Intense Poynting flux observed at very high latitude during magnetic storms

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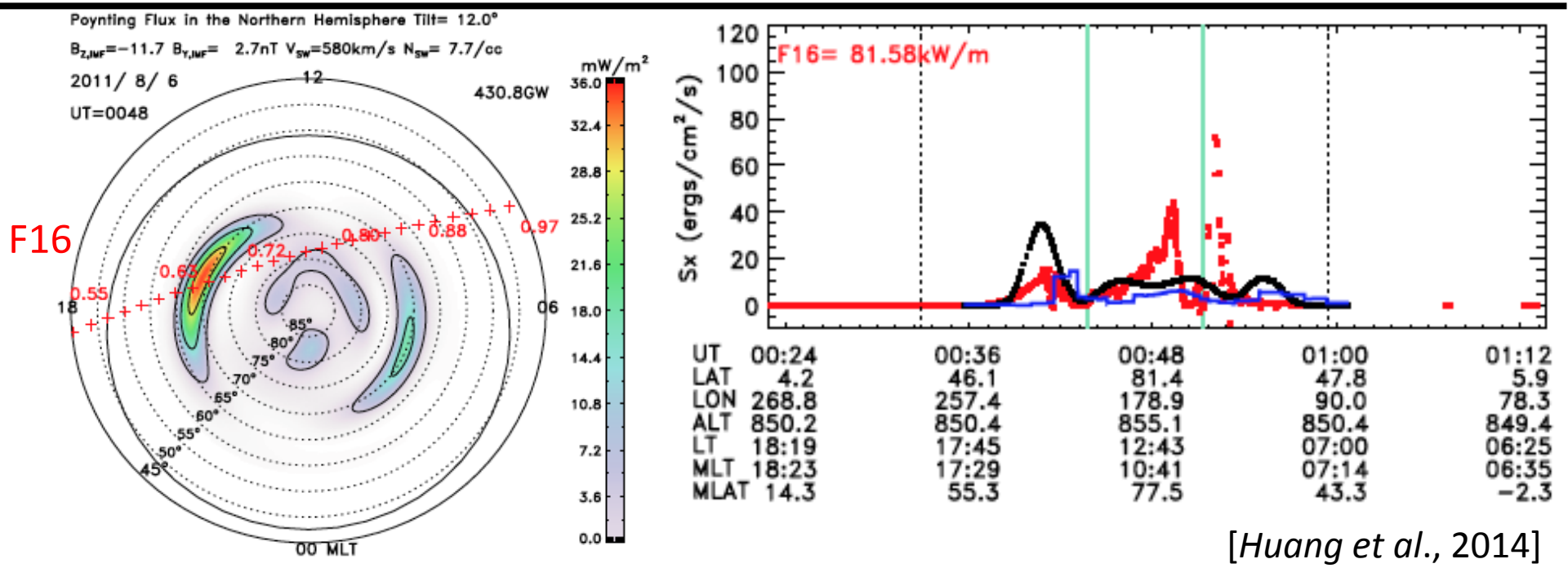
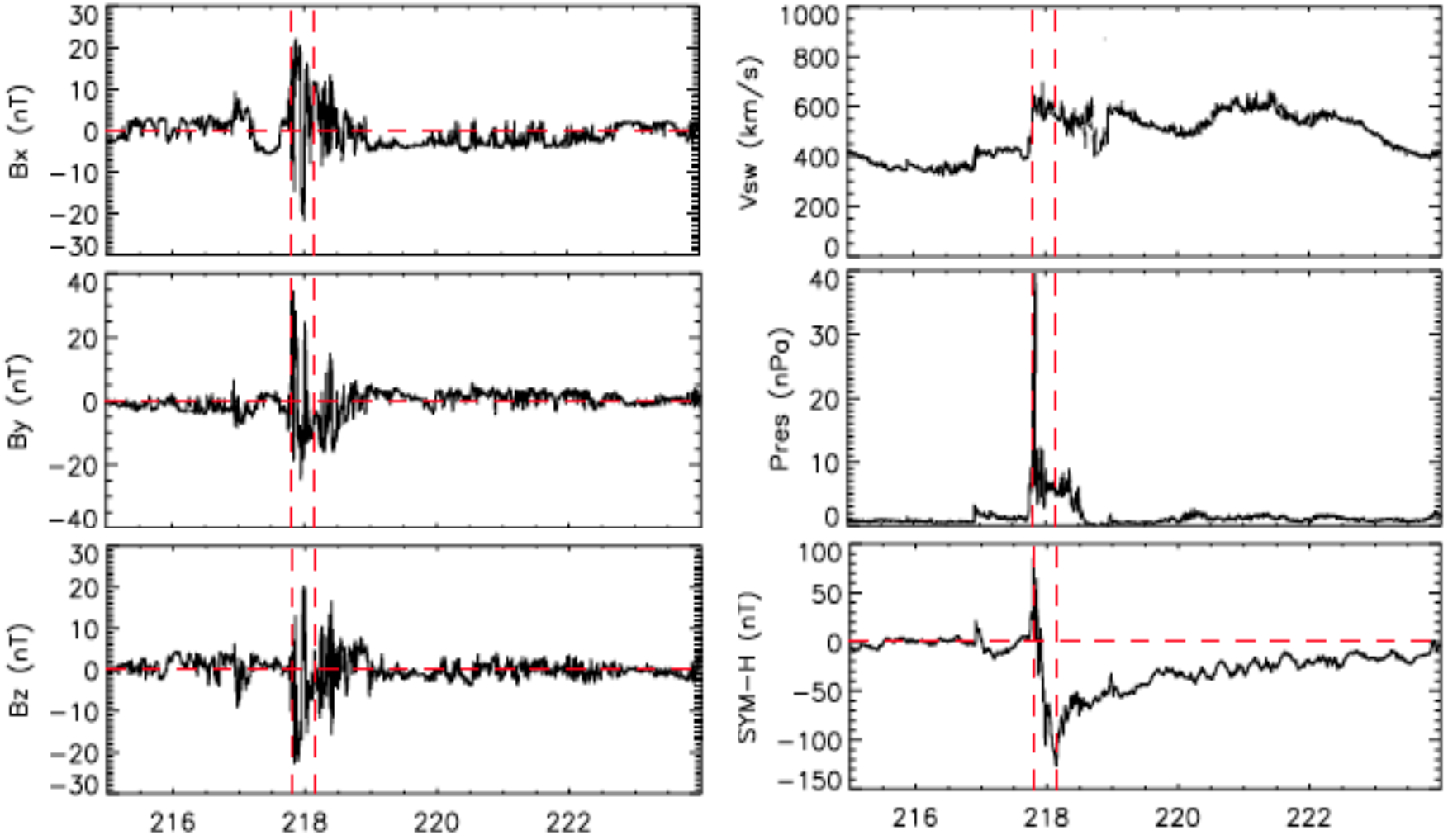
Weimer05 vs DMSP of Poynting Flux



