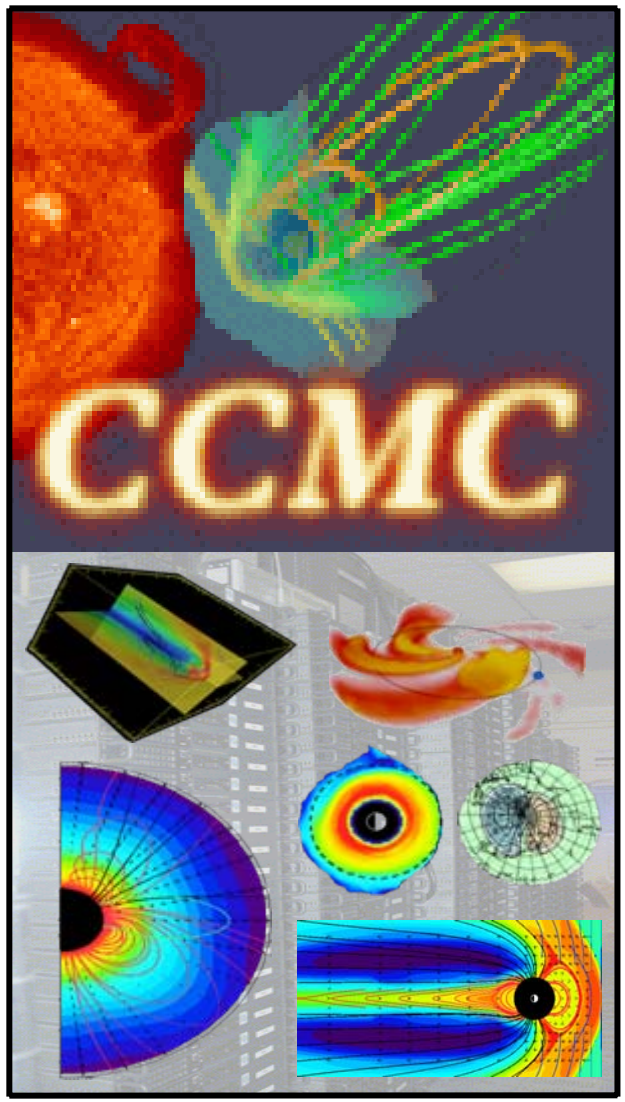


Director's Report

Michael Hesse

http://ccmc.gsfc.nasa.gov

NASA Goddard Space Flight Center

Workshop Purpose

- Assess (evolution to) CCMC state-of-affairs
  - What went well
  - What could have gone better
- Obtain input for future directions
  - Science service
  - Operations service
  - Collaborations with modelers
- Discuss other topics of interest

Our job is to listen to you…

… begin by summary of current status

NASA

NSF

AFRL

"A US multi-agency partnership to enable, support, and perform the research and development for next generation space science and space weather models"

AF/XOW - AFWA

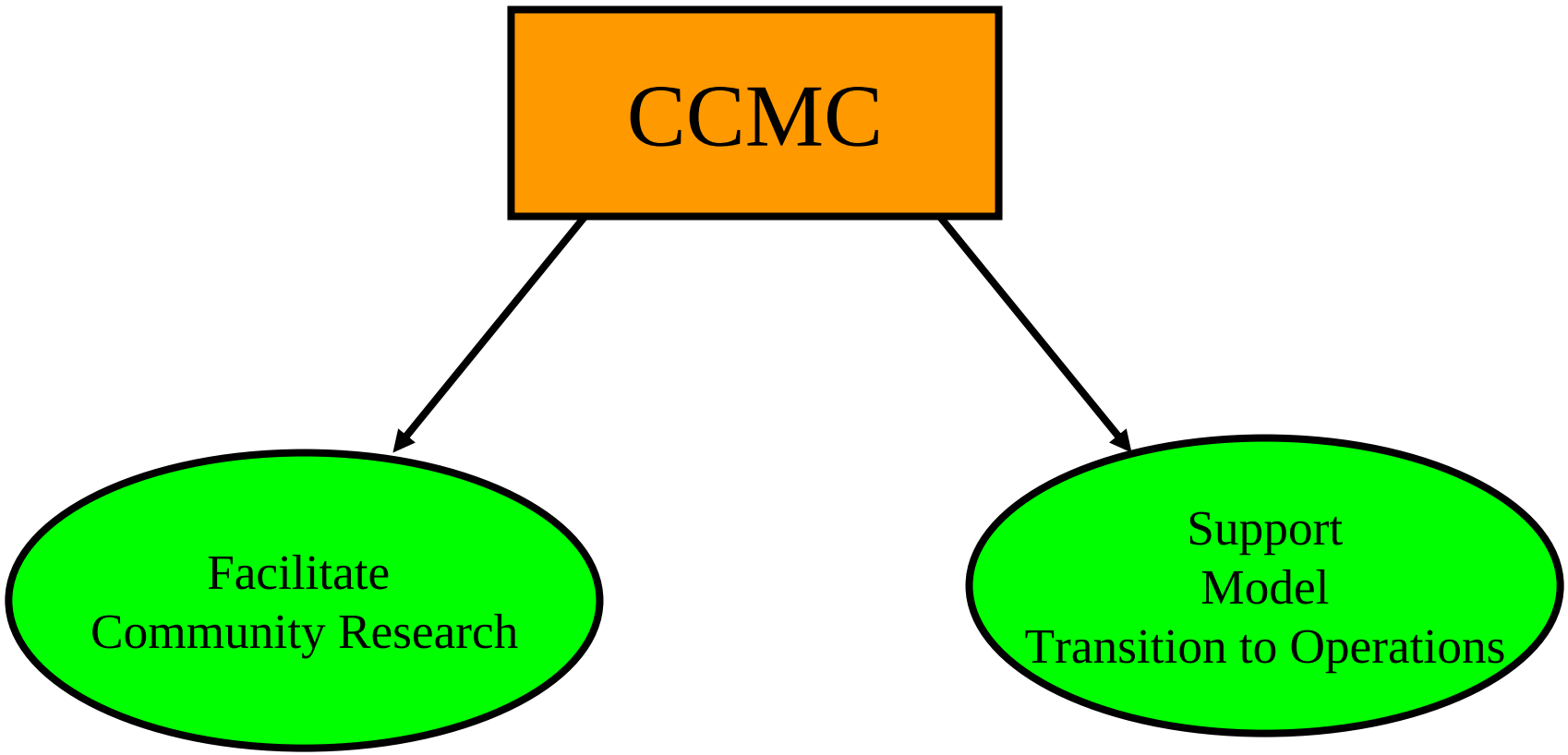
NOAA/SEC

AF SMC/CI

AFOSR

ONR

CCMC Goals



International Research Community

DoD and NOAA Space Weather needs

CCMC Goals

- Employ scientific research models to address National Space Weather needs
- Generate, with the research community, a flexible model chain, which addresses solar atmosphere to Earth's upper atmosphere
- Serve the research community through access to scientific model results ("open model policy")
- Perform broad-based testing and metrics-based evaluation of research models
- Make available science- and metrics-tested models to operational National Space Weather Agencies

Decision Flow

US National Space Weather Program Council

US Committee for Space Weather

Research Community

recommendations, needs

Operations Community

needs requirements

directs

informs

Science and Operations Advisory Committees

CCMC Steering Committee

Members:

NASA Headquarters	Dr. Chuck Holmes	(Co-Chair)
NSF	Dr. Paul Bellaire	(Co-Chair)
AF/XOW	Maj. Mark Adair	
AFOSR	Maj. David Byers	
AFRL	Dr. Nick Arge	
NASA GSFC	Dr. Michael Hesse	
NASA Headquarters	Dr. Madhulika Guhathakurta	
NOAA/SEC	Dr. Terry Onsager	
NSF	Dr. Bob Robinson	
ONR	Dr. Bob McCoy	
SMC/CI	Mr. Kevin Scro	(Facilitator)

Technical Advisors:

AFIT	Maj. Chris Smithro
AFSPC	Mr. Kelly Hand

The CCMC Staff

Staff member	Function
Dr. Michael Hesse	Director
Dr. Masha Kuznetsova	Models, Deputy Director
Dr. Joel Allred	Postdoctoral fellow
Mr. Sarabjit Bakshi	Sysadmin.
Mr. David Berrios	Visualization
Ms. Anna Chulaki	ROR system, metrics studies
Ms. Mary Goldfarb	WWW management
Dr. Peter MacNeice	Models, model coupling, frameworks
Mr. Marlo Maddox	Data Formats, visualization
Mr. Kiran Patel	Sysadmin., comp. resources
Dr. Lutz Rastaetter	Models, V&V, visualization, frameworks
Dr. Aleksandre Taktakishvili	Postdoctoral fellow
<u>Associate</u>	
Dr. Mei-Ching Fok	RC and rad. belt models

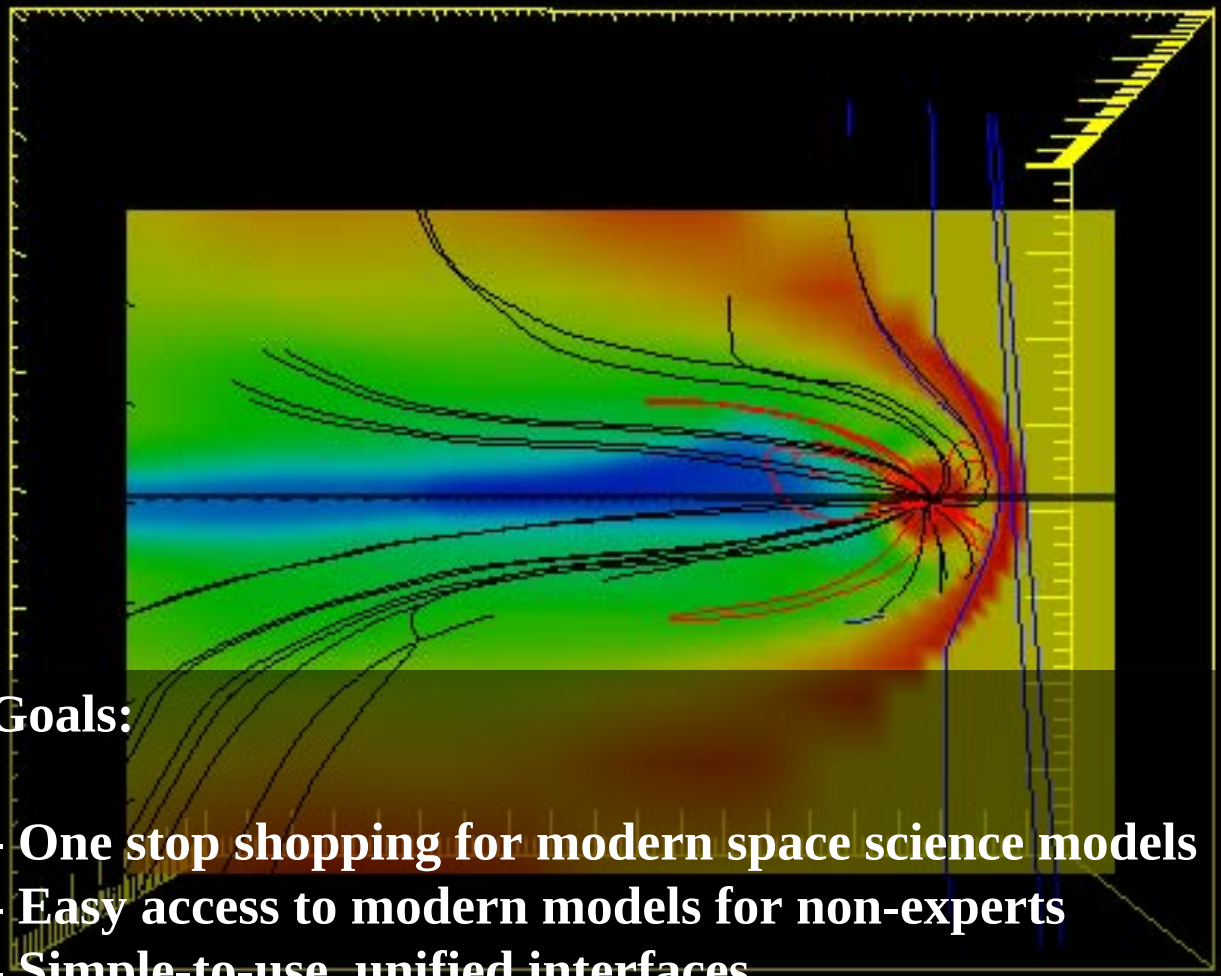
CCMC Facility

Located at
NASA GSFC

~200 node Beowulf system, sponsored by **AF/XOW, NSF, AFOSR,**
tech refresh sponsored by **NASA**

