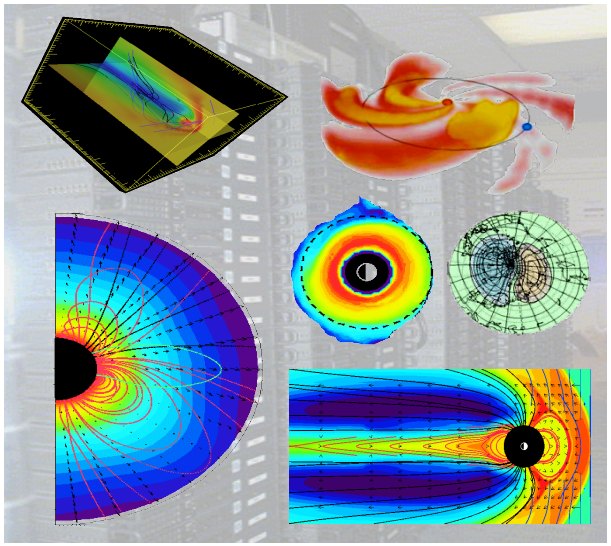
MMS support at the Community Coordinated Modeling Center (CCMC)



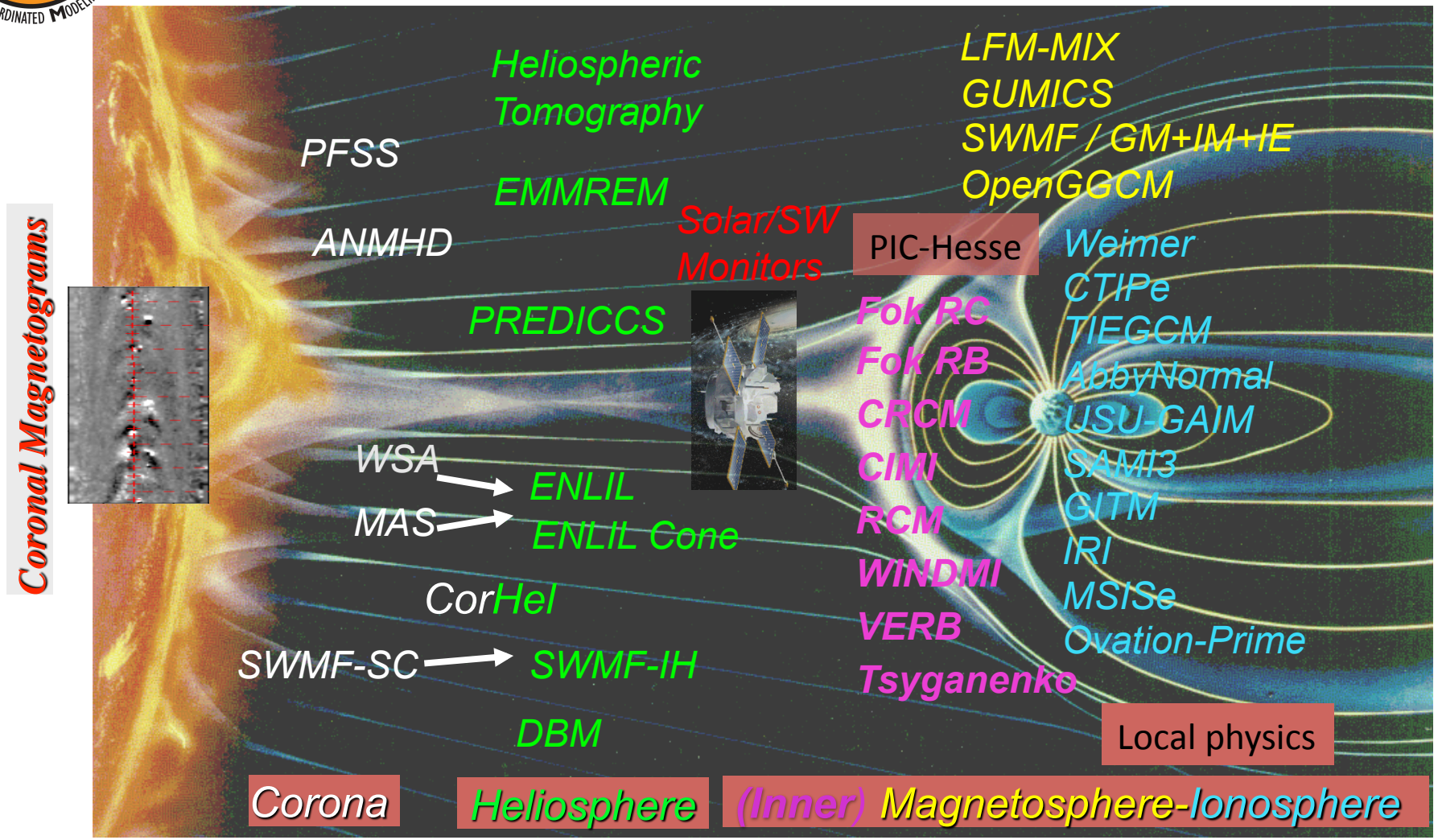
L. Rastaetter, M. Hesse, M. Kuznetsova,
A. Glocer, CCMC team

MMS Science Working Team Meeting,
11 March 2015

http://ccmc.gsfc.nasa.gov

Mission Support for MMS: ccmc.gsfc.nasa.gov/missionsupport/#mms

Expanding Collection of Models at the CCMC



CCMC: Making models and model combinations available for researchers and operational users.

