AN EVALUATION OF SPACE PLASMA DATA: EFFECTS UPON SPACECRAFT MATERIALS AND PREDICTIONS

by

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A complete LAPI and DE data analysis package has been developed through which data from all DE-2 experiments can be plotted on a common time scale. The analysis package has been implemented on a MASSCOMP 500 computer system. Analysis of space plasma data has shown the processes occcuring within the magnetosphere lead to large temporal and spatial variations in the space plasma. These variations can and do have a large impact on space systems. The studies undertaken are leading to a better environmental understanding with the ultimate goal being how to mitigate the effects. Keywords.

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I. INTRODUCTION

In a continuing Special Task effort for the Nondestructive Testing Information Analysis Center (NTIAC), space plasma environmental data are being analyzed to provide improved specification of the dynamic high latitude/magnetosphere environment. These studies involve the analysis and interpretation of a variety of space plasma data including information from the Dynamics Explorer (DE) 1 and 2 spacecraft. This evaluation is expected to lead to the establishment of a data base useful for predicting and/or avoiding damage and degradation of aerospace/satellite structural materials. Efforts to more accurately specify the highly dynamic high latitude/magnetosphere environment will lead to improved design of communications, surveillance, and navigation satellites which must operate within this environment, as well as propagate radiowaves through it. Also, accurate, dynamic, near-earth plasma specifications will result in realistic hardware specification for reliable satellite performance within and through this environment.

Specific objectives include the following:

A. Provide and interpret DE experimental data for selected periods coordinated with AFGL Airborne Ionospheric Observatory (AIO) flights and ground operations to measure optical and radio wave phenomena to study the characteristics of electrons and ions precipitating into the North polar cap region to: (1) identify the particle source regions for polar cap auroras; (2) study the convective flow in the polar cap; (3) investigate the generation of ionospheric irregularities; and (4) specify optical and radio wave signatures of polar cap auroras.

B. Obtain and analyze plasma wave, plasma, and energetic electron and ion data recorded by the DE satellites for input to: (1) the study of the formation and evolution of ion conic distributions in the supra auroral region; and (2) correlate the investigation of the incidence of electrostatic ion cyclotron cavitons, periodic density dips and paired shocks with DE measurements in the supra auroral region.

C. Engage in a program of coordinated measurements between DE and the AFGL/AIO flights at constant local time within the auroral oval; obtain and analyze DE-2 electron and proton data in both day and night sectors of the auroral oval together with other DE-1 and 2 particle and optical data available for analysis to: (1) determine the morphology and dynamics of the continuous aurora/auroral E region over the maximum spatial extent and duration of time possible; (2) determine the latitudinal distribution of precipitating protons and electrons and how the relationship between them differs in pre- and post-midnight sectors; and (3) study the local time extent of the injection of particles during substorms.

Summarized in this report is work accomplished under CLIN 0001AJ of NTIAC Contract DLA900-79-C-1266. Work to develop the space plasma data base is continuing as a Special Task under CLIN 0001AE of NTIAC Contract DLA900-84-C-0910.

II. ACCOMPLISHMENTS

A. Software

Significant progress has been made in the development of a complete LAPI and DE data analysis package. The data analysis package has been put together under a UNIX operating system for compatibility and portability between local UNIX based computers allowing users to perform analysis on machines based on their work loads. Some programs which require graphical output (versatec type) or require large amounts of computation or size (NCAR plotting package) have been placed on a local VAX 750. The following is a list of programs that are, or will be, available to the general user, their location, and comments. 1) Production of SATM (stand along telemetry modules) is available on both the VAX and UNIX machines. 2) Spectrograms can be produced on the UNIX machines either by creation of a plot tape which must then be dumped onto the local color computer/terminal (Chromatics CGC3200) or by directly running on the Chromatics. 3) Plasma parameters can be computed on both the VAX and UNIX machines. 4) Contour plots can be produced on both the VAX and UNIX machines. On the VAX the contours are produced by the NCAR plot package and can be output either on a versatec or in color on the chromatics. The UNIX contour package is much simpler than the NCAR package and allows production of color contours in much the same format as the production of spectrograms. 5) The production of vector plots for LAPI data is currently available on the VAX and will be later developed under UNIX. The vector plots consist of distribution function, energy flux, or number flux vs energy in a log-log or log-linear format. Output of these plots is currently performed on a versatec. 6) LAPI spectrograms plotted together with derived plasma parameters is available on the UNIX machines. This program is currently being updated to allow LAPI spectrograms to also be plotted together with data from other DE-2 instruments. At the present, data from the LANG instrument can be plotted both with LAPI spectrograms and plasma parameters. 7) A data base which keeps track of all the local LAPI data files obtained from the Sigma-9 with a cross reference to the UNIX SATM files exists on UNIX and is up-to-date. 8) A database containing all the slides which have been produced (including start and stop times and start and stop OA data) is available on UNIX. This database is not currently up-to-date but will be within the next few months. This database allows selection of slides based on time or OA data. The database has connected with it a phenomena database which allows identification of various geophysical phenomena on the slides. Slides can then be requested that have specific phenomena.

