CCMC for Mission Science Support
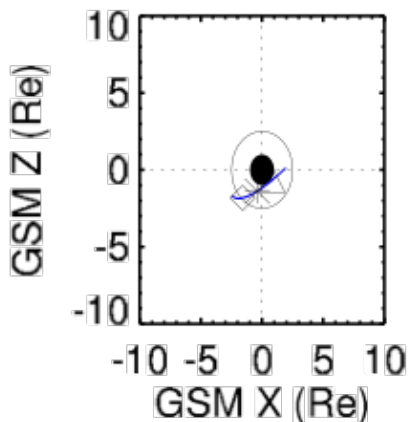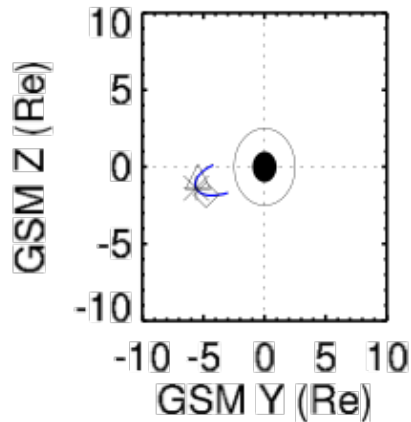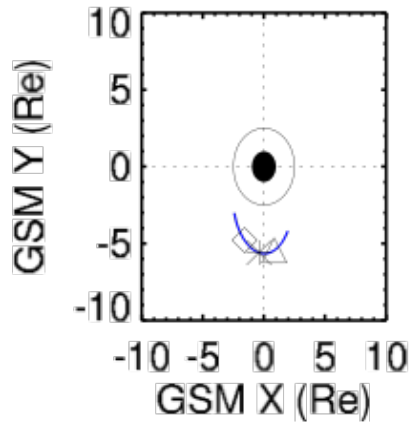
Alex Glocer

NASA/GSFC

Outline

- Focus on two missions in particular
  - Van Allen Probes
  - MMS
- In each case I will discuss my view of:
  - What CCMC currently has that supports the science carried out by these missions.
  - How existing models at CCMC can be augmented to further support mission science.
  - What models and capabilities exist in the community that could help CCMC better support mission science.
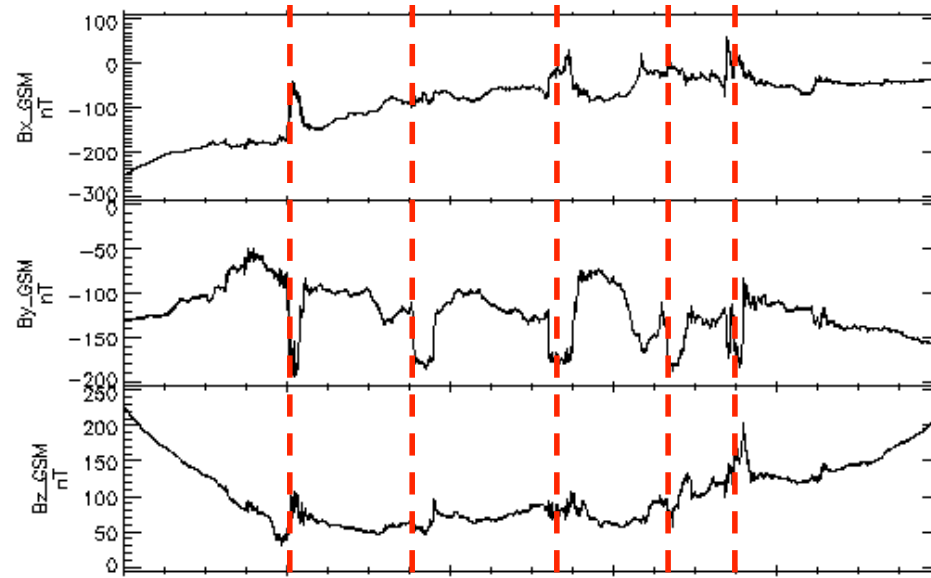
Van Allen Probes

- CCMC has quite a few resources that can support Van Allen Probes science.