Services for MMS Mission

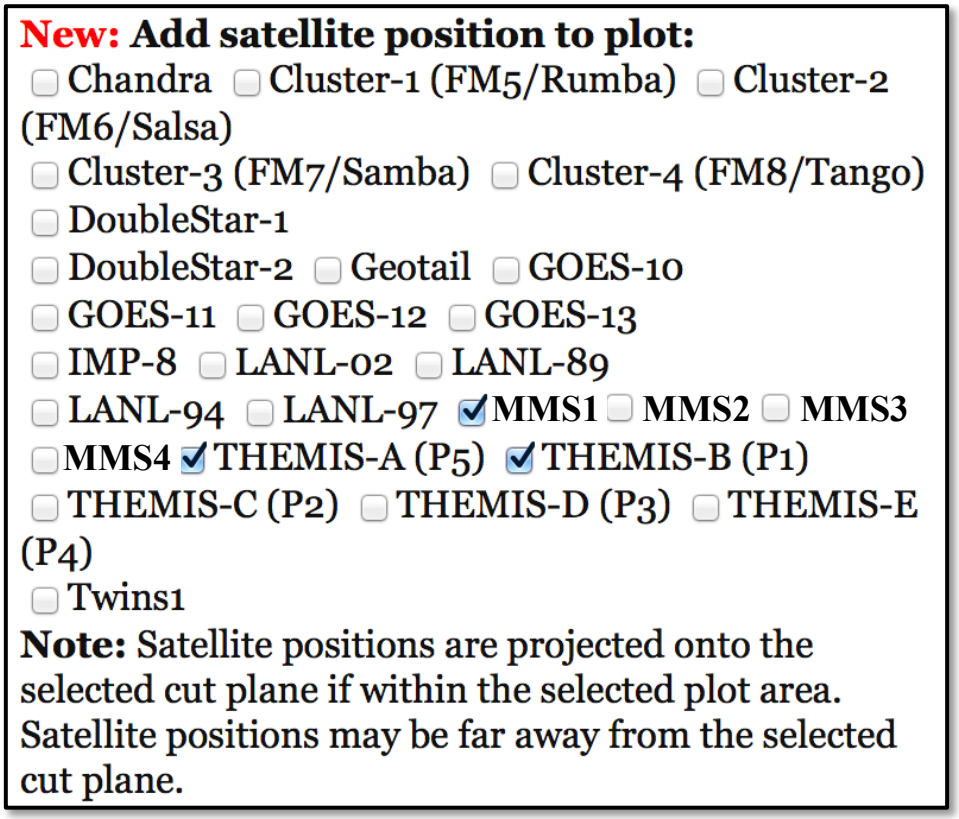
- Determine positions of MMS spacecraft in relation to magnetopause
- Detect reconnection sites in global MHD runs
- Space Weather Services (notifications, post-event analyses)
- Runs-on-Request with Particle-in-Cell models