The implementation of a data analysis package through which data from all of the DE-2 experiments could be plotted on a common time scale was undertaken with the understanding that initially all data plots of multiple instruments would contain a LAPI spectrogram as one of the plots and that this would define the time base. Also the time period over which this coordinated data sharing would occur would be limited to the first 100 days of DE-2 data, stopping at the time of the satellite word gate failure. Plots produced consist of a LAPI spectrogram in an upper panel and either a second spectrogram or up to two line plots on a lower panel. The limit of two line plots was chosen for readability.

The analysis package was implemented on a MASSCOMP 500 computer system configured with 1 Mbyte of user memory, an 80 Mbyte winchester disk, and an 840 x 600 color graphics terminal. All programs are at this point written in C and run under a UNIX operating system. Portability of the software has been proven in-house on several machines.

Example data was requested from each of the DE-2 experiments with the requirements that they be in ascii and time tagged. These data sets were then downloaded onto the MASSCOMP 500, and converted into binary random access files. Data from all of the experiments have completed this stage of processing. After reading each individual experimenter's data, it was added to the plotting module of the program. At this time all of the DE-2 data is able to be plotted with the exception of the VEFI AC and DC data. This will be undertaken in the future.

Besides the joint plotting of multi experiment data, the data analysis package can perform and output several other types of plots. Of the many planned outputs, only the color contour plots are now available. The access to the analysis package is through a program called DAP (Data Analysis Package). Through this program all of the implemented plots and analysis packages can be utilized. Each individual plotting routine utilizes a menu driven question page. Each set of replies can be saved and recalled for later use.

A code is under development for analyzing DE-2 LAPI ram ion data. It takes into account the low energy positive ion distribution function and fits it to a two dimensional flowing Maxwellian distribution function. Use is made of the Marquardt algorithm in least-squares fitting an arbitrary function as described in Bevington, 1969. The spacecraft frame potential from the Langmuir probe is used to correct the distribution functions. Derived are transverse and parallel to the magnetic field positive-ion flows as well as temperatures and densities of the ions. The mass of the ions can be selected at will.

B. Data Analysis

Analysis of space plasma data has resulted in the publication of several papers in the open literature. Abstracts of these papers, which serve as a summary of data analysis results, are given below:

1. F Layer Ionization Patches in the Polar Cap

E. J. Weber, J. Buchau, J. G. Moore, J. R. Sharber, R. C. Livingston, J. D. Winningham, and B. W. Reinisch
J. Geophys. Res., 89, 1683 (1984)

Ground based optical and digital ionosonde measurements were conducted at Thule, Greenland to measure ionospheric structure and dynamics in the nighttime polar cap F layer. These observations showed the existence of large-scale (800-1000 km) plasma patches drifting in the antisunward direction during a moderately disturbed ($k_p > 4$) period. Simultaneous Dynamics Explorer (DE-B) low-altitude plasma instrument (LAPI) measurements show that these patches with peak densities of $\sim 10^6$ el cm^{-3} are not locally produced by

structured particle precipitation. The LAPI measurements show a uniform precipitation of polar rain electrons over the polar cap. The combined measurements provide a comprehensive description of patch structure and dynamics. They are produced near or equatorward of the dayside auroral zone and convect across the polar cap in the antisunward direction. Gradients within the large scale, drifting patches are subject to structuring by convective instabilities. UHF scintillation and spaced receiver measurements are used to map the resulting irregularity distribution within the patches.

