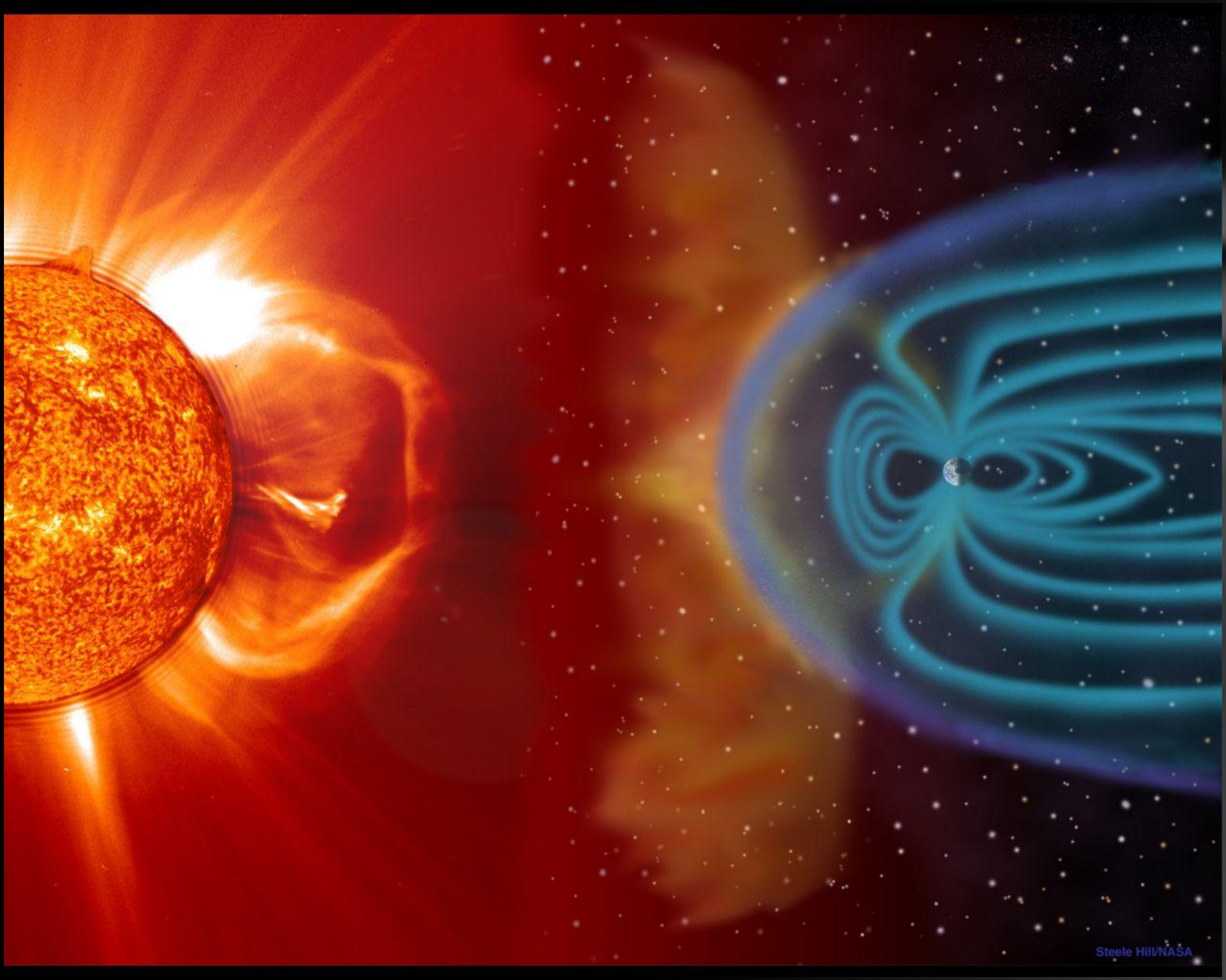
Characteristics of Auroral Precipitation Based on DMSP Observations

Nancy Holden
August 1st, 2012

Mentors:
Barbara Emery
Astrid Maute
Wen-Bin Wang

Sun-Earth System

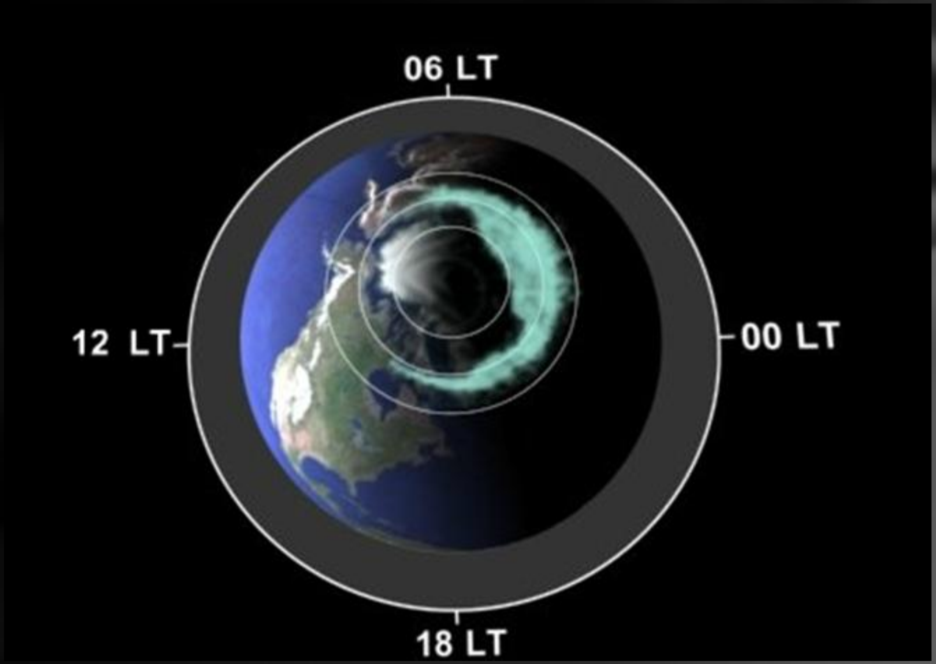


Sun-Earth System

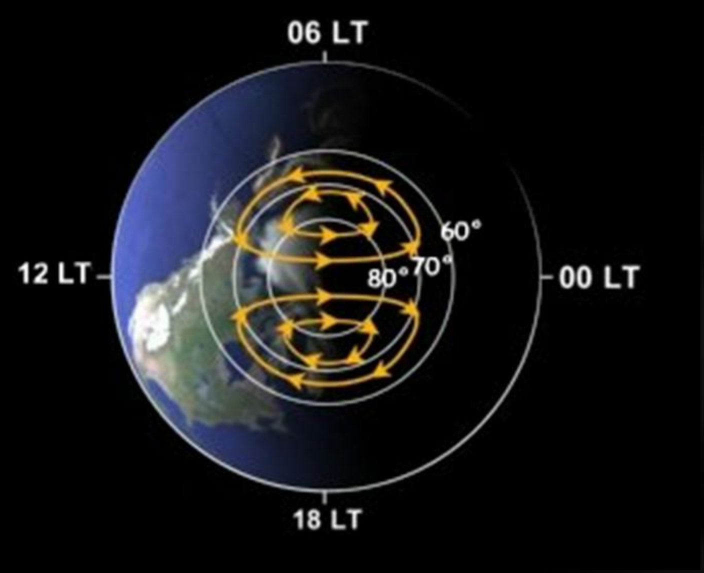
Magnetic Latitude (MLAT): Radial coordinate

