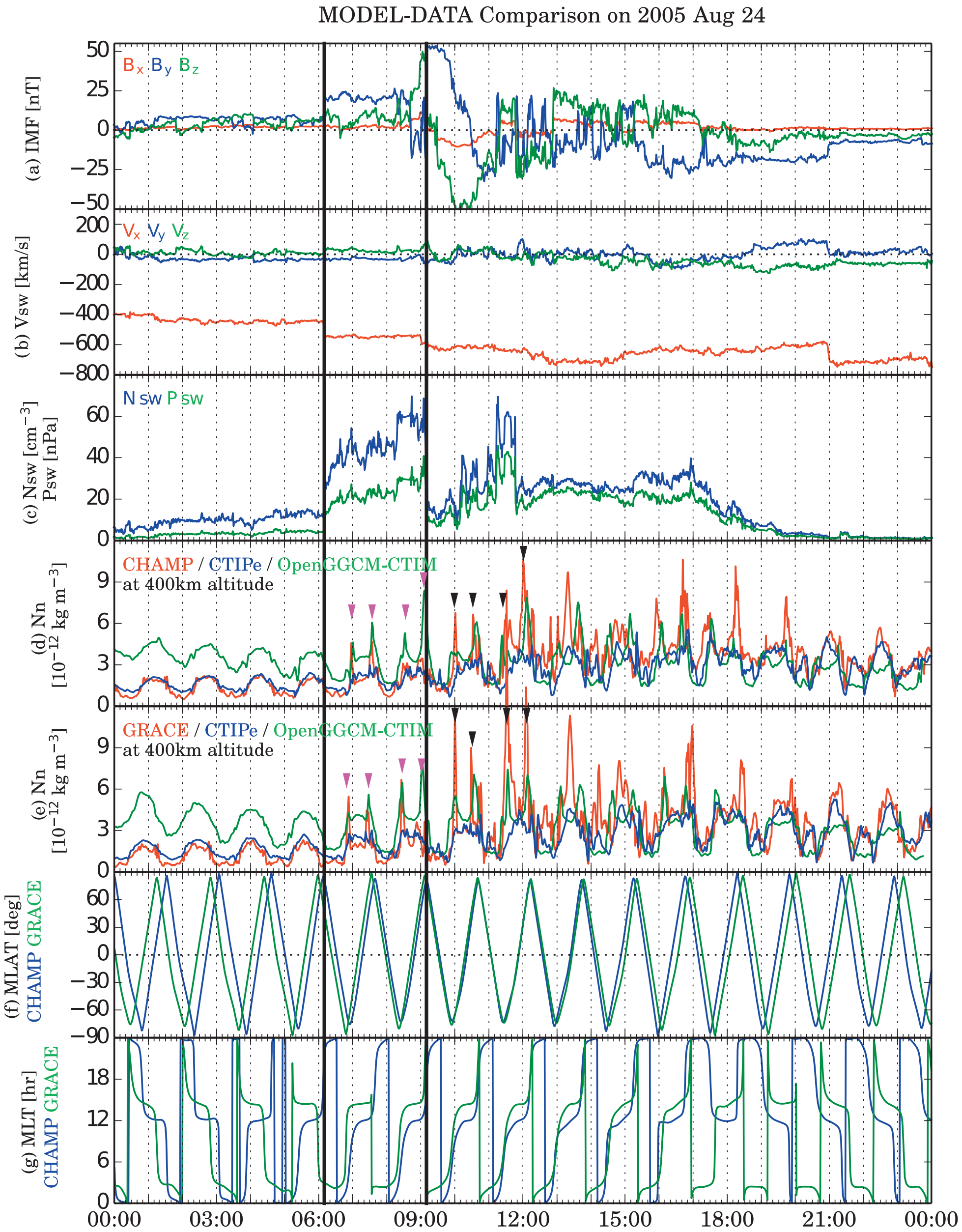
The Aug 24, 2005 Geomagnetic Storm



DRIVING CONDITIONS:

- Main phase: 09:00 – 12:00
  Bz maximum -45 nT,
  By maximum -40 nT,
  kp ~ 9
  Dst~ -180

Approaches of modeling

- Empirical models – MSIS90, etc.
- Statistical methods based on data fitting – CHAMP, GRACE, etc.
- **First-Principle methods** based on global-scale magnetosphere-ionosphere-thermosphere models – OpenGGCM-CTIM, CMIT

Cornor et al., [2016]

