Understanding Geospace dynamics and the effect of MI coupling

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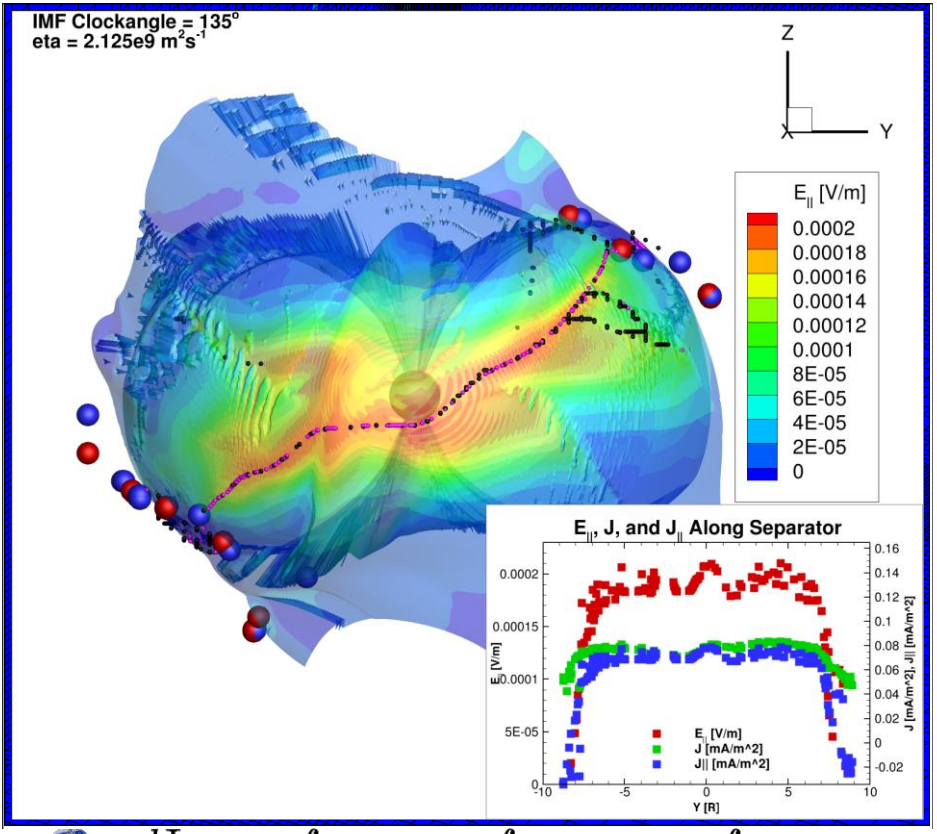
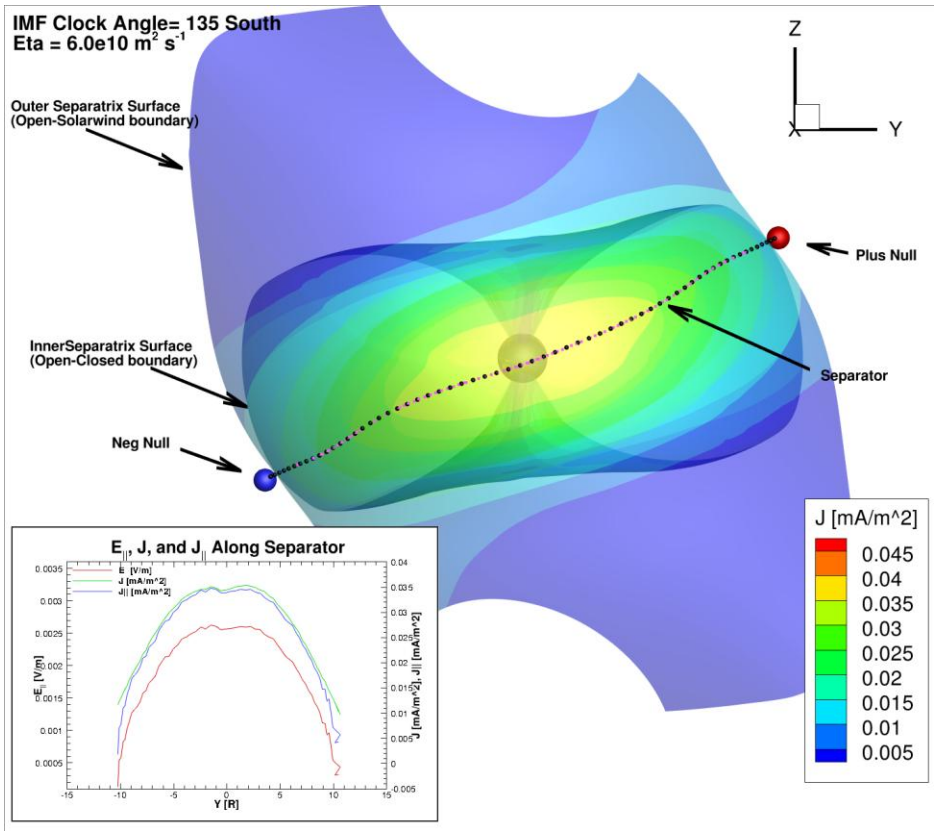
Geospace Physics Laboratory