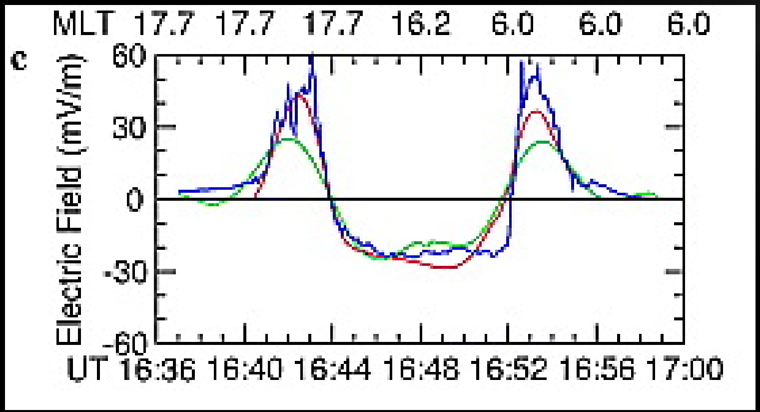
- Geomagnetic and geographic pole don't align

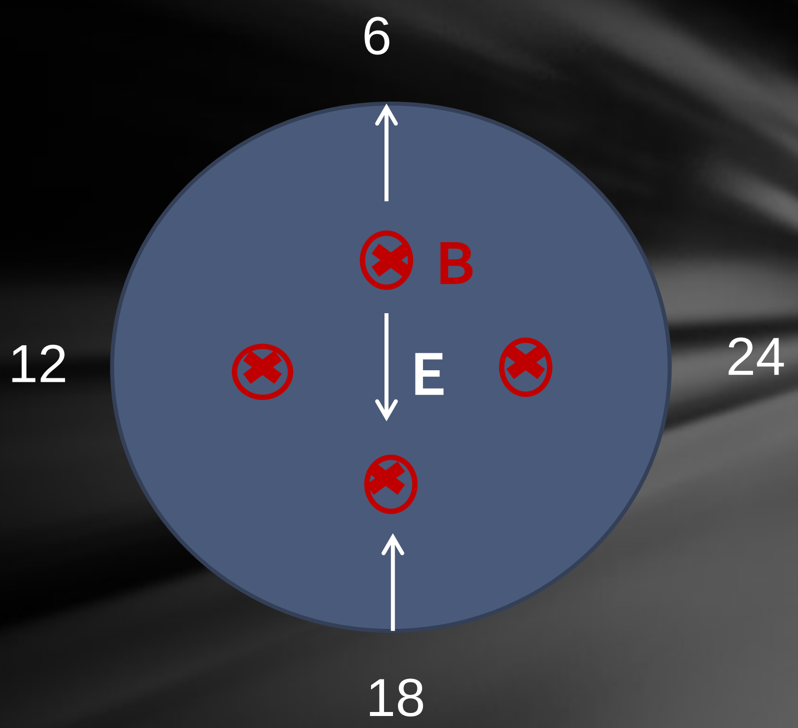
Magnetic Local Time (MLT): Angular Coordinate



Sun-Earth System





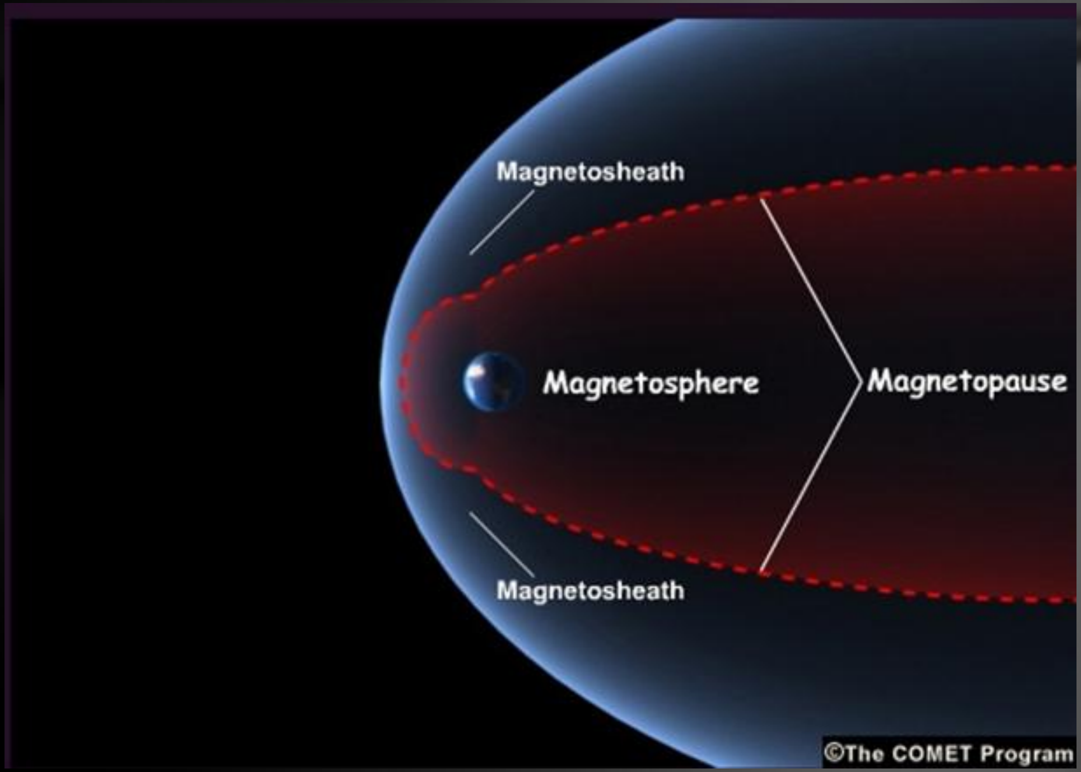


E x B gives direction of ion drift velocity (v_i)

