Poynting flux and particle precipitation in the high-latitudes during geomagnetic storms

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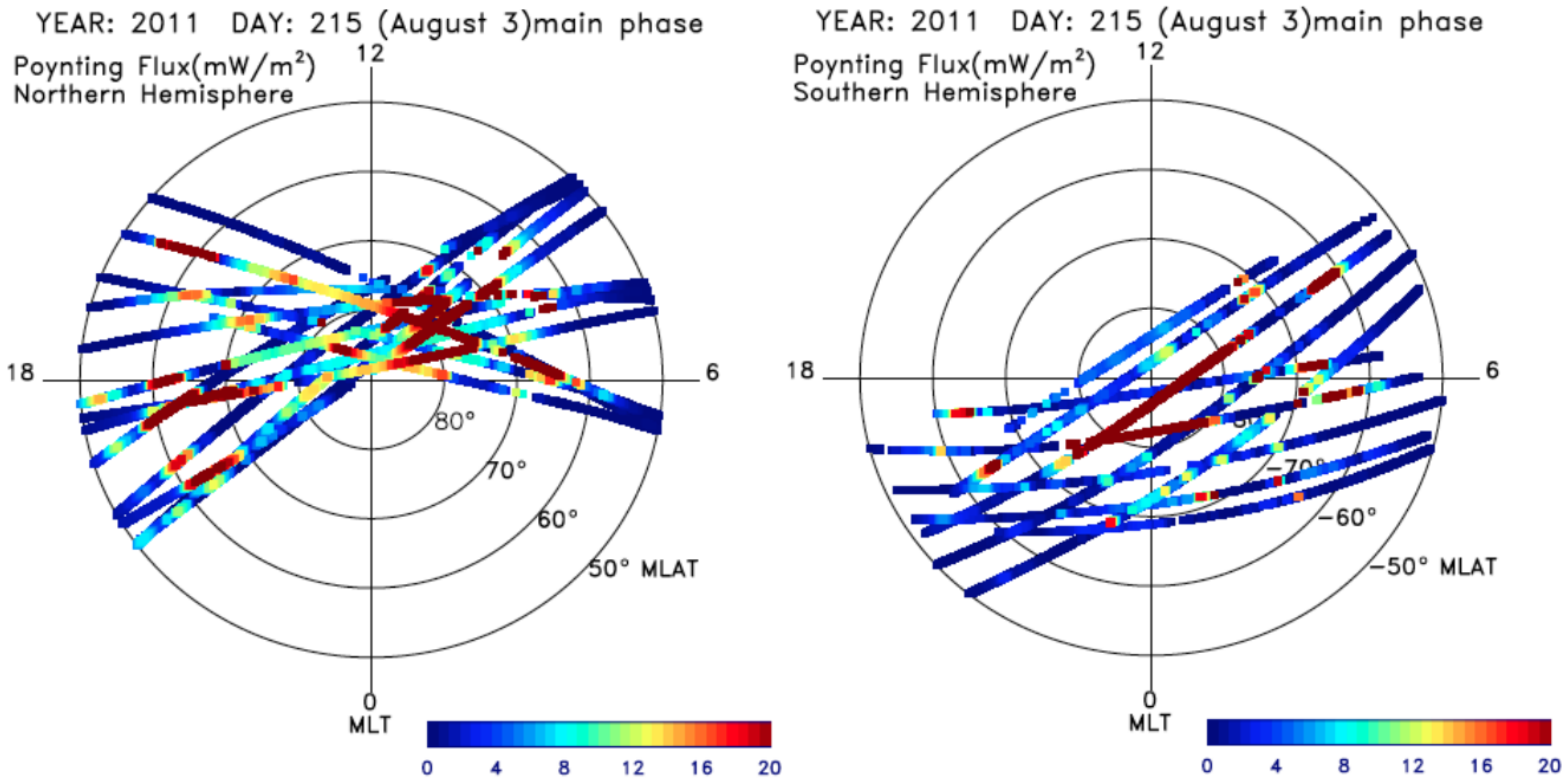
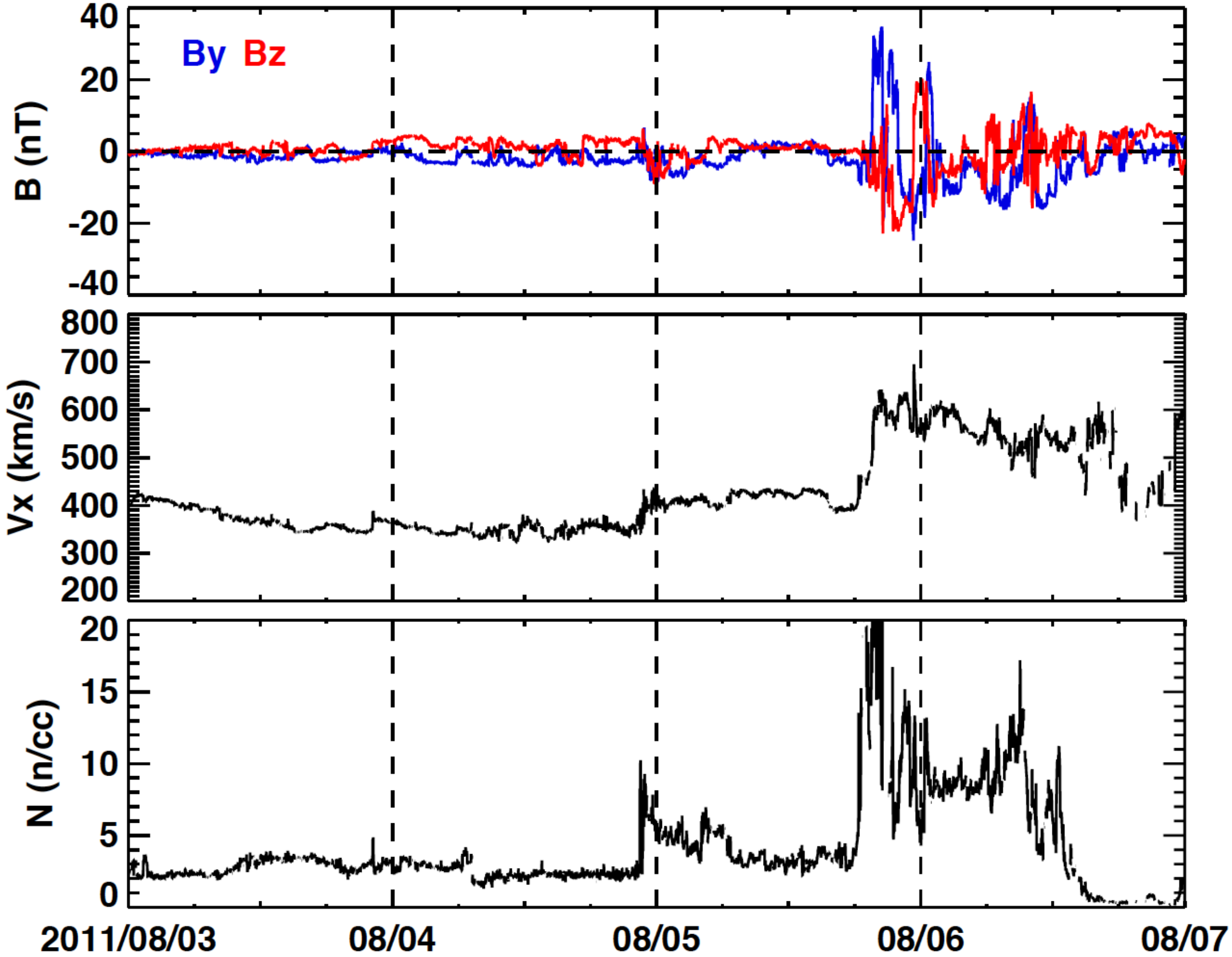
Motivation



