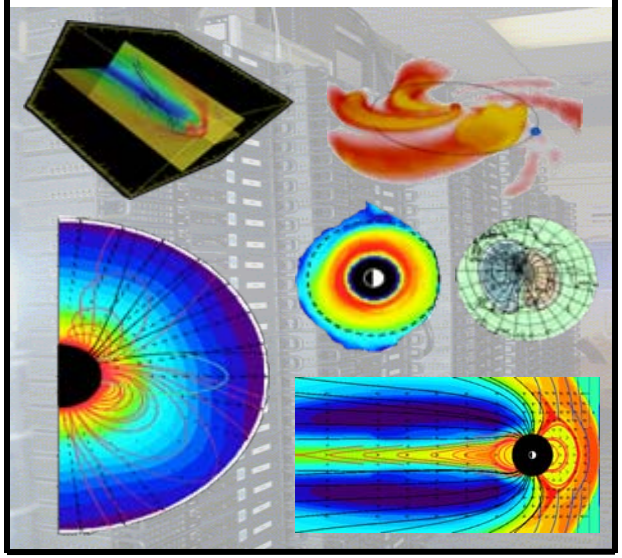
COMMUNITY COORDINATED MODELING CENTER



Director's Report

Michael Hesse

http://ccmc.gsfc.nasa.gov

NASA Goddard Space Flight Center

Workshop purpose

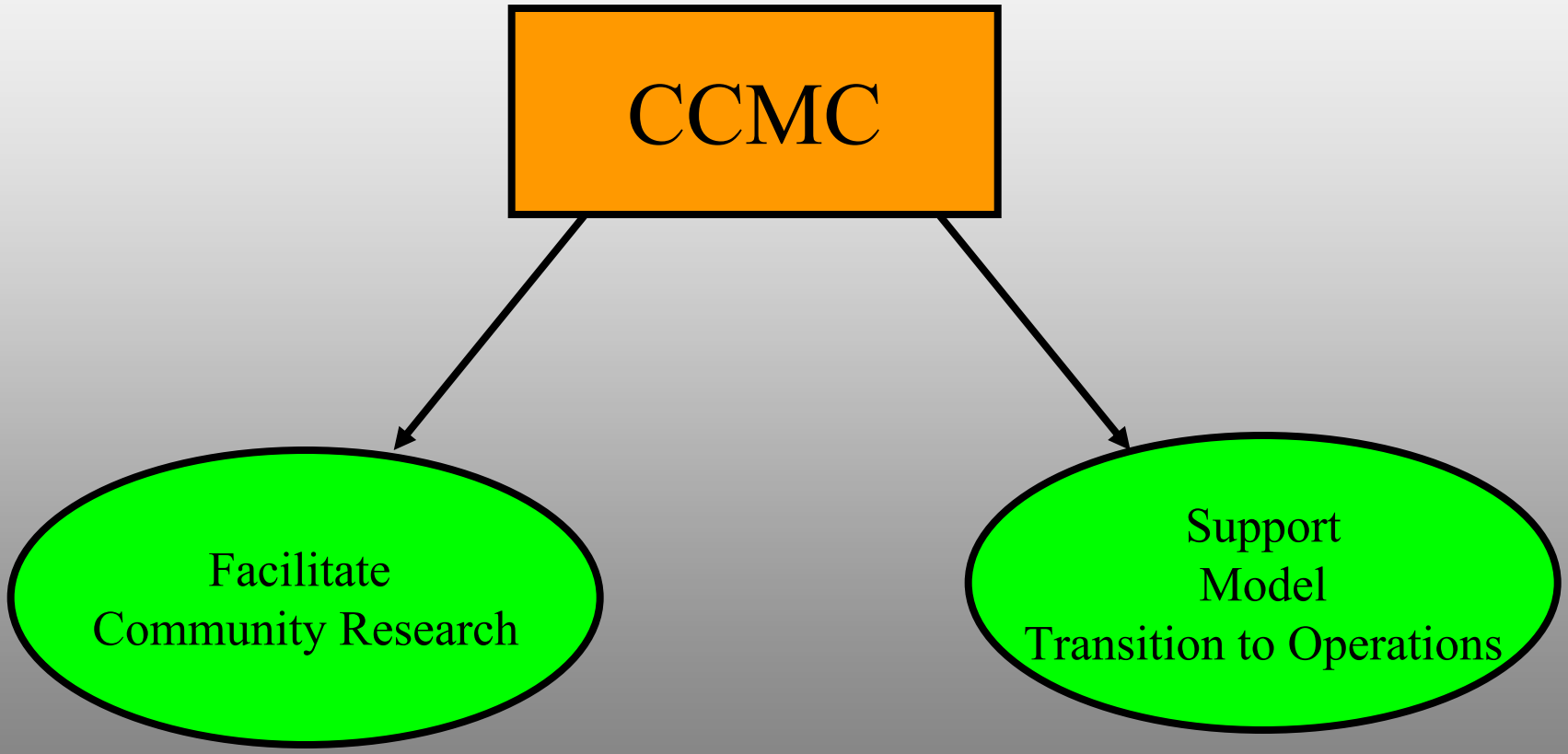
- Assess (evolution to) CCMC state-of-affairs
  - What went well
  - What could have gone better
- Provide input for future directions
  - Science service
  - Operations service
  - Collaborations with modelers
- Discuss other topics of interest

Our job is to listen to you…

… begin by summary of current status

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

CCMC goals

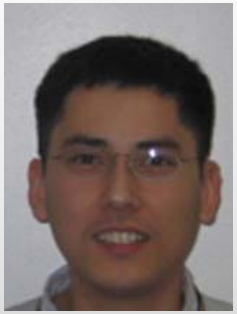


International Research Community

NASA, DoD, and NOAA, other Space Weather needs

CCMC staff

S. Bakshi


D. Berrios

A. Chulaki

L. Moiseev

M. Hesse

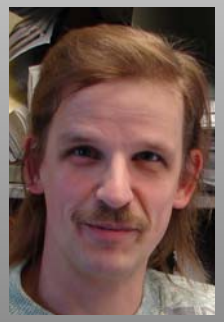
M. Kuznetsova

P. MacNeice

M. Maddox

K. Patel

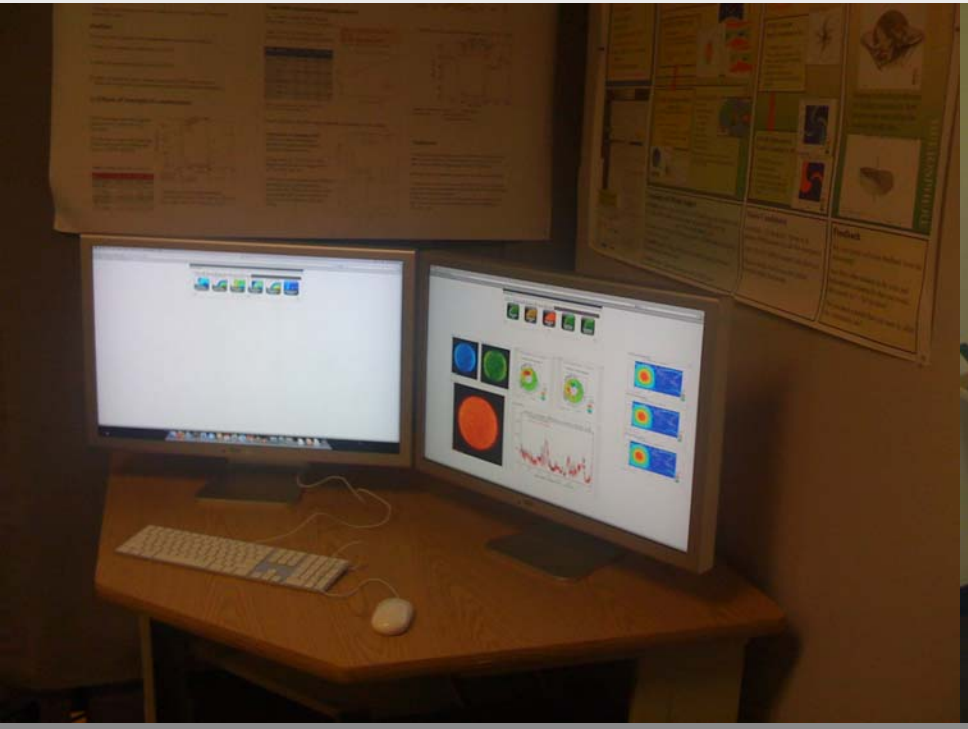
A. Pulkkinen

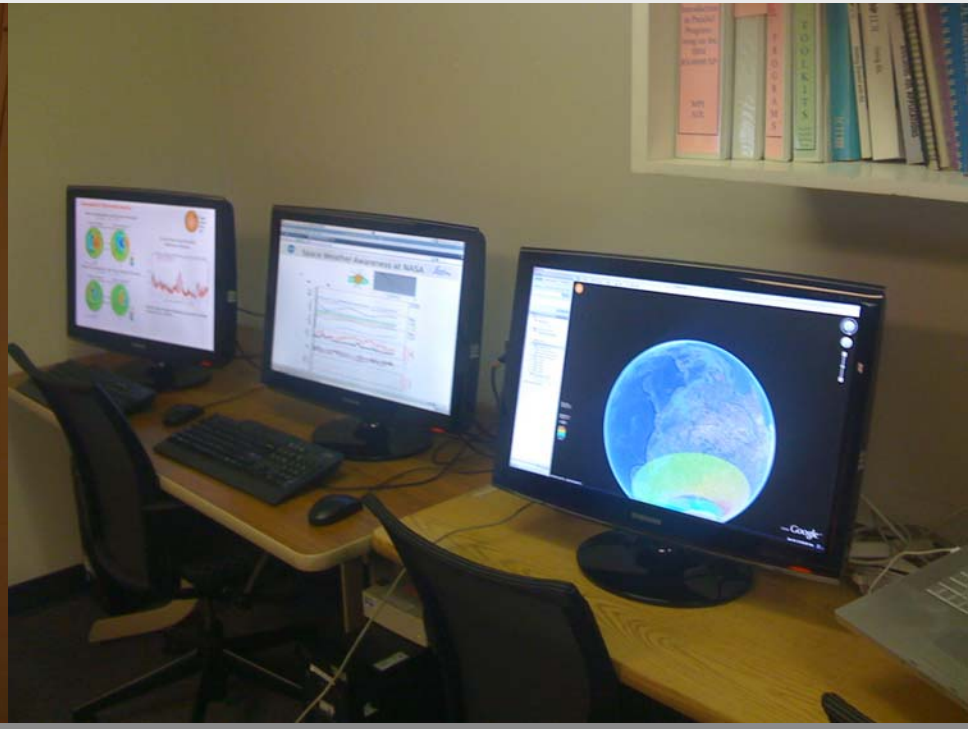

L. Rastaetter

J.-S. Shim

A. Taktakishvili

CCMC facility





M. Maddox, D. Berrios

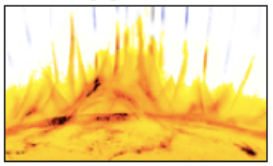
CCMC computing resources

~700 CPU Beowulf system, sponsored by **NASA, NSF,** started by **AF/XOW** investment

What is new?

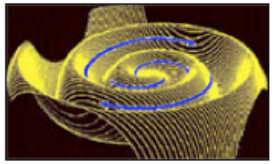
An (incomplete) synopsis
of changes and events 2008-2009

Models hosted by CCMC

Domain	Model Name	Developer(s)	Institution	Model Class	Services Available				
					Runs on Request	Instant Run	Real Time Run	Widget	Source Code on ftp
COUPLED SOLAR - HELIOSPHERE	CORHEL MAS/WSA/ENLIL	J. Linker, Z. Mikic, R. Lionello, P. Riley, N. Arge, D. Odstrcil	PSI, AFRL, U.Colorado	physics-based MHD	X				
	SWMF/SC/IH	Tamas Gombosi et al.	CSEM	Physics-based MHD	X				
COUPLED MAGNETOSPHERE	SWMF/BATS-R-US with RCM	Tamas Gombosi et al., R. Wolf et al.	CSEM	Physics-based MHD	X				
SOLAR 	CORHEL MAS/WSA/ENLIL	J. Linker, Z. Mikic, R. Lionello, P. Riley, N. Arge, D. Odstrcil	PSI, AFRL, U.Colorado	physics-based MHD	X				
	PFSS	J. Luhmann et al.	SSL/UC Berkeley	Potential Magnetic Field	X		X	X	
	WSA/PF with CS	Nick Arge	AFRL	Potential-based			X	X	
	SWMF/SC/IH	Tamas Gombosi et al.	CSEM	Physics-based MHD	X				

Models hosted by CCMC

	ANMHD	Bill Abbett, Dave Bercik, George Fisher, Yuhong Fan	UC Berkeley	physics-based MHD	X				
	CORHEL MAS/WSA/ENLIL	J. Linker, Z. Mikic, R. Lionello, P. Riley, N. Arge, D. Odstrcil	PSI, AFRL, U.Colorado	physics-based MHD	X				
	SWMF/SC/IH	Tamas Gombosi et al.	CSEM	Physics-based MHD	X				
	ENLIL	D. Odstrcil	Univ. of Colorado at Boulder	Physics-based MHD	X		X	X	
	ENLIL with Cone Model	D. Odstrcil	Univ. of Colorado at Boulder	Physics-based MHD	X				
	Heliospheric Tomography	B. Jackson, P. Hick	CASS/UCSD	Data Assimilative	X				
HELIOSPHERE	**Exospheric Solar Wind**	H.Lamy, V.Pierrard	IASB	Physics-based Kinetic	X				
				Physics-Based Lagrangian					

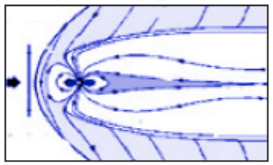


Models hosted by CCMC

	EMMREM	N. Schwadron, L. Townsend, R. Squier, F. Cucinotta, M. H. Kim, K. Kozarev, R. Hatcher, M. PourArsalan	Boston Univ., U. Tenn, NASA JSC	Kinetic Model for Primary Transport (Energetic Particle Radiation Environment Model); Physics-based Secondary Transport Model (EMMREM looping version of BaRYoN TRaNsport BRYNTRN Code)					
	Global Magnetosphere:								
	BATS-R-US	Dr. Tamas Gombosi et al.	CSEM	Physics-based MHD	X		X	X	
	SWMF/BATS-R-US with RCM	Tamas Gombosi et al., R. Wolf et al.	CSEM	Physics-based MHD	X				
	OpenGGCM	Joachim Raeder, Timothy Fuller-Rowell	Space Science Center, UNH	Physics-based MHD	X				

Models hosted by CCMC

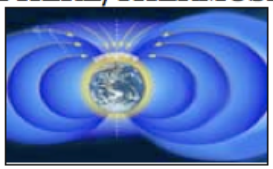
MAGNETOSPHERE



GUMICS	Pekka Janhunen et.al.	FMI	Physics-based MHD	X				
LFM-MIX	John Lyon, Slava Merkin, Mike Wiltberger, Peter Schmitt	Dartmouth College/Boston University	physics-based MHD					
WINDMI	W. Horton, M. L. Mays, E. Spencer and I. Doxas	Univ. of Texas at Austin	physics-based		X	X		
Inner Magnetosphere:								
Fok Ring Current	Mei-Ching H. Fok	NASA, GSFC	Physics-based	X			X	
AE-8/AP-8 RADBELT	Contact Person: D. Bilitza, NASA/GSFC	NSSDC, GSFC, NASA	Statistical		X			X
Geomagnetic Field Models:								
IGRF	Susan Macmillan, Stefan Maus	IAGA Working Group on IGRF	Statistical		X			X
Tsyganenko Model	Nikolai Tsyganenko	Univ. of St.-Petersburg, Russia	Statistical		X			X

Models hosted by CCMC

IONOSPHERE/THERMOSPHERE



Ionosphere/Thermosphere:								
SAMI2	Joseph Huba, Glenn Joyce, Marc Swisdak	NRL and Icarus Research, Inc.	Physics-based	X				
CTIP	Timothy Fuller-Rowell et al	NOAA SEC	Physics-based	X				
ABBYNormal	J. Vincent Eccles et al.	Space Environment Corporation	Physics-based	X	X	X		
USU-GAIM	R.W. Schunk, L. Scherliess, J.J. Sojka, D.C. Thompson, L. Zhu	Utah State University	Physics-based data assimilation	X				
IRI	D. Bilitza, NASA/GSFC	URSI/COSPAR Working Group on IRI	Statistical		X			X
Ionosphere Electrodynamics:								
Weimer	Daniel R. Weimer	Solana Scientific Inc.	Statistical		X	X	X	
Atmosphere:								
MSISE	A. E. Hedin	retired from. NASA, GSFC	Statistical		X			X

Models hosted by CCMC

ModelWeb Catalogue and Archive

Community Coordinated Modeling Center (CCMC) | Goddard Space Flight Center

Instant Runs and Runs on Request

Options to run models and view results using online interface are now available on the CCMC website
CCMC Instant Runs
CCMC Runs on Request

Model Catalog and Archive:

Atmosphere models [info]

Density and Temperature Models

- Exospheric H Model [info, ftp]
- NRLMSISE-00 Model [info, ftp, link]
- MSISE-90 Model [info, ftp, **RUN**]
- MSIS-86 Model [info, ftp]
- MET Model [info, ftp]
- CIRA: Thermosphere [info]
- CIRA: 0 km to 120 km [info, ftp]
- OLDER MODELS (pre-1985)

Wind Models

- Horizontal Wind Model (HWM) [info, ftp]

Ionosphere Models [info]

General Models

- Incoherent Scatter Radar Models [info]
- IRI [info, ftp, **RUN**]

Electron Density Models

- PIM Model [info]
- FAIM Model [info]
- SLIM Model [info]
- OLDER MODELS (pre-1985)

F2-Peak Models and Applications

- WBMOD Ionospheric Scintillation Model [info, link]
- URSI foF2 Model Maps [info]
- OLDER MODELS (pre-1985)

Electron Temperature Models

- Hinotori Model [info]
- Intercosmos Model [info]
- OLDER MODELS (pre-1985)

Ion Composition and Drift Models

- Intercosmos Ion Composition Model [info]
- OLDER MODELS (pre-1985)

Electric Convection Field Models

- Heppner-Maynard-Rich Electric Field Model [info, ftp]
- IZMIRAN Electrodynamic Model (IZMEM) [info, link]
- Utah Electric Convection Field Model [info]
- OLDER MODELS (pre-1985)

Auroral Precipitation and Conductivity Models

- AFGL Ion Precipitation Model [info]

Gravitation/Geopotential Models

- Earth Gravitational Model 2008 (EGM2008) [info, link]

Geomagnetic(Main) Field Models [info]

General Models

- IGRF Model [ftp, info, link, **RUN**]

Miscellaneous Geomagnetic Field Models

- USGS Model Coefficients for Continental U.S. and Hawaii [info]
- GSFC Model Coefficients: All [ftp], (11/87) [info], (12/83) [info], (9/80) [info], (12/66) [info], (9/65) [info]
- Summary Table
- OLDER MODELS

Magnetospheric Field Models [info]

- Toffoletto-Hill Magnetosphere Model [link]
- Xu-Li Neutral Sheet Model [info, ftp]
- User-Oriented Service Based on External and Internal Geomagnetic Field Models [RUN]
- Tsyganenko Magnetic Field Models and GEOPACK routines [info, link, url]
- OLDER MODELS (pre-1979)

Solar and Interplanetary Space Models

Solar Reference Spectra

- Solar2000 Model [link]
- OLDER REFERENCE SPECTRA

Solar Energetic Particle Models

- Nymmik Solar Energetic Particles Model [link]
- JPL Proton Model [info]
- SOLPRO Model [info, ftp]

Cosmic Rays and Related Software

- Geomagnetic Cutoff Rigidity [info, ftp]
- Spacecraft Anomaly Data Base [info]
- CREME Programs [info, link]

Planetary Models [info]

General Models

- EPIC general circulation model [link]

Venus Models

- PV Ionosphere Model [info, ftp]

- AFGL Ion Precipitation Model [info]
- AFGL Electron Precipitation Model [info]
- Rice Electron Precipitation Model [info]

Miscellaneous Auroral Models

- Auroral Absorption Model [info]
- Auroral Oval Representation [info, ftp]

Plasmasphere Models

- Akebono Model [info]
- IMAGE Model [info]
- IZMIRAN/SMI Model [info]
- GPID Model [info]
- GCPM Model [info] link

Trapped Particle Models [info]

- VAMPOLA PROGRAMS [info]
- SHIELDOSE [info, ftp, link]
- RADBELT [info, ftp, **RUN**]
- AE/AP Trapped Particle Flux Maps [info, ftp]
- OLDER MODELS (pre-1985)

- PV Ionosphere Model [info, ftp]
- PV Thermosphere Model [info, ftp]

Mars Models

- Mars General Circulation Model (GCM). [link]

Jupiter Models

- Galileo Interim Radiation Environment (GIRE) model [link]

Other Model Related Sites

- NASA's Community Coordinated Modeling Center (CCMC) [link]
- ESA's SPace ENVironment Information System (SPENVIS) [link]
- Open Channel/COSMIC software depository [link]
- Rice University Space Weather page [link]
- URSI'99 Session on Ionospheric Data and Models on the WWW [link]

Older Models:

Older Atmospheric models [info]

Density and Temperature Models

- U.S. Standard Atmosphere [info]
- Jacchia Reference Atmosphere [info, ftp]
- Atmospheric Handbook [info, link]

Older Ionosphere Models [info]

Electron Density Models

- Chiu Ionospheric Model [info, ftp]
- Bent Ionospheric Model [info]
- Penn State Mk III Model [info]

F2-Peak Models and Applications

- CCIR foF2 and M(3000)F2 Model Maps [info]
- ISS-b foF2 Maps [info]
- MINIMUF/QSTMUF Model [info]
- IONCAP Model [info]

Electron Temperature Models

- Density Dependent Electron Temperature Model [info]
- AEROS Electron Temperature Model [info]
- AE/ISIS Electron Temperature Models [info]

Ion Composition and Drift Models

- DY Ion Composition Model [info]
- ISR Ion Drift Model [info, ftp]
- St. Santin Ion Drift Model [info]

Electric Convection Field Models

- Polar Cap Potential Drop Model [info]
- Volland Electric Field Model [info]
- Heelis Electric Convection Field Model [info]
- Millstone Hill Electric Field Model [info]

Older Trapped Particle Models [info]

- MODEL Program [info]
- FLOUT Transformation [info]
- SOFIP [info]

Older Gravitation/Geopotential Models

- Older Earth Gravitational Models Earth Gravitational Model 1996 (EGM96) [info],

Older Geomagnetic(Main) Field Models [info]

Miscellaneous Geomagnetic Field Models

- Jensen-Cain Model Coefficients [info, ftp]
- POGO Model Coefficients: (3/68) [info], (10/68) [info], (8/69) [info], (8/71) [info]
- AWC (75) Model Coefficients [info]
- IGS (75) Model Coefficients [info]
- MGST Model Coefficients All [ftp], (6/80) [info], (4/81) [info]

Older Magnetospheric Field Models [info]

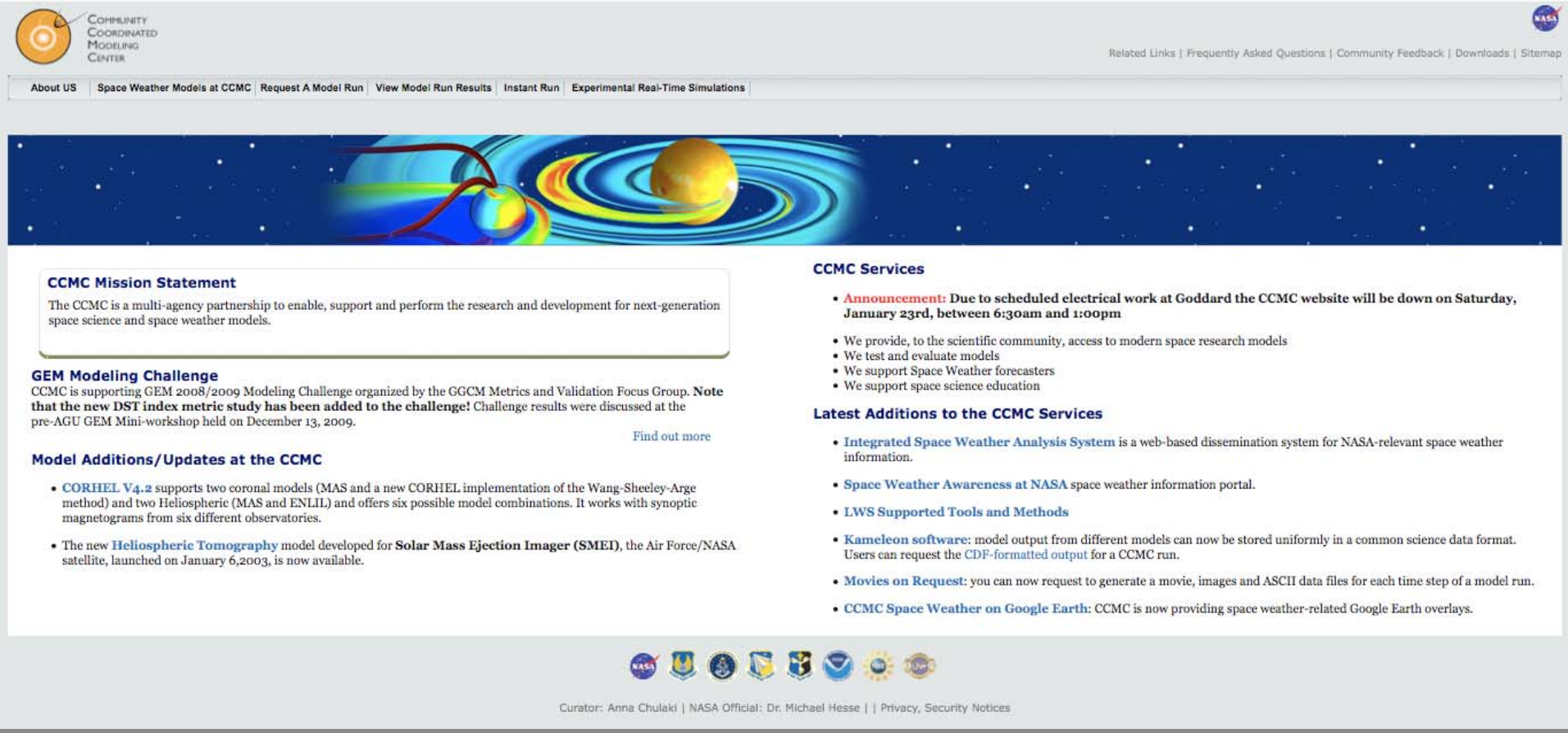
- Olson-Pfitzer Field Model [info]
- Mead-Fairfield Field Model [info]
- Geotail Field Model [info]