Characteristics of the Aurora

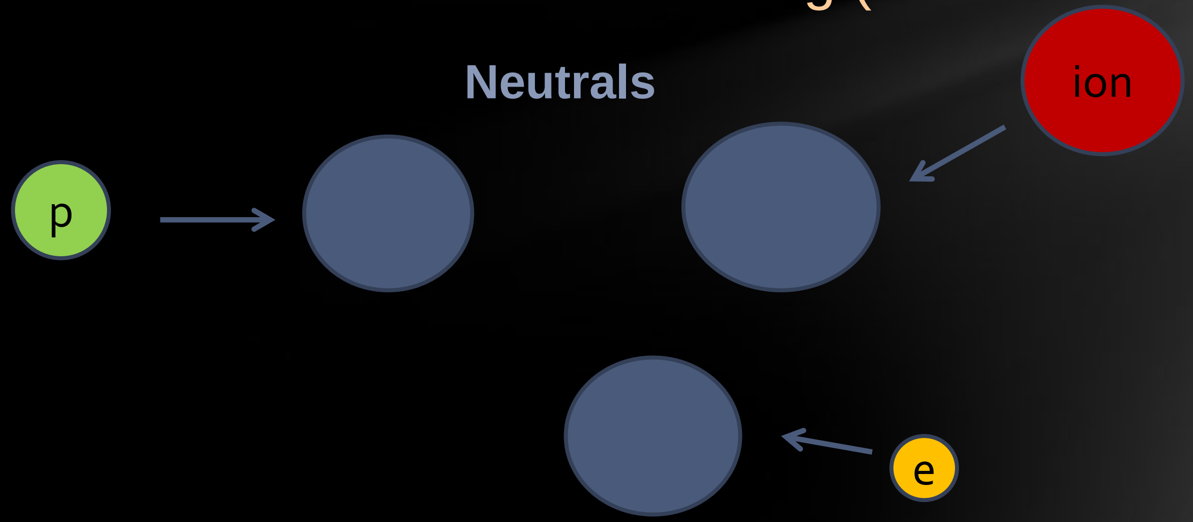
- Ion Convection: Magnetospheric convection that carries plasma and magnetic field lines from the dayside magnetopause into the magnetotail and back again
- Ion Convection:

  Ions of O, N_2, O_2, etc



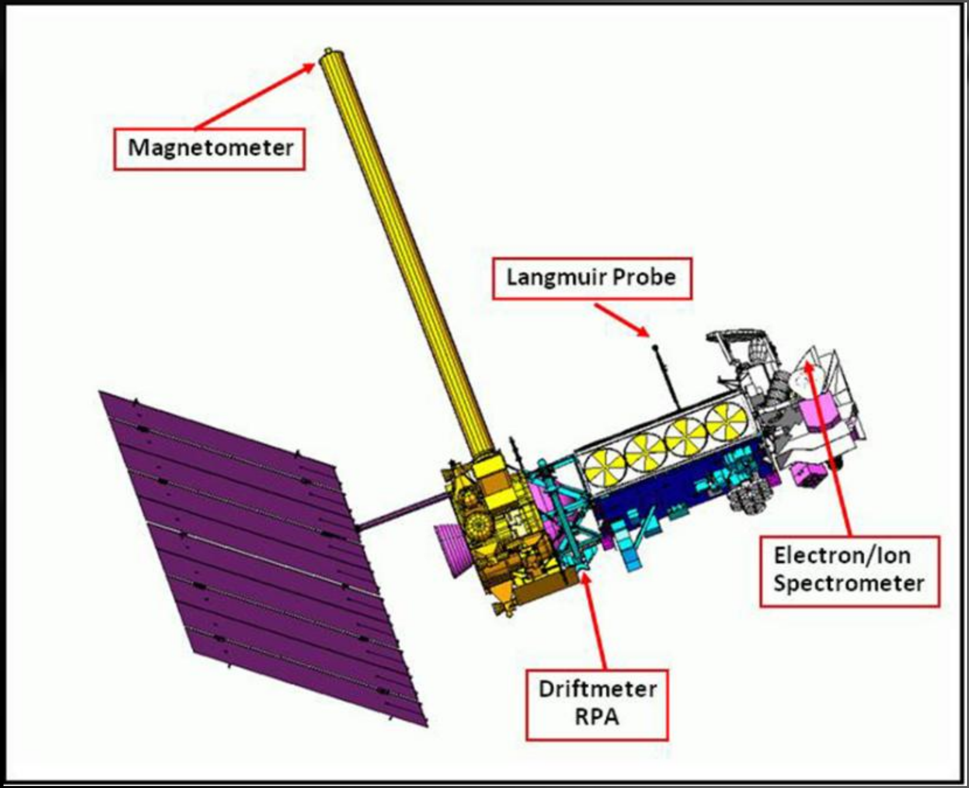
Characteristics of the Aurora

- Auroral Particle Precipitation: e- and p+
- Electron Energy Flux: Corresponds to how much electron energy comes into the atmosphere
  - Penetrates into atmosphere → increases ion and electron density
  - More collisions between ions and neutrals
  - Increases frictional heating (Joule Heating)