Huang et al. 2015

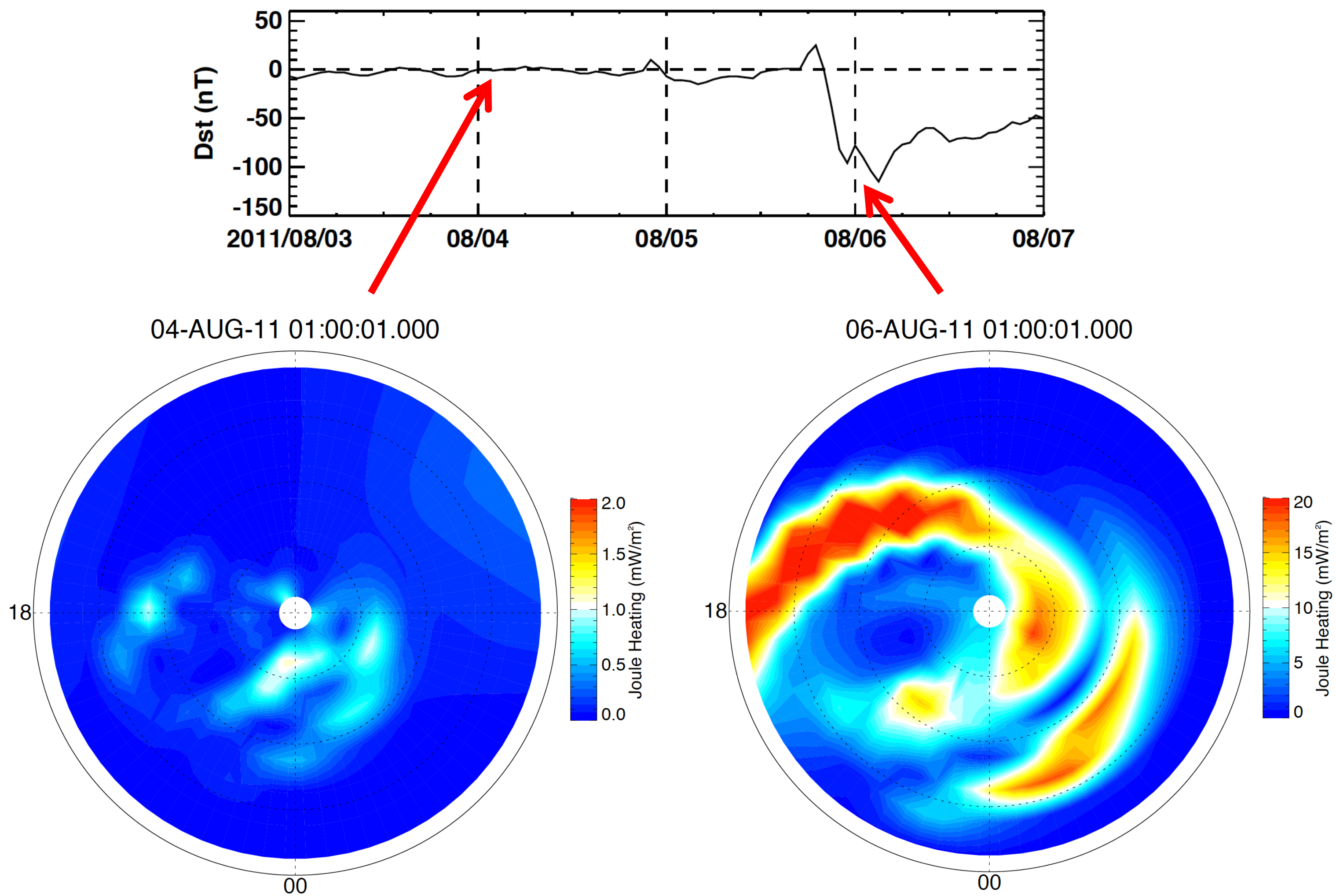
- Large Poynting flux has been observed in the polar cap during the main phase of the August 5, 2011 storm, the magnitude of which is comparable to that in the auroral zone.
- What are the mechanisms for the observed large Poynting flux in the polar cap?

