Ring Current Coupling with the Radiation Belt Plasmasphere and the Subauroral Ionosphere

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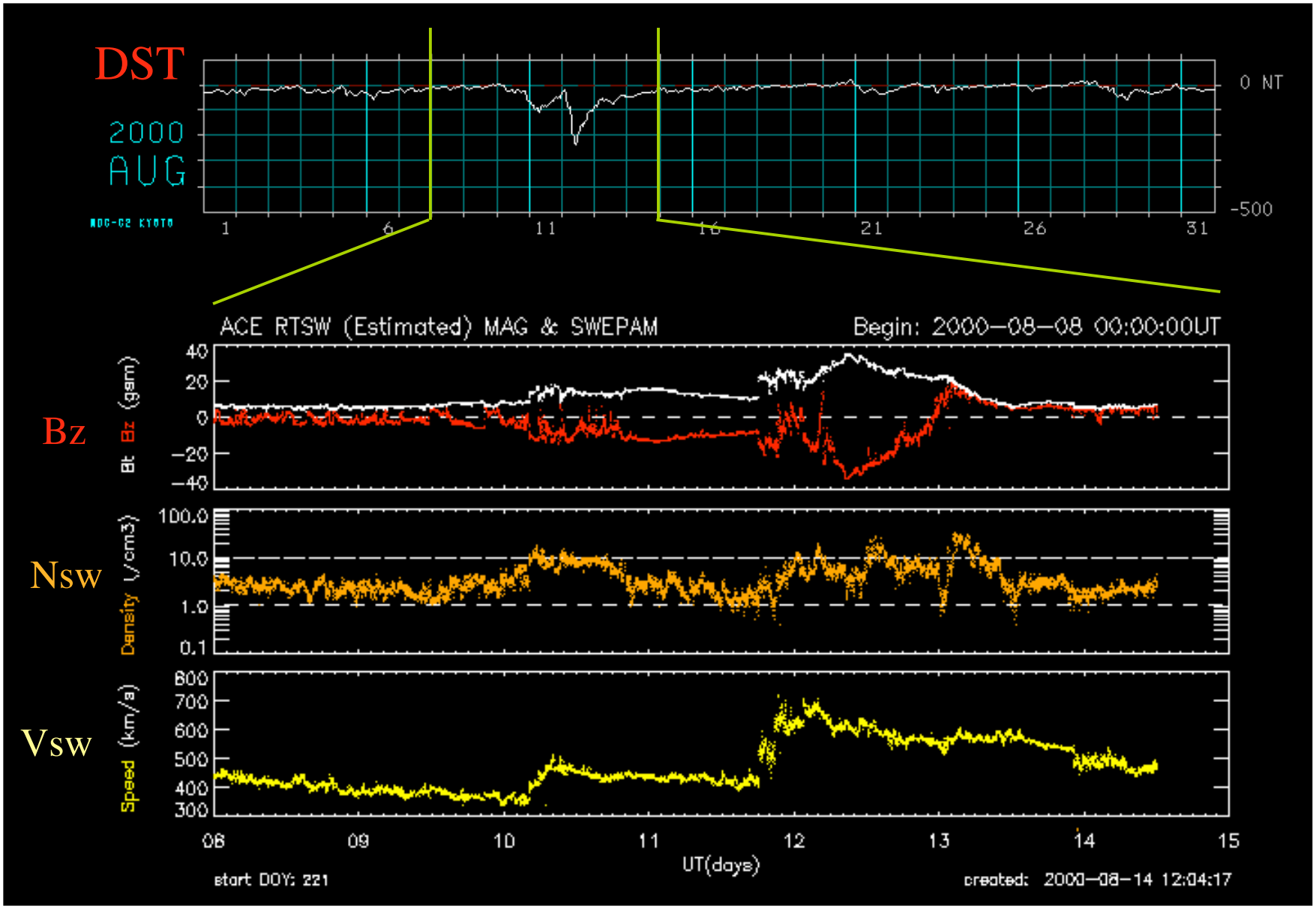
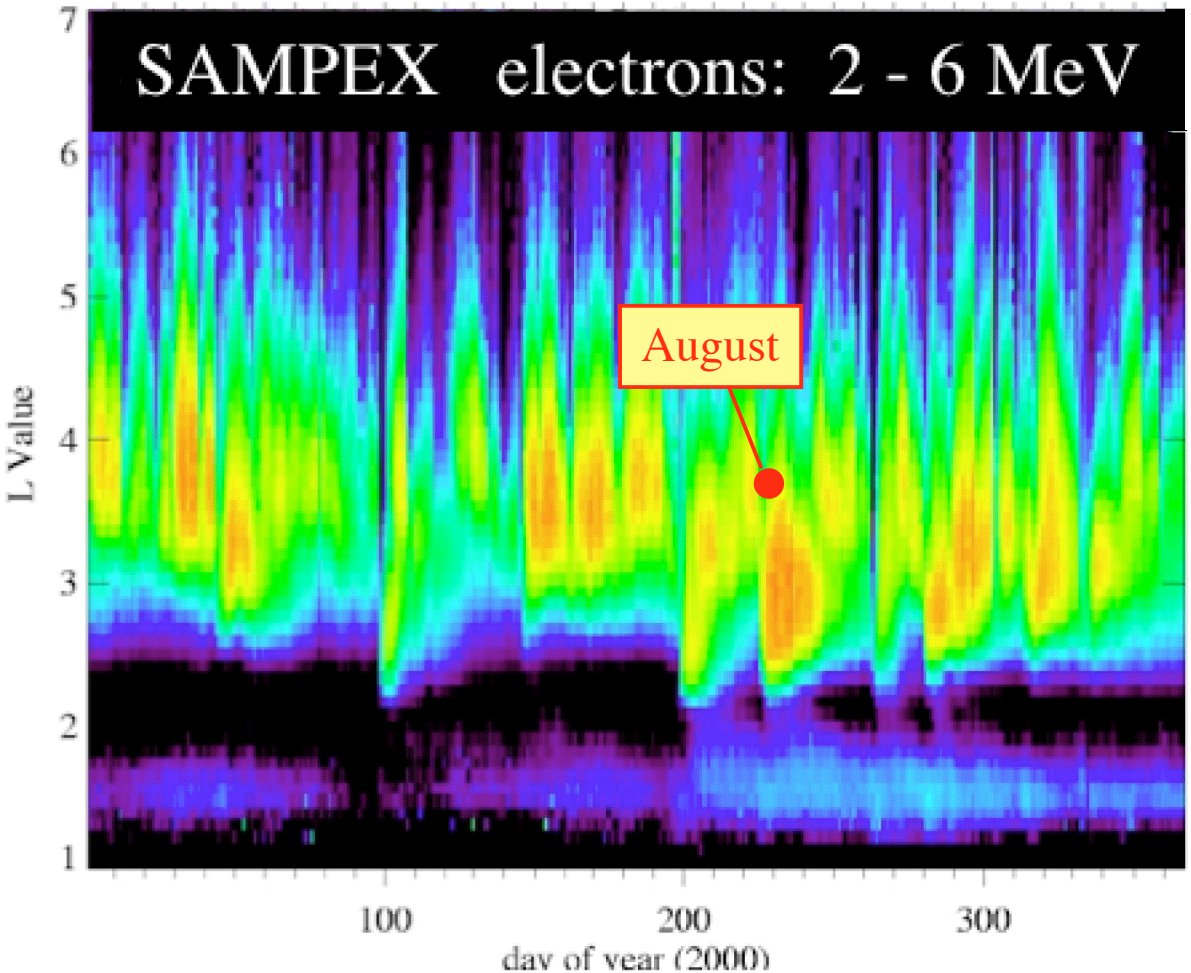
Ring Current: Key Element of Geospace Storms