Mission Support for MMS: ccmc.gsfc.nasa.gov/missionsupport/#mms

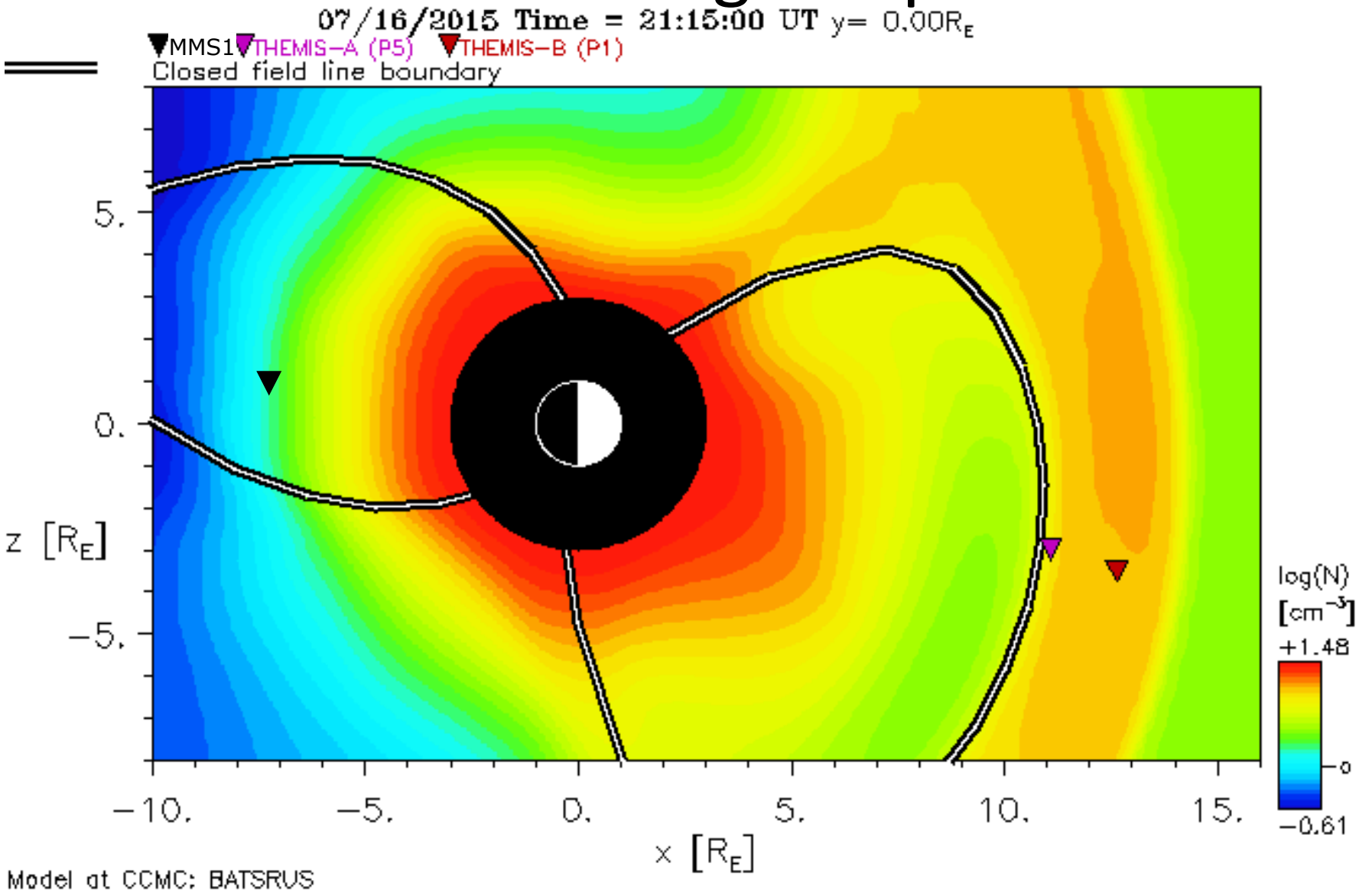
MMS Spacecraft and the Magnetopause

Satellite positions (from GSFC/SPDF/SSCWeb) now available in magnetospheric simulations.

- Analyses possible:
  - Inside/outside MP
  - Distance to MP
    - Modeled in MHD by SWMF/BATSRUS, LFM, OpenGGCM or GUMICS
    - Statistical model (Shue, …)