IMF & Solar Wind Conditions



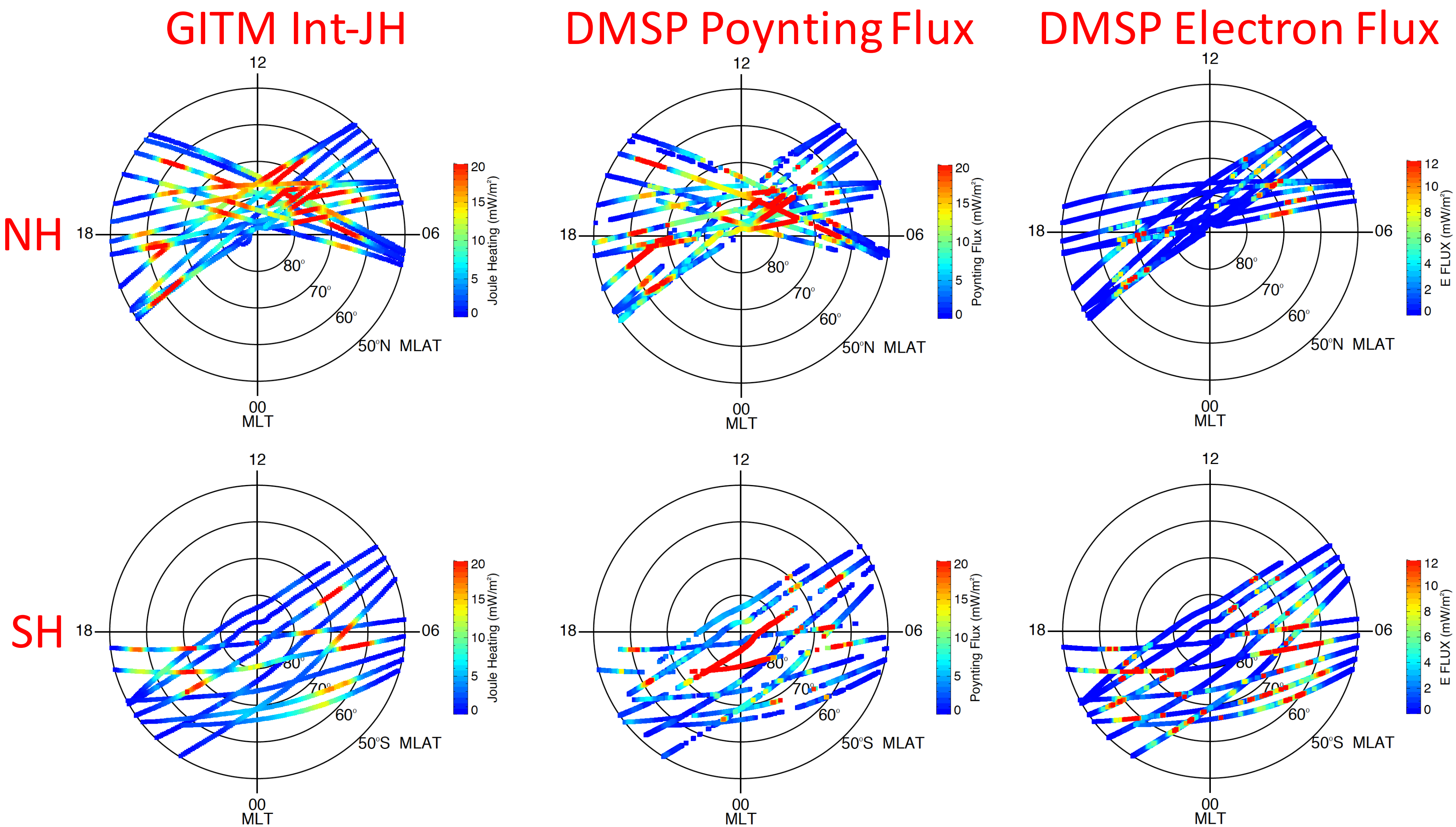
- IMF B_z reached -20 nT; B_y varied between -20 nT and 30 nT.
- V_x increased from 400 to 600 km/s; N increased from 3 to 20 n/cc.

