, measurement opportunities occur twice during each orbit of the Shuttle at the points of apparent sunset and sun-rise. In order to obtain good vertical resolution (2 to 3 km) during these measure-ments, together with the sensitivity to record molecular species at volume concentra-tions as low as parts per trillion, the observations must be made very rapidly and with high spectral information content. The ATMOS instrument is a Fourier transform spectrometer with an aperture of 75 mm and a field-of-view of 1, 2, or 4 milliradians. Solar radiation is acquired and directed into the instrument by a 2-axis sun tracker. A 16-mm camera records the Sun superimposed over the field stop to verify the posi-tion of the pointing vector with respect to the solar disc during each observation. A telescope system is used to concentrate the radiation received into a beam suitable for the interferometer. Cat's-eye retroreflectors replace the plane mirrors used in a conventional Michelson interferometer. A retroreflecting mirror double passes the radiation through the arms of the interferometer before it is recombined and sent to the detector. The use of the cat's-eye retroreflectors and double passing makes the instrument insensitive to both angular and lateral motion of the moving elements. The detector is a HgCdTe type, cooled to cryogenic temperatures. The total optical path difference in the interferometer is ±0.5 m, scanned at a rate of 0.5 m/sec. The inter-ferogram is sampled 400,000 times each second, with a resulting data rate of 16 mega-bits per second. A system controller, which coordinates all instrument functions and operations, formats the data for proper telemetry inputs and provides a responsive interface to the instrument microprocessor. Data taking sequences are normally initiated by a pre-entered command. A compendium of the characteristics of the ATMOS instrument is given in Table I-1.

A dedicated Data Analysis Facility has been developed at JPL to support the reduction and analysis of the large ATMOS data sets. As it is presently configured, this facility is comprised of a Prime 9955 minicomputer with 16 megabytes of main memory, three Floating Point Systems 5205 array processors each with 1 megabyte of random access memory (RAM), two 800/1600/6250 BPI magnetic tape drives, 6 moving head disk drives with a total storage capacity of 5.2 gigabytes, 14 Tektronix Model 4025 graphics terminals, and on-line and off-line copying and plotting capabilities.

An external Shared Access Memory System consisting of 32 megabytes of RAM is attached via high-speed interfaces to each array processor, thus providing the necessary speed and capacity of executing the data reduction and analysis programs in a reasonable amount of time. These programs represent nearly 100,000 lines of code developed for use with the Prime system.

The ATMOS Experiment was flown for the first time on board Spacelab 3 in the spring of 1985, and returned some 20 occultations comprising nearly 2000 spectra from both the northern and southern hemisphere. A partial list of the molecules for which volume mixing ratios were obtained during this flight and the altitudes covered by the measurements is shown in bar chart form in Figure I-5. During the ATLAS missions, similar but more comprehensive data sets are expected to be obtained which will provide the necessary comparisons for the determination of the types of variability mentioned above.

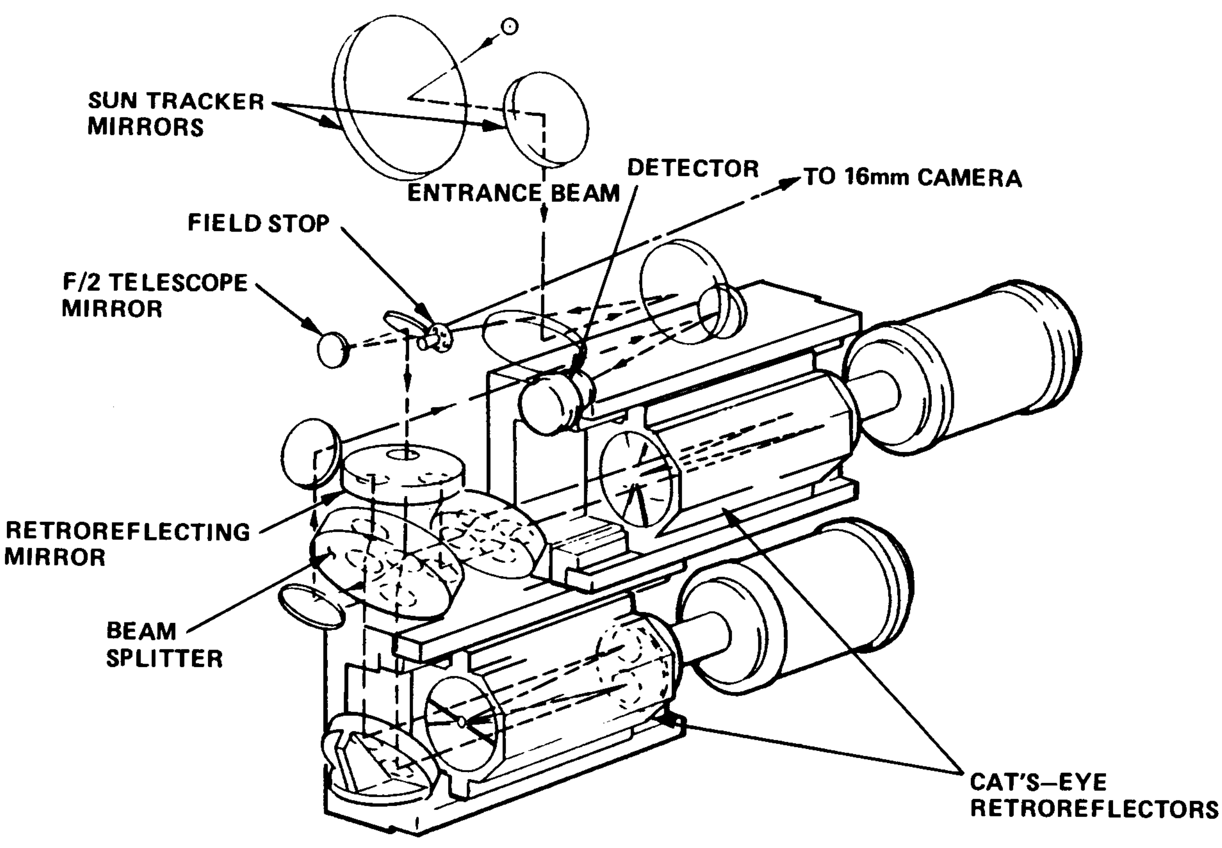

Figure I-4. ATMOS, interferometer optical path.