2. Particle Acceleration Parallel and Perpendicular to the Magnetic Field Observed by DE-2

R. A. Heelis, J. D. Winningham, M. Sugiura, and N. C. Maynard
J. Geophys. Res., 89, 3893 (1984)

Observations by the instrument payload on DE-2 have been used to study the plasma and electrodynamic properties of the ionosphere when field-aligned currents approaching 100 $\mu A\ m^{-2}$ flow at about 900-km altitude. In such a situation it is found that the thermal ions may account for a substantial fraction of the current carriers and that the bulk of the energetic electron population has undergone a net acceleration of a few hundred electron volts. Large amplitude electrostatic waves that have a maximum near 100 Hz and an energetic ion population that shows evidence for both parallel and perpendicular acceleration to about 30 eV also accompany such events. The horizontal thermal ion drift (electric field) that accompanies these plasma phenomena has extremely large gradients over small spatial scales. Such a signature is consistent with a requirement for a large field-aligned current and a limit to the available field-aligned potential difference that may be applied to the plasma.

3. ULF/ELF Waves and Turbulence in the High Latitude Dayside Magnetosphere

J. A. Holtet, A. Egeland, J. D. Winningham
Radio Sci., 18, No. 6, 955 (1983)

The magnetospheric polar cusp has been recognized as a region of strong plasma wave activity. The paper briefly summarizes previous observations of waves in the high altitude cusp and the dayside magnetosheath. The main part of the work is concerned with low frequency waves found in and near the cusp at low altitudes (500 -2000 km) and on the ground. Examining the AC electric field measurements made by polar orbiting satellites (mainly the DE-2) the following groups of waves appear to be characteristic for the dayside high latitude magnetosphere: (1) ULF/ELF broadband noise, extending from the low Hz range to approximately 1 kHz. The region of peak intensity is generally found to be consistent with the latitudinal extension of the cusp. (2) VLF - hiss is found to be present in the cusp region, but is generally extending outside of the established projection of the cusp. (3) Narrow band ELF emissions, covering frequencies 200 Hz $\leq f \leq$ 1 kHz are observed on the equatorward side of the cusp, in the closed field line regime.

Ground based low frequency wave measurements at $\Lambda = 75.4$ show in the daytime the presence of (i) strong micropulsations activity in the frequency range ~ 1 -100 mHz and (ii) polar ELF emissions, a narrow band of relatively unstructured noise at frequencies 300 Hz $\lesssim f \lesssim$ 1 kHz. The latter is believed to correspond to the satellite observed narrow band ELF noise.

The frequency range 1 -7 kHz is in general, both in the satellite and ground recordings, characterized by very low emission activity in the time period ~ 3 hours on either side of magnetic noon. This classification of the waves is independent of the level of magnetic disturbance.

It is discussed how the characteristic appearance of the ULF/ELF noise and the narrow band ELF emissions can be used to localize the position of the polar cusp.

4. Bands of Ions and Angular V's:
A Conjugate Manifestation of Ionospheric Ion Acceleration

J. D. Winningham, J. L. Burch, R. A. Frahm
J. Geophys. Res., 89, 1751 (1984)

Data from the hot plasma instruments on the Dynamics Explorer 1 and 2 spacecraft have been used to study the injection, drift, and subsequent precipitation of suprathermal positive ions in the aurural zone. The observation at both high and low altitudes of electron inverted "V" events in the boundary plasma sheet (BPS) and of ion "bands" (energy decreasing with decreasing latitude) in the adjacent central plasma sheet (CPS) leads to the following ion injection model: upward-moving energetic ion beams are injected onto BPS magnetic field lines by the electrostatic potential drops associated with electron ivnerted V's. As the ion beams move toward the equator and into the conjugate hemisphere they are convected to lower latitudes and into the CPS. The energy-latitude dependence of the ion bands, coupled with concurrent ion convection measurements, indicate that the ion distributions are primarily 0^+, in agreement with their postulated ionospheric source.

5. Polar Plasmas as Observed by Dynamics Explorers 1 and 2

J. Barfield, J. Burch, C. Gurgiolo, C. Lin, D. Winningham, N. Saflekos
Spacecraft Charging Technology, in press (1983)

Plasma measurements from the Dynamics Explorer 1 and 2 stellites have been used to characterize the polar cap environment. Analysis of numerous polar-cap passes have indicated that, in general, three major regimes of plasma exist:

(1) polar rain--electrons with magnetosheath-like energy spectra but much lower densities, most intense near the cusp and weakening toward the central polar cap;

(2) polar wind--low energy upward flowing ions with both field-aligned and conical distributions;

(3) acceleration events--sporadic events consistent with the acceleration of electrons and positive ions by parallel electric fields.

