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DESCRIPTION OF SAFIRE FOR ISES

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The SAFIRE (Spectroscopy of the Atmosphere using Far Infrared Emission) is a limb emission experiment using a far-IR Fourier transform spectrometer (FTS) and a mid-IR broadband multispectral radiometer covering the range 80–1600 cm^{-1}. The purpose of this experiment is to obtain vertical distributions of temperature and key constituents of O_y, HO_y, NO_y, ClO_y, and BrO_y families in the stratosphere, mesosphere, and thermosphere. The spectral channels and gases within each channel are summarized in Table I. The instrument includes a 48-element (6 × 8) Ge:GA detector array operating at 4K in the far-IR and a 105-element (7 × 15) HgCdTe array operating at 80K in the mid-IR.

The SAFIRE uses four different scan modes for vertical coverage and resolution to address various scientific requirements. The instrument has an Instantaneous Field of View (IFOV) of 1.5 km for the radiometer and 3.0 km for the FTS. With a proper selection of vertical step size, the range of altitude coverage can be varied. The Chemistry mode, for example, covers 10–110 km in 72 sec with a vertical step size of 1.5 km. The interferogram is sampled every 8 sec, with 1-sec mirror turn-around. The radiometer collects data during the same 8 sec at a 5-Hz rate. Therefore, the FTS data rates for the six 8-detector element arrays are 8.7 Mbs (83.5×10^9 bytes/day), and radiometer data rates for seven 15-detector element arrays are 8.4 Kbs (0.081×10^9 bytes/day).

The SAFIRE data reduction will start with the retrieval of temperature profile as a function of pressure using two CO_2 channel data. Constituent distributions then are obtained from other channel data using the retrieved temperature profile. The data reduction of a mid-IR radiometer is similar to the Limb Infrared Monitor of the Stratosphere (LIMS) procedure (Gille and Russell, 1984); i.e., the production of calibrated radiances from raw instrument counts and inversion of calibrated radiances to temperature and constituent distributions using a radiative transfer equation. The far-IR channel data reduction will require a more complicated procedure; i.e., production of a calibrated interferogram from raw instrument counts, phase correction on the interferogram, inverse Fourier transform of the interferogram to obtain emission spectrum, and nonlinear least-squares fit of the spectrum to retrieve constituent distribution (Park and Carli, 1986). The SAFIRE measurements are limited to the region above the tropopause because of radiance saturation by H_2O and clouds.

The computational capability necessary to process at the instrument data rate (from level 0 to level 1B) is estimated to be 19 MFLOPS for FTS data and 0.02 MFLOPS for radiometer data. It seems, therefore, that the real-time application of SAFIRE data using an onboard processing device is not feasible. Although a temperature anomaly may be detected from the two CO_2 radiometer channels using an onboard processor for the stratosphere, it is not possible to distinguish between CO_2 outflux and temperature anomaly. Temperature anomaly does not, therefore, offer tropospheric information useful for real-time application.

References

Gille, J. C. and J. M. Russell, III, The Limb Infrared Monitor of the Stratosphere: Experiment Description, Performance, and Results, J. Geophys. Res., vol. 89, 5125–5140, 1984.

Park, J. H. and B. Carli, Analysis of Far-Infrared Emission Fourier Transform Spectra, Appl. Optics, vol. 25, 3490–3501, 1986.

Table I. SAFIRE Spectral Channels and Measurement Gases
(interfering gases in parentheses)

Far-IR FTS

Channel	Measurement gas	90% pt. Filter (cm^{-1})
I	O_3 (OH HCl H_2O O_2)	82.0–84.4
II	H_2O_2 (HO_2 O_3 O_2)	94.0–96.0
III	$HOCl$ (H_2O O_3 O_2 HBr)	98.5–100.0
IV	H_2O_2 (H_2O O_3)	111.8–112.6
V	OH (H_2O O_3 O_2 HBr)	116.4–118.6
VI a	H_2O	157.0–159.0
VI b	N_2O_5 (H_2O)	310.0–390.0

Mid-IR Radiometer

Channel	Measurement gas	5% pt. Filter (cm^{-1})
I	CO_2 (H_2O O_3) (for temperature and pressure)	630.0–670.0
II	CO_2 (H_2O O_3) (for temperature and pressure)	580.0–760.0
III	HNO_3 (H_2O CO_2 O_3)	850.0–920.0
IV	CH_4 (H_2O CO_2 N_2O)	1335.–1365.
V	NO_2 (H_2O N_2O CH_4)	1560.–1630.
VI	O_3 (H_2O CO_2)	926.–1141.
VII	N_2O_5 (H_2O CO_2 O_3 CH_4 N_2O)	1225.–1265.