GEOSPACE REVISITED: RHODES, Sep 2014

Quantitative Reconnection Rate Calculation

Alex Glocer, John Dorelli



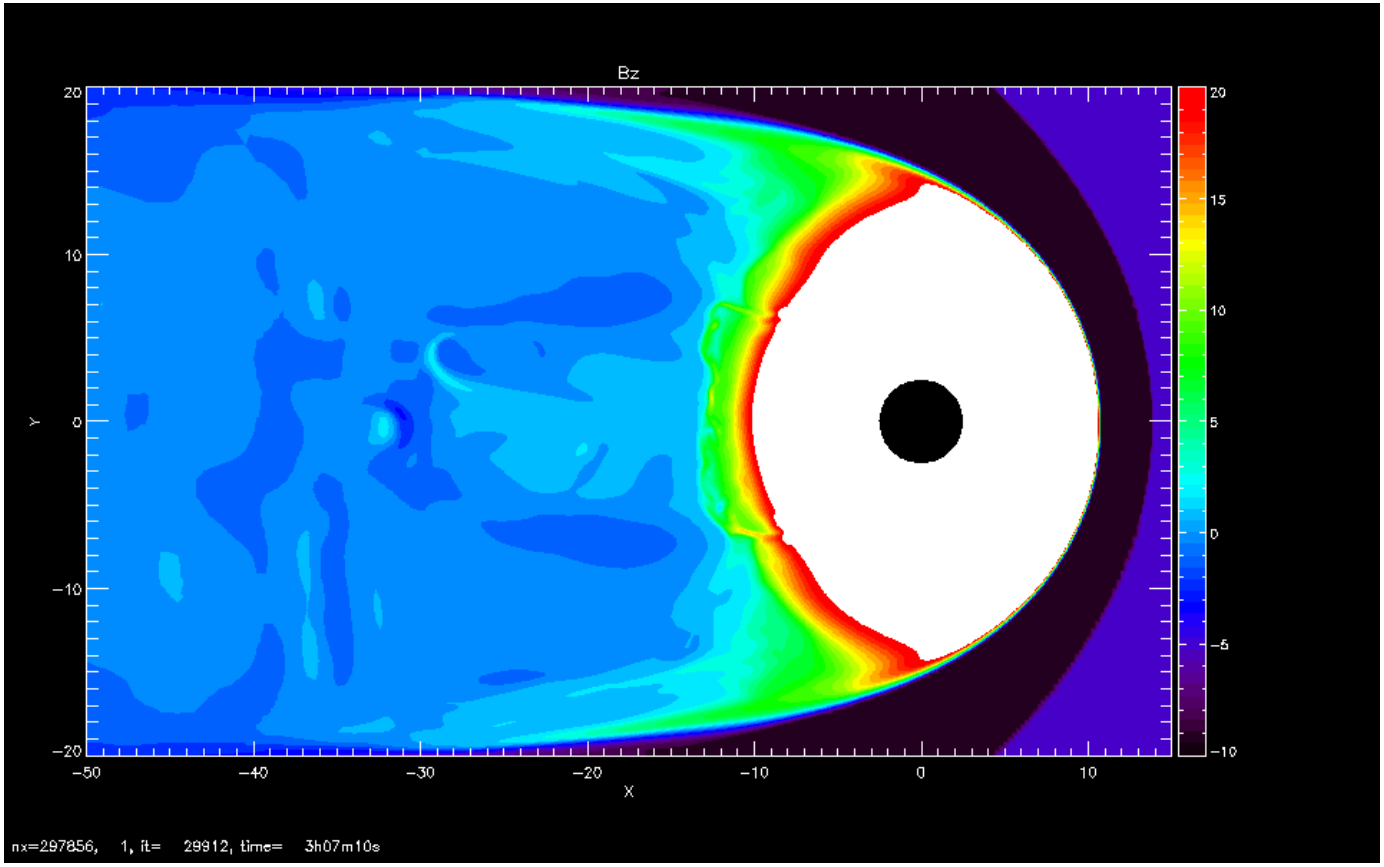


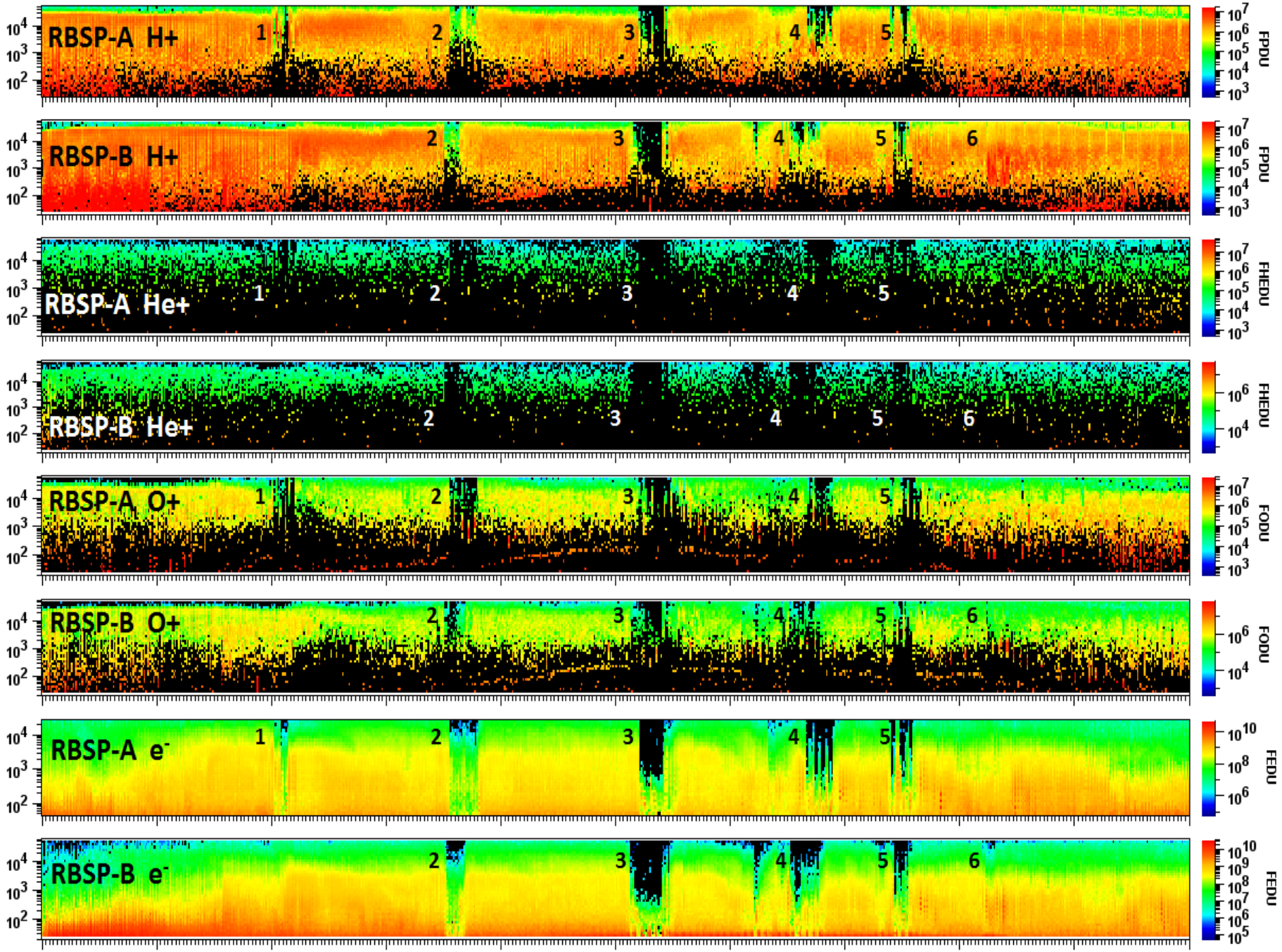
$$\frac{d\Phi_B}{dt} = \oint E_{\parallel} ds = \int_{DS} E_{\parallel} ds + \int_{NS} E_{\parallel} ds$$

- We focus here on the dayside, choosing a grid tailored to highly resolve the dayside MP.
- We have implemented 3 methods to determine the separator to arbitrary accuracy.