  - Global Magnetosphere Models (LFM, OpenGGCM, SWMF): magnetic mapping and global context

  - Ring Current Models (RCM,CRCM,CIMI)

  - Radiation Belt Models (RBE,CIMI, VERB)

- CCMC is also providing access to beacon data and realtime CIMI runs for "instant look".

  - http://ccmc.gsfc.nasa.gov/ccmc-swrt-display/CIMI-T96/index.php
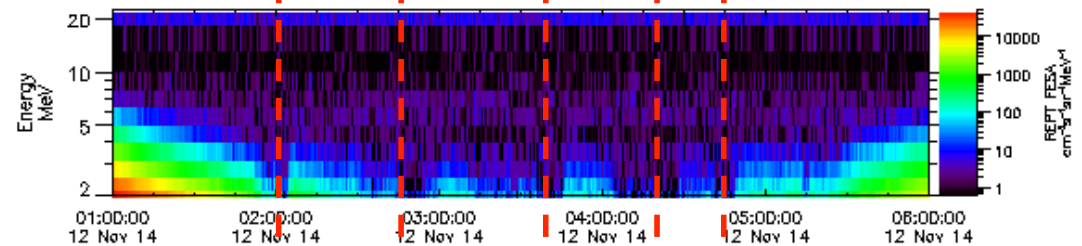
  - http://ccmc.gsfc.nasa.gov/RoR_WWW/RBSP/index.php

CASE STUDY: Nov. 14 2012

-10 -5 0 5 10
GSM X (Re)

-10 -5 0 5 10
GSM Y (Re)

-10 -5 0 5 10
GSM X (Re)

