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1 July 1986 - 31 December 1986

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THE UNIVERSITY OF TEXAS AT DALLAS

CENTER FOR SPACE SCIENCES

RETARDING POTENTIAL ANALYZER RESEARCH

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Principal Investigator

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DYNAMICS EXPLORER-2 RPA RESEARCH

Semi-Annual Report for period 1 July 1986 - 31 December 1986.

1. Introduction.

We have continued our studies in the areas of ionospheric electrodynamics, plasma irregularities and ion-neutral coupling that require collaborative efforts between different DE science team members and the data sets for which they are responsible. Most of these studies involve knowledge of the vector ion drift velocity as well as other ionospheric parameters and are therefore equally attributable to RPA and IDM research. As has been our practice in the past we choose not to duplicate reports but to provide an arbitray division in the description of our efforts between the RPA and IDM reports. Since our last report the submitted papers have now appeared and we are currently involved with another 5 papers that are either submitted or in press.

Over the past several years our group has been intimately involved in the processes responsible for ionospheric dynamics and composition. As such we have been requested to contribut to the US report to IUGG, which describes the contributions of US scientists in various fields of space science. In particular, two extensive reviews of work in the area of ionospheric composition and ionospheric plasma dynamics were undertaken by Breig and Heelis respectively. These papers have been accepted for publication in Reviews of Geophysics. Included as an appendix to this report are the introduction and/or abstarcts of papers that are in the submittal cycle or have been submitted to scientific journals.

2. Plasma Structure.

We have been working in conjunction with scientists at AFGL on the relationship between the spectral characteristics of structure in the ion concentration and the electric field at high latitudes. We find that in the region of velocity shears the relationship between the slopes of the two spectra are dependent on the the existence of large field-aligned currents and apparently large ionospheric conductivity gradients. Large conductivity gradients and field-aligned currents are associated with with velocity shear frequencies of about 10 Hz or greater. Under these conditions the concentration and electric field irregularities have the sam spectral slope at scale sizes above a few hundred meters but at smaller scale sizes the spectral slope in the electric field steepens and that in the ion concentration does not. When the velocity shear frequency is of order 1 Hz the evidence for conductivity gradients and intense field-aligned currents is less apparent. In such regions the spectral slopeof the electric field structure was steeper than that of the of the ion concentration at all observable scale sizes. A discussion of these features and their applicability to various plasma instability theories is discussed in the paper "Simultaneous density and Electric field fluctuation spectra associated with velocity shears in the auroral oval" which has been submitted to the Journal of Geophysical Research. An abstarct of this paper is included as an appendix to this report.

3. Joule Heating.

At say 400 km altitude the relationship between the Joule dissipation computed from in-situ measurements and the locally measured value of the ion temperature, is complicated by the relationship between the local neutral wind velocity and that existing at much lower altitudes. Examination of the horizontal ion drift velocity shows that drifts above about 300 m/sec are well confined to latitudes above about 60 degrees. Figure 1 show a gray-shade representation of their distribution. With a suitable estimation of the ionospheric conductivity distribution, which would undoubtedly display an auroral zone enhancement, it can be easily demonstrated that the Joule heating rate has local maxima in near local noon and midnight in the auroral zones. This can be contrast with a similar gray-shade representation of the ion temperature which shows evidence for enhanced local frictional heating in the auroral zone near local dawn and extending throughout the auroral zone and to lower latitudes in the local time sector near 2000 hrs magnetic local time. These findings must be reconciled with the motion of the neutral air in the altitude region below about 600 km. The results suggest that in the dawn side auroral zone the neutral wind and the ion convection have substantial difference velocities on the dayside. In the duskside the difference velocities are largest in the evening local time sector and extend to lower latitudes where the neutral wind opposes the tendancy of the ions to corotate to the east. While further interpretive study is required to complete this work the available data base shows the potential to expose some of the differences in the large scale convective features of the ions and the neutral gas above about 300 km.