GITM Simulations of Joule Heating



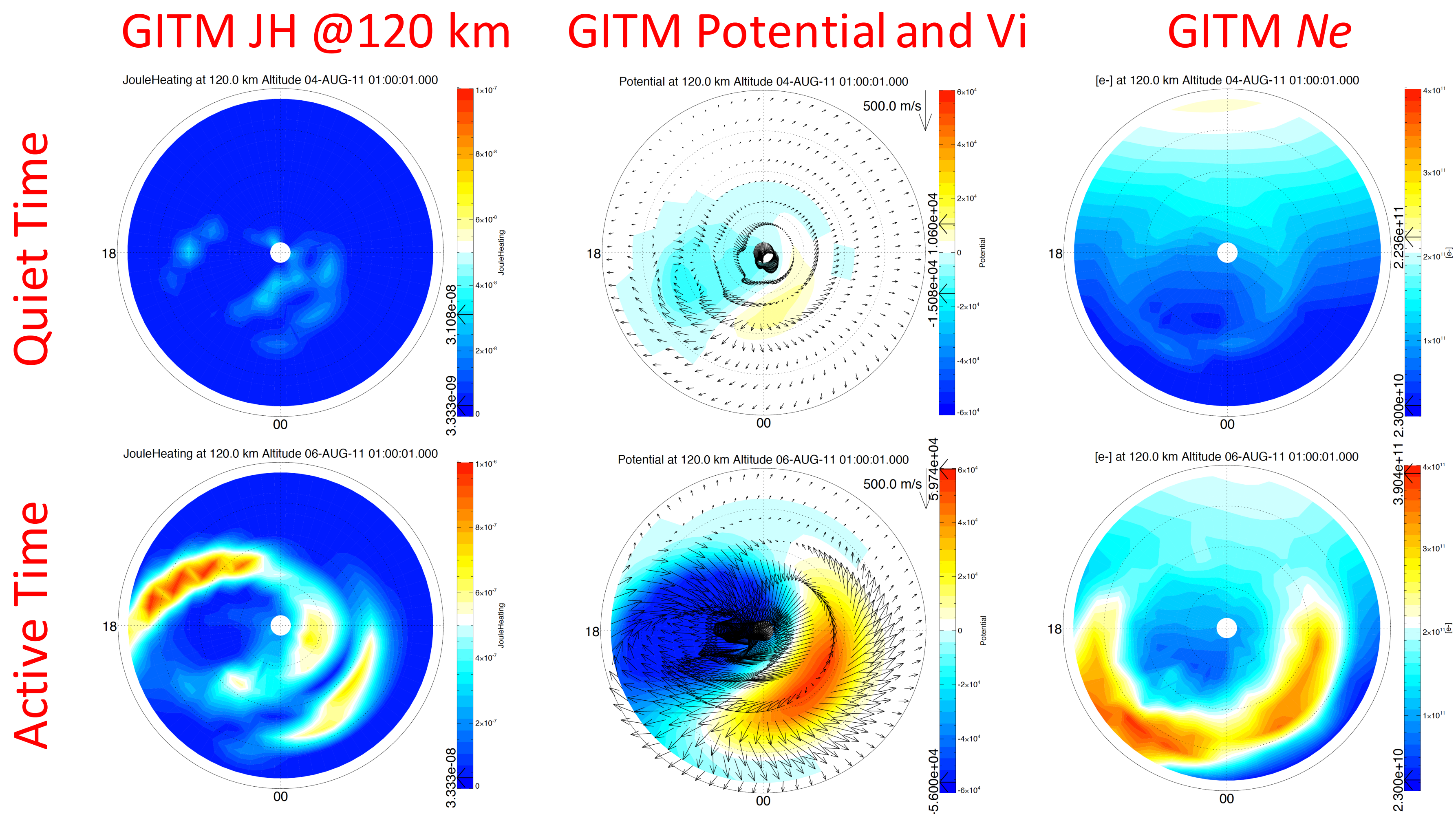
- ➢ The main phase started from 19:06 UT on August 5th. Dst → -120 nT.
- ➢ Both auroral zone and polar cap showed significant increase of Joule heating during active time