BATSRUS simulation of dipolarization fronts

John Dorelli, Natasha Buzulukova



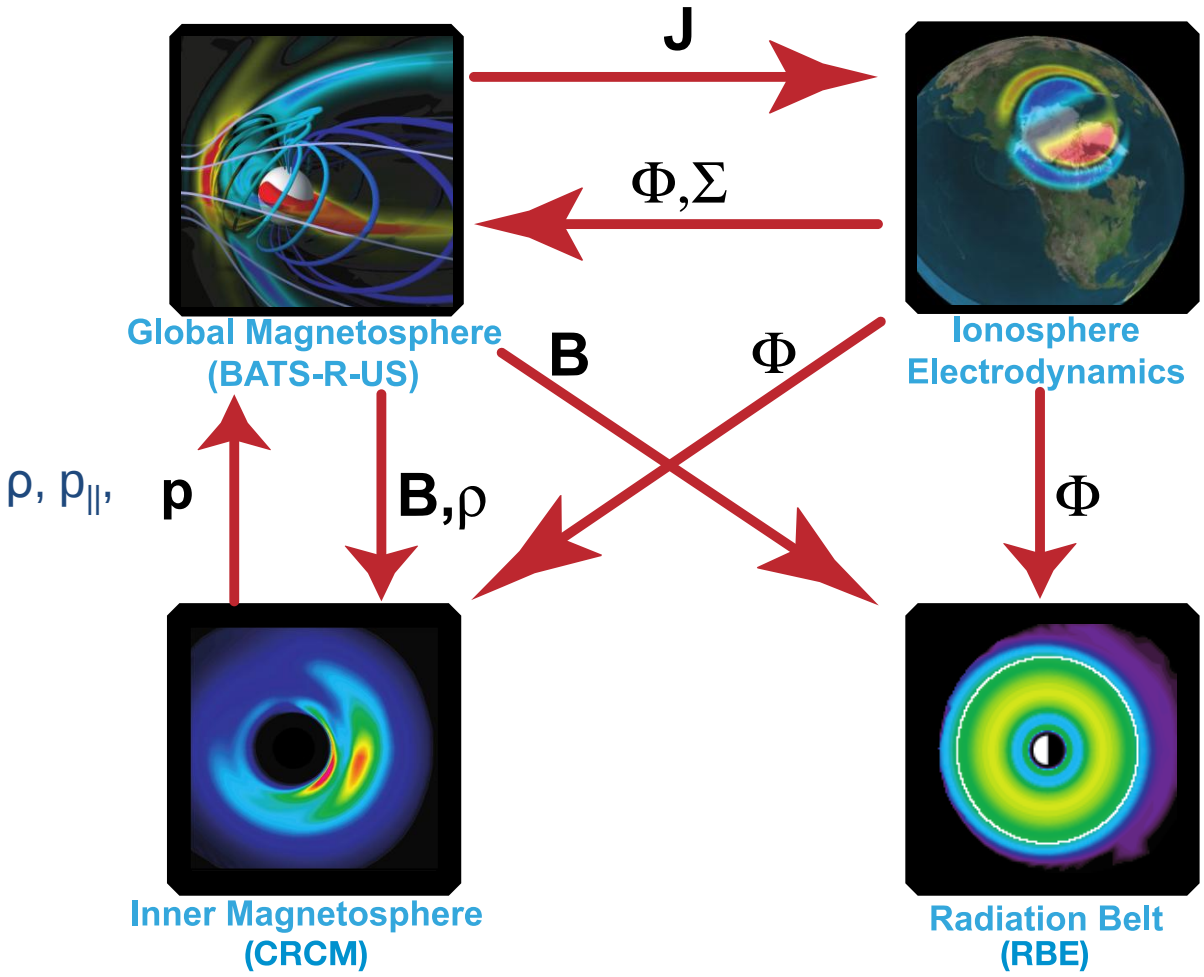

RBSP-A H+
RBSP-B H+
RBSP-A He+
RBSP-B He+
RBSP-A O+
RBSP-B O+
RBSP-A e-
RBSP-B e-
FPDU
FHEDU
FODU
FEDU
01:00
2012-11-14
01:30
02:00
02:30
03:00
03:30
04:00
04:30
05:00
05:30
06:00

HSD

NASA

A Fully Coupled Model of the Earth's Inner and Outer Magneotsphere

Interfacing GSFC's CRCM and RBE with UMich's SWMF



Alex Glocer
Mei-Ching Fok

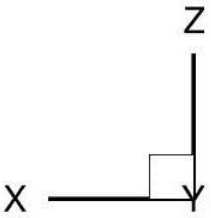
- Glocer et al. [2009, 2011, 2013], Meng et al. [2013]

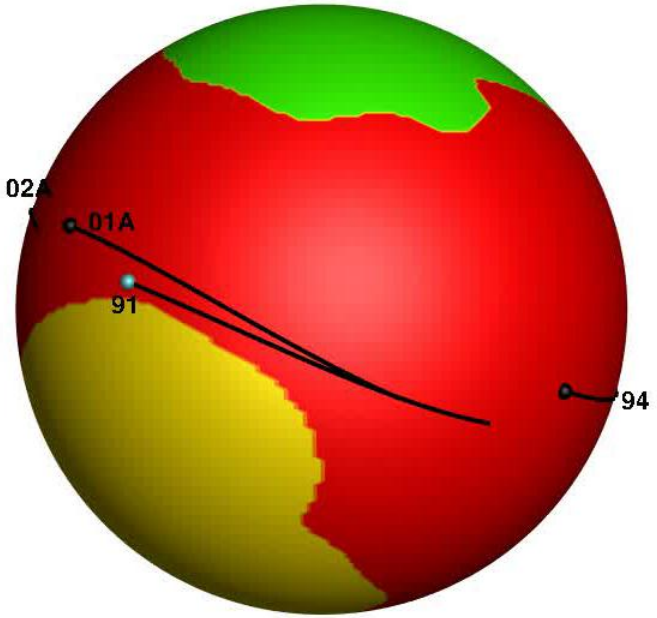
LANL-GEO trajectories 1991-080 and LANL-01A shown with pretty good correlation to observed dropouts predicted from BATSRUS+CRCM

Red = Closed field lines, Green = Open northern hemisphere, Yellow = Open southern hemisphere

Courtesy: Alex Glocer, GSFC

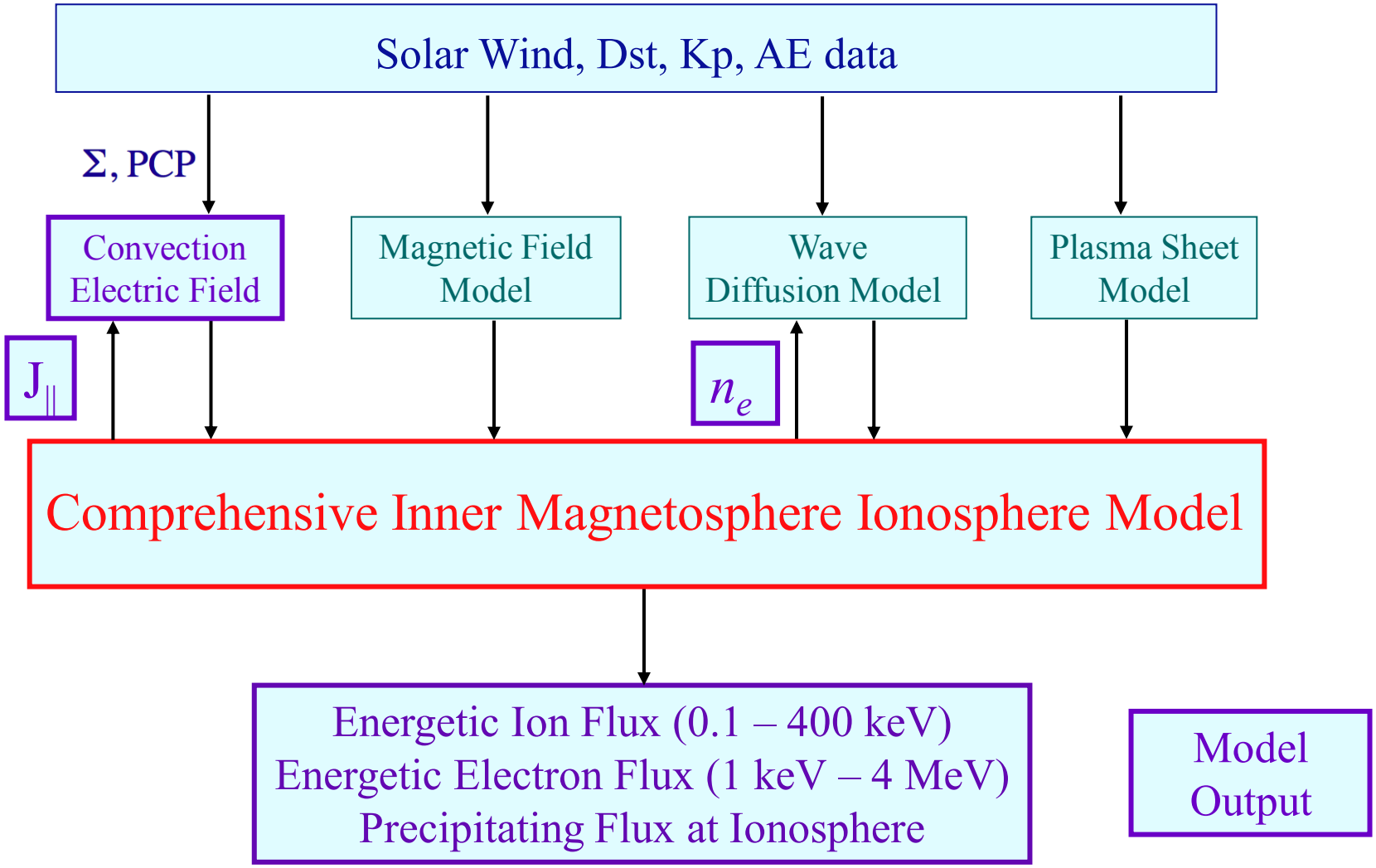
X-Z GSM plane looking at dusk, sphere is 6.6 R_e