S. Bakshi, K. Patel

CCMC Functions: Research Support

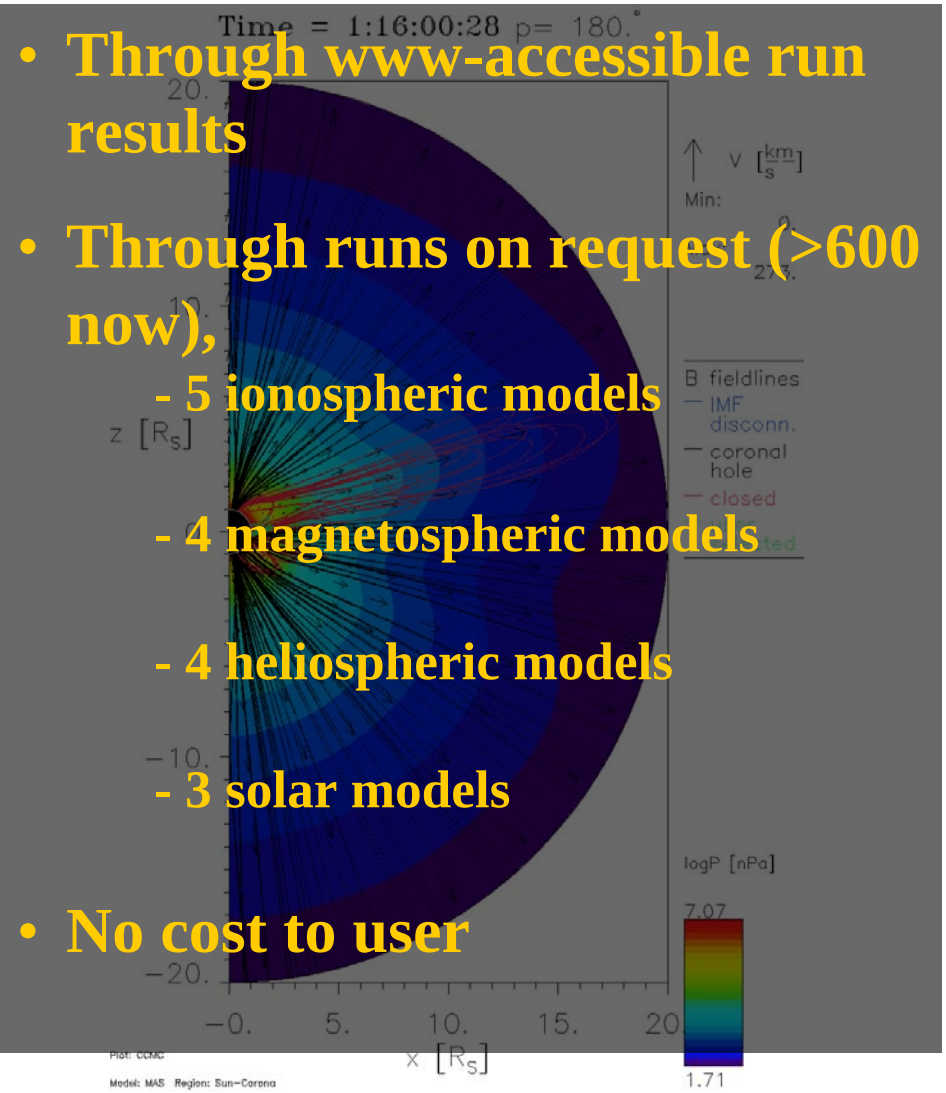


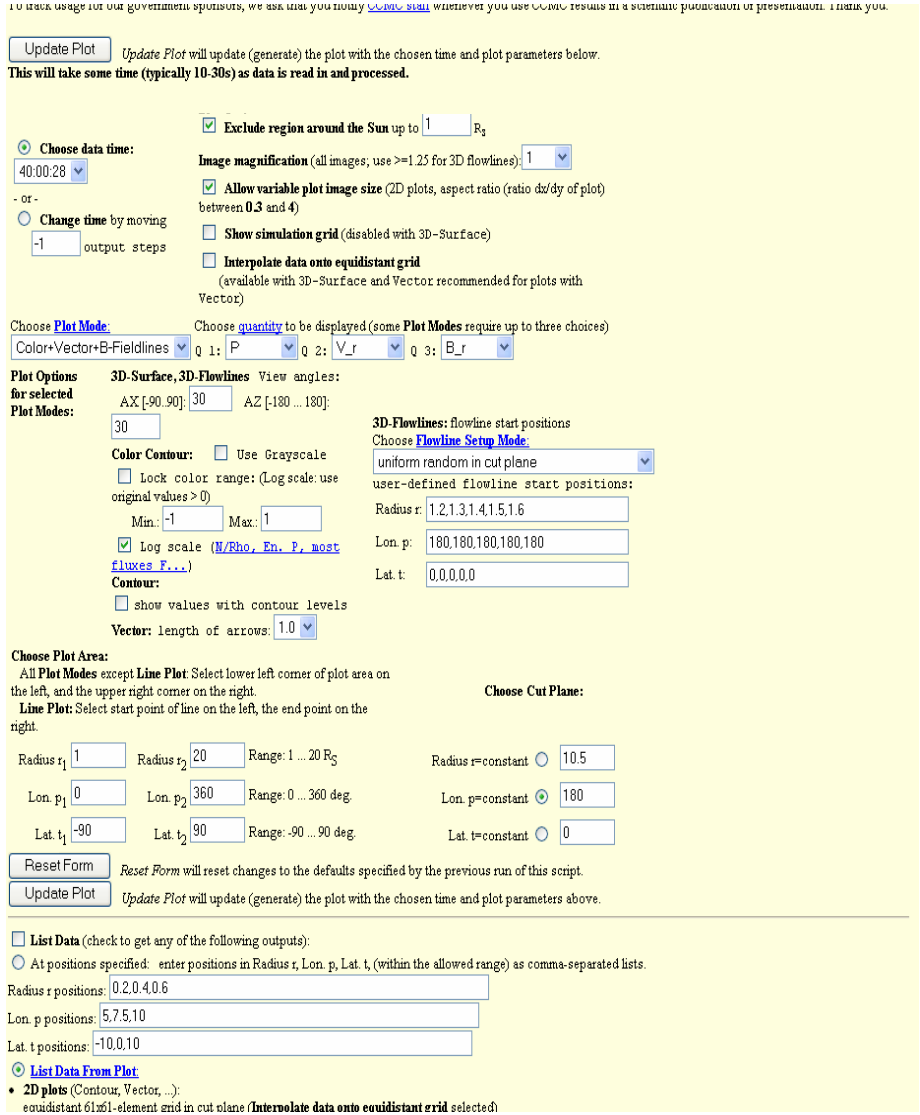
Goals:

- One stop shopping for modern space science models
- Easy access to modern models for non-experts
- Simple-to-use, unified interfaces
- Advanced, tailored visualization tools
- Continuous improvements through user feedback

Service

- **Through www-accessible run results**
- **Through runs on request (>600 now),**
  - **5 ionospheric models**
  - **4 magnetospheric models**
  - **4 heliospheric models**
  - **3 solar models**
- **No cost to user**





Demos on Thursday

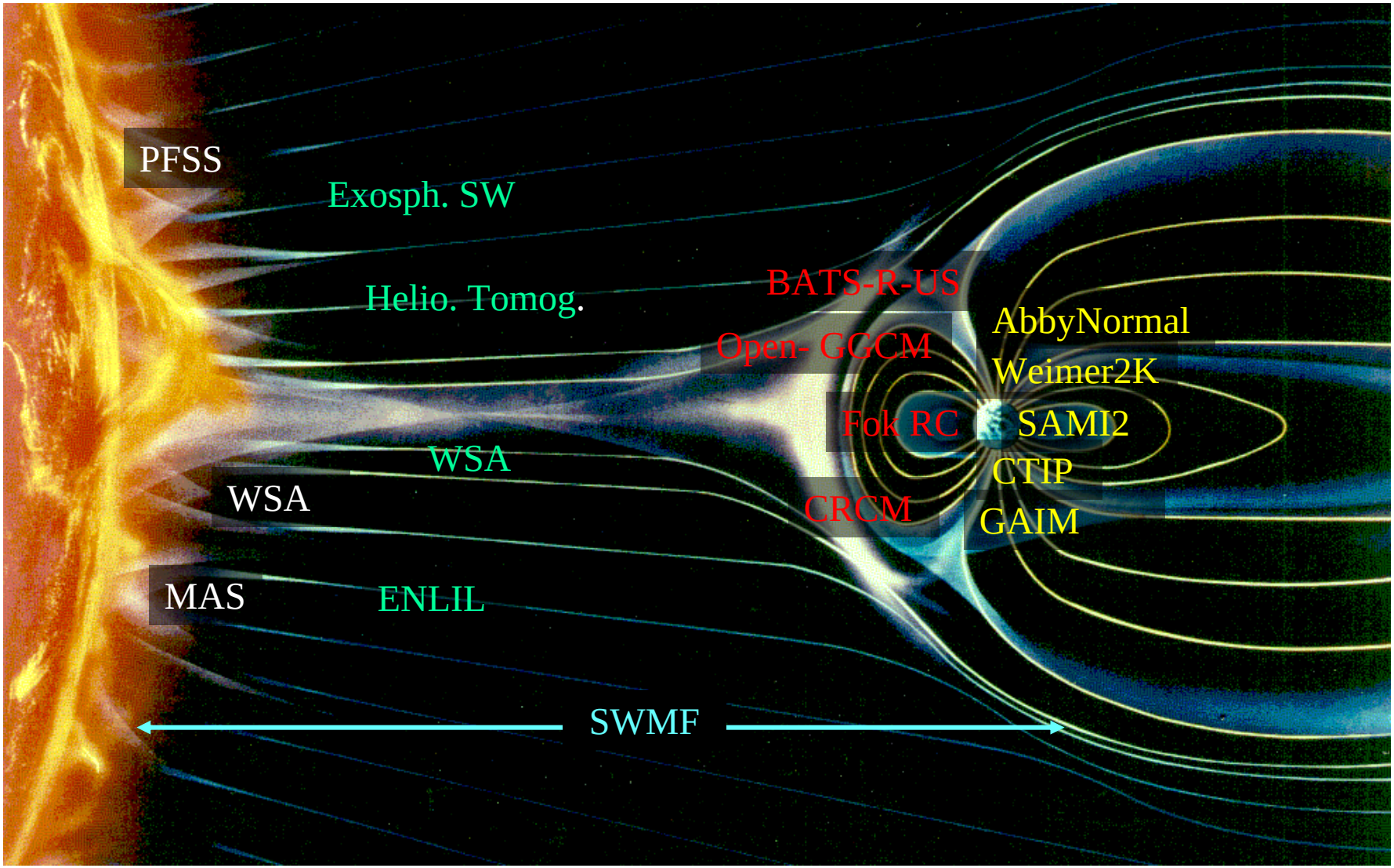
A. Chulaki, L. Rastaetter, M. Goldfarb

Service Improvements

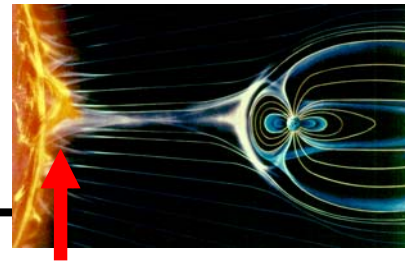
Comprehensive interface that allows:
-Requesting and displaying satellite trajectories
-Line, surface, volume, and VRML plotting capabilities
-Various grid selections
-Output in standardized form with access libraries