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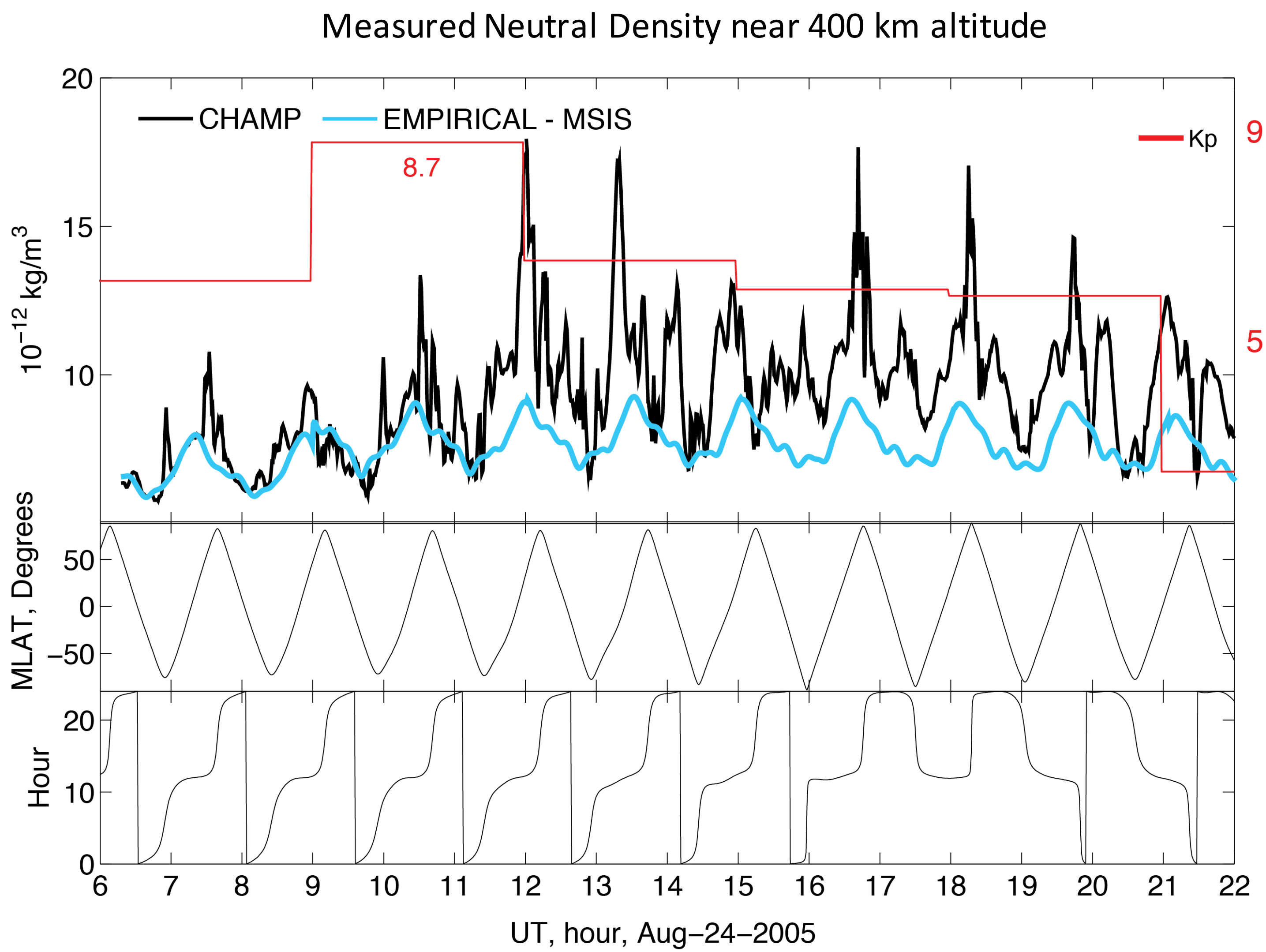
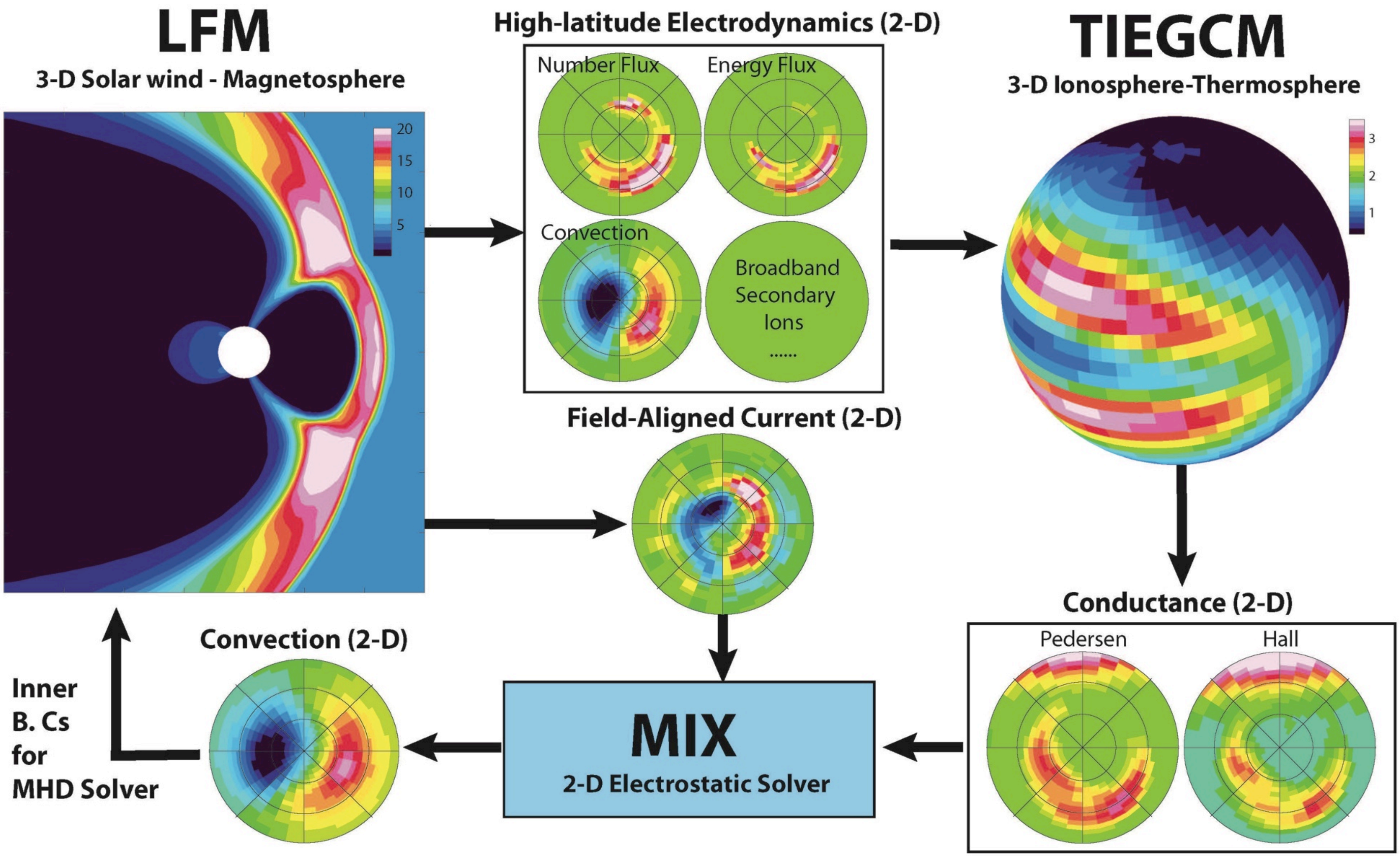


