CISM-CCMC collaborations and future plans

with help from a host of others

But they sent me to give palusible deniability

CISM Goals

- Create a physics-based model(s) going from the Sun to the Earth
- Make the model(s) available to the community
  - invite community participation
  - initiate trek across the valley of death
  - open source
- Educate grad students who see an integrated physics from the Sun to the Earth (heliophysics)
- Bring a more diverse population into the field

CISM Thrusts

- Solar/Heliospheric (Janet Luhmann)
- Magnetospheric (Mary Hudson)
- Ionosphere/Thermosphere (Stan Solomon)
- Code Coupling (Chuck Goodrich)
- Validation (Harlan Spence)
- Knowledge Transfer (Dan Baker)
- Education (Nick Gross)
- Diversity (Ramon Lopez)

We need help!

- Leverage and leverage some more
- Partners:
  - SWPC (SEC)
    - primary partner for transition to operations
    - two people stationed at SWPC for this (Michael Gehmeyr and George Millward)
  - CCMC
    - primary partner for community access to models
    - independent validator of CISM models
    - conduit for feedback from the community

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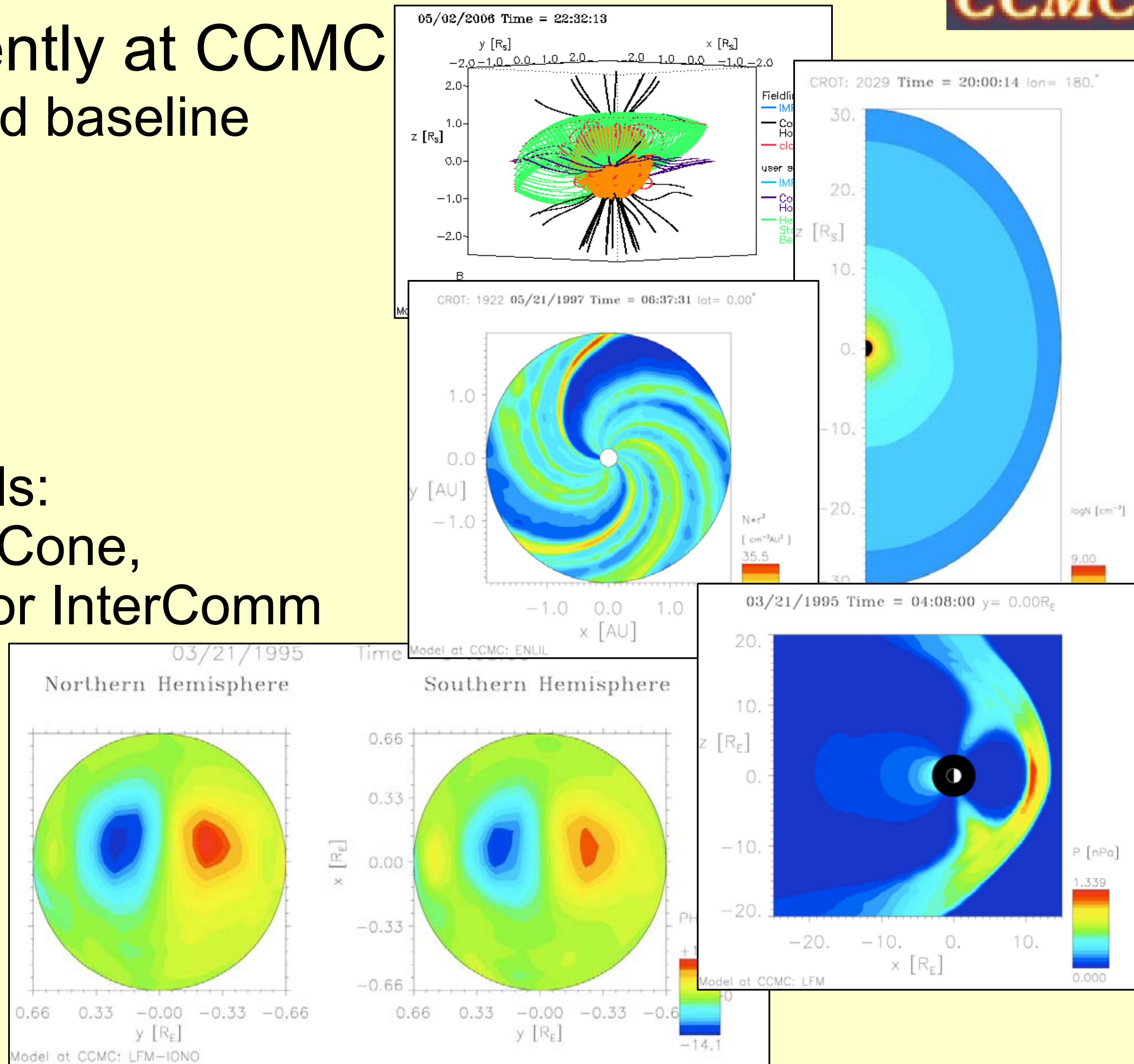
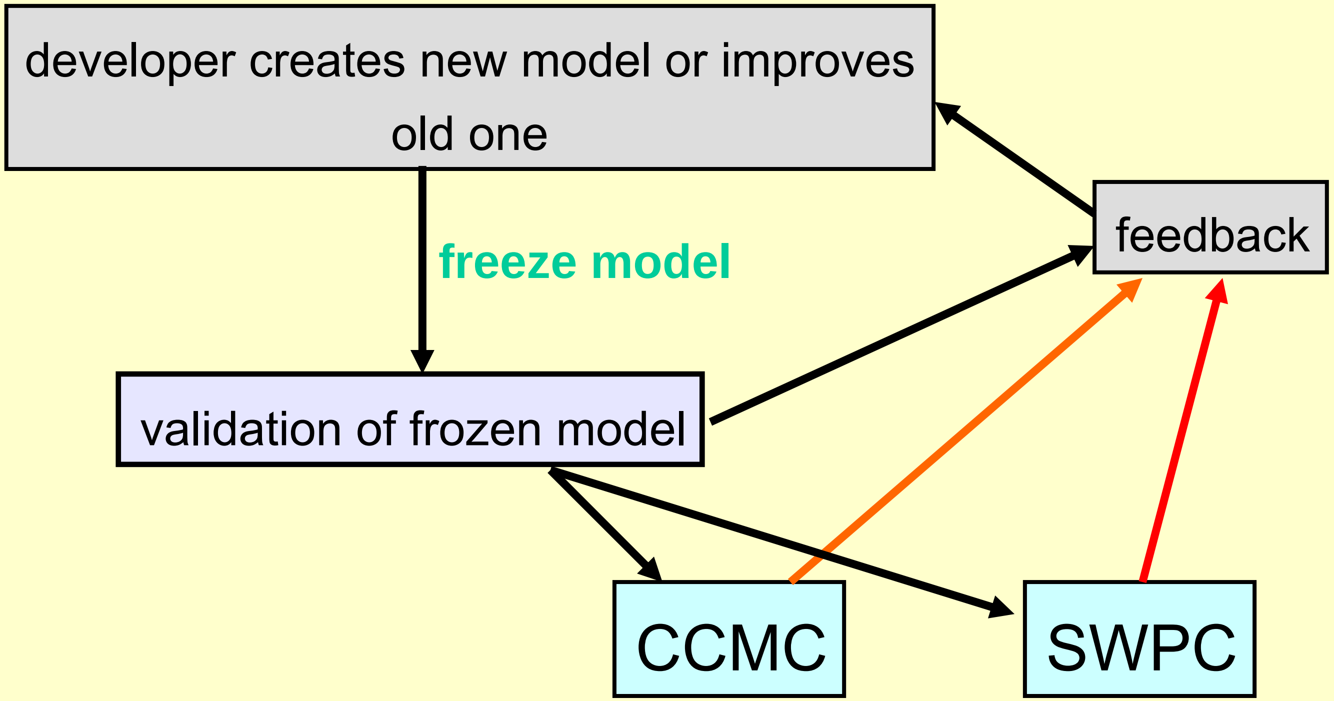
Delivering Models to CCMC