November 14, 2012. Time [hours]= 1

CRCM + RBE = CIMI
Mei-Ching Fok



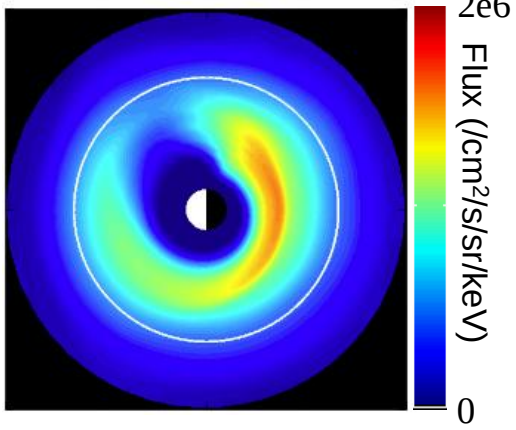
HSD

Comparison with TWINS

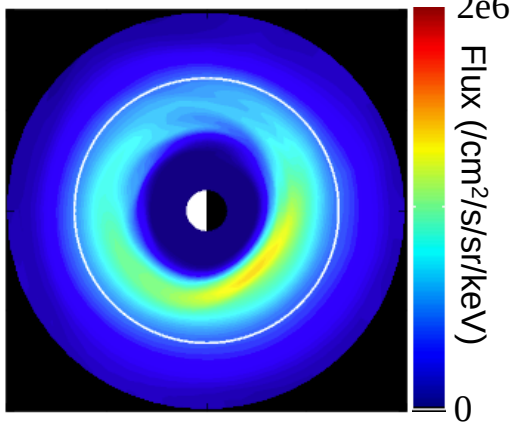
Storm Main Phase ~18:15 UT on 6 April 2010