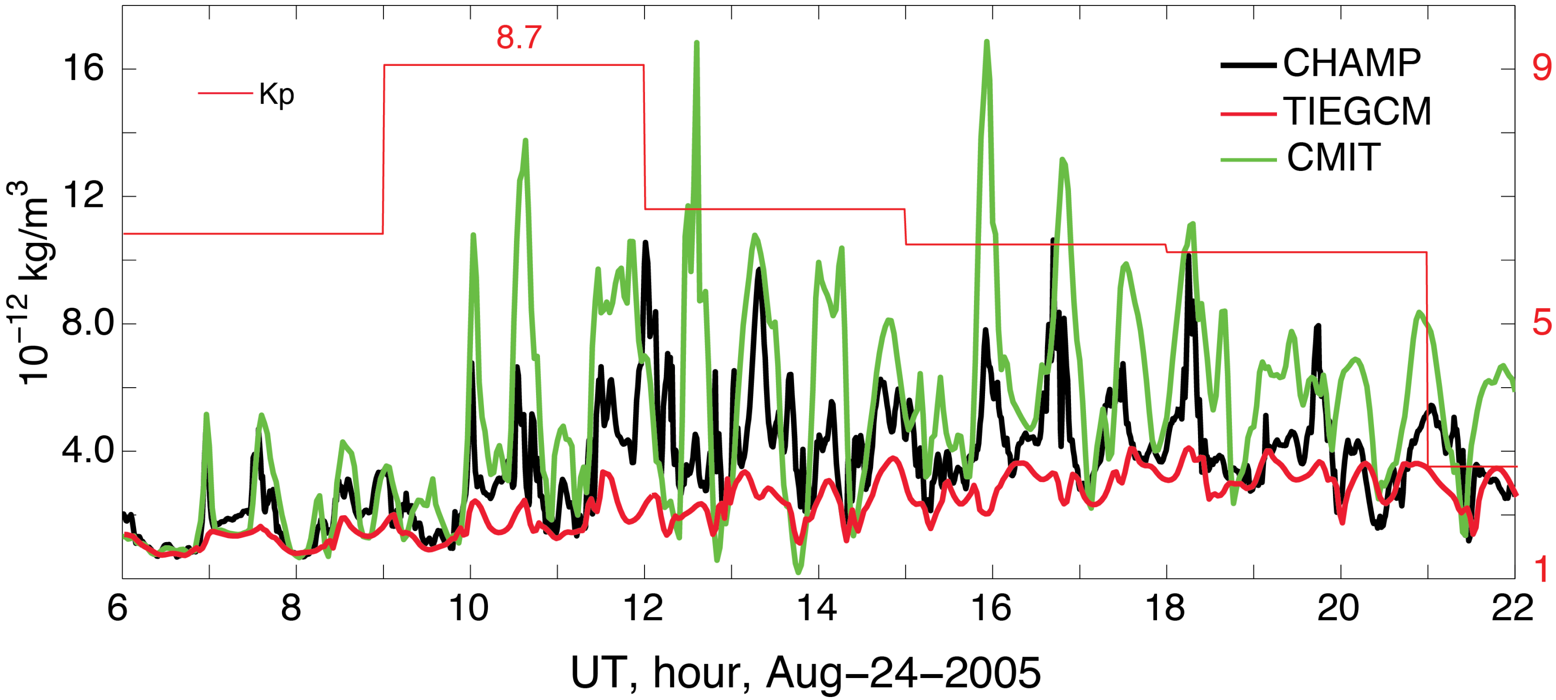
The Coupling between M and I-T (CMIT)