Solar and Interplanetary Space Models

Solar Reference Spectra

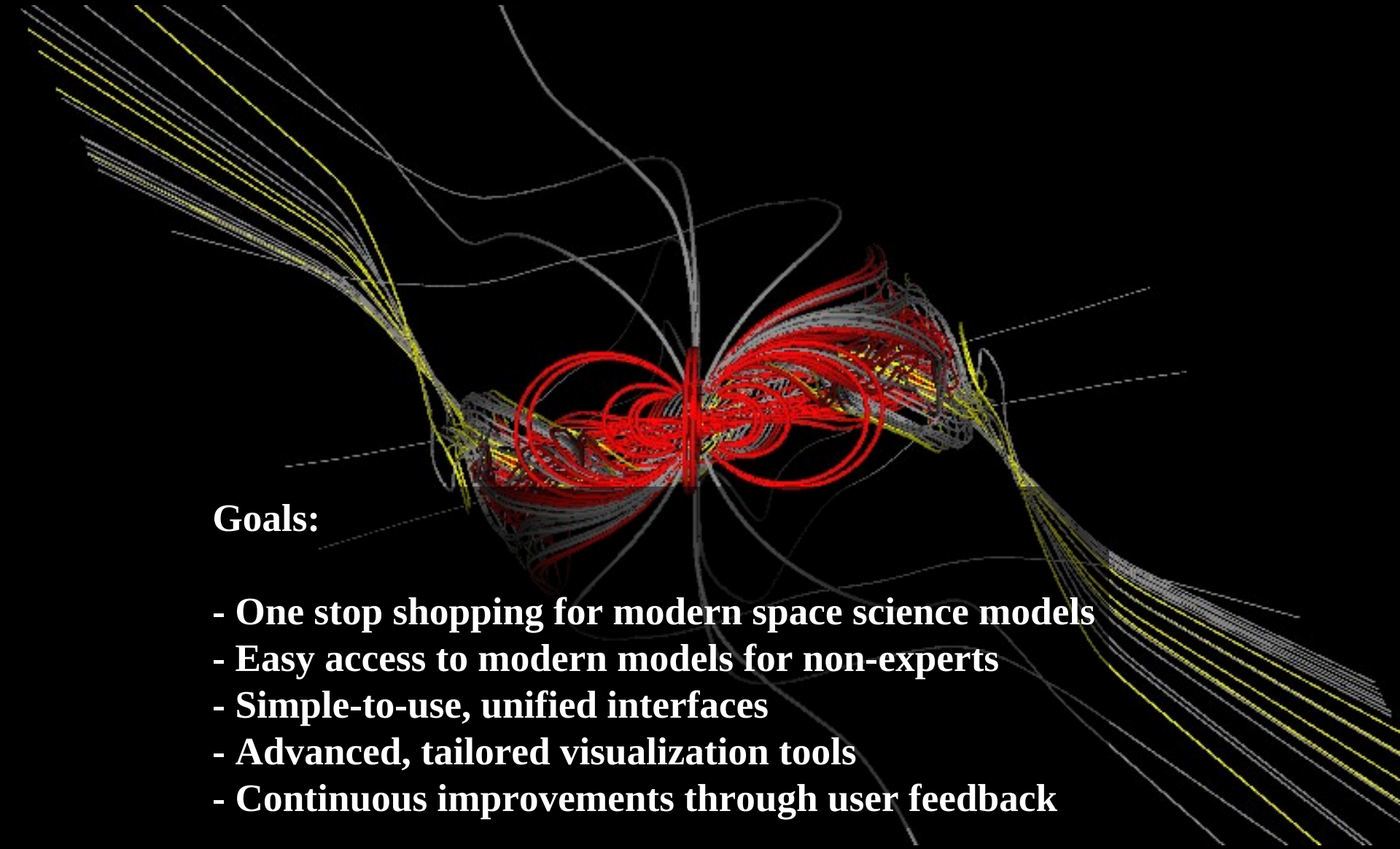
- Revised SERF2 Solar EUV Flux model [info, ftp]
- EUV Reference Spectrum 74113 [info, ftp]

CCMC web site - new functionality



A. Chulaki
L. Moiseev

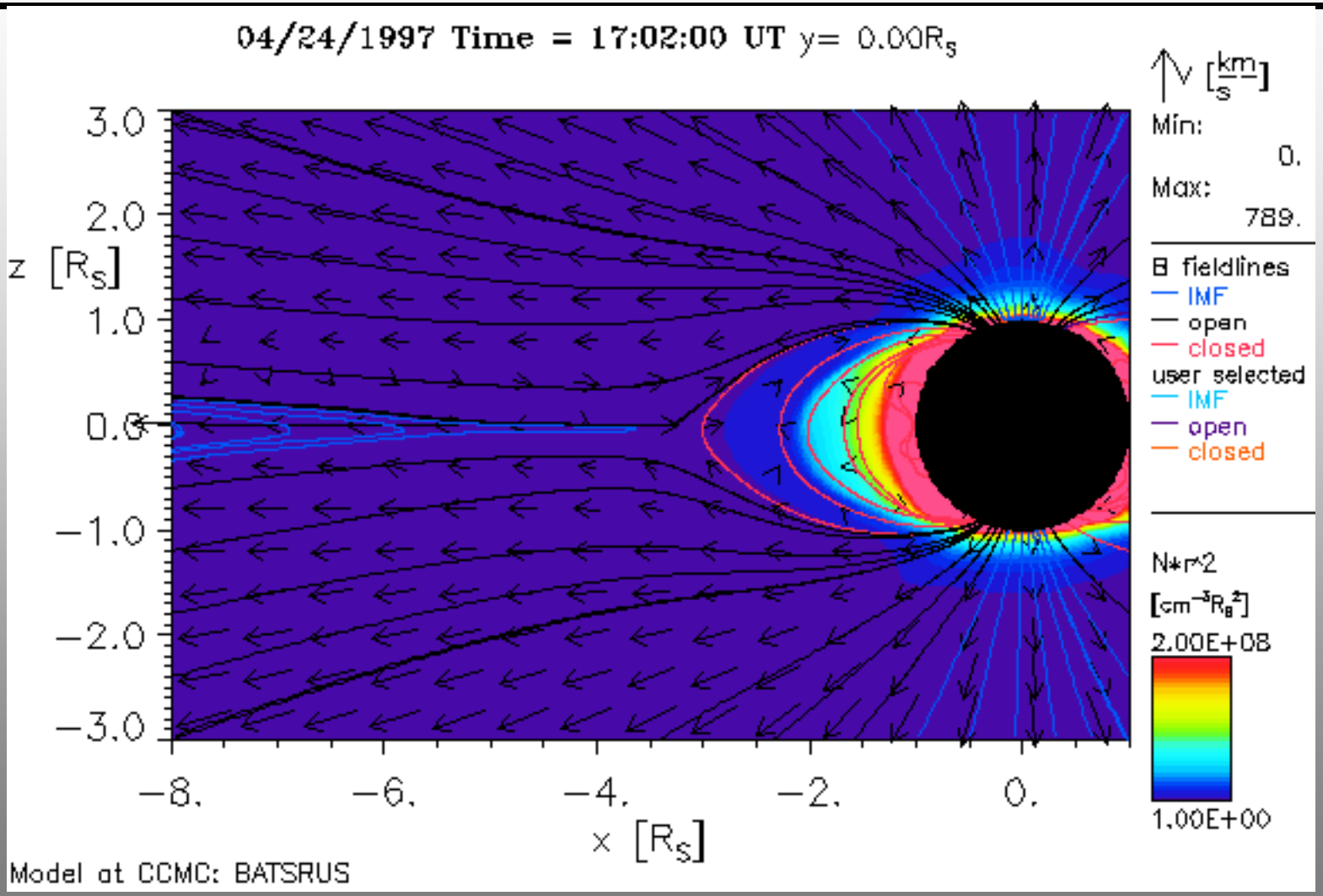
Science user support



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

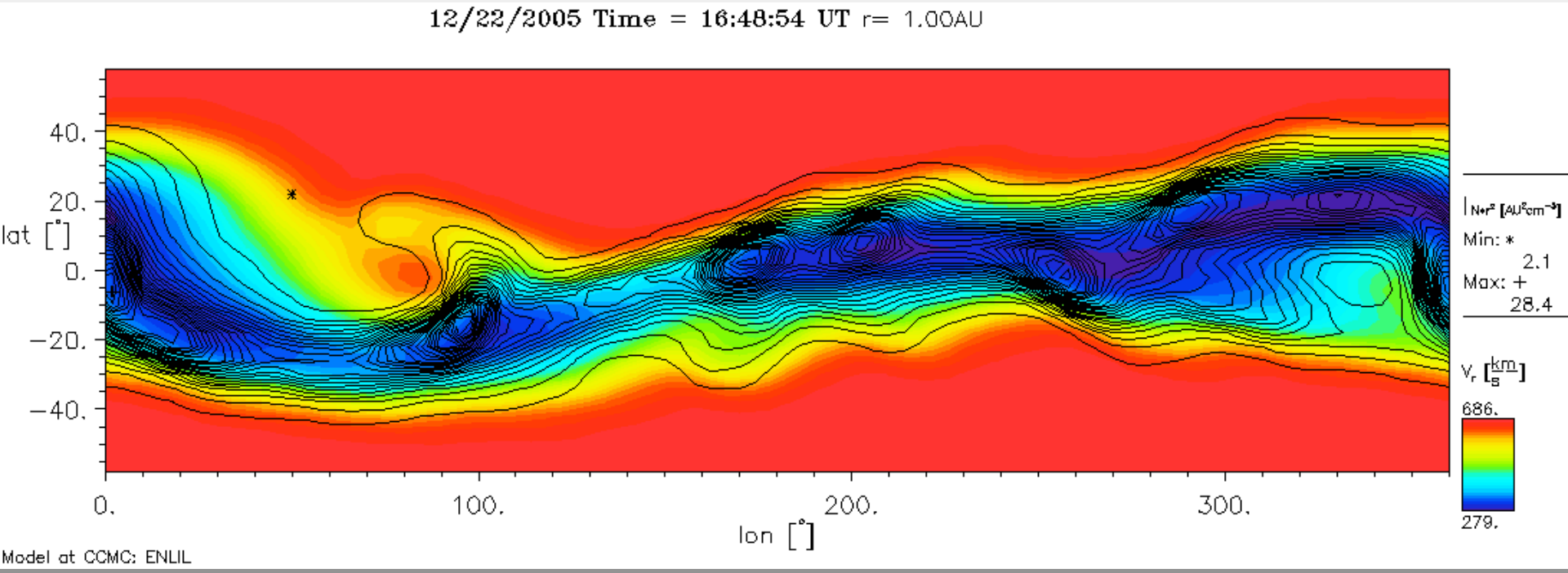
Solar and heliospheric models



UMichigan SWMF Solar/Heliospheric Model

S. Taktakishvili, M. Kuznetsova

Solar and heliospheric models



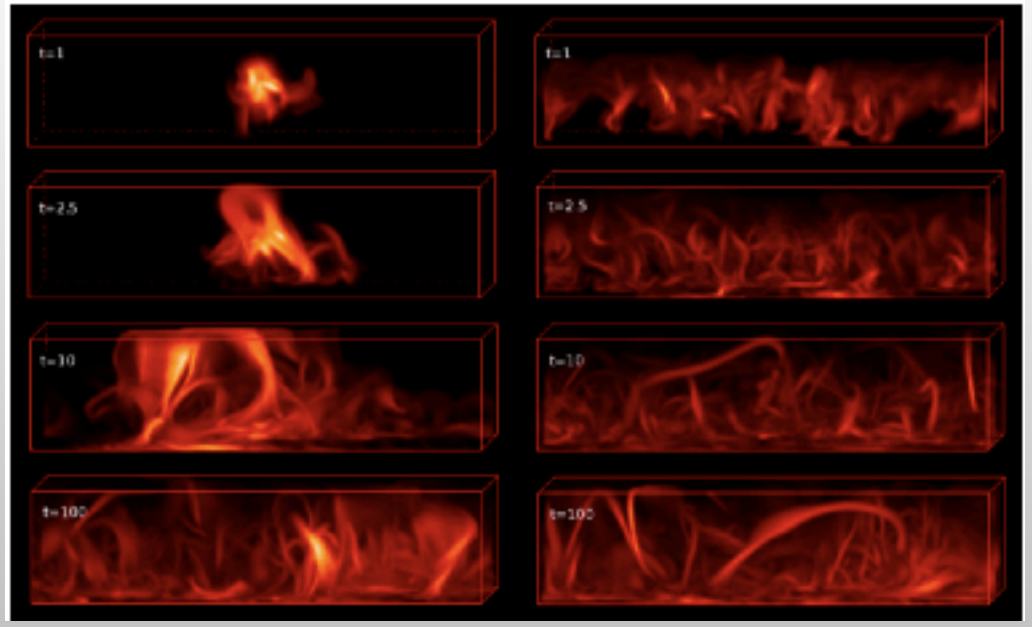
CISM CORHEL 4.2 Includes parallel MAS (Predictive Science)

12 different combos (MAS-p, MAS-t, WSA*)/(MAS-p, MAS-t, ENLIL)

Various ENLIL updates

P. MacNeice

Solar and heliospheric models

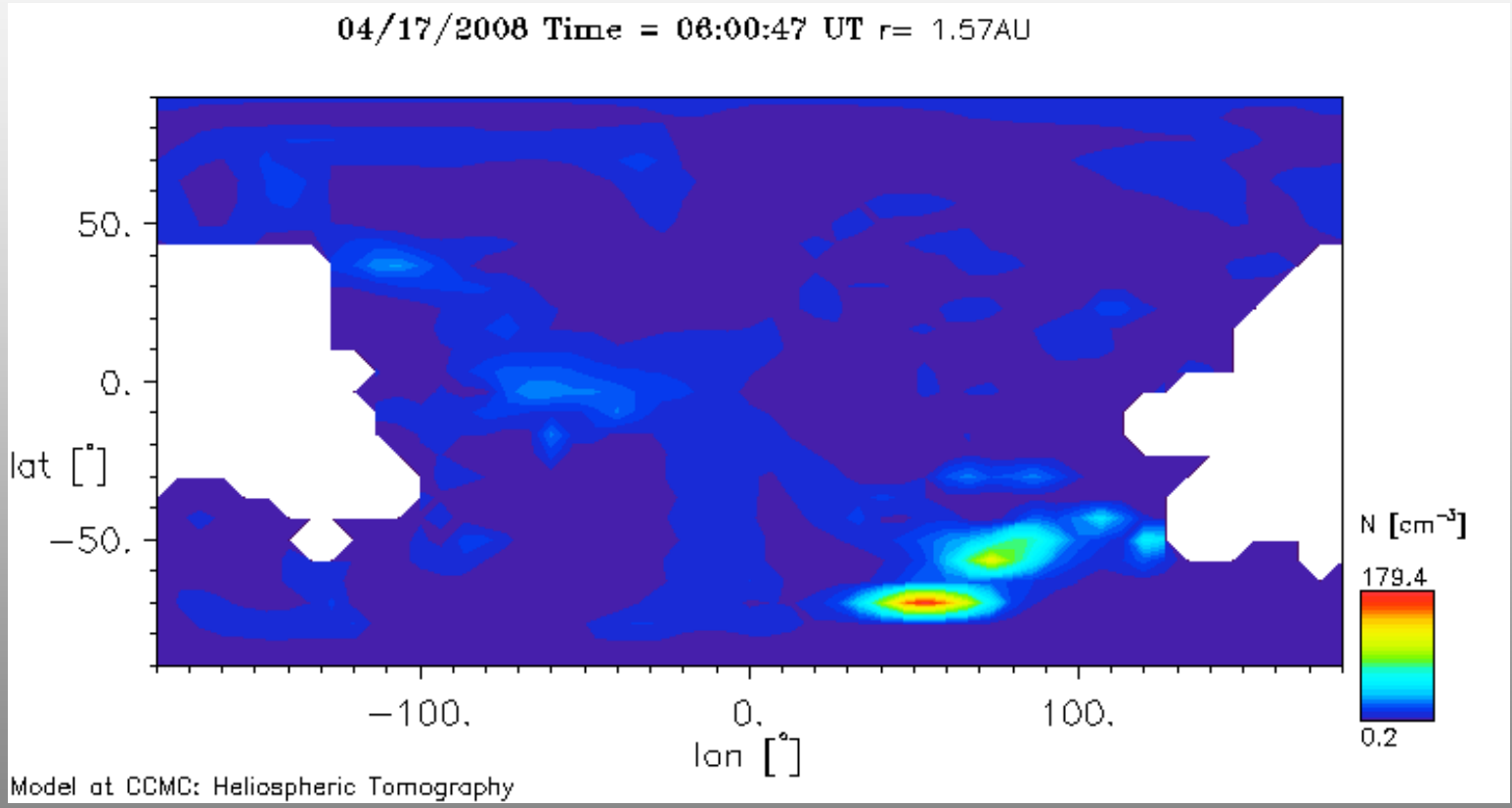


ANMHD flux emergence model/G. Fisher - UCB

Model installed, available for RoR

P. MacNeice

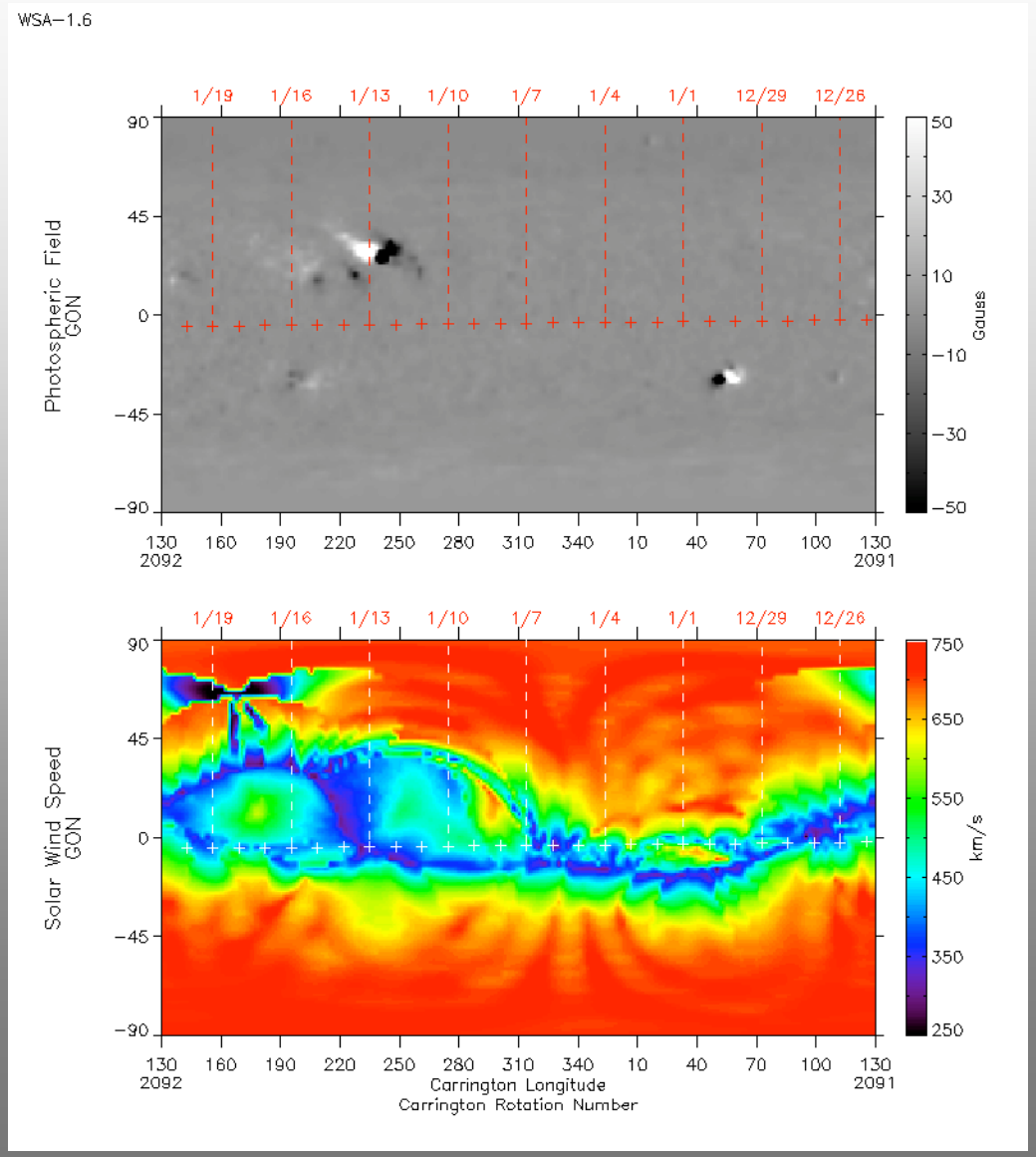
Solar and heliospheric models



Jackson et al. Heliospheric Tomography: available with SMEI data

S. Taktakishvili

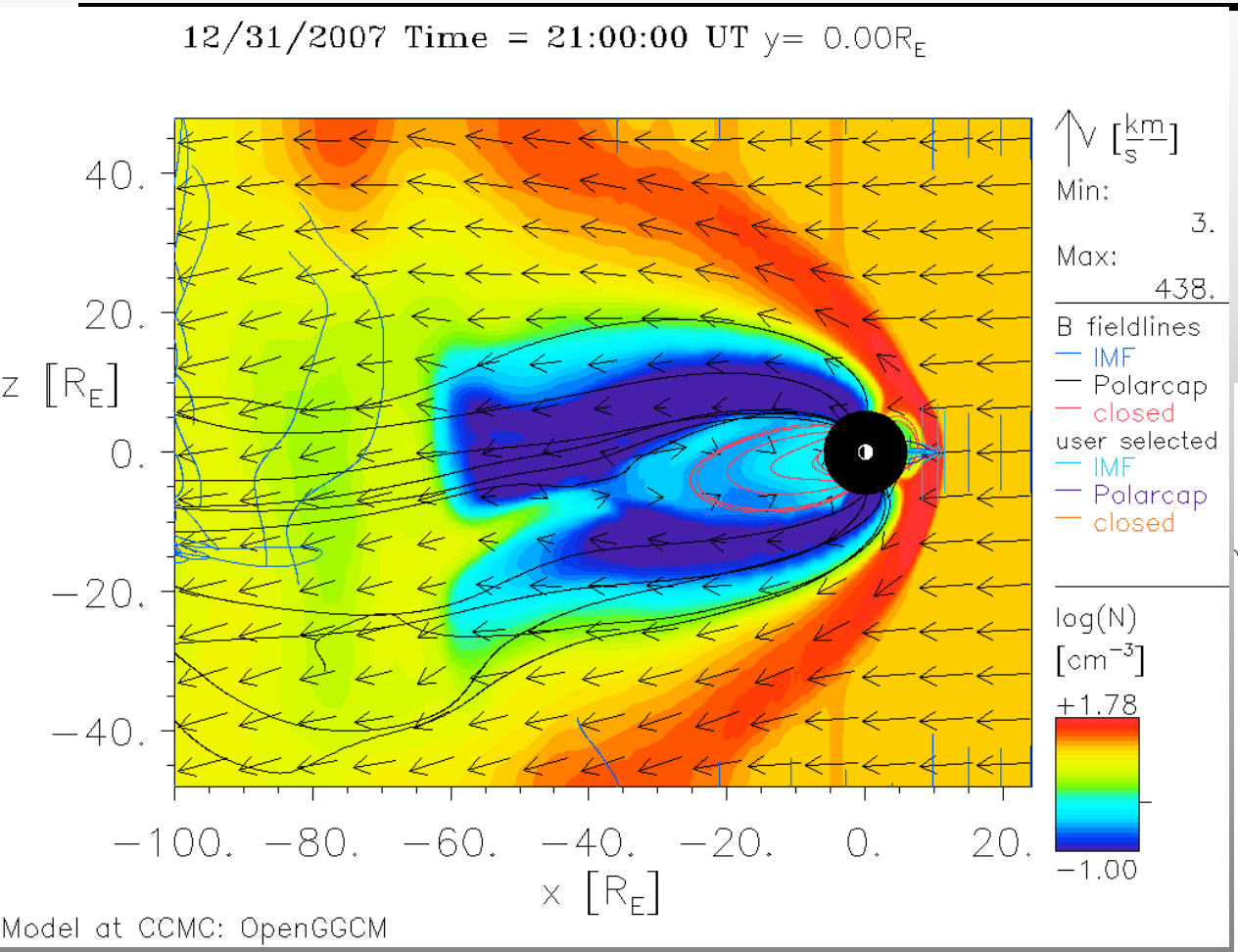
Solar and heliospheric models

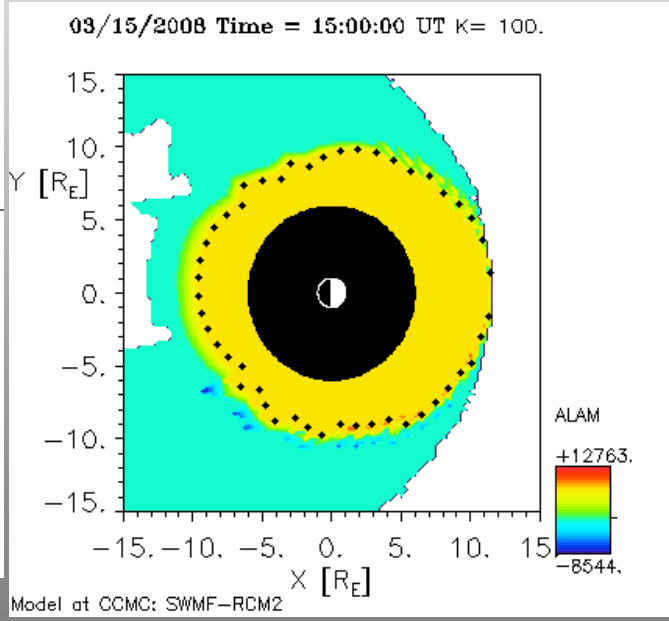


WSA: various updates, different data sources

P. MacNeice

Magnetospheric models



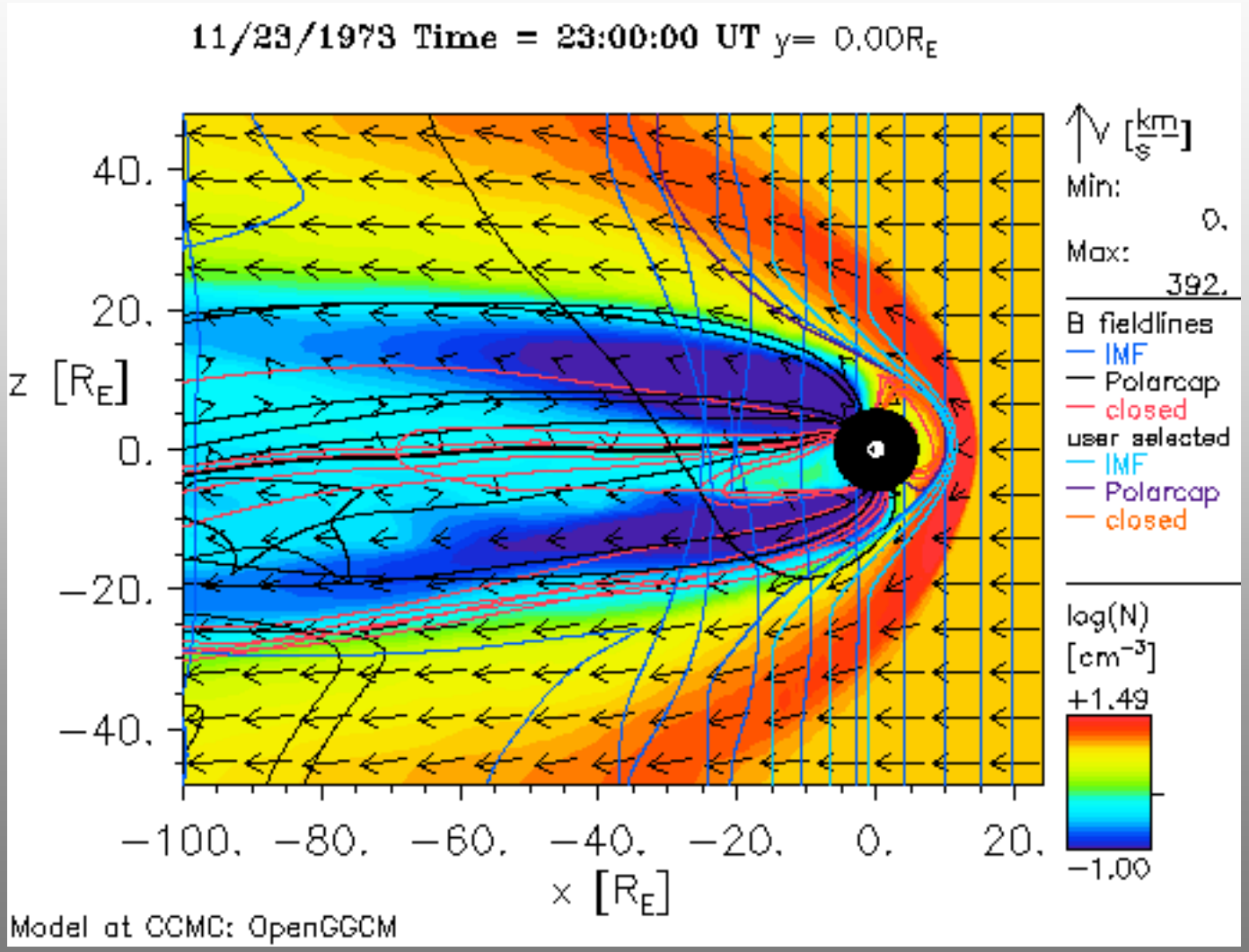


SWMF: CSEM collaboration

Updates include RCM and RB

M. Kuznetsova, L. Rastaetter

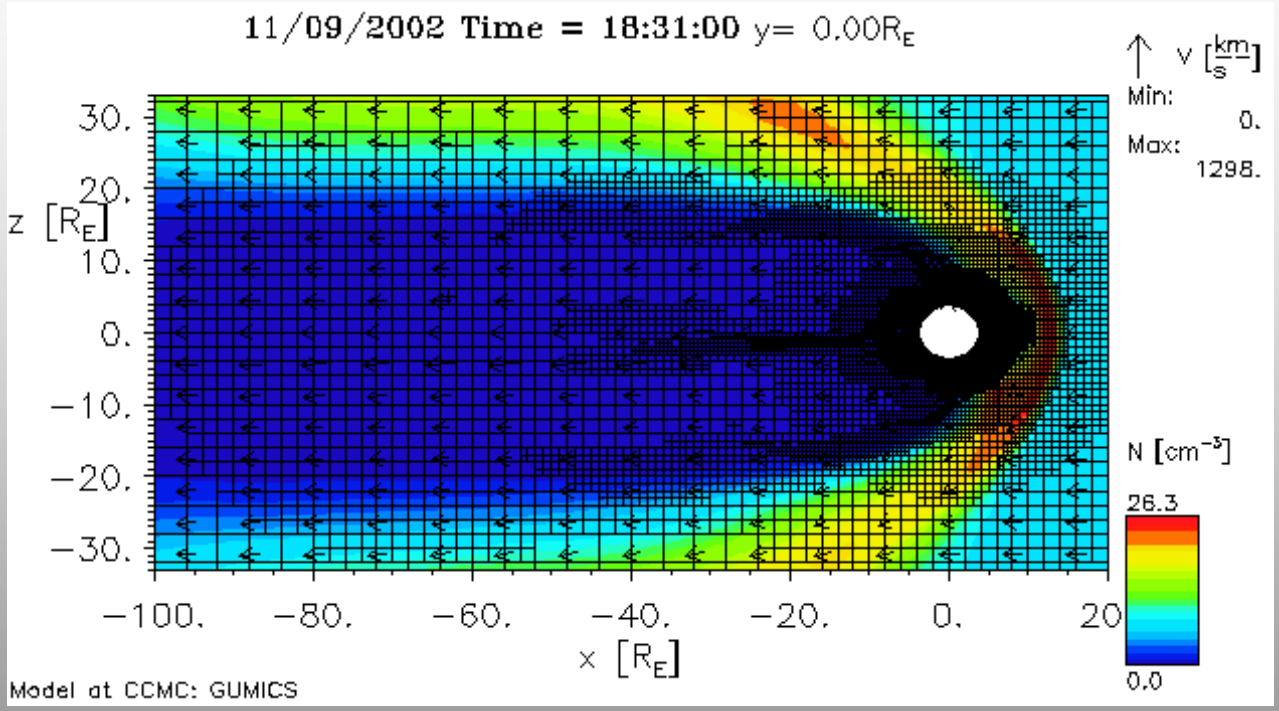
Magnetospheric models



OpenGGCM Updates

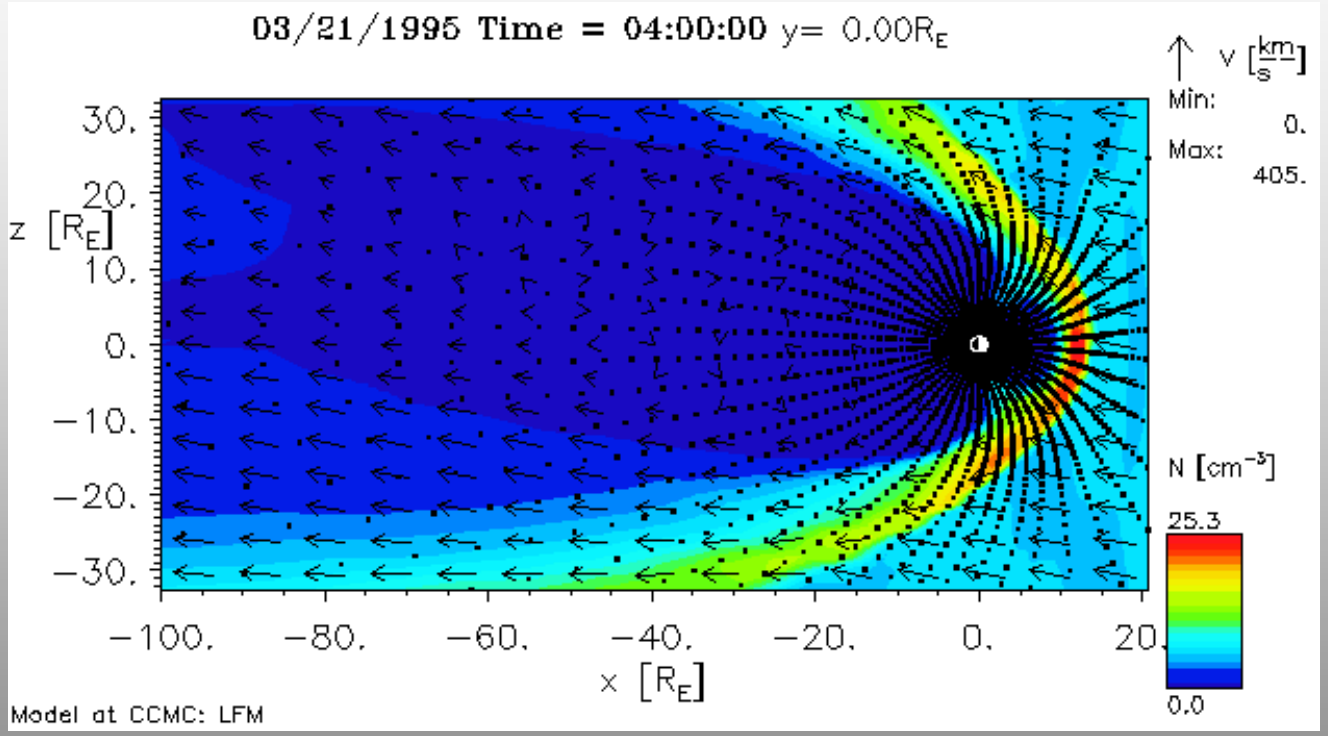
L. Rastaetter

Magnetospheric models



GUMICS- Finnish Meteorological Institute: Run service and procedural updates

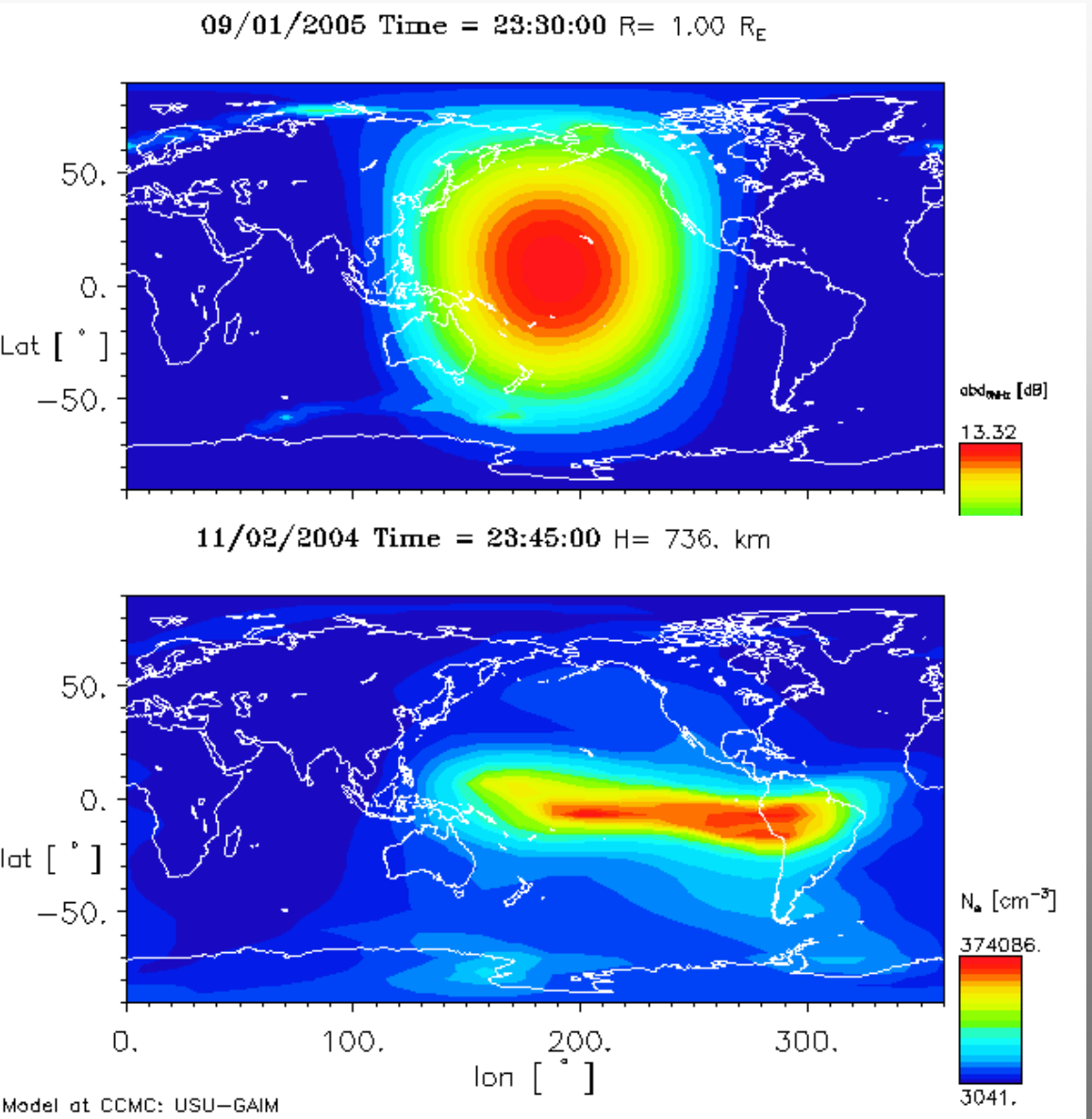
Magnetospheric models



CISM/CMIT
CISM collaboration
Now available for runs-on-request

L. Rastaetter

ITM models

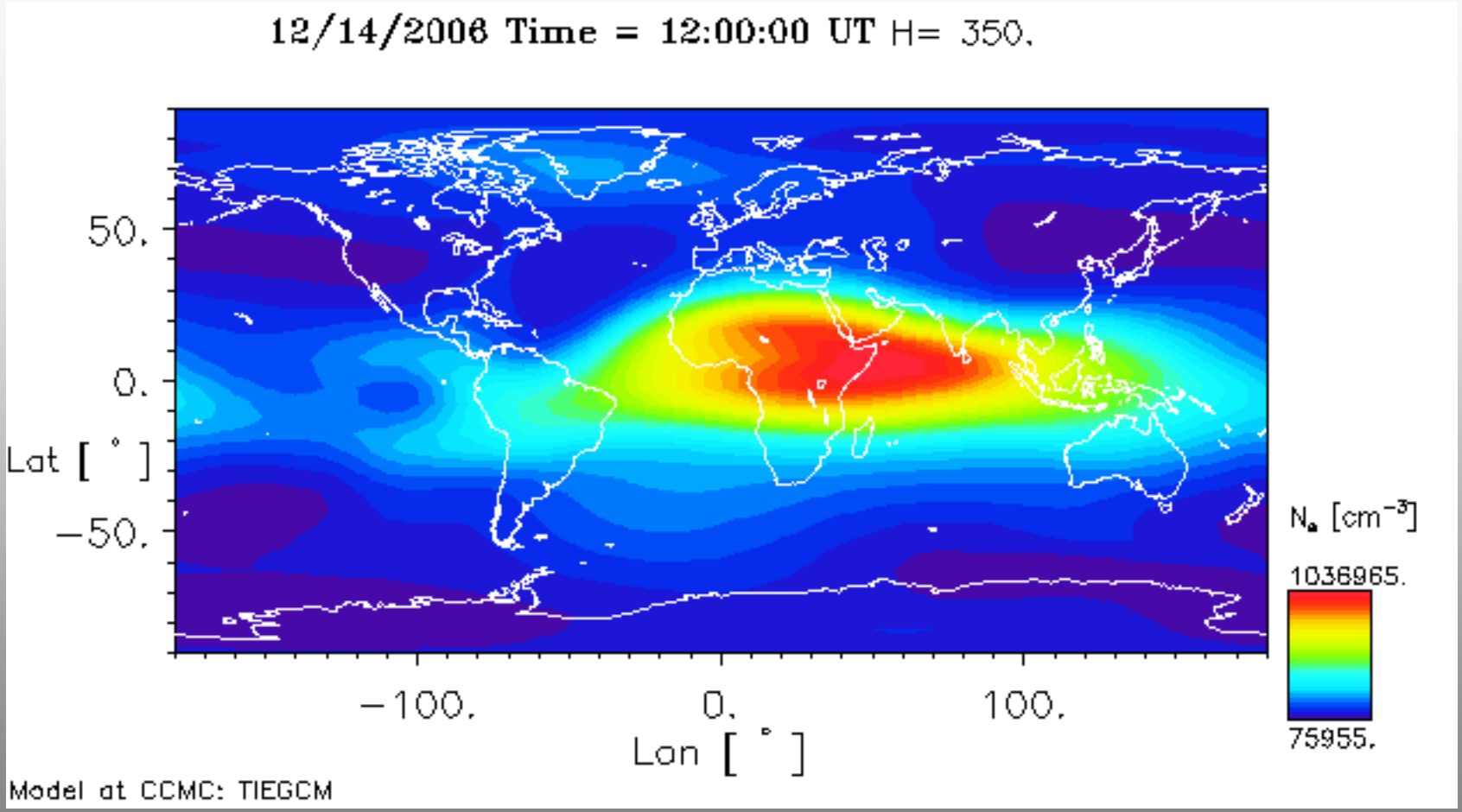


AbbyNormal (Eccles):
RT runs

USU GAIM: Assimilative