Observation vs. Simulation



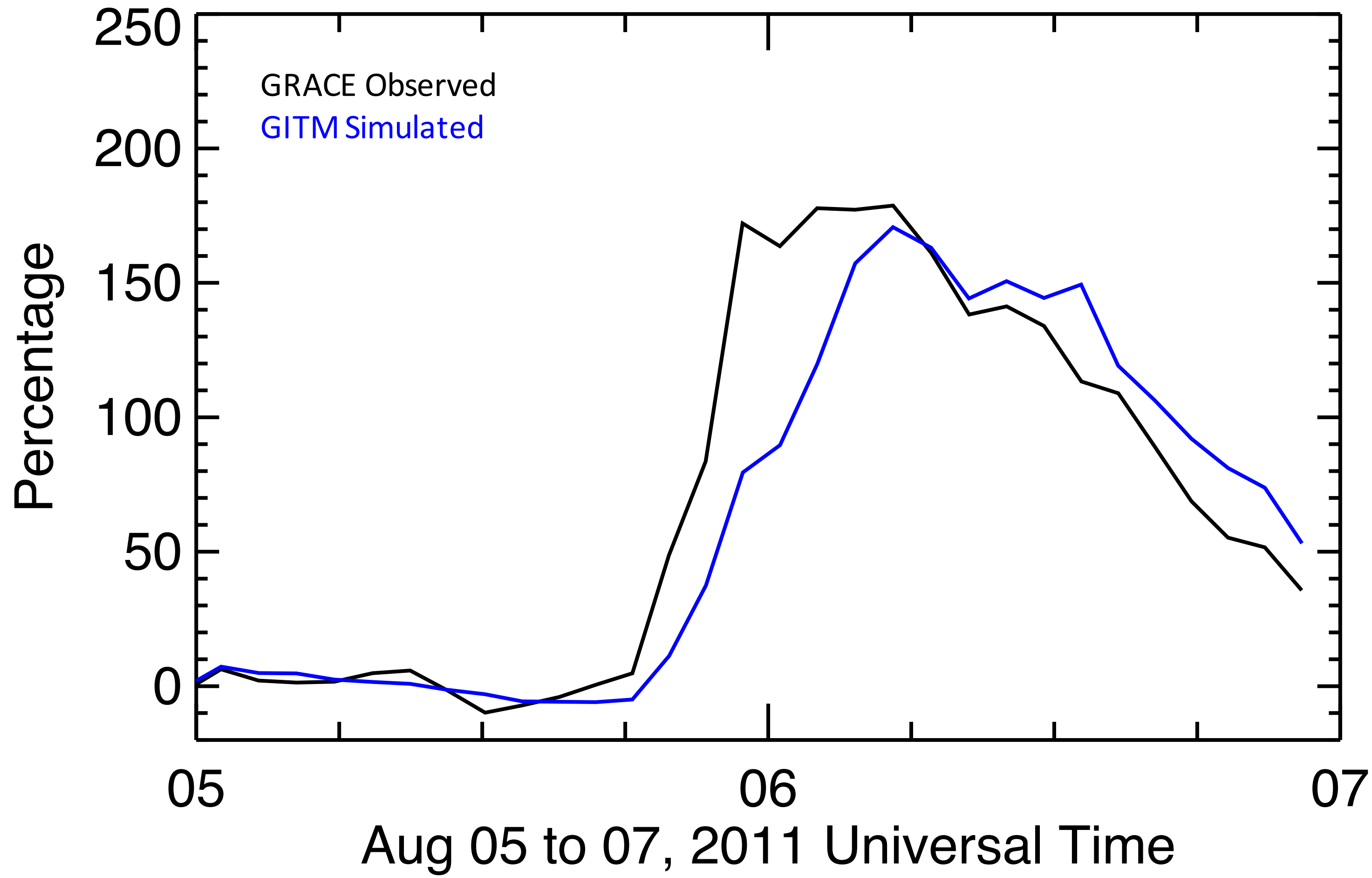
- Simulation captures the main feature of observation that large Joule heating occurs in the polar cap.
- Particle observations show the particle precipitations are mainly in the auroral zone and there is no clear enhancement in the total electron flux in the polar cap .

Contribution of Ion Convection



- In the polar cap, Joule heating @120 km increases by more than 100%. Joule heating peak in the polar cap is comparable with those in the auroral zone.
- The ion convection increases significantly during active time in the polar cap. In the simulation, there is no clear increase in the electron density in the polar cap. The ion convection enhancement contributes most the polar cap Joule heating peak.