CIMI simulations

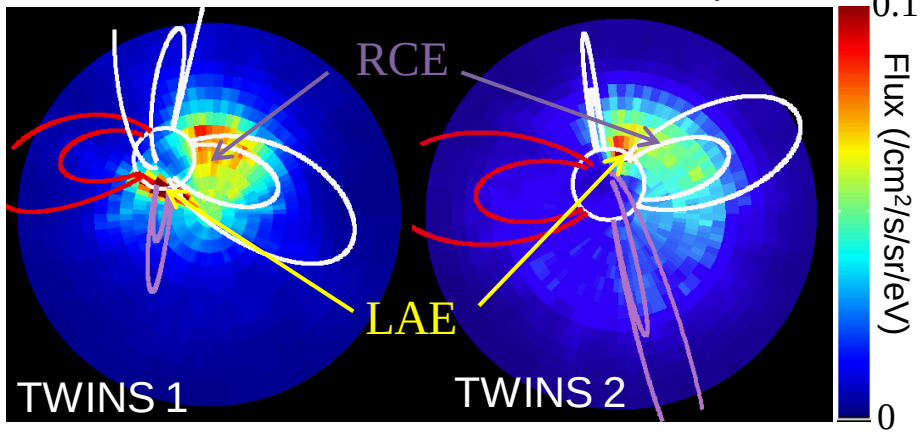
Run 1: 20 keV H^+



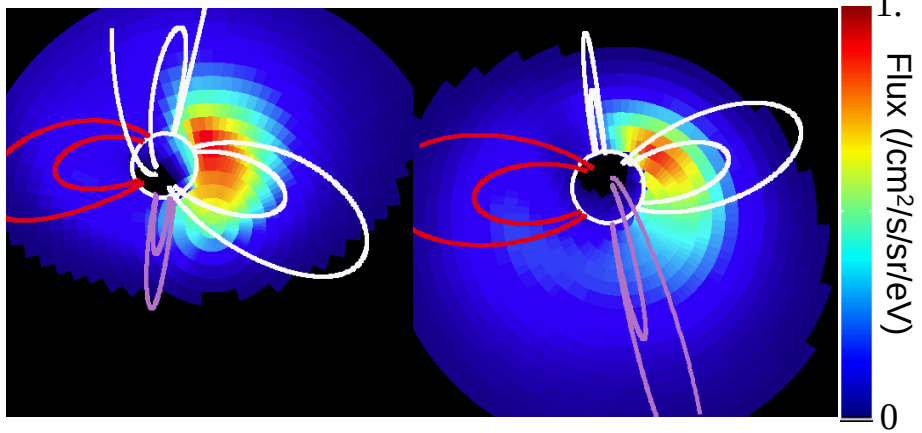
Run 2: 20 keV H^+



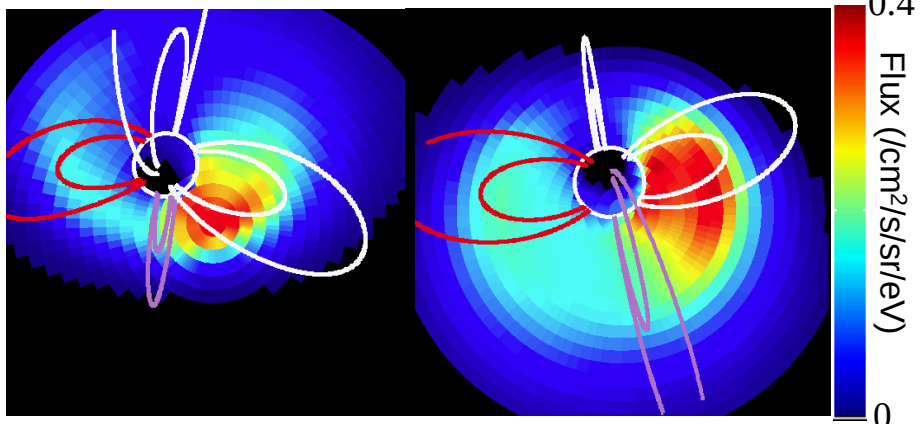
TWINS 20 keV H, 18:15-18:30UT, Apr 6



CIMI-SCE 20 keV H ENA



CIMI-Weimer 20 keV H ENA

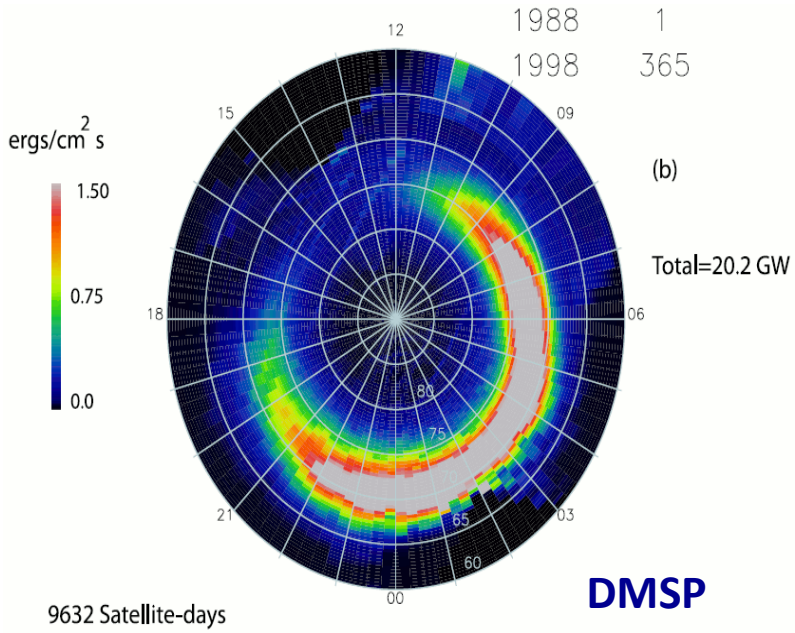


The Energy Interplay Studies in the Region of Diffuse Aurora: New Theoretical Approach – George Khazanov

Why is the diffuse aurora important?

Because Diffuse Aurora Accounts for About 75% of the Auroral Energy Precipitating Into the Ionosphere (e.g., Newell et al. [2009])!

(A)

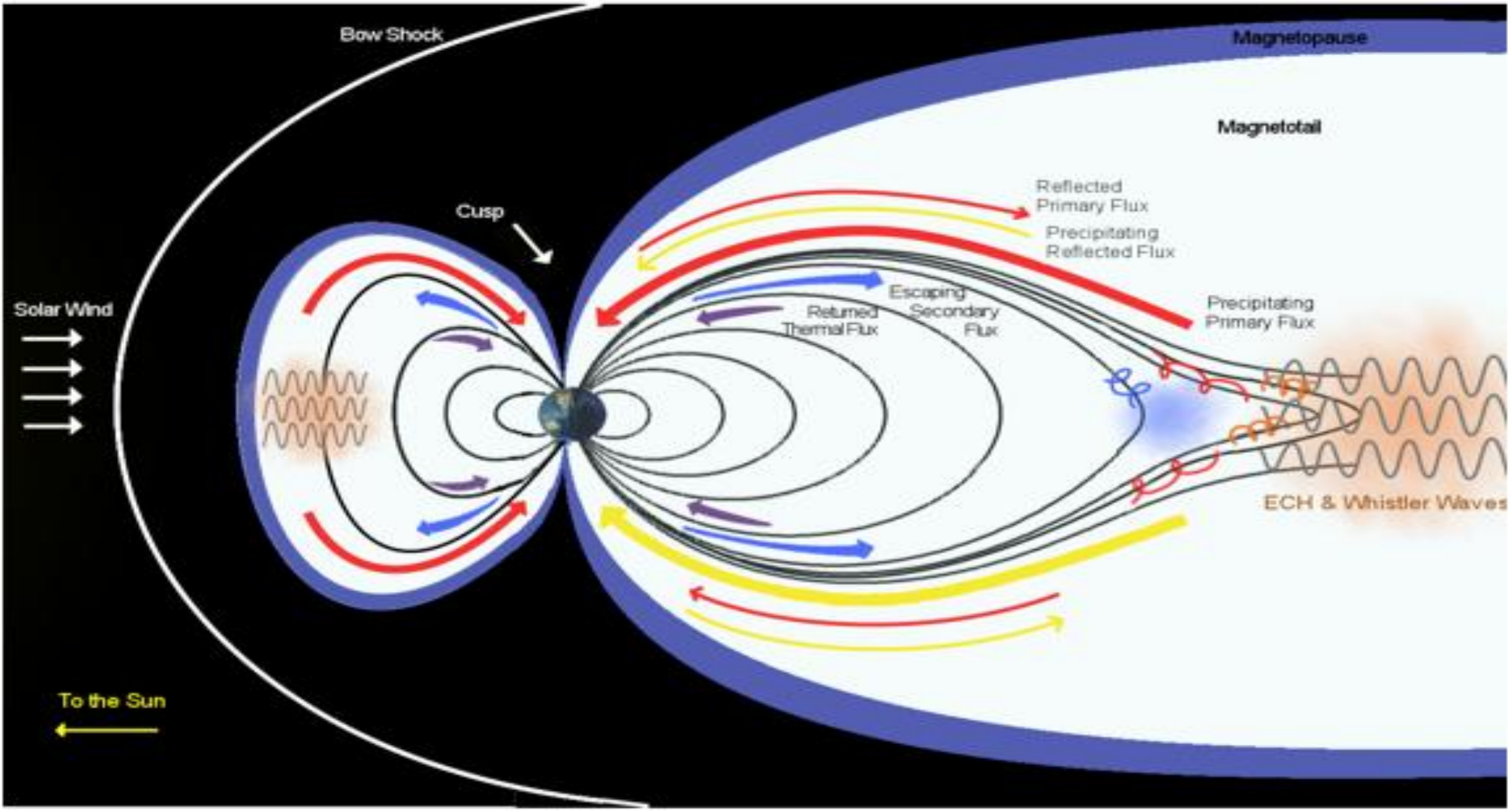


(B)