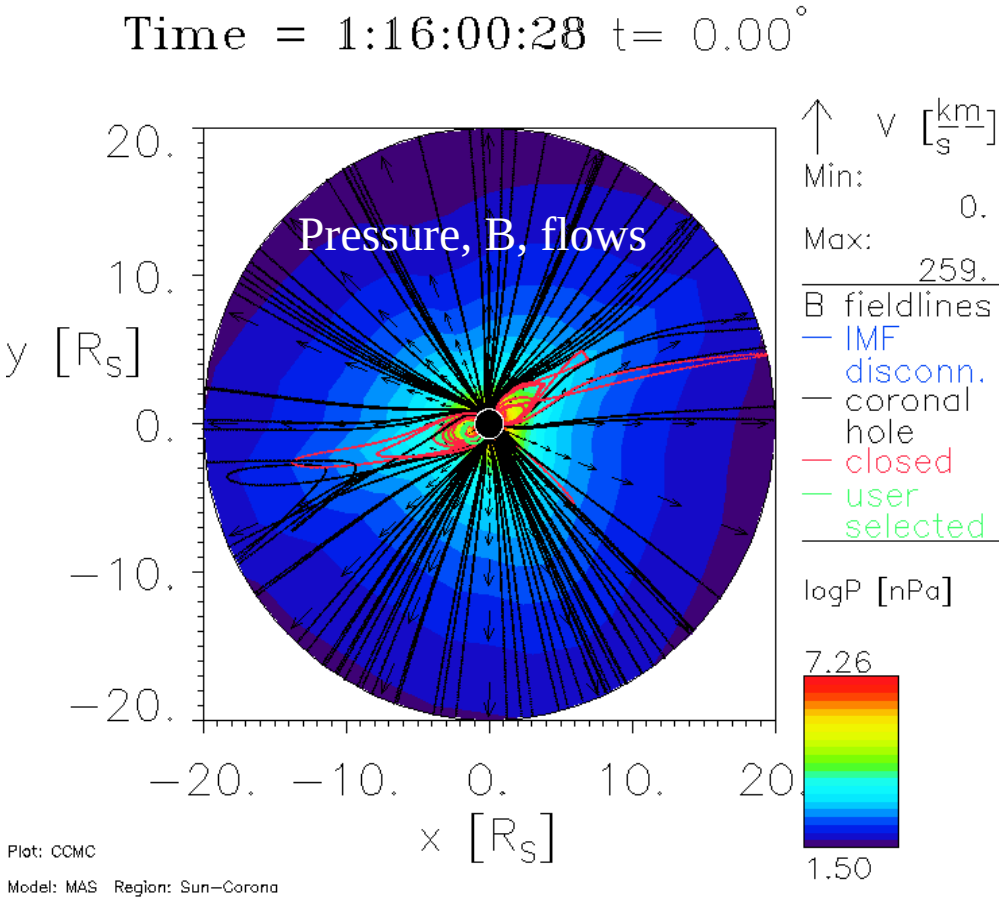
More models:
-WSA
-ENLIL
-GAIM
-Eccles HF Absorption
-SWMF Solar and Heliospheric elements
-SWMF Magnetosphere/RCM
-Exospheric heliospheric model
-Fok CRCM

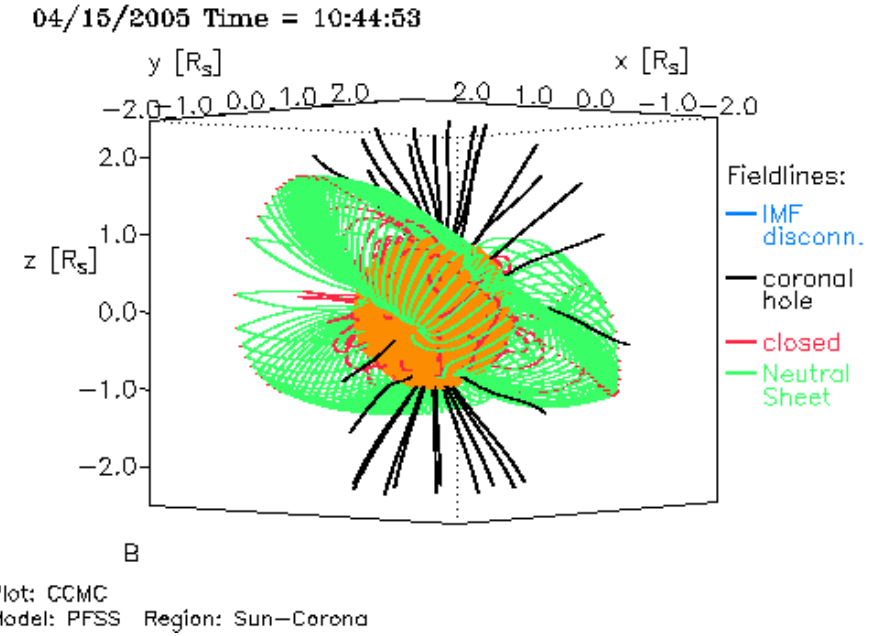
Models: Overview



Solar Models





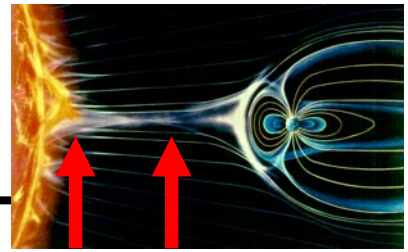


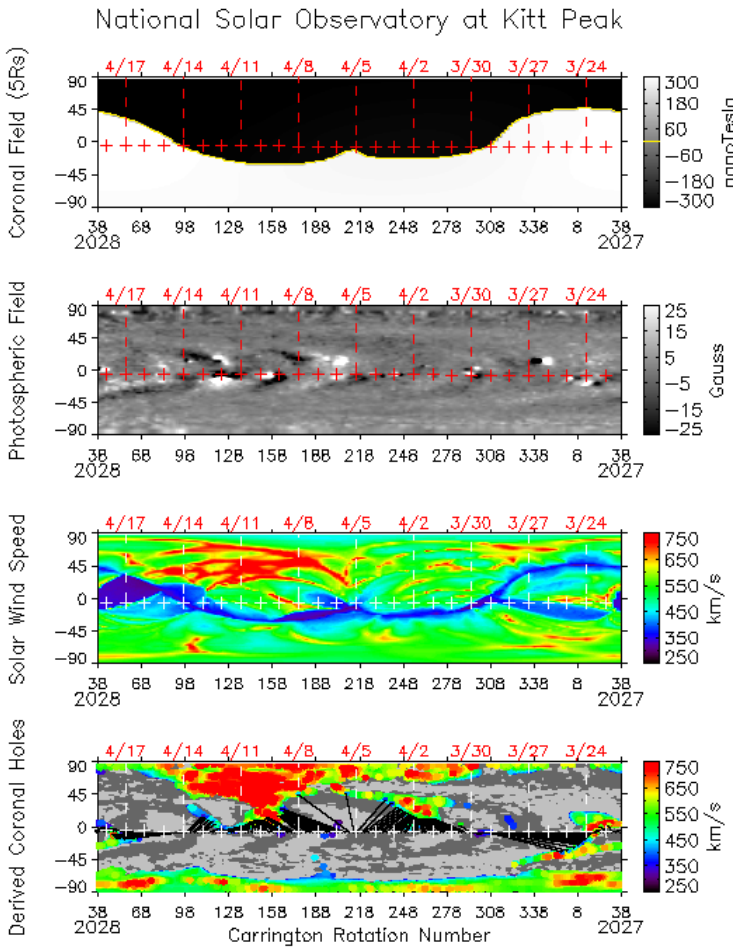
- **MAS** (Linker et al – SAIC) – Global solar magnetic field and plasma structure

- **Potential Field Source Surface** (Luhmann, UCB) - Global solar magnetic field structure

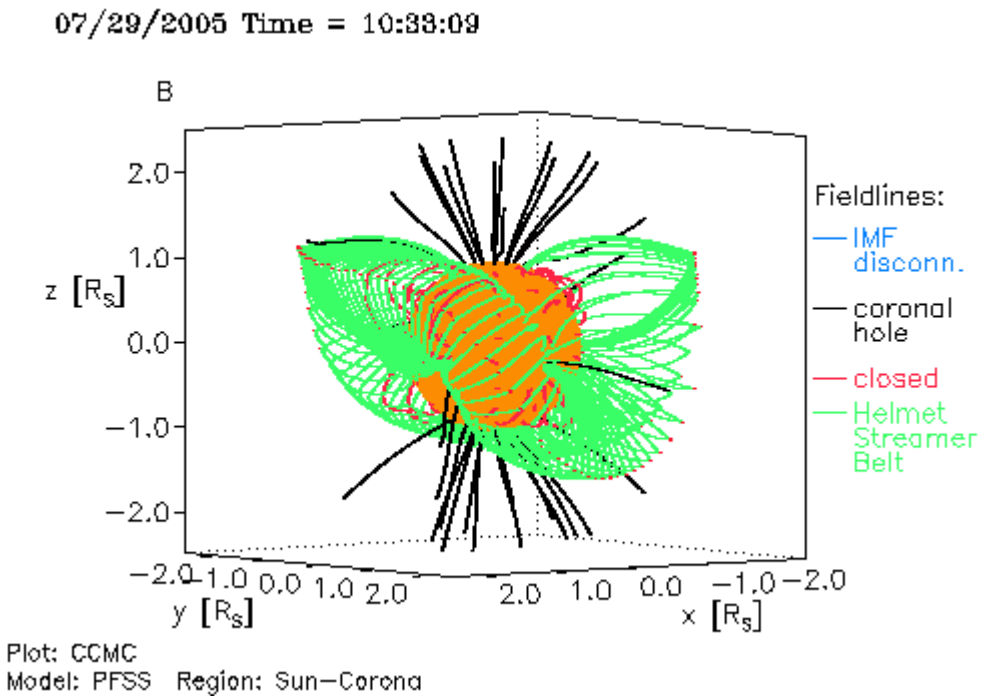
P. MacNeice, L. Rastaetter

Solar/Heliospheric Models



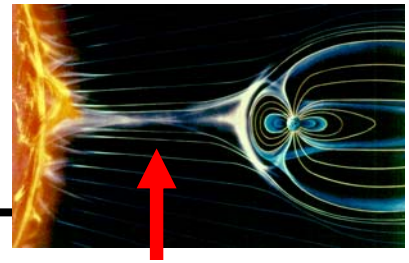


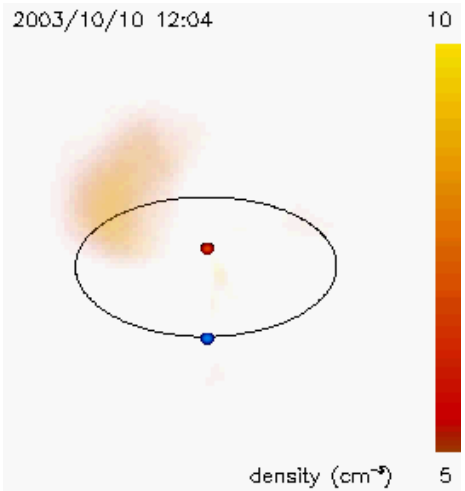
WSA (Wang-Sheeley-Arge) – PFSS corona + 'potential' current sheet + empirical kinematic solar wind

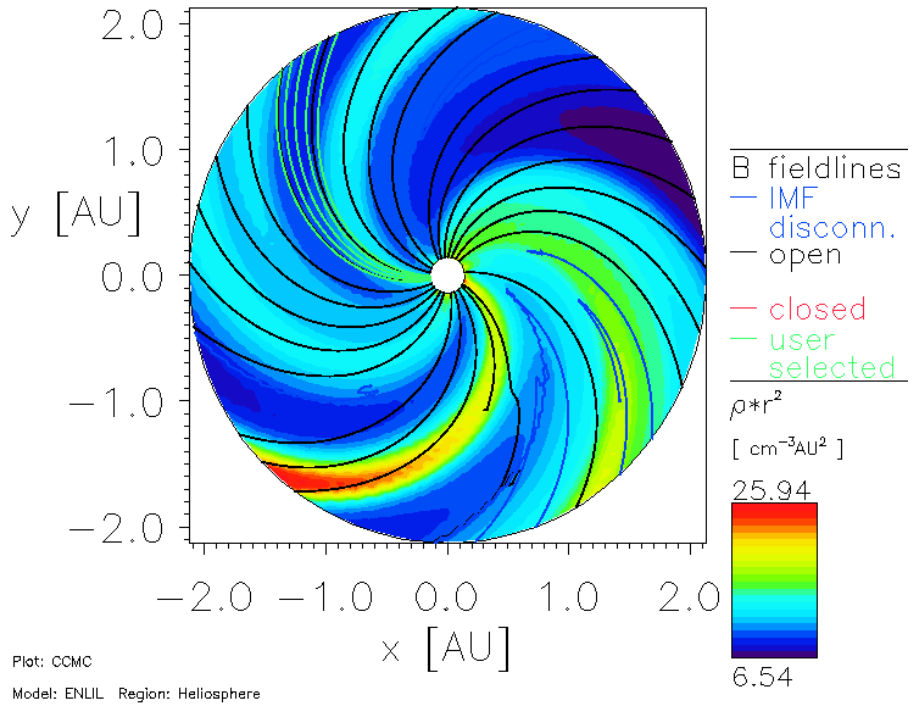


P. MacNeice, L. Rastaetter

Heliospheric Models







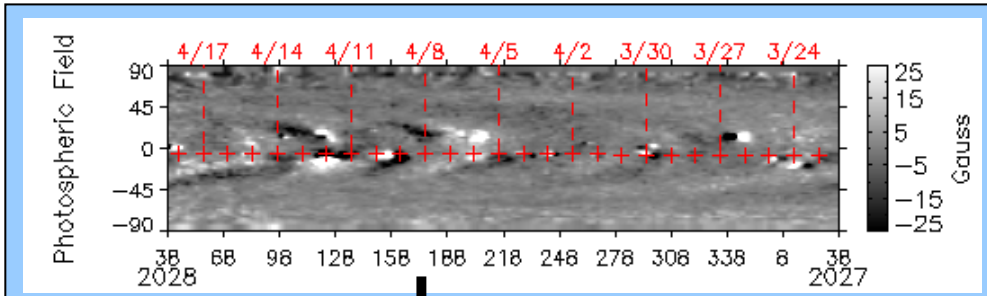
- Heliospheric Tomography (Jackson,Hick – UCSD) – Constructs global mass and velocity distribution from a simple kinematic model and assimilation of radio scintillation data.