4. Ion-Neutral Coupling.

The importance of ion-neutral coupling has been investigated in additional studies involving the nature of the coupling at high latitude boundaries and during times of magnetic disturbances. Much of the behavior of high latitude themosphere can be modelled using global circulation models. A critical input to such models is the extent, geometry and flow speeds involved in the high latitude ion convection pattern. In order to study the storm time response of the thermosphere we have derived the global ion convection pattern from DE-2 measurements and used it as input to a circulation model. The calculated variables of neutral velocity and composition and temperature are the compared with measurements to validate the technique. Following this validation, the model can be used to expose the important physical processes that operate during the storm. This work appears in the publication " Thermospheric

Dynamics during 21-22 November, 1981: Dynamixs explorer measurements and TGCM predictions" which has been submitted to the Journal of Geophysical Research. An abstract of this paper is included in the appendis of this report.

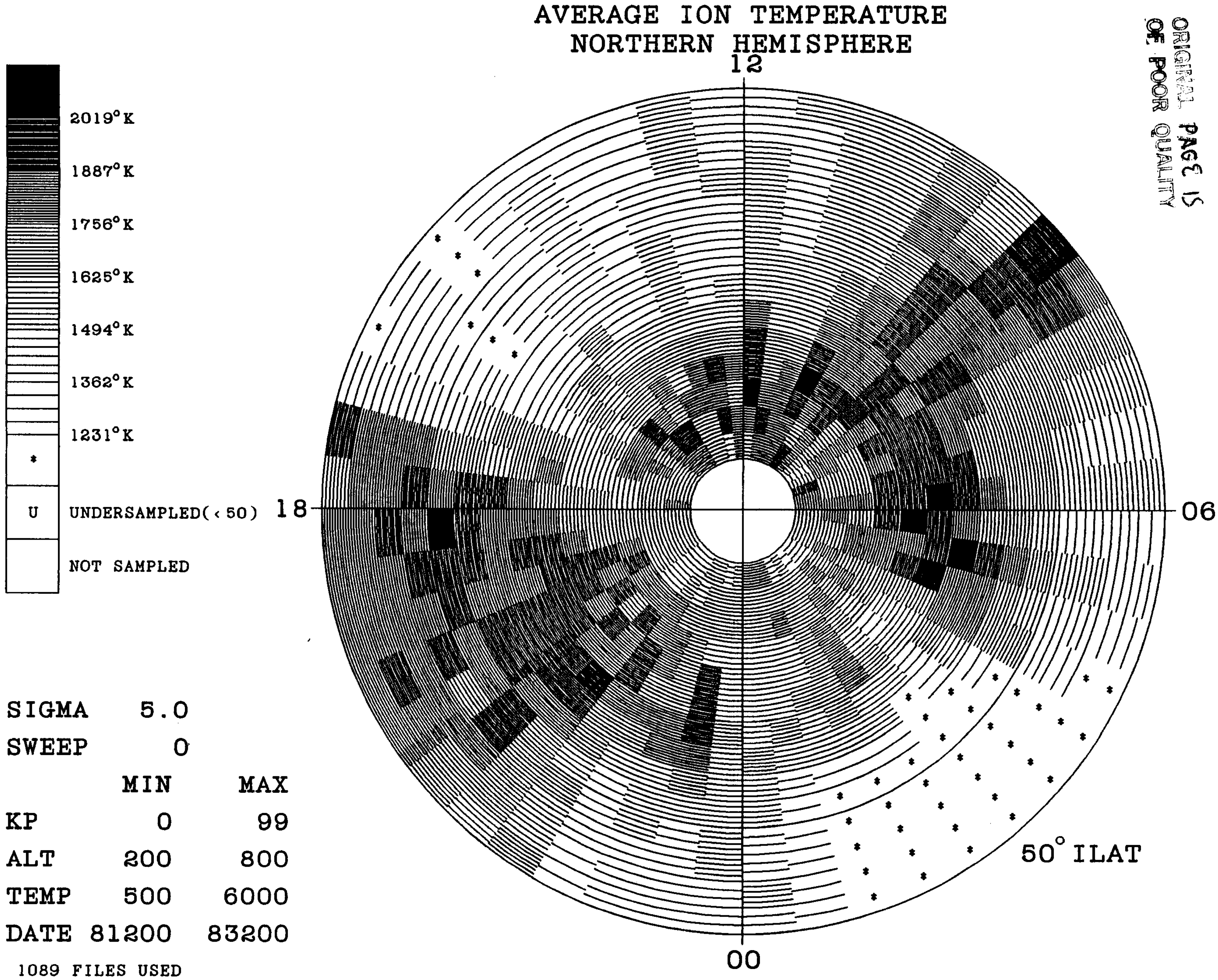
The largest differences in the ion and neutral flow velocities frequently occur at the convection reversal boundary and at the low latitude extremes of the instantaneous convection pattern. This is due to the fact that the neutral gas inertia does not allow it to follow the ion gas over very small spatial or temporal scales. Thus, a well defined convection reversal in the ion velocity may not be so well defined in the neutral gas and the expansion or contraction of the ion convection pattern may not be accuratle mimiced by the neutral gas. In order to examine these attribute of the ion-neutral coupling, it is desirable to add the almost instantaneous two dimensional perspective provided by the auroral imager on DE-1. On this basis we see that the ion convection displays a convection reversal that nicely maps to the poleward edge of the imaged oval. On many occasions, that we judge to be stable periods in the IMF, we see that the neutral flow mimics the ion flow on the dusk side and thus a reversal boundary in the neutral flow corresponds to the auroral zone poleward edge. However it is more frequent that these boundaries do not coincide and the frictional heating of ions due to the ion-neutral velocity difference is evident. The ion and neutral flows frequently extend beyond the equatorward edge of the auroral zone, and again frictional heating can sometimes be observed due to a difference in these two velocities. In these circumstances a more rigorous examination of the idividual veleocities is required to establish if the ions are dragging the neutrals (i.e. a leakage field) or if the neutrals are leading the ions which may signify the presence of a disturbance dynamo.