RBSPA, 11/14/2012 Event

nRMSE = 32.90/108.23= 0.304

RBSPA, 11/14/2012 Event

nRMSE = 36.75/124.79= 0.294

RBSPA, 11/14/2012 Event

nRMSE = 23.86/113.79= 0.210

November 14, 201...   ...er 14, 2012. Time [hours]= 4.4999998
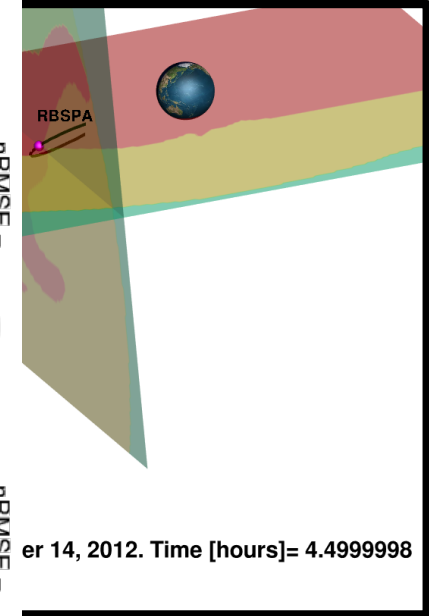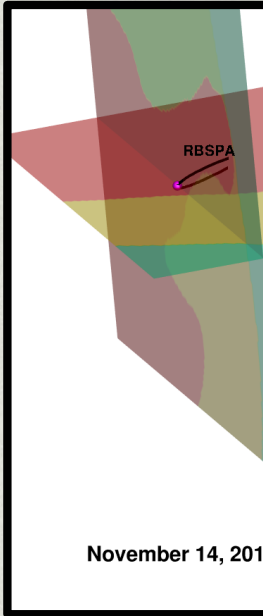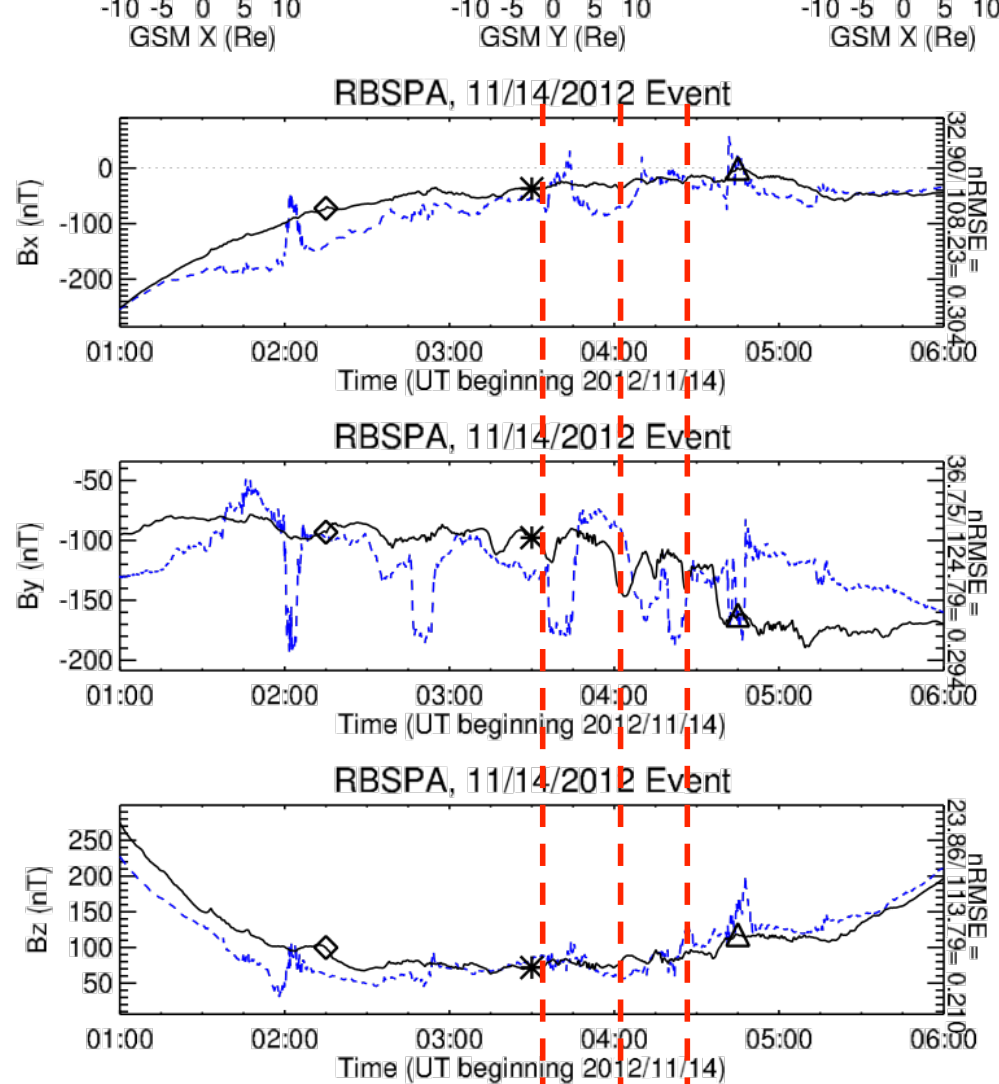
- RBSP A is seen to skirt the boundary OCB after about 3:30 UT until about 5UT.

- The periods where the s/c is closest to the OCB during this period correspond simulated By excursions.

- Some drop outs occur prior to this period so crossing OCB cannot explain those cases (at least in the model!)