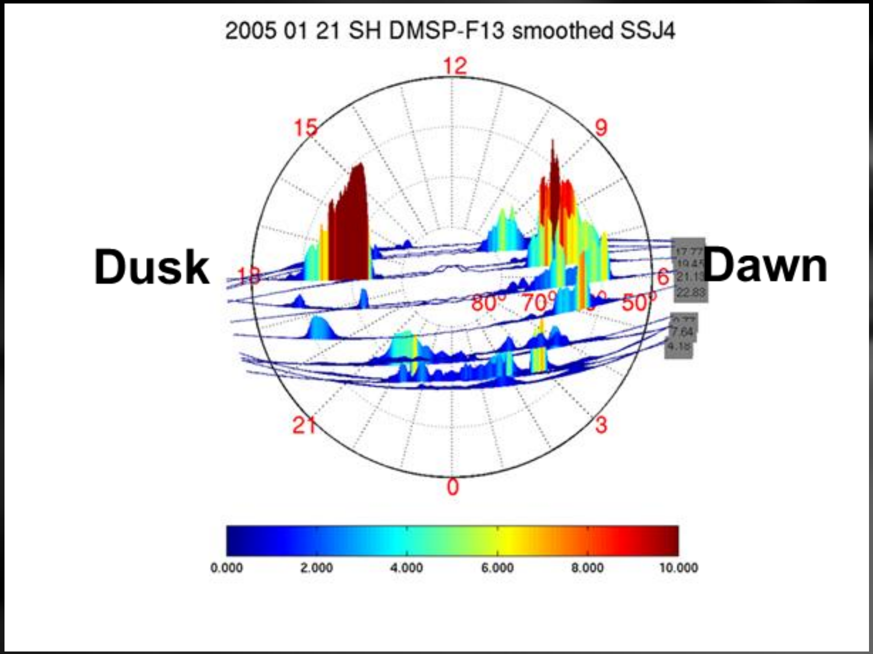


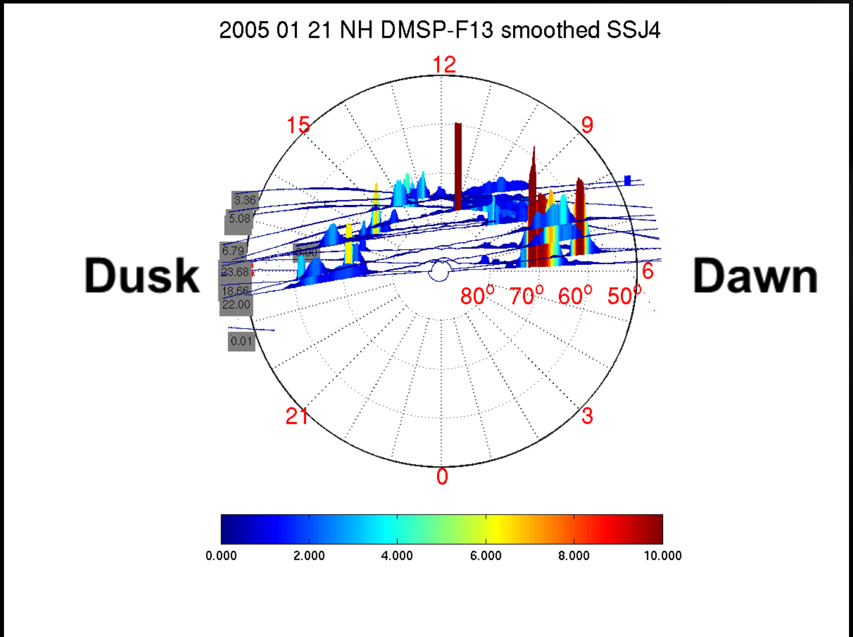
Codes and Instruments Used

- DMSP (Defense Meteorological Satellite Program) F13 Satellite
  - SSJ4 Particle Detector
  - IDM (Ion Driftmeter)
- Matlab & Fortran



