2025 Workshop: Whole Geospace Modeling and Validation

Long title
Modeling of whole Geospace Coupling and Validation
CEDAR-GEM
Conveners
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Description

The geospace system, which includes the mesosphere, thermosphere, ionosphere and magnetosphere, is a strongly coupled, nonlinear dynamic system. To understand the structure and variability of this system and its response to external driving conditions, the chain of physical processes from solar wind-magnetosphere interaction, magnetosphere ionosphere and thermosphere coupling to lower atmosphere wave precondition of the thermosphere and ionosphere response to storms has to be simulated not only with first principles models of each sub system of the geospace, but also the coupling among these sub systems with fully coupled whole geospace models. The model simulations are also needed to be validated with observations to ensure the fidelity of the coupled model for both research and space weather applications. The recent advances in coupled models of the whole geospace system and its component sub system, as well as new ground and space observations, enables the community to gain new insights into the cross-scale, internal dynamics of the system, as well as the response of the geospace, as a whole system, to varying external driving conditions. This workshop invites modeling, model-data comparison, and data analysis presentations that include but not limited to: 1) quantifying energy and momentum inputs into, flows through and impacts on the geospace due to disturbed solar irradiance and solar wind conditions, and forcing from lower atmospheric waves including gravity waves, tides and planetary waves; 2) investigating regional and global mesoscale and large-scale processes generated under such conditions and the cross-scale coupling between

these processes, and 3) comparing model and data, revealing model-data discrepancy, and guiding model improvement.

Agenda

June 27, Friday Morning, 10am-12pm, Ballroom B

Zoom link https://ucar-edu.zoom.us/j/91434028198?pwd=Uzskja2LPuWbaitIlqhajtJpMqddCz.1

Agenda

1) Eric Becker (10:00-10:08): New developments of the HIAMCM regarding major constituents

2) Snively, Jonathan (10:08-10:16): Scalable and Adaptive Coupling for GEMINI and MAGIC Environments in FIGMENTS

3) Xuguang Cai (10:16-10:24): Investigation of NmF2 Mean field and Variability Responses to Minor Geomagnetic forcing during a 30-day quiet period in solar minimum

4) Jordi Vila-Pérez (10:24-10:32): The role of whole geospace modeling in the ionosphere-thermosphere system: insights from TIEGCM within MAGE

5) Xian Lu (10:32-10:40): Validation of TIEGCM simulation forced by realistic ICON tides with various I-T Observations: agreements and disagreements

6) Anthony Sciola (10:40-10:48): Red aurora

7) Joel Tibbetts (10:48-10:56) Simulating Energetic Neutral Atom Imaging with MAGE

8) Adam Michael (10:56-11:04): Multiscale Modeling of Storm-time Energetic Electron Precipitation

9) Kevin Pham (11:04-11:12): Identifying cusp in MAGE

10) Anusree Devanandan (11:12-11:20): Storm-Time Statistical Analysis of Bursty Bulk Flows

11) Savvas Raptis (11:20-11:28): Evaluating plasma sheet properties with *in-situ* observations and machine learning – Recent advancements and limitations

12) Xiaojia Zhang (11:28-11:36): Developing a New Particle Precipitation Model Using Combined DMSP and ELFIN Observations

13) Qian Wu (11:36-11:44): Recent HIWIND results from New Zealand Flight

14) Aaron Bukowski (11:44-11:52): Validating Ionospheric Electrodynamics with GITM

Justification

The whole geospace system (mesosphere, thermosphere ionosphere and magnetosphere) is an open, nonlinear, dynamic and strongly coupled system that is greatly influenced by external solar radiation, solar wind and lower atmospheric weather conditions. For instance, at high latitudes, Joule heating, particle precipitation, and ion drag - each varying across different temporal and spatial scales - are imposed on the thermosphere-ionosphere system by solar wind-magnetosphere interaction and internal magnetospheric dynamics. These processes not only alter local neutral and plasma density, temperature, and velocity but also generate local mesoscale and large-scale structures that propagate globally, redistributing energy and momentum across regions and causing global perturbations to the I-T system. Waves from the lower atmosphere also deposit energy and momentum in the I-T modifying its global circulation, composition and dynamo electric fields and thereby its local and global structures. Furthermore, transient solar events of flares and eclipse also affect photochemical processes of the I-T system and feedback to the magnetosphere affecting its dynamics. To understand the effects of external forcings from above and below and their coupling with internal processes requires both first principles models of the coupled geospace system that can accurately represent the dynamic variability of multi-scales and data to validate models and guide model development. This is critical to understanding the fundamental physics within the geospace system and better predicting the space weather events that affect human space activity.

Related to CEDAR Science Thrusts:
Encourage and undertake a systems perspective of geospace

Explore exchange processes at boundaries and transitions in geospace
Explore processes related to geospace evolution
Fuse the knowledge base across disciplines in the geosciences
Manage, mine, and manipulate geoscience/geospace data and models
Workshop format
Short Presentations
Keywords
Geospace system dynamics, space weather, whole geospace modeling, cross-scale coupling
Focus Group and Group Leader

MPEC:
Dong Lin
Dogacan Su Ozturk

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