- ENLIL (Odstrcil – NOAA) – 3D MHD model of inner heliosphere ($30r_s$ – 2AU) .

• Exospheric Solar Wind Model (Lamy/Pierrard) – 1D kinetic model of solar wind solution along a coronal hole fieldline.

P. MacNeice, L. Rastaetter, M. Kuznetsova, A. Chulaki

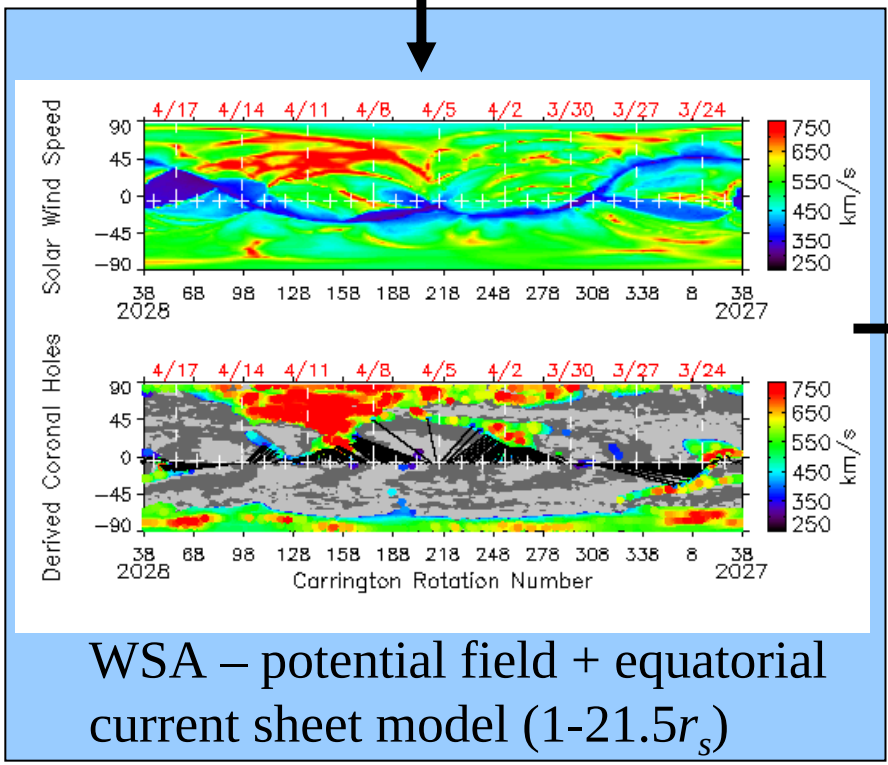
Forecasting : Sun to Earth



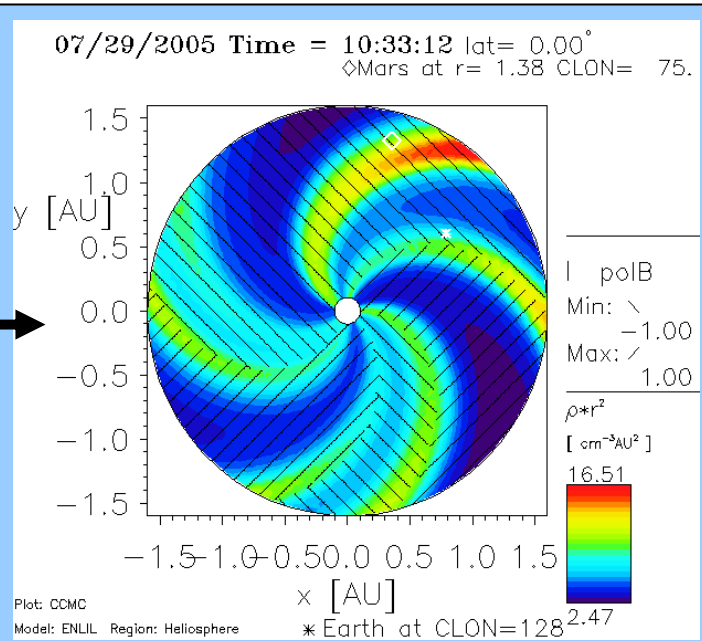
Photospheric Synoptic magnetograms

Running in realtime, collab. With CISM

P. MacNeice, L. Rastaetter

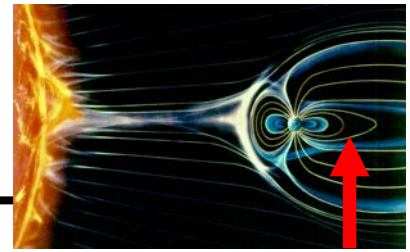


WSA – potential field + equatorial current sheet model (1-21.5r_s)

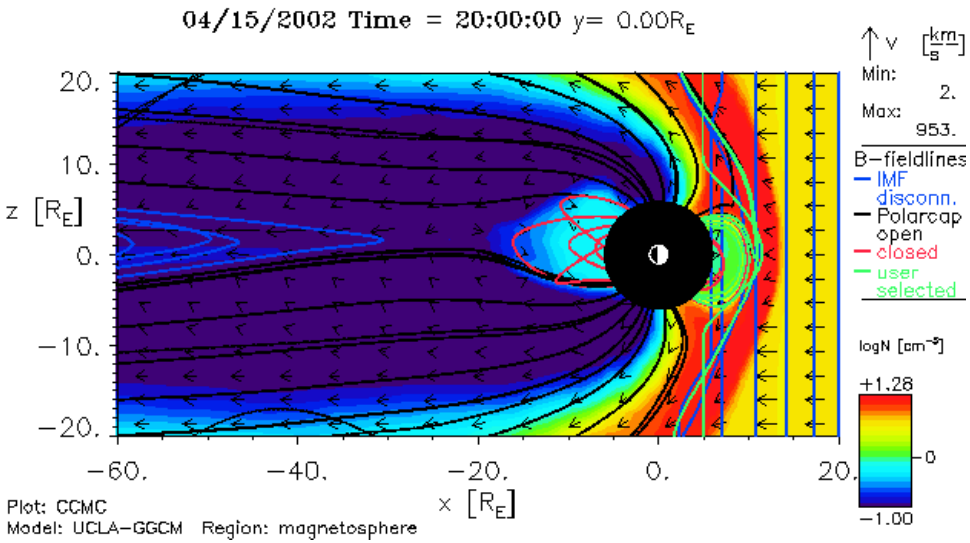


ENLIL - 3D MHD Heliosphere (21.5r_s – 2AU)

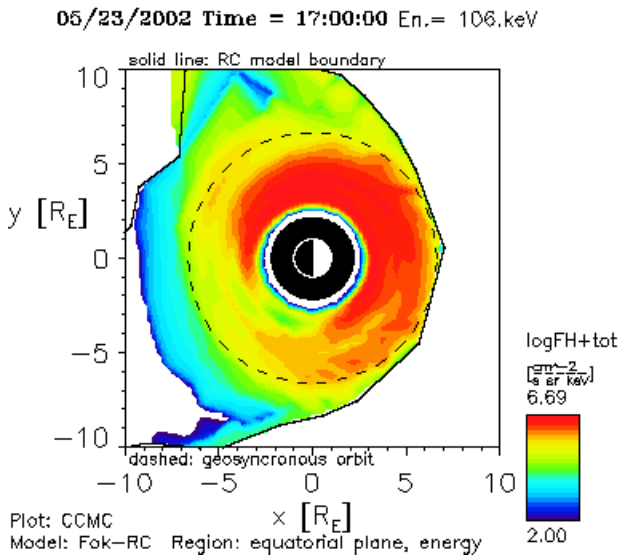
Magnetospheric Models



•OpenGGCM (UNH), BATSRUS (UMich) – 3D global MHD models of magnetosphere ($2R_E - 200R_E$) .

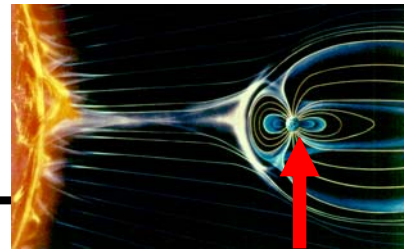


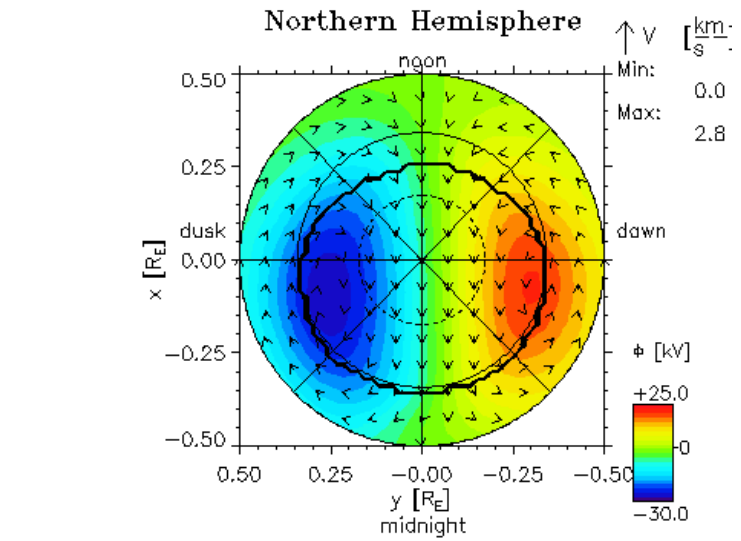
•Fok kinetic Ring Current and Radiation Belt Models ($2R_E - 6R_E$) .