Some updates

J. S. Shim, M. Kuznetsova

ITM models

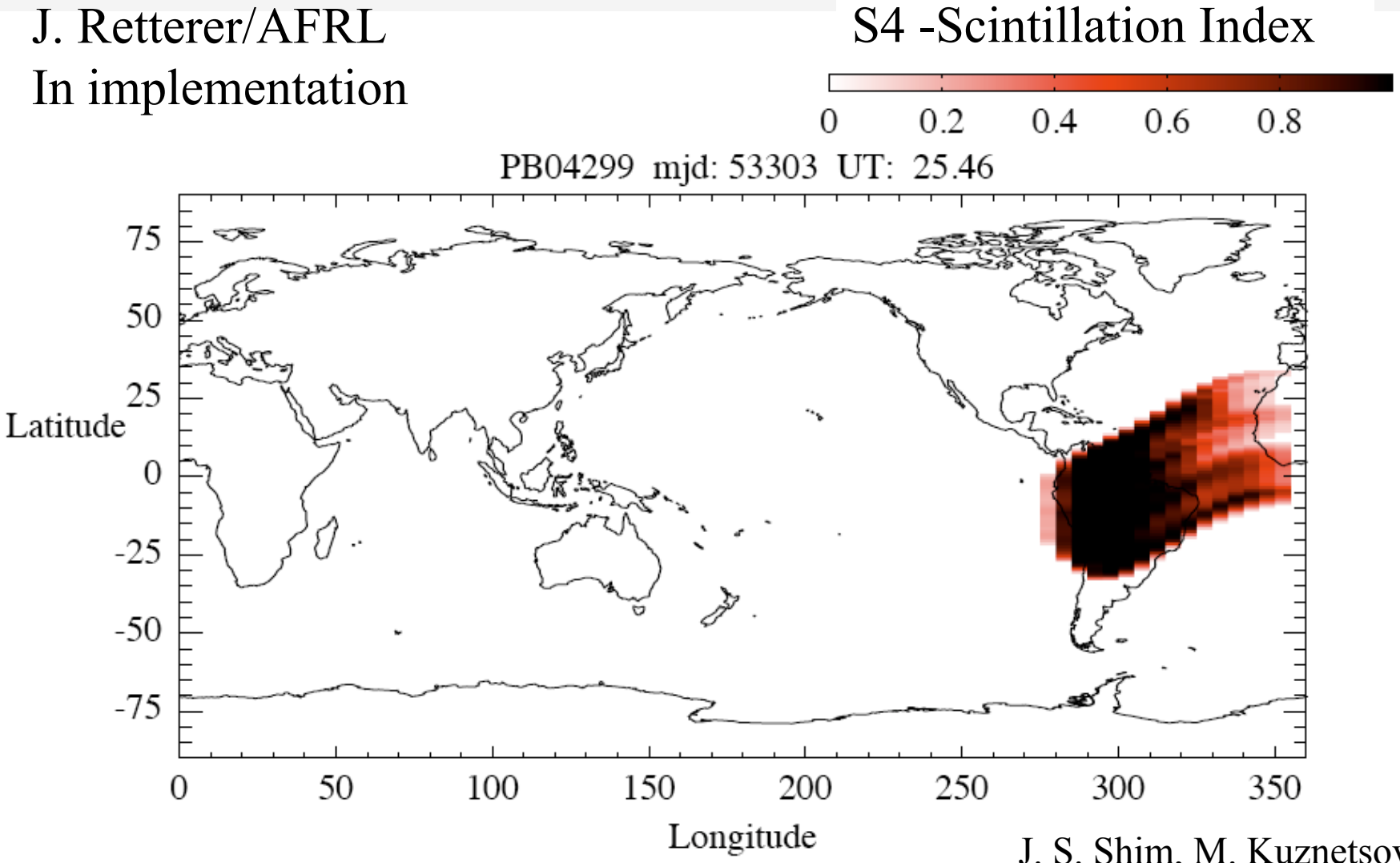


TIEGCM: available for RoR

J. S. Shim

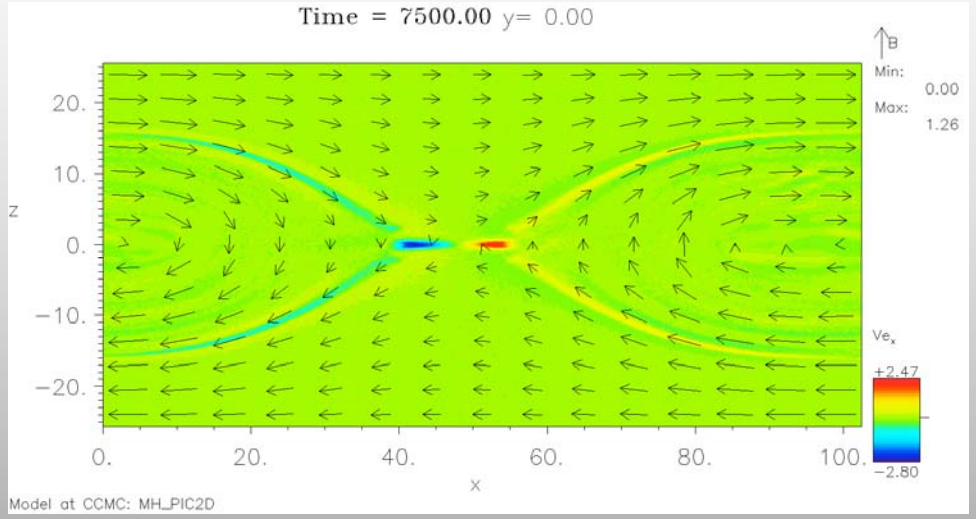
ITM models

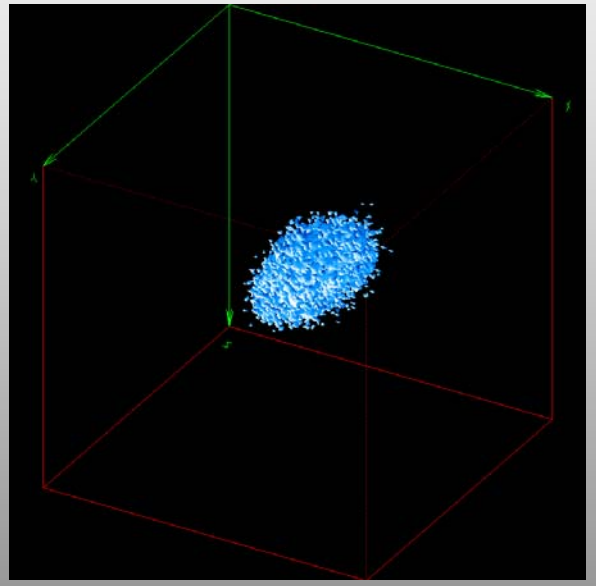
J. Retterer/AFRL
In implementation



J. S. Shim, M. Kuznetsova

New Product: Kinetic Models



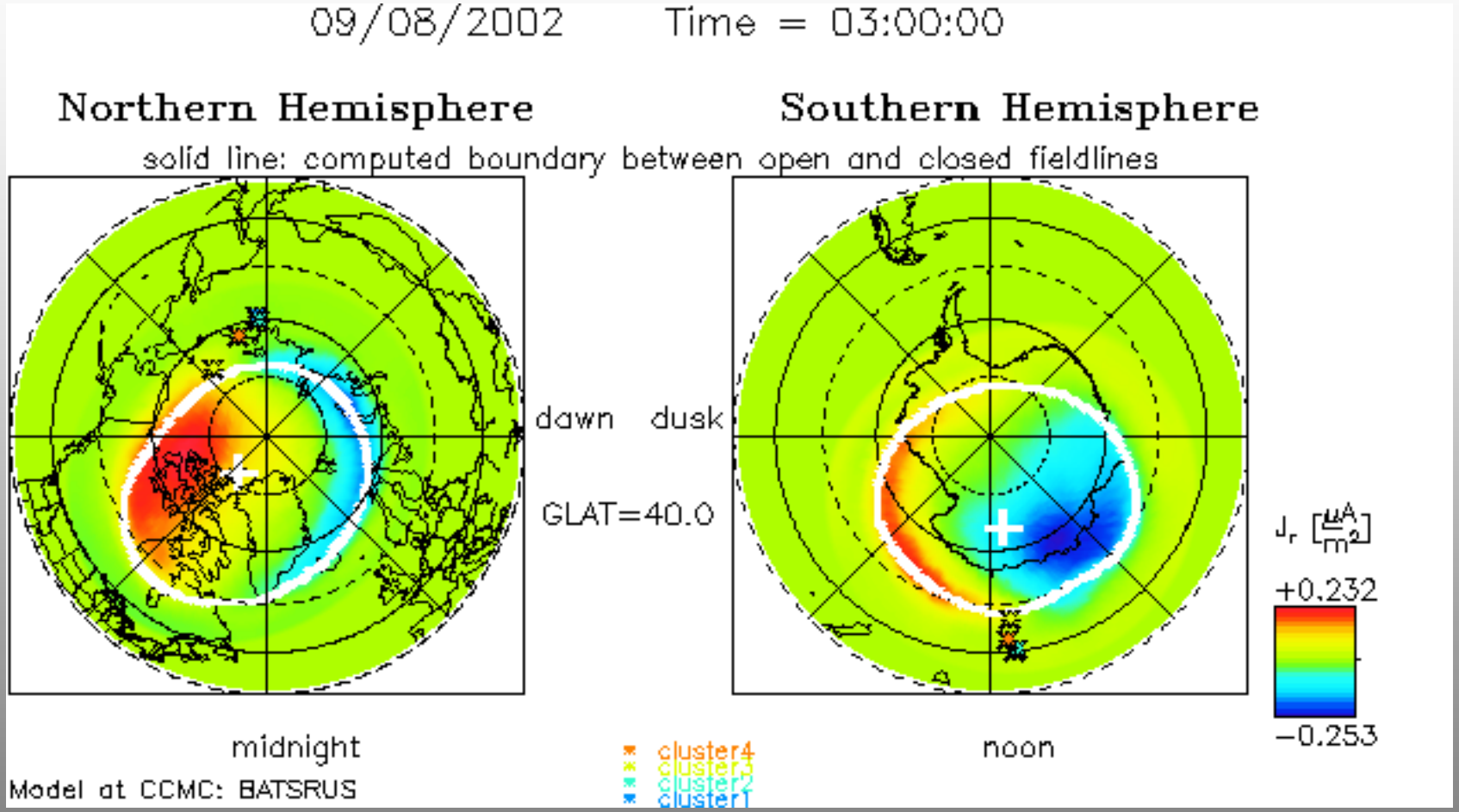


Available now: runs for various conditions, also for MMS support

Soon: distribution functions (beta now)

L. Rastaetter, M. Hesse

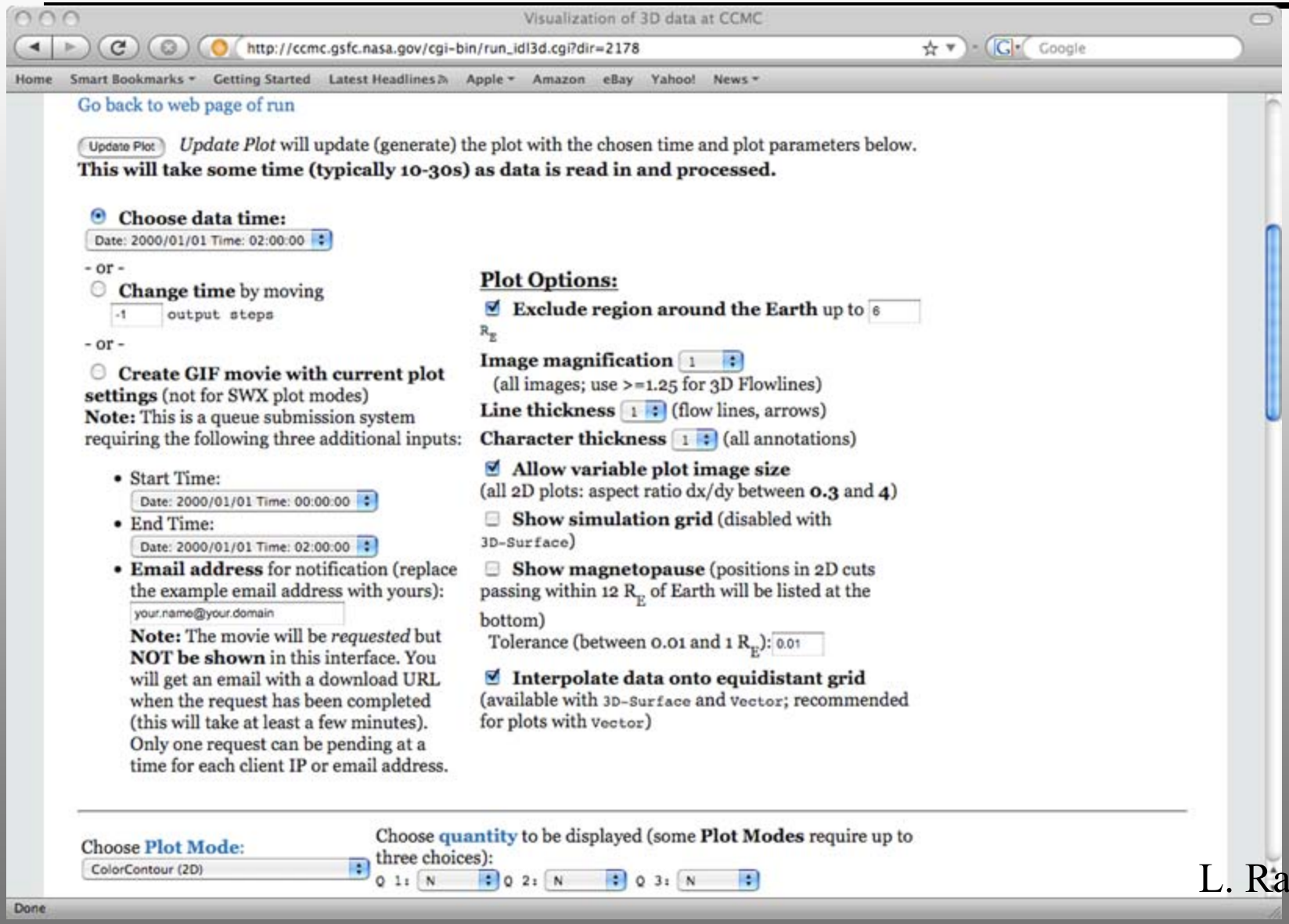
New research tool: Field line tracing



Cluster footpoints

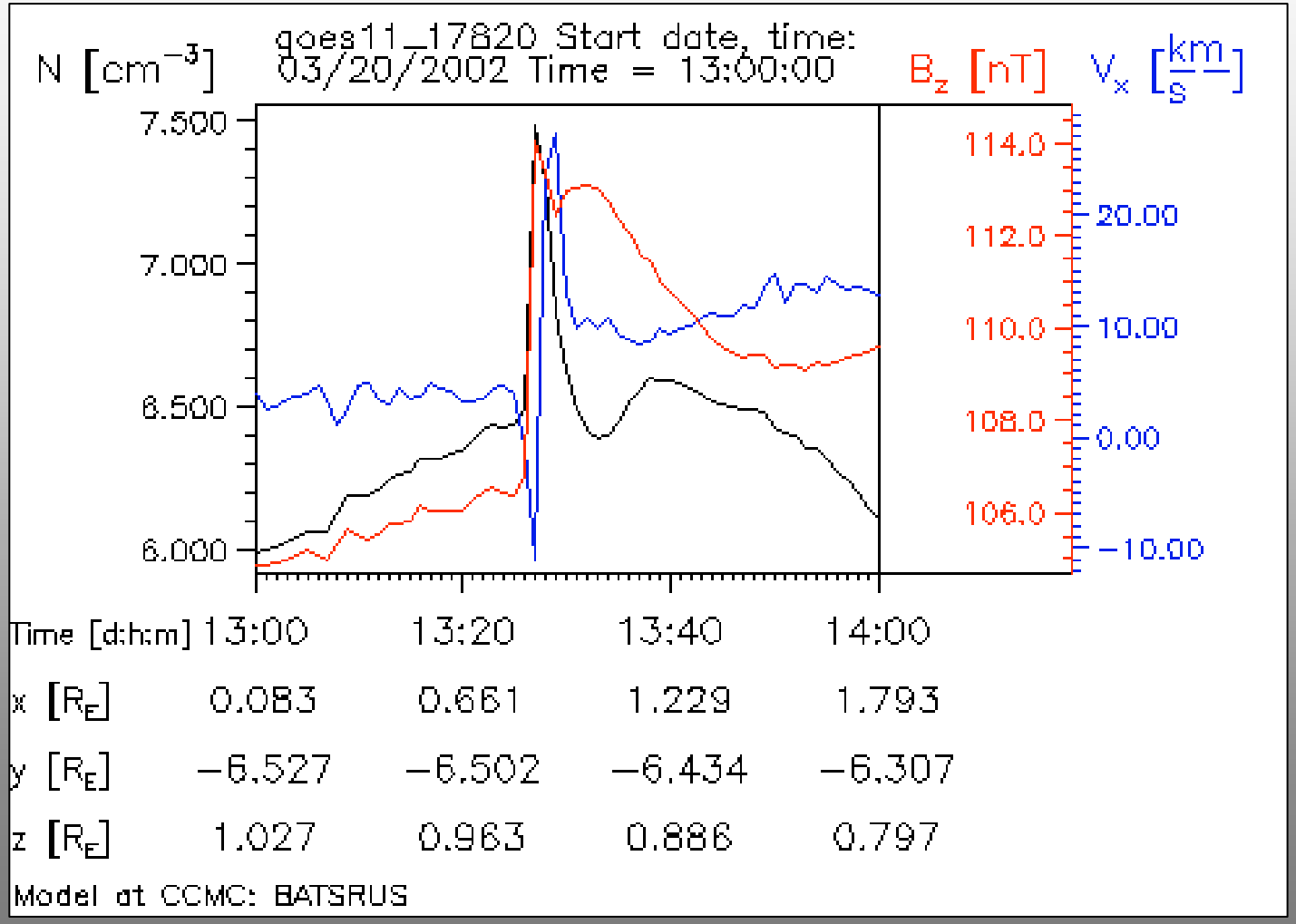
L. Rastaetter

New Capabilities: Movie Making



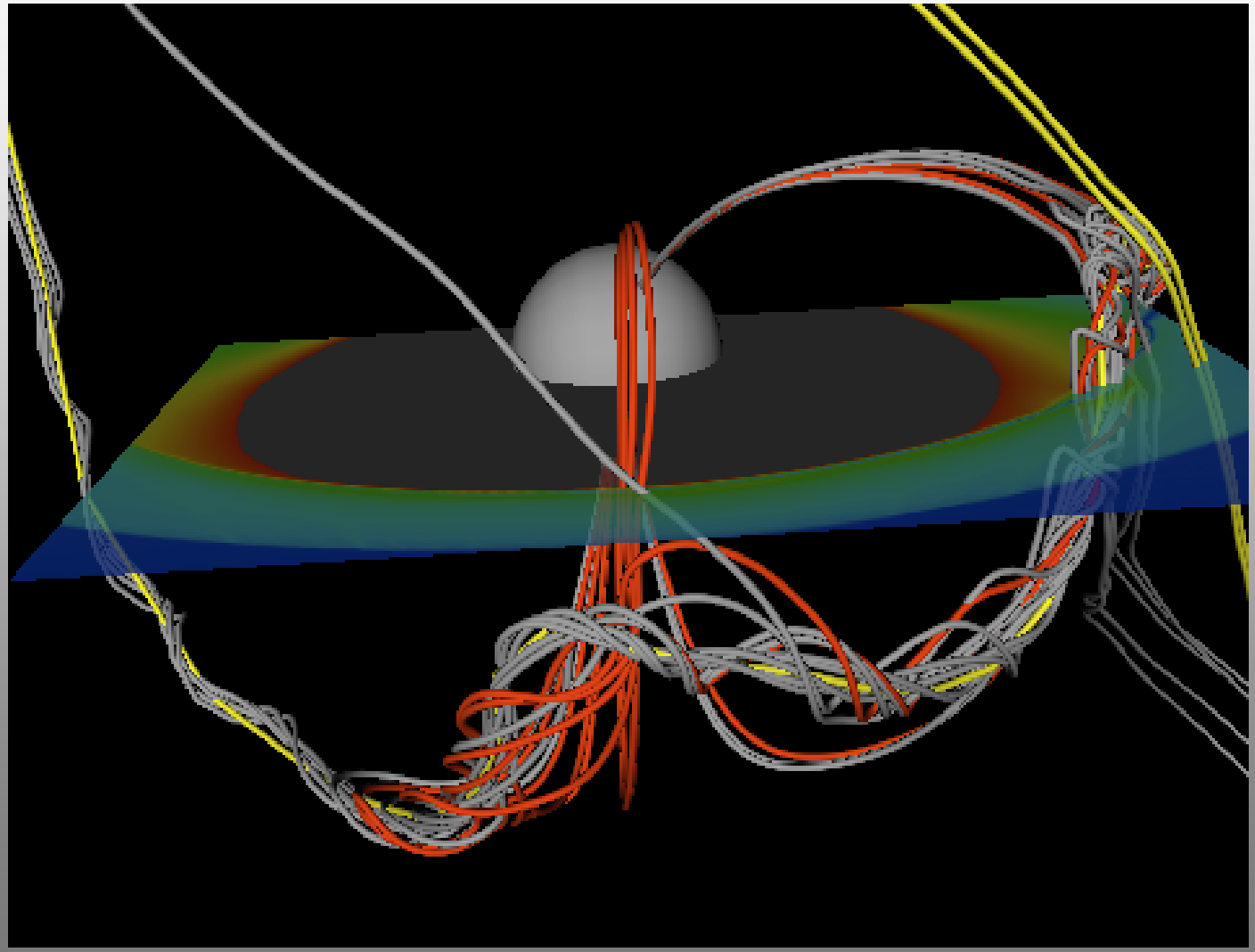
L. Rastaetter

New capability: Time series



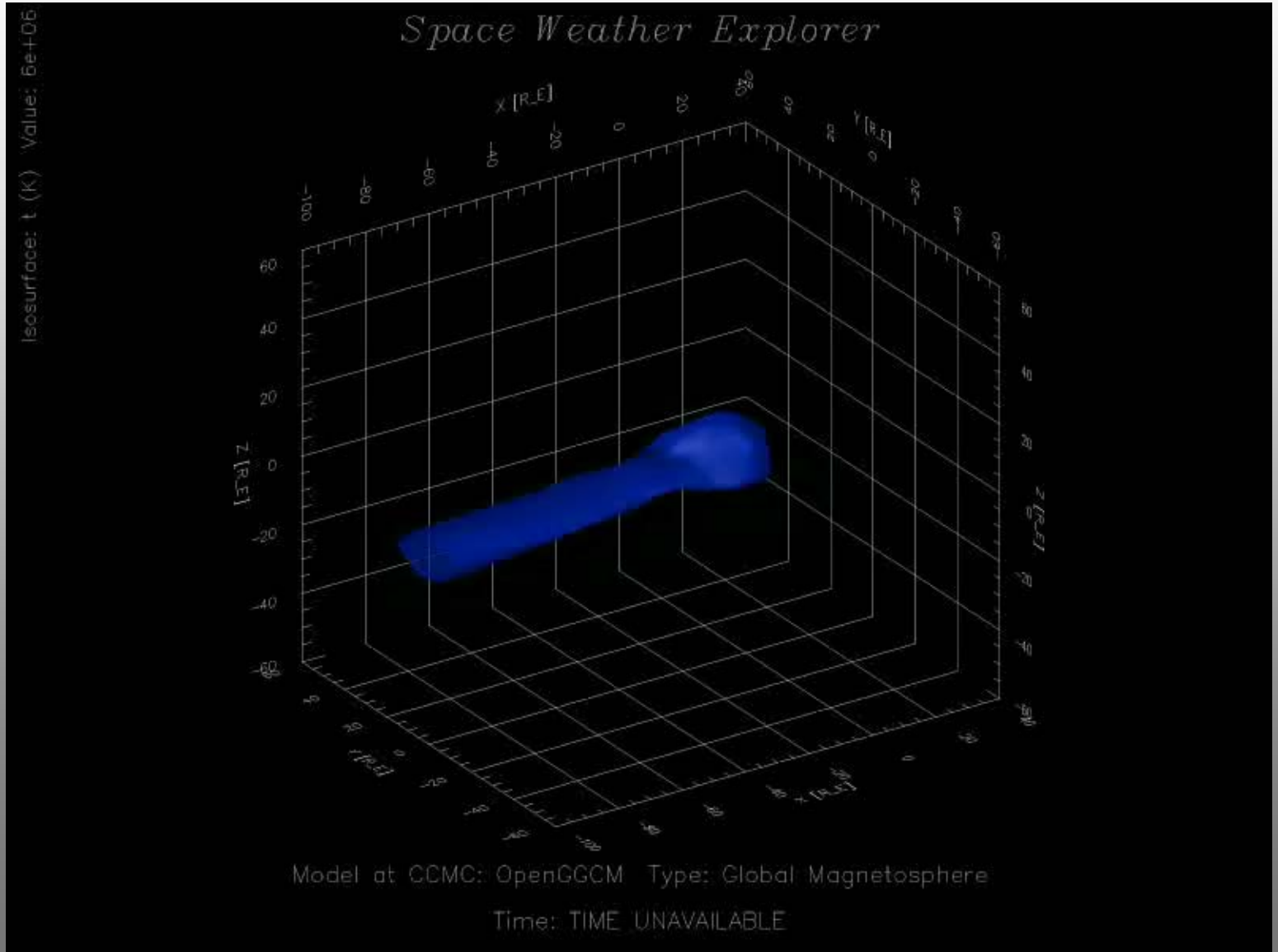
L. Rastaetter

Innovative dissemination: Space Weather Explorer

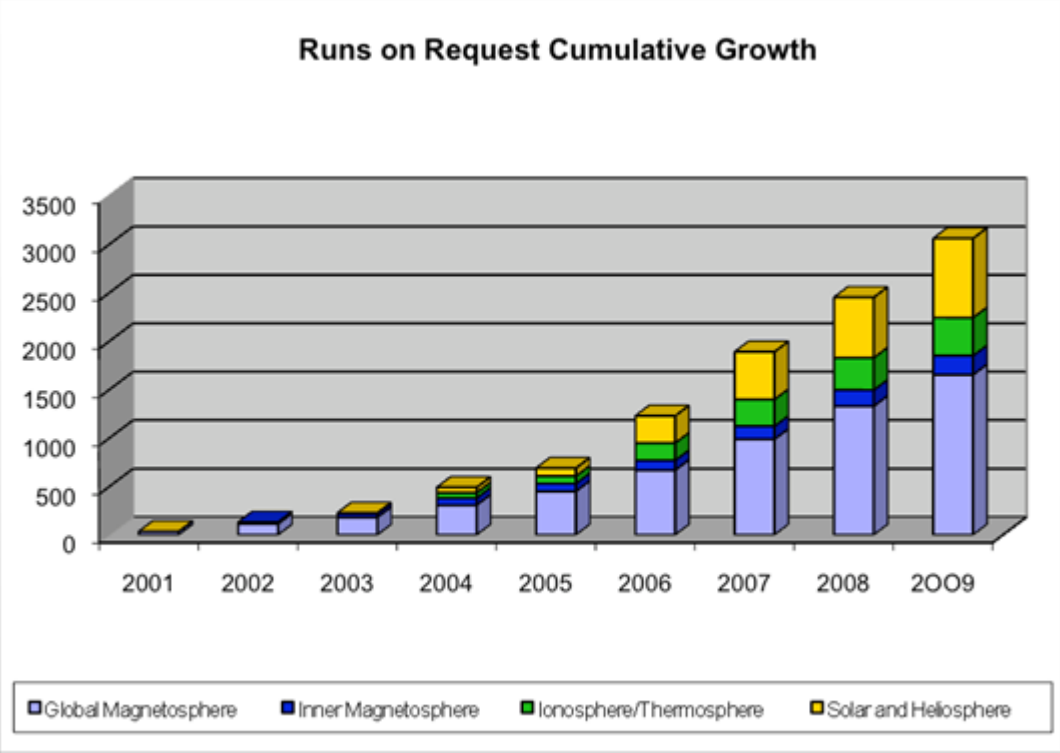


D. Berrios

Space Weather Explorer



RoR and service usage



CCMC Website statistics for 2009:
Monthly website visitors: 4,080
Monthly website visits: 18,800
Monthly website hits: 1.850,000
Monthly visualization users: 340
Monthly visualization requests: 34,000

