Quantitative Comparison of Measured Plasma Sheet Electron Energy Flux and Remotely Sensed Auroral Electron Energy Flux

M. O. Fillingim[1], (matt@ess.washington.edu), G. K. Parks[2], D. Chua[1], G. A. Germany[3], R. P. Lin[2], M. McCarthy[1]

[1]Department of Earth and Space Sciences, University of Washington, Seattle

[2]Space Sciences Laboratory, University of California, Berkeley

[3]Center for Space Plasma, Aeronomy, and Astrophysics Research, University of Alabama in Huntsville

SM51A-0789
Electrodynamic Coupling of High-Latitude Ionosphere and Plasma Sheet I

Abstract

In situ plasma sheet observations and auroral images give us two views of magnetospheric dynamics. With in situ observations, we get a detailed point measurement; auroral images give us a global view. Previous studies have shown an excellent correlation between dynamic plasma behavior in the plasma sheet and auroral activity. Here we extend the previous work with quantitative comparisons between the two regions. We directly compare the electron energy flux measured in the plasma sheet with the electron energy flux into the ionosphere inferred from auroral images. We find that during quiet times, the plasma sheet is able to supply the aurora with nearly all of the observed energy flux. During intervals of intense auroral emission, the electron spectrum in the conjugate region of the plasma sheet changes, increasing the amount of energy flux incident on the ionosphere. However, the increases in the plasma sheet energy flux is not enough to account for the inferred energy flux into the ionosphere from the images by nearly an order of magnitude. This implies that additional energy flux must be entering the loss cone through pitch angle diffusion or through the presence of parallel electric fields between the plasma sheet and the ionosphere during intervals of intense auroral emission. A likely source of this additional energy flux is the low altitude auroral acceleration region.

Introduction

•Excellent correlation has been observed between **ion** dynamics in the plasma sheet and auroral activity [*Fillingim et al.*, 2000, 2001; *Parks et al.*, 2000, 2001a, b].

•Features include

- •large Earthward ion velocity moments (<**V**>);
- •increased energetic particle fluxes (up to MeV energies);
- •dynamic, anisotropic, multi-component ion distributions;
- •large amplitude, high frequency magnetic fluctuations.

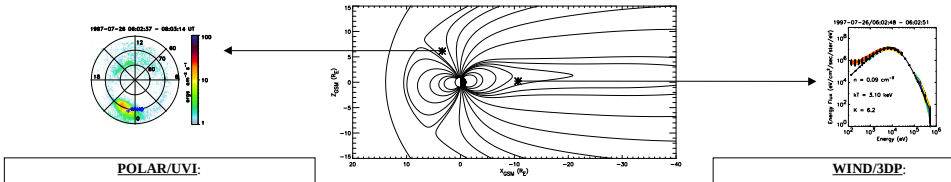
•**Electron** dynamics in the plasma sheet associated with auroral activity have largely been ignored.

•However, electron precipitation is responsible for the aurora.

•Quantitatively compare electron energy flux measured in the plasma sheet with precipitating electron energy flux into the ionosphere inferred from auroral images.

•Can we remotely monitor the process(es) occurring between the plasma sheet and the ionosphere?

2 Views of Magnetospheric Dynamics



POLAR/UVI:

Auroral intensity ~ precipitating electron energy flux

Peak energy flux "near" WIND footprint

~ **19 ergs/cm^2/s**

WIND/3DP:

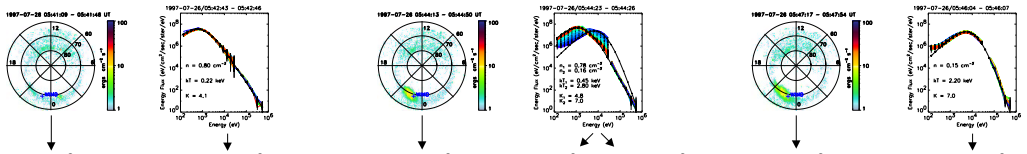
Electron energy flux spectrum from 0.1 to 500 keV

