INTERIM AND FINAL REPORT

(to fulfill reporting requirements from September 1981 through present)

concerning

DYNAMICS-A EXPLORER RIMS DATA ANALYSIS

CONTRACT NUMBER: NAS8-34430

Prof. P. M. Banks (P.I.)
Dr. C. R. Clauer (Co.I.)

Submitted to:

George C. Marshall Space Flight Center

Contracting Officer:
Doris M. Grubbs

Leland Stanford Jr. University
Space, Telecommunications, and Radioscience Laboratory
Stanford, California 94305

September, 1985

Interim and Final Report
NASA Contract No. NAS8-34430
Covering the Interval 9/17/81 - 9/30/85

Dynamics-A Explorer RIMS Data Analysis

• OBJECTIVES

1. Participate in the planning activities of the RIMS instrument during the extended mission. These activities will be to determine the modes of operation for RIMS to achieve the science requirements utilizing the new and exciting information on the composition and dynamics of the low energy (0-50eV) ions in the earth's ionosphere and magnetosphere. The contractor will identify the specific science problems he is interested in studying and the required RIMS operational modes to acquire the desired data and coordinate these requirements with MSFC.

2. Perform the necessary analysis on the RIMS data to achieve the science results and utilize this new information in determining RIMS operations during the latter part of the mission Suggest necessary sensitivity tests of RIMS operating modes and instrument performence.

3. Compare the inflight results with theoretical models.

• WORK PERFORMED AND ACCOMPLISHMENTS

1. Sept. 1981 - Sept. 1983

During this interval of the contract, the scientific investigation focused on a theoretical explanation of the large verticle acceleration experienced by ionospheric heavy ions at high latitudes and observed by RIMS. This analytical investigation examined the electrodynamic forces on particles which **E x B** drift in a converging magnetic field geometry such as exists at the earth's polar ionosphere. The drifting particle would experience an upward "mirror force" due to gradients in the field experienced by the particle as it drifts. Unfortunatly, after considerable time was spent in deriving the appropriate equations in a dipolar coordinate system, it was determined that this mechanism was insufficient to account for the observed large acceleration of heavy ions.

During this time interval, the contract provided partial support for numerical modeling of high latitude processes. In particular, an electrodynamics model built to describe the global electric field resulting from arbitrary distributions of field-aligned current and conductivity was adapted to run on the laboratory's VAX computer. The code was used to investigate the consequences of various current configurations in the polar cleft region. The original code, developed by T. Araki of Kyoto University during a sabbtical stay at Utah State University, ran originally on the NCAR Cray computer.

Also during this interval, an experimental program of high latitude observation of ionospheric electrodynamics was initiated using the Sondre Stromfjord, Greenland incoherent scatter radar. The experiments were focused in the region of the polar cleft with the goal of describing the morphology and electrodynamic behavior of currents which connect the solar wind with the high latitude ionosphere. These experimental observations were funded by another source and brought no cost against this contract. Several of the experimental investigations, however, were coordinated with the DE satellite and coordinated analysis of the resulting data sets was anticipated. Unfortunatly, processing of the DE data has been slow and no data sets for correlative study were obtained for study during this period.

In addition, at the beginning of this time interval the principal investigator of this contract was installing himself and his research group at Stanford University. Contract funds were used to acquire equipment necessary to the research effort, including computer terminals, modems and a microfiche reader and printer. Plans were also developed during this period for a STARlab computer system to be linked to MSFC via the SPAN DECnet.

1.1. Papers Presented at Meetings

The contract provided partial support for the preparation and presentation of two papers at scientific meetings from September 1981 through September 1983.

1. Clauer, C. R., "Solar wind control of geomagnetic activity", presented at the Huntsville Solar-Terrestrial Meeting, October, 1982.

2. Clauer, C. R., P. M. Banks, E. Friis-Christensen, V. B. Wickwar, J. D. Kelly, O. de la Beaujardiere, J. R. Doupnik, J. C. Foster, T. S. Jorgensen, E. Friis-Christensen, and T. Araki, "Coordinated observations of the polar cusp", presented at the IUGG XVIIIth General Assembly, Hamburg, Germany, August, 1983.

