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QUARTERLY PROGRESS REPORT

Contract NAS8-33982

SPACE PLASMA RESEARCH

April - June 1986

by

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Prepared for

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July 1986

(NASA-CR-178898) SPACE PLASMA RESEARCH Quarterly Progress Report, Apr. - Jun. 1986 (Alabama Univ., Huntsville.) 14 p CSCL 20I

N86-32289

Unclas
G3/75 43306

ANALYSIS TECHNIQUES AND SOFTWARE DEVELOPMENT

Temperature and density analysis in the Automated Analysis Program (for the global empirical model) have been modified to use flow velocities produced by the flow velocity analysis. This should have significant effect only for some portions of the outer plasmasphere and beyond. It will permit the estimate of a better flux density for those regions where the standard RPA analysis cannot be carried out.

Revisions have been started to construct an interactive version of the technique for temperature and density analysis used in the automated analysis program. This will be similar in operation to the current interactive program, but will use the + or - Z-head for temperature analysis and the radial head only for densities. Interactive analysis is desirable for case studies, since it provides the best possible results for a given data set and also provides a clear picture of the quality of the data. These data will also extend the current radial head data set to periods of other local times and magnetic activity conditions.

During this period, we have incorporated a new effect into the parallel equation of motion used in our ion transport calculations. This effect, pointed out recently by Cladis, is essentially a "centrifugal" acceleration on the ion parallel motion given by

$$\underline{V_c}*\underline{db}/dt.$$

This term contributes an important acceleration to the ion motion when the convection velocity is large and the direction of the magnetic field is changing significantly along the ion trajectory, as in the tail regions. The resulting energization of O+ can be quite substantial. We hope to have some runs of bulk parameters produced soon.

DATA ANALYSIS AND MODELING

A study of ion and electron heating at high altitudes in the outer plasmasphere has been initiated. It is designed to investigate the mechanisms for heating the plasma in this region and the possible links between this heating and observed heavy ion enhancements. A parametric study to determine the magnitude of the energy source necessary to raise ion temperatures to those observed was carried out with the results reported at the Spring Meeting of the AGU (Ref. 1). This study showed that to properly account for observations in the ionosphere and at high altitudes energy must be put into both the electrons and the ions in a ratio of about 10 to 1. The resultant high temperatures in the model are sufficient to increase the O+ density to values comparable with those observed. Initial results from a collaborative effort with researchers at The University of Michigan suggest that Coulomb interactions involving suprathermal and ring current ions and the thermal plasma can supply the required amount of energy. A detailed case study involving DE 1 and 2 data and modeling is under way.

Results of a related collaborative study involving DE-1 and DE-2 observations, together with theoretical calculations, show that the portion of the energy going to the electrons from the Coulomb interactions just noted is sufficient to drive SAR arcs observed simultaneously. They also demonstrate that the spatial distribution of heating is consistent with the distribution of heating needed to produce the observed SAR arcs (Ref. 2,3). Further analysis of the set of coordinated observations has delineated high and low altitude signatures of SAR arc field lines (Ref. 4,5), among them the heavy ion enhancements near the plasmapause, which we have examined in detail with RIMS observations and are preparing for publication (Ref. 6), and which we are studying further with numerical simulations, as noted above.

The data base of DE-1/RIMS temperatures and densities has been extended to over 100 plasmasphere transits. Results of the statistical analysis are not qualitatively different from those reported previously. In addition, available ISEE-1/PCE temperatures have been compiled and given a similar statistical treatment. Although the size of the ISEE sample is much smaller than that of RIMS, there is general consistency between the two sets. The quantitative differences of note are a general lower magnitude of dayside temperatures in the ISEE-1/PCE data set and indications of somewhat more spatial structure. While the lower temperatures in the inner L-shells are consistent with the lower level of solar activity for the time frame of the ISEE observations, the lower temperatures in the outer L-shells require a different explanation, since night side temperatures are higher. A nightside heat source in the outer plasmasphere may resolve this difference. These results were reported to the COSPAR meeting in Toulouse, France (Ref. 7).

The statistical study of 1982 data for occurrences of equatorially trapped plasma has been repeated. The previous survey, which utilized only the MSFC summary fiche, has been supplemented with the GSFC summary fiche, which has had the effect of substantially improving the late 1982 coverage. We find that in the post midnight region (1 - 3 LT), the trapped plasma is limited to ± 5 degrees magnetic latitude, while in the early afternoon (13-15 LT), latitude ranges as high as ±30 degrees are found.

