CCMC Role in GEM GGCM Metrics and Validation Activities

Stanislav Sazykin

2010 CCMC Workshop, Key Largo

Outline

- GEM Geospace Global Circulation Modeling (GGCM)
- Metrics and Validation within GEM GGCM
- Current GEM Metrics Challenge and CCMC
- Future activities

Geospace Environment Modeling

- Geospace Environment Modeling (GEM) is a broad-based, community-initiated research program on the physics of the Earth's magnetosphere and the coupling of the magnetosphere to the atmosphere and to the solar wind. The purpose of the GEM program is to support basic research into the dynamical and structural properties of geospace, leading to the construction of a global Geospace General Circulation Model (GGCM) with predictive capability. This GGCM model will be modularized and will complement parallel developments of magnetohydrodynamic models. The strategy for achieving GEM goals is to undertake a series of campaigns and focus groups, in both theory and observational modes, each focusing on particular aspects of the geospace environment.

- The GEM program is sponsored by National Science Foundation (NSF) Division of Atmospheric and Geospace Sciences

- http://aten.igpp.ucla.edu/gemwiki/index.php/Main_Page

GEM Structure

GEM is organized into 5 research areas

Dayside magnetosphere

- Berchem, Jean (2009 - 2012)
- Trattner, Karl-Heinz (2009 - 2015)

Inner magnetosphere and storms

- Friedel, Reiner (2006 - 2012)
- Chan, Anthony (2009 - 2015)

Tail, including plasma sheet and substorms

- Henderson, Mike (2006 - 2012)
- Kepko, Larry (2009 - 2015)

Magnetosphere - ionosphere coupling, aurora

- Murr, David (2006 - 2012)
- Lysak, Bob (2009 - 2015)

GGCM

- Sazykin, Stan (2006 - 2012)
- Merkin, Slava (2009 - 2015)

GEM Focus Groups

Real work is done in Focus Groups that fall under one of the research areas:

- GGCM Metrics and Validation (2005 - 2010, M. Kusnetzova & A. Ridley, RA: GGCM)
- GGCM Modules and Methods (2005 - 2010, J. Dorelli, M. Shay, B. Sullivan, RA: GGCM)
- Foreshock, bowshock, magnetosheath (2004 - 2009, N. Omidi, RA: Dayside)
- Plasma Entry and Transport into and within the Magnetotail (2006-2011, S. Wing, J. Johnson, and A. Otto, RA: Tail)
- Component versus Anti-parallel Reconnection (2004 - 2009, J. Berchem, RA: Dayside)
- Cusp Physics (2006 - 2010, K-H. Trattner, RA: Dayside)
- MIC Electrodynamics (2003 - 2008, J. Semeter & B. Lotko, RA: MIC)
- Near Earth Magnetosphere: plasma, fields, and coupling (2007 - 2012, S. Zaharia, S. Sazykin, B. Lavraud, RA: IMS, Tail)
- Space Radiation Climatology (2006 - 2011, P. O'Brien and G. Reeves, RA: IMS)
- Diffuse Auroral Precipitation (2006 - 2011, R. Thorne and J. Borovsky, RA: MIC, IMS)
- Plasmasphere-Magnetosphere Interactions (2008 - 2013, J. Goldstein and J. Borovsky, RA:IMS)
- Substorm Expansion Onset (2008 - 2013, V. Angelopoulos, S. Ohtani, K. Shiokawa, RA:Tail)
- Modes of Solar WInd-Magnetosphere Energy Transfer (2008 - 2013, B. McPherron, L. Kepko, RA:Tail)

Focus Group on Metrics and Validation

- Convened by M. Kuznetsova and A. Ridley
- Most significant recent activity was to set up a modeling "challenge" in 2008.
- The goal of this challenge was to evaluate the current state of the space physics modeling capability and to address the differences between various modeling approaches.
- CCMC volunteered to host the challenge, keeping track of both the data and model results.