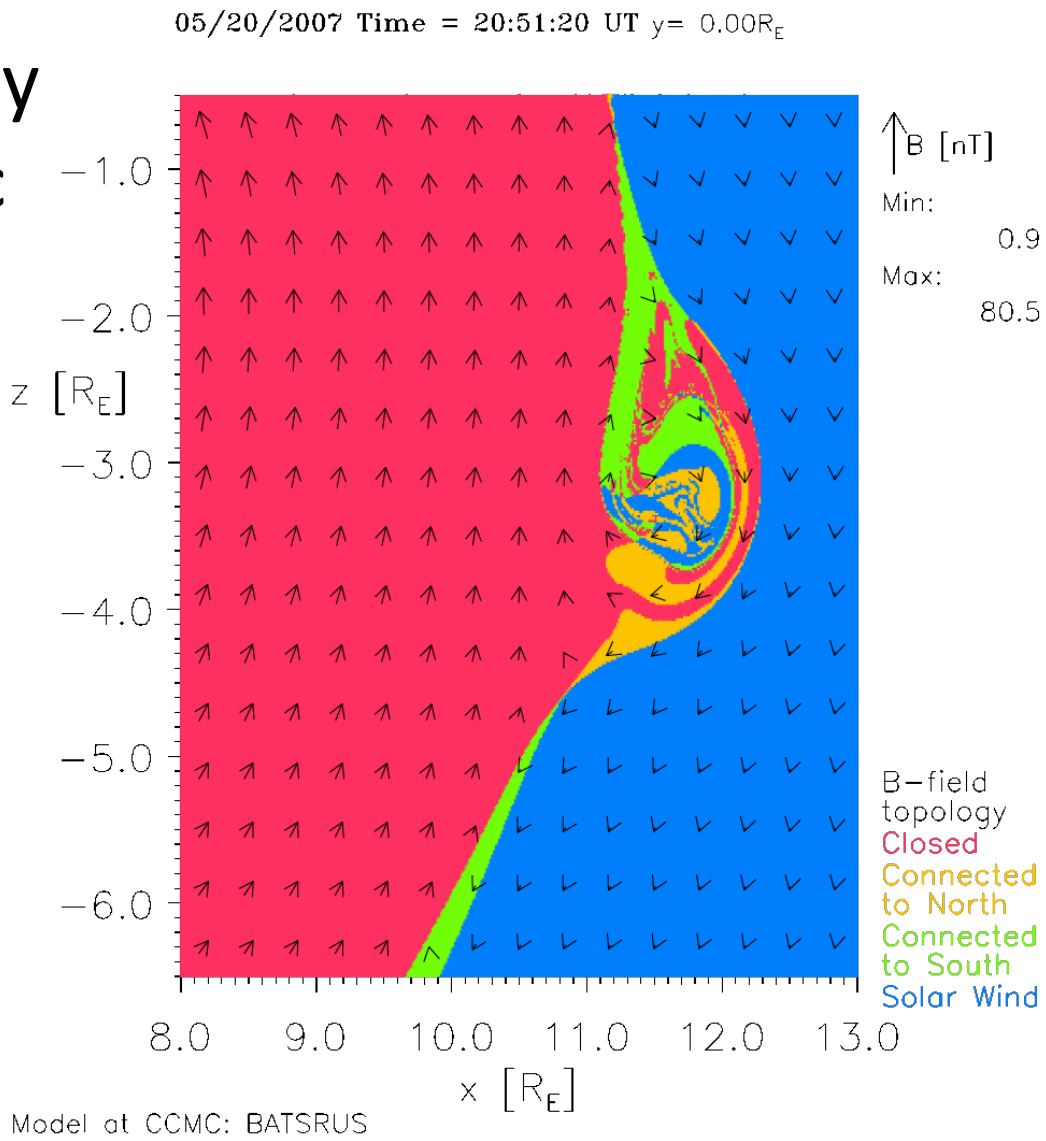


MMS Spacecraft and the Magnetopause



Reconnection at Magnetopause

- Magnetic topology through magnetic field line tracing
  - 2D slices (now at CCMC)
  - 3D tracking of separators and magnetic nulls



Reconnection in Global Models

IMF clock angle: 135
Eta=6.0e10m^2/s

Outer Separatrix Surface
Open-Solar Wind boundary

Inner Separatrix Surface
Open-Closed boundary

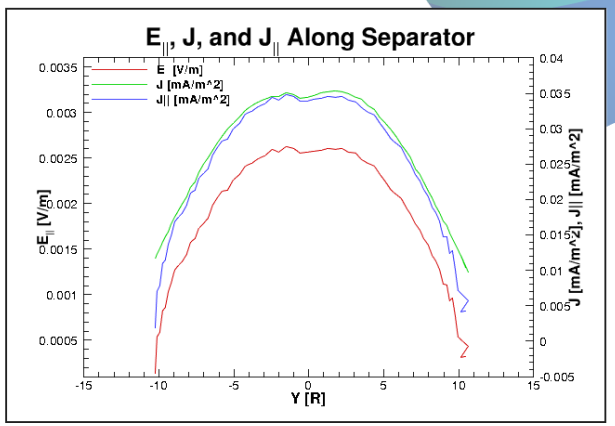
Minus Null

Plus Null

Separatrix

Z
Y

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



Apply tool to all magnetosphere models at CCMC

Provide context to MMS observations

A. Glocer, 2014

Space Weather Services

Mission Support for MMS:
ccmc.gsfc.nasa.gov/missionsupport/#mms

CCMC/SWRC issues notifications to NASA robotic missions:

- Current space radiation and geomagnetic activity
- Short-range activity forecasts
- Post-event analysis through Space Weather database (tracks CMEs, Solar energetic particles, geomagnetic activity)

Particle-in-Cell (PIC) modeling

PIC-Hesse model at CCMC

- Simulation run parameters

Visualizations:

- Fields
  - Scalars, vectors
- Distribution functions
  - Selection by Region-of-Interest
  - Electrons and Protons:
    All particles or particles from top or bottom region
  - Fly-through: ROIs along Z

Run: Michael_Hesse_021915_2

Key Word: MMS Support, 2D Asymmetric reconnection

Model Type: LP/PIC
Model: PIC-Hesse, version v20150219
Initial Configuration: Harris Sheet along X with added Bx

Run parameters:

- proton/electron mass ratio: 25
- electron/proton temperature ratio: 0.2
- electron cyclotron/electron plasma time ratio (ω_{pe}/ω_{ce}): 2

Boundary parameters (N and P averaged for each particle species):

Quantity	bottom (Z=-12.8)	top (Z=12.8)
B_x	-0.5	1.5
B_y	0.	0.
B_z	0.	0.
N_e	0.997	0.33
P_e	0.249	0.083
N_i	0.997	0.33
P_i	1.245	0.413

- View 2D fields output
- Select 3D distribution function (in velocity space) by Region-of-Interest (ROI)

This interface has recently been updated. If you experience problems or have any questions please contact the CCMC staff.