[*Huang et al.*, 2014]

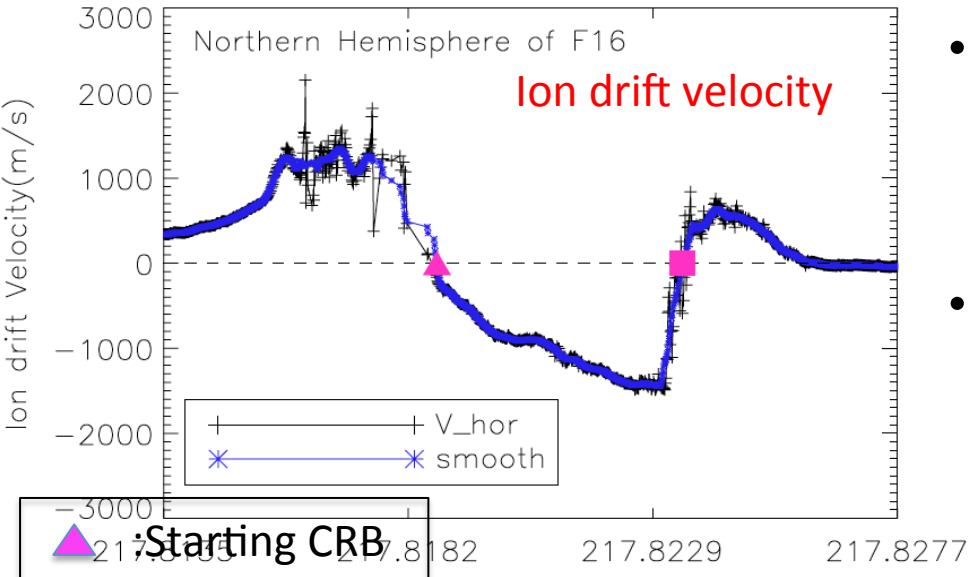
- August 2011 storm, main phase, northern hemisphere (NH).
- Disagreement of magnitude and location.
- Clear enhancement of Poynting Flux inside ion flow reversal boudaries, which is missed by empirical model simulation.
- Question: where does the EM energy deposit during the main phase of magnetic storms?

Solar wind and IMF conditions



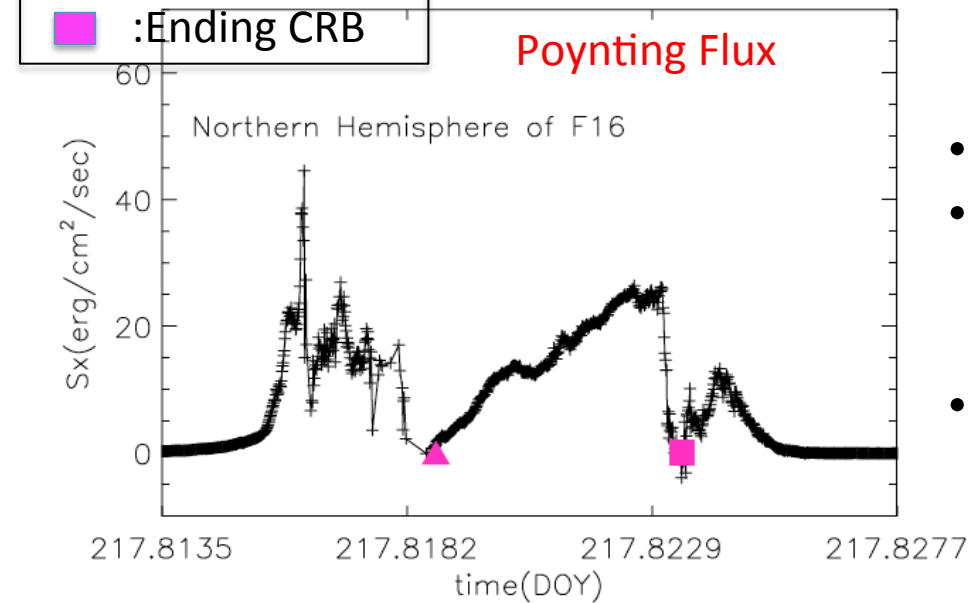
- August 5, 2011 storm: moderate storm with enhanced solar wind pressure. Main phase is between the two vertical red lines.

Indication of Polar cap area: Convection Reversal Boundaries (CRBs)



:Starting CRB

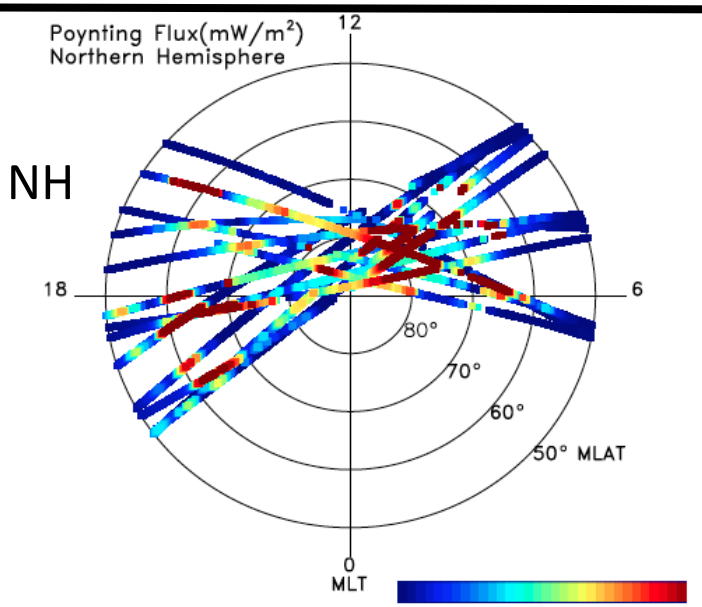
:Ending CRB

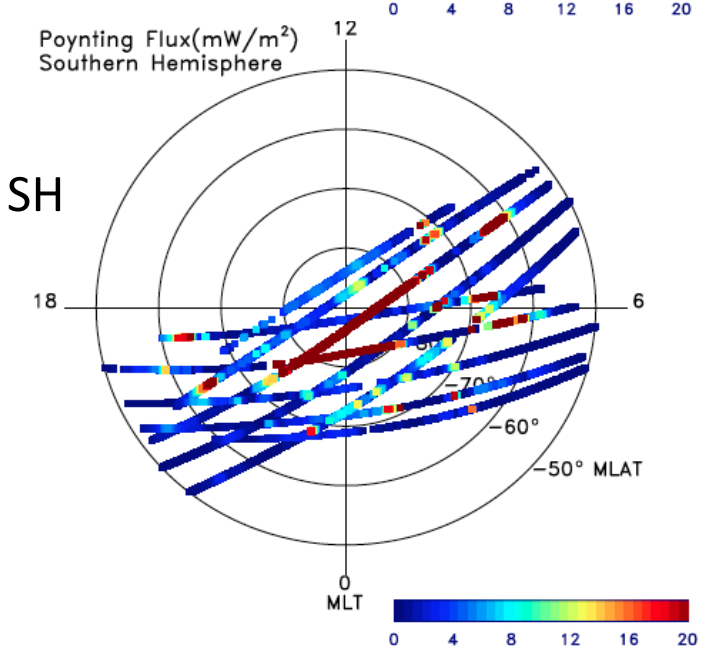


- Black plus signs: ion drift velocity measured along a path of DMSP F16 over the northern hemisphere during main phase of August 5, 2011 storm.
- Blue line: smoothed velocity using a moving window of 20 secs.
  - Sunward: auroral zone
  - Anti-sunward: polar cap

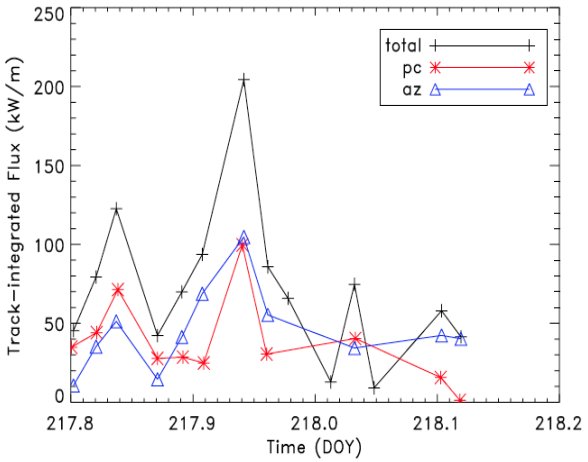
- Clear correlation of drift velocity and PF.
- Strong PF is located poleward of CRBs that correlates with the anti-sunward flow in this region.
- PF is intense where the flow is strong, and is weak where the flow reversals.

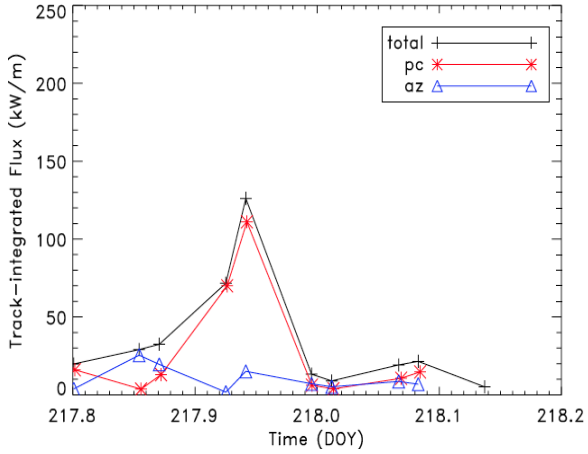
Track-integrated Poynting Flux(TIPF)



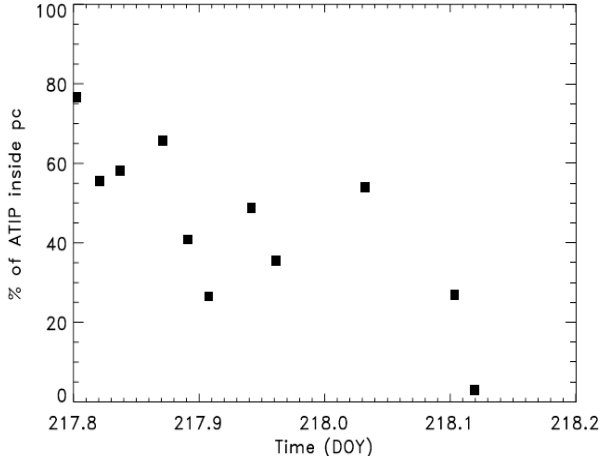


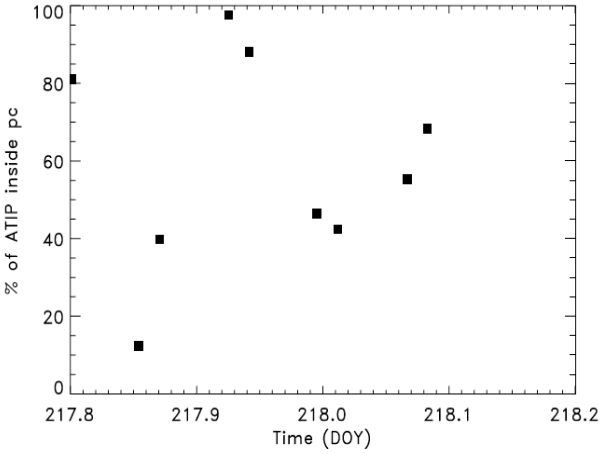
TIPF



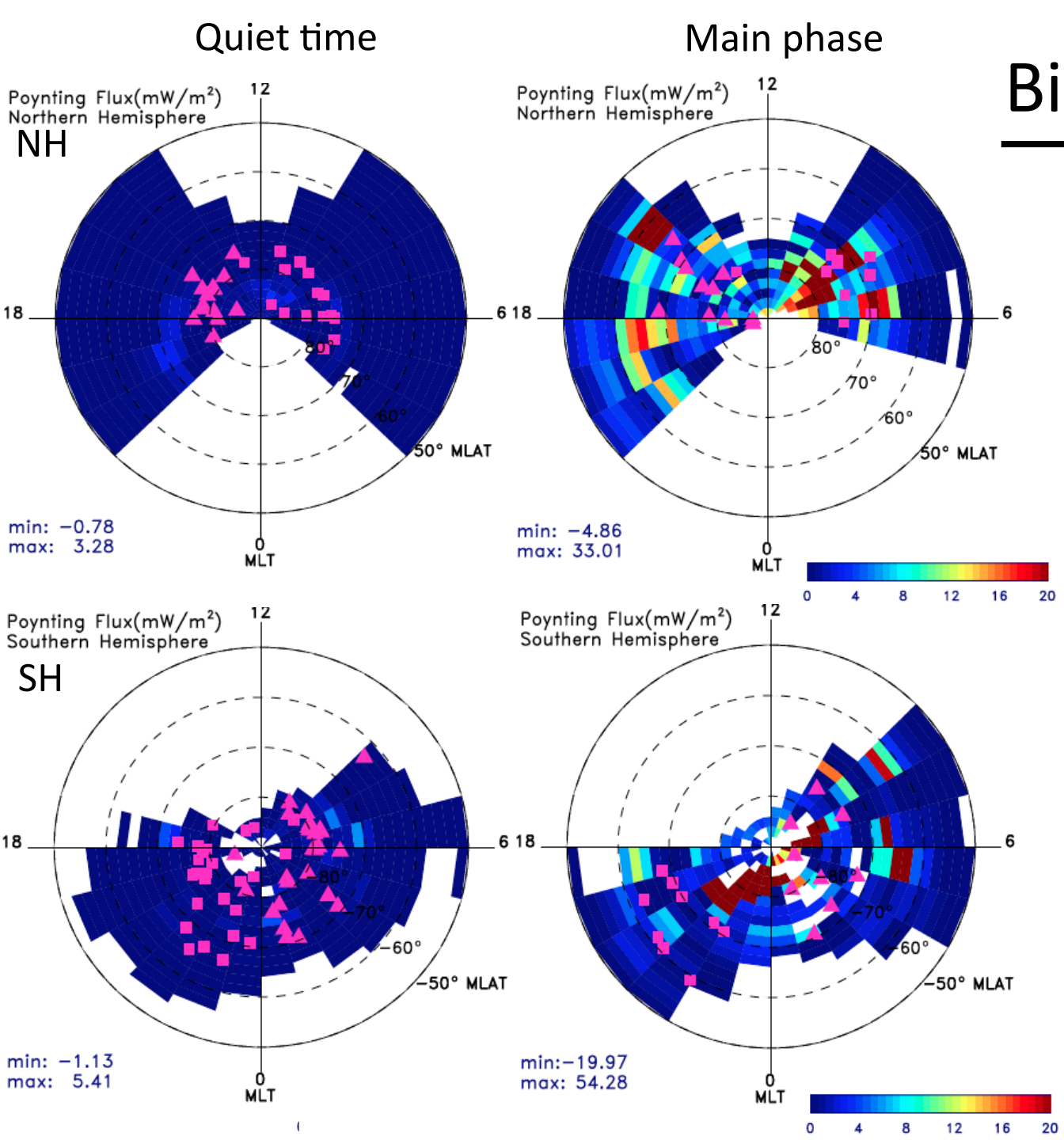


% of TIPF in polar cap