Models Currently at CCMC

- Component and baseline models:
  MAS
  ENLIL
  WSA
  PFSS
- Coupled models:
  CORHEL with Cone,
  CMIT (ad hoc or InterComm coupled)



Model Development at CISM



Release to partners after initial internal validation

Geospace Status at CCMC

- CMIT delivered and running but not available
  - underlying LFM is OpenMP version
    - doesn't scale well (at all) on clusters
- Parallel LFM with hooks for CISM Framework undergoing final tests for delivery to CCMC and SWPC
- CISM Framework pieces ported to CCMC

CISM Framework at CCMC

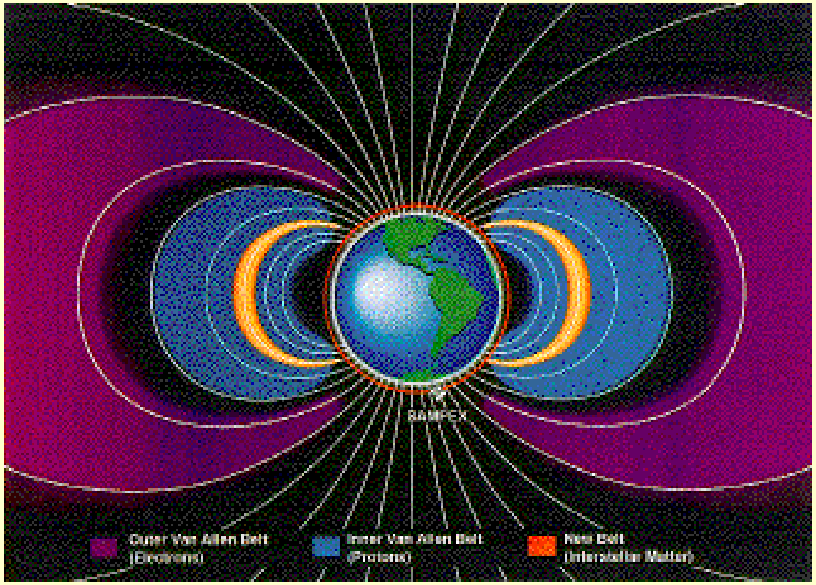
- Loosely coupled model for interaction between codes
  - interact at OS level not at program level (SWMF)
  - can be used across distributed systems
  - InterComm (communication library to solve MxN problem and process synchronization)
  - HPCalc (resource discovery and process launcher)
- Can play well with others
  - integrated with ESMF, should be simple to integrate with SWMF (CCMC-CISM-CSEM?)

Near term deliveries to CCMC

- parallel LFM with ionospheric solver
- CMIT 2.0 (TIEGCM + parallel LFM)
- RCM-LFM
  - works, but is still not robust (caveat emptor)
- RCM-LFM-TIEGCM (LTR)
- Radiation belt codes
  - SEP cutoffs
  - equatorial guiding center code

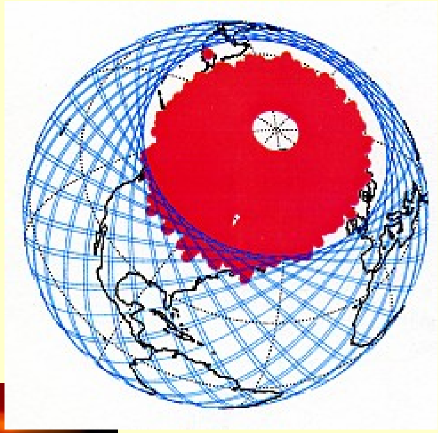
Test Particle Simulations of Radiation Belts

- 2D: Drift motion of electrons and ions in the equatorial plane is followed using time-varying electric and magnetic fields from global MHD simulation