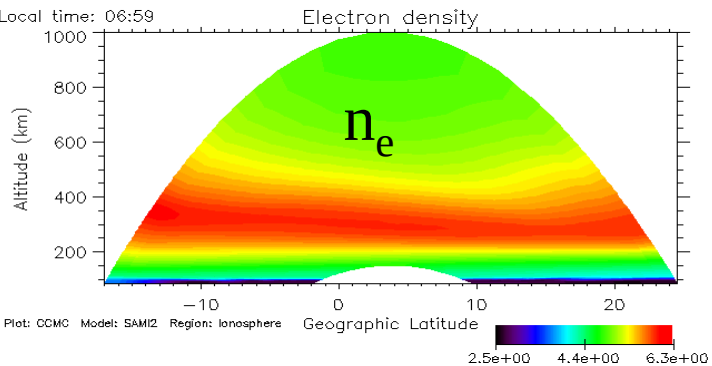


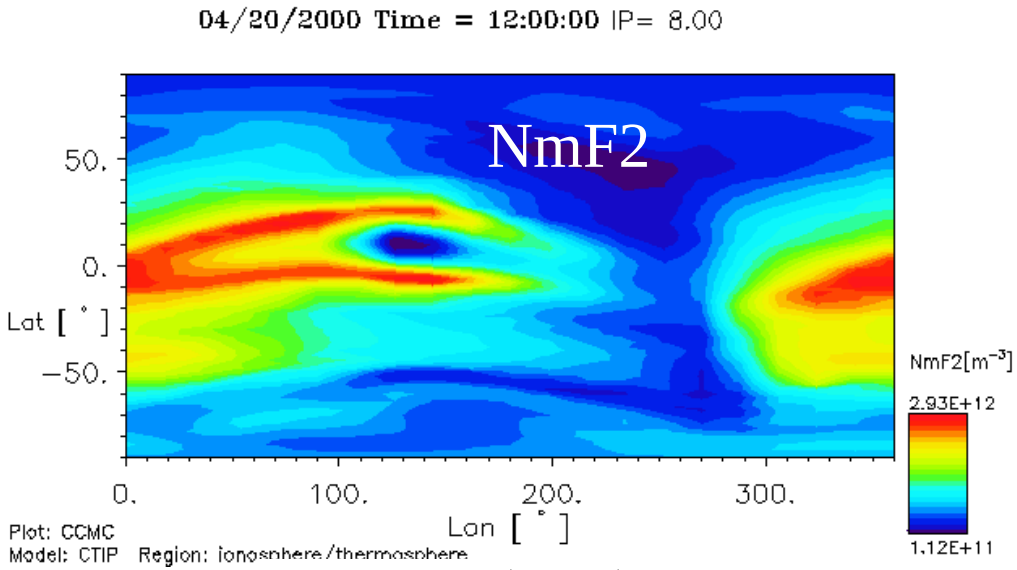
L. Rastaetter, M. Kuznetsova

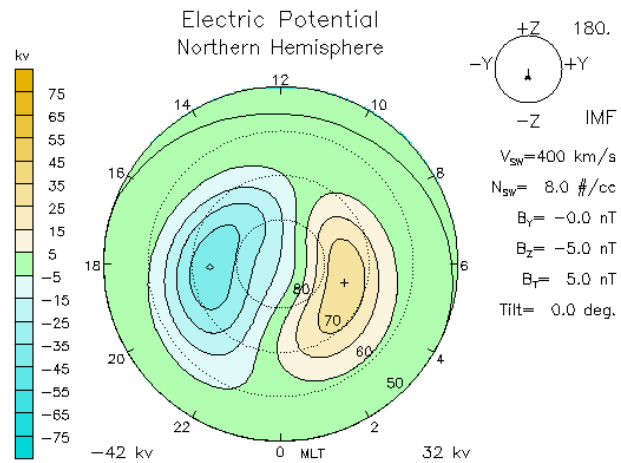
Ionospheric Models







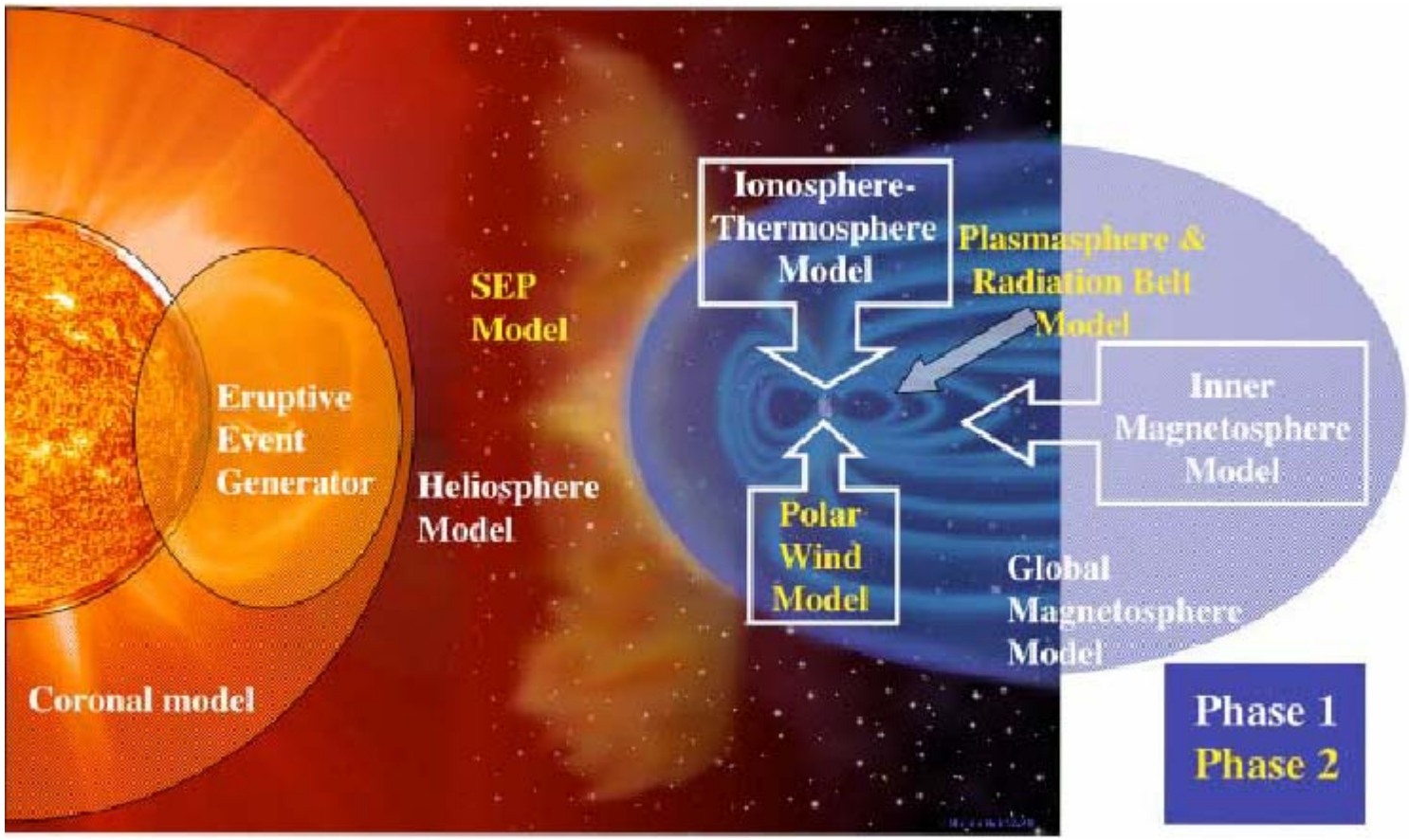




- Electrodynamic (MHD ionospheric modules)
- Empirical (Weimer statistical)
- SAMI 2 meridional ionosheric (Huba, NRL)
- CTIP global ionospheric (Fuller-Rowell et al, NOAA)

M. Kuznetsova, L. Rastaetter

Space Weather Modeling Framework



Entire framework incl. models at CCMC

CCMC will support incorporation of additional models

→ *Presentation by Peter MacNeice*

L. Rastaetter, P. MacNeice

Key Usage Statistics

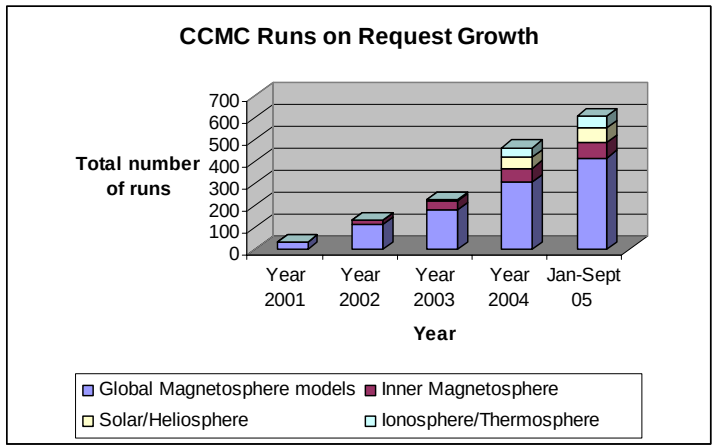
- Total executed model runs:

  Over 600 runs executed so far

- Monthly website stats ‘05:
  - 17,900 website hits/month
  - 600 unique visitors/month
  - 1350 visualization requests/month

- International resource

- Responding to user feedback:
  - interface streamlining underway

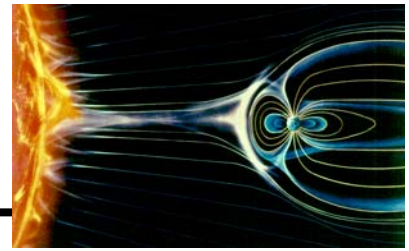


Visitors domains/countries

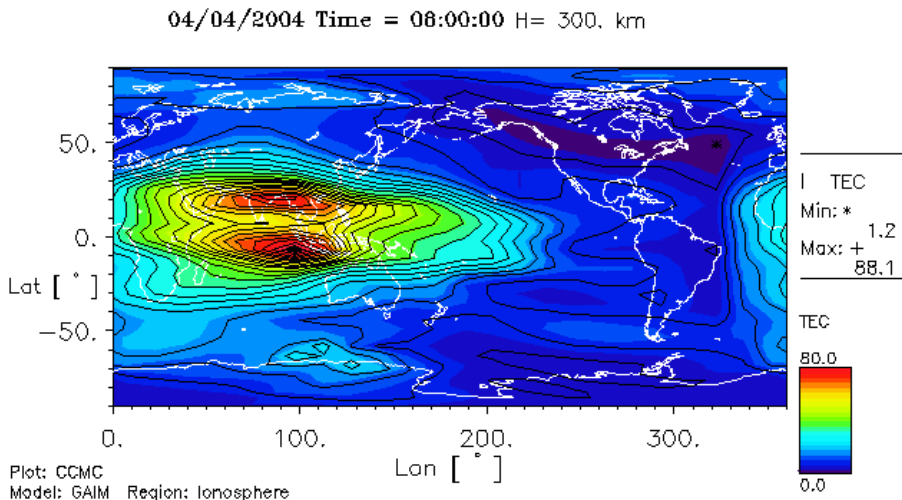
Domains/Countries		Pages	Hits
USA Educational	edu	1000	1716
USA Government	gov	529	801
Czech Republic	cz	493	917
Network	net	491	855
Commercial	com	348	405
Denmark	dk	193	274
USA Military	mil	192	264
United Kingdom	uk	40	60
Bulgaria	bg	30	42
Belgium	be	29	46
Non-Profit Organizations	org	22	29
Argentina	ar	19	34
Finland	fi	13	29
Italy	it	12	21
Japan	jp	10	20
Germany	de	8	13

A. Chulaki

Models: Future



- Sun, Heliosphere, Magnetosphere and Ionosphere:
  - **SWMF (UMichigan)** includes 9 component models covering solar corona to upper atmosphere.
  - **CISM 1.0**: First version of CISM Sun-Earth model.
- Sun:
  - **Updated MAS** step toward eruption modeling
  - **New models:** UCB ANMHD model, DeVore ARMS, DeForest Fluxon
- Ionosphere:
  - **GAIM (USU)** installed (compiled code only)
    - CCMC will support GAIM V&V
  - **Eccles HF absorption model**
    - Installation completed
    - NASA/LWS supported
- Input from Science & Operations?