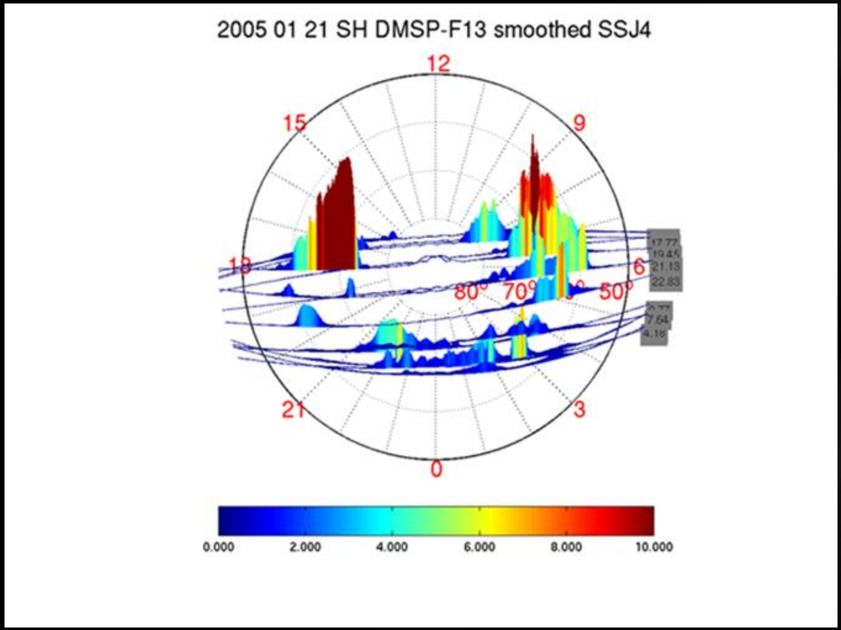
Codes and Instruments Used



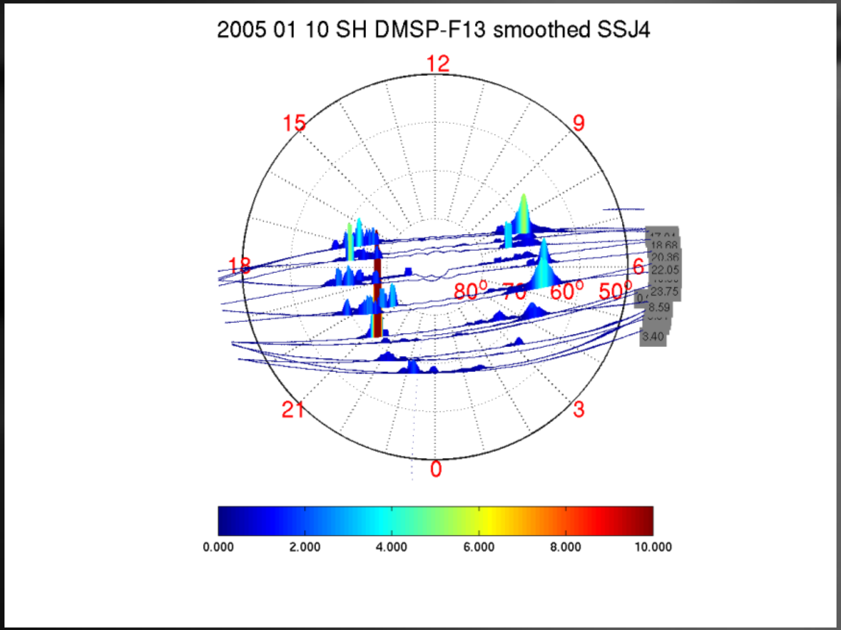


Data Analysis

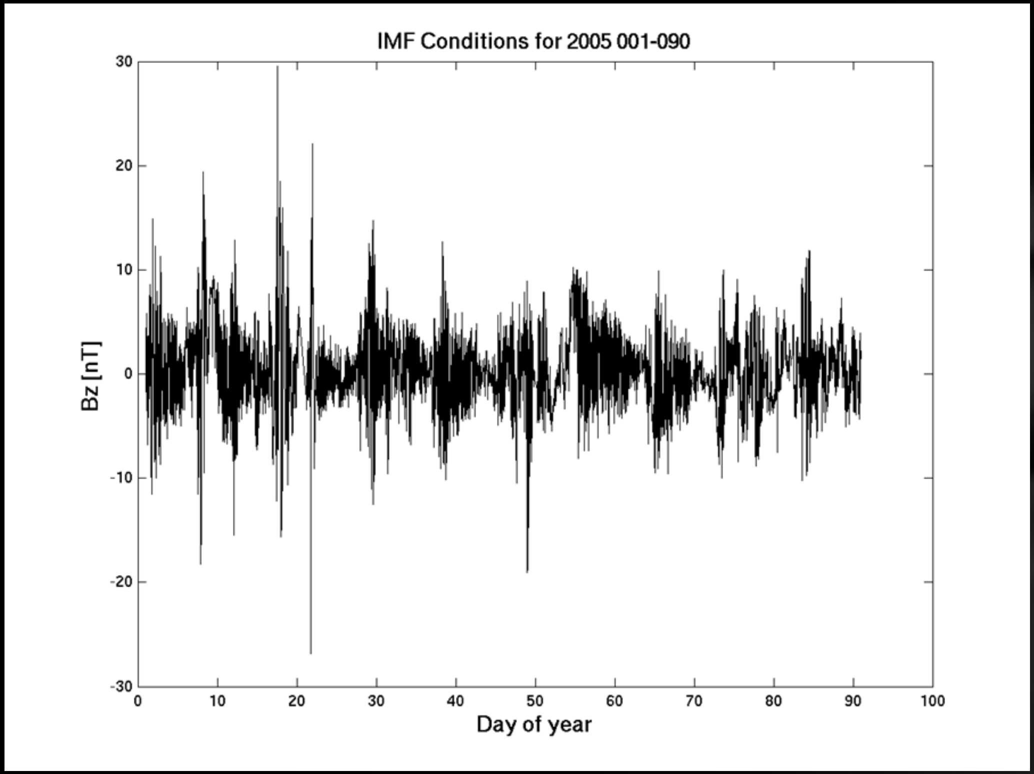
Day of a Storm



Calm Day



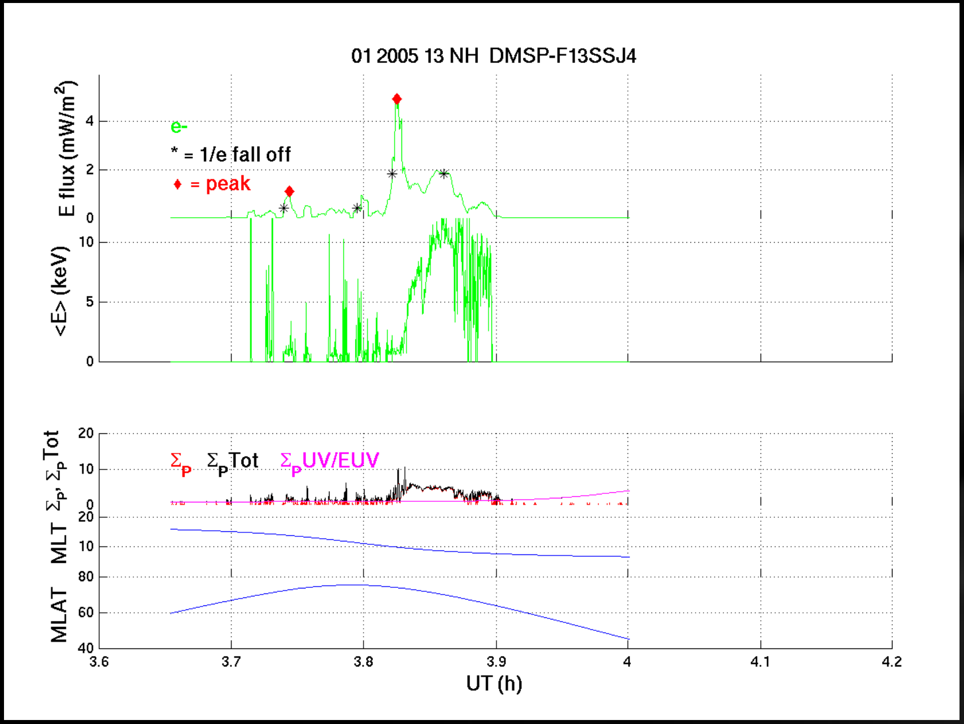
Data Analysis: -Bz Conditions



OMNI Data

- 5 minute data
- Compensate for travel time between OMNI measurement and ionosphere by averaging data between 5-20 minutes before time considered