- Ring current deforms the Earth magnetic field and alters the transport of radiation belt particles.
- SubAuroral Polarization Stream (SAPS) occurs as a result of ring current-ionosphere coupling.
- Sudden decrease in ring current source produces interchange instability.
- Plasmasphere and subauroral ionosphere response to SAPS and interchange instability.

The Great Magnetic Storm in August 2000

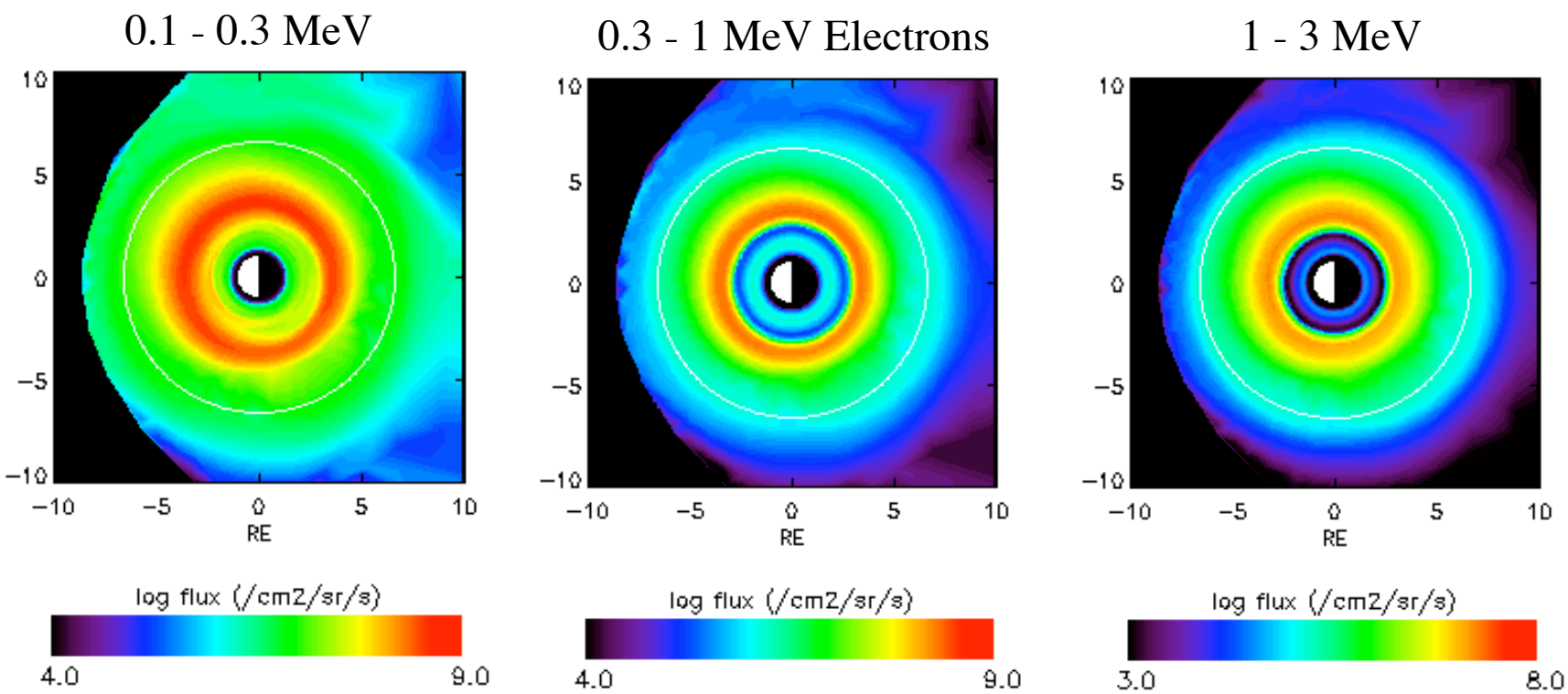


Filling of the Slot Region During the August 2000 Storm

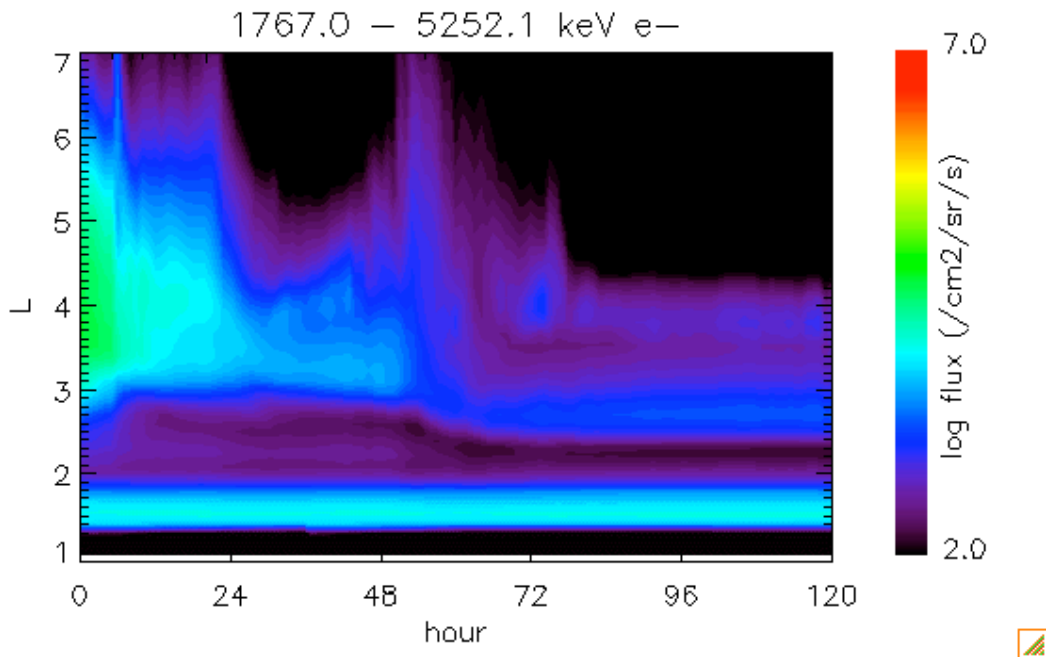


Storm Simulation with the Radiation Belt Environment (RBE) Model

$$\frac{\partial f_s}{\partial t} + \langle \dot{\lambda}_i \rangle \frac{\partial f_s}{\partial \lambda_i} + \langle \dot{\phi}_i \rangle \frac{\partial f_s}{\partial \phi_i} = \frac{1}{\sqrt{M}} \frac{\partial}{\partial M}\left(\sqrt{M} D_{MM} \frac{\partial f_s}{\partial M}\right) + \frac{1}{T(y)\sin 2\alpha_o} \frac{\partial}{\partial \alpha_o}\left(T(y)\sin 2\alpha_o D_{\alpha_o \alpha_o} \frac{\partial f_s}{\partial \alpha_o}\right) - \left(\frac{f_s}{0.5\tau_b}\right)_{\substack{\text{loss}\\ \text{cone}}}$$

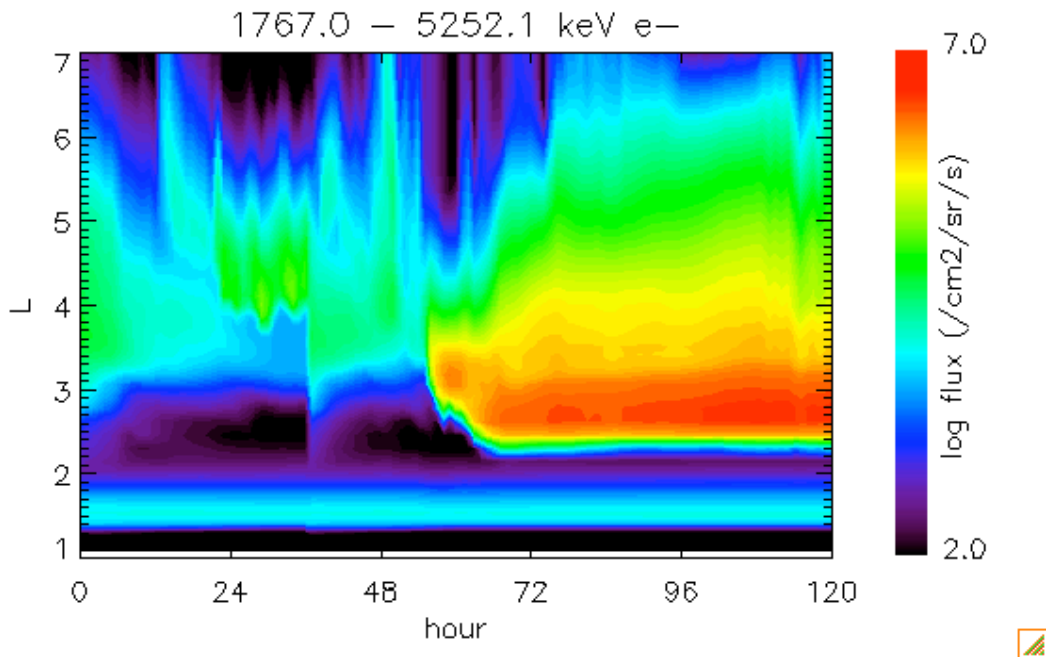


RBE Simulation in Tsyganenko 96 Magnetic Field Model



8/10 8/11 8/12 8/13 8/14

RBE Simulation in Tsyganenko 04 Magnetic Field Model



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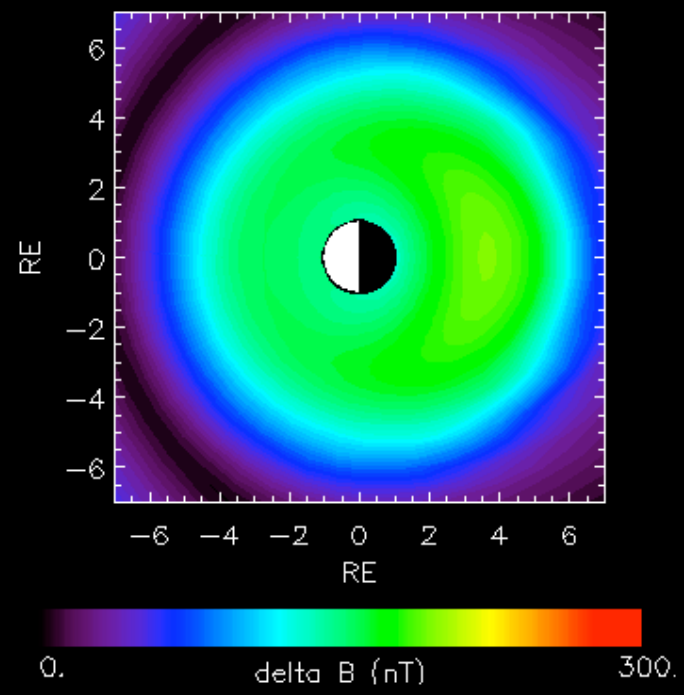
Magnetic Field Distortion in T96 and T04