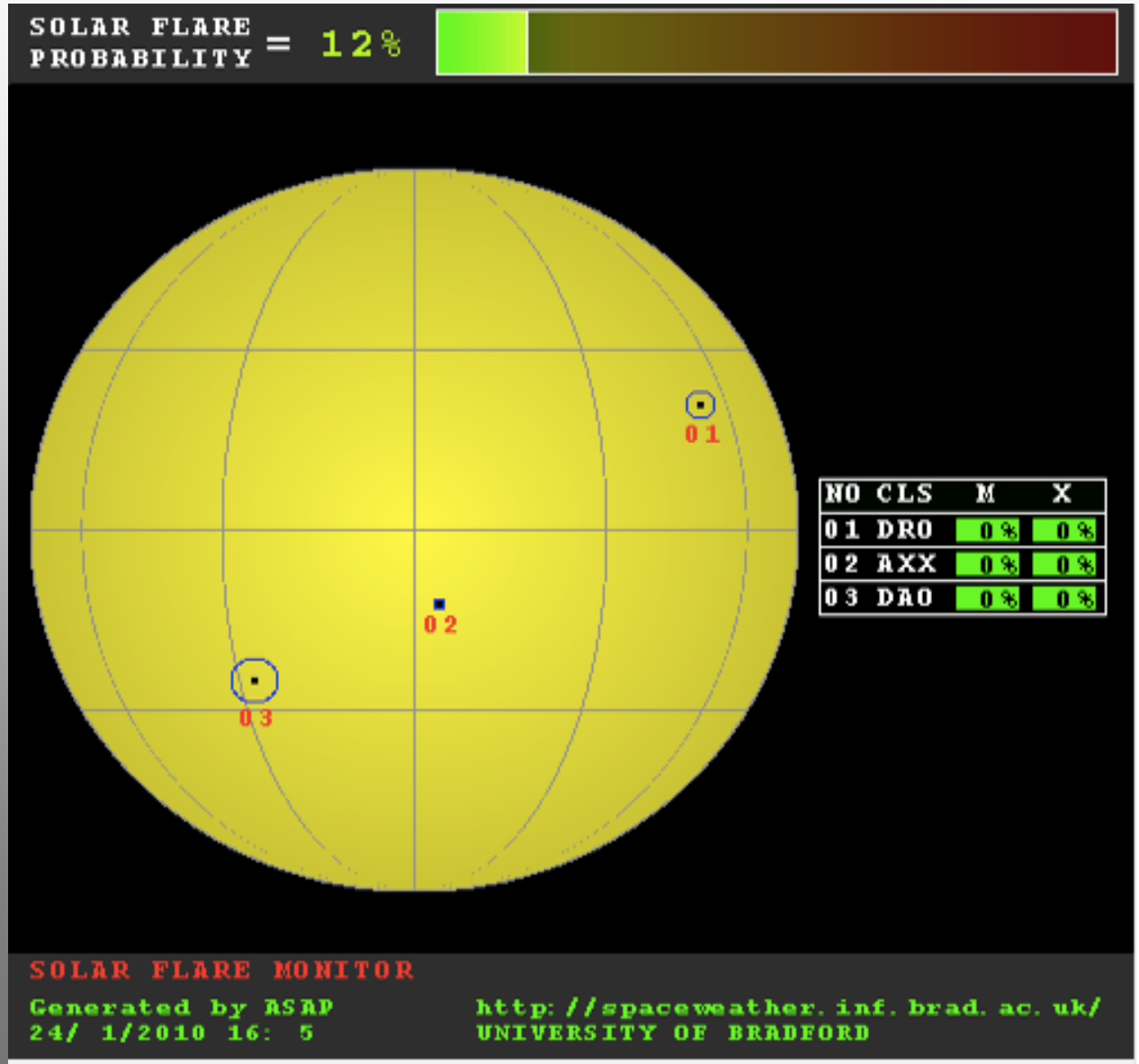
A. Chulaki, L. Moiseev

Examples of Space Weather Tools

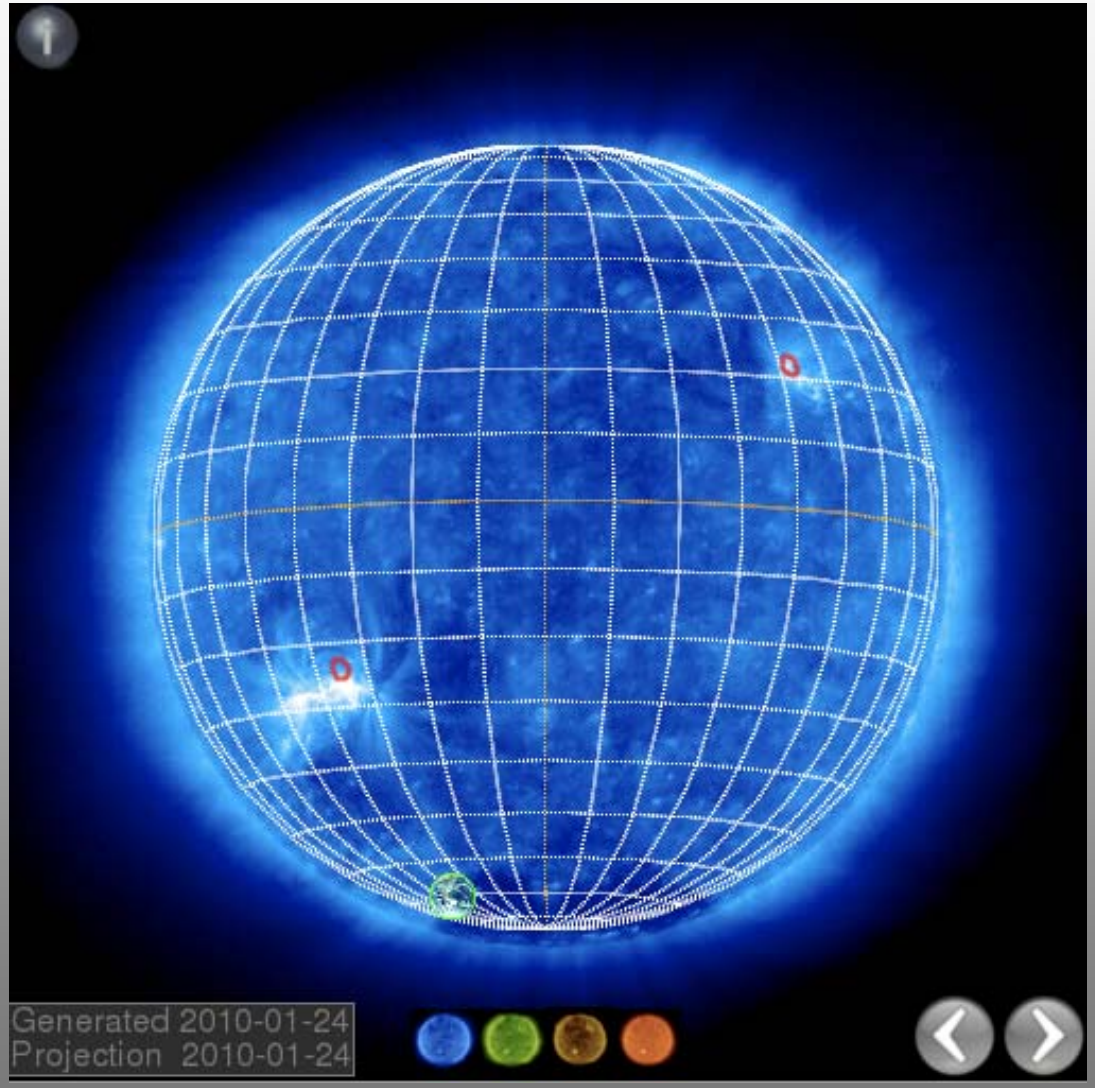
Space weather tools: benefits

- Facilitate model evaluation through a relevant product
- Support NASA robotic mission ops (direct) and human missions (through SRAG)
- Support bootstrapping of services at partners in government and industry
- Showcase value of space research and modeling at NASA, NSF, AFOSR, ONR… to interests in government as well as across society

Flare monitoring product (U. Bradford, UK)



Magnetic connectivity product

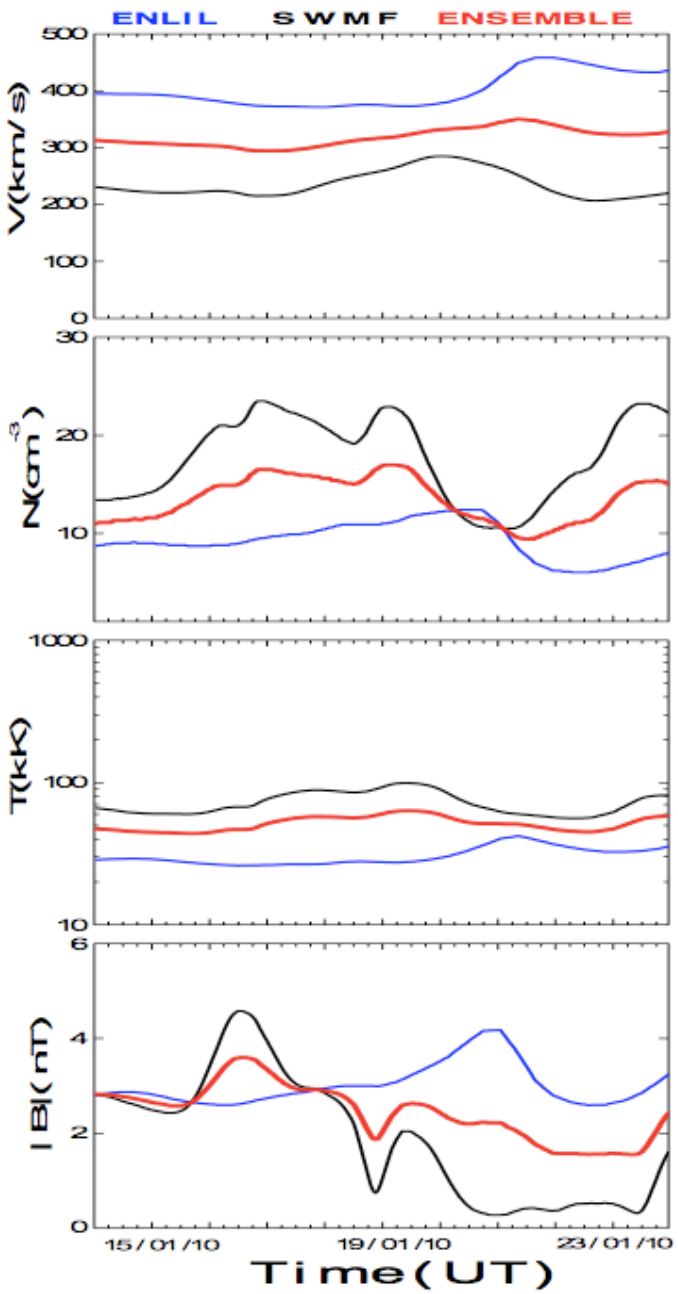


Based on WSA/ENLIL, input from AFWA

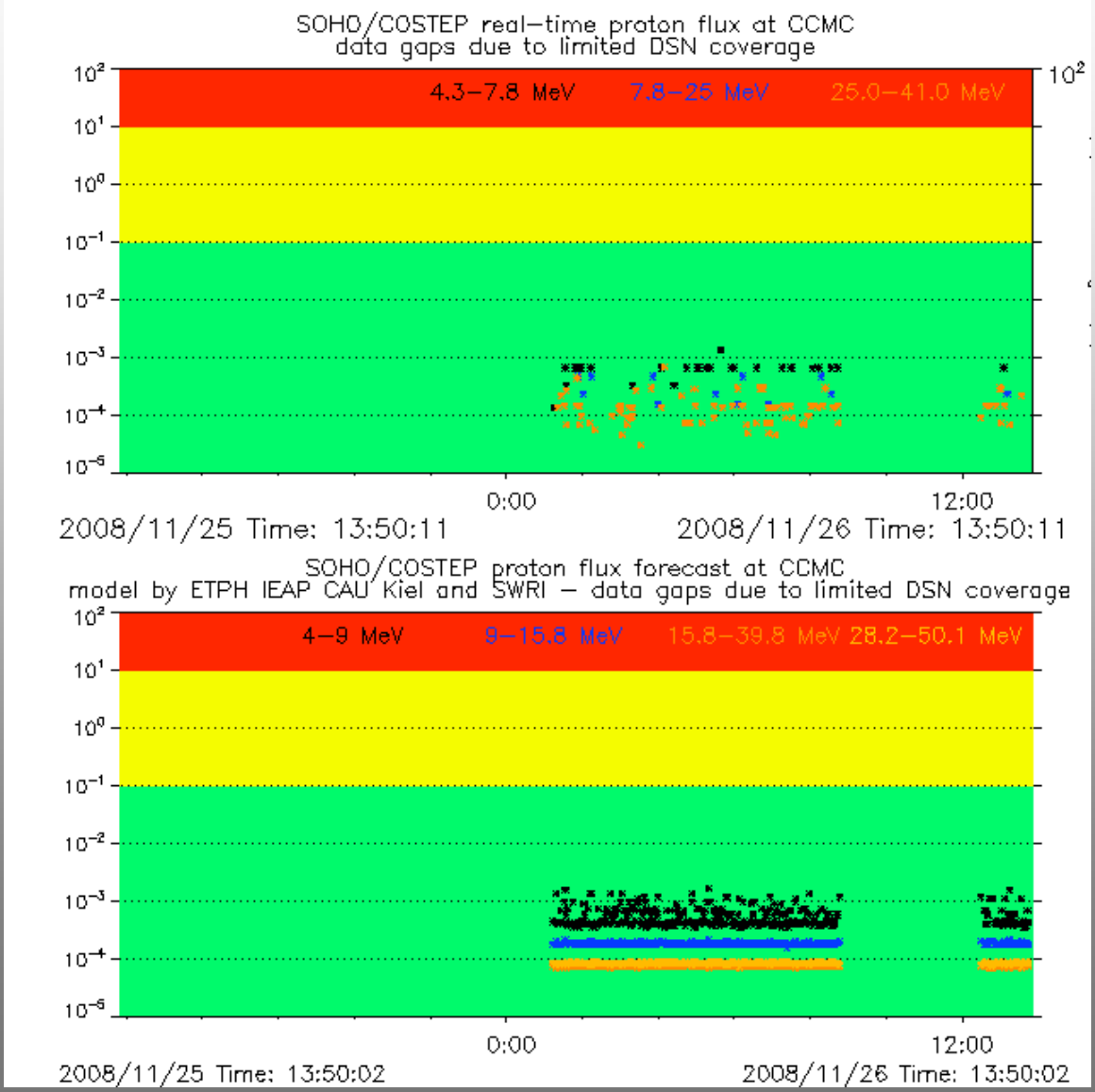
Solar Wind Forecasts

RT ops imminent, addition of WSA

Model: WSA/ENLIL (CISM), SWMF (CSEM)

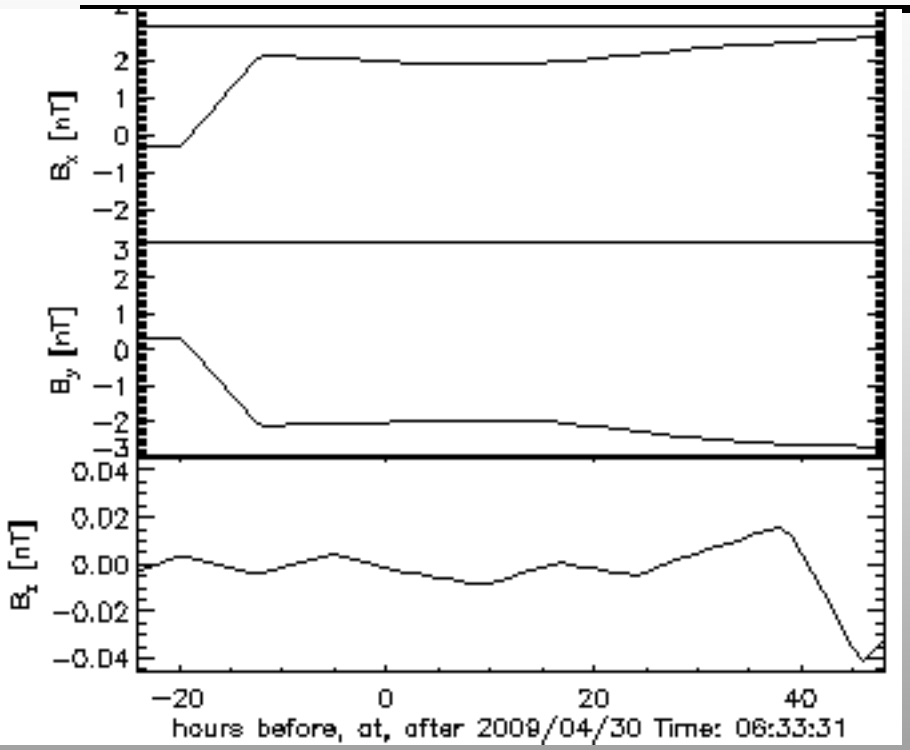


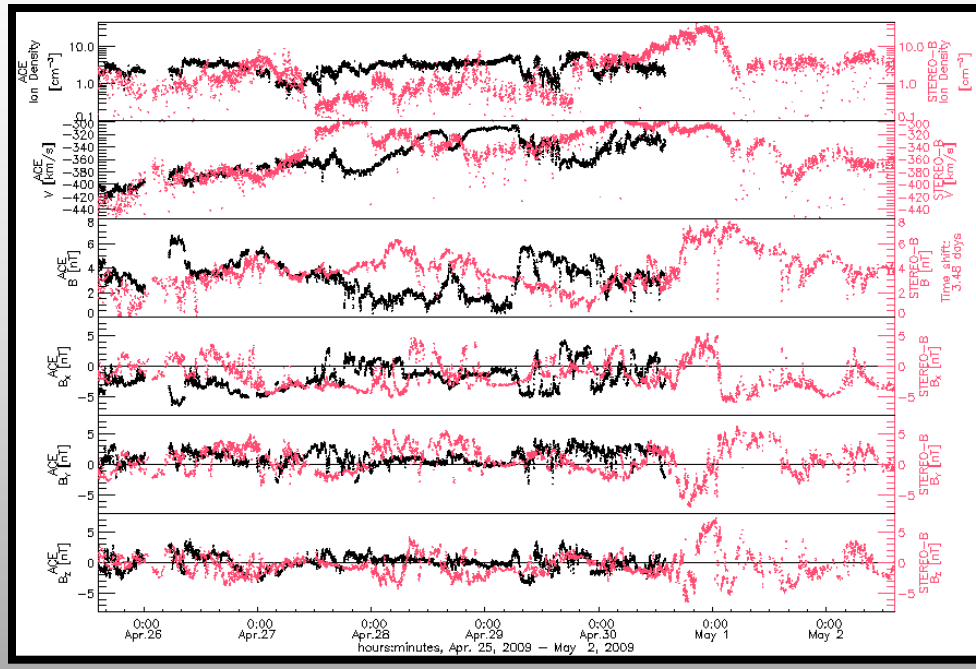
SEP forecasts



A. Posner/NASA/HQ

Presently Available Tools





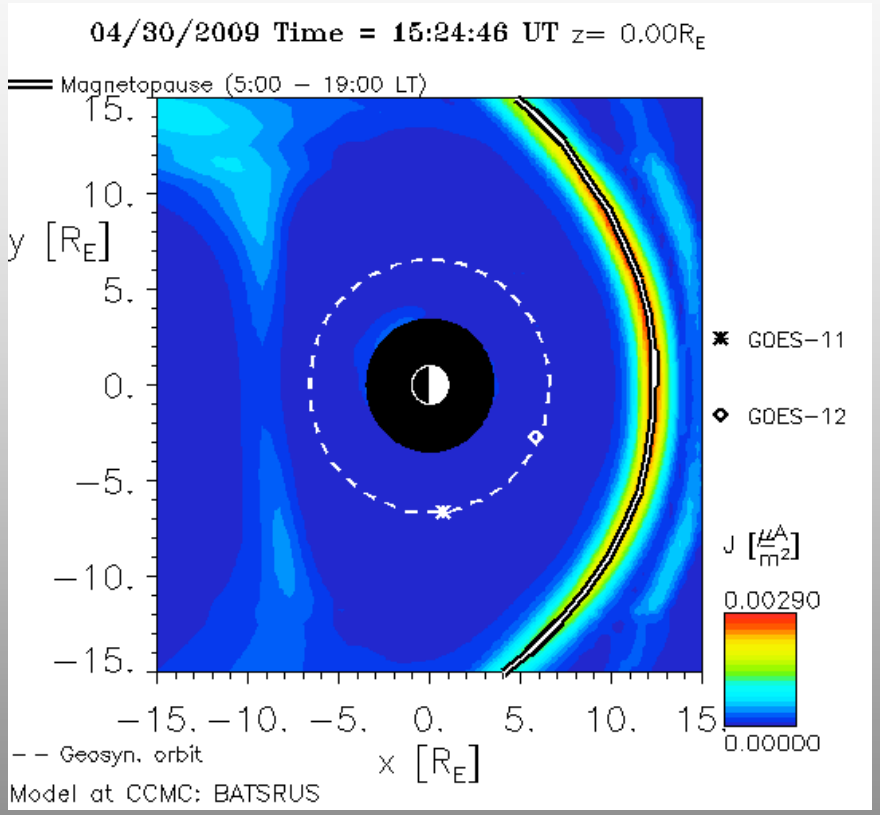
L1 Plasma and magnetic field:
Geomagnetic storm forecast
Includes CME forecast
Up to 48h forecast
Updated daily/on CME obs.

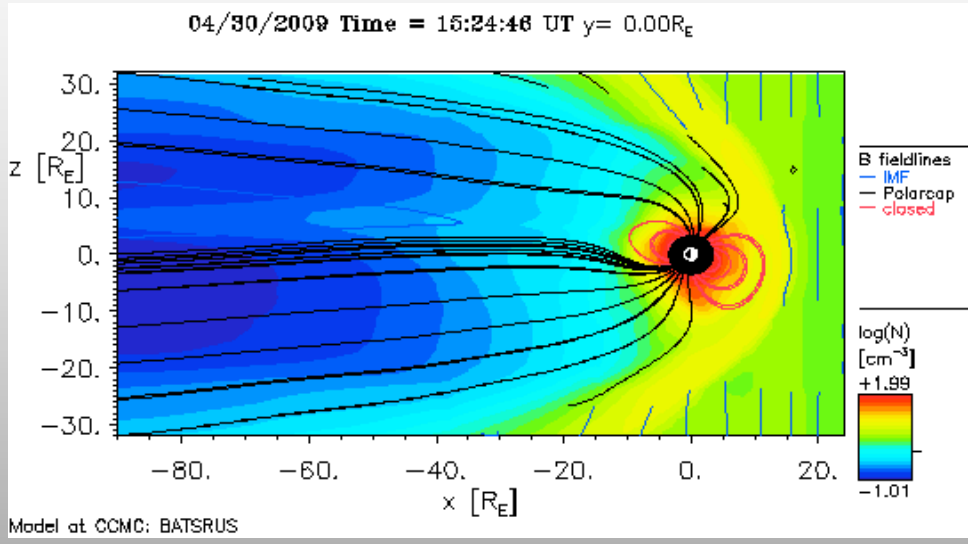
Model: WSA/ENLIL N. Arge, D. Odstrcil (CISM)

Solar wind forecast:
Based on STEREO behind
~48h forecast

Source: STEREO, ACE (NASA)

Magnetospheric information



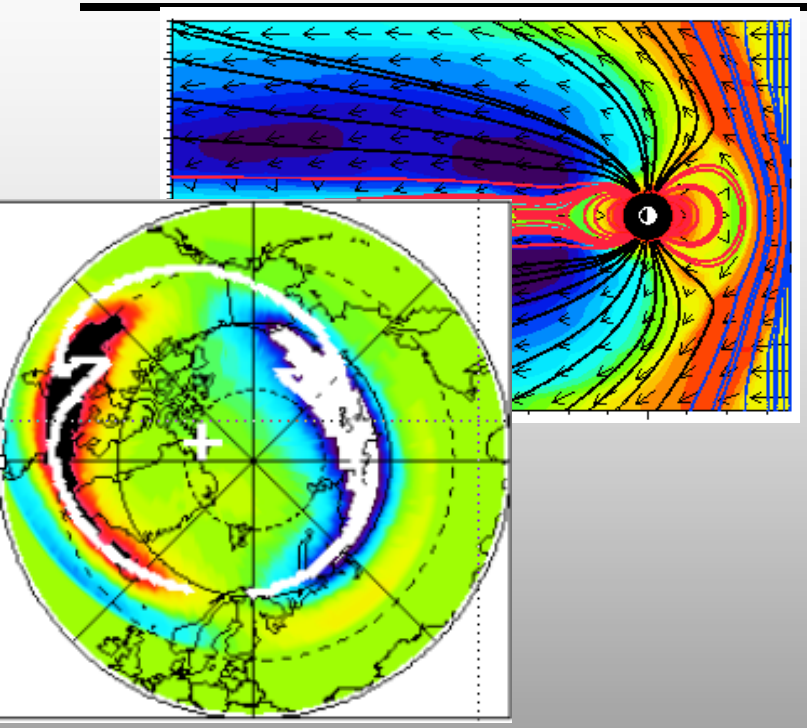


Magnetopause position:
S/C orientation
Updated every 4mins
~45min forecast

1-10keV plasma density:
S/C charging
Updated every 4mins
~45min forecast

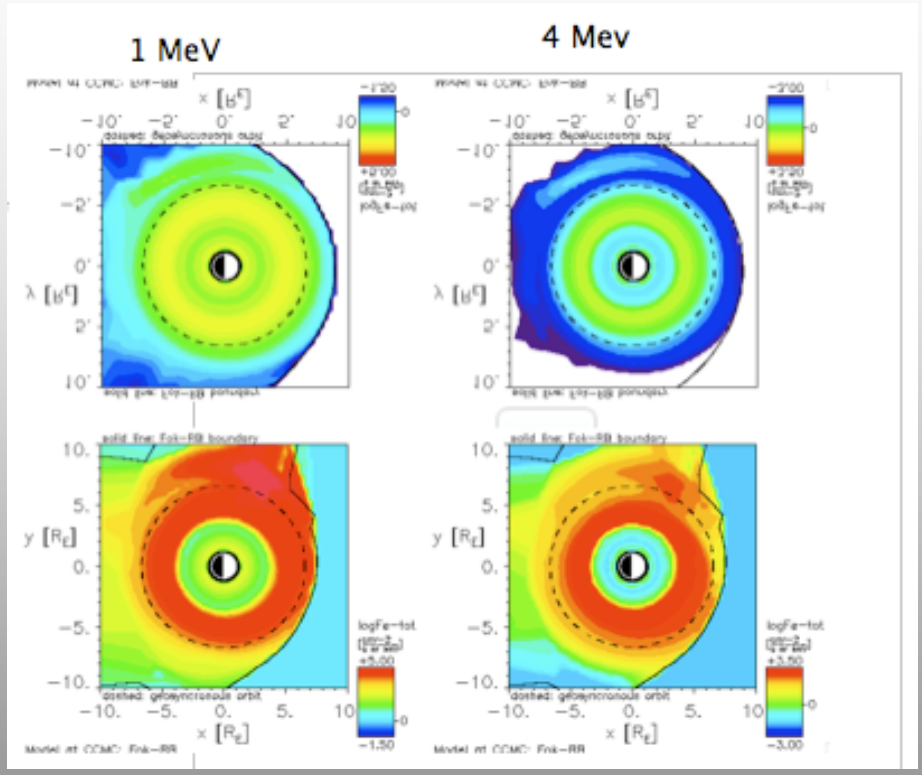
Model: SWMF T. Gombosi et al. (CSEM)