(1)-(3) have been observed at high altitudes by Dynamcis Explorer 1, while (1) and (3) have been observed at low altitudes by Dynamics Explorer 2. The plasma parameters associated with these plasma regimes are presented and discussed in terms of source and acceleration mechanisms.

6. Cooperative Investigation with Dynamics Explorer Particle Experiments

James R. Sharber, J. D. Winningham, and J. L. Burch
Proc. 2nd U.S.-Finland Workshop on Magnetospheric and Ionospheric Phenomena in Auroral Regions, pp. 78-84 (1984)

The High-and Low-Altitude Plasma Instruments (HAPI and LAPI) on Dynamics Explorer 1 and 2 have produced an extensive amount of particle data, much of it during the 1981-82 period initially designated for U.S.-Finland satellite and ground-based cooperative investigations. This report gives a brief description of each instrument, provides an example of recent results using the LAPI experiment in a coordinated polar cap study, and discusses the use of HAPI and LAPI in co-operative study with the Finland-Scandinavian ground network of observatories.

7. IMF B_y-Dependent Plasma Flow and Birkeland Currents in the Dayside Magnetosphere

J. L. Burch, P. H. Reiff, J. D. Menietti, R. A. Heelis, W. B. Hanson, S. D. Shawhan, E. G. Shelley, M. Sugiura, D. R. Weimer, and J. D. Winningham
J. Geophys. Res., in press (1984)

Plasma, magnetic-field and DC electric-field observations from Dynamics Explorers 1 and 2 are used to investigate the morphology of solar-wind ion injection, Birkeland currents, and plasma convection in the morning-sector for both positive and negative IMF B_y components. The results of the study are used to construct a B_y-dependent global convection model for southward IMF. A significant element of the model is the coexistence of three types of convection cells ("merging cells", "viscous cells", and "lobe cells"). This model can account for observations of a nearly stationary (in local time) convection "throat", a sunward-antisunward convection reversal zone at the polar-cap boundary in both the morning and afternoon quadrants, the morphology of solar-wind ion injection and transport in the mid-altitude polar cusp, and B_y-dependent dawn-dusk asymmetry of polar-cap electron fluxes.

8. Observations of Large Scale Ion Conic Generation with DE-1

J. D. Winningham and J. L. Burch
MIT Seminar Series, 1984

Data from Dynamics Explorer 1 have been analyzed to investigate the phenomena that are associated with the occurrence of upward conical ion distributions in the nightside auroral oval. In a single pass through the boundary plasma sheet (BPS) and central plasma sheet (CPS) at altitudes near 1 R_E and MLT ~ 19 contained distinct signatures of the parallel and perpendicular flow

velocities that were determined from calculated moments of the ion distribution functions. In addition to the expected presence of field-aligned currents and waves in the <100 Hz frequency range, the CPS conic region, where the highest-energy conics were observed, contained a population of upward-streaming electrons with temperatures between 1 and 2 eV. It is suggested that the upward-streaming electrons may be the primary source of free energy for ion conic generation.

In addition, to the above publications, several additional papers are in draft stage. They include:

1. Thermospheric and Ionospheric Structure of the Southern Hemisphere Polar Cap on 21 October 1981 as Determined from Dynamics Explorer-2 Satellite Data

B. A. Emery, R. G. Roble, E. C. Ridley, T. L. Killeen, M. H. Rees, J. D. Winningham, G. R. Carignan, P. B. Hays, R. A. Heelis, W. B. Hanson, N. W. Spencer, L. H. Brace, and M. Sugiura

The Dynamics Explorer satellite (DE-2) passed over the Southern Hemisphere Polar Cap on orbit 1174 between 23:26UT and 23:45UT on October 21, 1981. The altitude of the satellite over the Polar cap ranged between 325 and 390 km and the local times were about 2100LT on the downleg and 0900LT on the upleg portions of the orbit. The full complement of instruments on the De-2 satellite were making measurements during this pass. The electron precipitation spectra detected at a pitch angle of 7.5° were averaged over 8-second (0.5 degrees of latitude) intervals and these spectra were used in an auroral model to calculate the ionization rates below the satellite in an atmosphere determined from the neutral temperature and composition measurements. These ionization rates are combined with solar photoionization rates and used in a photochemical equilibrium model with O^+ diffusion to calculate the electron and ion densities below the satellite. The electron and ion temepratures are also calculated assuming a local thermal energy balance and the temperatures and densities are used to calculate the parallel, Pedersen and Hall electrical conductivities. The total neutral gas heating rate is also calculated which is composed of four main sources: (1) particle heating, (2) Joule heating, (3) solar EUV heating, and solar Schumann-Runge heating. The particle heating is determined by multiplying the particle ionization rate by a particle heating efficiency determined from earlier studies. Joule heating at the satellite altitude is determined from the calculated Pedersen conductivity and the relative difference between the measured ion drifts and the neutral winds. Below the satellite altitude the Joule heating is calculated using the winds from the NCAR Thermospheric General Circulation Model and a mapping of the measured ion drift into the lower ionosphere. The TGCM winds are shown to be in reasonable agreement with the measured winds at the satellite height. For this satellite pass, the height integrated Joule heating exceeds both the auroral particle heating and the solar heating rates over the entire magnetic polar cap. The neutral gas heating rates peak in the vicinity of the morning auroral oval where the electric field increases abruptly from typical polar cap values of 30 mVm^{-1} to a high of about 100 mVm^{-1} just poleward of the dayside cusp aurora.