- This demonstrates utility of magnetic mapping for understanding high energy particles
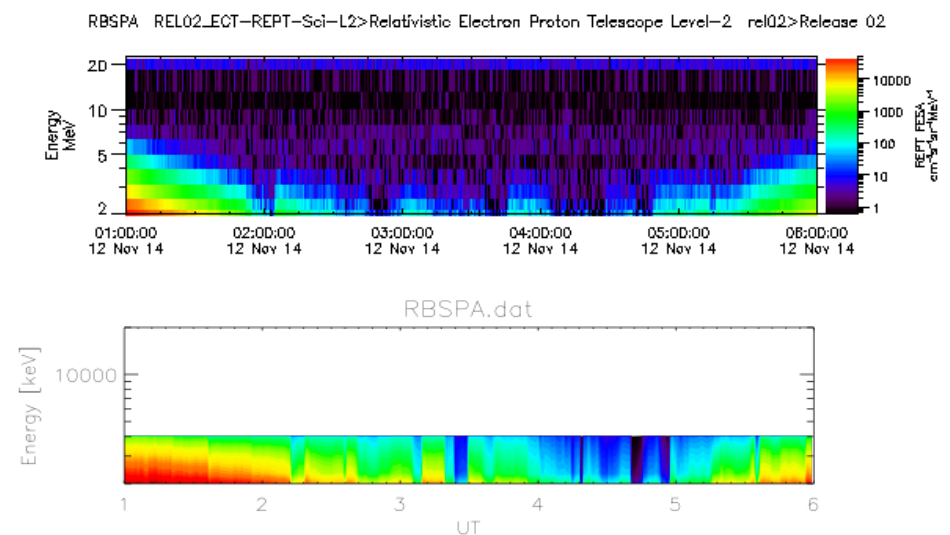
Examine the Response in Particle data

- It is useful to see the response in particle data as well.

- CRCM+RBE+SWMF available at CCMC, currently exports this data along the satellite trajectory.

- This capability is also present in the coupled RCM+SWMF

- We hope to soon have these types of plots available for any user to make when requesting a RoR.
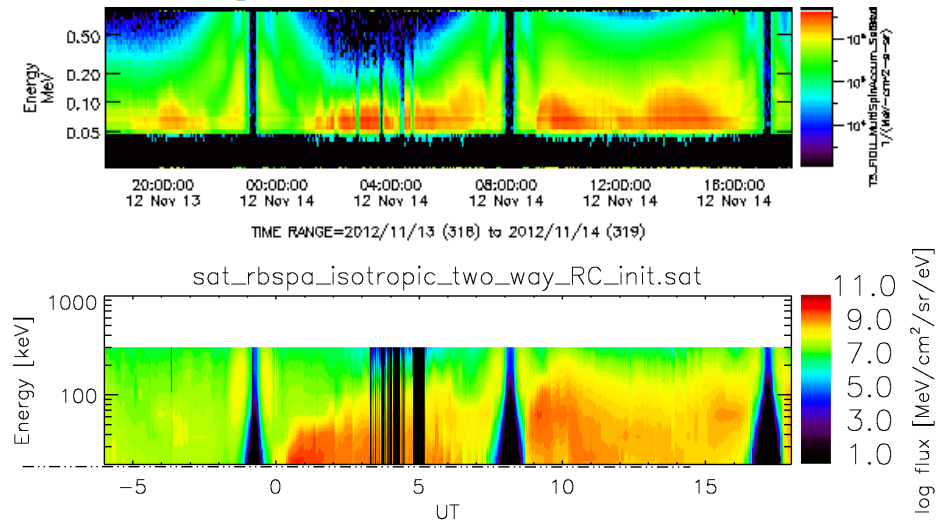
Studying the Open Closed Boundary

Z

X
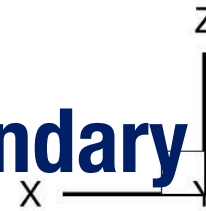
RED=Closed
GREEN=Open N.
Yellow=Open S.