Magnetospheric information



Radiation access to upper atmosphere:
PC Absorption, high flyer
Updated ~4mins
~45min forecast

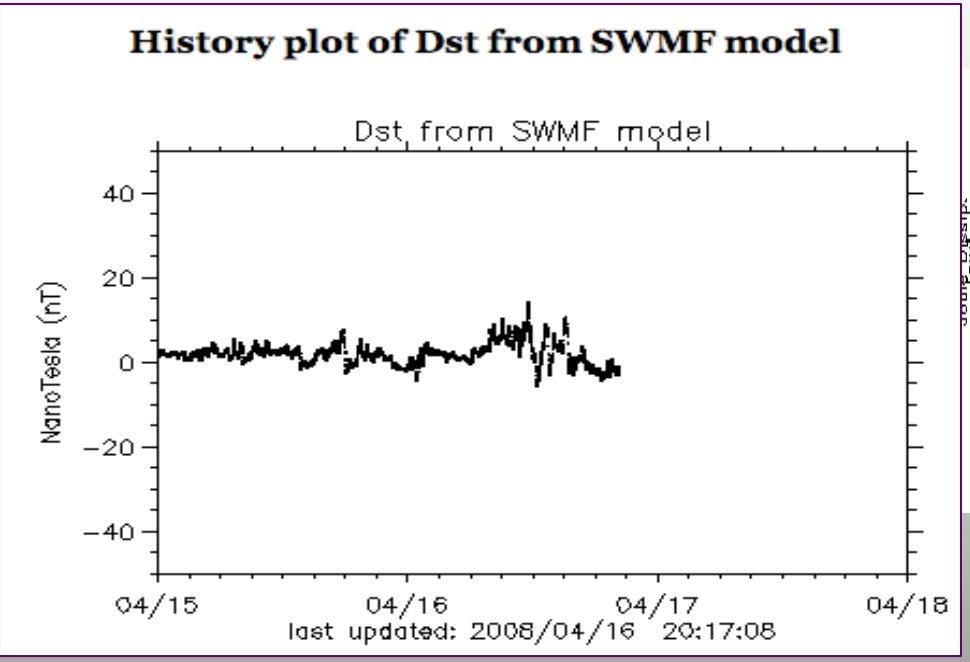
Model: SWMF T. Gombosi et al. (CSEM)

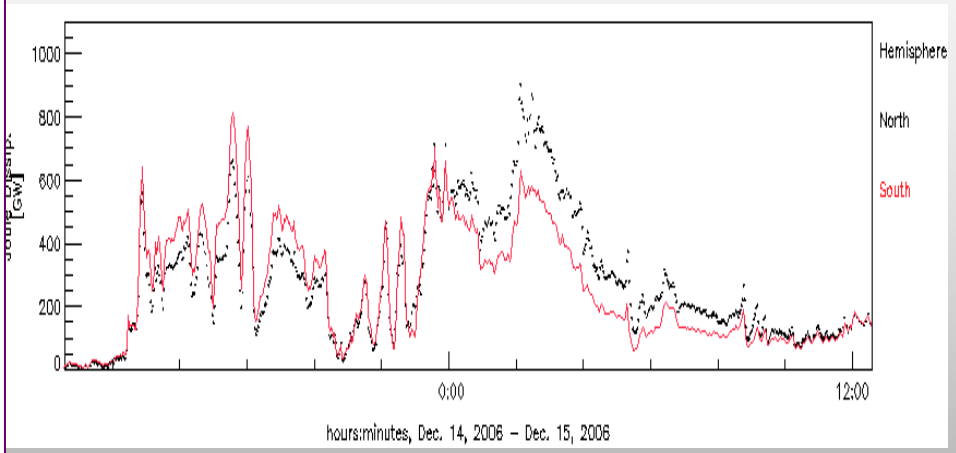


1keV-10MeV electron fluxes:
S/C charging, SEU, radiation hazards
Updated every 4mins
~45min forecast

Model: RC/RB M-C Fok (GSFC)

Magnetospheric information



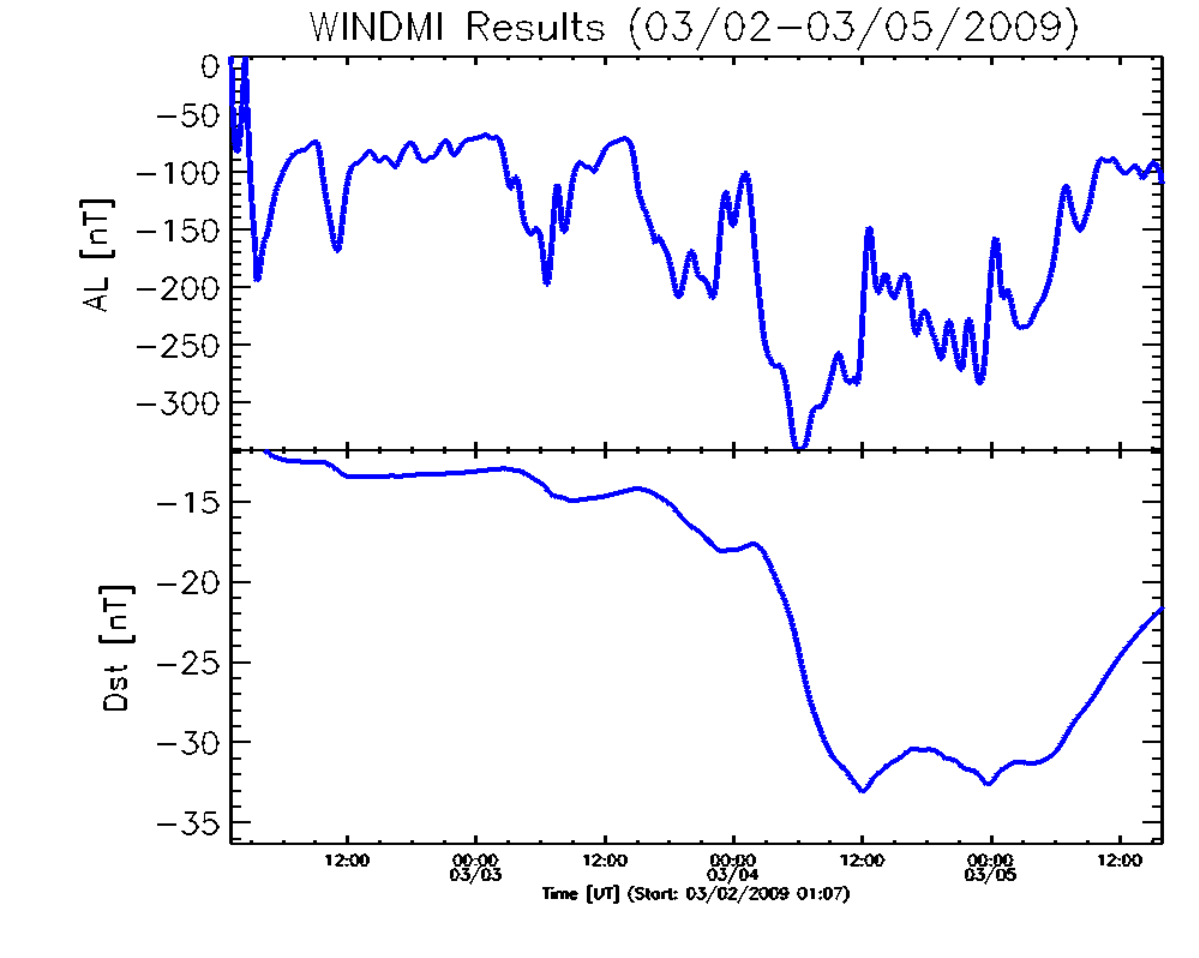


Dst:
Input for various products
Updated ~4mins
~45min forecast

Atmospheric Joule heating:
Atmospheric drag
Updated ~4mins
~45min forecast

Model: SWMF T. Gombosi et al. (CSEM)

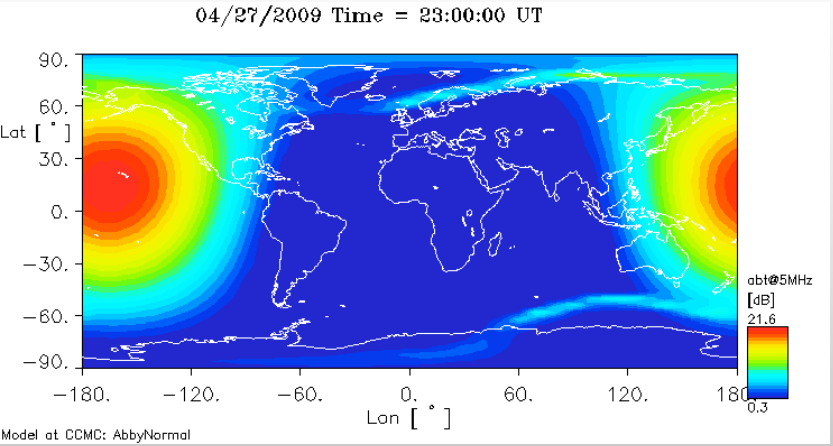
Magnetospheric information

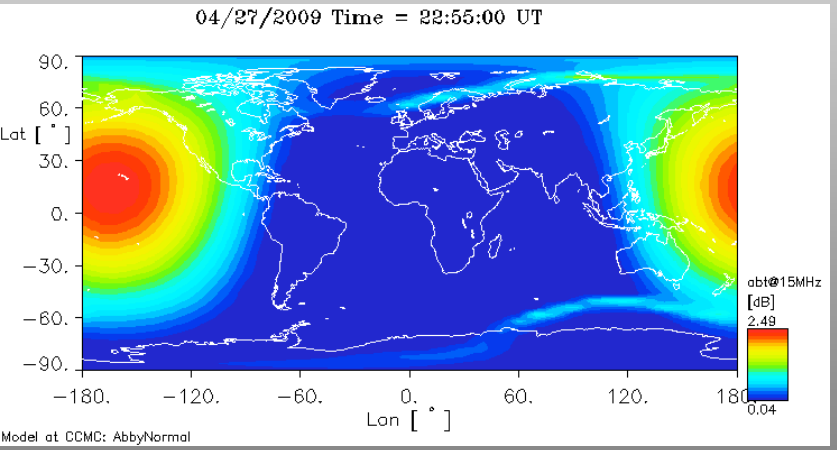


WINDMI: Dst Prediction Model/UTexas/GSFC

L. Rastaetter

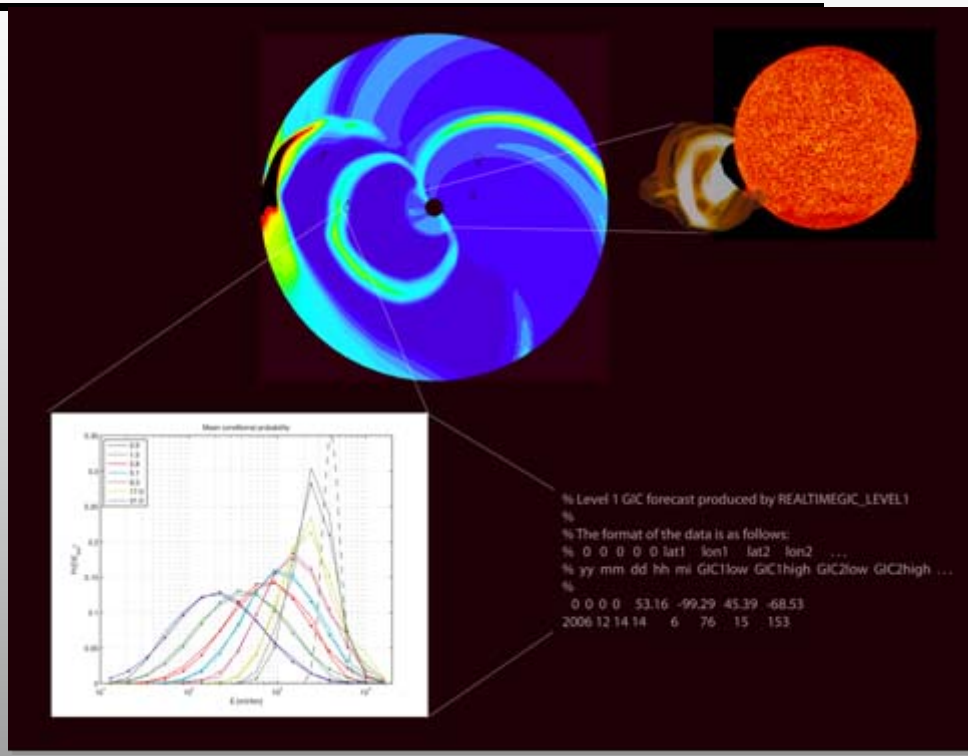
Ionosphere and ground information





HF absorption:
Executing in real-time

Model: AbbyNormal V. Eccles (USU)

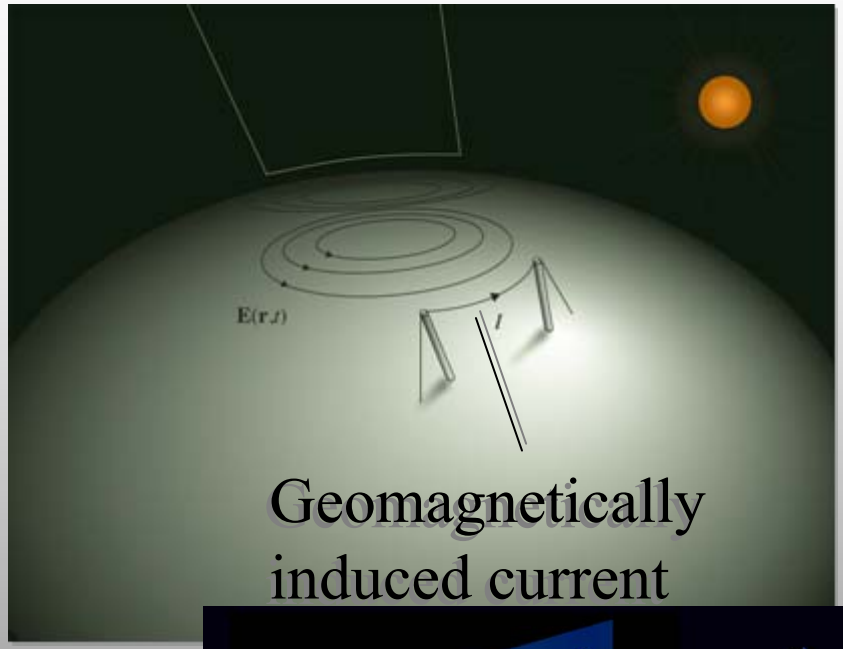


GIC Warning:
Electric power grid safety
Updated every 4mins
~45min forecast
Different mode for CME events

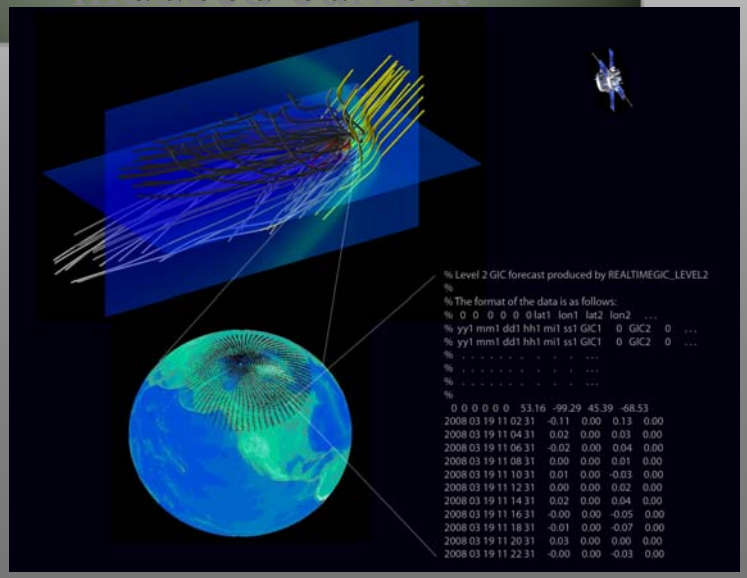
Model: WSA/ENLIL, SWMF, A. Pulkkinen

Realtime runs – applications

- Solar Shield - Forecasting and Mitigating Solar Effects on Power Transmissions Systems in North America
- CCMC and Electric Power Research Institute (EPRI) collaboration
- Two-level GIC forecasts
  - Level 1 providing 1-2 day lead-time.
    - Enlil Cone model $\boldsymbol{v} \times \boldsymbol{B} \rightarrow \boldsymbol{E_g}$
  - Level 2 providing 30-60 min. lead-time.
    - GM/IE driven by ACE data $\rightarrow \boldsymbol{E_g}$
- Coupling to EPRI's SUNBURST decision support tool.

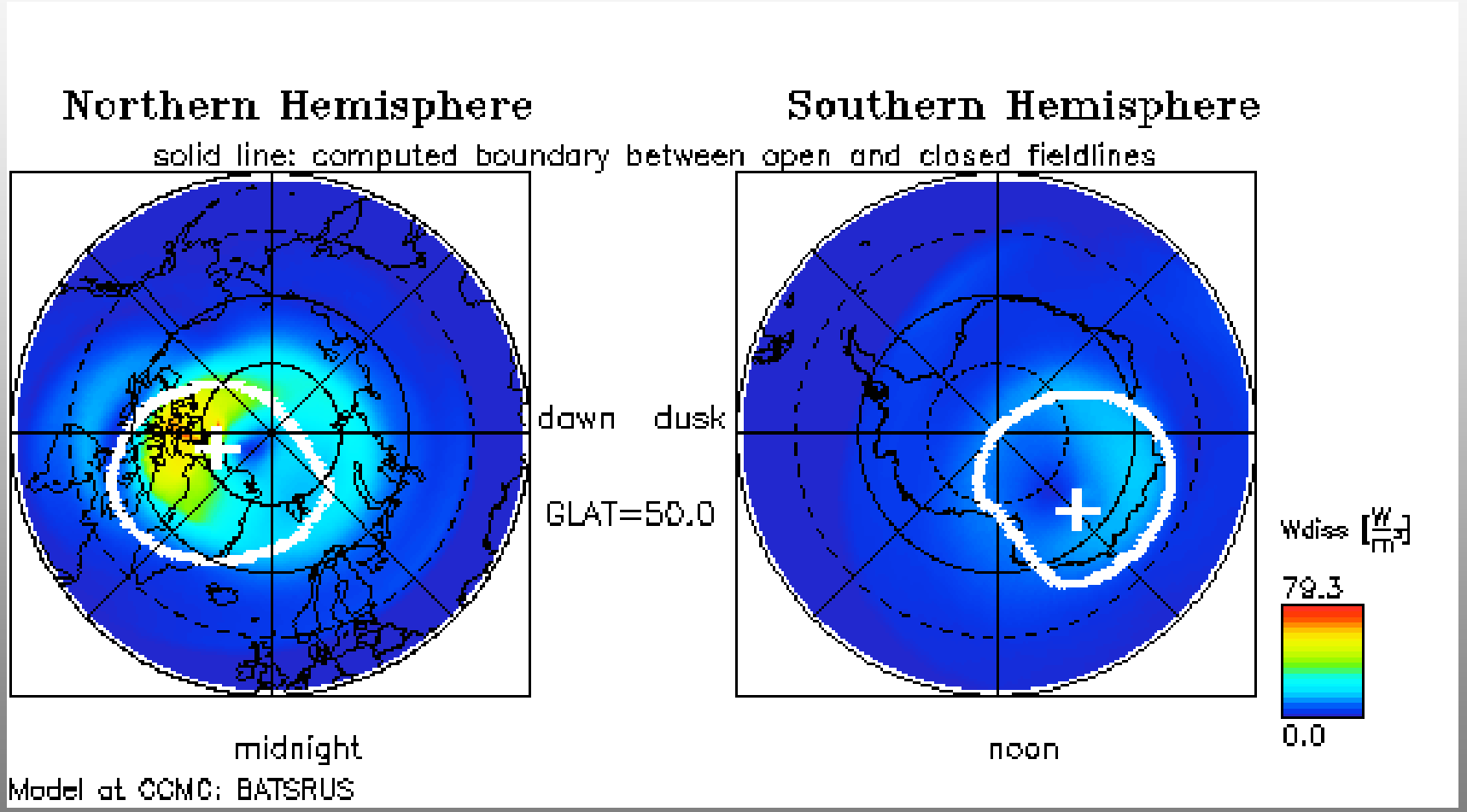


Geomagnetically induced current



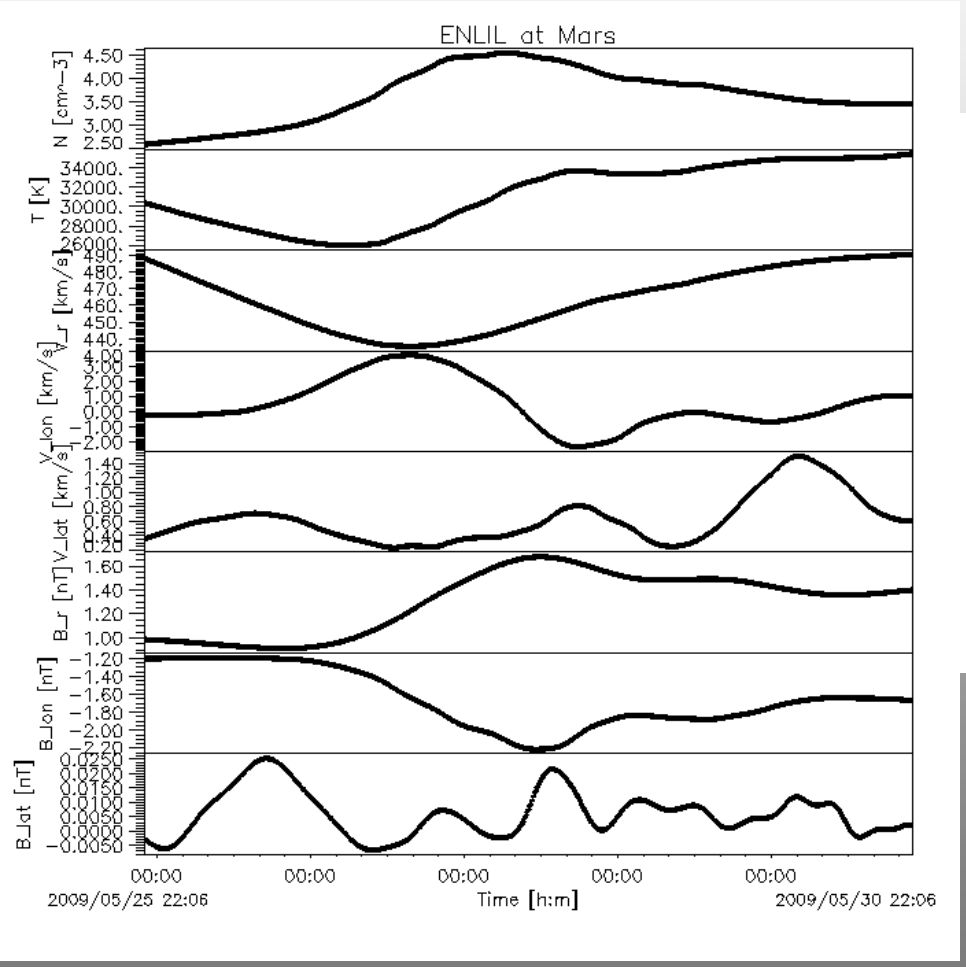
A.Pulkkinen, L. Rastaetter

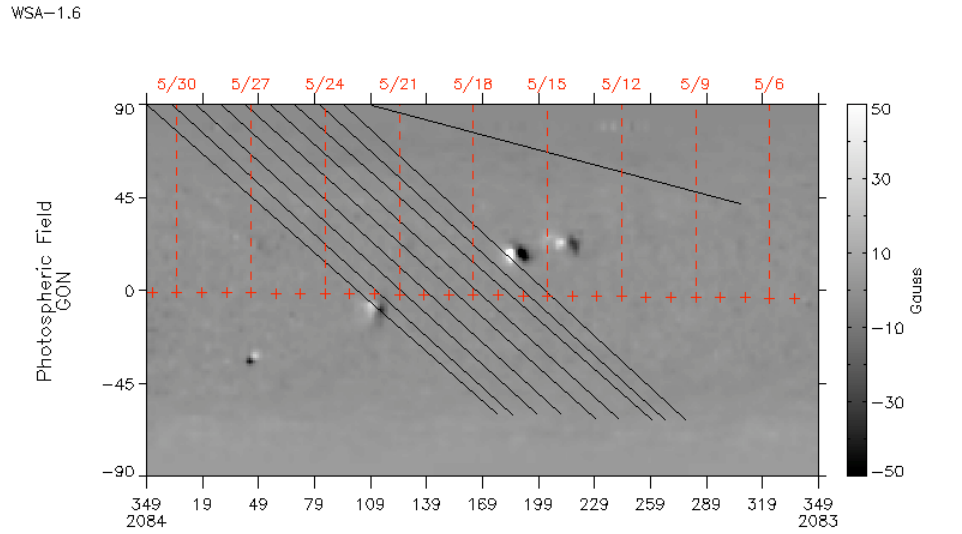
New product: hemispheric heating



also on ISWA

Planetary SWx pages

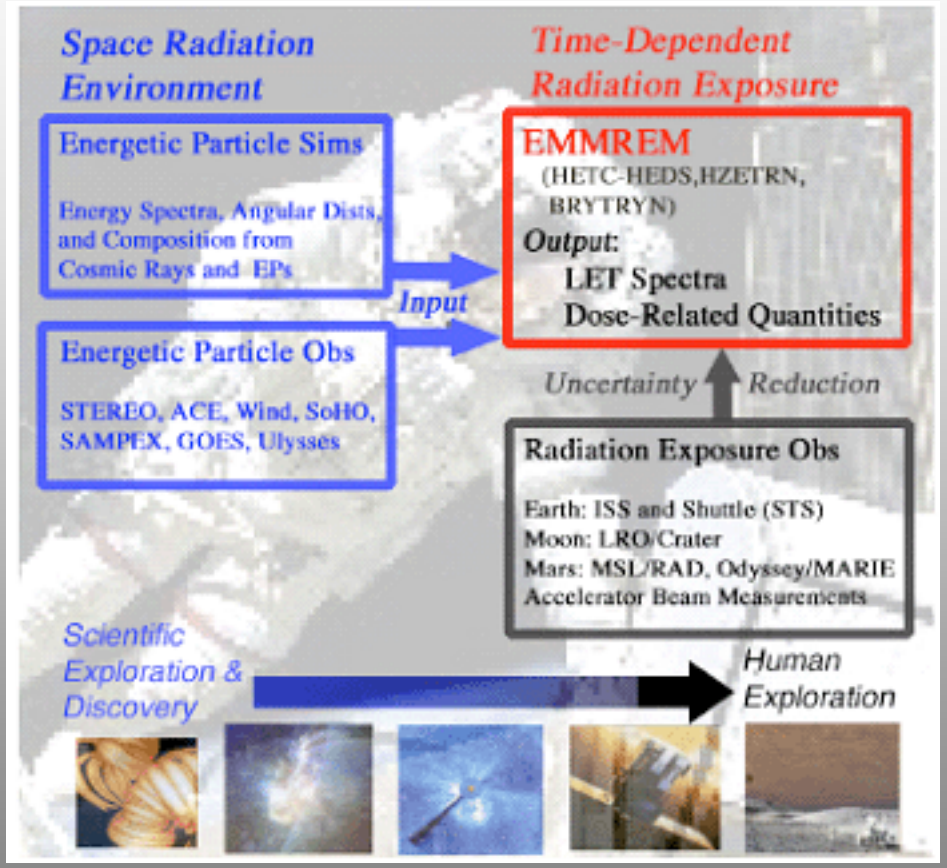




e.g., for Mars

P. MacNeice, L. Rastaetter

Near future: EMMREM



N. Schwadron et al., BU – driven by SEP models and other environment information

P. MacNeice, L. Rastaetter

Model evaluations: V&V and metrics

Decision makers and operational agencies need model evaluations

- Science-based validation: Compare model output to measurements for select events, detailed analysis