2. Enhanced Ion Outflows Measured by the DE-1 High Altitude Plasma Instrument in the Dayside Plasmasphere During the Recovery Phase

J. D. Menietti, J. D. Winningham, J. L. Burch, W. K. Peterson, J. H. Waite, Jr., and D. R. Weimer

Ion flow velocities both parallel and perpendicular to the magnetic field and including the effects of spacecraft charging, plasma co-rotation and spacecraft velocity have been measured during the recovery phase of two large magnetic stores on October 14 and 21 of 1981. These measurements were made both inside and outside the plasmasphere and indicate unexpected, substantial outflows of ions within the dayside plasmasphere (October 14). Combined data from instruments on board the Dynamics Explorer satellite including the High Altitude Plasma Instrument (HAPI), the Energetic Ion Composition Spectrometer (EICS), the Retarding Ion Mass Spectrometer (RIMS) and the Plasma Wave Instrument (PWI), indicate that these ions are predominately 0^+ at energies at least as low as 4.5 eV. The nightside pass (Oct. 21), which occurred during the recovery phase of a similar storm, showed almost no appreciable plasmaspheric outflows. The results indicate that a large contribution to the outflux into the dayside plasmasphere during the recovery period is due to $E > 4.5$ eV ions.

3. Near-Conjugate Observations of Inverted-V Electron Precipitation Using DE-1 and DE-2

C. S. Lin, J. N. Barfield, J. L. Burch, and J. D. Winningham

Near-conjugate plasma measurements from the DE-1 HAPI and the DE-1 LAPI instruments during nightside inverted-V events are examined to determine quantitatively the energization of inverted-V electrons. The plasma moments, including number flux, energy flux and average energy, are computed. For the four near-conjugate passes examined, the total downward energy flux at the DE-1 altitudes (8,000 -12,000 km) is generally several ergs/cm^2-s. At the DE-2; altitudes (500 -1,000 km), the peak of the total downward energy flux is 3 - 15 times that measured by DE-1. Similar variation of the total downward energy fluxes with respect to invariant latitude is found at high and low altitudes. The average parallel electric field between the DE 1/2 satellites, deduced from the energy at the peak of the distribution function, varies from 0.1 to 0.7 V/m, in agreement with S3-3 direct measurements of parallel DC electric fields. According to the model that electrons are accelerated adiabatically by an electrostatic field, the downward energy flux at the DE-2 altitude is calculated from the DE-1 plasma data as a function of potential drop and compared with that measured by DE-2. When the modelled downward energy flux is assumed to equal the measured total downward energy flux, the required potential drop is shown to agree reasonably well with the potential drop inferred separately from the measured distribution function. This empirical result suggests that adiabatic acceleration of inverted-V electrons by parallel DC electric field below the DE-1 altitudes can account for the total downward energy flux measured at the DE-2 altitudes.

4. The Relation Between Morning Sector PI 1 Pulsations and Particle and Field Characteristics Observed by the DE-2 Satellite

M. J. Engebretson, L. J. Cahill, Jr., J. D. Winningham, T. J. Rosenberg, R. L. Arnoldy, N. C. Maynard, M. Sugiura, and R. A. Hoffman