02A
01A
91
94
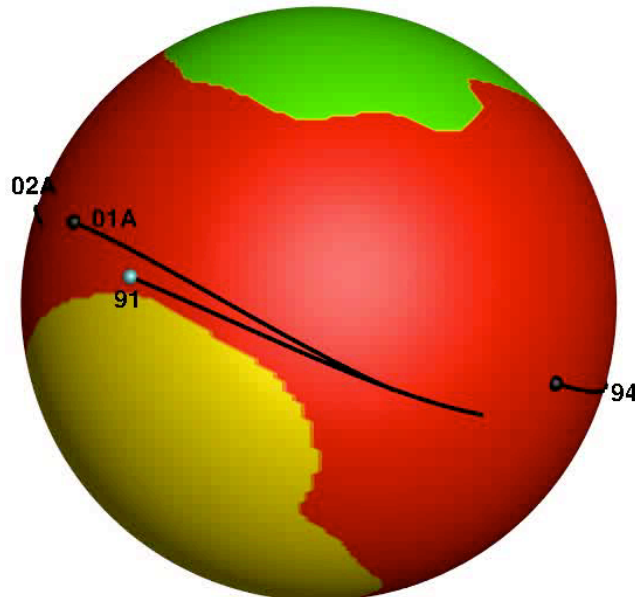
Sphere with radius 6.6 RE with topology sampled on surface

Lobe crossings are seen at geosynchronous orbit by 01A and 91
(Collaboration with Elizabeth MacDonald)

Visualization of a s/c proximity to a topological boundary is some times
more useful for understanding data than just an actual crossing prediction.

November 14, 2012. Time [hours]= 1

Looking at Wave Generation

- EMIC, Chorus, and Magnetosonic waves are major players in energy and pitch-angle evolution of IM populations.

- Some inner magnetosphere models available at CCMC can look at impacts of waves through the inclusion of diffusion coefficients.
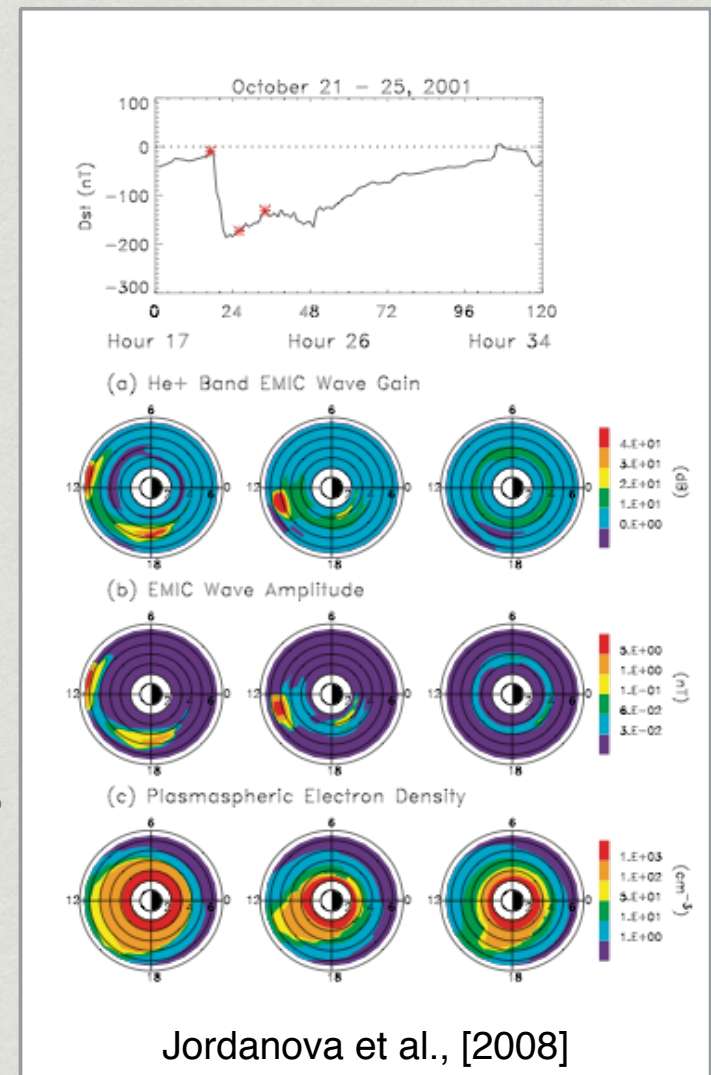
- Models looking at wave generation are not currently available at CCMC.

- Similarly models that calculate the diffusion coefficients expected from waves are not currently available.