TIEGCM/CMIT Modeling Results

Observation versus Stand-alone LFM and TIEGCM

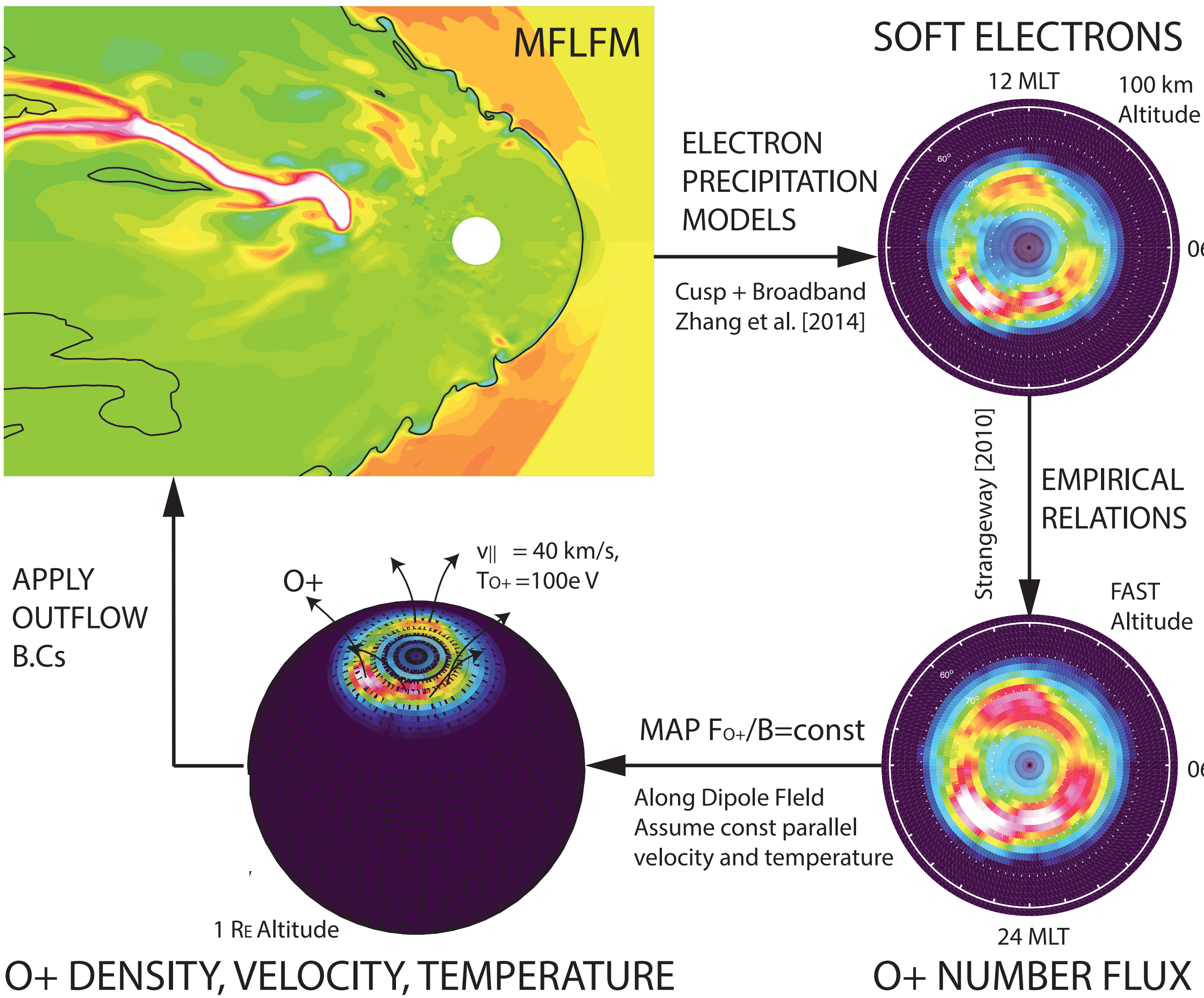
06:00 – 22:00 UT, Aug-24-2005



- TIEGCM ***underestimates*** thermospheric mass density along CHAMP orbits, especially at high latitudes – not enough heating due to empirical specifications of geospace drivers
- CMIT ***overestimates*** thermospheric mass density by approximately a factor of two at high latitudes – too much heating due to the overestimated geospace drivers
- What's ***missing***? – the feedback loop associated with ionospheric O^+ outflow