5. DE Imaging and geophysical screening objects.

A large but previously undetected influx of small comets into the earth's upper atmosphere was invoked by Frank et al. (1986a,b) to explain the observation of excessively dark pixels in UV images of the earth's dayglow obtained using the spin-scan imager on DE-1. The published comment of Hanson (1986) disputes the conclusions of Frank et al. on geophysical grounds, noting that some signature of the comet-ionosphere interaction should be present in thermal ion measurements made on various spacecraft. We have recently submitted a comment (Cragin et al., 1986) to GRL which disputes the cometary influx hypothesis based on our analysis of data comprising 182 DE-1 UV images kindly provided by Frank et al. We confim these authors' previous findings concerning the existence of anomalously dark pixels in the images, but based on statistical anaysis of the properties of these events, we conclude that they cannot be caused by comets or any other geophysical ''screening objects''. The analysis is sophisticated but not exceedingly subtle. We infer that the dark pixels, at least in our data sample, are probably artifacts of the data.

6. D.E. Review.

During the last five years considerable advances in our understanding of ionospheric and magnetospheric electrodynamics have taken place, aided in part by the Dynamics Explorer data base and the teams of scientists that have devoted some of their efforts to its interpretation. At this time it seems appropriate to review the work performed in this and other areas and investigators at UTD have pursued this task. The subject matter can be divided rather broadly into consideration of large and small scale characteristics and within each of these catagories the role of the dual spacecraft mission is emphasized. Such topics as the convection cell geometry and the nature of the convection pattern drivers will be discussed as well as the convective configuration of auroral emissions occuring during times of northward IMF. This work has been presented as part of an AGU special session and is currently being reprocessed for publication.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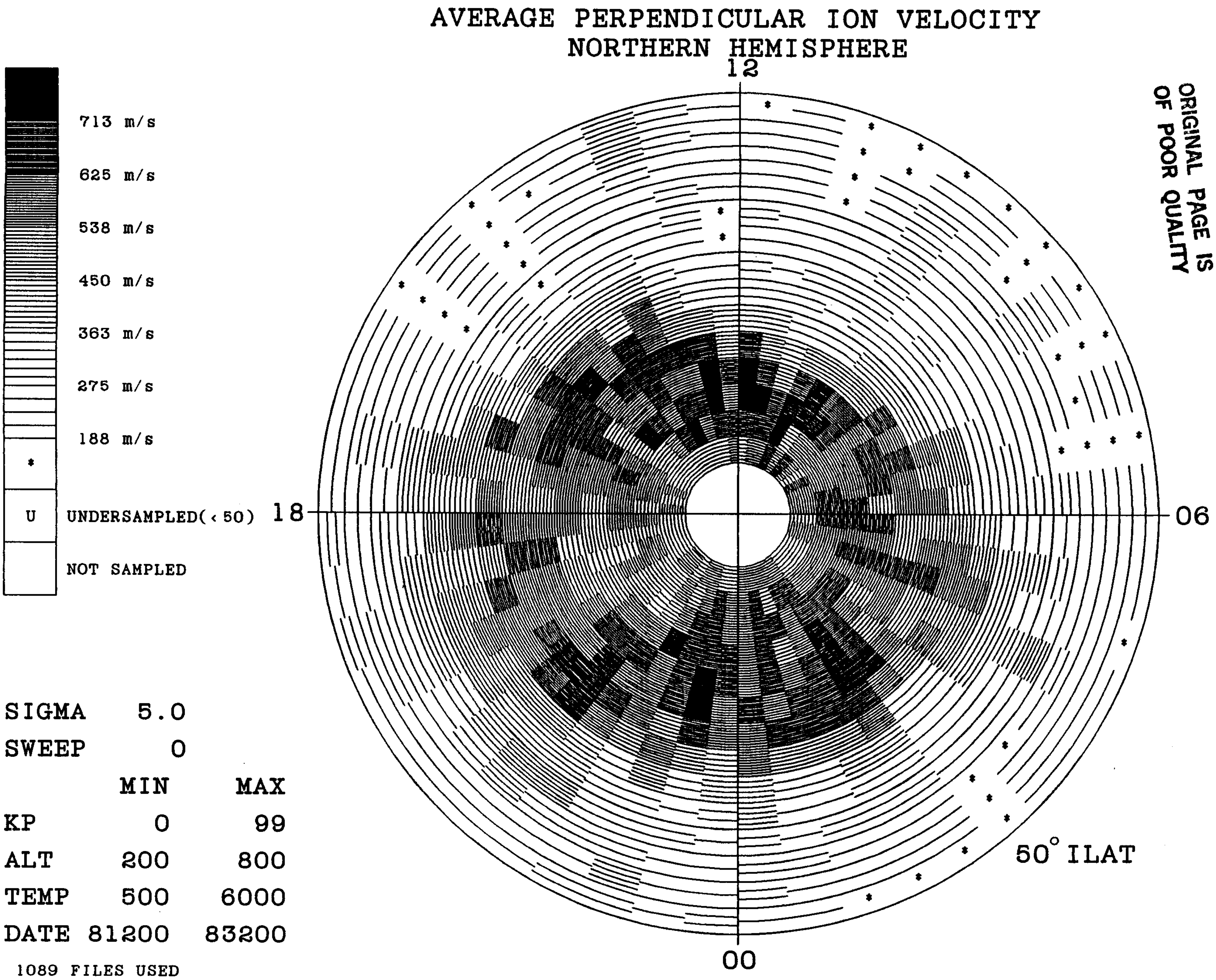
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Figure 2

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