2. Oct. 1983 - Sept. 1985

Major efforts during this interval focused on three topics: (1) Modeling the distribution of field-aligned currents in the polar cleft and the resulting high latitude ionospheric electric field and their response to variations in the interplanetary magnetic field (IMF), (2) Correlative observations at conjunctions between DE and the Sondre Stromfjord,

Greenland incoherent scatter radar in the vicinity of the polar cleft and (3) Data management and correlative data analysis using computer networks and SPAN in particular.

A great deal of progress has been obtained in our effort to model the configuration of field-aligned currents in the dayside polar cleft and the control of these currents by the solar wind. The computer model calculates the ionospheric electric potential distribution for a given configuration of field-aligned currents and conductivity distribution. By setting the currents based on IMF observations obtained from the IMP-8 spacecraft, the time varying ionospheric electric field and the resulting plasma convection can be simulated. This, in turn, can then be compared with observations of the high latitude plasma convection in the vicinity of the polar cleft obtained using the Sondrestrom radar. Several events have been examined and the agreement between the radar simulation and observation is quite impressive. For some of the events examined, there exist conjugate observations between the Sondrestrom radar and the DE, HILAT and DMSP satellites. These intervals are:

1. 84 March 7 (day 067)

2. 84 March 16 (day 076)

3. 84 March 20 (day 080)

Plots of the ionospheric convection observed by the Sondrestrom radar along with a discription of the events are enclosed in the appendix to this report. These intervals have been selected as DE Science Passes and the intervals have been processed. We are presently working with Dr. Bill Peterson at Lockheed and Hunter Waite at MSFC to assemble the correlated observations. It is hoped that coordinated analysis of these correlated data sets will provide more specific constraints on the input parameters used in the computer simulation and a better understanding of the electrodynamic coupling of the solar wind with the high latitude ionosphere in the polar cleft. DE RIMS data will be examined in these events to determine the relative locations of the ionospheric convection reversal boundary, the location of field-aligned currents, the location of plasma precipitation and the location of upward flowing accelerated ionospheric ions. An initial paper presenting this work will be given at the Fall meeting of the American Geophysical Union, *Clauer*, (1985).

The contract has also provided partial support to another major effort to develope data management techniques and software suitable to the coordinated analysis of data from a variety of experiments and sources. The result of this effort has been the development of the data management software called FLATDBMS. A paper, recently submitted to EOS, describing this software is enclosed in the appendix of this report. FLATDBMS has been very effictive in the management of data for correlative work using a variety of data sets. FLATDBMS is presently in use at Stanford in the STAR Laboratory as well as several other space science research laboratories includeing UCLA, Los Alamos,

Lockheed Palo Alto Research Laboratory, Utah State University, Johns Hopkins Applied Physics Laboratory and the University of Newcastle (Australia). In addition, we have recently had requests for the code from Imperial College (London), the Space Research Institute of the Austrian Academy of Sciences and the Air Force Geophysics Laboratory. Many of these laboratories are connected via the Space Physics Analysis Network (SPAN) and the use of FLATDBMS has facilitated collaboration and analysis of data over the network.

2.1. Papers Presented at Meetings

1. Banks, P M, "The ionosphere as a source of magnetospheric plasma", invited review presented at the Yosemite meeting, Planetary Plasma Environments: A Comparative View, February, 1984.

2. Clauer, C. R., "Field-aligned currents and ionospheric electric fields in the vicinity of the dayside polar cleft: Observation and model", to be presented at the Fall Meeting of the American Geophysical Union, December, 1985.

2.2. Publications

1. Smith, Anne Q., and C. Robert Clauer, "A versatile, source independent system for digital data management", submitted to *EOS, Trans. American Geophys. Union*, September, 1985.

3. Budget

Interim and Final Report — September, 1985
NAS 8-34430
Dynamics-A Explorer RIMS Data Analysis
Prof P M Banks, Principal Investigator

Report Period:	9/81 through 9/83	10/83 through 9/85
Total Contract Value:	$71,592	$81,492
Total Cumulative Costs:	$56,304	$81,487
Percentage of Funds Expended:	79%	100%
Estimated Percentage of Physical Completion:	79%	100%
Estimated Costs to Complete:	$15,288	$5
Significant Variance of Funds Expended to Percentage of Physical Completion	None	None