This survey has provided a link to earlier ATS-6 and ISEE studies of pancake distributions. Although the most energetic, and most anisotopic plasmas are trapped within a few degrees of the equator, the results of these equatorial interactions extend substantially along the magnetic field line in the afternoon and dusk region, and these high latitude extensions were previously studied by the Huntsville group.

In work for a COSPAR presentation (Ref. 8) and for the associated JGR and Advances in Space Research papers, we have been examining statistical trends in the density profiles in the plasmasphere. We have obtained a number of interesting statistical results, including the tendency for relatively featureless profiles to occur in the dawn sector and multiple plateau profiles to appear in the dusk-evening side of the plasmasphere. It would appear that these results can be interpreted in terms of the time dependent effects of convection electric fields on the plasmasphere, as discussed, for example, by Chen and Wolf.

SPACECRAFT SHEATH STUDIES

The analysis of electron gun experiments on SCATHA has been extended to include eclipse operations in order to test a hypothesis that there are interactions between the 50-100 eV beam and spacecraft generated photoelectrons. There are limited data in the desired modes, but the tentative conclusion is that our hypothesis is supported by the recently analyzed data. There are similarities between the eclipse and sunlight data, however, which suggest that in our one good eclipse measurement, there is a naturally occurring cold plasma around the satellite, which is interacting with the beam.

LABORATORY PLASMA FLOW STUDIES

The MASSCOMP software to be used in taking and displaying data in the two-ion plasma experiment was tested and is now working satisfactorily. It was decided to analyze the Langmuir probe experimental data by computer. Software development has been initiated for analysis on the VAX system.

It was found that a new signal amplifier needed to be installed in the Differential Ion Flux Probe. This is under way along with several other improvements to the instrumentation.

MEETINGS

Drs. Chandler and Horwitz and undergraduate B. Giles attended and presented papers at the Spring AGU Meeting. These and other members of the UAH magnetosphere group were authors or coauthors of nine papers (Ref. 1, 2, 4, 9-14) presented there.

Dr. Olsen presented an invited paper (Ref. 15) at the NATO meeting on spacecraft charging in The Hague, Netherlands.

Drs. Comfort, Horwitz and Olsen presented papers to the XXVI COSPAR Meeting in Toulouse, France. Members of the UAH magnetosphere group were authors or coauthors of 9 papers (Ref. 5, 7, 8, 16-21) presented to various symposia or topical meetings comprising that Meeting.

PUBLICATIONS

In addition to the papers noted above, the following papers are at the indicated stage of the publication cycle.

* Papers published during this period are those on: low energy ions around a magnetspheric satellite (Ref. 22), latitudinal plasma distribution in the dusk bulge (Ref. 23), plasma phenomena in wakes (Ref. 24), upwelling ion source characteristics (Ref. 25), plasma and wave observations in a compressional Pc 5 event (Ref. 26), tail lobe ion spectrometer (Ref. 27), velocity filter mechanism for ion bowl distributions (Ref. 28), and DE - Chatanika observations of

ionosphere / magnetosphere coupling (Ref. 29).

* Papers accepted for publication and in press are those on: ion flows in the plasmasphere (Ref. 30), more Pc 5 plasma and wave observations (Ref. 31), plasma boundaries in the inner magnetosphere (Ref. 32), potential modulations of the SCATHA spacecraft (Ref. 33), DE-1 and DE-2 measurements of plasmasphere-ionosphere coupling (Ref. 34), electric fields near the plasmapause (Ref. 35), ATS-6 record charging events (Ref. 36), solar wind control of the geomagnetic mass spectrometer (Ref. 37), transport of accelerated low energy ions in the polar magnetosphere (Ref. 38), geomagnetic spectrometer in the magnetotail lobes (Ref. 39), and ion acceleration during plasma expansion into a vacuum (Ref. 40).

* Papers submitted for publication and in review are those on: O++ in the plasmasphere (Ref. 41), plasma measurements at the magnetic equator (Ref. 42), and parabolic heavy ion flow (Ref. 14).

* Papers in draft stage in preparation for submission are those on: semi-empirical modeling of spin modulation of RPA fluxes (Ref.43), comparisons of theoretical spacecraft wake models (Ref. 44), plasmasphere and plasmapause characteristics (Ref. 45), and comparisons of theory and data for the tail lobe ion spectrometer (Ref. 17).

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FINANCIAL STATUS REPORT

CONTRACT NAS8-33982

Total Cumulative Costs incurred as of 6/30/86	$1,289,035.10
Estimate of cost to complete	$ 60,962.90
Estimated Percentage of Physical Completion 95.48%	

Statement relating the Cumulative cost to the percentage of physical completion with explanation of any significant variance: