

Modeling Methods and Validation

Topic

A core effort of the GEM community is to promote the use and improvement of an array of magnetospheric models. The models being used span the magnetosphere, including the inner magnetosphere (radiation belts and ring current) and magnetosphere-ionosphere coupled systems, requiring a variety of modeling techniques. We propose a Modeling Methods and Validation Focus Group, which will contribute to a comprehensive and global understanding of the validity and appropriate use of these models. Our aim for this group is to direct discussion toward the science behind the modeling methods and what we can gain scientifically from model/data comparisons. The purpose of this is to inform those who make use of the model results - the operational community as well as our fellow scientists - and to provide directions for future model improvements.

Timeliness

This year, the Metrics and Validation Focus Group comes to a close, allowing us to refocus on current needs. NOAA, the CCMC, and the scientific community have an ongoing need to know how the models are performing. To continue improving the models and their usefulness to the community requires us to understand how well each model captures the relevant magnetospheric areas and phenomena. This Focus Group will continue the validation work that is critical to the GEM mission, with a focus on leveraging the many excellent data sets (e.g. RBSP, MMS, ground-based auroral observations) as well as the robust modeling capabilities of our community to understand in a physics-based way how the numerics and methods of our models affect the model predictions.

Fit

This Focus Group complements existing Focus Groups through developing and testing additional tools and providing a global numerical focus on questions that are relevant to each of the existing groups. We plan to collaborate closely with the existing and future Focus Groups on their challenges, as well as engaging specific Focus Groups on the expected activities described below.

Goals & Deliverables

This Focus Group has two major goals:

1. Helping other Focus Groups with their challenges and providing a global link between those challenges

The deliverables are data sets and challenges initiated by existing Focus Groups or that tie together multiple Focus Groups. We will work with the leaders of these other FGs to ensure fair and objective implementation of challenges, maximize participation of modeling groups and conduct independent simulations at the CCMC, and enable the use of best-practice metrics and model-model or data-model comparison techniques. As needed, we will assist in disseminating results and manuscript preparation following each successful challenge.

2. Implementing efforts of our own for global model understanding and validation

In addition to enabling the other Focus Groups to smoothly conduct their challenges, we will take a lead role in identifying and addressing issues of greatest concern to the community regarding numerical model understanding and advancement. We will carry out both climatological and event challenges, using all data sets deemed relevant to assessing model performance and advancing scientific understanding.

In particular, we will focus on the following key topics of immediate need in global and regional modeling:

- Plasma validation - making use of MMS, RBSP, and THEMIS plasma data for increasing model reliability and our understanding of the physical processes leading to certain types of plasma structures and velocity space distributions
- Magnetopause validation - for both reconnection physics and magnetopause shadowing in energetic particle transport
- Ionospheric conductance - carrying out validation of precipitation and conductance models and assessing global effects

Here, the deliverables include tools for cross-model comparison and analysis, and a collection of papers on the intersection between physics and numerical methods.

Note that our goal is not only to enable the community assessment of magnetospheric models and provide benchmark quantification of how certain models perform for specific geophysical situations, but also to address compelling science questions through large-scale, multi-code numerical investigations. Rather than simply identifying “which code is best,” we plan to explore the physical processes responsible for the evolution of the geospace system and how numerical implementation of equation sets influences the model results.

Co-chairs

Katherine Garcia-Sage (Catholic U, GSFC): katherine.garcia-sage@nasa.gov

expertise - Global MHD and ionospheric outflow modeling, Magnetospheric composition

Mike Liemohn (U of Michigan): liemohn@umich.edu

expertise - Global MHD and inner magnetosphere coupling and dynamics

Lutz Rastaetter (GSFC/CCMC): lutz.rastaetter-1@nasa.gov

expertise - Global MHD modeling, Visualization and analysis of MHD, drift-kinetic, multi-fluid, and Particle-in Cell models of the magnetosphere-ionosphere system

Rob Redmon (NOAA): rob.redmon@noaa.gov

expertise - Magnetosphere/ionosphere coupling and dynamics; Space particles and fields instrument and model development, integration and performance; Operational environments.

Research Area

Global System Modeling

Term

5 years

Expected activities

We intend to focus workshop-type discussions around the physical insights to be gained from examining diverse models through both climatological and event studies. We will organize and lead a series of modelling challenges with direct participation from relevant modeling groups.

Key activities will include:

- **Global and inner magnetosphere plasma validation**, performed independently and in conjunction with the several Focus Groups that touch on this topic.
- **Magnetopause validation**, performed in close collaboration with existing Focus Groups, specifically the Quantitative Assessment of Radiation Belt Modeling and the Magnetic Reconnection in the Magnetosphere groups.
- **Ionospheric conductance model challenges**, providing an area for collaboration with CEDAR starting with the joint workshop in the summer of 2016.
- **ULF wave challenge**, performed in collaboration with the proposed ULF wave group.