A- View From the Ground

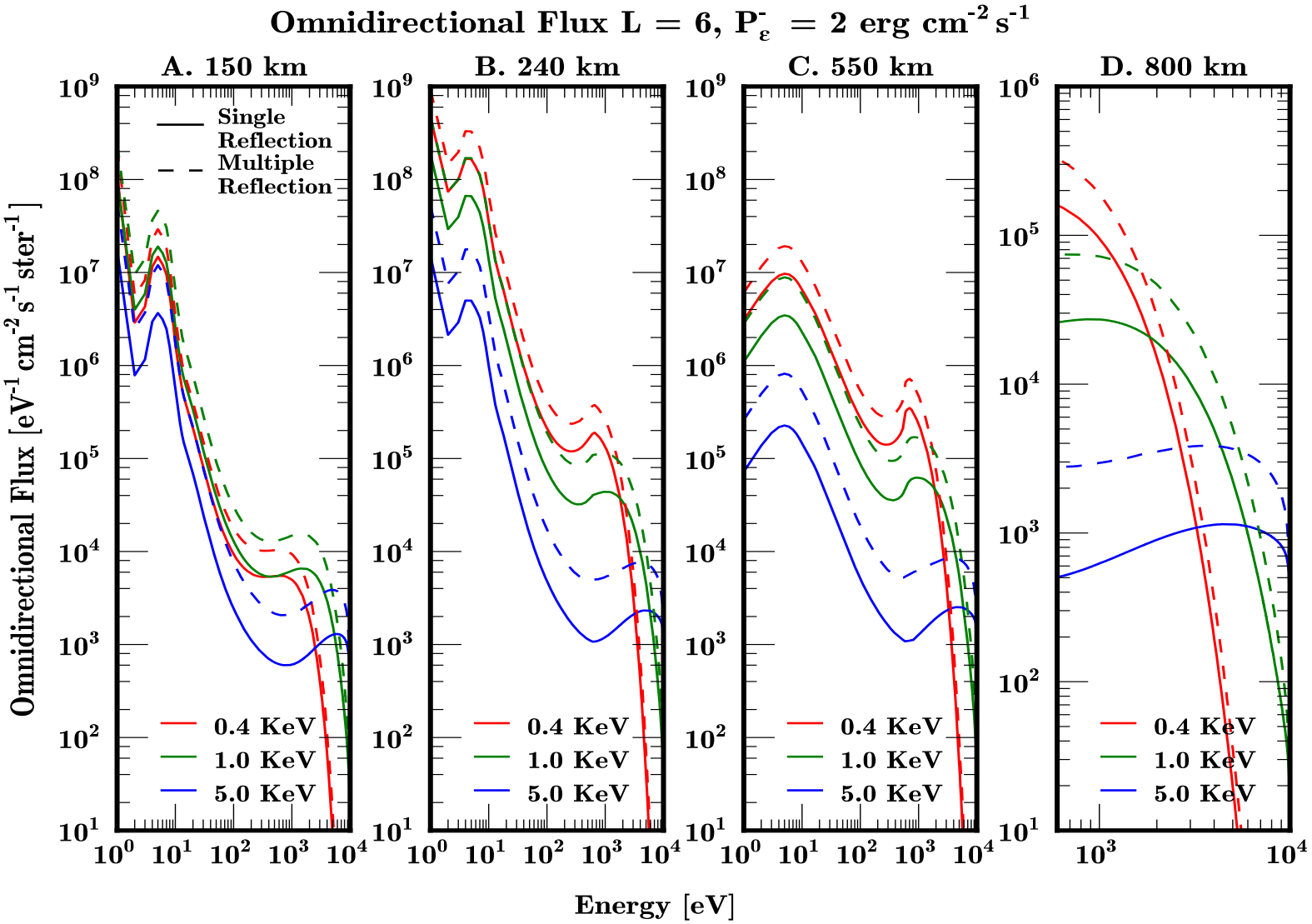
B- Energy Flux in Situ Measurement

Ionosphere-Magnetosphere SE Coupling in the Diffuse Aurora



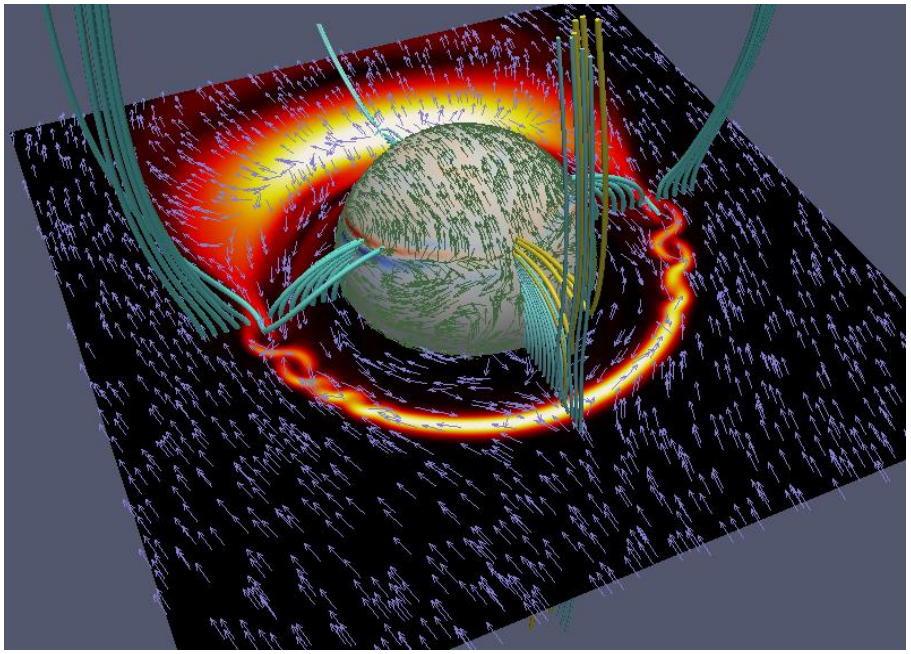
New Element: Multiple reflections of precipitated fluxes from the magnetically conjugated atmospheric regions. **What MIAC does?**

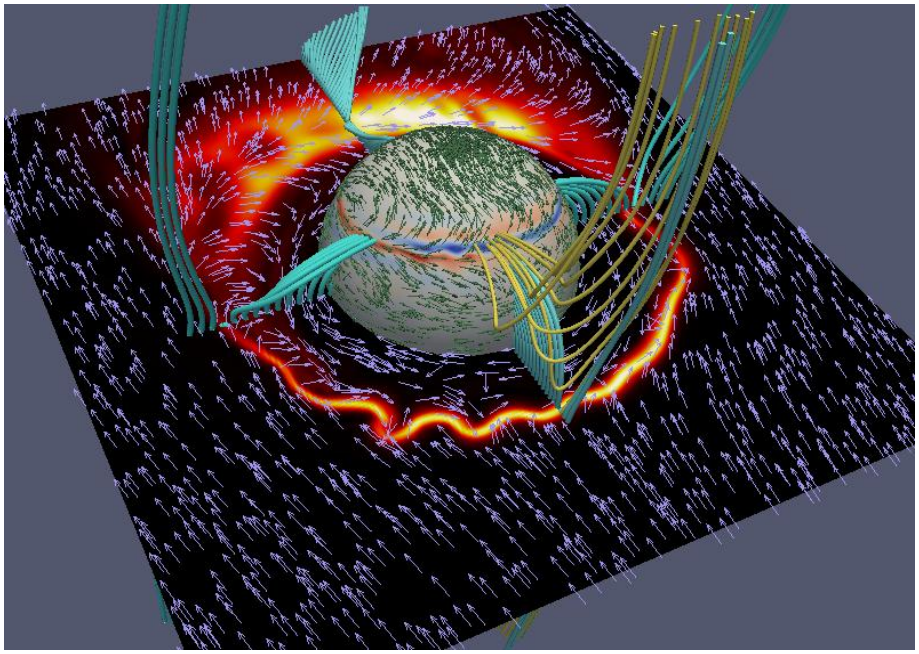
Ionosphere-Magnetosphere SE Coupling in the Diffuse Aurora