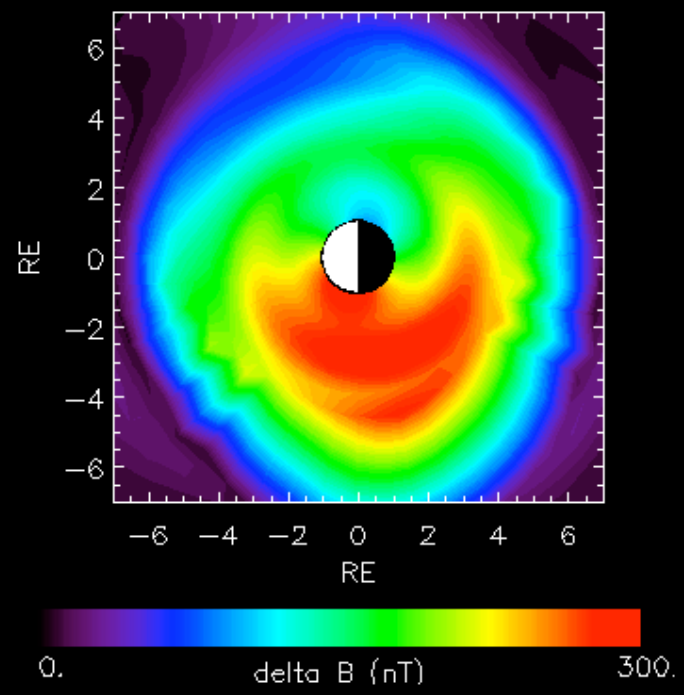
12 Aug 2000, 10:00 UT

T96



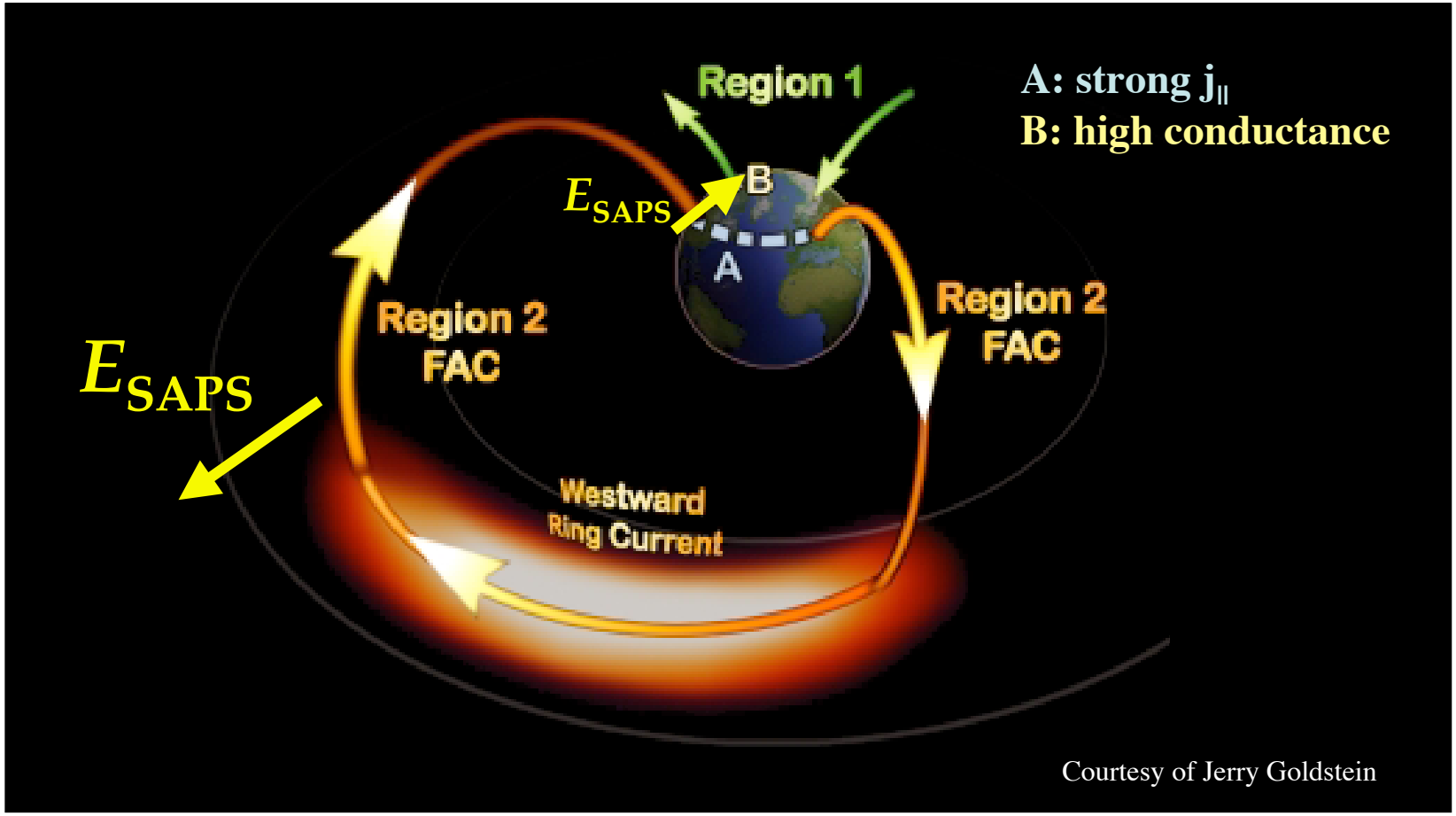
parmod(1:4): 3.0, -100, 10., -10.

