2026 Workshop: Ionosphere-Thermosphere Regulation of Magnetosphere

Long title
Storm-Time Polar Upward Coupling: How Does the Ionosphere-Thermosphere System Regulate Magnetosphere
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Description

Understanding how the polar ionosphere-thermosphere (I-T) system regulates magnetospheric dynamics remains a central challenge in CEDAR science. While magnetospheric forcing drives high-latitude convection, field-aligned currents (FACs), and particle precipitation, the coupled I-T system actively reshapes current closure, energy partitioning, and plasma redistribution through conductivity modulation, wind-driven dynamo effects, and ions upflow and outflow. Storm-time Joule heating and precipitation alter neutral winds, composition, and temperature, which in turn modify electrodynamic coupling and hemispheric asymmetries in the global current system. Polar wind upwelling and plasma escape further contribute to magnetospheric mass loading, influencing plasma sheet composition and storm-time evolution.

Despite substantial progress using AMPERE, SuperDARN, DMSP, GNSS observations, and coupled modeling frameworks such as MAGE and SWMF, significant uncertainties remain in quantifying these upward feedback processes. In particular, the roles of wind-driven dynamo effects in current closure, plasma redistribution in regulating particle precipitation and outflow, and interhemispheric asymmetries in storm-time dynamics remain incompletely constrained. Recent advances in global data reconstruction, data assimilation, and fully coupled simulations now enable system-level evaluation of I-T feedback to the magnetosphere. This workshop will bring together observational, modeling, and theoretical efforts to identify the dominant feedback mechanisms and establish quantitative diagnostics necessary to improve predictive understanding of storm-time polar electrodynamics.

Justification

Our overarching goal is to quantify how the polar ionosphere-thermosphere system regulates magnetospheric dynamics during geomagnetic storms. Specifically, we propose to address the following questions:
(1) How do storm-time wind-driven dynamo effects and conductivity redistribution reshape polar current closure and modify magnetospheric electric fields and energy partitioning?
(2) How do storm-time plasma redistribution processes-including ion upwelling, outflow, and how these changes modify magnetospheric mass loading and dynamics?
(3) What controls interhemispheric asymmetries in storm-time electrodynamics, and how do differences in neutral winds, conductivity, and IMF orientation alter global geospace response?

This session will begin with invited scene-setting talks that explicitly highlight unresolved issues and emerging challenges. Then transition to short, contributed talks and extended open discussion, aimed at refining science questions, identifying methodological gaps, and building new collaborations. To encourage cross-community interaction, the discussion will be organized around thematic topics that intentionally pair data providers and modelers, fostering direct dialogue between observational and simulation perspectives.

This study will leverage extensive observational datasets, including ground-based networks such as SuperMAG, SuperDARN and GNSS, as well as satellite measurements like AMPERE, DMSP and Swarm. In parallel, numerical modeling frameworks-particularly MAGE-TIEGCM and SWMF-GITM will play a central role in the investigation. Additionally, machine learning and data-assimilation techniques will be integrated to synthesize information and support coordinated research campaigns.

Related to CEDAR Science Thrusts:
Encourage and undertake a systems perspective of geospace
Explore exchange processes at boundaries and transitions in geospace
Develop observational and instrumentation strategies for geospace system studies
Manage, mine, and manipulate geoscience/geospace data and models
Workshop format

Short Presentations

Round Table Discussion

Keywords

Polar ionospheric electrodynamics, magnetosphere-ionosphere coupling, storm-time geospace response, interhemispheric asymmetry

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