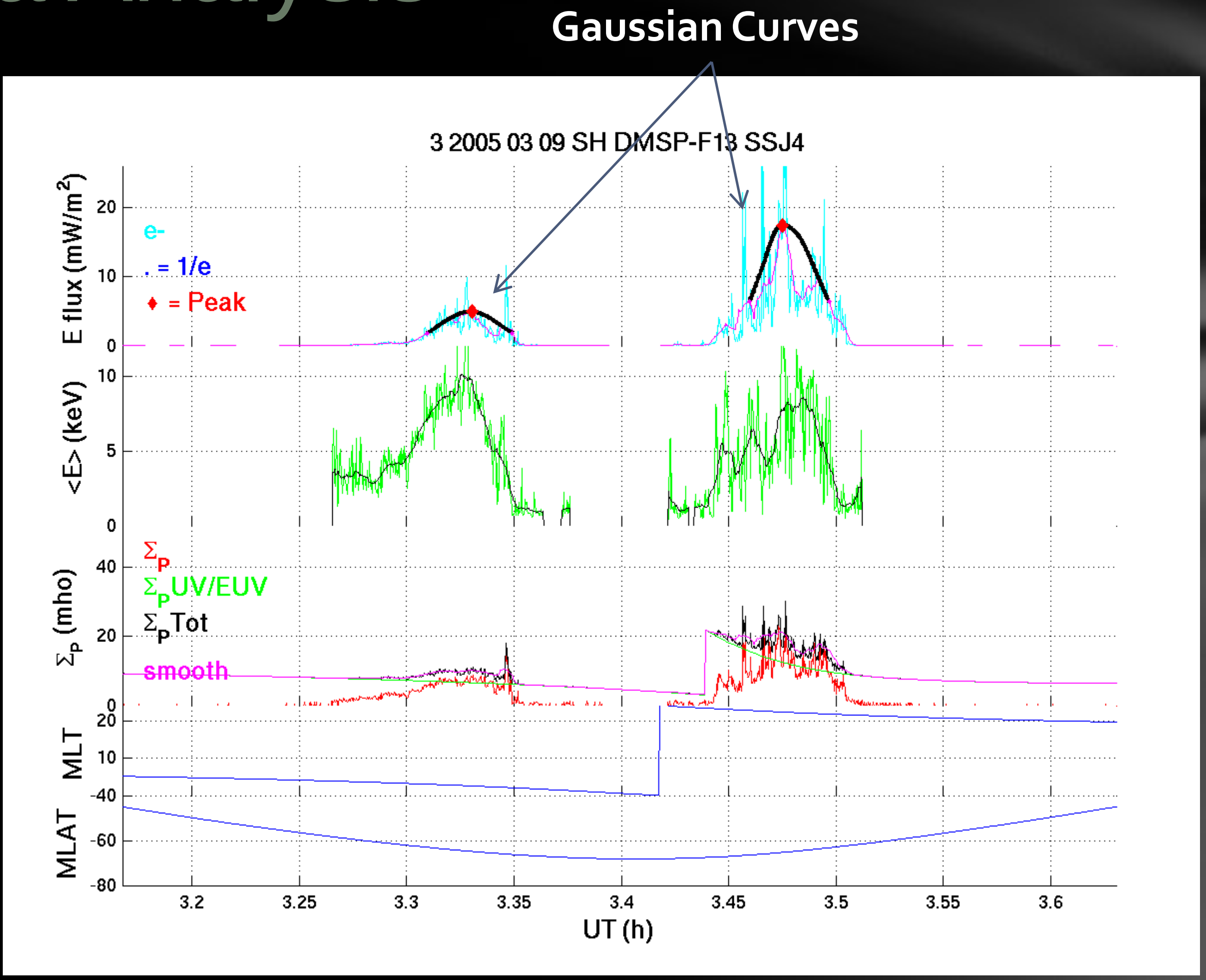
Data Analysis



Single DMSP pass

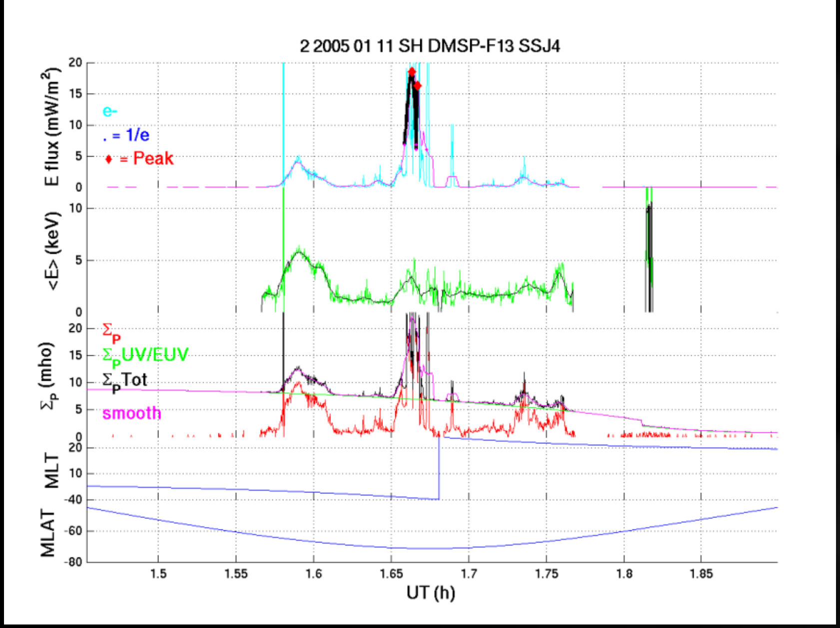
- Peaks in electron energy flux with corresponding equatorward and poleward fall offs
- Mean Energy
- Conductivities