T04

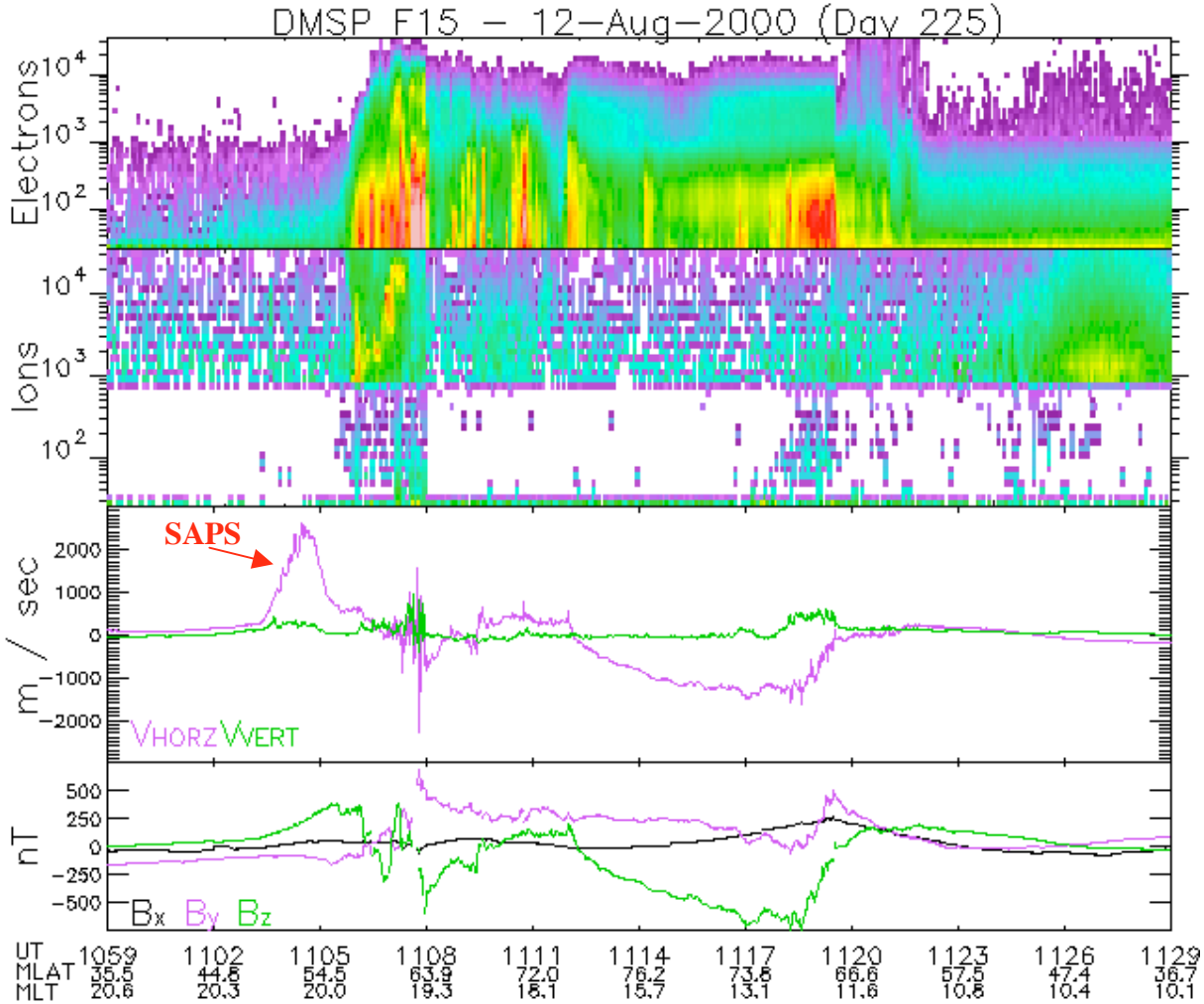


parmod(1:10): 3.0, -232, 22., -25.
5.8, 3.6, 5.1,
15.8, 6.7, 9.3

SubAuroral Polarization Stream (SAPS)