Comparison of neutral density

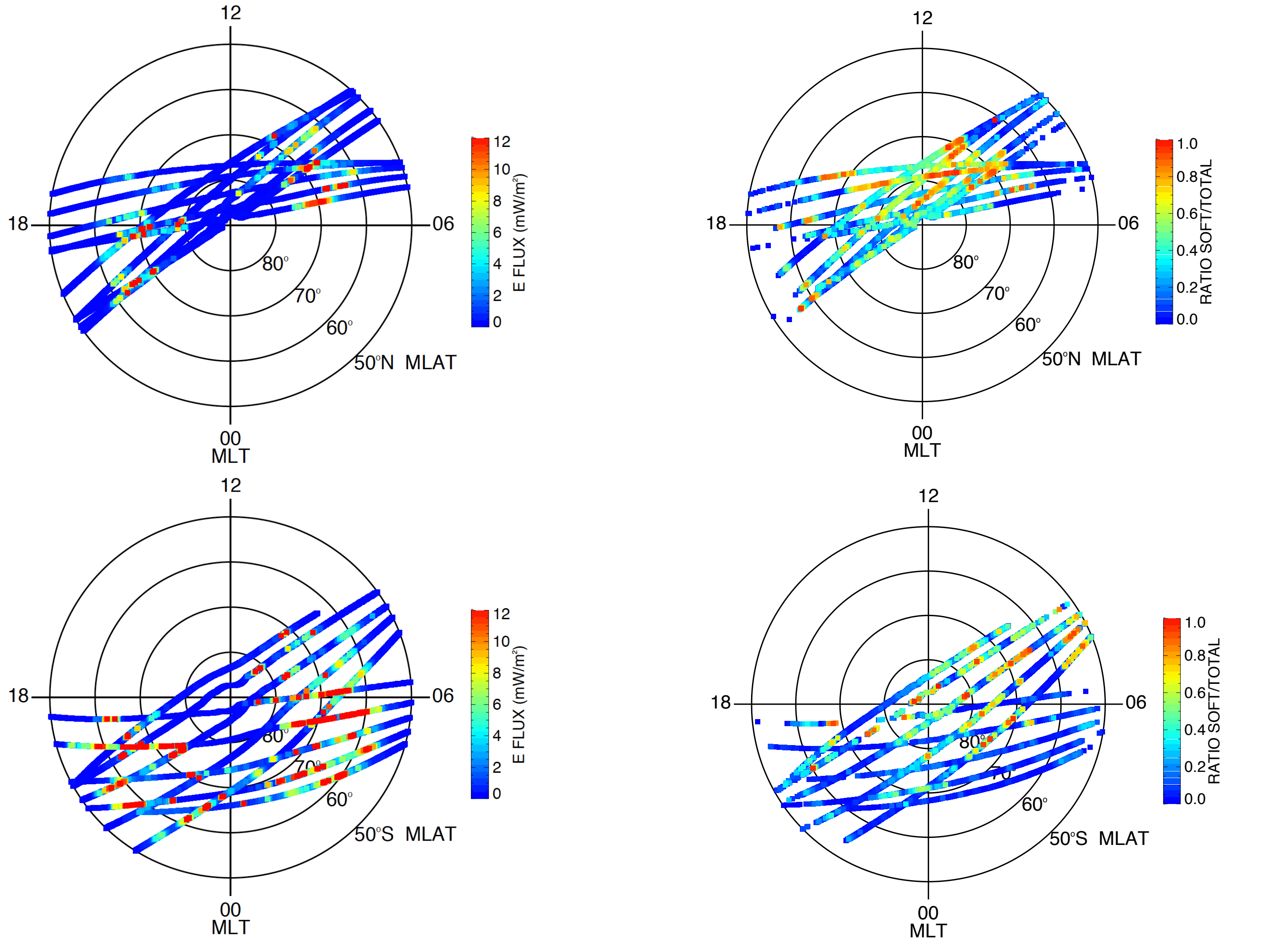


Soft Electrons in the Polar Cap

DMSP total Electron Flux | Soft Electron Flux / Total Flux

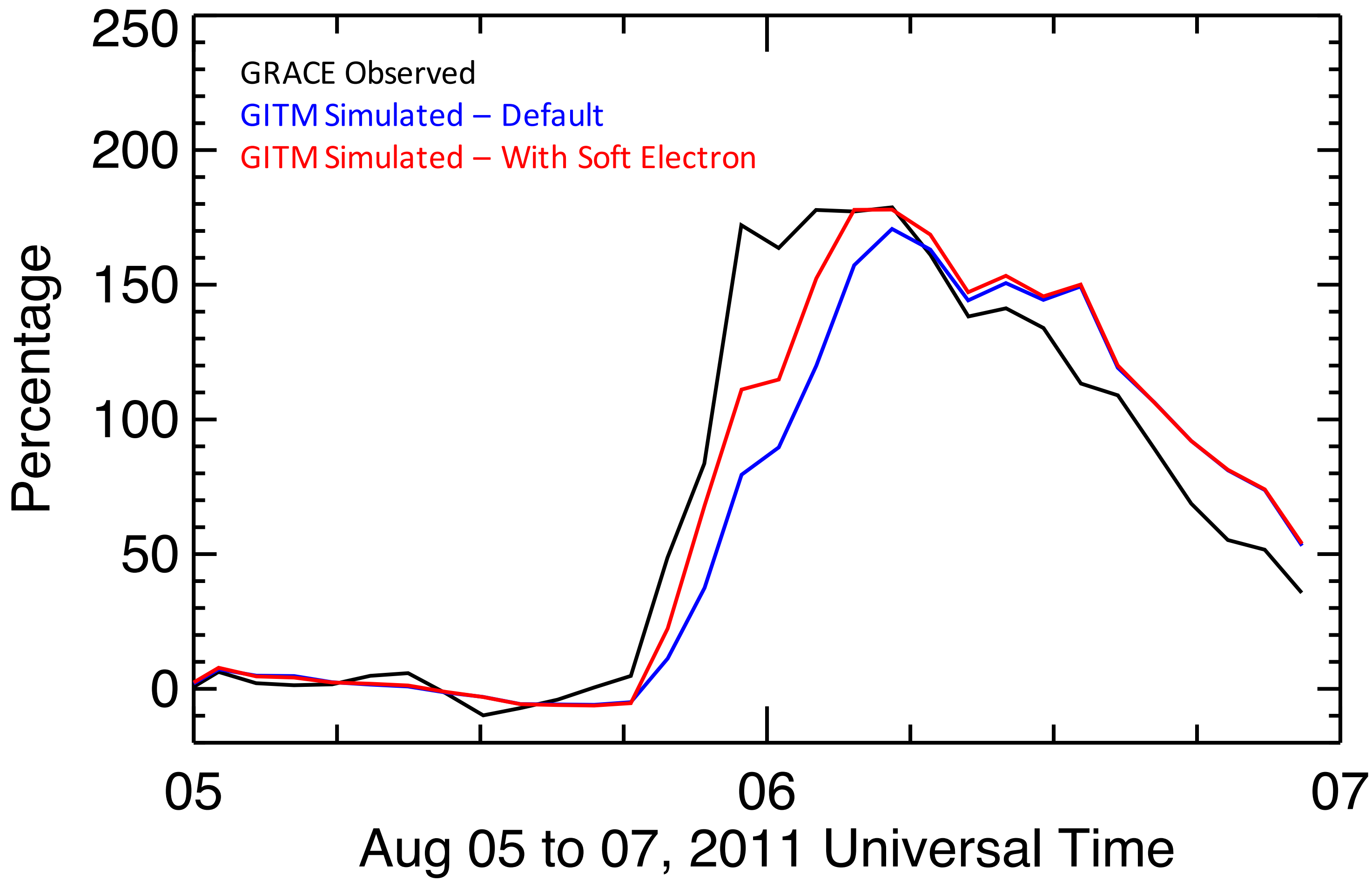
NH

SH



- Continuous soft electron precipitation in the polar cap region.
- The flux is usually less than 0.5 mW/m^2.