Energy flux mapped to ionosphere = **1.23 ergs/cm^2/s**

Theoretical energy flux mapped to ionosphere

$n[2kT^3/m/\pi]^{1/2}K^2/(K-1)/(K-2)$ = **1.46 ergs/cm^2/s**

Evolution of Plasma Sheet Electron Energy Flux Spectrum During Auroral Activity



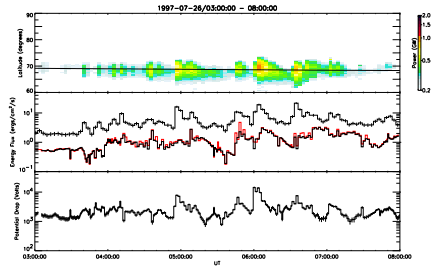
1 erg/cm^2/s **0.36 ergs/cm^2/s** **11 ergs/cm^2/s** **0.86 ergs/cm^2/s** **2.07 ergs/cm^2/s** **10 ergs/cm^2/s** **1.35 ergs/cm^2/s**

Estimation of Parallel Potential Drop Between Plasma Sheet and Ionosphere

•Keogram constructed from UVI images. Line shows latitudinal position of WIND footprint.

•Upper curve: Precipitating electron energy flux "near" WIND footprint.
Lower curves: Measured plasma sheet electron energy flux mapped to the **northern** and **southern** ionosphere.

•Estimated potential drop between the plasma sheet and ionosphere.
$ef_{UVI}/ef_{3DP} = x^2 f_1(K) + x f_2(K) + 1$; $x = q\Phi/kT$



Assumptions

•Don't know **exact** footprint of WIND
Use peak "near" mapped position

=> **Overestimate** UVI energy flux

•But POLAR wobble smears out image
Peak energy fluxes may be reduced by ~ 3

=> **Underestimate** UVI energy flux

•Can't resolve loss cone ($\alpha \leq 1°$)
If loss cone is depleted in the plasma sheet

=> **Overestimate** 3DP energy flux

Summary & Conclusions

•Compare measured electron energy flux in the plasma sheet to precipitating electron energy flux into the ionosphere

=> Up to an order of magnitude discrepancy

•During quiet times, small discrepancy
(UVI sensitivity threshold ~ 1 erg/cm^2/s)

•At onset of auroral activity, electron spectrum in the plasma sheet changes

=> increased kT

=> increased electron energy flux (~ kT$^{3/2}$)

•But still large discrepancy during active aurora

=> energy flux must be entering loss cone

•Parallel potential drop of ~ 1 to 10 kV can account for discrepancy

•Potential drop appears correlated with auroral activity

=> intense aurora

=> increased energy flux into ionosphere

=> larger potential drop

•Change in electron spectrum in the plasma sheet implies that not all of the action occurs at low altitudes

=> What process(es) responsible for change in electron spectrum?

References

Fillingim, M. O., G. K. Parks, L. J. Chen, M. Brittnacher, G. A. Germany, J. F. Spann, D. Larson, and R. P. Lin, Coincident POLAR/UVI and WIND observations of Pseudobreakups, *Geophys. Res. Lett.*, *27*, 1379, 2000.

Fillingim, M. O., G. K. Parks, L. J. Chen, M. McCarthy, J. F. Spann, and R. P. Lin, Comparison of plasma sheet dynamics during pseudobreakups and expansive aurorae, *Phys. Plasmas*, *8*, 1127, 2001.

Parks, G. K., L. J. Chen, M. Fillingim, M. McCarthy, and R. P. Lin, Plasma behavior during pseudobreakup and expansive aurorae, *Proc. 5th International Conference on Substorms*, ESA SP-443, 235, 2000.

Parks, G. K., L. J. Chen, M. Fillingim, and M. McCarthy, Kinetic characterization of plasma sheet dynamics, *Space Sci. Rev.*, *95*, 237, 2001a.

Parks, G. K., L. J. Chen, M. Fillingim, R. P. Lin, D. Larson, and M. McCarthy, A new framework for studying the relationship of aurora and plasma sheet dynamics, *J. Atmos. Terr. Phys.*, in press, 2001b.