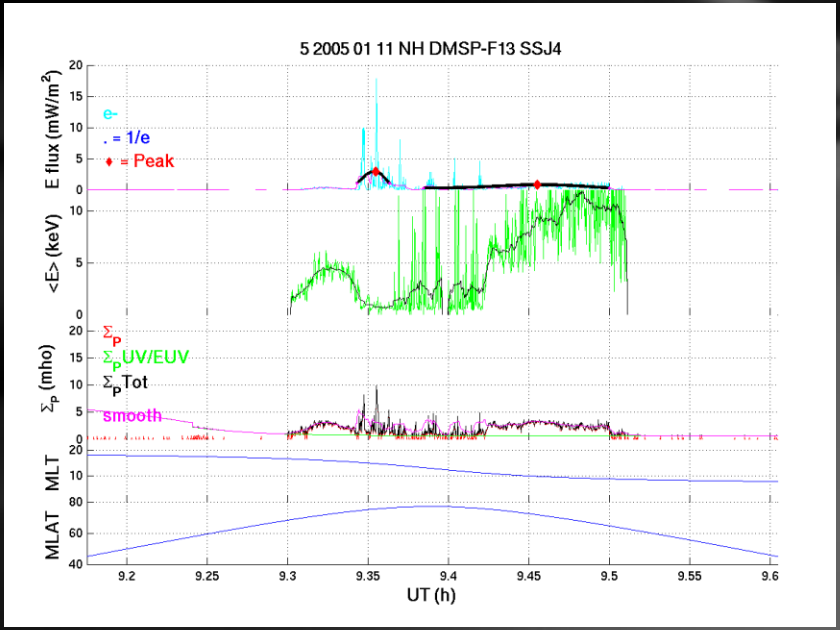
Data Analysis



Data Analysis

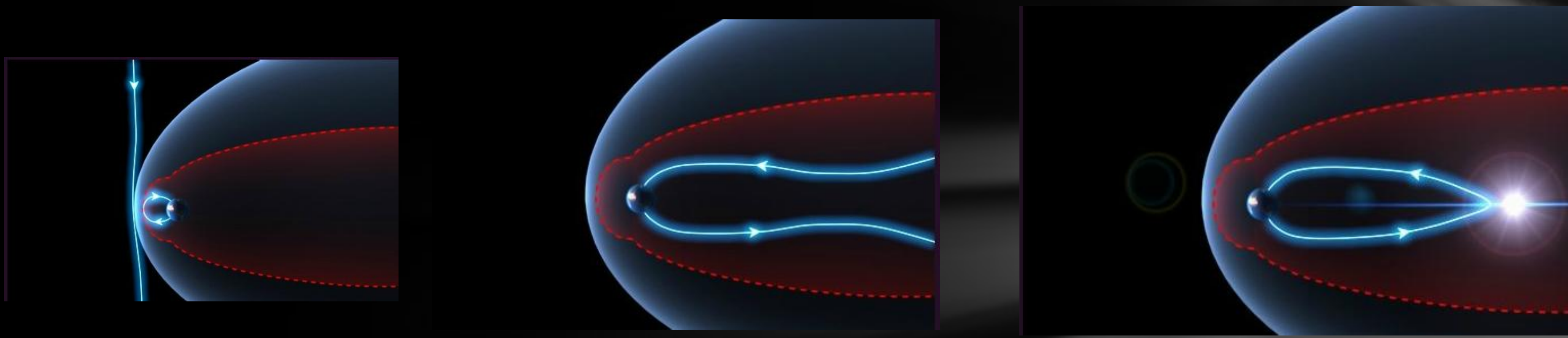
Disregarded Data



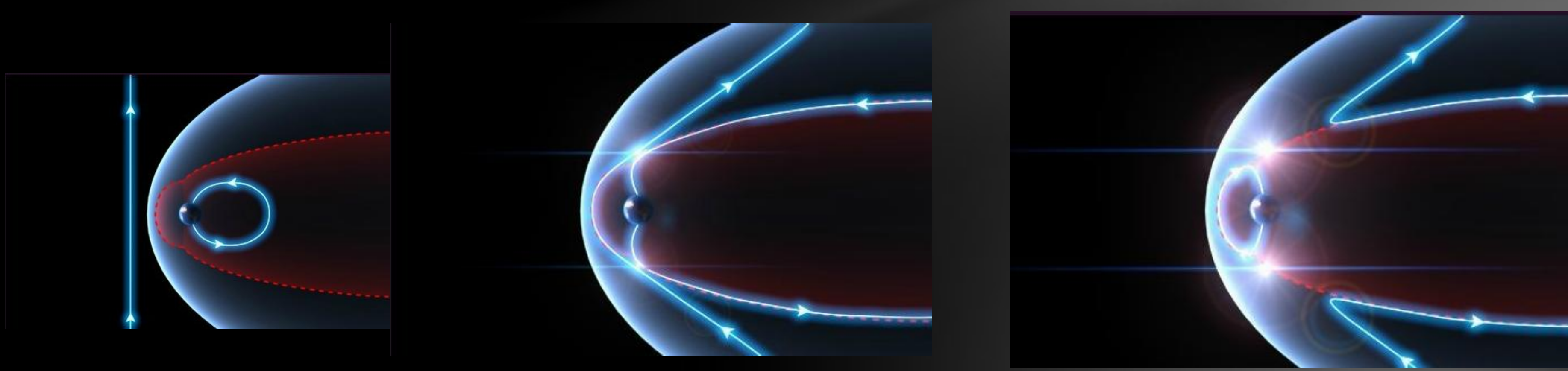


Comparing with Bz Conditions

Bz Negative



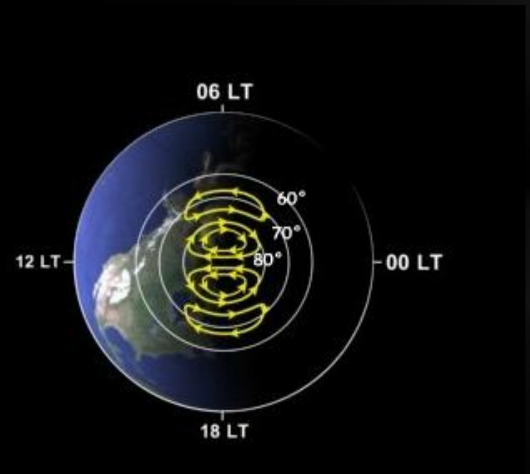
Bz Positive



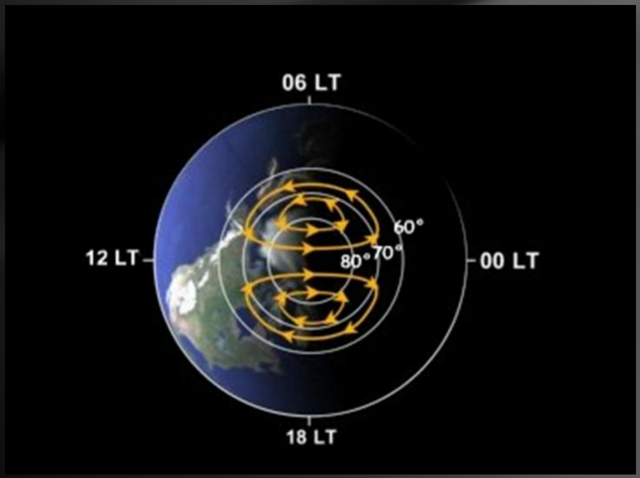
Comparing Bz Conditions

Differences in Ionospheric Convection Pattern

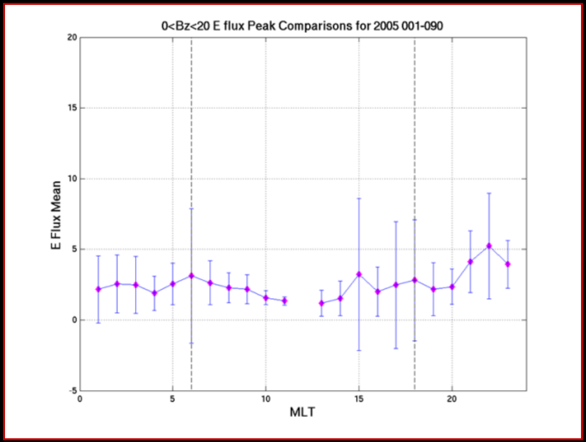
Bz positive

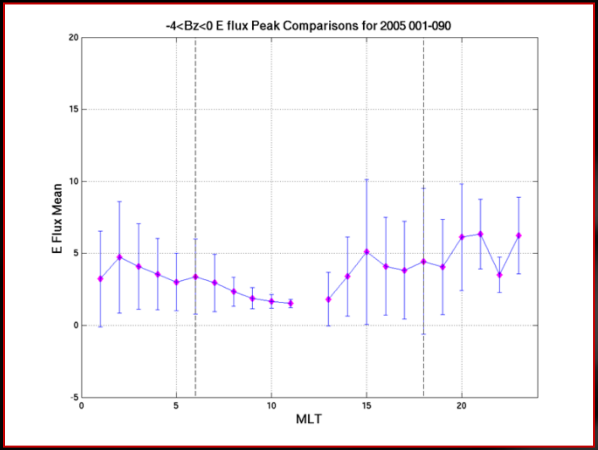


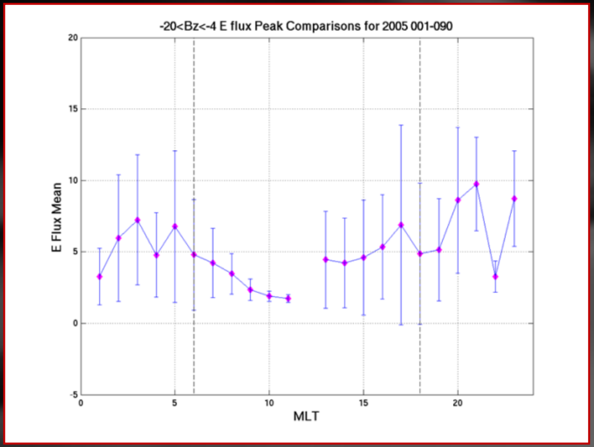
Bz negative



Comparing with Bz Conditions

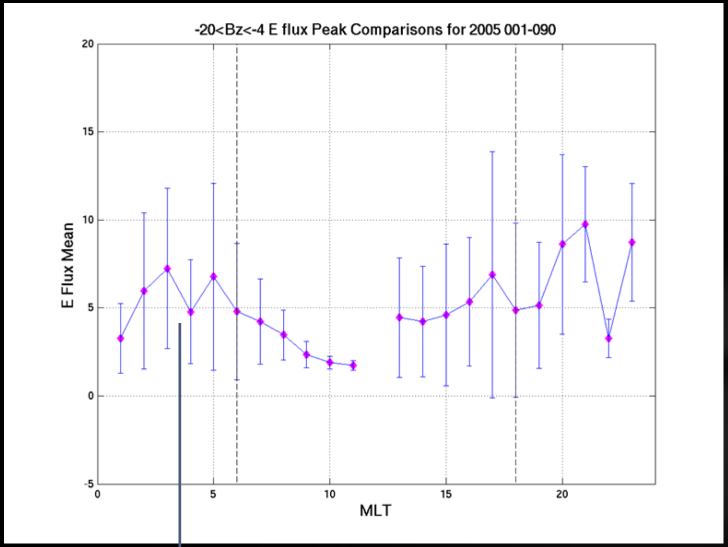


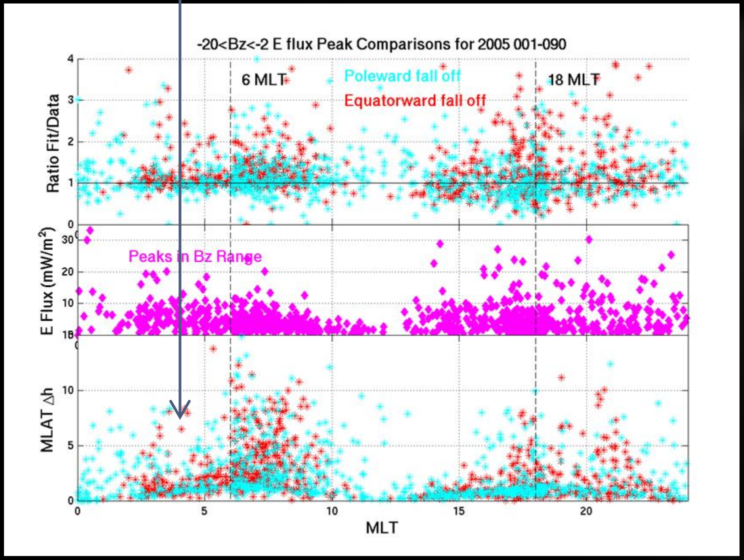




- As Bz becomes more negative, the mean energy flux increases
- Peaks in energy flux appear shifted towards midnight

Peak and MLAT Delta h Relationship



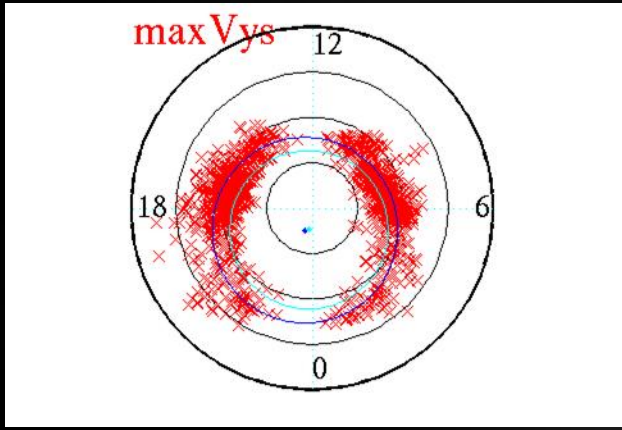


Large peaks in electron energy flux correspond to small delta h values

Next Step

Integrating results with Ion Driftmeter data

- To compare relative peak positions of electron energy flux with those of ion drift
- Alignment of relative peak positions of ion drift and energy flux will give regions of optimum energy input



Eventually…

- Joule Heating
- Find E field
  - Electron drift velocity proportional to $\vec{E} \times \vec{B}$
  - Use IGRF model
- Calculate Joule Heating
  - $q_j = j\,E = \Sigma_P * E^2$

Conclusions