- These are significant areas of need that could be remedied.

Jordanova et al., [2008]

Magnetospheric Multiscale Mission
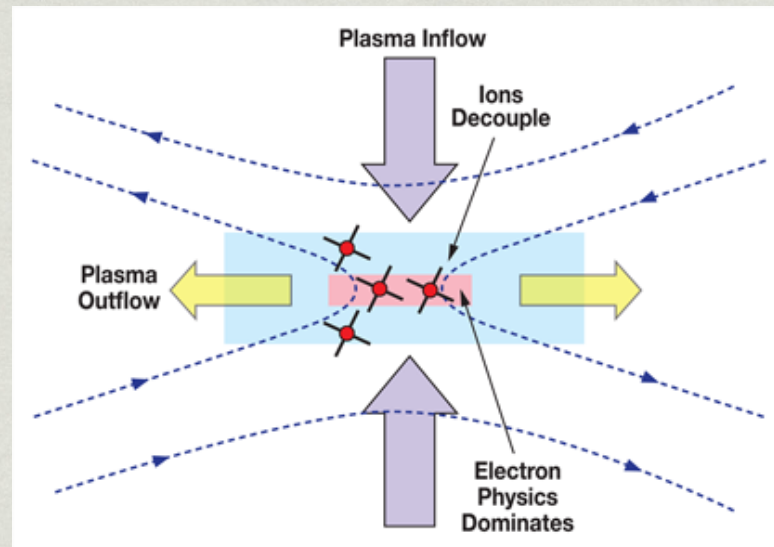
- MMS will reveal, for the first time, the small-scale three-dimensional structure and dynamics of