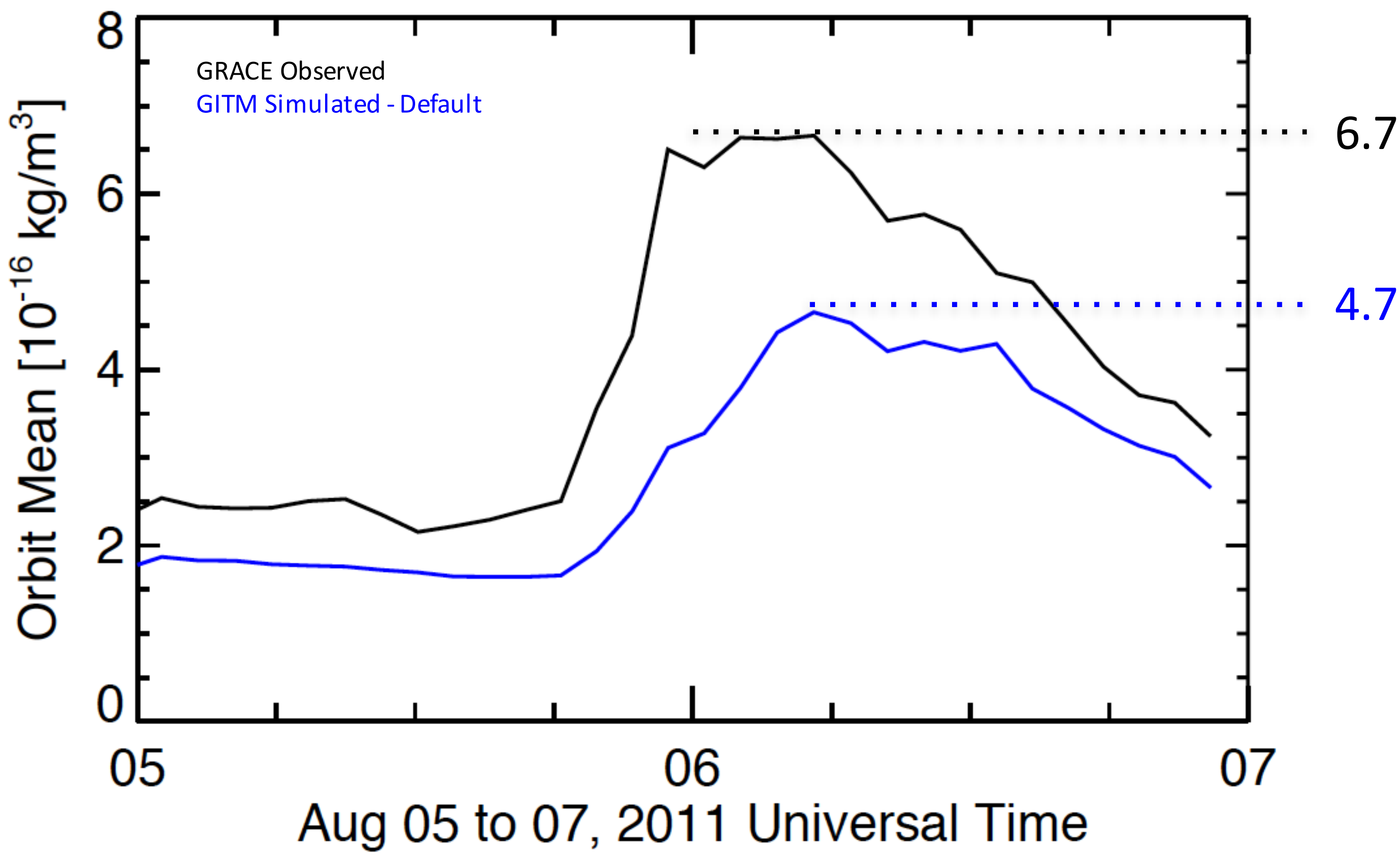
Influence of Soft Electrons on Rho



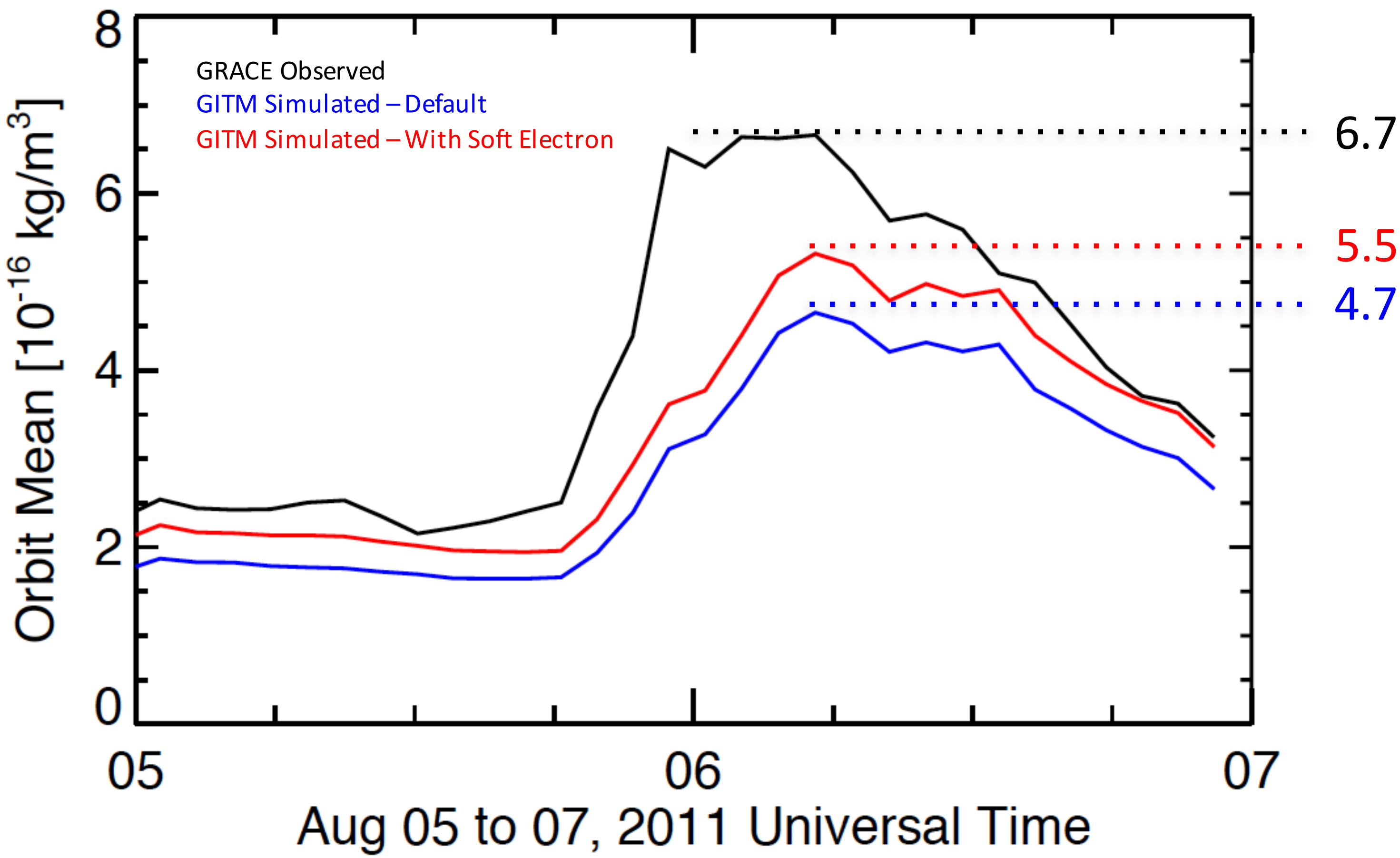
Conclusion

- GITM simulation shows a significant enhancement of Joule heating in the polar cap during the storm, the magnitude of which is comparable to that in the auroral zone. This feature is consistent with DMSP observations.
- The ion convection variation is the major contributor to the polar cap Joule heating enhancement during the active time.
- Continuous soft electron precipitation is found in the polar cap region, which lifts up the altitude of effective Joule heating and increases the neutral density at the upper atmosphere.
- A more sophisticated specification of soft electron precipitation is needed to precisely simulate the influence.

Influence of Soft Electrons on Rho



Influence of Soft Electrons on Rho



- Soft electrons added in the model: (100 eV, 0.3 mW/m^2)