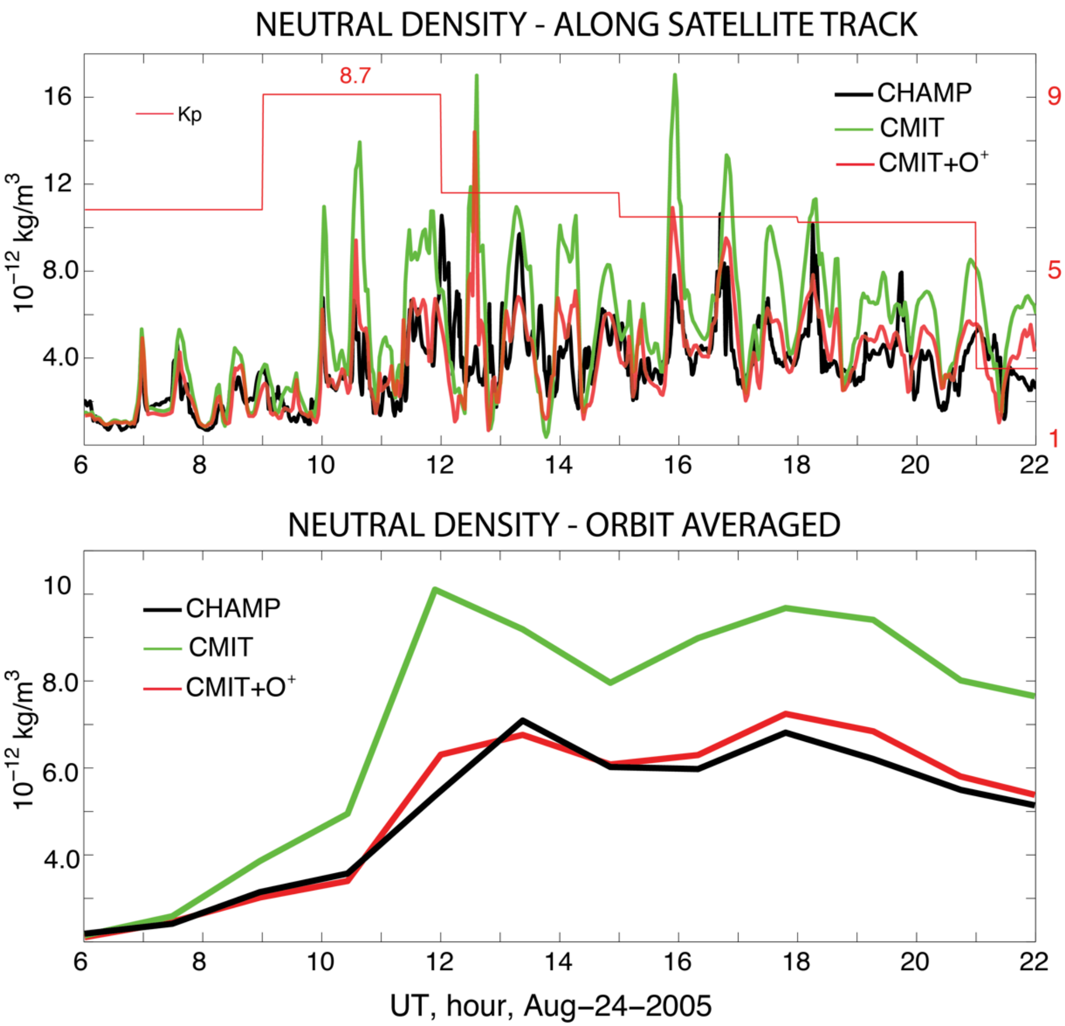
Implementing an O^+ Outflow Model in CMIT

