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Efforts to Improve Modeling of Ionospheric Conductance and Inner Magnetospheric Electric Fields in the Rice Convection Model Equilibrium (RCM-E)

Margaret W. Chen[1], Colby L. Lemon[1], James Hecht[1], and J. Scott Evans[2]

[1]The Aerospace Corporation, Los Angeles, CA
[2]Computational Physics, Inc, Springfield, VA

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Outline of Work in Progress

I. Improve modeling of electron and ion pitch-angle scattering losses in the RCM-E to obtain more realistic diffuse auroral energy flux spectra

II. Perform model-data comparisons of ionospheric and inner magnetospheric electric field intensity E, which is important for
   - particle transport
   - Joule heating (= $\sigma_{ped}E^2$) in the ionosphere

III. Include more accurate calculations of ionospheric conductance based on ionospheric transport equations using the *Strickland et al.* [1993] B3c code rather than empirical relationships of *Robinson et al*. [1987].

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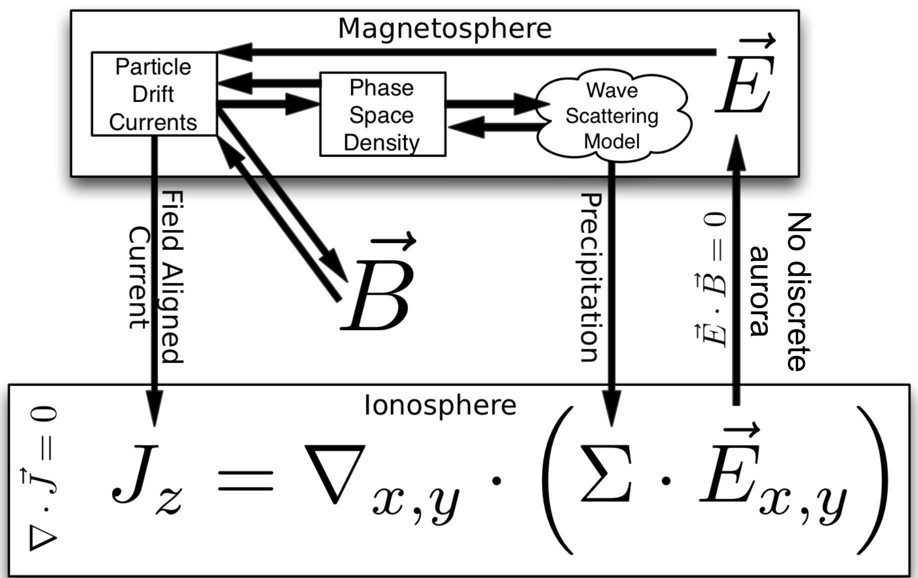
RCM-E (Aerospace's Version)

- Computes bounce-averaged guiding center drift of isotropic ions and electrons
- Electric field & magnetic field are self-consistent with the plasma [*Lemon et al.*, 2003].
- Simple plasmasphere model with refilling rate of *Denton et al*. [2012].



Current Continuity and Ohm's Law

See [*Toffoletto et al*., *Space Sci. Rev*., 2003]

M-I Coupling through

- Particle precipitation that affects ionospheric conductance Σ. For Σ use relations of
  - *Robinson et al.* [*JGR*, 1987] for electrons
  - *Galand and Richmond* [*JGR*, 2001] for protons
- Field-aligned or Birkeland currents J_z that depend on particle pressure gradients
- Ionospheric electric field

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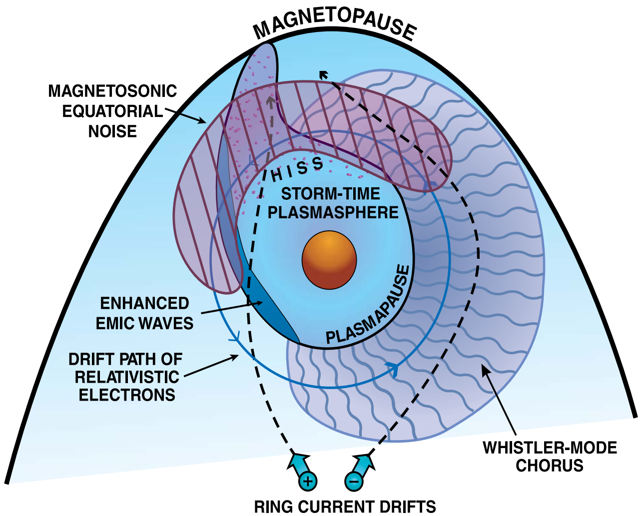


From *Thorne* [*GRL*, 2010]

Electron Loss

Kp- and MLT-parameterized scattering due to whistler chorus [*Orlova and Shprits*, *2014*] **and plasmaspheric hiss** [*Orlova et al.*, 2014]

Fitted quasi-linear p. a. diffusion coefficients calculated using statistical wave properties from CRRES & Polar to functions.

Fill gaps: 8–10 R_E and 15–21 MLT outside plasma-sphere, smoothed parameterized rates. **1 – 3 R_E**, used *Chen and Schulz* [2001] scattering rate.

H^+ and O^+ Ion Loss

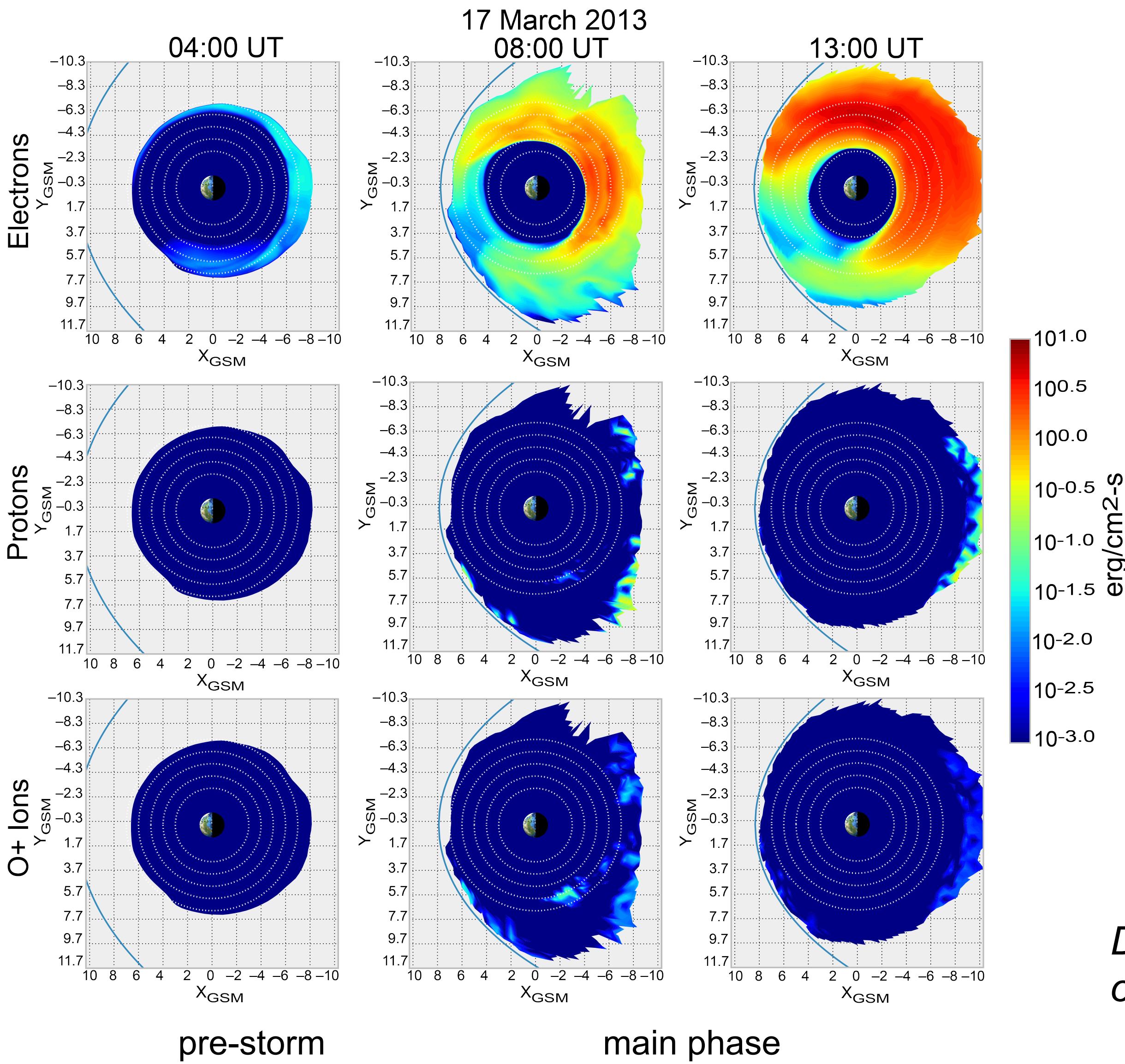
Charge exchange with neutral H

Ion precipitation due to field line curvature (FLC) scattering modeled by

$$\boxed{\lambda_{ion\_FLC} = \text{minimum}(100 \cdot \varepsilon^5, 1) \cdot \lambda_{ion\_strong}}$$

where $\varepsilon = r_{gyro}/r_{curvature}$ and λ_{ion_strong} is the strong ion pitch-angle scattering rate given by *Schulz* [1971].

RCM-E Precipitating Energy Flux at 850 km (equatorial view)



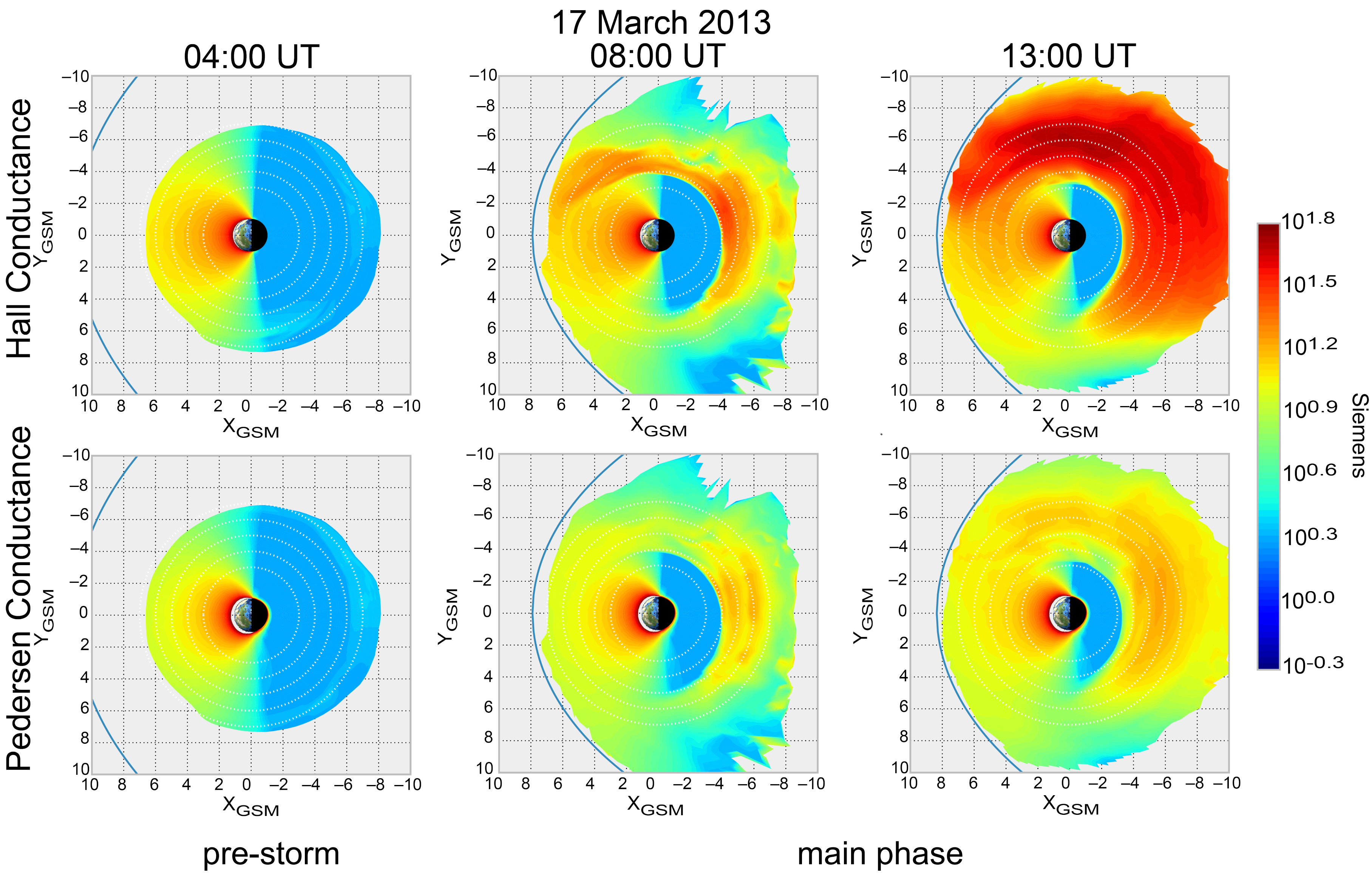
Overall, electrons dominate total precipitating particle energy flux

Precipitating electron energy flux tends to be larger on morning side

There can be localized & transient precipitating H^+ and O^+ ion energy fluxes typically near dusk to pre-midnight.

Dotted white circles have radius of 3, 4, …, 7 R_E.

Model Ionospheric Conductance (equatorial view)



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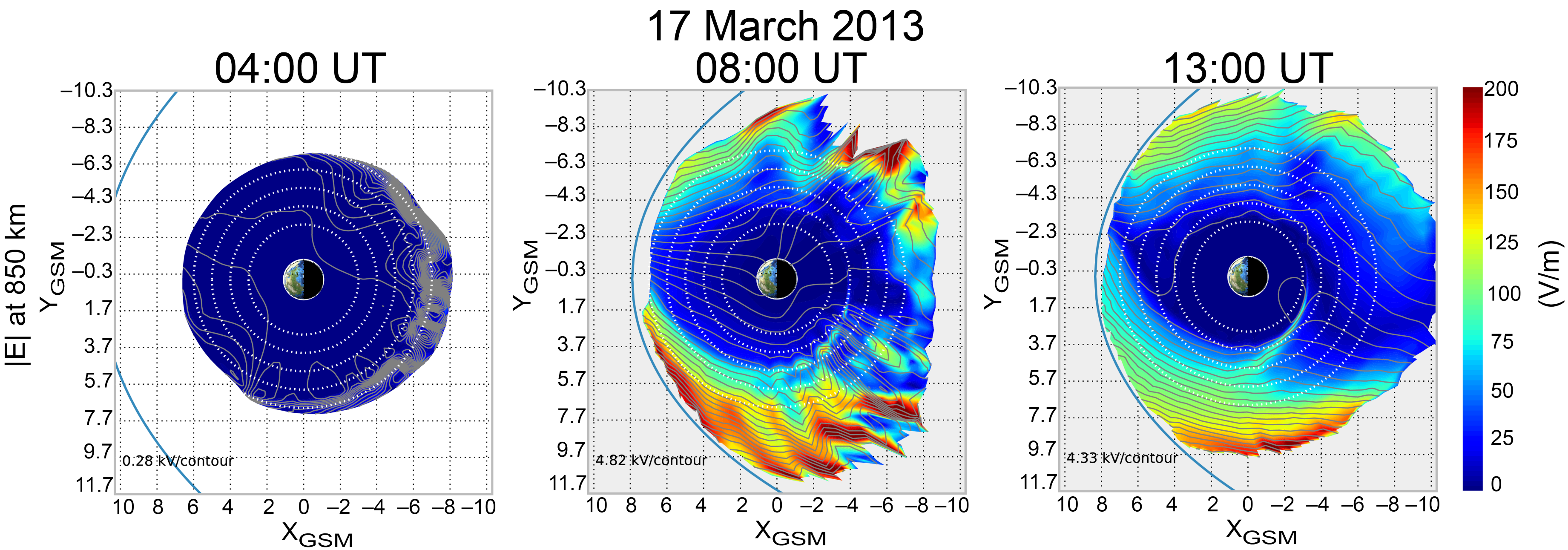
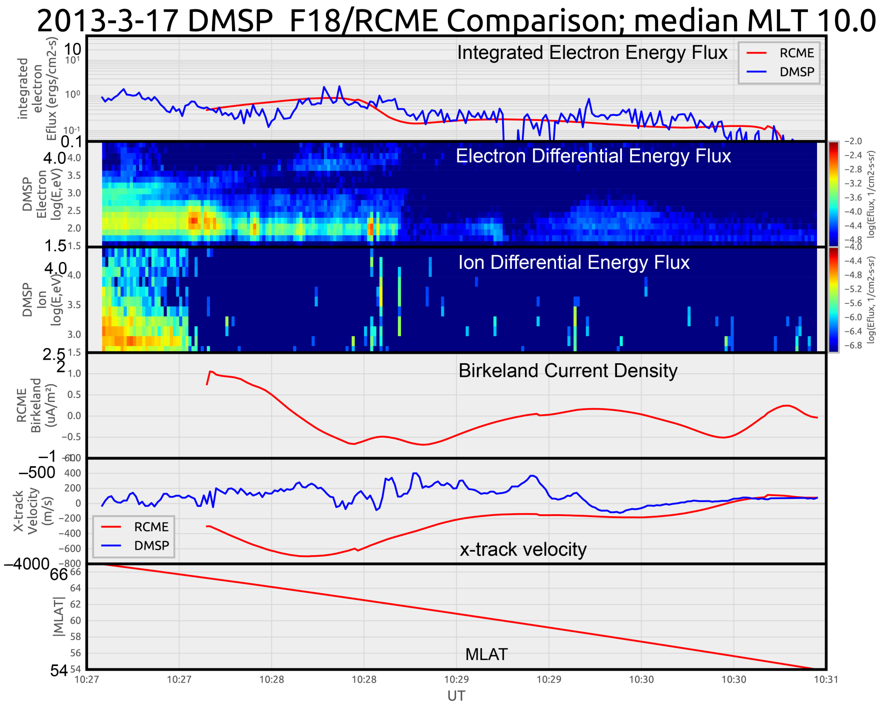
RCM-E Electric Field Intensity at 850 km (equatorial view)



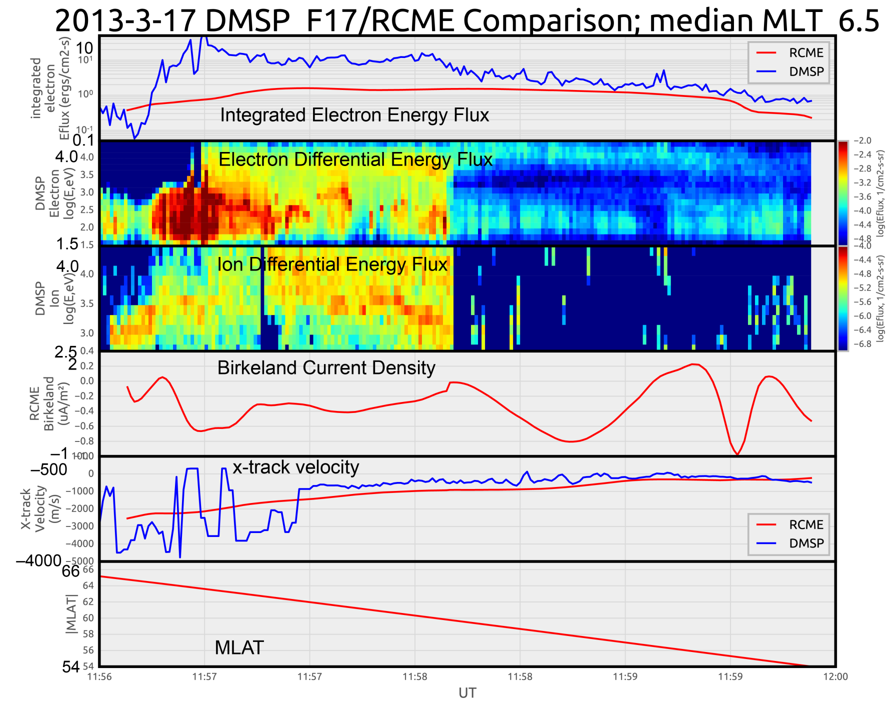
- During early main phase, |E| gets very strong between afternoon and pre-midnight ~7 to 10 R_E; partially due to low conductance where electron scattering from waves is relatively smaller.
- Perhaps also as a result of too much shielding that may be alleviated by including plasma bubbles on the outer boundary in the future.
- Simulations show formation of Subauroral Polarization Streams (SAPS) that occur as low as L ~ 3.

DMSP-RCM-E Comparisons

Dayside 10:00 MLT



Dawn 06:30 MLT



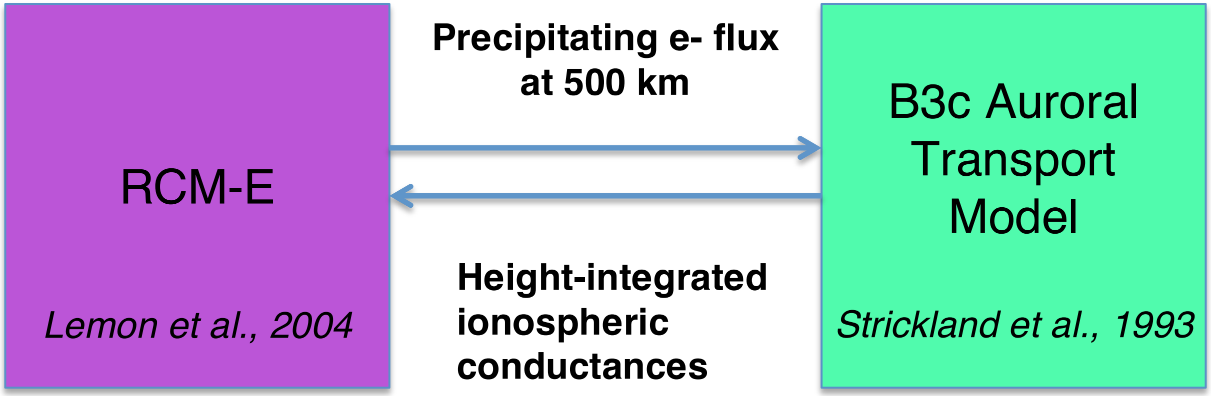
- RCM-E precipitating electron energy flux roughly similar to DMSP observations in the dayside example; underestimate DMSP values at higher latitudes where discrete aurora are observed in the dawn example; including loss due to scattering with ECH waves may help.

- RCM-E and DMSP E x B velocity tend to agree better at lower latitudes but not as well at higher latitudes.

Improve calculation of ionospheric conductance

- RCM-E currently uses *Robinson et al.* [1987] empirical formulas to estimate "auroral" conductance.

- B3c [*Strickland et al*., 1993] computes the coupled set of linear Boltzmann equations for e^-, H^+, and H atom fluxes with full inclusion of collisional processes [*Basu et al*., 1993].



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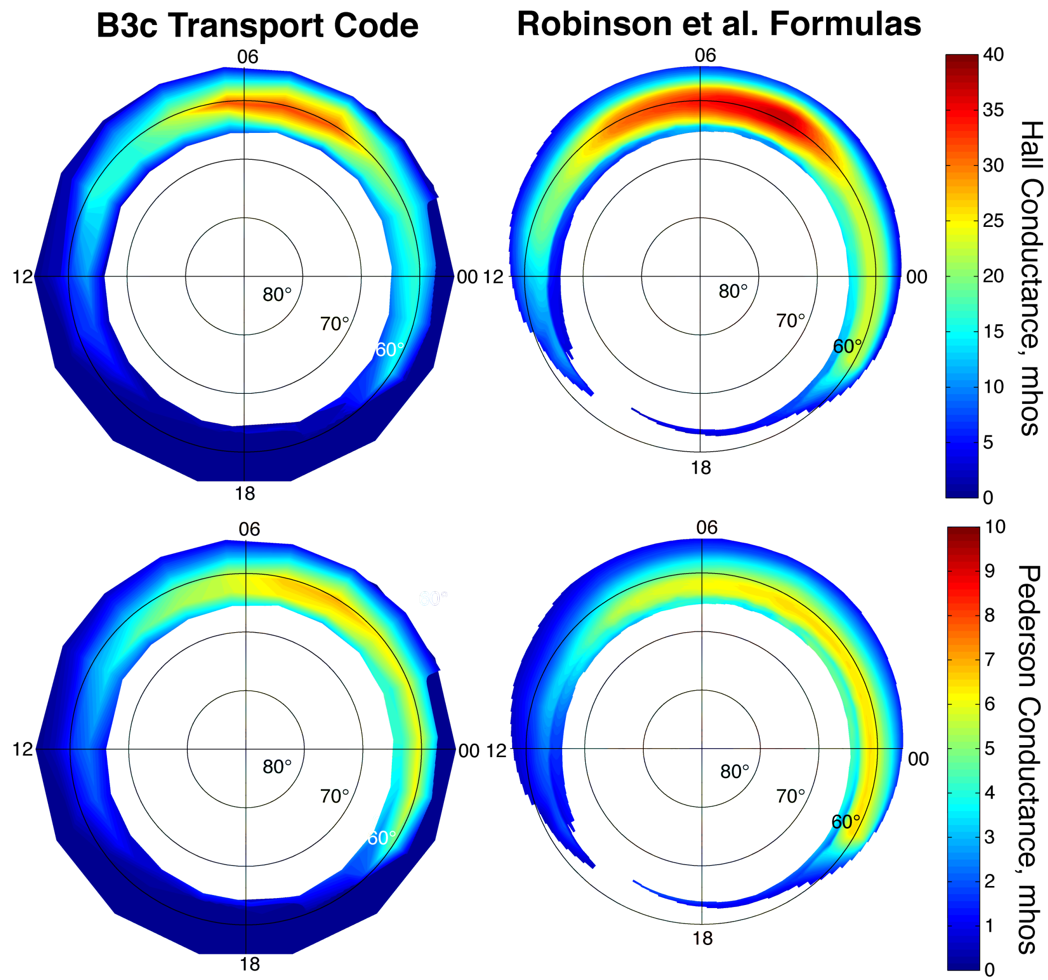
Simulated Ionospheric Conductance

- Pederson conductance from B3c and *Robinson et al.* formulas are roughly comparable.
- From pre-midnight to noon, B3c Hall conductance tends to be smaller than those from the *Robinson et al.* formulas. Lower conductance would lead to a larger electric field.
- Develop two-way coupling between RCM-E & B3c in future



