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MAGNETIC DEFLECTION ION MASS SPECTROMETER

EXPERIMENT

FOR

ATMOSPHERE EXPLORER

FINAL REPORT

For Contract No. NAS5-11406

TO

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GODDARD SPACE FLIGHT CENTER

FROM

THE UNIVERSITY OF TEXAS AT DALLAS

CENTER FOR SPACE SCIENCES

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FINAL REPORT

CONTRACT NO. NAS5-11406

MAGNETIC DEFLECTION ION MASS SPECTROMETER EXPERIMENT FOR ATMOSPHERE EXPLORER

The Atmosphere Explorer program consisted of the study of data from three satellites to further our understanding of the aeronomy of the earth's upper atmosphere. Included in the satellites' payload was the capability to measure the constituent composition and temperature of the neutral and ionized gas as well as the motion of these atmospheric components. These data together with measurements of the electron temperature, the energetic particle input and the atmosphere airglow emissions have provided the foundation upon which giant strides in the understanding of our environment have been made.

The magnetic ion mass spectrometer was carried aboard Atmosphere Explorer C and Atmosphere Explorer D. The instrument measures the relative abundance of ionic species with very high sensitivity and very high mass resolution. Thus isotopic ratios for various ion species can be examined and minor ion species such as O^{++}, N^{++}, and H^{+} can be detected when their relative abundance is very small. These instruments functioned with no critical internal failures but the premature loss of the AE-D spacecraft after only a few months of operation has led to an emphasis of scientific achievement from AE-C. The very long lifetime of AE-C coupled with the prolonged time that this spacecraft spent near the F-region peak led to the accumulation of very large count numbers in the chan-

neltron detectors. This operational profile together with the requirement to increase the multiplier gain for some science studies made it necessary to correct for decreased sensitivity in the latter part of the AE-C mission. The existence of the RPA data and MIMS data at the same institution has allowed vaulable interaction in this area so that absolute constituent ion concentrations were achieved for the entire AE-C mission.

A great deal of fundamental ionospheric chemistry has been achieved by utilizing the data base from the MIMS.

The elliptical orbit of the AE-C satellite allowed a number of measurements to be made in a confined latitude and local time region but with varying neutral and ionized gas concentrations by virtue of a changing altitude. Under such conditions the details of many chemical reactions can be studied. In particular, reaction rates for species that are extremely hard to produce in a laboratory can be studied. The AE data base has been put to good use in this area with the magnetic spectrometer and RPA providing details of the ionic constituents, the airglow instrument providing information on excited neutral and ion species and the bulk neutral gas densities provided by mass spectrometers. New information on fundamental ion recombination rates has been returned as well as an improved understanding of chemistry of minor ions such as O^{++} and N^{++}. Accurate measurements of the He^{+} number density were used to obtain etimates of the EUV ionization flux to the atmosphere as well as illustrating a rather unique feature of the high latitude ionosphere during equinox.

An exhaustive study of the morphological features of the metallic ion distribution in the ionosphere has shown the role that neutral winds play in the distribution of these long-lived ions at the equator and at high latitudes. Finally, the mass spectrometer was used to evaluate the interaction of the spacecraft itself with the neutral atmosphere. In this study, the effects of

neutral particle impact ionization were considered.

There are many new questions that the AE mission has produced but also many that were originally posed and answered by this highly productive effort. The AE mission has produced a large amount of high quality published material, and attached to this report is a list of those publications fully or partially supported by this contract.

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