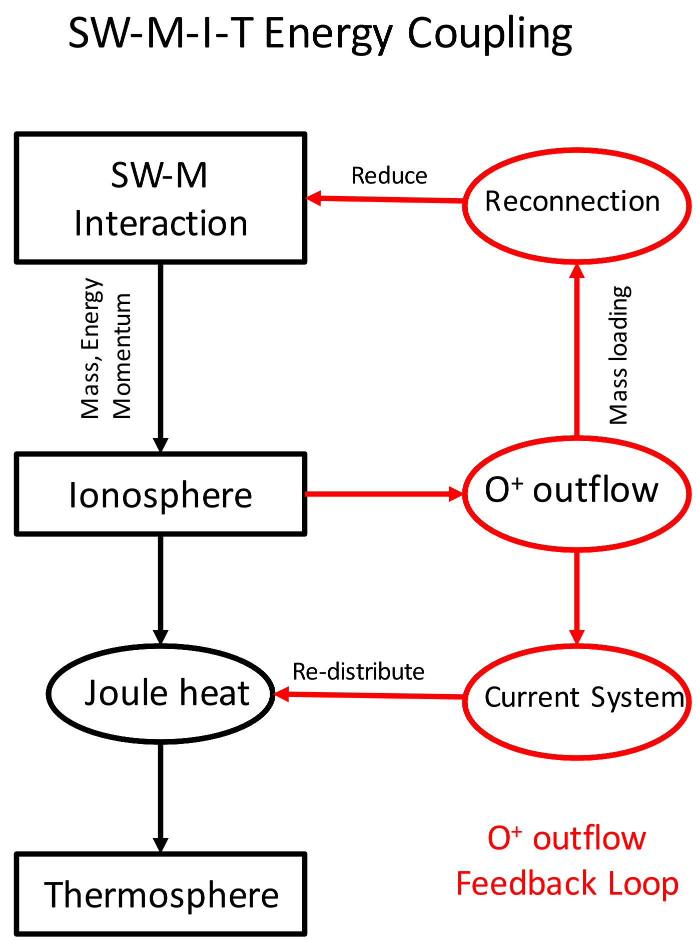
A Causally-Driven, Empirical O^+ Outflow Model