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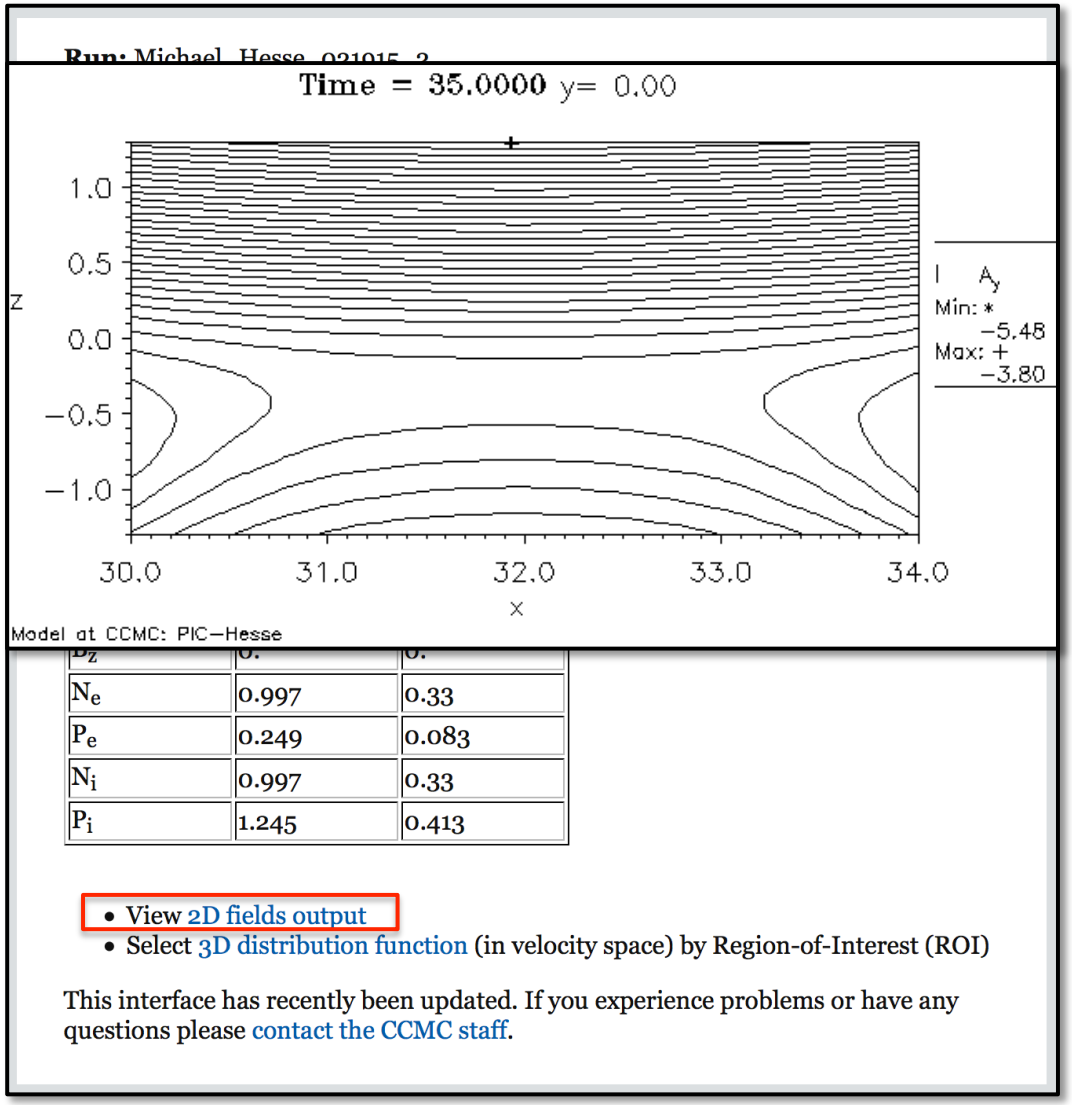