•3D : Drift and bounce followed for

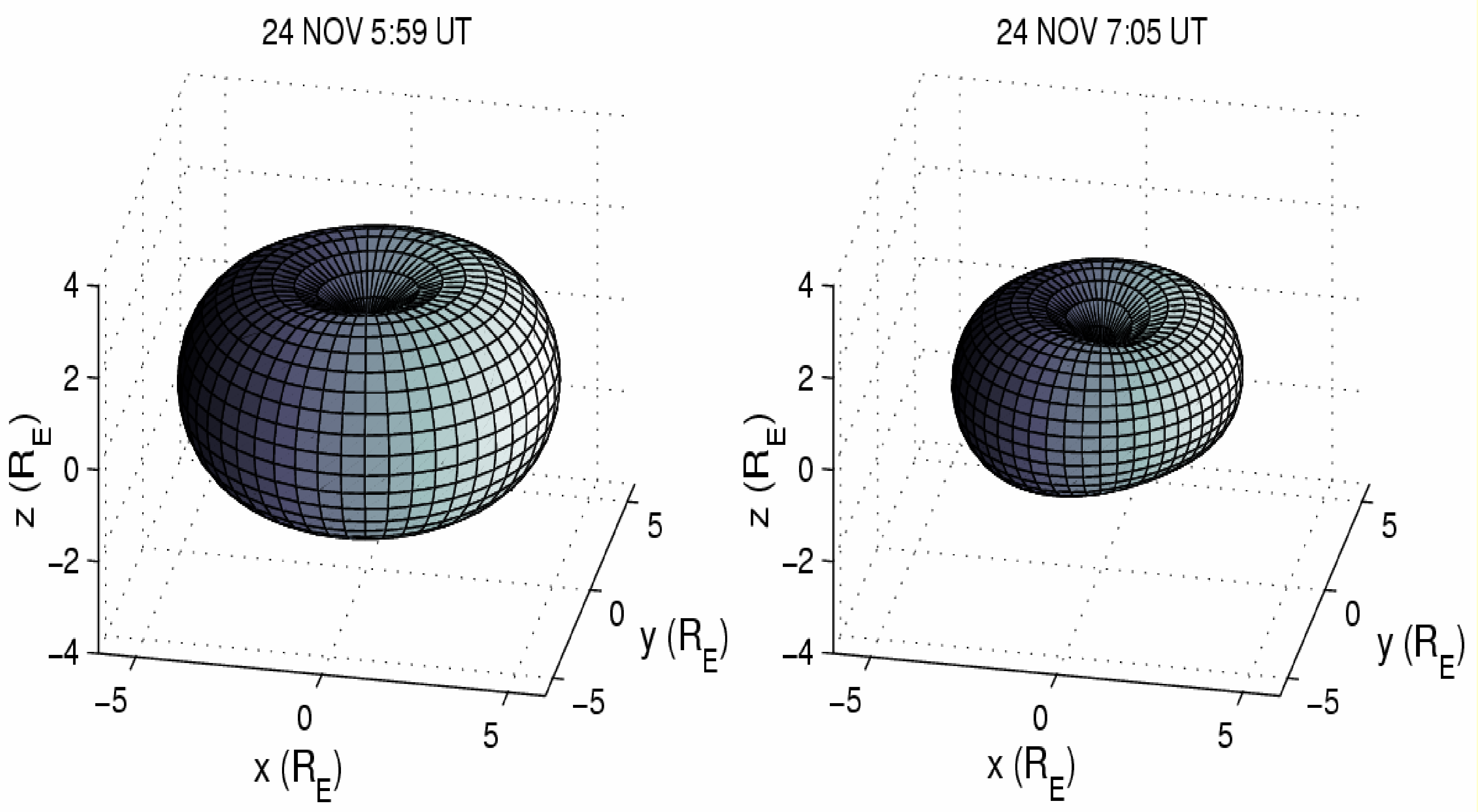
•electrons, gyromotion included for ions



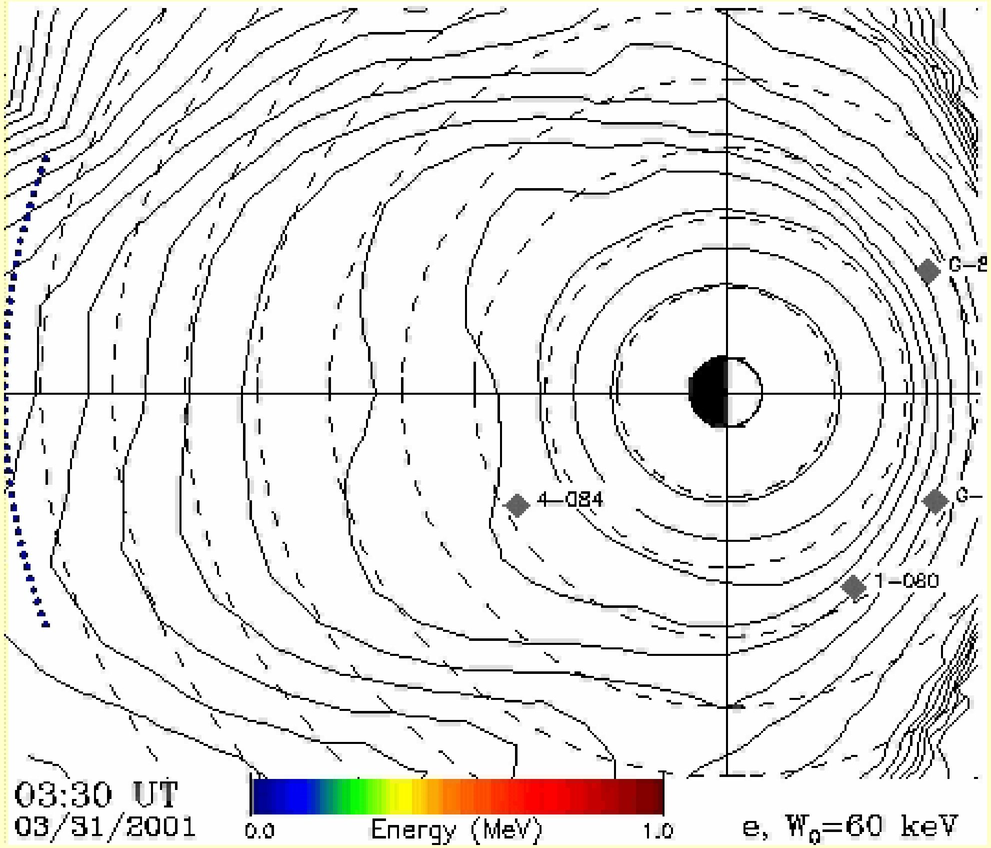
SEP cutoffs calculated using MHD fields

LFM-SEP simulations:

Effect of solar wind pressure pulse on SEP cutoff surface



MHD Fields injection of RadBelt Electrons

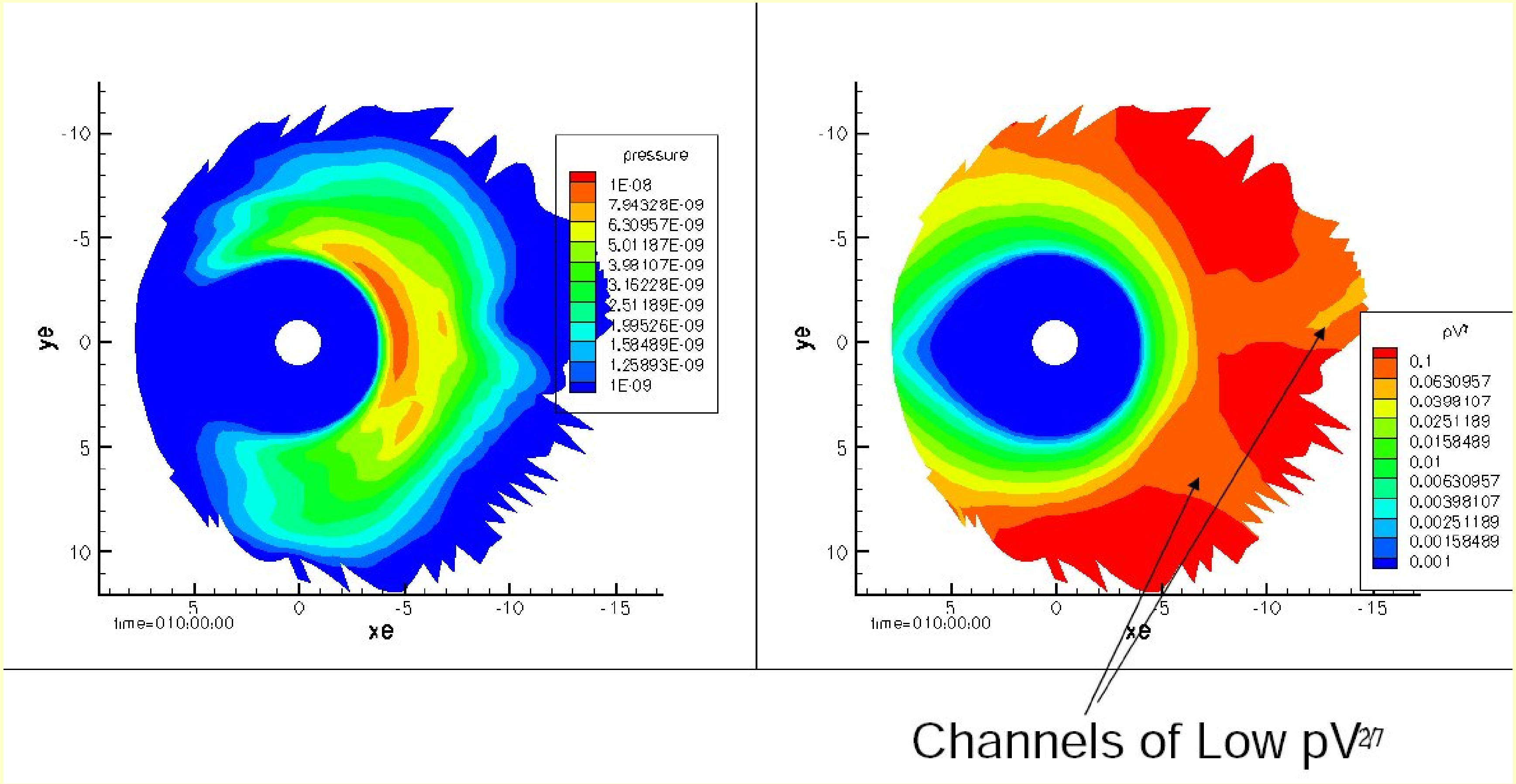


From CU/LASP staff scientist and Dartmouth PhD Scot Elkington

Coupled models

- One of our major tasks is to convince the community of the power of coupled models
- CCMC will play a lead here
- Collaborations are difficult without a dedicated team
- Examples
  - RCM-LFM
  - CMIT