Key Result: A new picture of magnetospheric convection in Ganymede

John Dorelli, Alex Glocer

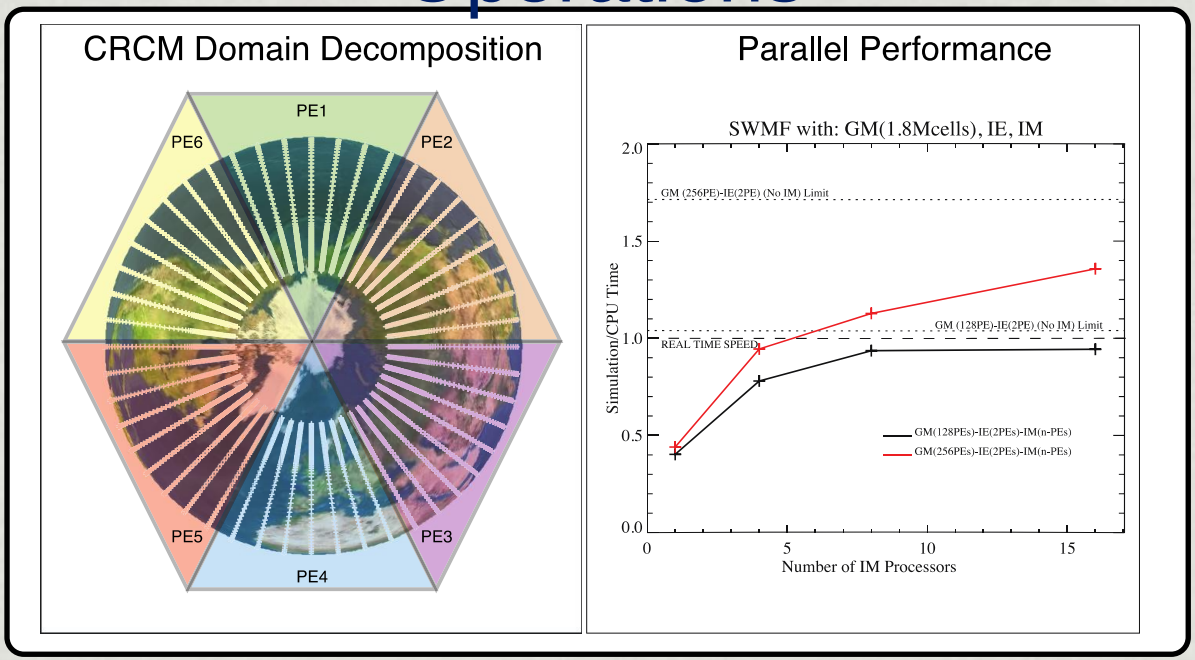




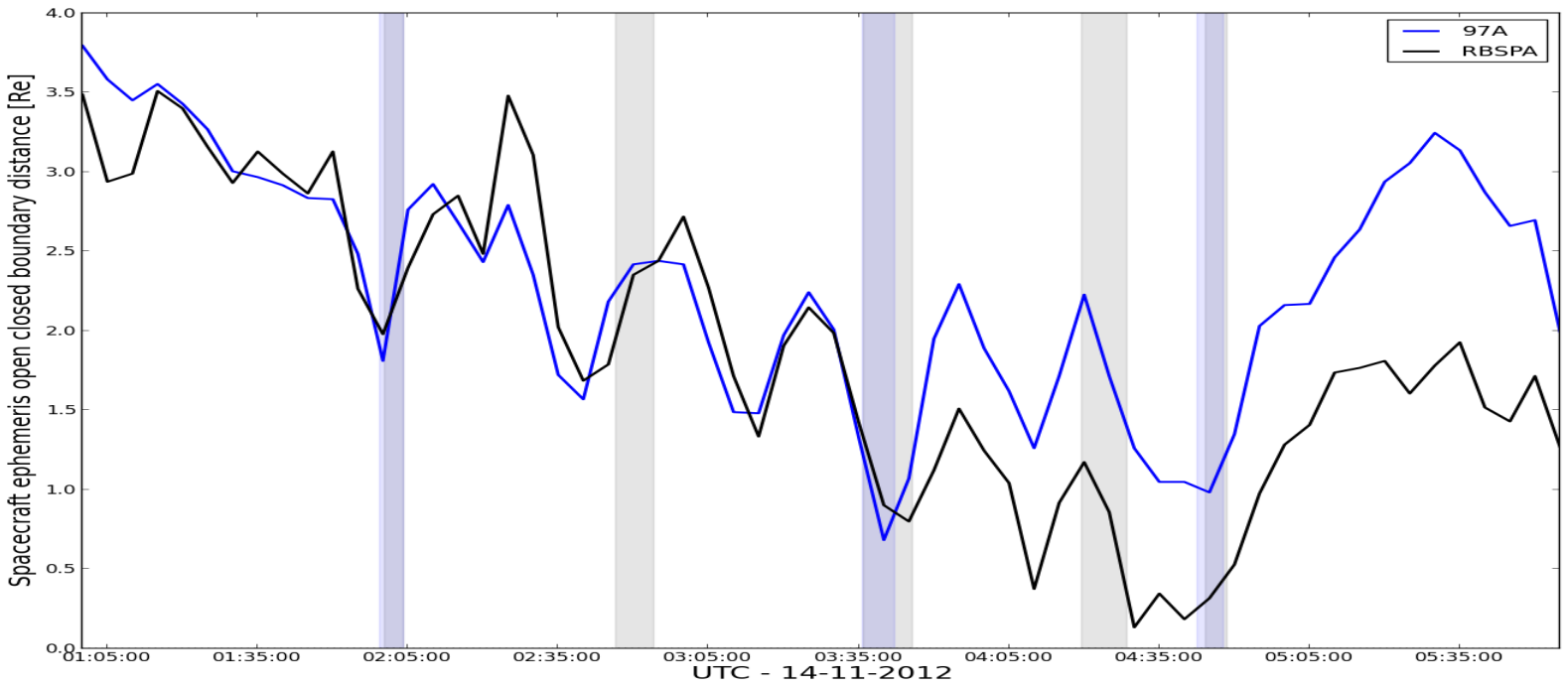
- **The classic Dungey Cycle convection pattern does not apply to Ganymede (MHD doesn't get the right pattern of "magnetospheric winds" – Hall MHD gets us much closer to the real picture).**
- **If these results "scale up" to Earth, the implications for space weather prediction would be significant.**
- **To get there, we need access to more powerful machines (e.g., large GPU clusters like ORNL's Titan)**

Backup Slides

Now Parallelized for NASA Supercomputers, the Model can be Evaluated for Space Weather Operations