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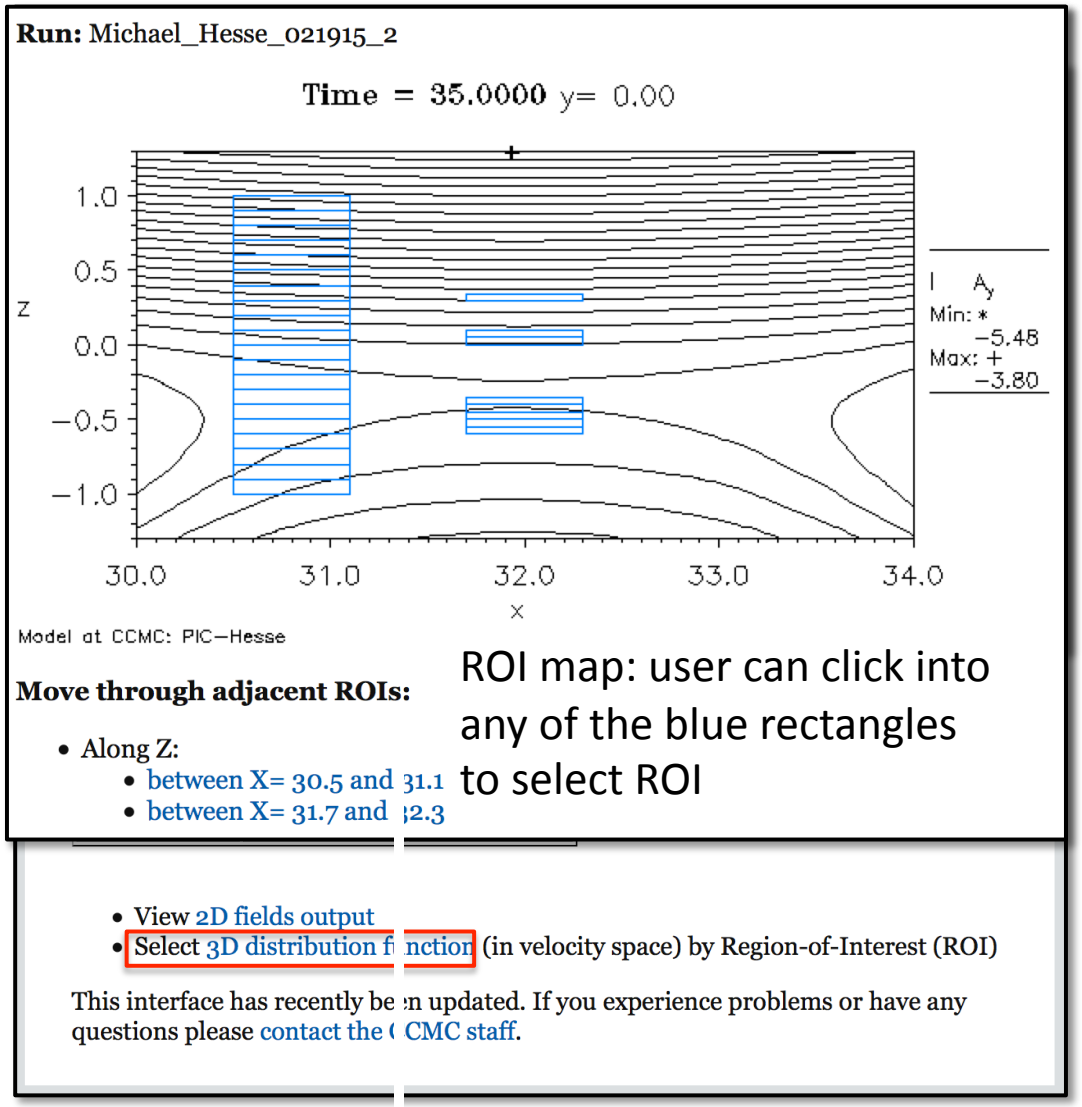

ROI map: user can click into any of the blue rectangles to select ROI

Particle-in-Cell (PIC) modeling

PIC-Hesse model at CCMC

- Simulation run parameters

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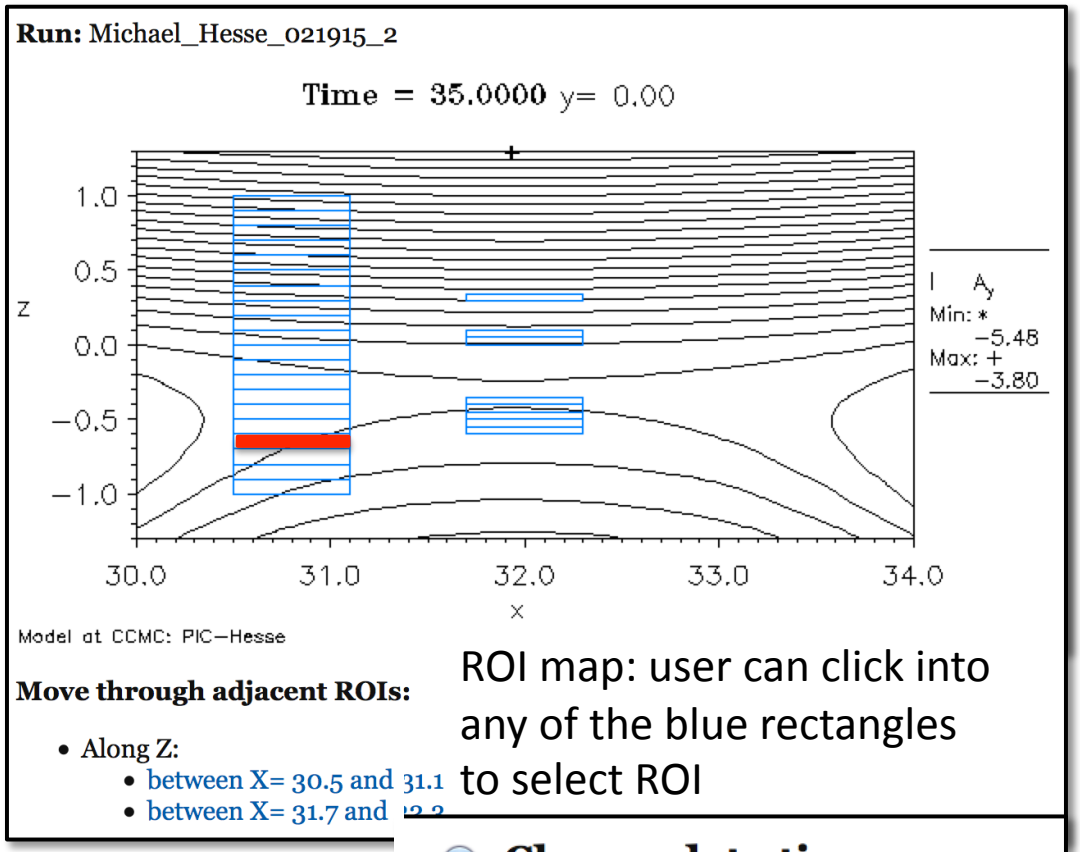
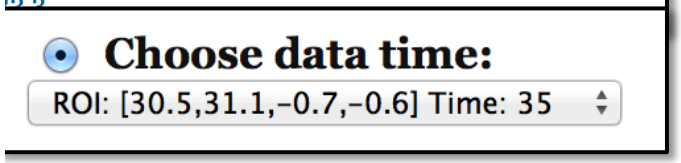