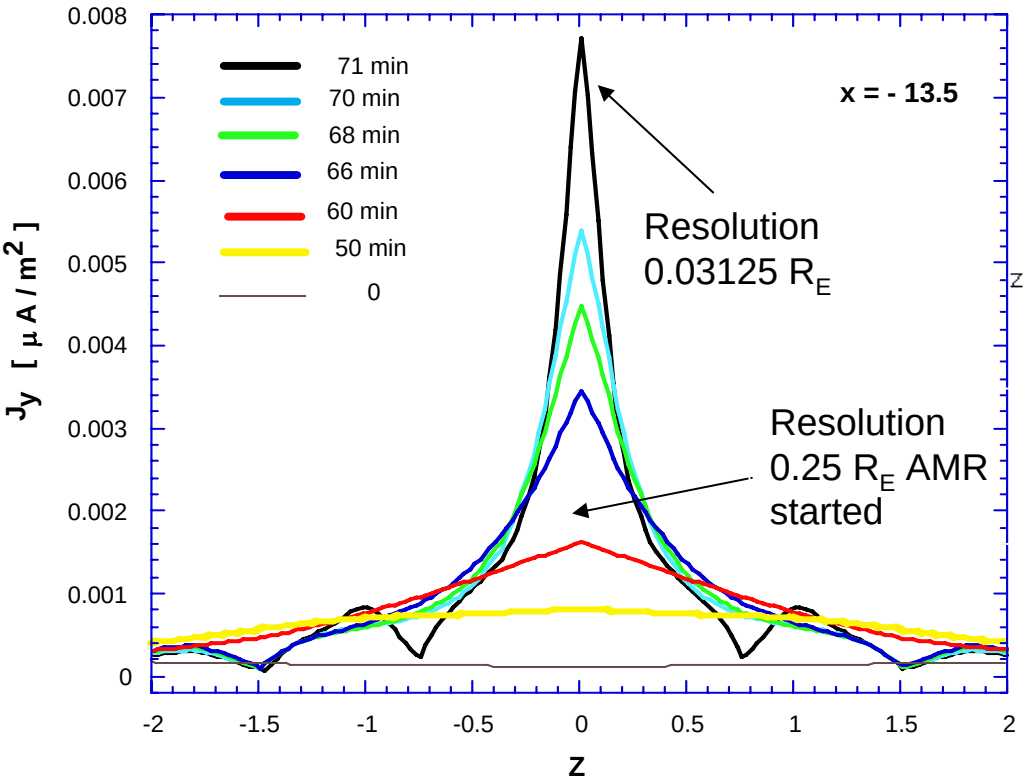
CCMC Transition Support Activities

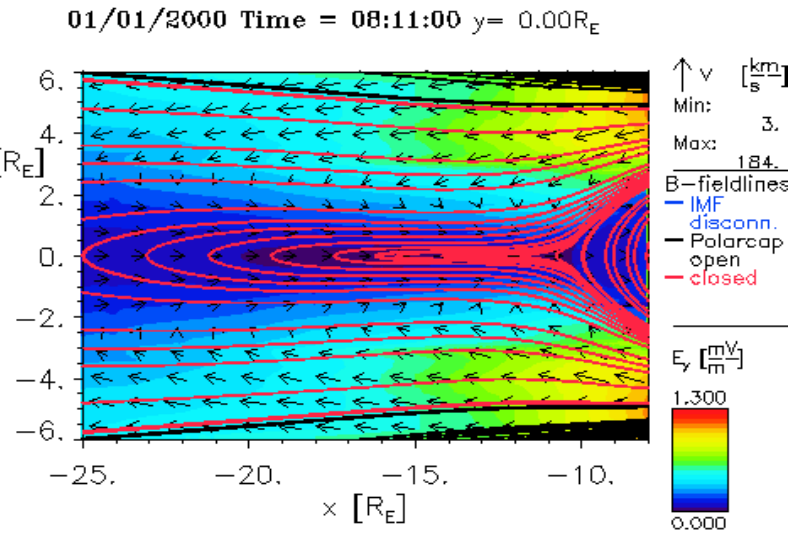
- Evaluate scientific research models to address National Space Weather needs
  - Regarding validity
  - Regarding robustness, reliability
  - As unbiased evaluator
- Focus on research models with space weather operations benefits
- Develop real-time systems that apply to operations
- Participate in space weather education
- Transfer science- and metrics-tested models to operational National Space Weather Agencies

Presentation by Masha Kuznetsova

V&V Activity: Model Validity

Current sheet fidelity as function of Numerical resolution

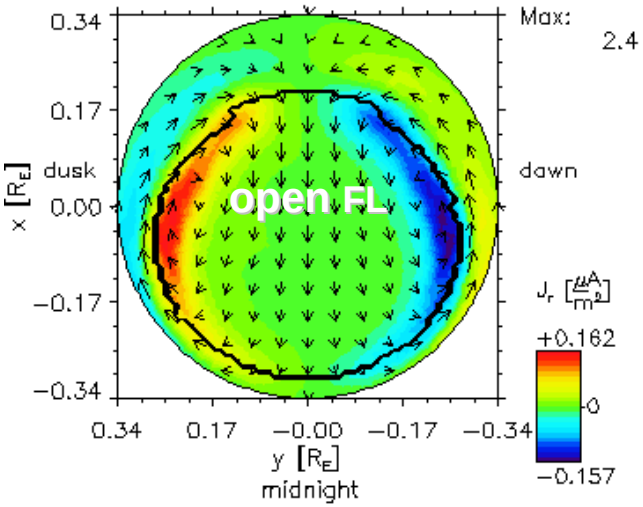


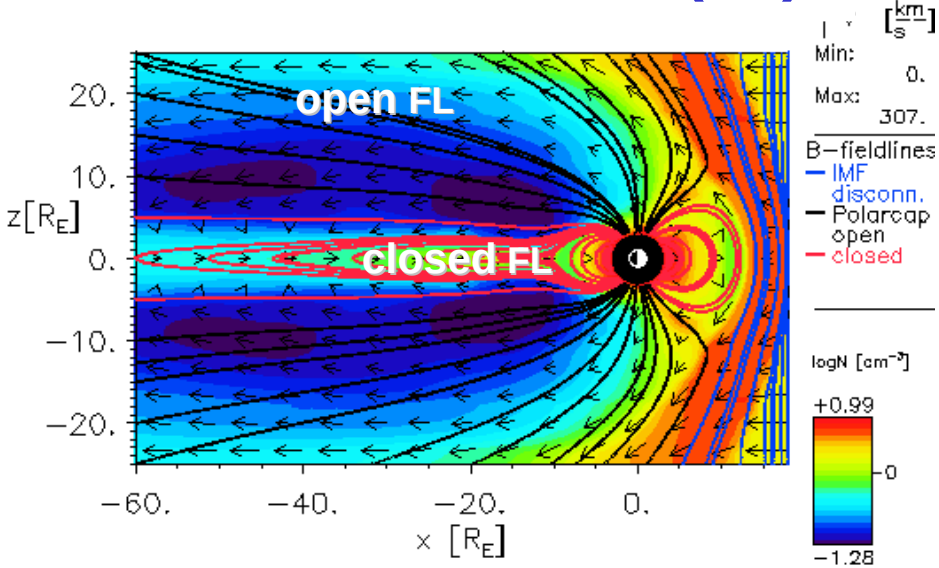


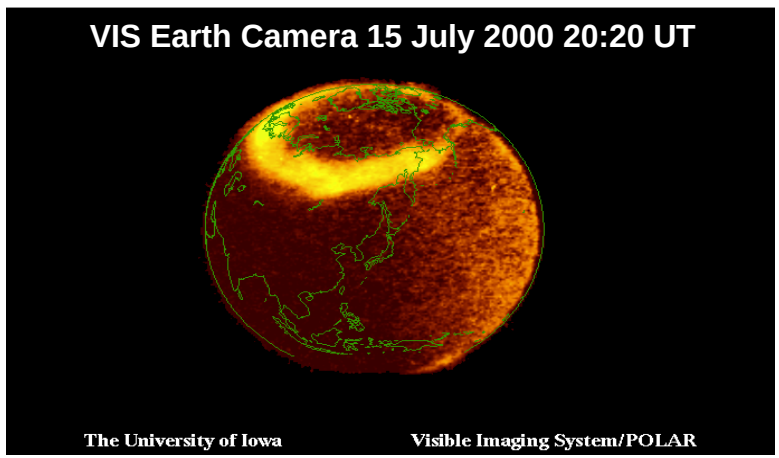
Kuznetsova et al., in press, 2005

V&V: Simulate Polar Cap Size

Boundary between open and closed field lines (FL)

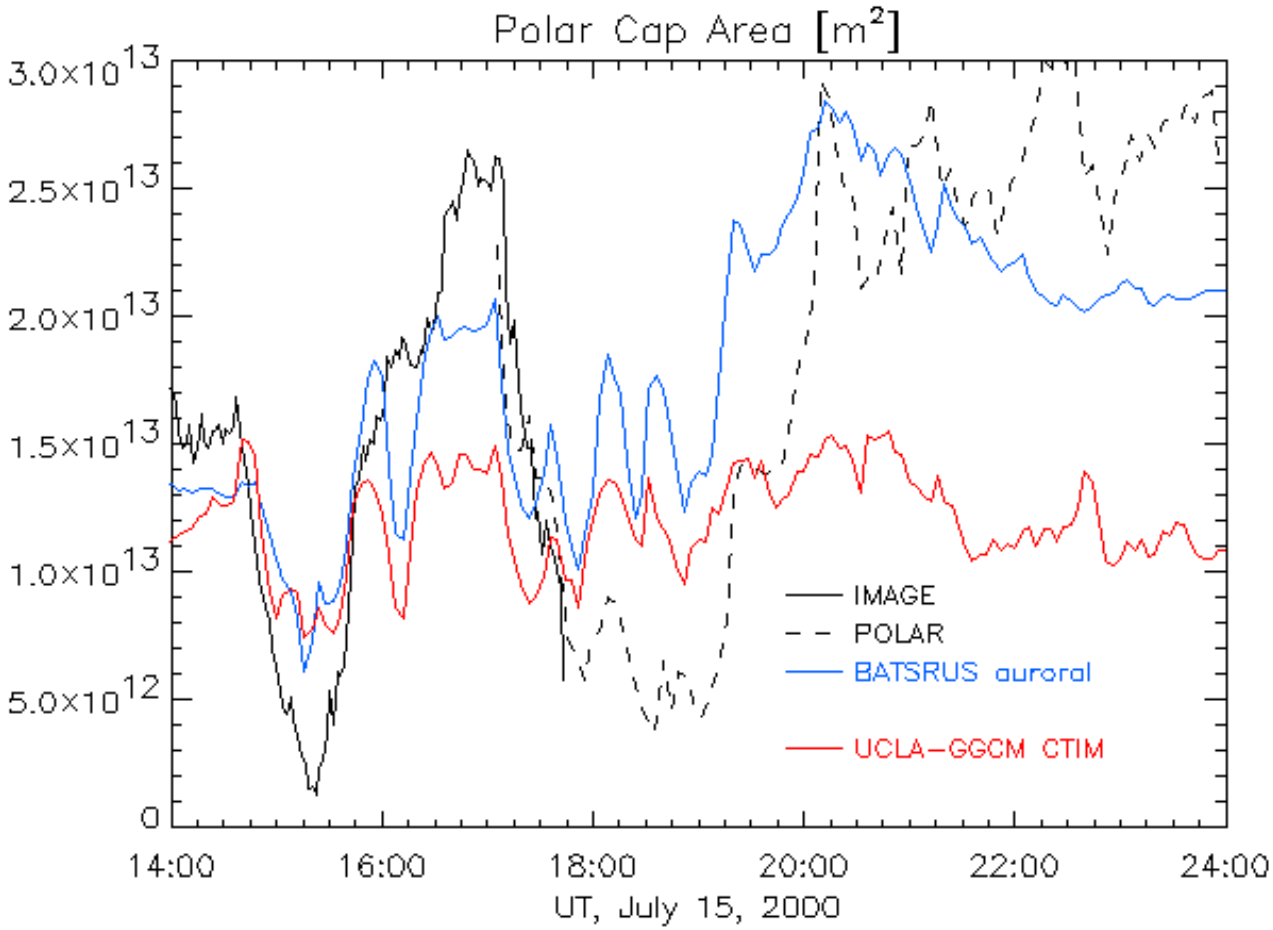






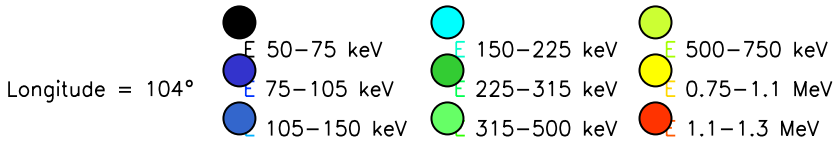
← **Polar cap boundary observed by POLAR**