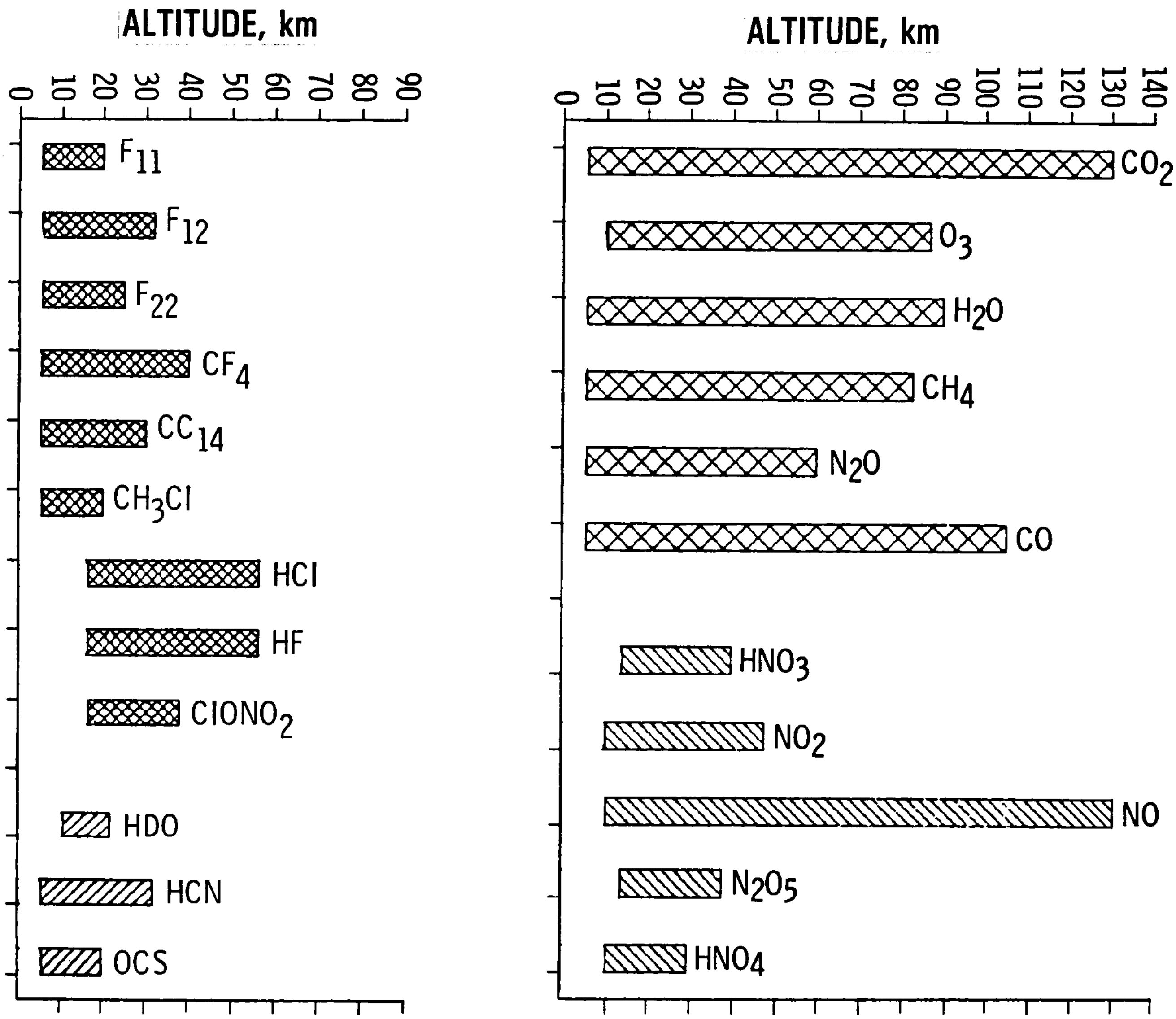

Figure I-5. Species detected by ATMOS on Spacelab 3 and the altitude of the measurements.

TABLE I-1. ATMOS INSTRUMENT CHARACTERISTICS

Spectral Coverage	550-4800 cm^{-1} (2.1 to 18 microns)
Spectral Resolution	0.01 cm^{-1} (unapodised) (50 cm OPD)
Spectral Precision	0.001 cm^{-1} (He/Ne Laser)
Spatial Resolution	2 km
Field of View	Selectable 1, 2, or 4 mrad
Aperture	7.5 cm Diameter
Scan Time	1 sec
Pointing Accuracy	0.1 mrad (2-Axis Suntracker)
Detector	HgCdTe (77°K)
Data Rate	16 Megabits/sec
Mass	250 kgm
Volume	∿1 m Cube (includes electronics and structure)
Average Power	350 Watts