06:00 UT on 11 August 2000

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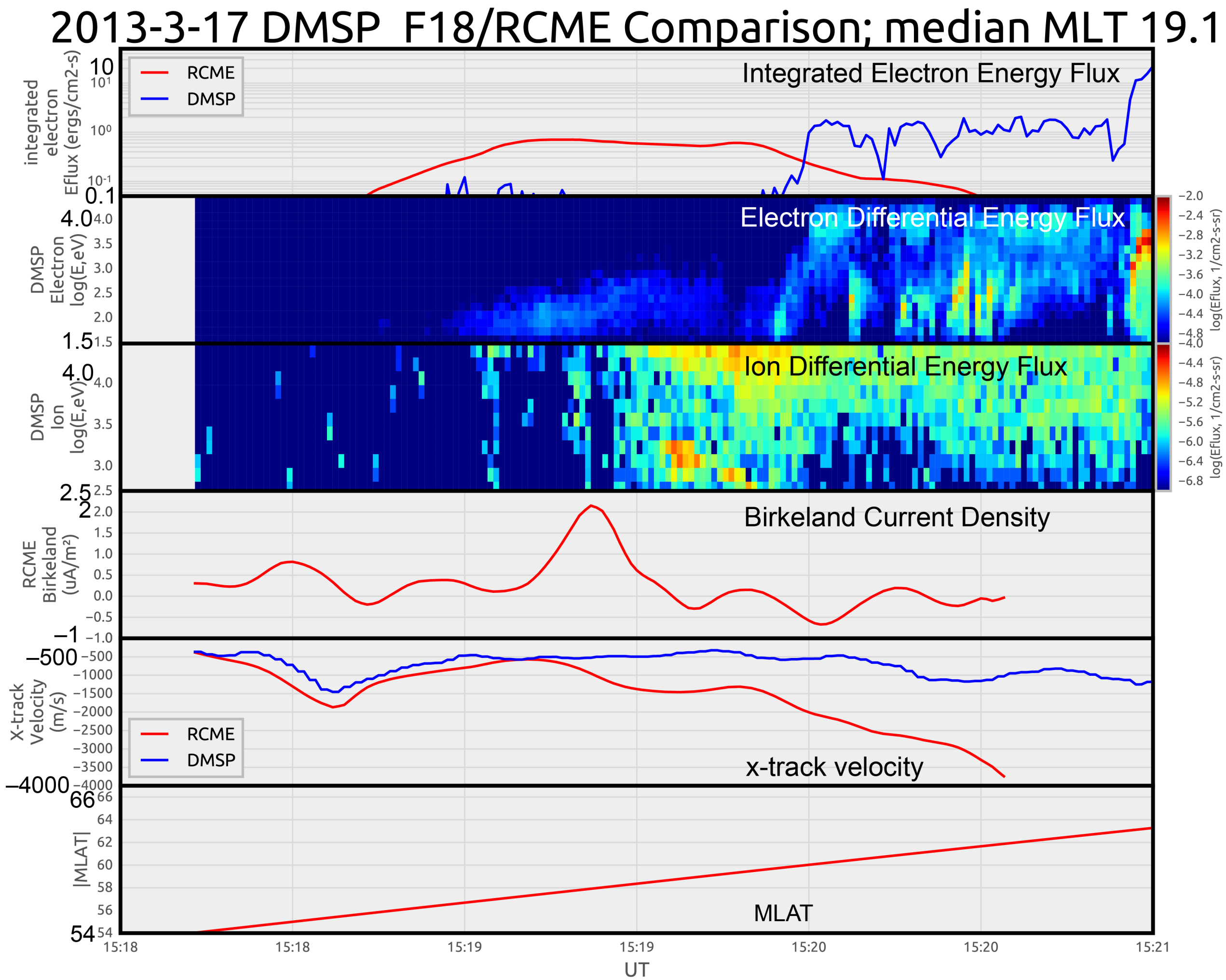
Back up slides

RCM-E & DMSP Comparison Near Dusk



15:19 UT

Underestimate electron and ion precipitation at ~60–62° MLAT or ~7 – 10 R_E leads to smaller conductance and overestimate of E x B velocity. Evidence of too much shielding.

MLAT and SAPS peak velocity agree better in this example.

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