Reproduce Polar Cap Area: MHD models

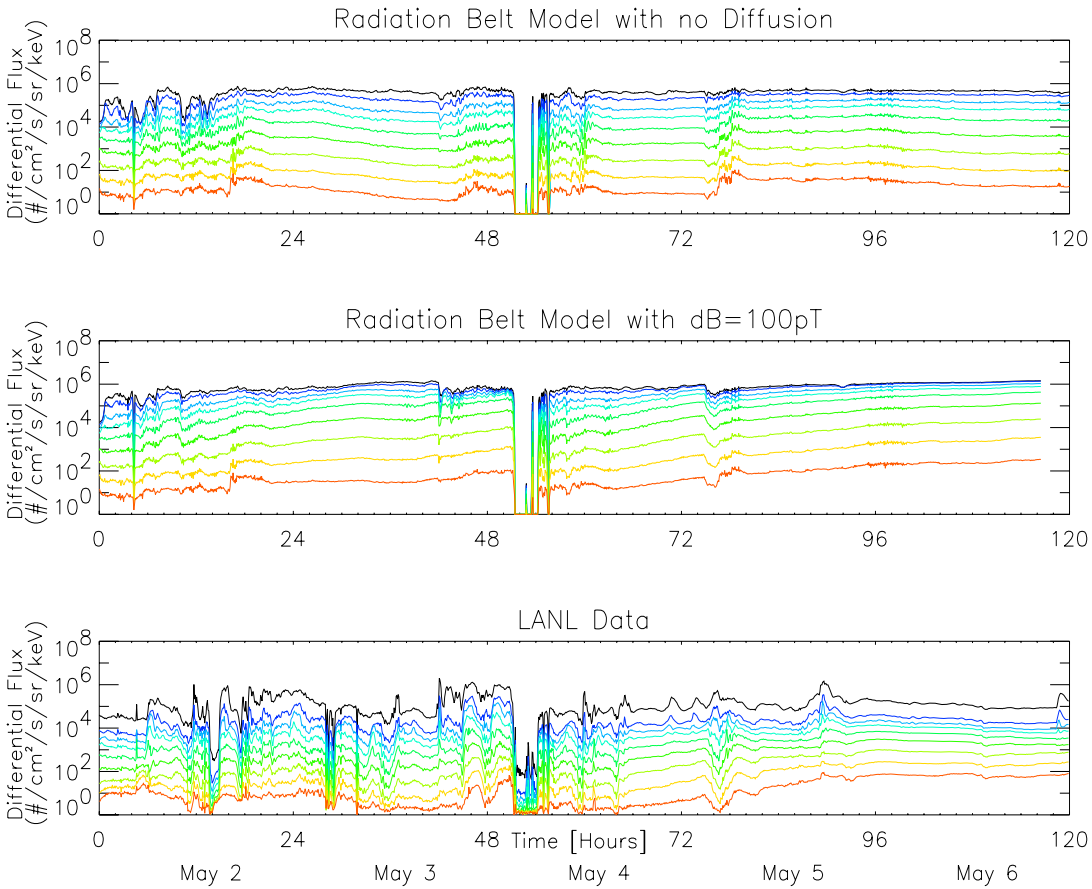


Rastaetter et al., 2005

Science-Based Validation: Fok Radiation Belt Model



Fok radbelt model



Original Model

Improved Model

LANL Data

K. Keller

V&V: Radiation Belt

UPOS geo MeV electron forecasting model

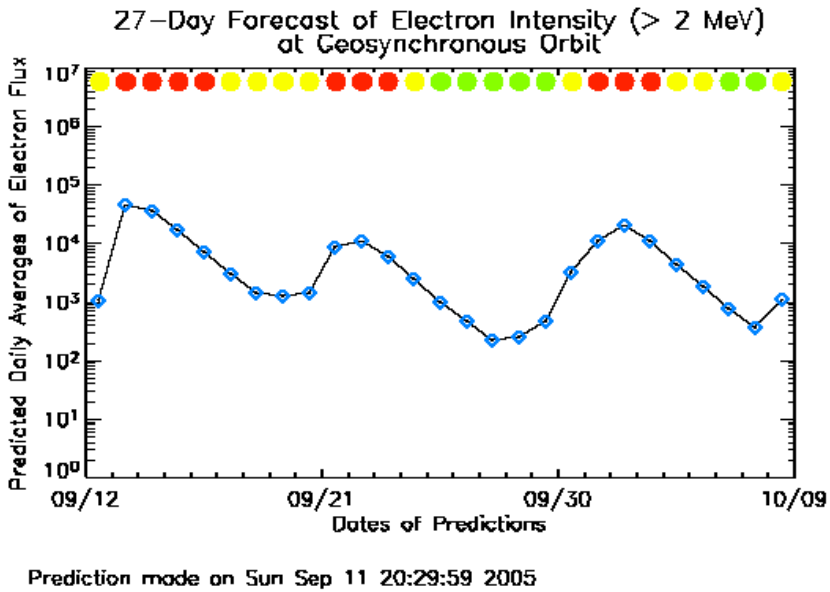
-V&V activity requested by AFWA

-Installation completed

-Feedback to developers

-V&V activities ongoing

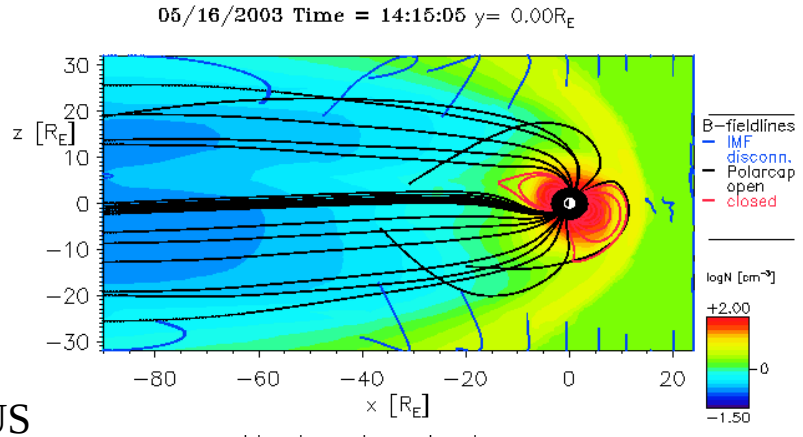
-First report to AFWA

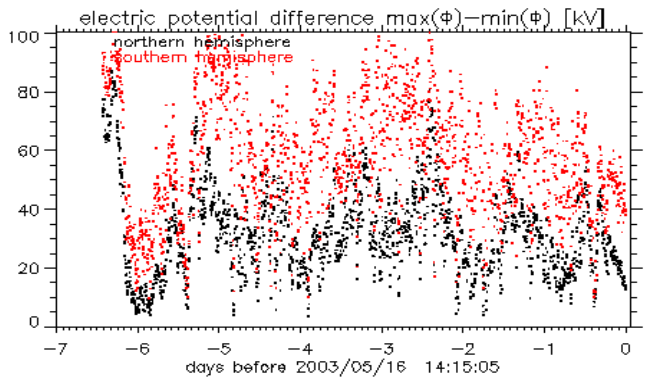


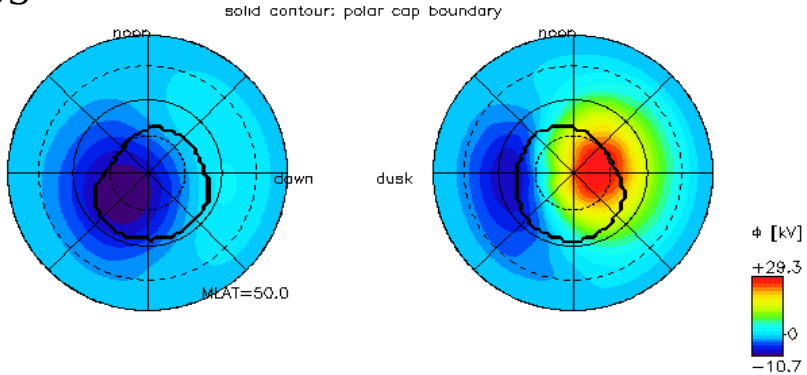
A. Chulaki

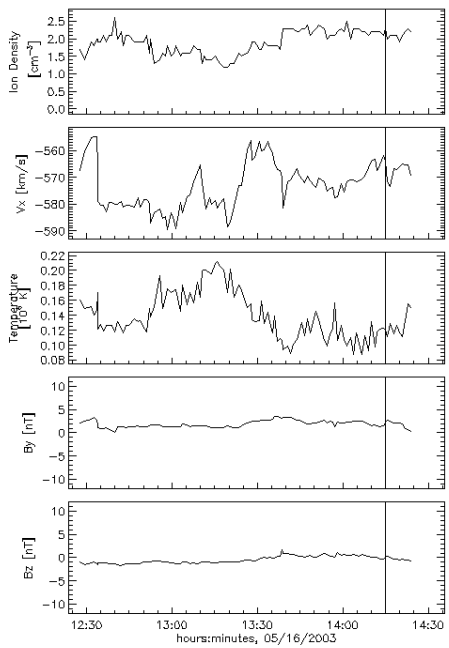
Experimental Real Time Page

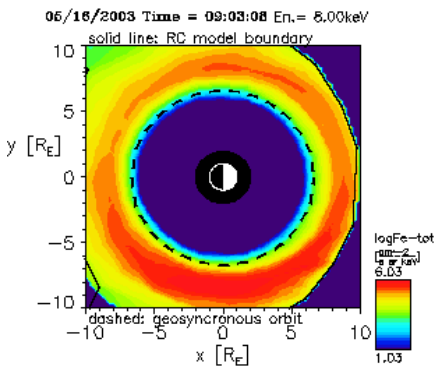
BATSRUS

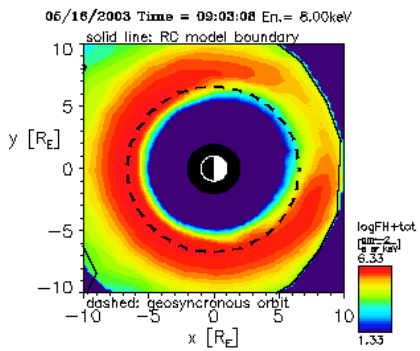






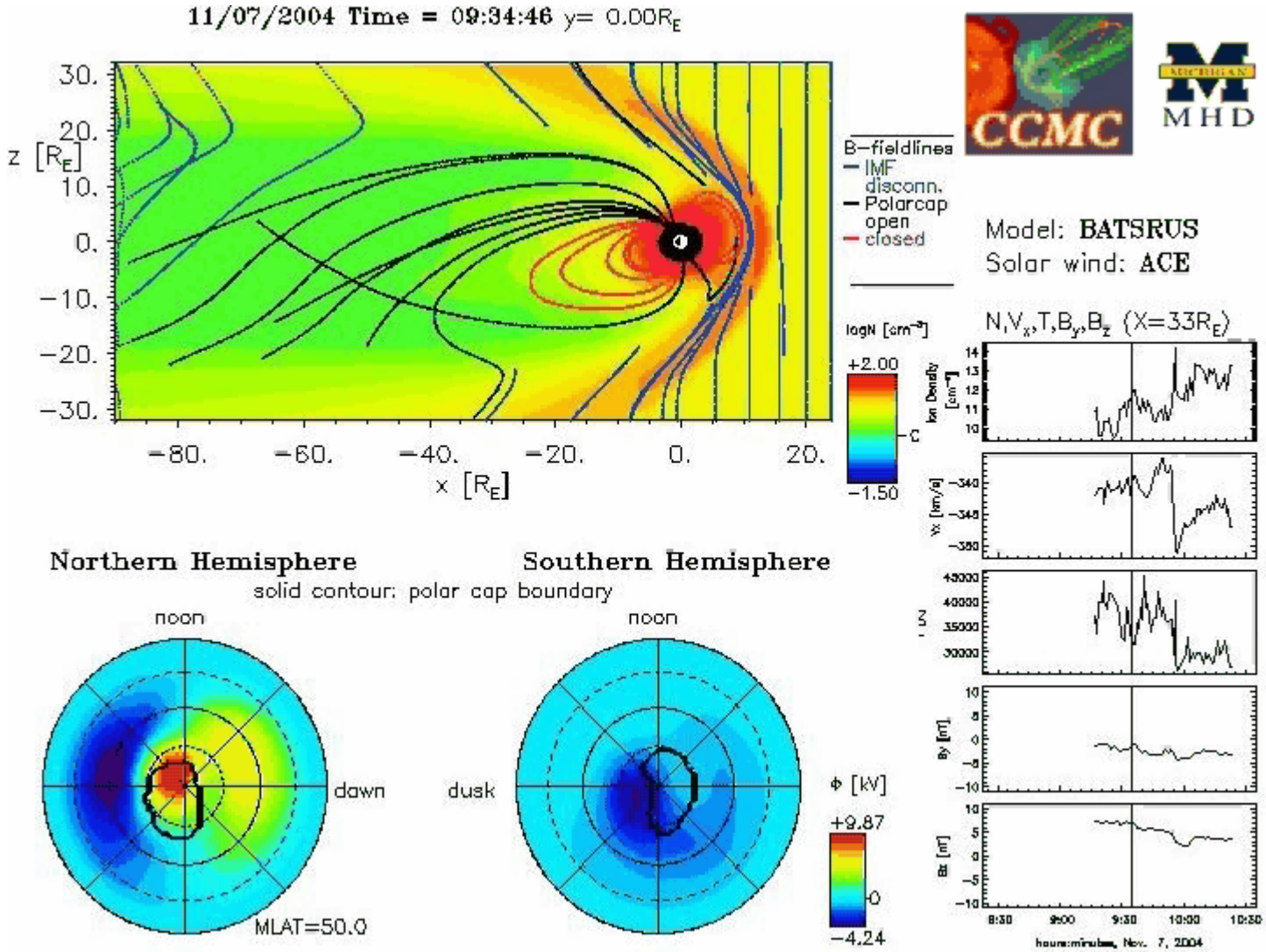






L. Rastaetter

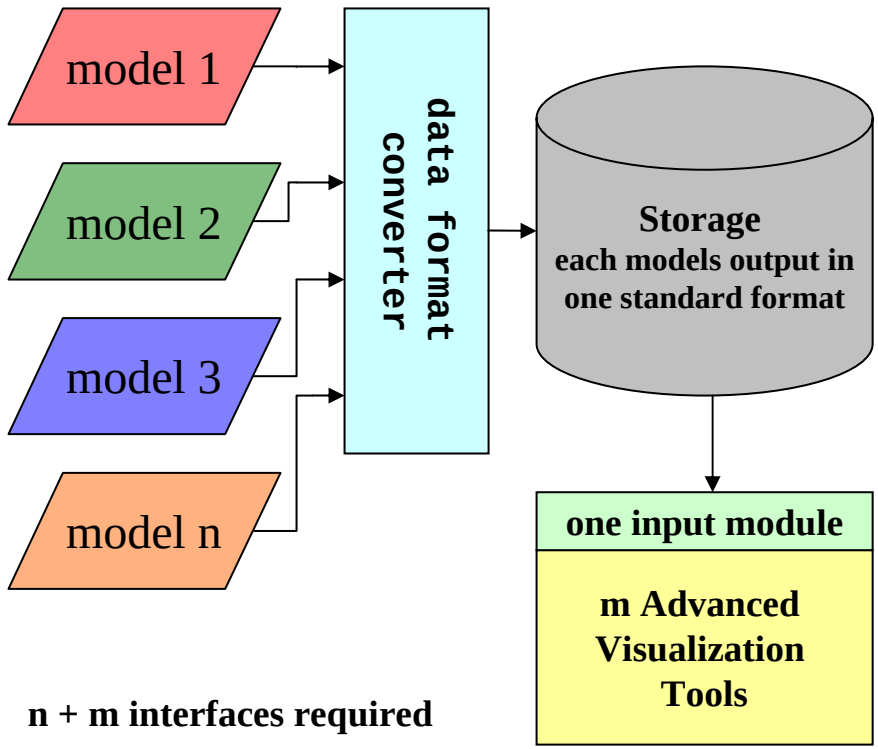
November 7, 2004 Storm



Data Standardization

Standardized Environment

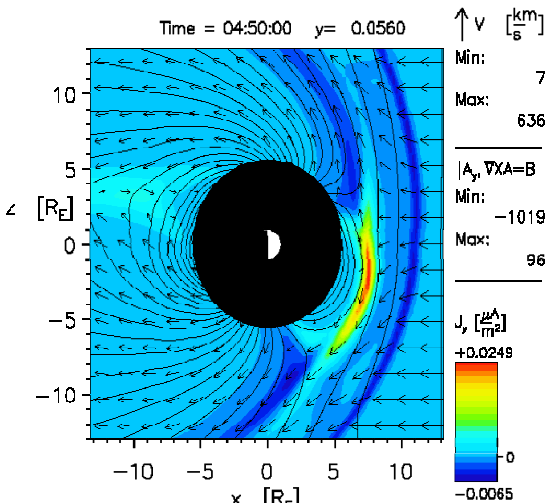
- Standard format for storage, coupling, & visualization
- Ensures compatibility between models for coupling
- Resolves multiple-interface challenge
- Ground work for which standard, reusable interfaces and tools can be developed

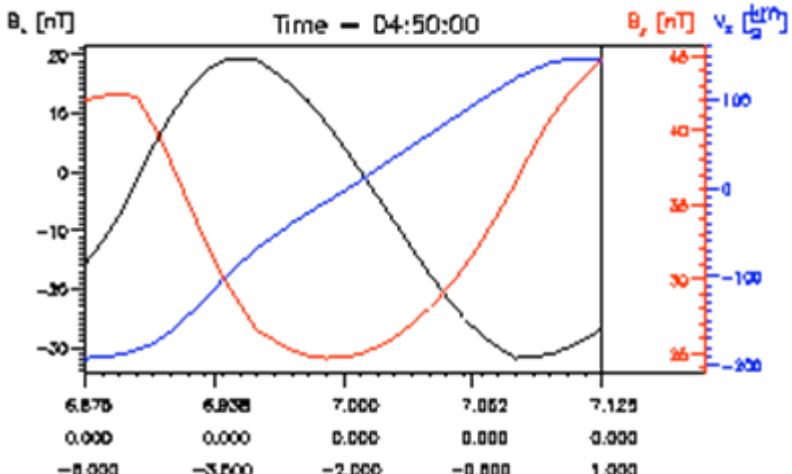


→ *Presentation by Marlo Maddox*
→ *Demo on Wednesday*

Data Standardization: Benefits

- Speed and efficiency of direct data access
  - Simple data access library
- Same interface regardless of model
- Platform independent
- Facilitates data & code reuse
- Permits rapid analysis of data sets from complex models
- Data format and access tools used by various customers
- Available to interested customers/libraries delivered to 2 modelers

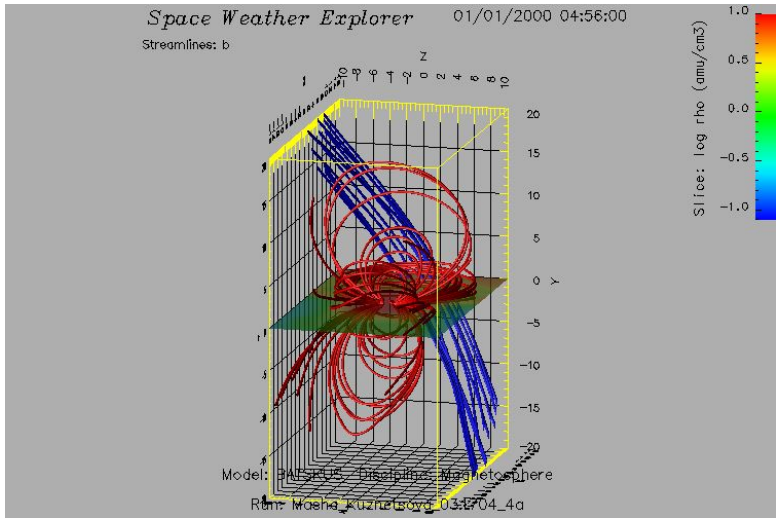


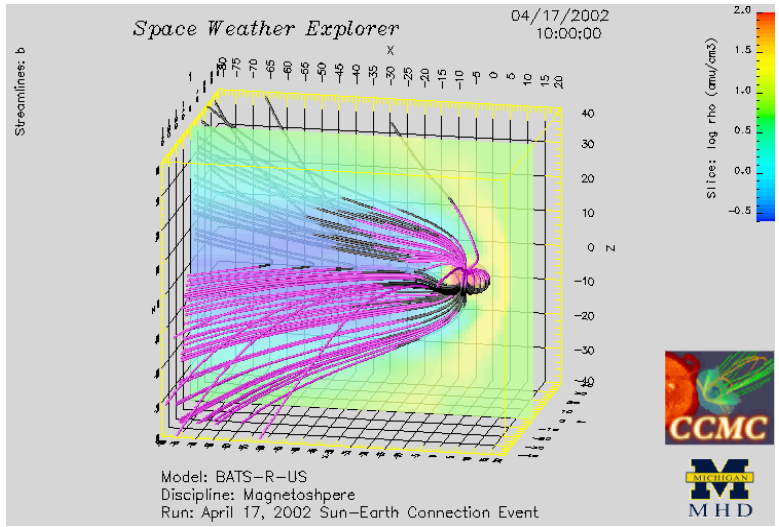