ROI map: user can click into any of the blue rectangles to select ROI



Selected ROI listed in visualization interface

Particle-in-Cell (PIC) modeling

PIC-Hesse model at CCMC

- Simulation run parameters

Visualizations:

- Fields
  - Scalars, vectors
- Distribution functions
  - Selection by Region-of-Interest
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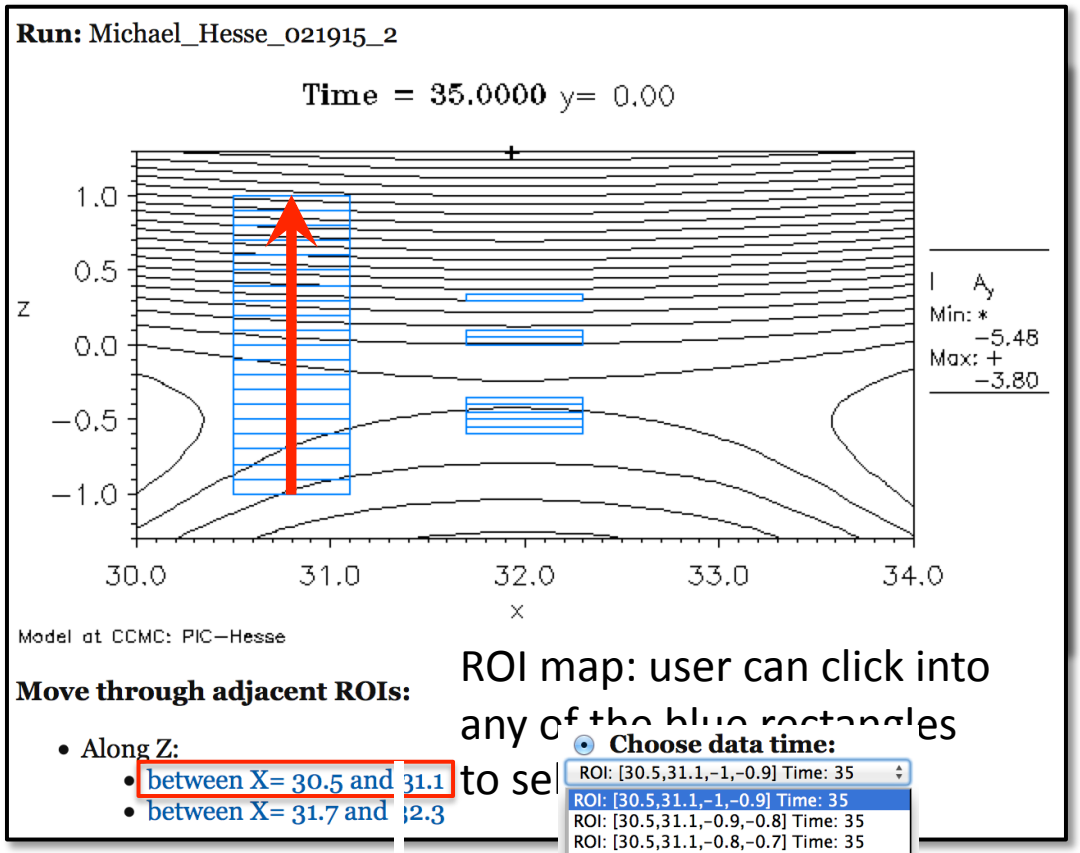