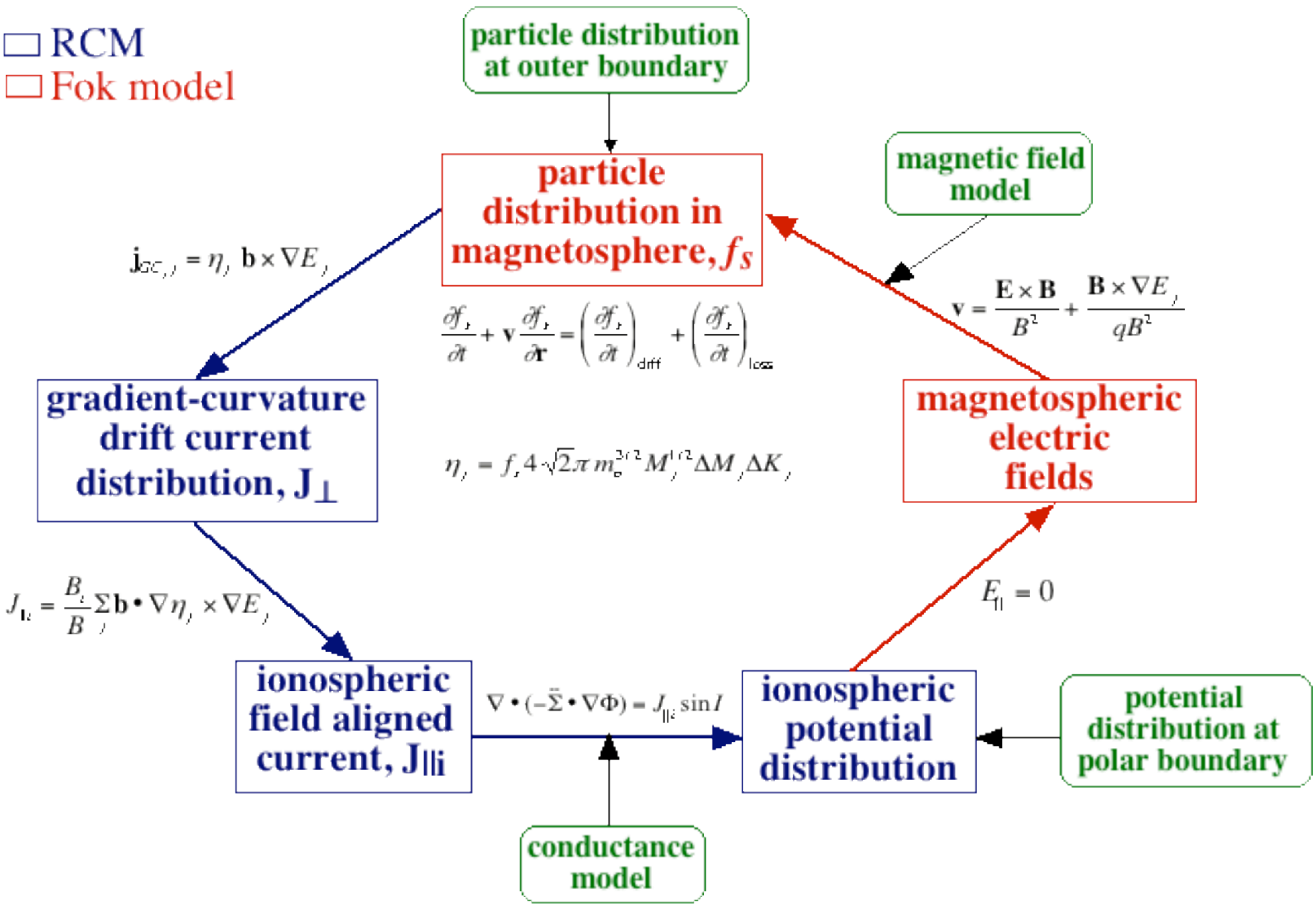


DMSP Observed Strong SAPS on 12 August 2000

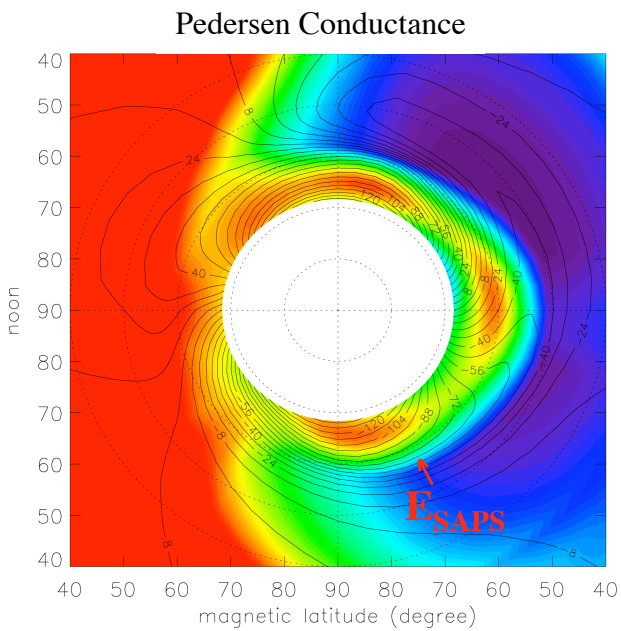


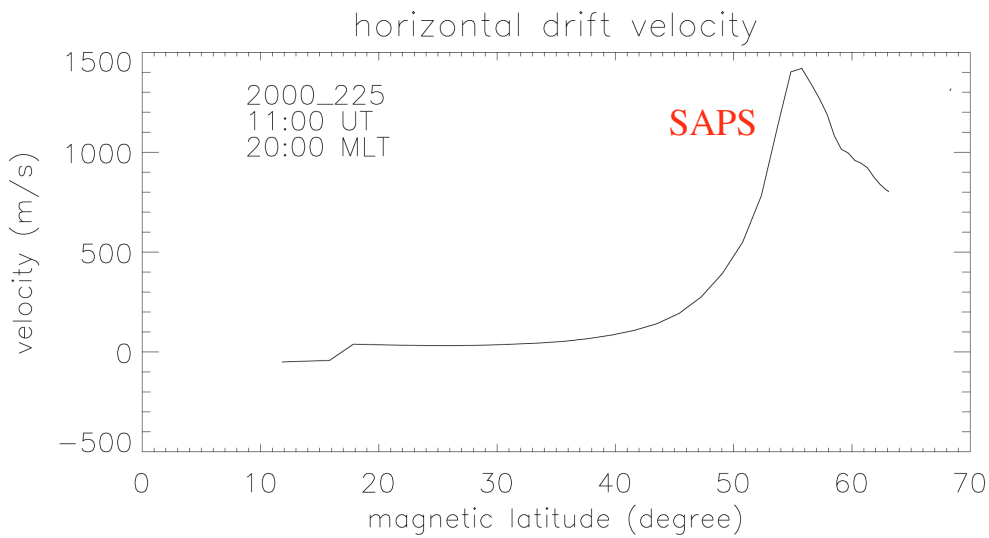
Courtesy of John Foster

The Comprehensive Ring Current Model (CRCM)