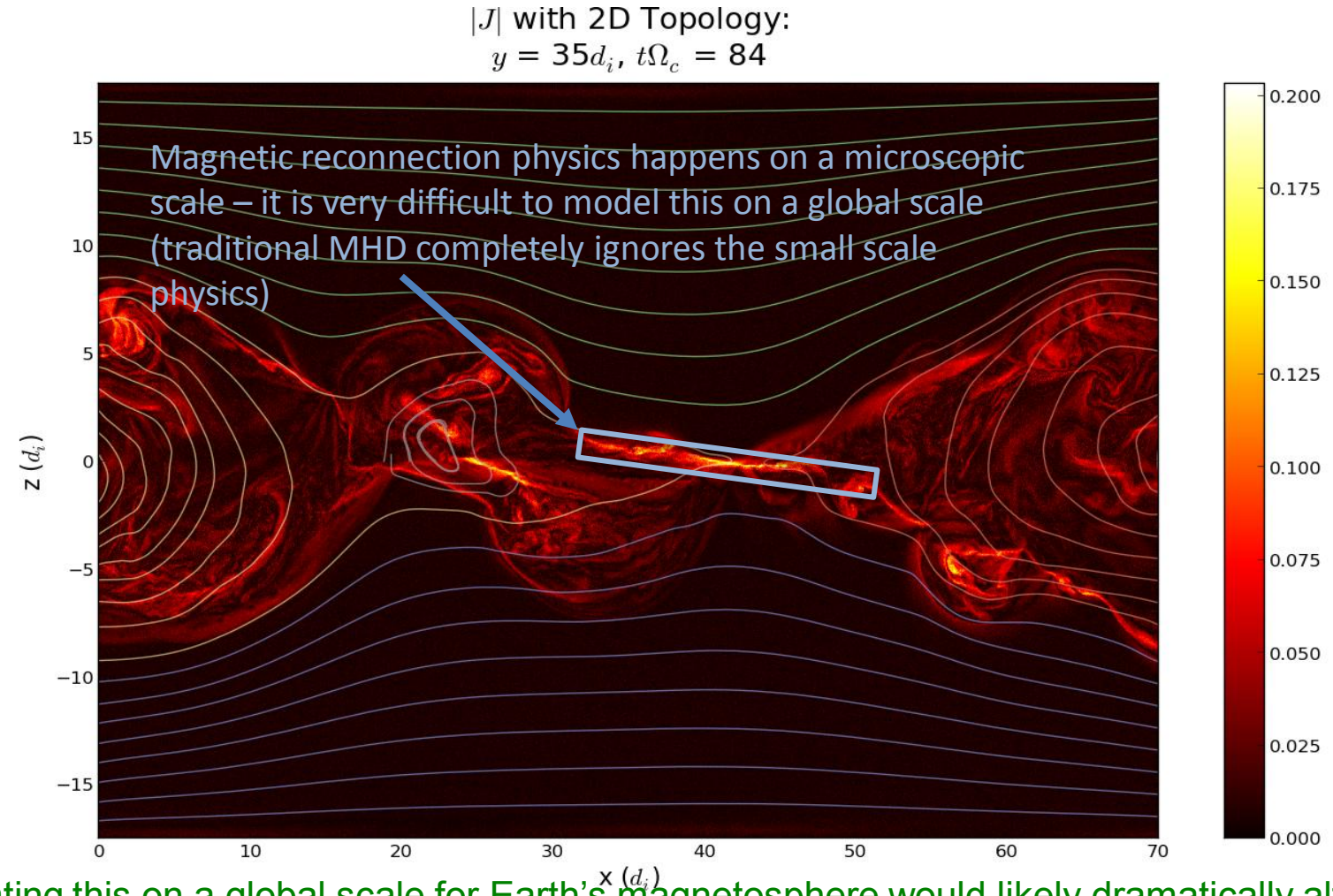
- Space weather applications require faster than real-time performance.
- Parallelized with domain decomposition, GSFC's CRCM model has achieves significant speedup.
- High resolution Magnetosphere-Ionosphere-Ring Current simulations accounting for pitch-angle anisotropy are now possible in real time!
- This breakthrough is documented in:
  - Meng, X., G. Tóth, **A. Glocer, M.-C. Fok**, and T. I. Gombosi (2013), Pressure anisotropy in global magnetospheric simulations: Coupling with ring current models, J. Geophys. Res. Space Physics, 118, 5639–5658.



Glocer's new data-model comparison technique, Follow the s/c trajectory and calculate the nearest boundary in the model…

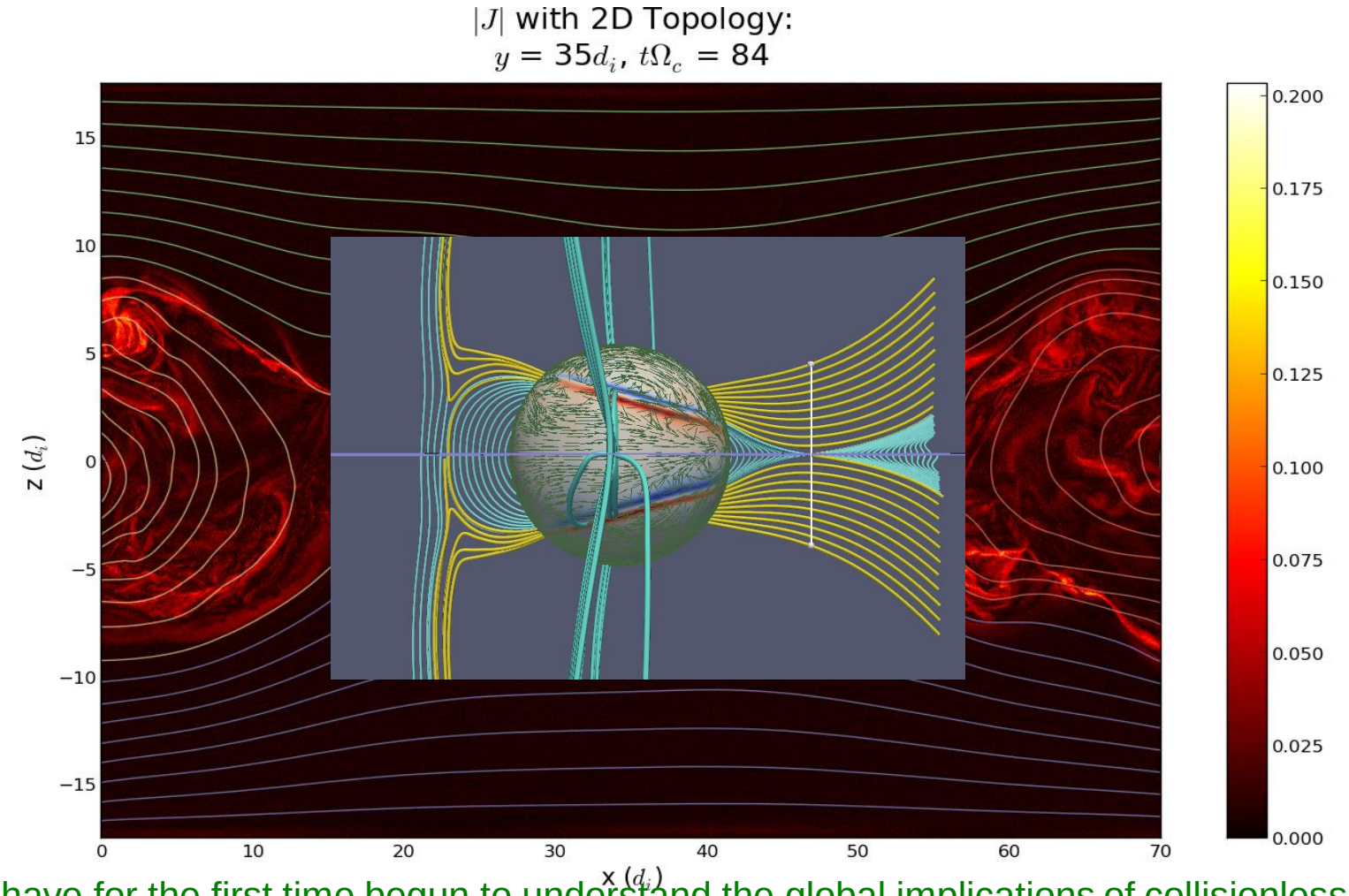
1) For spacecraft at positive and negative magnetic latitude, similar boundary behavior
2) Lobe crossing times correspond to decreases in the boundary distance, but ~2 Re off
3) Some consistency, 1) and 2) imply that model field not flattened enough and rippled ?

Long term goal: global kinetic model of Earth's magnetosphere



Simulating this on a global scale for Earth's magnetosphere would likely dramatically alter our basic picture of magnetospheric structure and dynamics; but we cannot currently fit such a problem on modern supercomputers.

Look for a microscopic magnetosphere: Ganymede!



We have for the first time begun to understand the global implications of collisionless reconnection; the results were surprising!