- Clearly enhanced PF in polar cap (F15, 16, 18).
- Percentage of PF inside polar cap is not negligible .



Bin averaged PF

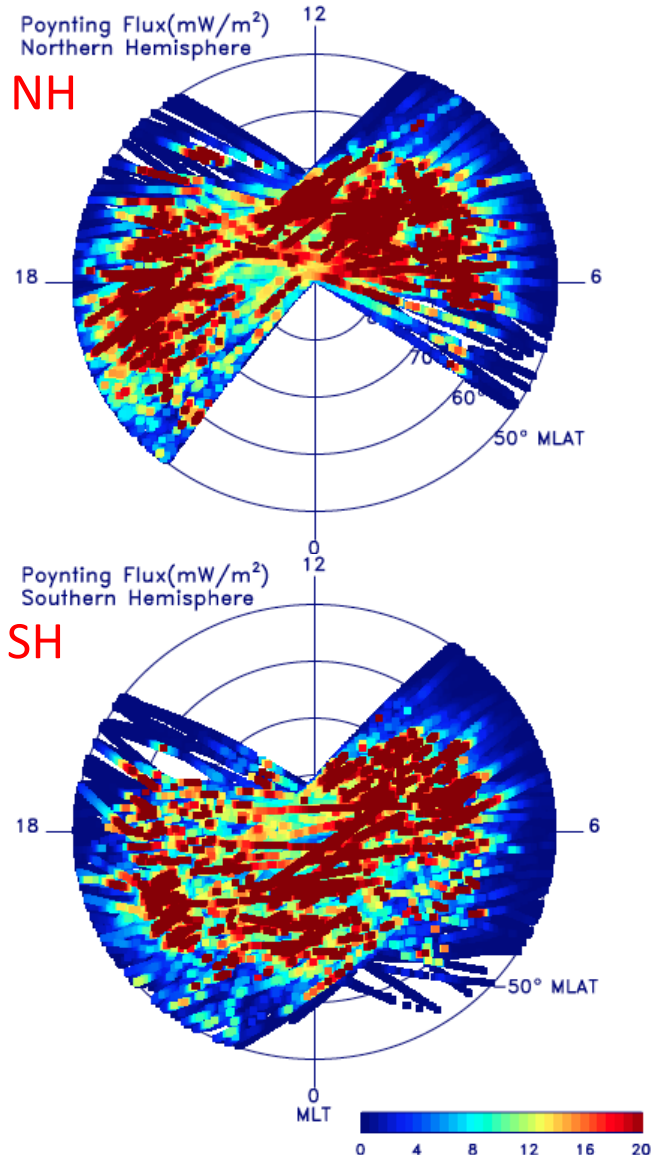
- August 2011 storm, main phase
- DMSP F15, 16, 18
- Bin size:

$$2^\circ \text{ MLAT} \times 1 \text{ hr MLT}$$

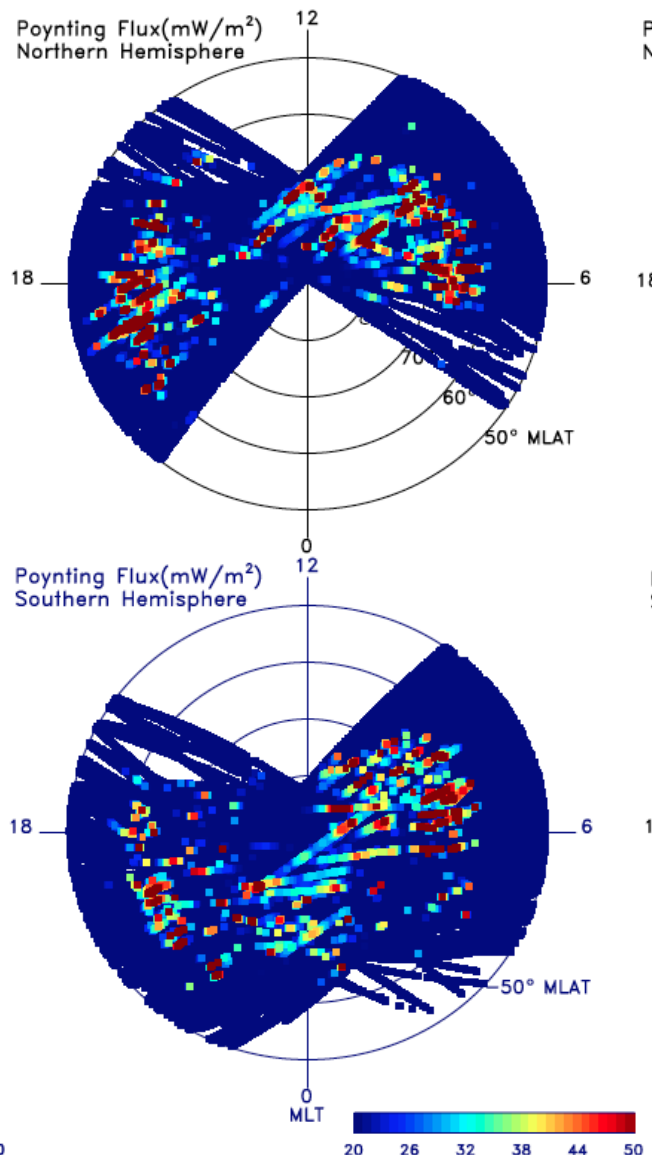
- Clearly enhanced PF poleward of 75 MLat in the dayside and nightside.
- Equator-ward Extended polar cap to 60 MLAT during main phase.

14 moderate storms (-100>Sym-H>-200 nT)