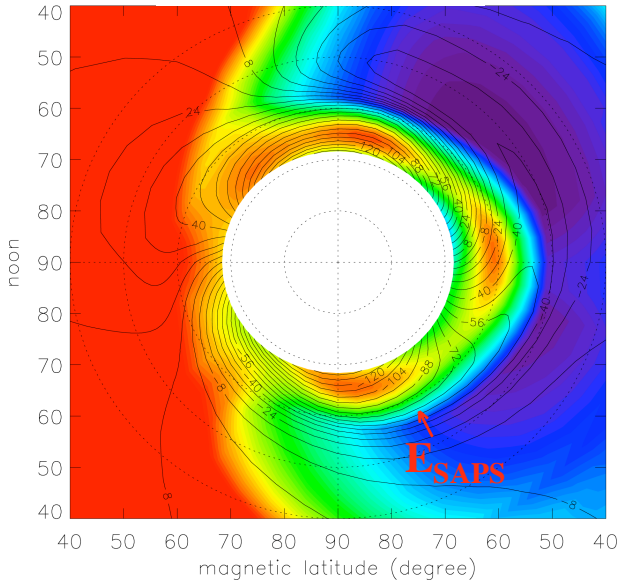
CRCM Simulated SAPS

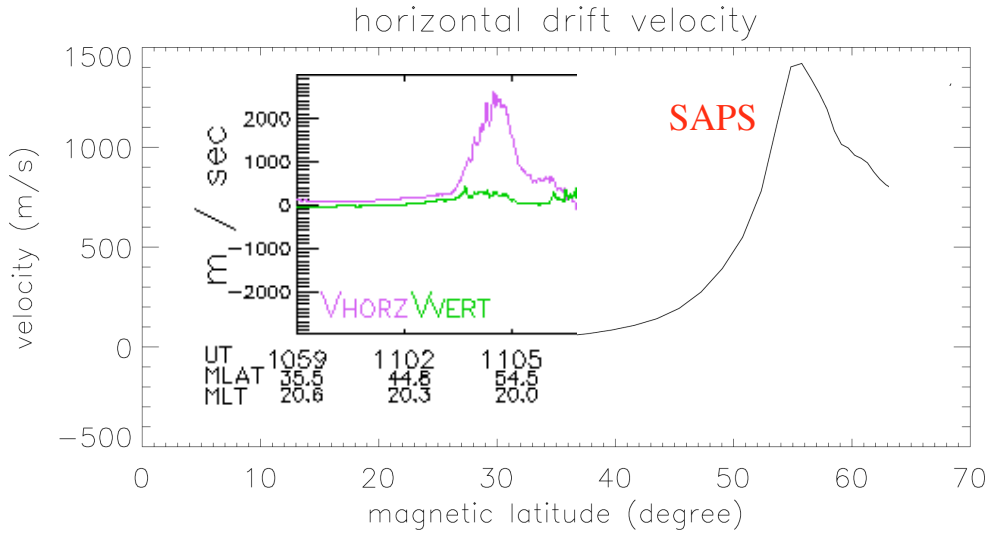




CRCM Simulated SAPS

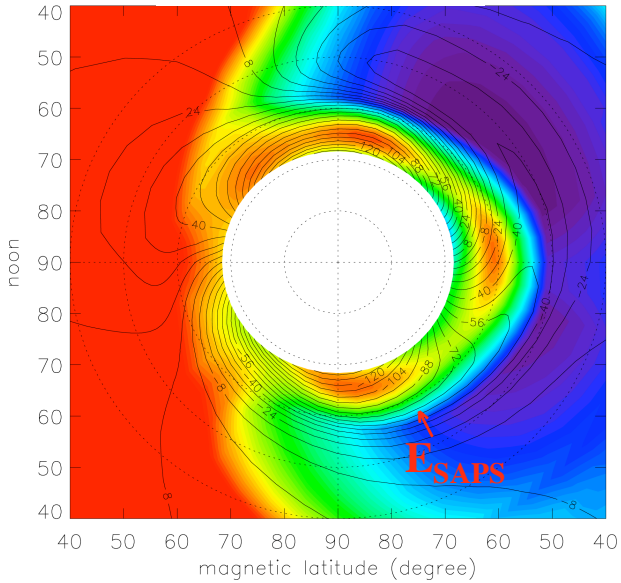
Pedersen Conductance

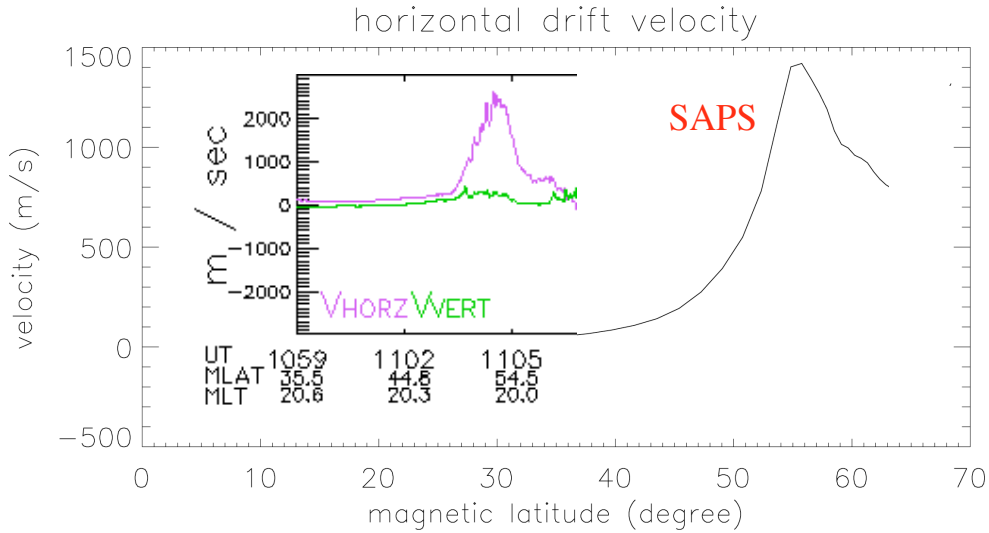


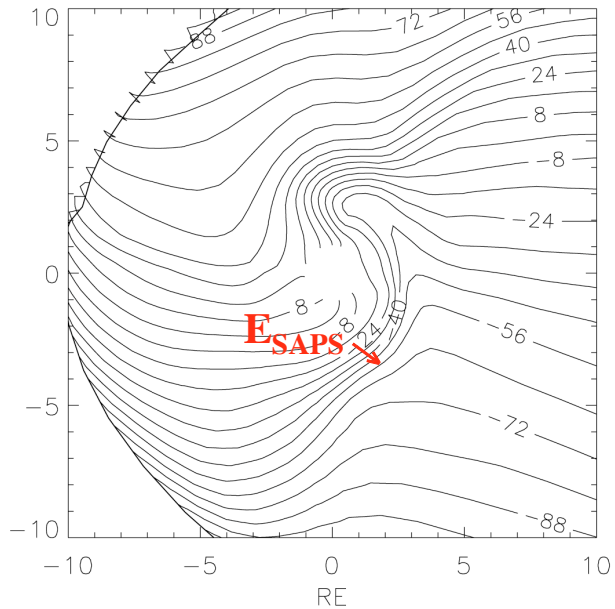


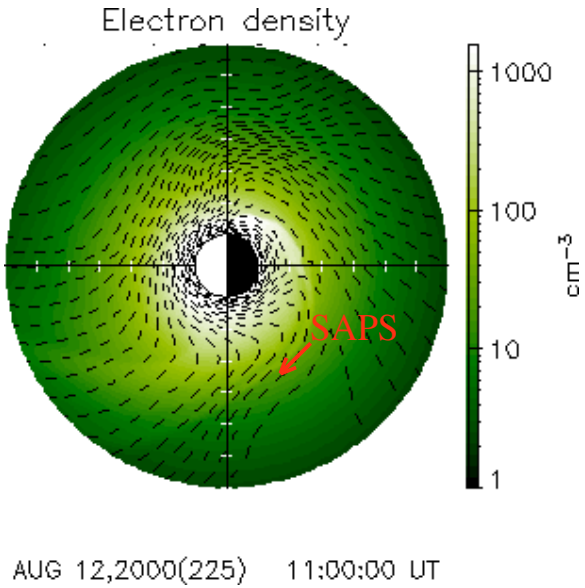
CRCM Simulated SAPS

Pedersen Conductance



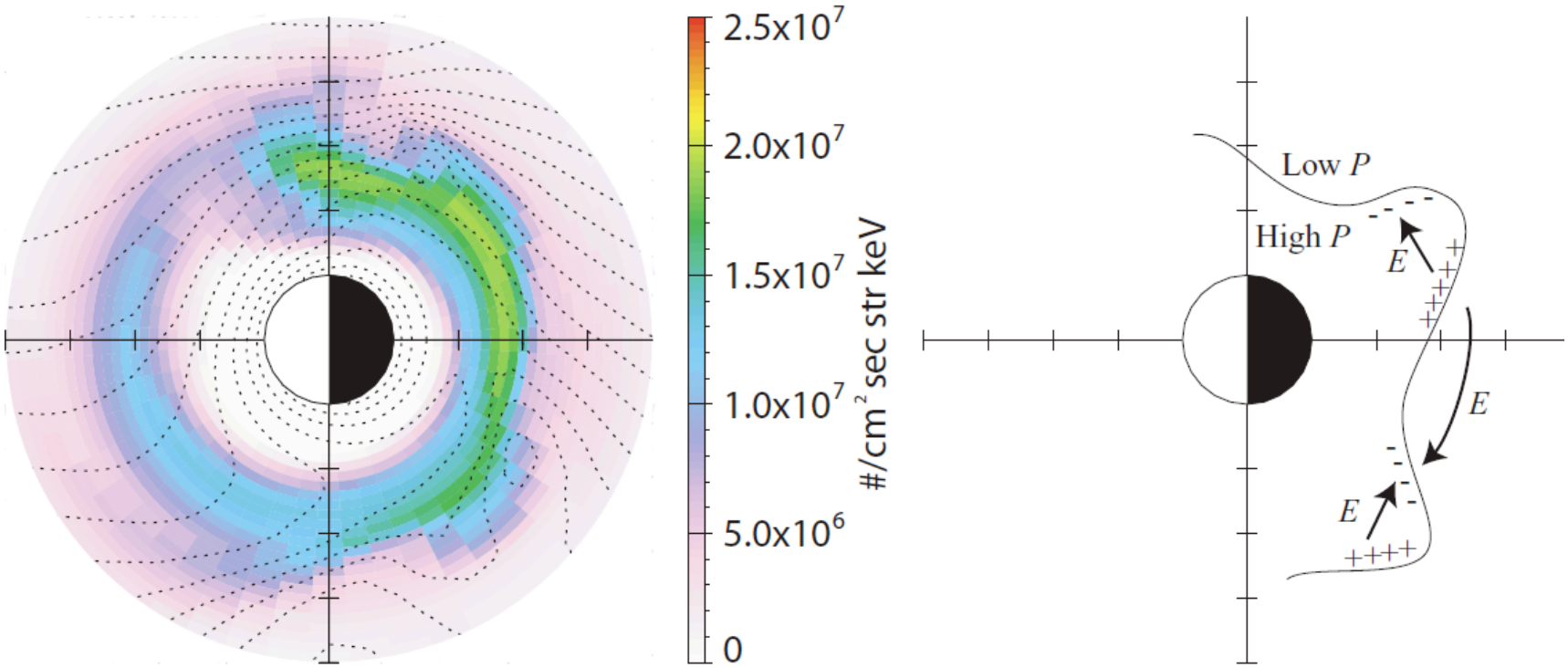






Interchange Instability

Develops when the plasma sheet density suddenly decreases (Sazykin et al., 2002).

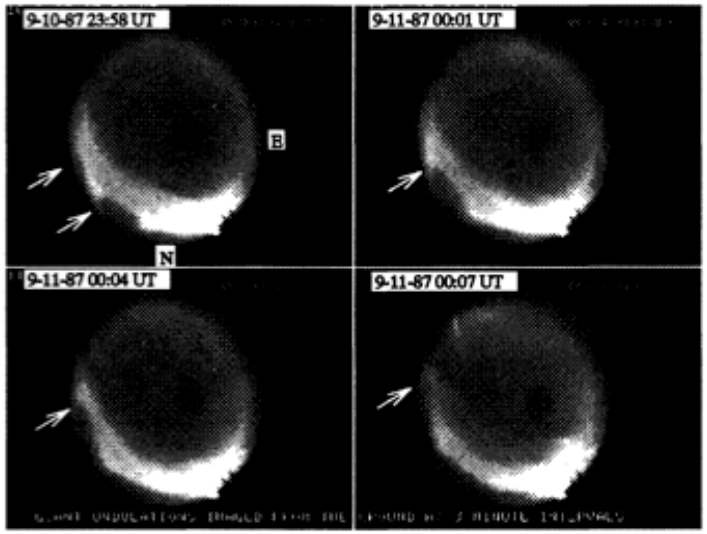


(1) Simulation