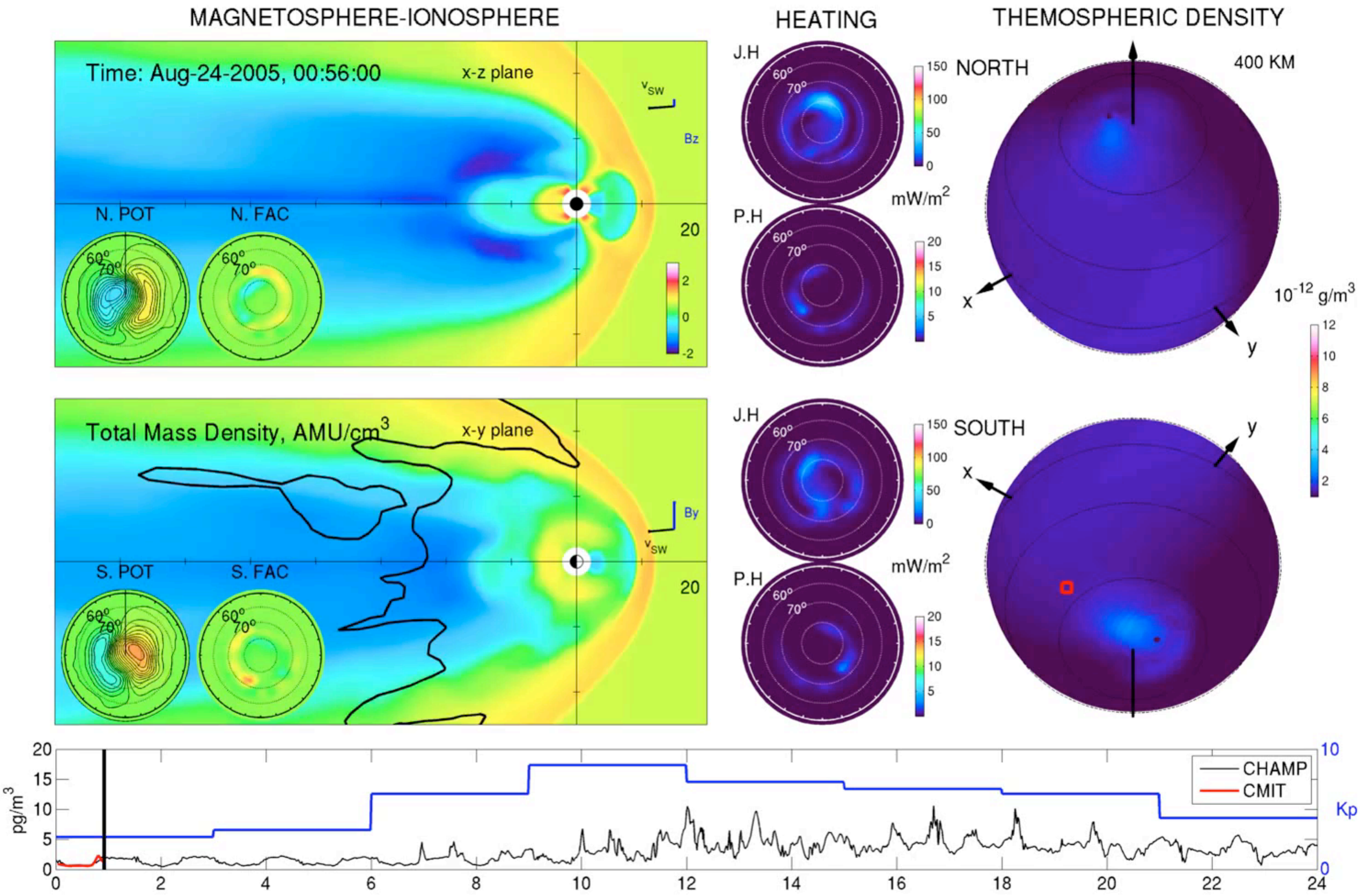
Improved Mass Density Modeling with O+

Effects of O+ ions on thermospheric mass density



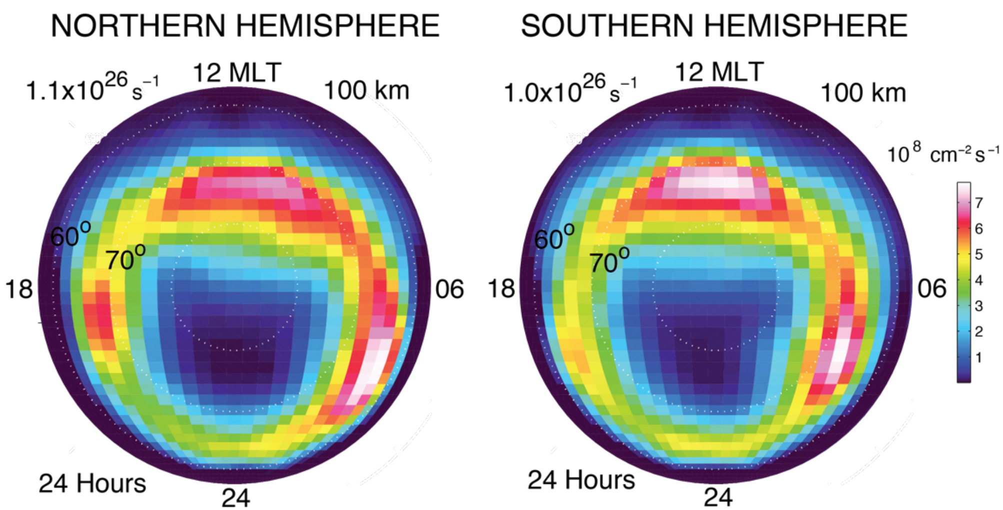


The Storm-Time SW-M-I-T Dynamics

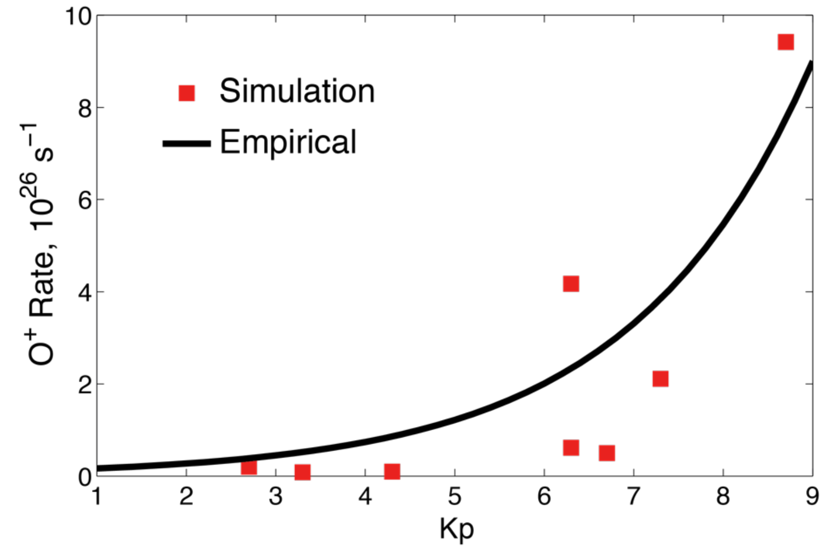


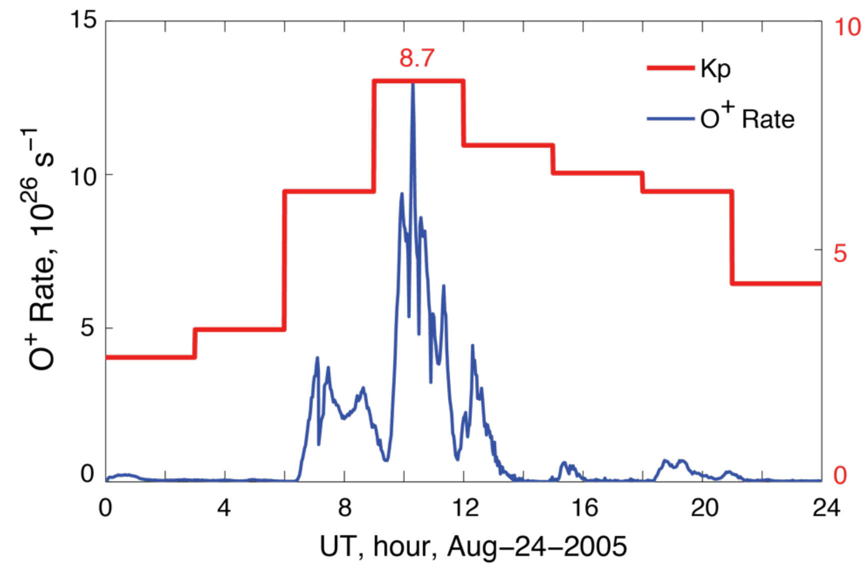
Simulated Storm-Time O^+ Outflow properties