ROI map: user can click into any of the blue rectangles to sel

List of matching ROIs displayed in visualization interface

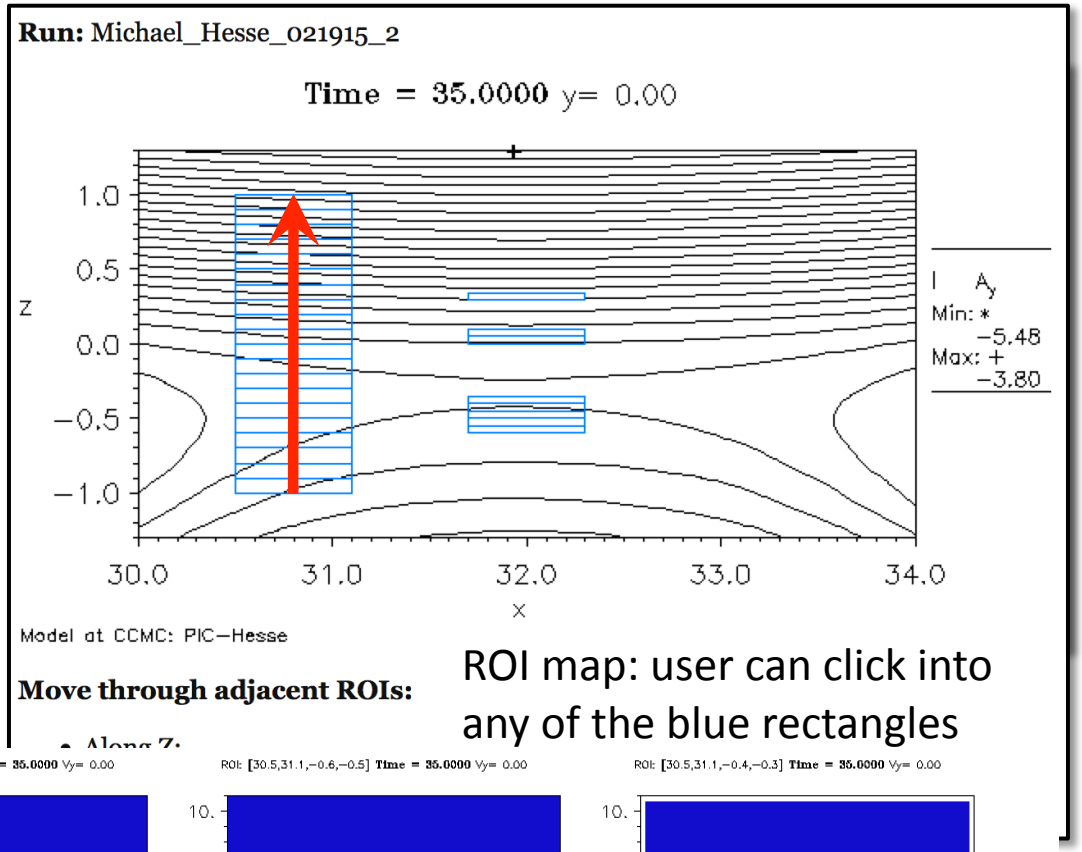
Particle-in-Cell (PIC) modeling

PIC-Hesse model at CCMC

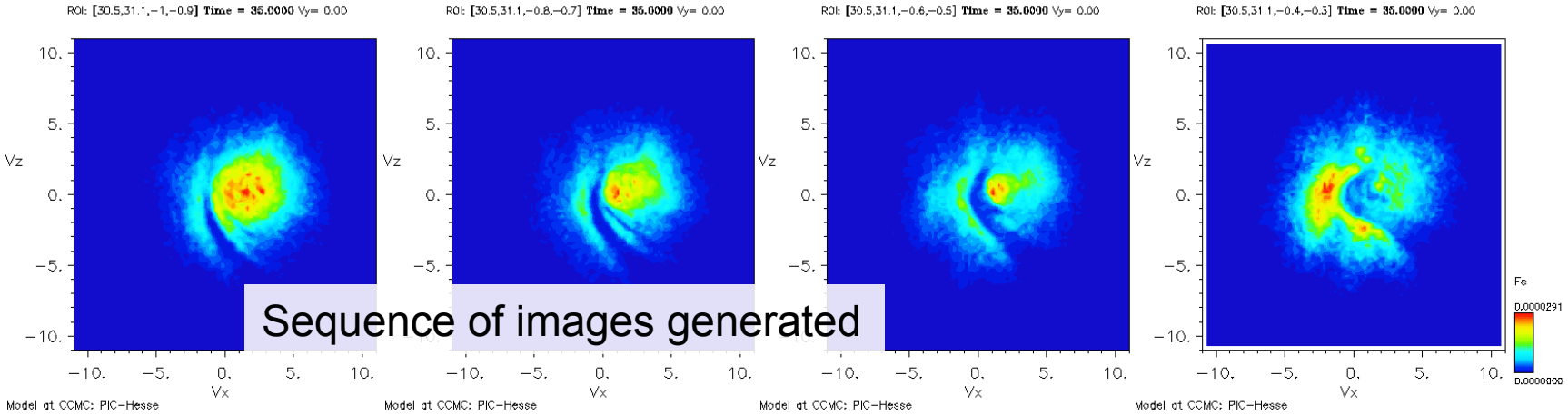
- Simulation run parameters

Visualizations:

- Fields
  - Scalars, vectors
- Distribution functions
  - Selection by Region-of-Interest
  - Electrons and Protons:



ROI map: user can click into any of the blue rectangles



Sequence of images generated

Future of PIC modeling at CCMC

- Add more runs (same model, other models)
  - Develop request interface (problem type, parameters)

- Visualization of fields:
  - Convert to dimensional values to match magnetopause conditions with user-submitted scaling, e.g.,
    - length L_0=400 km,
    - density N_0=0.1cm^{-3},
    - magnetic field B_0=40nT.

- Visualization of distribution functions:
  - Region-of-Interest-on-Request: user input of sets of 4 corner positions
  - Fly-through with arbitrary start and end positions (satellite trajectory)
  - Spectrogram plots, pitch angle distribution (vs. spacecraft trajectory or B-field). Use instrument-specific parameters (e.g., energy bins, view angles)