- Metrics studies: Repeatable comparison between model output and measurements, “one number”

Need to be blind studies, performed by independent agent

Specifically, CCMC does not own candidate models

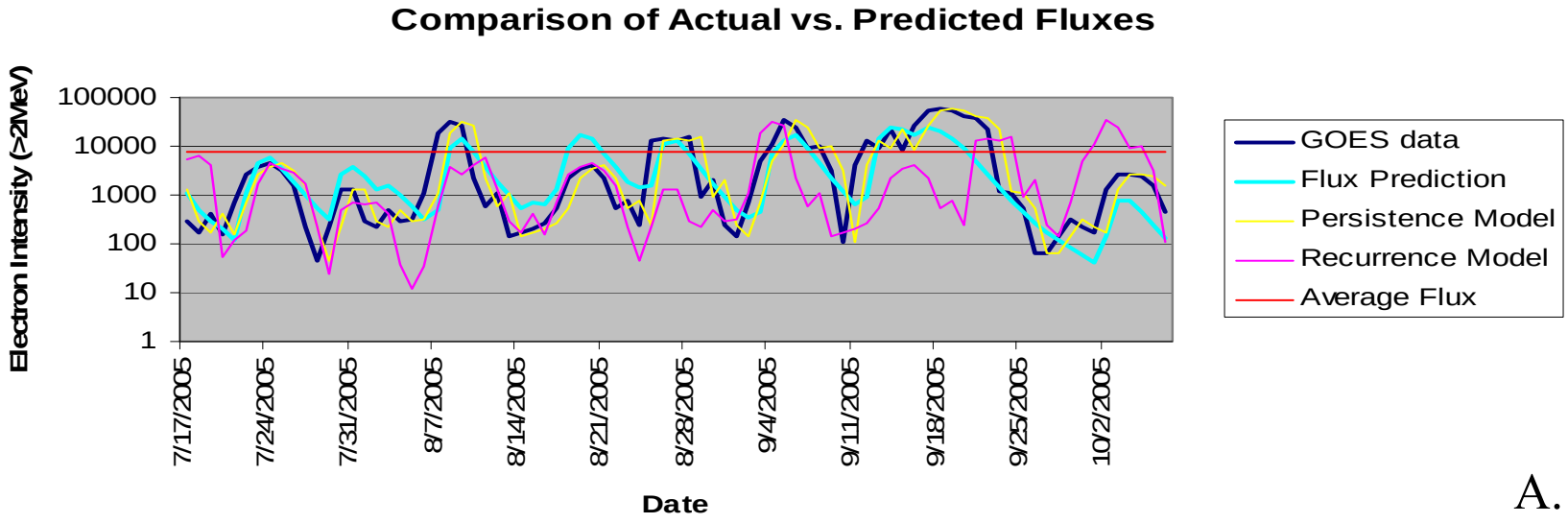
Metrics study (AFWA request)
Predicting MeV electron intensity in radiation belt

Evaluated model:

- Software predicting MeV electron intensity at the geostationary orbit
- Developed at: APL/UPOS
- Input: real-time ACE data
- Output: polar cap potential

- Quiet vs Storm period
- Now also for Dst model

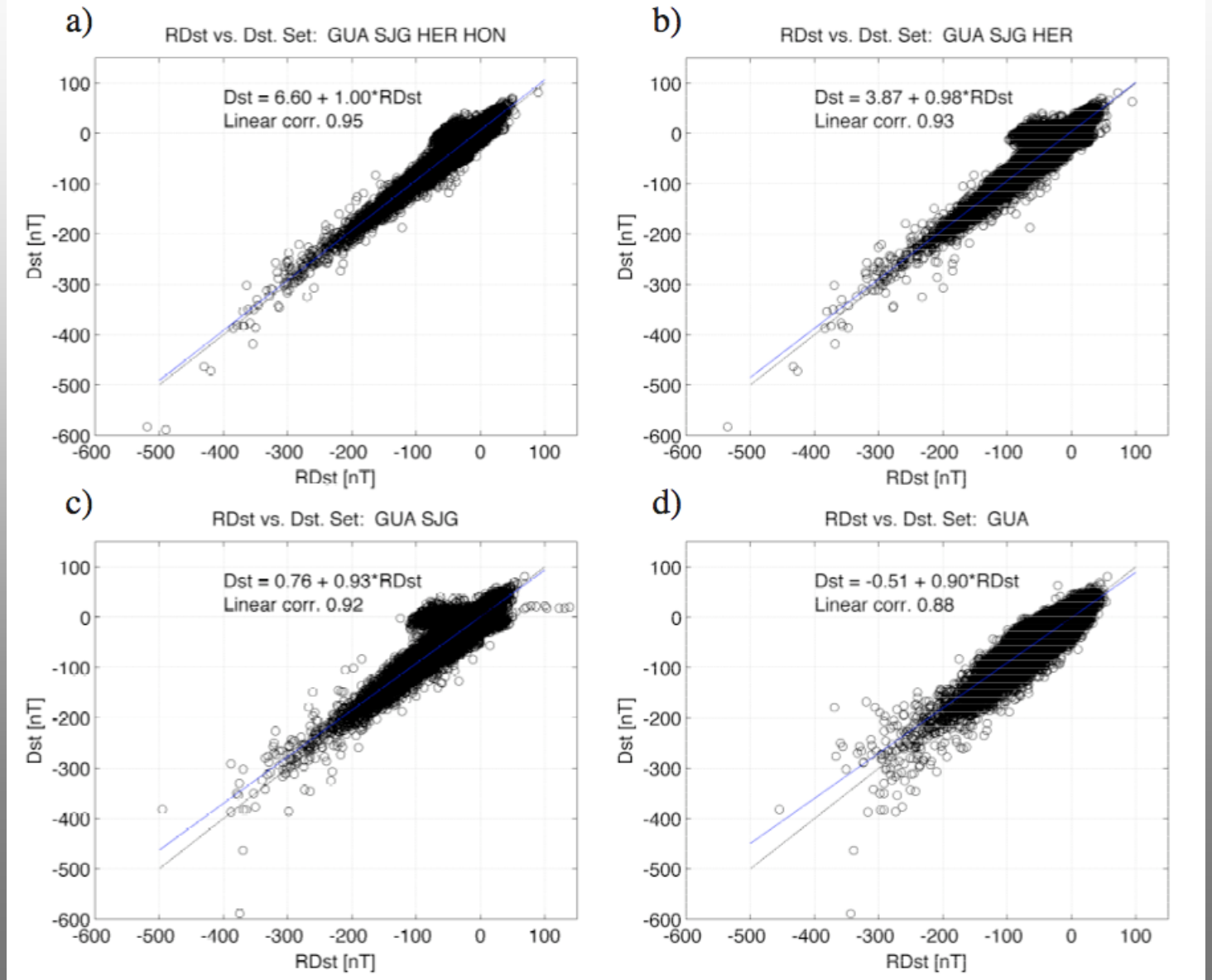
Reference Model	Skill Score		
	Whole interval	Quiet	Stormy
1-day persistence	-0.3544	-0.3864	0.2355
Mean	0.2041	0.2294	0.2047
27-day recurrence	0.2935	0.2468	0.3629



A. Chulaki

Metrics study (AFWA request)

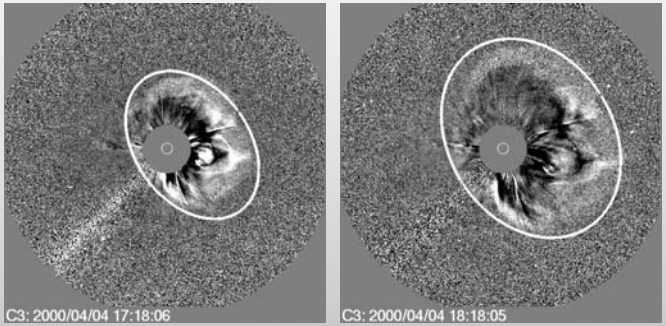
Dst prediction – RDST model



A. Pulkkinen

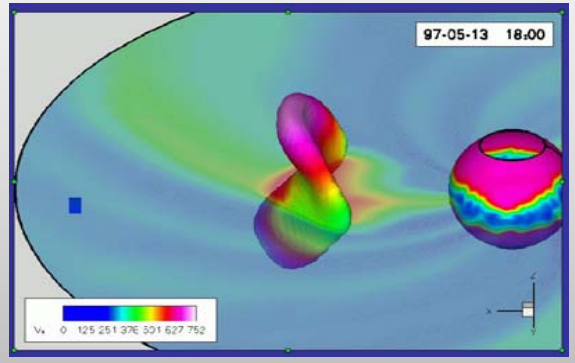
ENLIL cone model: CME prediction

SOHO LASCO C3 RD Images

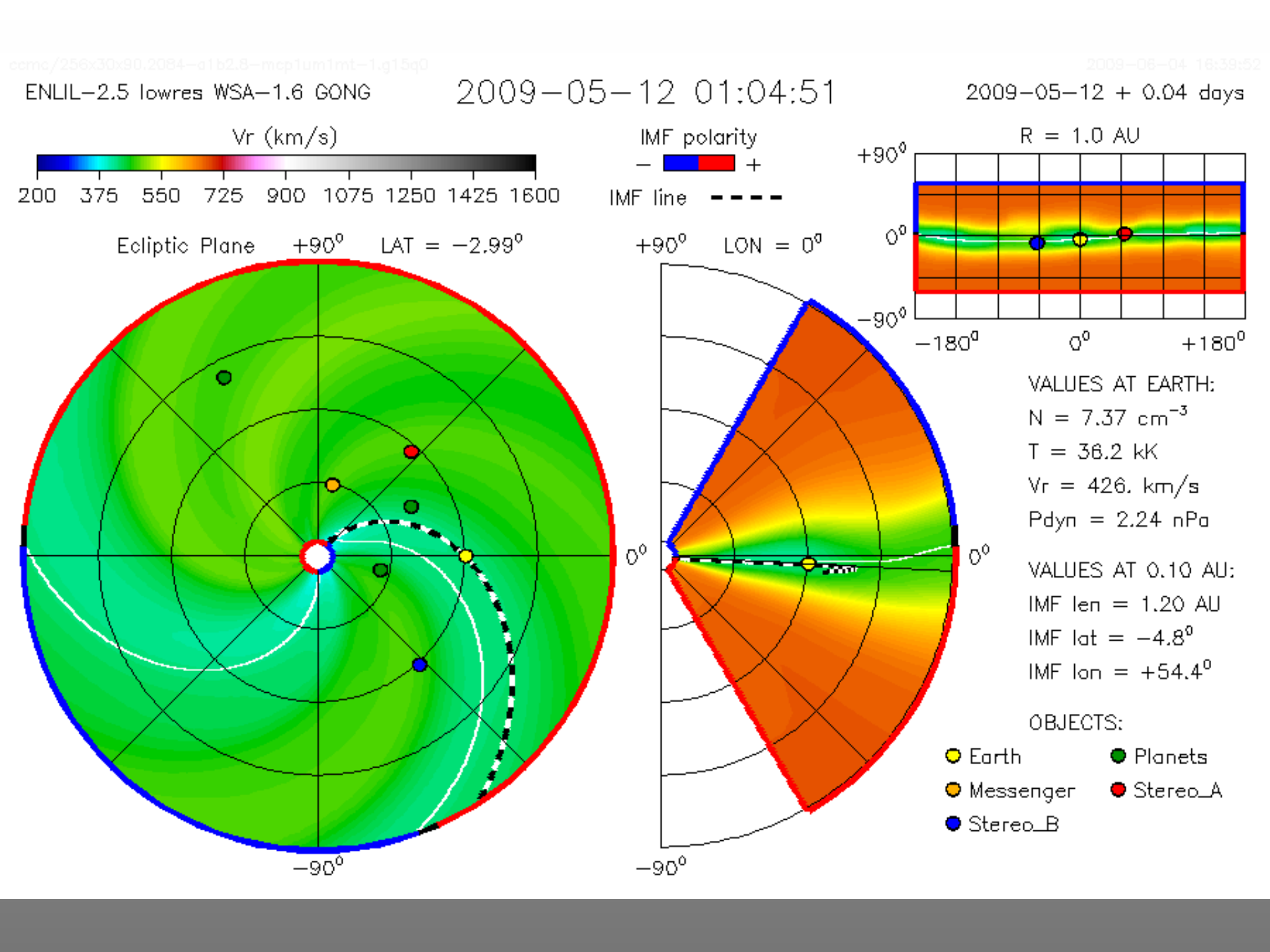


Enlil Cone Model

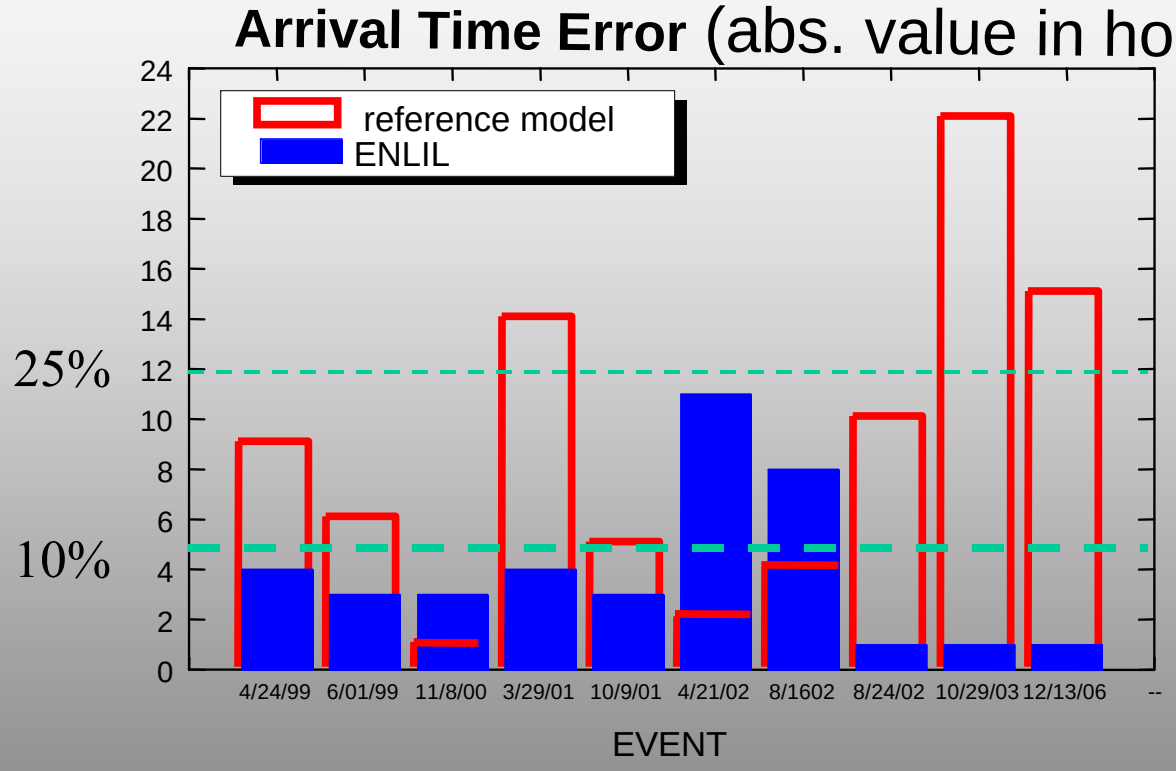
CME Arrival Prediction



- **Time** of CME Arrival
- Measure of **Uncertainty**
- **Magnitude** of Impact


ENLIL–2.5 lowres WSA–1.6 GONG
2009–05–12 01:04:51
2009–05–12 + 0.04 days
Vr (km/s)
200 375 550 725 900 1075 1250 1425 1600
IMF polarity
–
+
IMF line
R = 1.0 AU
+90°
0°
–90°
–180°
0°
+180°
Ecliptic Plane +90° LAT = –2.99°
–90°
+90° LON = 0°
0°
0°
–90°
VALUES AT EARTH:
N = 7.37 cm^{-3}
T = 36.2 kK
Vr = 426. km/s
Pdyn = 2.24 nPa
VALUES AT 0.10 AU:
IMF len = 1.20 AU
IMF lat = –4.8°
IMF lon = +54.4°
OBJECTS:
Earth
Planets
Messenger
Stereo_A
Stereo_B

ENLIL cone model: CME arrival time



Reference Model:

Average of Halo CME speed from the CME catalogue).

V_{avg}= 850 km/s

Average propagation time to the ACE satellite:

Typical error: +/-6 hours

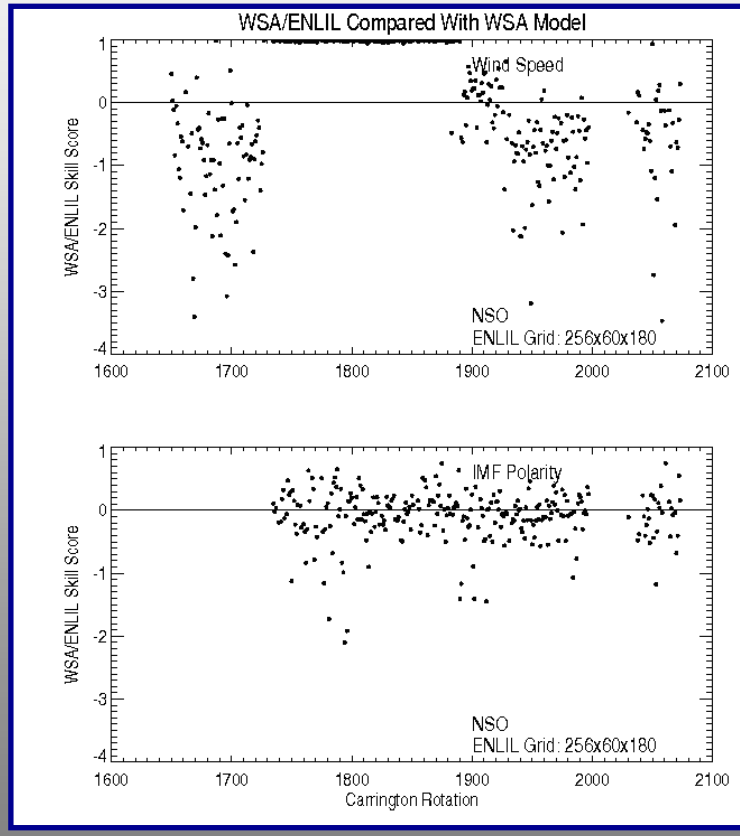
vs.