Flow channels in LFM-RCM



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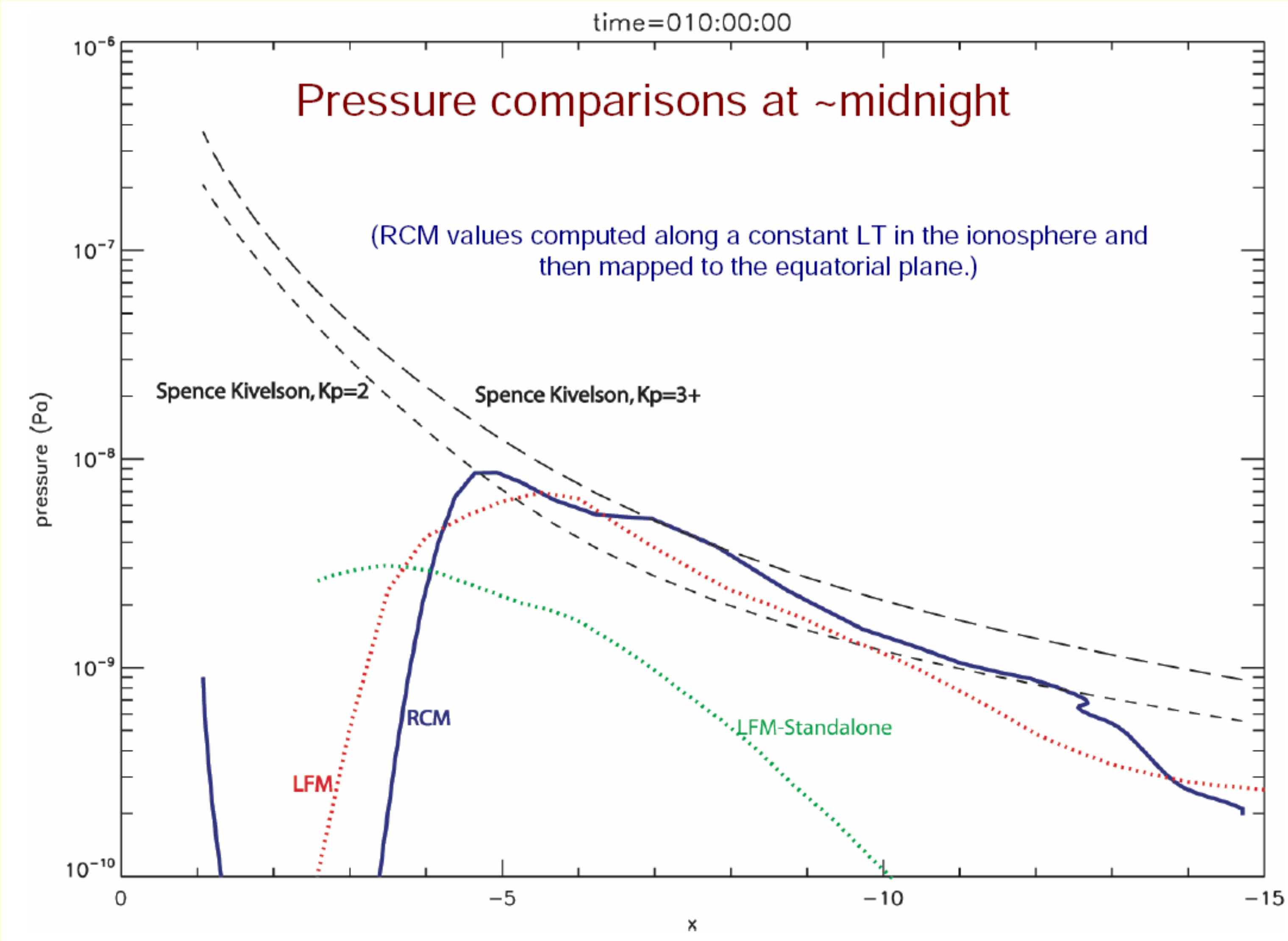
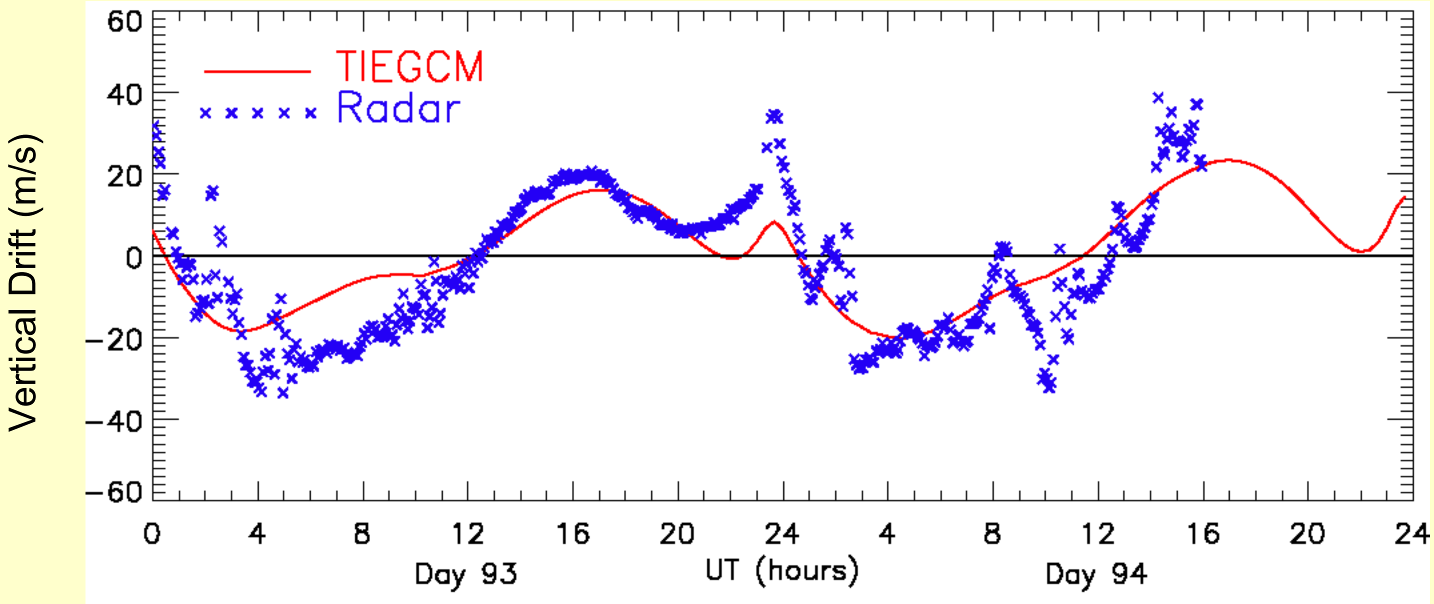