the elusively thin and fast-moving electron diffusion region.
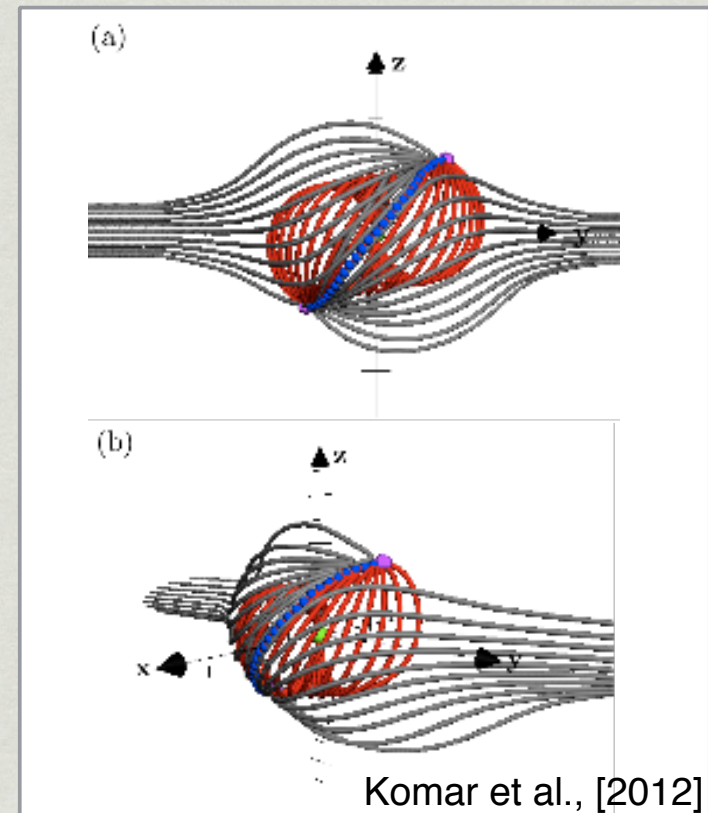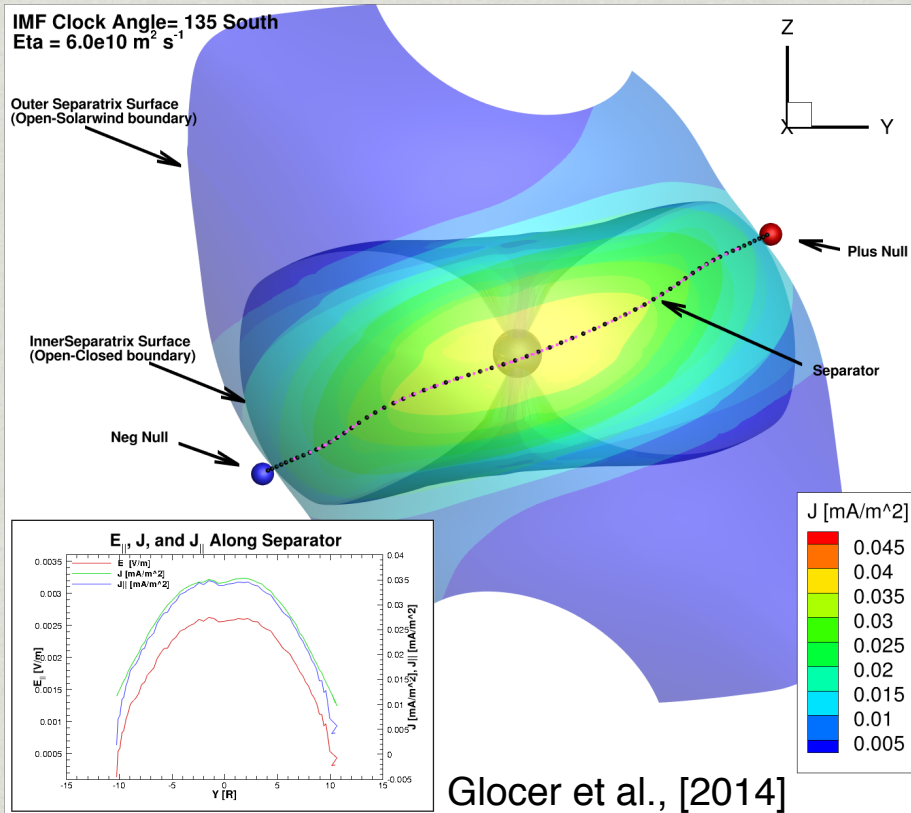
- This is really local physics since the electron inertial length is on the order of only 10 km on the magnetopause.