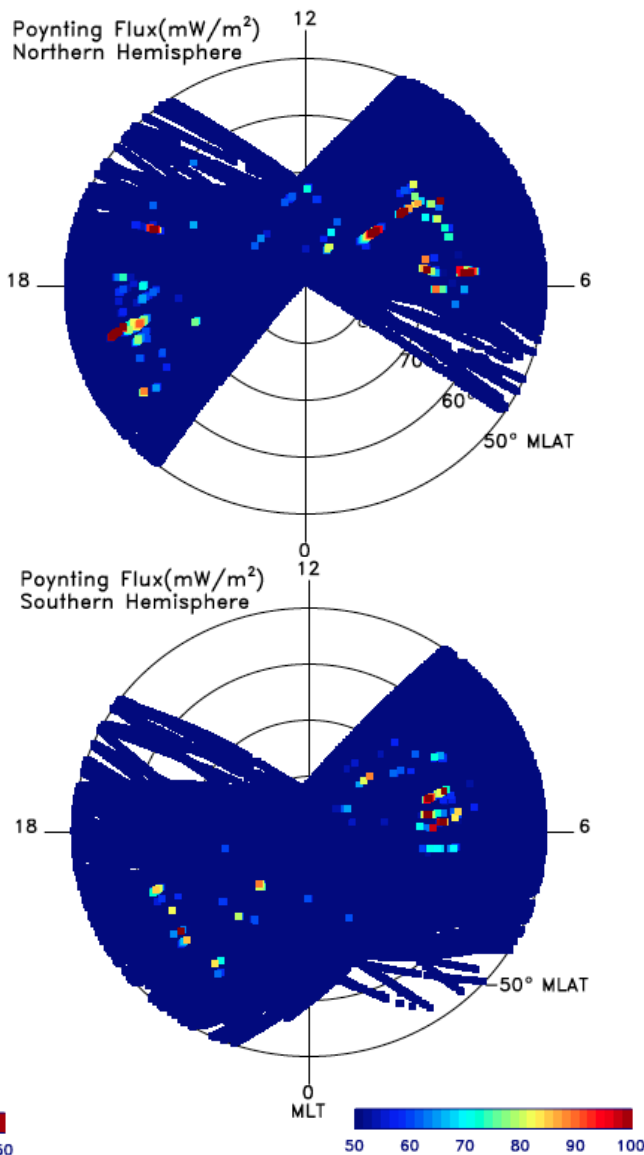
Sx: 0~20 mW/m^2



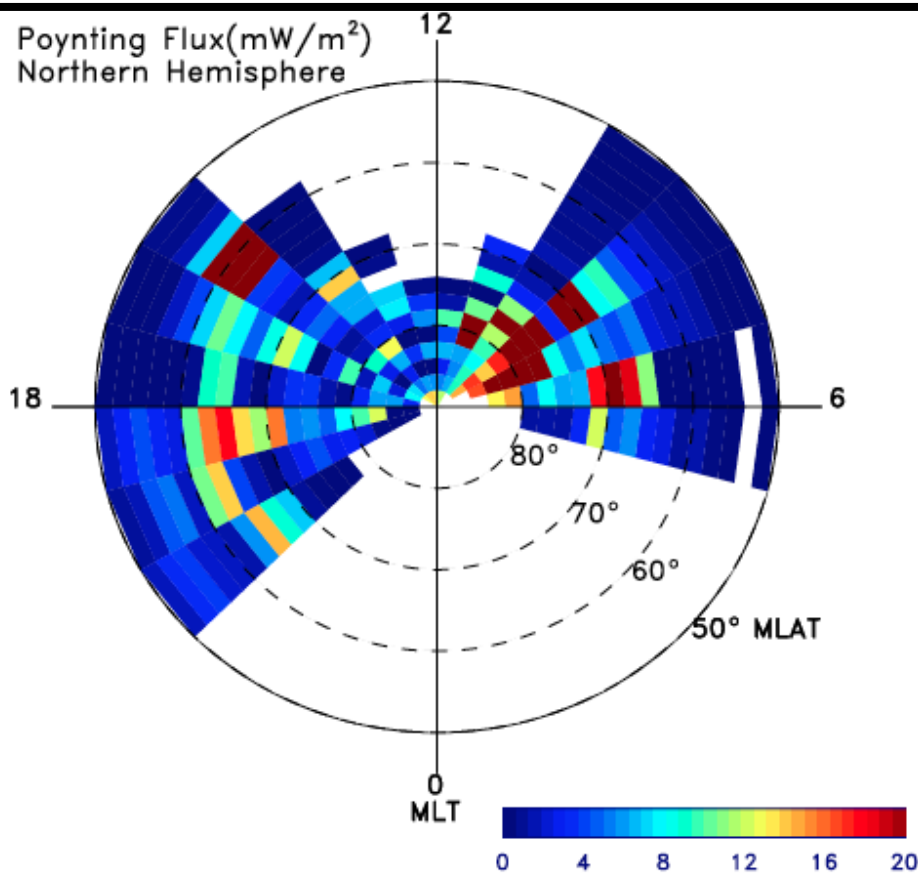
Sx: 20~50 mW/m^2

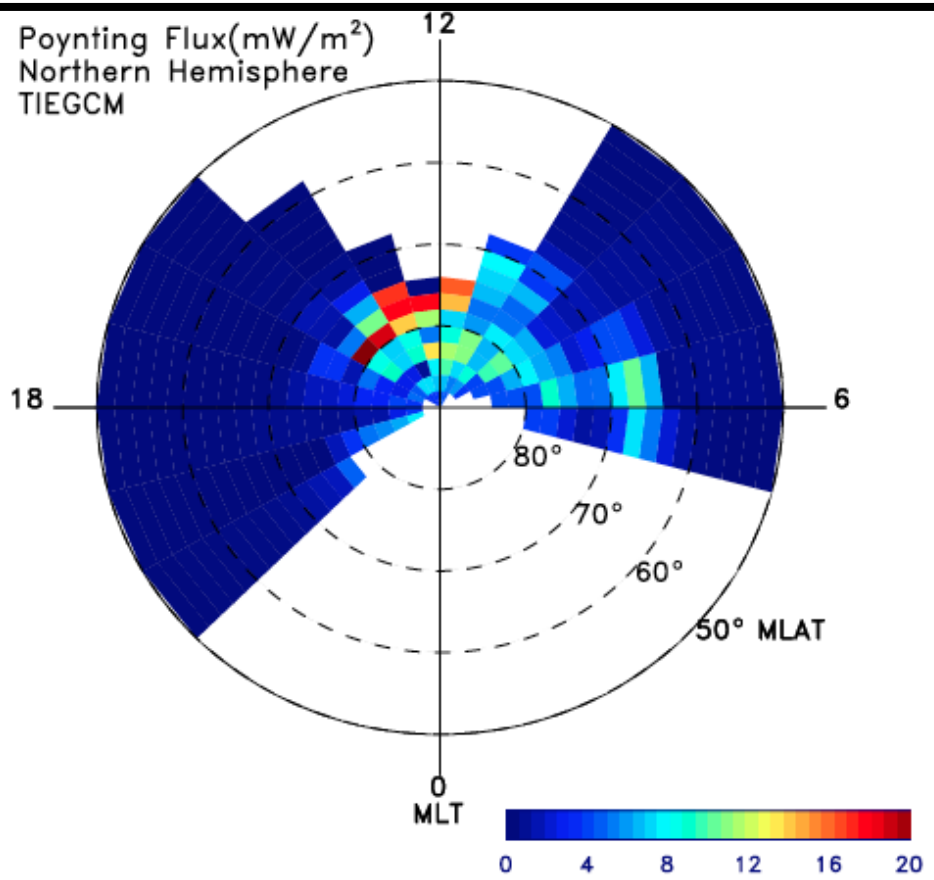


Sx: 50~100 mW/m^2



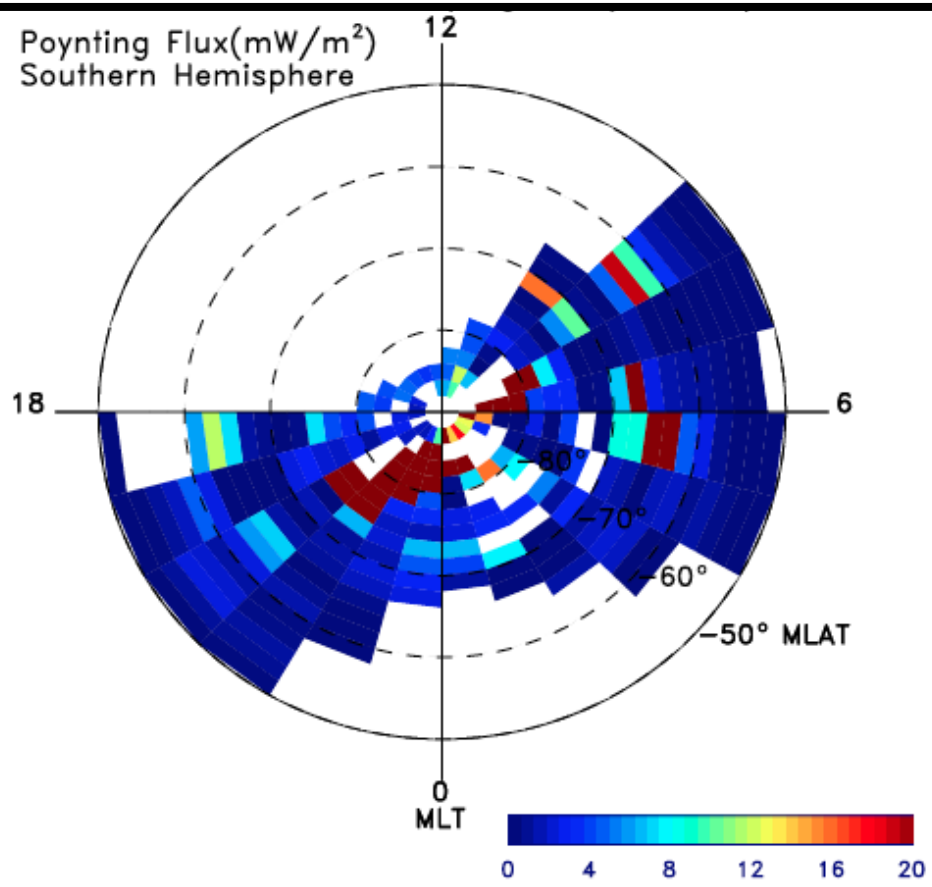
DMSP PF vs TIEGCM Joule heating

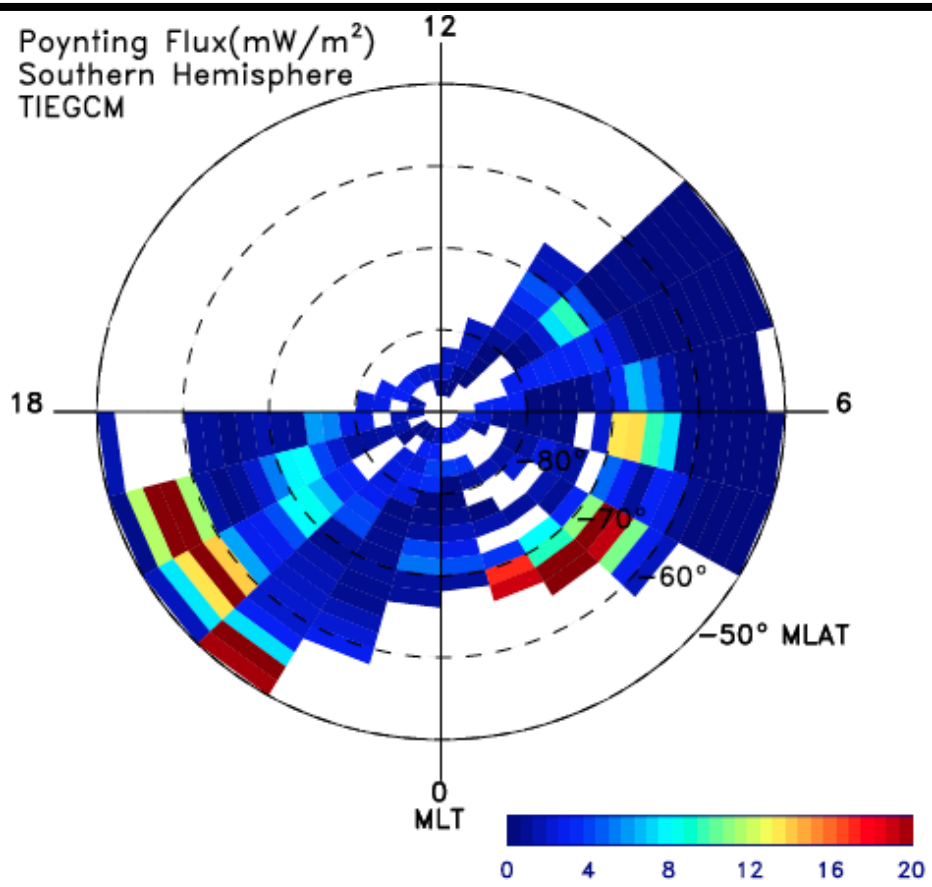




- Bin average of all the DMSP passes in the main phase of August 5, 2011 storm, NH
- TIEGCM Resolution: $5°lat \times 5°lon$
- Different locations, different magnitudes

DMSP PF vs TIEGCM Joule heating





- Bin average of all the DMSP passes in the main phase of August 5, 2011 storm, SH
- No polar cap feature in SH for the model results.

Summary

- We investigated the Poynting Flux measured by DMSP satellites (F15, F16, F18) during magnetic storms.
- We defined the area of polar cap using CRBs.
- Polar cap can extend equator-ward to 60 degree MLat during main phase.
- Clear enhancement of Poynting Flux was found in the polar cap, which is comparable to that in the auroral zone during main phase.
- Track-integrated flux often peaks at polar latitudes.
- Energy enters IT system at all local times in polar cap.
- Improvements are needed in the high-latitude driver of GCMs.

14 moderate storms (-100>Sym-H>-200 nT)

Sx: 0~20 mW/m^2

Sx: 0~50 mW/m^2

Sx: 0~100 mW/m^2

NH

SH