In ballpark for weak activity

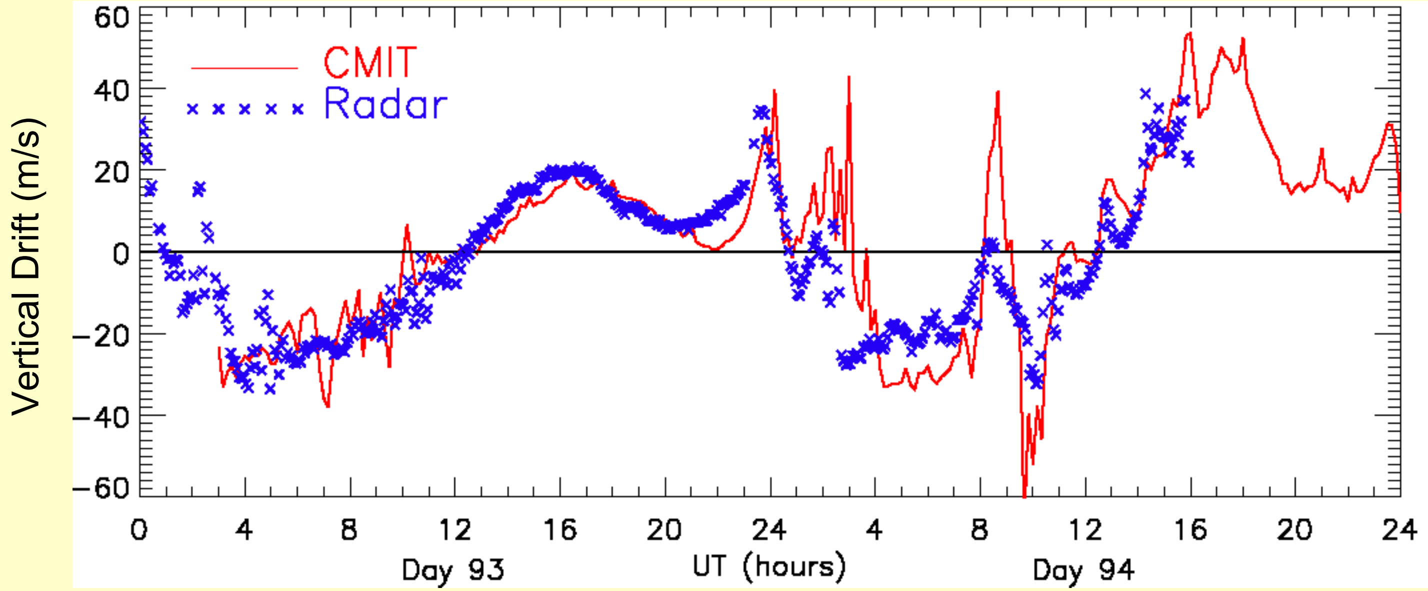
LFM shows diffusion of RCM profile

Equatorial Vertical Drift — Comparison with Jicamarca

TIEGCM alone



Coupled
LFM/TIEGCM
CMIT 2.0



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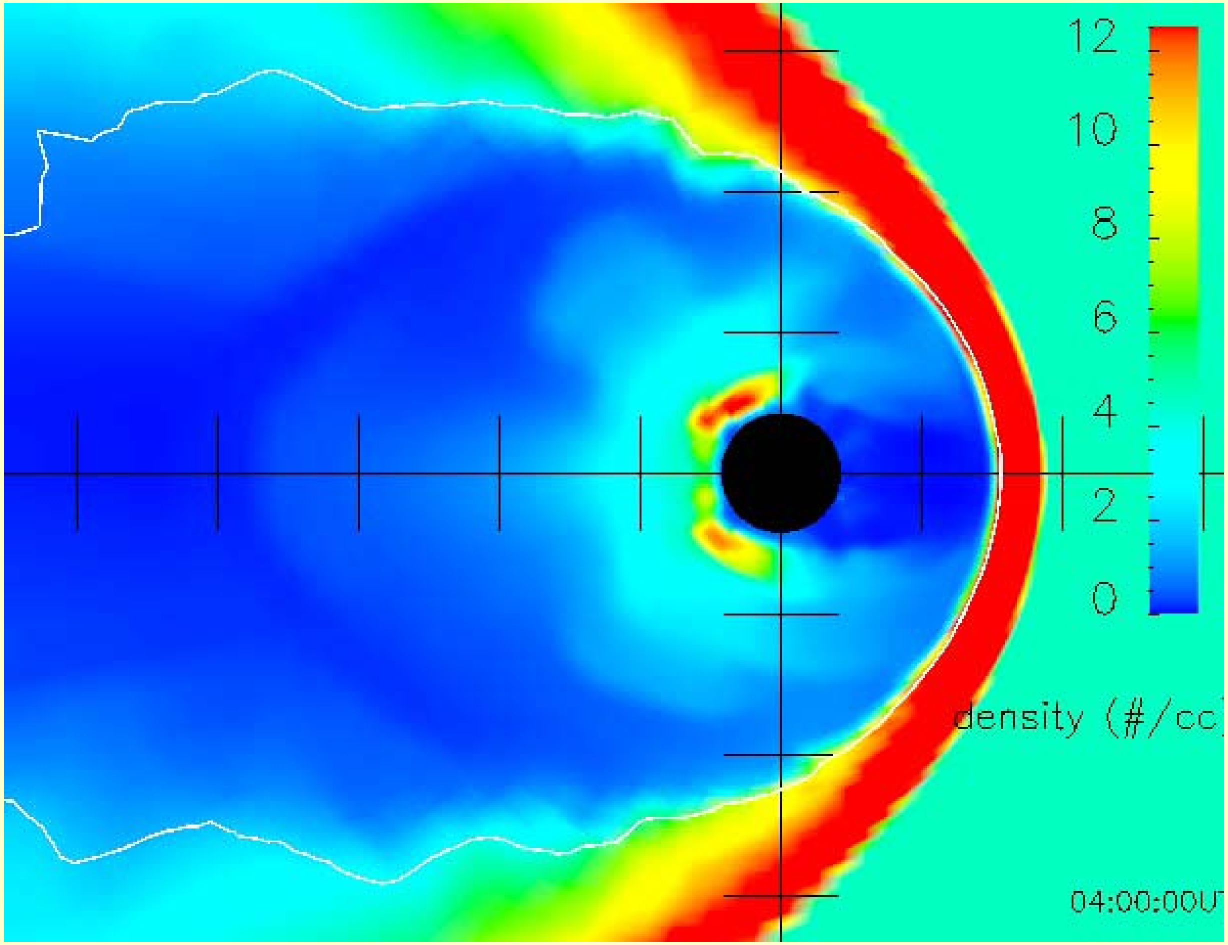
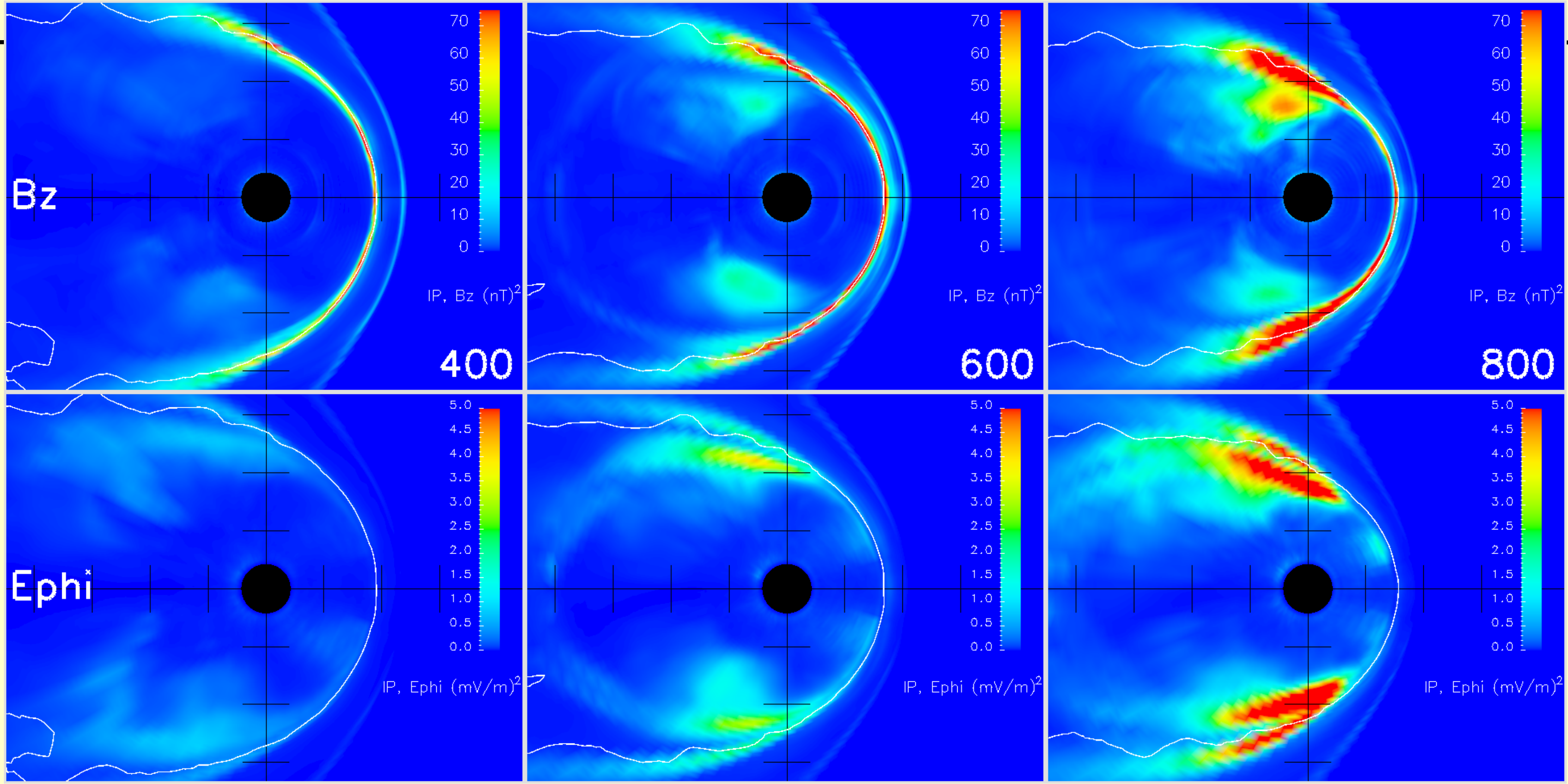
K-H and more

- Plug for work done by Seth Claudepierre at CU with Scott Elkington and Mike Wiltberger
- Good example of possible future interactions of students with CCMC models
  - Analysis of model results without having to code himself
  - Serendipitous results
    - Originally a general search for ULF waves
    - Led to analysis of K-H waves (and something else)

Kelvin-Helmholtz in LFM



Spatial Distribution of ULF Wave Power



Equatorial plane cuts of ULF wave power, integrated from 0.5 to 15 mHz for the simulation B_z (top row) and E_φ (bottom row) for the three simulations in this study (columns). The white contours represent the approximate location of the magnetopause. Color scales are the same in each row to emphasize the increasing intensity of ULF wave power as the solar wind speed is increased.

