

GGCM Metrics and Validation Focus Group, GGCM Research area

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Topics:

- GGCM Modeling Challenge
- GGCM baseline model comparison

The GEM community has recognized that due to the maturity and the increasing complexity of the state-of-the-art global space weather models, there is a great need for a systematic and quantitative evaluation of different GGCM modeling approaches. In summer 2008 the GGCM Metrics and Validation Focus Group initiated the GGCM modeling Challenge on the inner magnetospheric dynamics and ground magnetic field perturbations. The first results of the Challenge were reported at the GEM 2009 Summer Workshop. The reports are available at the CCMC website and at the GEM wiki. The draft for the paper based on the first Challenge results on ground magnetic field perturbation (with all Challenge participants as co-authors) is prepared for the submission to the Space Weather journal. The paper will be submitted after the final discussion at the GEM mini Workshop in December 2009.

We propose to continue and extend GGCM Modeling Challenge on the inner magnetospheric dynamics and ground magnetic field perturbations. We also initiated joint Challenge with Inner Magnetosphere Focus group on Dst index comparison. We plan to repeat metrics study exercise on yearly basis.

Community Coordinated Modeling Center (CCMC) will continue to support the Challenge. To support the Challenge the CCMC developed a Metrics Tools Suite. The web-accessible CCMC Metrics Tools include interactive simulation results submission interface, on-line time series plotting tool, database of model settings, and configurable table of archived metrics results. The availability of these tools will allow further extension of GGCM metrics and validation activities.

The goals of the Challenge:

- to evaluate the current state of GGCM models
- to track model improvements over time, especially as researchers couple various models together.
- to address differences between various modeling approaches, numerical techniques, grid resolutions, etc.

- to facilitated further GGCM model improvement
- to facilitate interaction between research and operation communities in developing metrics for space weather model evaluations.

Events and physical parameters for the Modeling Challenge were selected at the GEM 2008 Workshop and extended at the GEM 2009 Workshop.

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 GEM 2009 summer workshop).

GGCM Metrics and Validation Focus Group received an invitation to arrange a Special Issue at J. Atmospheric & Solar-Terrestrial Physics on Geospace Models Metrics and Validation. The Special issue will include an introductory paper, 3-4 reports summarizing Challenge results, and series of science papers with physics-based analysis. Expected primary focus of science papers are physical parameters addressed by Challenge metric studies. Events selected for metrics Challenge are preferable but not required. Simulation results/visualization tools available at CCMC can be used for research analysis. We plan to agree on the Special Issue content at the GEM 2010 Summer Workshop.

During 2009, significant progress was achieved for Metrics studies 1 & 4 (magnetic field at geosynchronous orbit and ground based stations). These metrics studies were selected as our primary focus because they were identified of the most interest to the operation community. We plan to repeat these metrics studies on a yearly basis and continue dialog with the operations community to refine the metrics format. During the next few years, we are planning to dedicate more efforts to other metrics studies (2, 3 and 5) to evaluate current modeling capabilities of plasma parameters in inner magnetosphere, Dst index, and the magnetopause position. For the plasma parameters and magnetopause position challenge, we are ensured to receive a support from the LANL plasma instrument scientists (both MPI and SOPA). We already received magnetopause crossing timelines for magnetopause position study. We are expecting to received plasma pressure timelines before the GEM Summer 2010 Workshop.

To analyze the effects geospace environment on the ionosphere we are planning

to involve CEDAR Community to the Modeling Challenge. This activity is especially relevant due to upcoming joint GEM-CEDAR Workshop in 2011. Preliminary discussion with ionosphere modelers at CEDAR was held at the CEDAR 2009 Workshop. GEM Metrics and Validation Focus group Co-Chairs were involved in the organizing of the CEDAR Electrodynamics-Thermosphere-Ionosphere Challenge

([http://cedarweb.hao.ucar.edu/wiki/index.php/Community:CEDAR ETI Challenge](http://cedarweb.hao.ucar.edu/wiki/index.php/Community:CEDAR_ETI_Challenge)). CEDAR modelers will include GEM challenge storm events for the series of planned comparative studies. On the other hand our focus group is planning to add time interval to overlap with CEDAR climatology project. Further, many of the magnetospheric models are coupled to ionosphere-thermosphere models, therefore, the metrics can be conducted for both coupled and uncoupled simulations on both models.

An aspect of validating models is to determine how well they solve the equation set that they are supposed to be solving. This type of validation has to do with checking the numerics of the codes. The method in which this validation will be conducted is to have researchers run different MHD codes for various solar wind and IMF conditions and compare the results. For this, we have requested that modelers run a time period in which the solar wind stays constant at 5 cc and -400 km/s, while the IMF Bz drops every few hours from -5, -10, -20, -30, -35, to -40 nT. The ionospheric conductance was held constant at 5 mhos.

Initial simulation results were presented at GEM 2009. It was shown that many of the models had significant differences. It was decided upon that the subsolar magnetopause location, the cusp location, and the current structures at the magnetopause will be investigated under the different IMF conditions. Further investigations will include (1) examining the reconnection rate in the different codes to determine how each handles reconnection for the different IMF orientations; (2) examining the tail length, the amount of open flux in the polar caps and the plasma sheet density during the different intervals; (3) the cross polar cap potential; and (4) the Dst as a function of time. With these types of comparisons, the GGCM Metrics and Validation Focus Group can collaborate with other focus groups within the GEM community. It is expected that this aspect of the FG will arrange a special issue of a journal to capture the results of these comparisons.