- What can we do with global models typically available from CCMC?

Quantitative Reconnection Studies with Global Models

IMF Clock Angle= 135 South
Eta = 6.0e10 m² s⁻¹

Outer Separatrix Surface
(Open-Solarwind boundary)

InnerSeparatrix Surface
(Open-Closed boundary)

Neg Null

Plus Null

Separator

J [mA/m^2]
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005

Glocer et al., [2014]

(a)

(b)

Komar et al., [2012]

- Global magnetosphere models are available at CCMC, but tools the tools to extract reconnection relevant info is not yet.
- Modeling the location of magnetic nulls, separators, and separatrix surfaces can provide context for MMS observations

Supporting the Local Physics That MMS is After Requires More…
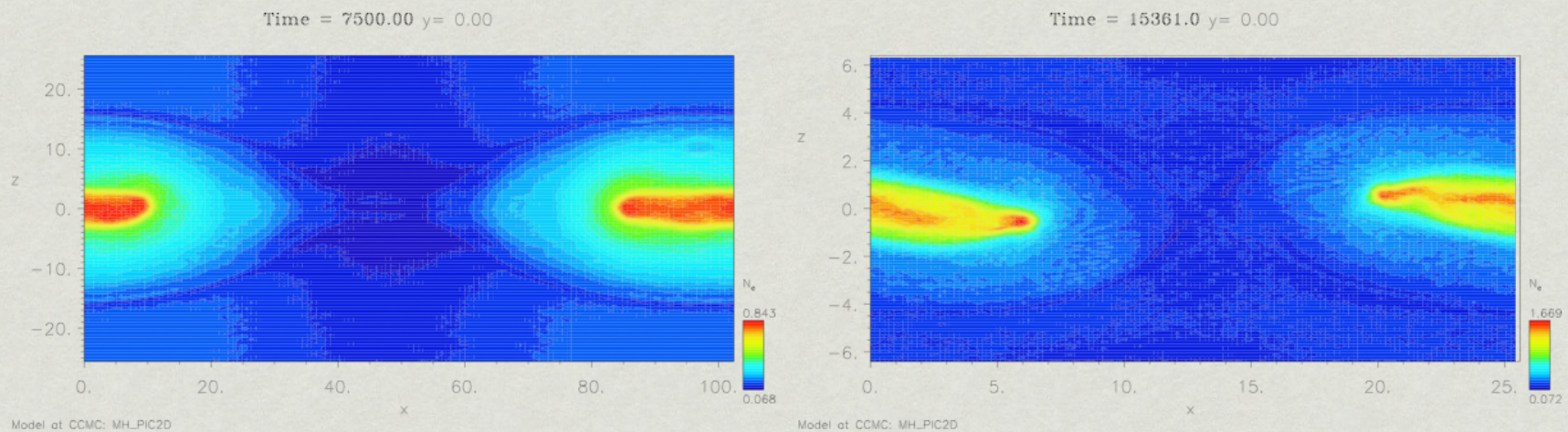
- While global models can provide context and some insight for MMS, the prime science objectives are local scale.

- Appropriate models for this type of science are really PIC simulations, but such models cannot currently be requested.

- CCMC hosting PIC simulation results submitted by modelers and providing visualization tools may be a way forward.

- PIC simulations embedded in a global simulations (like recently developed at UofM) is an exciting new capability.

What about Energetic Neutral Atoms (ENA)?
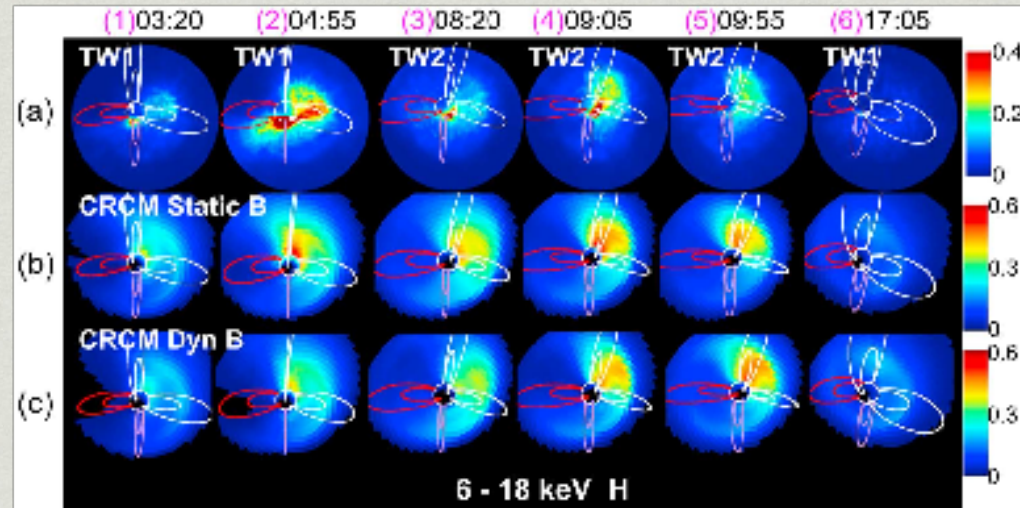
- Current (TWINS, IBEX) and past (IMAGE) missions have flown ENA detectors.

- ENA are one of the few ways we can use remote sensing for many plasma populations.

- Understanding the images can be hard without a model due to the LOS integration.

- Inner magnetosphere models at CCMC should have an option for ENA visualization of results.

Conclusions

- CCMC already provides access to a vast array of models capable of mission support.

- Augmentation of these models with post processing and visualization tools can enhance their utility for mission science.

- In some cases more models are needed: Inner magnetospheric waves and PIC models for reconnection.

- CCMC is already providing a great service to scientists trying to understand mission data!