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Research Relative to Atmosphere Physics and Spacecraft Applications Studies

Cooperative Agreement NCC 5-35

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Semiannual Status Report for period 15 November 1986 - 14 May 1987

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The following outlines progress made during the third six months period of the cooperative agreement, from 15 November 1986 to 14 May 1987.

Spacelab Data Analysis

An intensive effort was made to abstract thermal ion mass spectrometer measurements made during the Spacelab 2 Shuttle mission from mission data tapes. Computer software was developed to dump the ion measurements from the mission data tapes using a VAX computer. Printouts of the entire data base were produced. Floppy disk copies of the data base were made to perform correlation analysis and plots on an IBM AT. Software was also developed for reading and abstracting Shuttle data from the mission ancilliary data tapes - such as attitude, position, thruster firings, etc. The ion measurements were correlated with the ancilliary data for different phases of the Spacelab mission in order to understand the Shuttle environment.

San Marco Activity

A minicomputer (Masscomp 500) was interfaced to other VAX and IBM computers and to the NSSDC center for the purpose of transferring scientific data or mail messages either directly or through networks such as Bitnet, SPAN, or UUCP. Software was developed to acquire raw San Marco telemetry data, process it and store the reduced data in a cataloged data base. Assistance was provided in the generation of an empirical model of the thermospheric neutral temperature, vertical wind and zonal wind. This activity is in support of the upcoming launch of San Marco.

Molecular Physics

Computer programing was undertaken and graphics prepared for the following problems:

(1) Atmospheric odd oxygen production due to the photodissociation of isotopic molecular oxygen
(2) Temperature dependence of the band oscillator strength in diatomic molecules
(3) Determination of the Bethe coefficients in ion-atom collisions.

Stellar Energy Analysis

Approximately 100 IUE spectral images of alpha centauri were examined and a subset selected for analysis. The spectra of these data sets were examined in the continuum region to establish the existence, within measurement accuracy, of the variability of the stellar energy output. Results suggest that there is a significant variability. The results are being applied to the question of the variability of our sun.

Troposphere Data Analysis

Research activity has concentrated upon analysis of atmospheric angular momentum fluctuations associated with large variations in the Earth rotation rate. The momentum behavior for the period 1977 to 1984 has been derived from an archive of the National Meteorological Center, containing 2.5 by 2.5 degree zonal wind grids, reported at 12 pressure levels between 1000 and 50 mb.

Analytical methods were developed to determine the net flux of angular momentum across latitude bands, revealing that a physical interchange, or "seesaw" of momentum takes place on time scales from about 50 days down to intervals as short as one week or less. These excursions in momentum are most prominent between mid and high latitudes, and are at times sufficient to dominate the global variation in atmospheric momentum. These excursions are present simultaneously at all altitudes up to the upper stratosphere, and are interpreted as evidence of eddy transport. Results are to be submitted to JAS.

Voyager Encounter Analysis

Existing software and analysis programs have been rewritten and modified to allow the detailed analysis of plasma measurements from the Voyager spacecraft encounters with Saturn. A beginning has been made on a detailed study of the interaction of the ionized atmospheres of the moons of Saturn with Saturn's magnetosphere. Investigations will include a study of the plume-like extensions of Titan's upper atmosphere, a study of the dense high pressure plasma that populates low magnetic latitudes and may originate from Saturn's inner moons, and plasma instability processes associated with these interactions.

This research has already stimulated a theoretical paper, "Effects of Finite Plasma Pressure on the Loss of Saturn's Nightside Plasmasheet" by S.A. Curtis and E.C. Sittler, Jr. which will be submitted to JGR.

A theoretical investigation was conducted of Titan's ion density and composition and results compared with data from the Pioneer flyby.

Similar studies were initiated on Uranus.

Laser Activity

Work has concentrated on measurement of infrared aerosol backscatter using CO_2 laser wavelengths. The first task involved the integration of a laser pre-amplifier and low-pressure gain cell into the existing 10 micron CO_2 laser backscatter apparatus. This was followed by a series of aerosol measurements. Development of diode-pumped Nd:YAG laser sources for altimetry applications was continued.

Development of a data system electronics and computer operating system for the Shuttle Laser Altimeter prototype for flight on Wallops Flight Facility (WFF) aircraft has also continued.

Work is under way in support of the balloon borne laser radar. This instrument uses the techniques of laser induced fluorescence and differential absorption for the measurement of hydroxyl radical and ozone in the stratosphere. The system is scheduled to fly twice a year for the next few years. Computer analysis of ozone data obtained on the most recent flights of the lidar is being undertaken.

Gravity Wave Study

A three-dimensional gravity-wave program was modified to calculate the response to atmospheric perturbations in magnetic coordinates instead of geographic coordinates. Dynamics Explorer 2 SAI telemetry was converted into auroral images to be used to compute the sources of the gravity waves. This model is being applied to Venus studies.

Venus Studies

Electron density and temperature fluctuations in the Venus nightside ionosphere were correlated with the Venus magnetic field configuration to help identify electron heat sources. A paper on this topic is being prepared for J. Geophys. Rev. A study was made of the use of Langmuir probe photoelectron current on the Pioneer Venus spacecraft during solar occultation opportunities for determining the atmospheric density below 100km altitude. Studies were also conducted of the use of the Langmuir probe for measurement of the Solar EUV flux in the vicinity of Venus.

Shuttle Environmental Studies

Further development of the Space Shuttle Environmental data base was carried out, including: 1) updating the data for some of the environmental disciplines; 2) transferring the data base to the micro VAX II; 3) preliminary development of a more user friendly data base program for interaction with the users;

4) development of a graphics system to supplement the text data base; and 5) publication of the newsletters. Proceedings of the workshop held at the Belmont conference center in September 1986 to evaluate and plan the data base activity are being prepared for publication, and a further workshop at Belmont was held in late May 1987. Plans have been developed for establishing a Space Station Environmental data base program.

List of Publications

Thermal Ion Complexities Observed within the Spacelab 2 Bay
J.M. Grebowsky, H.A. Taylor, M.W. Pharo, and N. Reese
submitted to Science.

Thermal Ion Perturbations Observed in the vicinity of the Space Shuttle
J.M. Grebowsky, H.A. Taylor, Jr., M.W. Pharo, III, and N. Reese
accepted for publication Planetary and Space Science.

Atmospheric Odd Oxygen Production due to the Photodissociation of Ordinary and Isotropic Molecular Oxygen
K. Omidvar and J.E. Frederick
accepted for publication in Planetary and Space Science

Effects of Finite Plasma Pressure on the Loss of Saturn's Nightside Plasmasheet
S.A. Curtis and E.C. Sittler, Jr.
in preparation for submission to J. Geophysics Research.

DE/ISIS Conjunction Comparison of High-Latitude Electron Density Features
W.R. Hoegy and R.F. Benson
submitted to J. Geophysics Research.

Design of a Multiple-pass Laser Diode pumped Nd-YAG Amplifier
K. Chan
submitted to Applied Optics

CO_2 Laser Pre-amplifier for LIDAR Applications
K. Chan and J.L. Bufton
in preparation for submission to Applied Optics