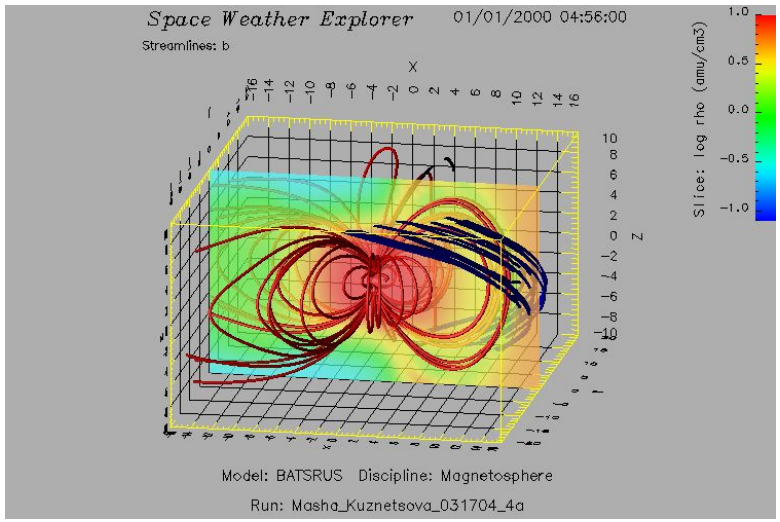
Required v_x, B_x, B_y in Range of ~$10R_E$
Reduced plot times from **15min to <5sec**

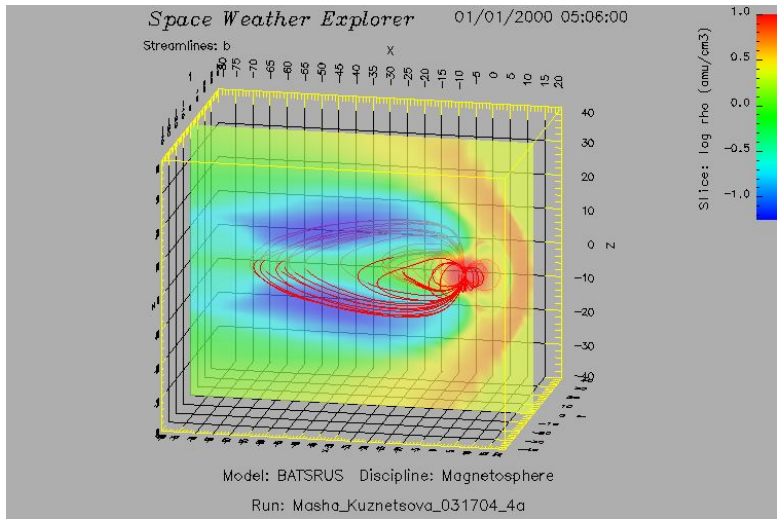
M. Maddox

Advanced Visualization: OpenDx









Demo on Wednesday

D. Berrios

Future Activities: Research Support

- Support the generation of advanced space science models
  - Address Space Weather-relevant processes
- Collaborate with related activities (CISM, CSEM, ILWS…)
- Expand strong service to (international) research community
  - Execute runs-on-request
  - Provide ready access to model output with enhanced tools
  - Includes mission support, e.g., STEREO
  - Includes campaign support, e.g., IHY
- Expand model base
  - UCB ANMHD model
  - DeVore ARMS
  - DeForest Fluxon model
  - Eruption modeling capability
  - GAIMs: USC/JPL
- Serve models developed under LWS and NASA/NSF partnership

Future Activities: Operations Support

- Provide tool by which science progress at NASA, NSF feeds into Space Weather operations
- Focus on science models with operational benefits
  - Operator input to identify model needs
- Address immediate payoffs as well as strategic value models (e.g., solar forecasting)
- Provide expanded, independent model evaluations
  - Obtain metrics, V&V procedures from operators
  - Support GAIM V&V
  - Perform priority evaluations for operations
  - Provide rapid response service in emergencies
- Other opportunities for closer collaborations/tailored support
  - Education: Coordination initiated with AFIT, USAFA
  - Interacting with AFWA (LtCol. Cade, Maj. Nobis)
  - Interacting with NOAA/SEC (J. Kunches, B. Murtagh)
  - Coordinating with AFSPC (K. Hand)
  - Implementation: Installation design and support possible
  - Tool development following operator needs