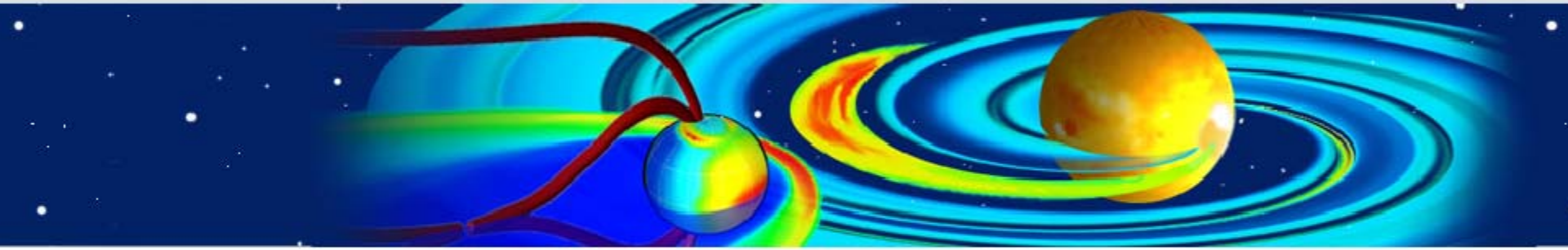
GGCM Modeling Challenge

- Started in summer 2008 by M&V Focus Group
  - inner magnetospheric dynamics
  - ground-based perturbations
- Reported first results at summer 2009 Workshop
- CCMC provided place to run models, archive results
- CCMC developed tools for analysis (Metrics Tools Suite)
- Modelers were allowed to enter more than one model result, so they can show what can be done in near-real-time and in a more science-grade production.
- It was not required to participate in all aspects of the comparisons.

GEM Modeling Challenge

- **Event 1:** Oct 29, 2003 06:00 UT - Oct 30, 06:00 UT
  Event 2: Dec 14, 2006 12:00 UT - Dec 16, 00:00 UT
  Event 3: Aug 31, 2001 00:00 UT - Sep 01, 00:00 UT
  Event 4: Aug 31, 2005 10:00 UT - Sep 01, 12:00 UT
- **Metric Study 1:** Magnetic field at geosynchronous orbit (GOES)
  Metric Study 2: Magnetopause crossings by geosynchronous satellite (GOES and LANL)
  Metric Study 3: Plasma density/temperature at geosynchronous orbit (LANL)
  Metric Study 4: Ground magnetic field perturbations (ground based magnetometers)
  Metric Study 5: Dst index (*added at the GEM 2009 summer workshop*)

COMMUNITY COORDINATED MODELING CENTER



CCMC Mission Statement

The CCMC is a multi-agency partnership to enable, support and perform the research and development for next-generation space science and space weather models.

GEM Modeling Challenge

CCMC is supporting GEM 2008/2009 Modeling Challenge organized by the GGCM Metrics and Validation Focus Group. **Note that the new DST index metric study has been added to the challenge!** Challenge results were discussed at the pre-AGU GEM Mini-workshop held on December 13, 2009.

Find out more

Model Additions/Updates at the CCMC

CCMC Services

- We provide, to the scientific community, access to modern space research models
- We test and evaluate models
- We support Space Weather forecasters
- We support space science education

Latest Additions to the CCMC Services

- **Integrated Space Weather Analysis System** is a web-based dissemination system for NASA-relevant space weather information.
- **Space Weather Awareness at NASA** space weather information portal.
- **LWS Supported Tools and Methods**
- **Kameleon software**: model output from different models

CCMC Metrics Tools

- Web interface to submit simulation results
- Online time series plotting tool
- Database of model settings
- Customizable table of archived results for metrics study

-Special issue of JASTP with papers based on results learned in the challenge.

Future of Metrics and Validation FC

- Previous several years, focus group on metrics and validation has been very successful.
- In December 2009, GEM steering committee decided to renew this focus group.
- It is expected that within this focus group, CCMC will facilitate different modeling "challenges".
- Other focus groups will bring their challenges to this group (Inner Magnetosphere focus group is in the process of setting up a challenge for Dst index). CCMC-developed tools and hosting capabilities will be of great value.

GGCM Baseline Model Comparison and Model Capabilities

- Evaluate current state of GGCM models
- To track model improvements over time, especially as researchers couple various models together, and improve various aspects of their models (such as numerical techniques, grid resolutions, etc.)
- Regular (annual) journal paper documenting model results over time for the same simulation(s).

Conclusions

- CCMC has provided valuable contribution to GEM Focus group on Metrics and Validation.
- 2008 GEM Challenge
  - CCMC provided means to submit and organize results
  - CCMC developed tools for displaying metrics results
  - Science improvements should result for models already on CCMC
  - Results are collected for models not at CCMC
- "Place" for challenges organized by other focus groups in GEM.
  - Archival services for simulation runs
  - Analysis tools
  - Interaction between CCMC and GEM participants regarding metrics
- Periodic publication to record state of models at CCMC relevant to GEM.