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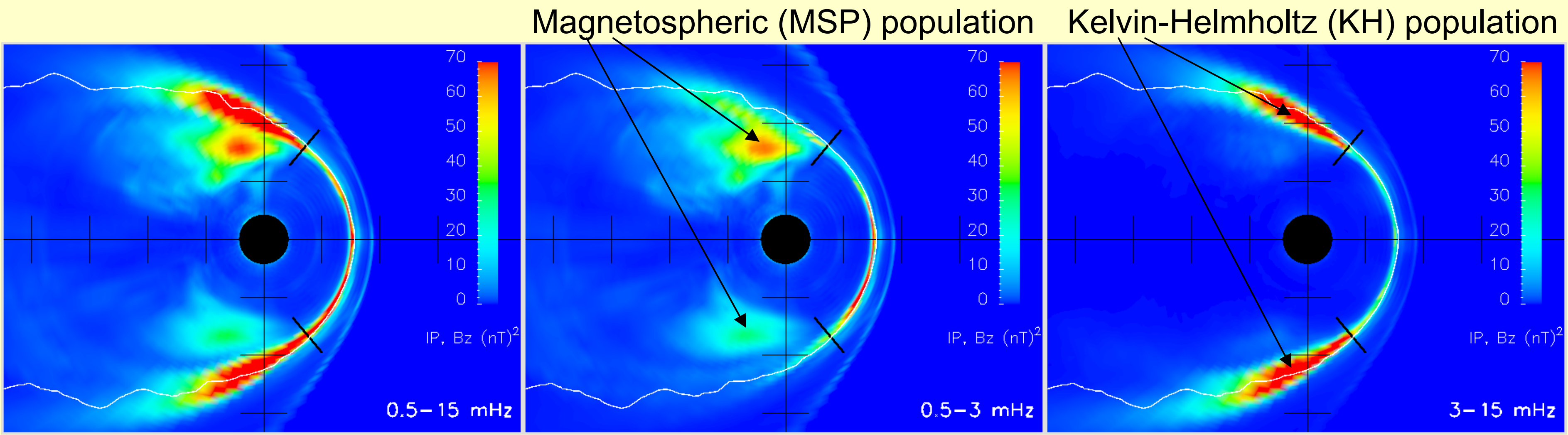
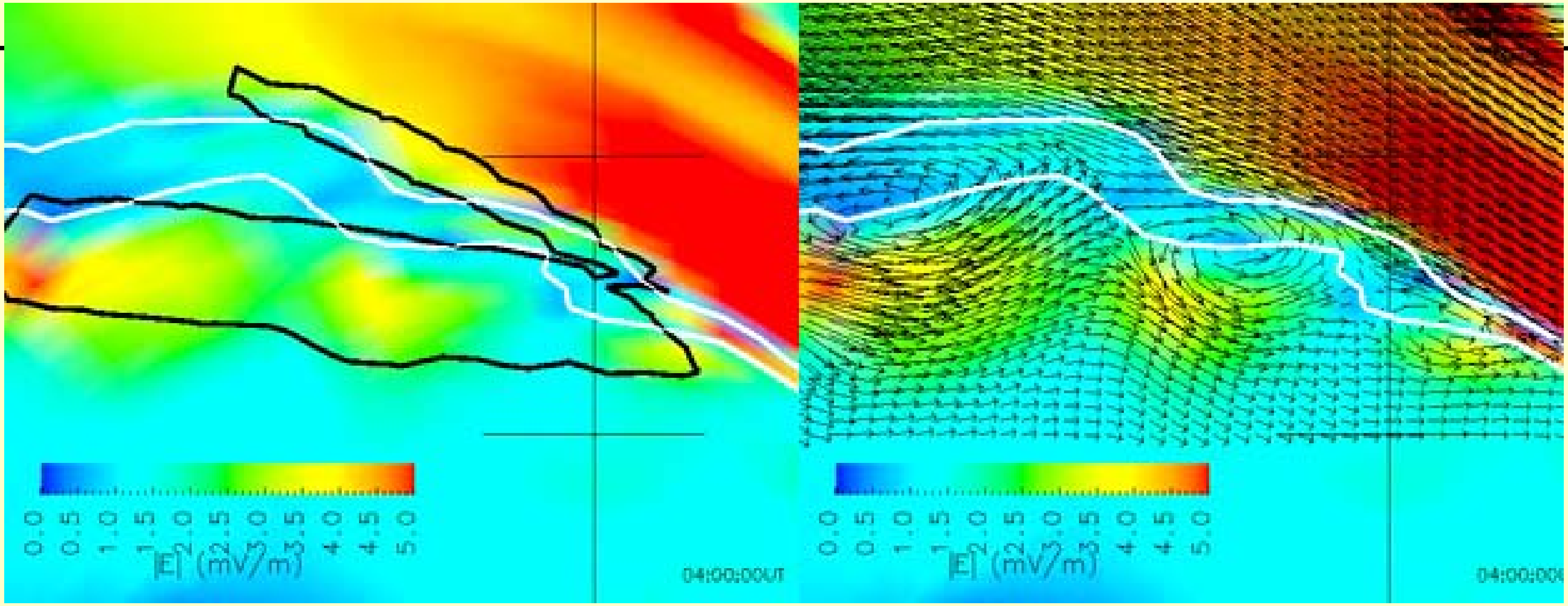
ULF Wave Population Distinction (1/2)

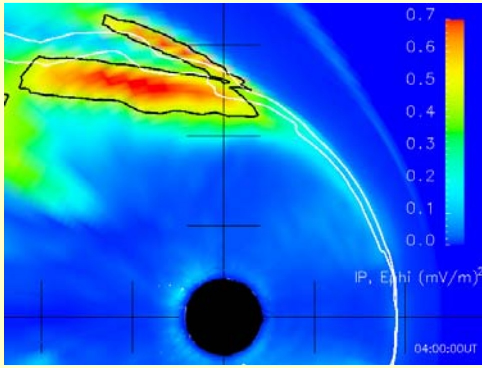


Equatorial plane cuts of B_z integrated ULF wave power from the 800 km/s simulation, integrated over three different frequency bands: 0.5–15 mHz (left), 0.5–3 mHz (middle), 3–15 mHz (right). The black ticks perpendicular to the magnetopause mark the point along the boundary where the KH waves are generated.

Visualization of Magnetopause Surface Waves



Equatorial plane cut near the dusk magnetopause for the 400 km/s simulation. Total electric field is on the color scale from 0 to 5 mV/m. The two black contours in the left panel are E_φ IP contours to outline the inner and magnetopause KH modes. The upper white contour is the approximate location of the magnetopause and the lower white contour is the inner edge of the boundary layer (IEBL). The right panel is the same as the left panel except that the E_φ IP contours have been replaced with the local velocity field.



- CISM-CCMC collaboration has already been fruitful
- CISM will keep models coming
- We’re depending on you!