Standard model error: +/- 8hours

S. Taktakishvili

Validation

- Ambient/Realtime
  - Use WSA as baseline
  - Evaluate both Skill Scores and ‘event’ forecasting
  - ‘Event’ detection algorithm published
  - Comprehensive WSA validation in press
  - WSA/ENLIL validation in preliminary stages
  - SWMF updated – preliminary validation should be completed soon
  - Fieldline tracing in WSA/ENLIL



P. MacNeice

Community metrics studies

Metric study 1: Magnetic field at geosynchronous orbit

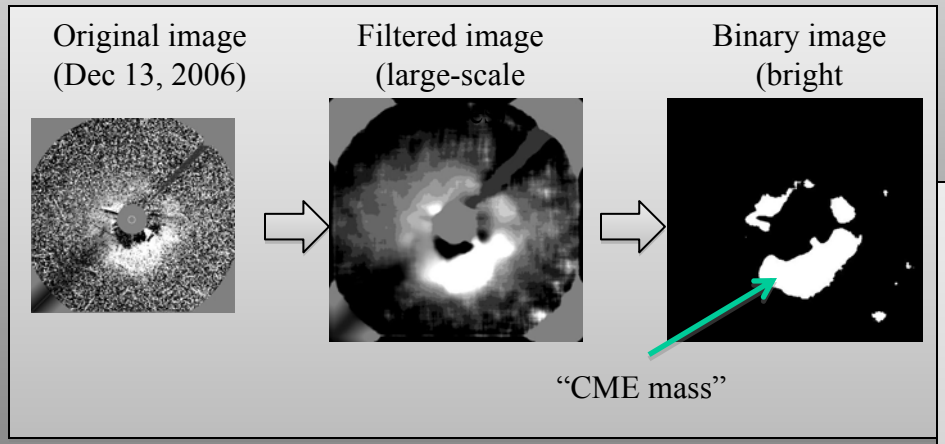
Model Setting ID	Model Name, Version	Resolution	Event	Prediction efficiency		Log-spectral distance		CCMC ROR Run / Submission ID	Satellites
				Per event	Average	Per event	Average		
1_CMIT	CMIT2.0 LFM + TIEGCM	LFM (53x24x32 grid) + TIEGCM (5x5 deg)							
1_LFM	LFM	**0.3Re** 160K cells							
1_OPENGGCM	OpenGGCM v3.1 OpenGGCM + CTIM	**0.3 Re** 3M cells							
1_SWMF	SWMF v2.0 BATSRUS v.7.73	**0.25 Re** 2M cells	1	-0.327	-0.33	1.355	1.35	ccmc_ccmc_082208_1a	2
1_WEIGEL	Weigel_2009-v0								
1_WEIMER	Weimer 2005		1	NA or TBD	NA or TBD	NA or TBD	NA or TBD	GEM08_Daniel_Weimer_030809_E1_3	2
2_OPENGGCM	OpenGGCM v3.1 OpenGGCM + CTIM	**0.25 Re** 6.5M cells							
2_SWMF	SWMF v2.0 BATSRUS v.7.73	**0.25 Re** 700K cells	1	-0.355	-0.35	1.434	1.43	ccmc_ccmc_082208_1	2
3_SWMF	SWMF v2.3 BATSRUS v.8.01 + RCM2	**0.25 Re** 2M cells	1	0.17	0.17	1.242	1.24	CCMC_CCMC_102708_1	2
4_SWMF	SWMF v2.3 BATSRUS v8.01	**0.125 Re** 3M cells	1	-0.273	-0.27	1.145	1.15	CCMC_CCMC_122408_1	2
5_SWMF	SWMF v2.3 BATSRUS v8.01+ RCM2	**0.125 Re** 3M cells	1	-0.185	-0.19	1.586	1.59	CCMC_CCMC_040209_1	2
6_SWMF	SWMF V.20090403, BATSRUS + RCM2	**0.25 Re** 900K cells	1	NA or TBD	NA or TBD	NA or TBD	NA or TBD	GEM08_Aaron_Ridley_010609_E1_1	2
2_WEIMER	new model		1	NA or TBD	NA or TBD	NA or TBD	NA or TBD	GEM08_Daniel_Weimer_030809_E1_4	2
3_OPENGGCM			1	-0.635	NA or TBD	NA or TBD	NA or TBD	GEM08_Alexander_Vapirev_090909_E1_1	2
T96	Tsyganenko T96								
T04	Tsyganenko T04								

GEM metrics study, community and SWPC support

A. Pulkkinen, M. Kuznetsova, L. Rastaetter, A. Chulaki

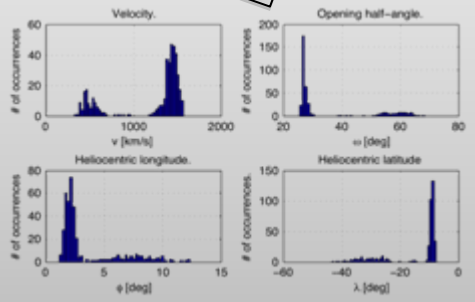
Cone model forecasting: the next step

- Current Operational system
  - Manual generation of cone model parameters from LASCO difference images
- Automated system (paper published)*
  - Fit error estimates define 'ensemble forecast' parameter set



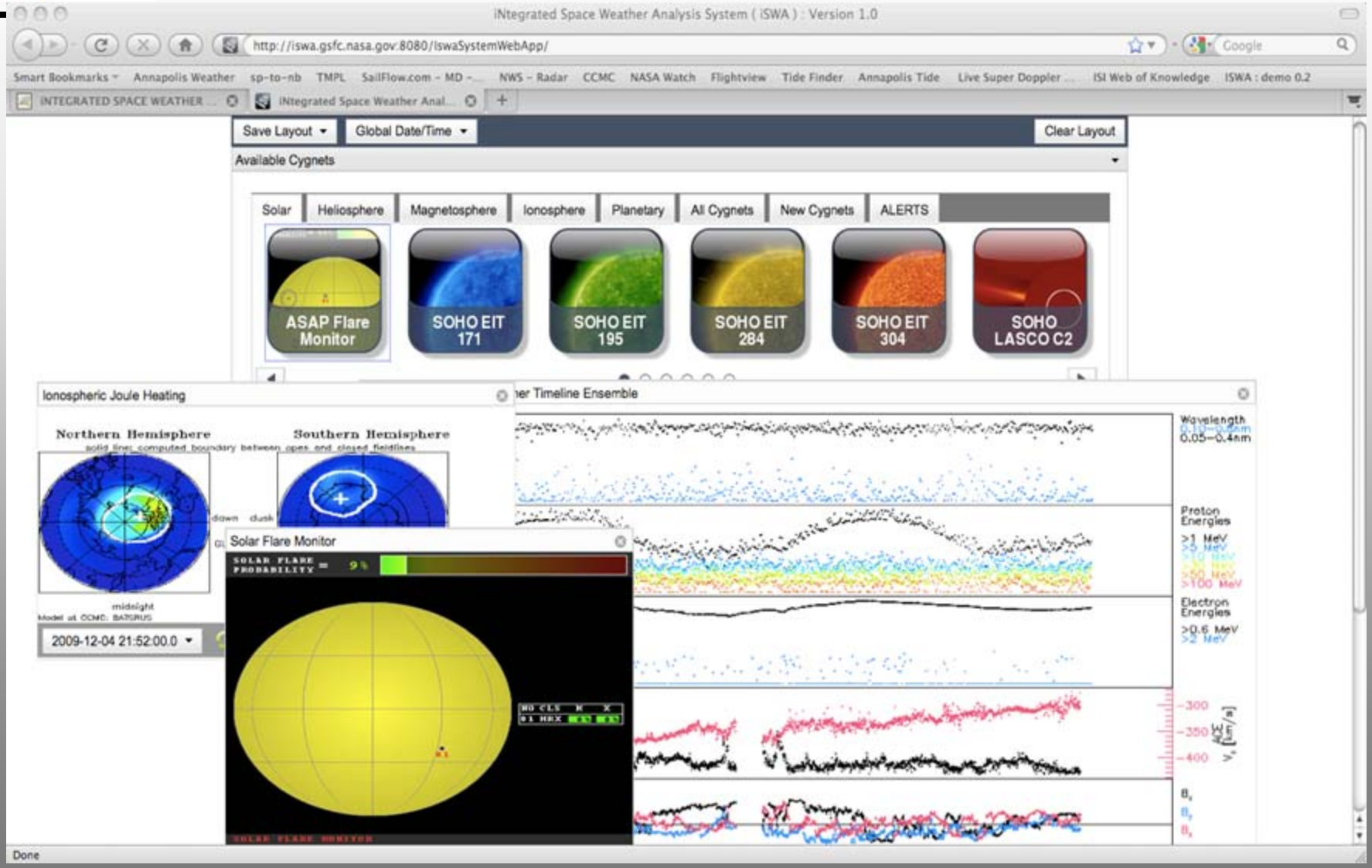
$$\min_{\{v,x_0,\omega,\theta\}} \left[\sum_i \left((y_i-\hat{y}_i)^2+(z_i-\hat{z}_i)^2\right)+\mu|\omega-\omega_0|\right]$$

Sequence of binary images



A. Pulkkinen, S. Taktakishvili, D. Berrios

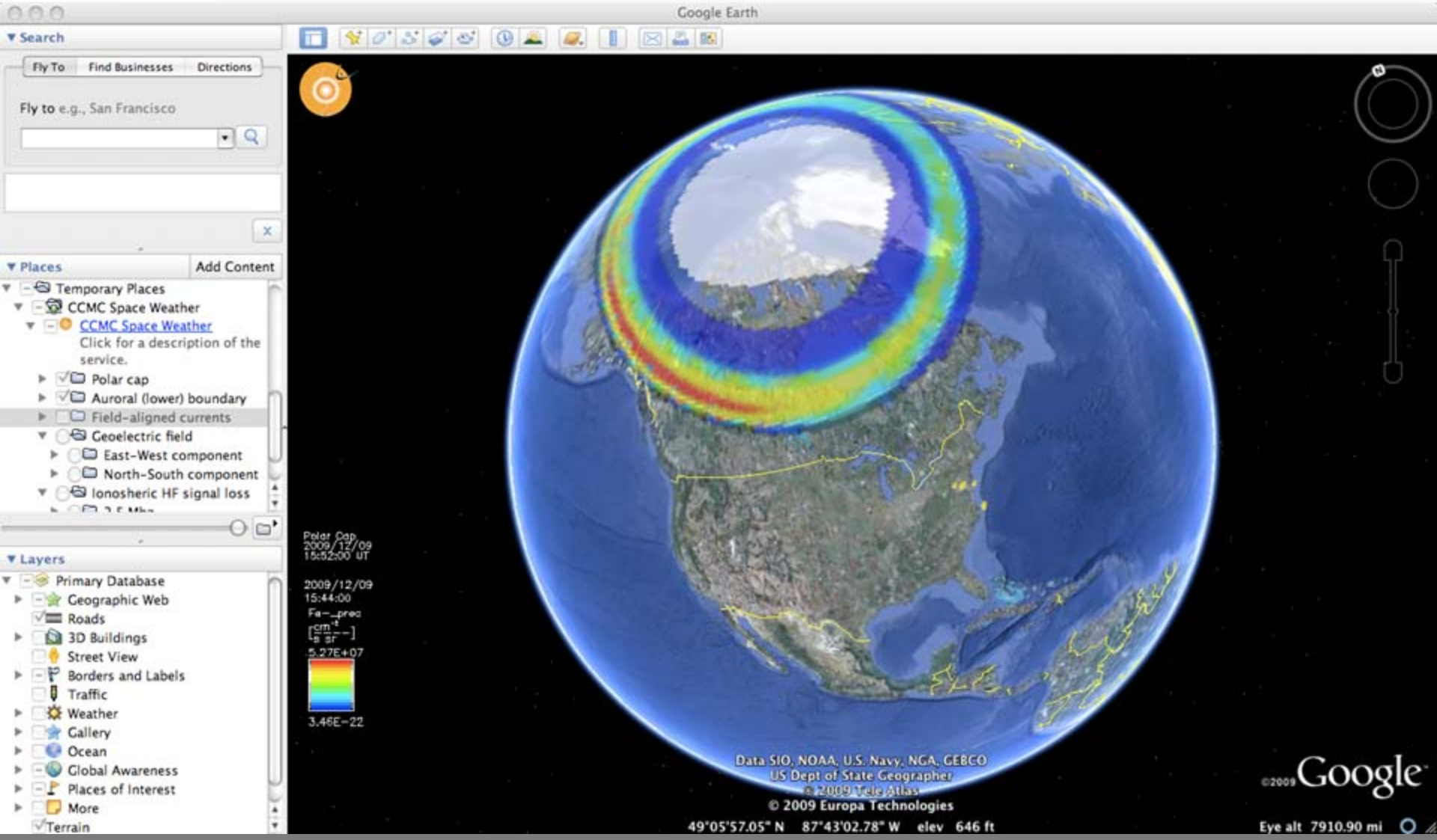
Innovative dissemination: iSWA



iswa.gsfc.nasa.gov

M. Maddox, D. Berrios, R. Mullinix, P. Jain

Innovative dissemination: Google Earth



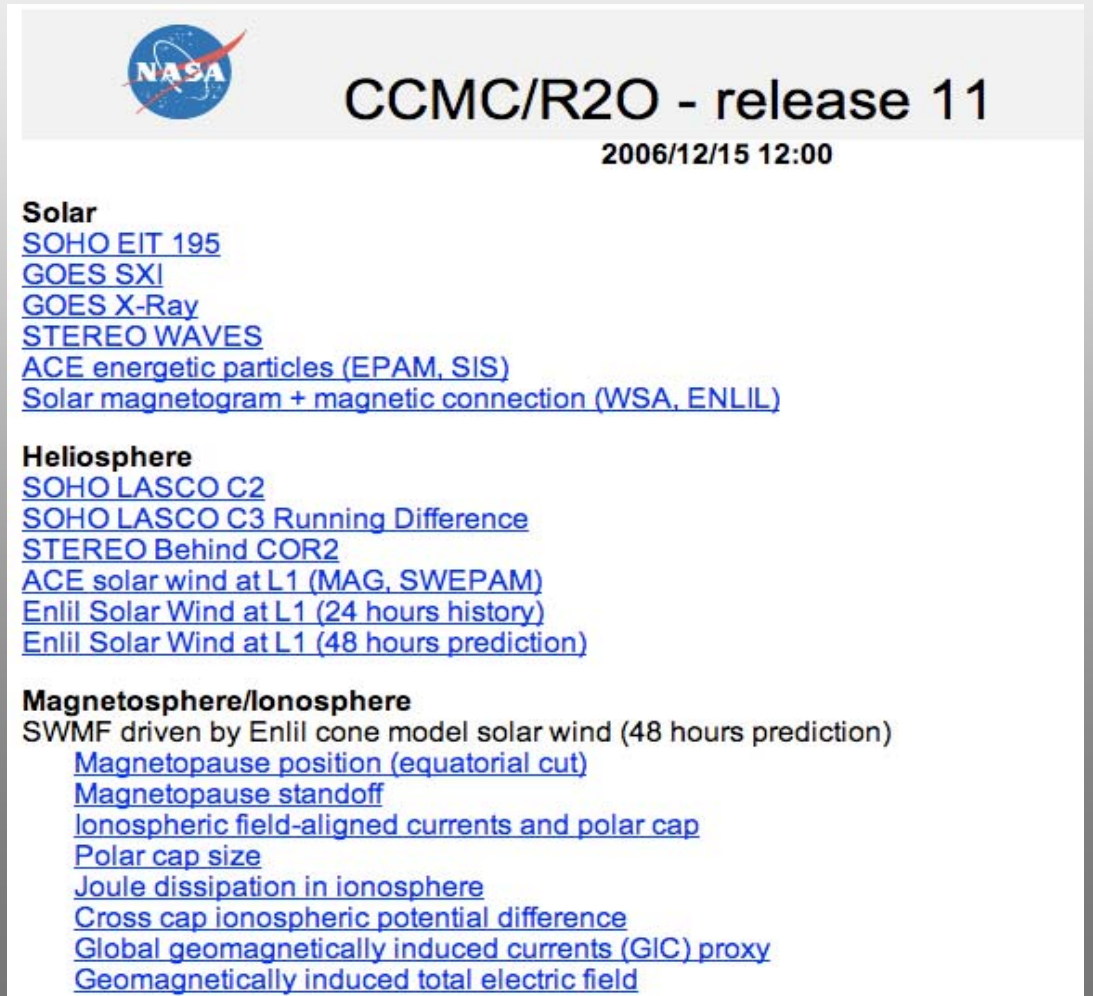
A. Pulkkinen, L. Rastaetter

R2O workshop (October 2007)

Tool for Space Weather Architecture Planning

- http://ccmc.gsfc.nasa.gov/R2O

- Expose models to operators
- Identify forecast products
- Identify optimal display
- Forum for feedback
- Future workshop tailored to AFWA needs



CCMC/R2O - release 11

2006/12/15 12:00

Solar
SOHO EIT 195
GOES SXI
GOES X-Ray
STEREO WAVES
ACE energetic particles (EPAM, SIS)
Solar magnetogram + magnetic connection (WSA, ENLIL)

Heliosphere
SOHO LASCO C2
SOHO LASCO C3 Running Difference
STEREO Behind COR2
ACE solar wind at L1 (MAG, SWEPAM)
Enlil Solar Wind at L1 (24 hours history)
Enlil Solar Wind at L1 (48 hours prediction)

Magnetosphere/Ionosphere
SWMF driven by Enlil cone model solar wind (48 hours prediction)
- Magnetopause position (equatorial cut)
- Magnetopause standoff
- Ionospheric field-aligned currents and polar cap
- Polar cap size
- Joule dissipation in ionosphere
- Cross cap ionospheric potential difference
- Global geomagnetically induced currents (GIC) proxy
- Geomagnetically induced total electric field

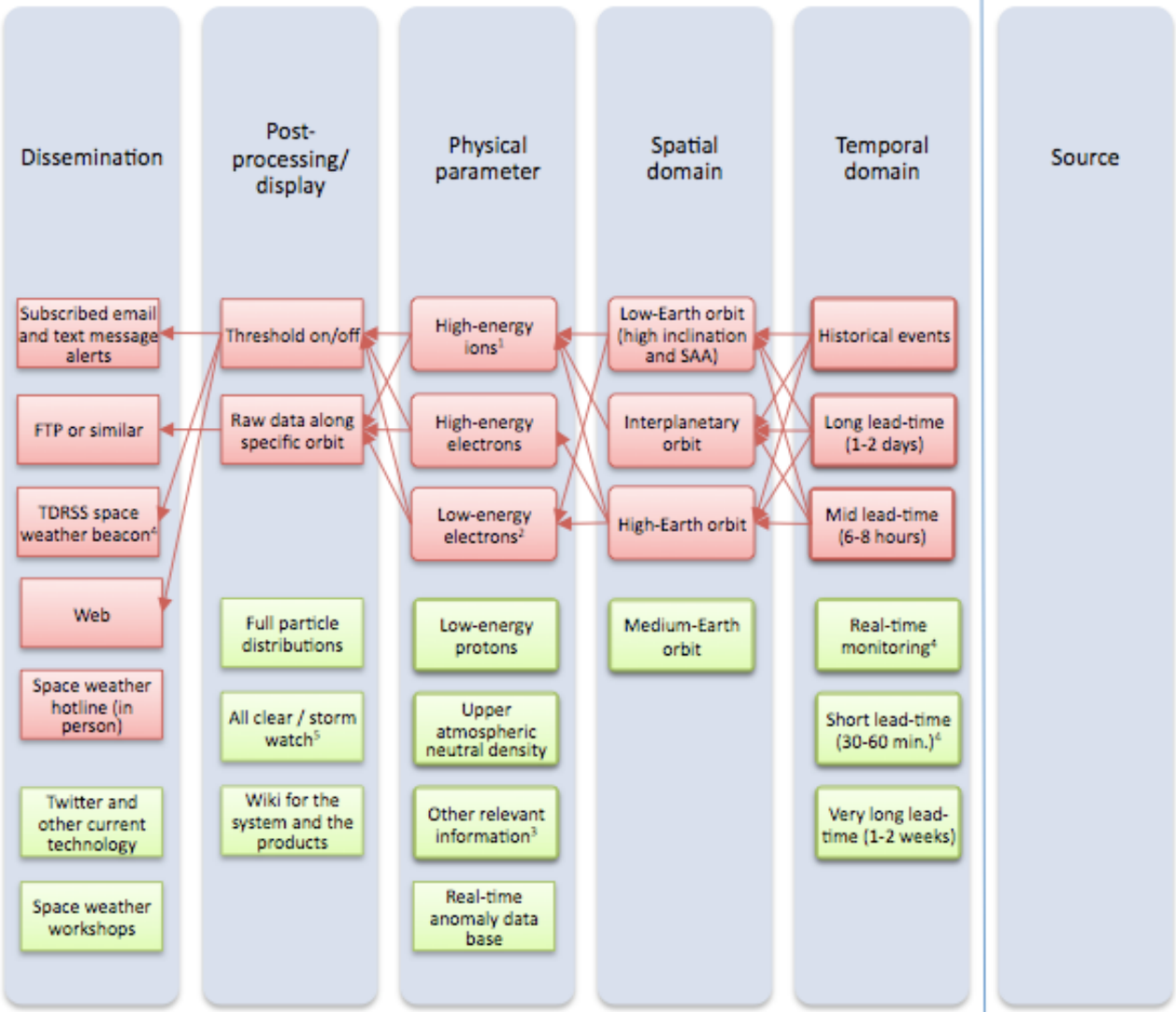
NASA mission ops workshop 9/09

Approximately 30 individuals from NASA mission operations in person or through audio-visual remote access.

Higher priority

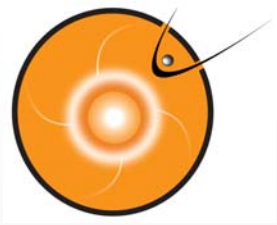
Lower priority

Space Science Mission Requirements



[1]Including characterization of galactic cosmic rays and solar protons.
[2]Including auroral electron fluxes.
[3]Polar cap size, magnetic cutoff rigidity, Kp, Ap and Dst indices, f10.7 flux, location relative to different magsph. regions.
[4]Provided that, for example, TDRSS space weather beacon can provide the information to spacecraft.
[5]Including information about the start time, intensity and the end time of the event.

US Air Force Weather Agency partnering

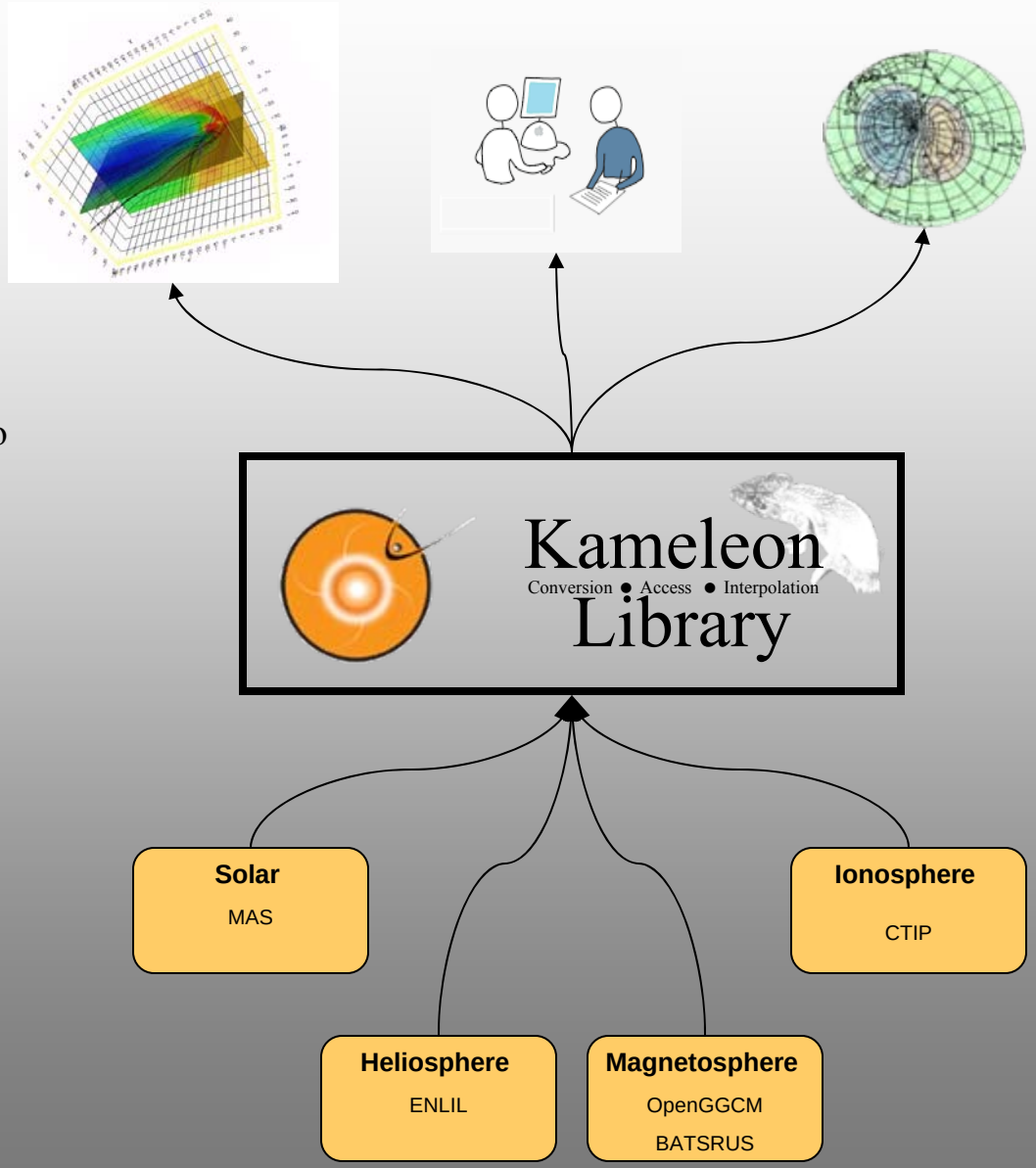


Simulation data standardization

Kameleon Software Suite

- Converts and stores disparate data sets into self-descriptive standardized files
- Comprehensive metada model applied to each file
- Library provides direct data access to converted space weather data
- Interpolation, metadata extraction, & derived variable calculations available
- Library callable from any C-supported programming language or application
- Promotes data reuse & code reuse

- Various library improvements
- Available to all interested users



M. Maddox, D. Berrios

Education

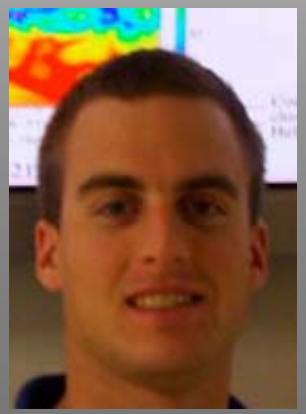
Students

- Jonathan Conti-Vock

- Thea Falkenberg

- Patrick Zhou

- Derek Andeweg



Students

- Brian Elliott

- Jeff Garneau

Other roles in education

- K-12 and college:
  - Introduction to magnetosphere (George Siscoe), now web accessible, demo later
  - Support college classes (e.g., UCLA/Ray Walker)
  - Supported space weather classes at George Mason and U. Colorado
  - Presentations at local Elementary and Middle Schools
  - Presentation at 2008 and 2009 CISM workshops
  - Not all university uses are known!
  - Supported LWS student workshop
  - Working with George Mason U. grad. student
  - Created “science on the sphere” display at GSFC’s visitor Center

….

Challenges

- Manage the RoR load
- Manage the data load, incl. archiving
- RT run maintenance
- Manage IT security needs and requirements
- Small staff - large workload

Future of CCMC Research Support

- Expand strong service to (international) research community
  - Supporting STEREO, THEMIS, IHY…
  - Continue to heed customer feedback
- Expand close collaborations with model owners
- Collaborate with related activities (CSEM, CISM, …)
- Make new models rapidly available to science customers
  - CCMC is designated repository for LWS/TR&T-produced models
- CCMC education support
  - AFIT graduate students
  - USAF Academy
  - NASA summer student program
  - Supporting courses at UCLA, UColorado, George Mason…
- Always looking for feedback/suggestions to develop services

Future of CCMC SWx Support

- Serves as a tool by which science progress at NASA, NSF, AFOSR, ONR feeds into Space Weather operations
- Focus on science models with operational benefits

- CCMC has unique experience in RT ops

- CCMC has trusted relation with model owners

- Partnering with AFWA, Transition support for SWPC

- CCMC models and data streams supporting NASA Robotic Mission ops right now
  - Model output tailored to operator needs -> ISWA project
  - Quasi-operational model results/forecasts already existing

- Much more is possible – suggestions and help are invited!

Thank you!!

- Our Sponsors: NASA and NSF

- The model owners

- Our users

- The CCMC staff