- Small MLAT delta h values tend to correspond to large electron energy peaks and large MLAT delta h values tend to correspond to small peaks. This suggests sharp fall-offs for large peak values and a slower, more gradual fall-off for smaller peaks in electron flux.
- Trends show the average electron energy flux often peaks at pre-midnight
- Mean electron energy flux for –Bz conditions tend to be larger than for +Bz conditions
- Further study using more data and considering various geophysical conditions must be considered in order to verify these results and eventually calculate Joule heating

References

G. R. Wilson, W. J. Burke, D. Knipp, and K. A. Drake, Using DMSP data to quantify the energy input to the upper atmosphere.

Hardy, D. A., W. McNeil, M. S. Gussenhoven, D. Brautigam, 1991. A statistical model of auroral ion precipitation, 2. Functional representation of the average patterns. *J. Geophys. Res.*, **96**, 5539–5547.

Rich, Frederick J., Gussenhoven, M. S., Greenspan, Marian E., 1987. Using simultaneous particle and field observations on a low altitude satellite to estimate Joule heat energy flow into the high latitude ionosphere. *Ann. Geophys*., **5**, 527-534.

Robinson, R. M., R. R. Vondrak, K. Miller, T. Dabbs, D. Hardy, 1987. On calculating ionospheric conductances from the flux and energy of precipitating electrons. *J. Geophys. Res*., **92**, 2565–2569.

Questions?