Average O+ flux distributions



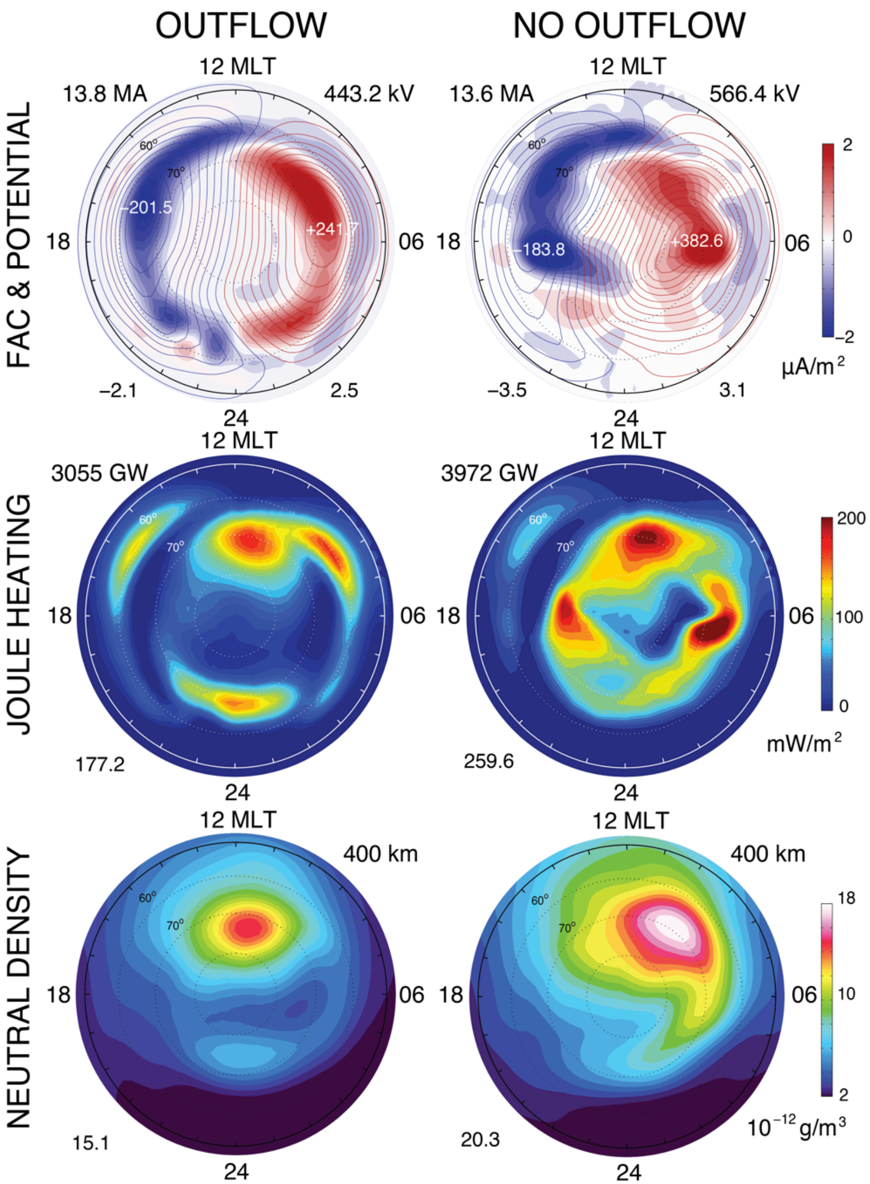
Hemispheric O+ Rate versus Kp





- A large portion of O+ flux occurs near the dayside cusp region (direct-entry electrons)
- The hemispheric outflowing O+ flux rate increases with the driving conditions (kp)
- The simulated O+ rate is consistent with the *Yau et al*. empirical relation

The Role of O+ on High-latitude EM Energy



- The simulated ionospheric potential is reduced when O^+ ions are included in the simulation
- The region-2 currents are significantly improved when O^+ outflow is included in the coupled global simulation
- The improved current system affects the distribution of Poynting flux especially in the polar cap, resulting less Joule heating in the polar cap region.