Final Technical Report

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LOWER ATMOSPHERIC COMPOSITION OF JUPITER FROM VOYAGER INFRARED MEASUREMENTS

Mian M. Abbas

Department of Physics and Atmospheric Science
Drexel University
Philadelphia, PA 19104

1. SUMMARY

This report deals with the work performed on "Lower Atmospheric Composition of Jupiter From Voyager Infrared Measurements" at Drexel University under the Grant NAG 5-208. The Voyager infrared spectroscopy experiment employed a Michelson interferometer (IRAS) to measure thermal emission spectrum of the Jovian atmosphere from 180-2300 cm^{-1} (55-4 μm) with an apodized spectral resolution of 4.3 cm^{-1}. The observed spectrum exhibits spectral features of H_2, CH_4, C_2H_6, NH_3, H_2O, GeH_4 and CH_3D. During the course of this investigation, analytical programs were developed for radiative transfer calculations and for retrieval of lower atmospheric composition of Jupiter from the observed infrared spectrum. The program models developed are based line by line transmittance calculations with appropriate convolution of the instrument function. The inversion scheme employed an approach similar to that of Smith. The constituent inversion programs were evaluated for accuracy by analyzing synthetic data for retrievals of NH_3 profiles. The inversion programs were employed for retrieval of NH_3 profiles from the Voyager infrared data with results generally in agreement with the accepted values.

2. OBJECTIVES ACHIEVED

During the period funded by this grant, the following specific objectives were achieved.

i) Analytical programs for radiative transfer calculations and inversion of Jovian infrared spectra were developed for retrieval of the lower atmospheric vertical constituent profiles. The retrieval technique

is based on formal inversion theory and employs line by line transmittance calculations.

ii) Weighting functions suitable for inversion of NH_3 profiles were found in three spectral regions of 200 cm^{-1}, 1000 cm^{-1} and 1800 cm^{-1}. The peaks of these weighting functions span the atmosphere from 0.2 - 5.0 bar levels.

iii) Inversions of synthetic data were carried out to evaluate the accuracy with which gas constituent profiles may be retrieved. Retrieval accuracies for NH_3 profiles were found to be in the range of $\sim$ 10 - 20%.

iv) The programs developed for constituent inversions were employed for retrieval of NH_3 from the observed infrared data by Voyager. The retrieved profiles were found to be in agreement with the accepted values.

3. CONCLUSIONS

The radiative transfer and inversion programs developed during the course of this investigation may be employed for retrieval of constituent profiles of the lower Jovian atmosphere from the observed IRAS data with high accuracy. Retrieval of altitude profiles of NH_3 and PH_3 for the North Equatorial is expected to provide good results. For gases with spectral features with SNRs < 10, the inversions will probably be restricted to total column densities only. The variation in the concentration of the volatile gases (NH_3, H_2O) and the reactive gases (PH_3) for the Jovian features such as belts, zones, brown barges, Great Red Spot etc., may be studied.