20 Nov 2003, 2140 UT

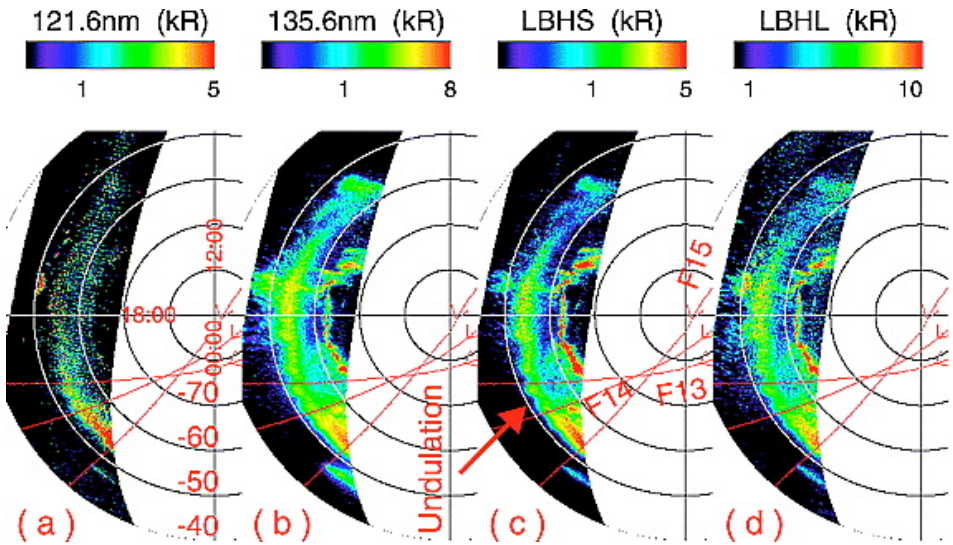
(2) Schematic representation

Ebihara et al. (2005)

Interchange Instability: Possible Association with Auroral Undulations



Nishitani et al. (1994)



Zhang et al. (2005)

Summary

- Ring current → magnetic distortions → radial transport of radiation belt particles → filling the slot region
- SAPS field changes the shape of the plasmasphere, sharpens the duskside plasmapause
- Interchange instability may be associated with auroral undulations
- **Ring current is the key element of geospace storms**