Impulsive short-period magnetic field fluctuations (Pi 1) observed by ground instrumentation in the morning sector auroral zone have in recent years been convincingly tied to the passage overhead of pulsating aurora. We here present simultaneous records from ground-based magnetometer, photometer, and riometer instrumentation at Siple, Antarctica and its conjugate point, Roberval, Quebec, and low altitude particle and magnetic and electric field data from the DE-2 spacecraft. Satellite magnetometer observations support earlier findings of a link between morning sector Pi 1 and the presence of a region 2 Birkeland current sheet. The addition of energetic electron observations provides further characterization of Pi 1 pulsation events. Intense fluxes of energetic electrons (from 10 keV to over 35 keV) are observed simultaneously with Pi 1 pulsations and region 2 Birkeland currents. When fluxes of lower energy electrons (E < 3 keV) are simultaneously present, we observe strong region 2 Birkeland currents and strong Pi 1 pulsations; when lower energy electrons are less abundant, region 2 Birkeland currents and Pi 1 pulsations are considerably weaker. No Pi 1 pulsations have been found in regions without intense fluxes of energetic electrons.

5. The Theta Aurora

L. A. Frank, J. D. Craven, D. A. Gurnett, S. D. Shawhan, D. R. Weimer, J. L. Burch, J. D. Winningham, C. R. Chappell J. H. Waite, R. A. Heelis, N. C. Maynard, M. Sugiura, W. K. Peterson, and E. B. Shelley

The theta aurora is a remarkable configuration of auroral luminosities that is characterized by a transpolar arc extending contiguously from the dayside sector of the auroral oval to the nightside oval. The theta aurora is established as a significant, durable phenomena with global imaging from the DE-1 spacecraft at high altitudes. Simultaneous measurements of in situ fields and particles with the fully instrumented DE-1 and its low-altitude sister spacecraft DE-2 provide an unprecedented opportunity to interpret this major auroral configuration. The results of a correlative study of thermal and hot plasmas, field-aligned currents, convection and plasma waves are presented here in order to provide a coherent observational basis for theoretical analyses and magnetospheric modeling.

III. FUTURE WORK

Development of a space plasma data base is continuing as a Special Task under NTIAC Contract DLA900-84-C-0910, CLIN 0001AE.

A coordinated study of the diffuse CPS precipitation with LAPI and HAPI conjunction passes is underway. An initial goal of this study is to determine how the equatorward edge of the CPS varies with altitude and what effect this has on statistics based on low altitude particle measurements and optical observations. A second phase of the study will utilize the joint data base to determine diffusion coefficients for electrons and ions.

A study of the statistics, correlation with ground obserations, and theoretical base for SAR arc associated particles is being carried out. This study is a joint effort with Don Stater of Batelle Northwest. The goal is to determine the exact role of the SAR arc associated particles fluxes. That is, are they directly responsible for the optical emission, what is their energization mechanism, and what is the source of the energy?

An extended tail on the normal photoelectron distribution has been observed at times. This power low tail extends from the nominal 60 eV "classical" cutoff energy to ~ 600 eV where it falls below the instrument sensitivity level. Initial comparison with IMP X-ray fluxes indicates the occurrence to be related to increases in low energy solar X-rays. The purpose of this study will be to determine if these "anomalous" electrons are photoelectrons produced by solar X-rays.

Research into the level and causes of DE 1 and 2 spacecraft charging is being carried out. Data from multiple instruments is being utilized. The variability of charging with altitude and current carriers will be investigated.

An algorithm for computing the field-aligned currents that use two components of the curl of the magnetic field has been developed. The intent of this approach is to handle current sheets which are not east-west aligned and to look for potential field effects at a distance due to localized beam current distributions. The inferred magnetometer current will be plotted against time on the same scale as the calculated current from the measured particle distribution functions. This correlative study will allow us to understand the differences in the small-scale variations of the currents measured by two separate instruments. Nonuniformities of current density in the east-west direction may be the principal cause of the apparent disagreement between the two different methods of measuring current densities.

Work on the analysis of space plasma data is being expanded to include processes that affect the electron density profile in the terrestrial ionosphere. From a practical point of view, the electron density profile and its temporal variation are of utmost importance. The electron plasma is responsible for the absorption and reflection of radio waves, and thus can directly affect Air Force Communications and Surveillance Systems, and operation of Over the Horizon radar systems. Therefore it is of great importance to know what physical observables are useful for monitoring the daytime electron density profile.

This additional work will include analysis and evaluation of data and information pertaining to the following processes:

1. The relationship among ionospheric optical emissions, the neutral density and wind, and the electron density.

2. The effect of the curvature of the geomagnetic field on the formation of equatorial irregularities.

3. The role of nonlinear processes in the formation of ion conics in the topside, high-latitude ionosphere.