2025 Workshop: New Perspectives on Whole-Atmosphere Coupling and MIT System Impacts

Long title

Whole-Atmosphere Coupling and Its Impact on the Magnetosphere-Ionosphere-Thermosphere System: New Perspectives from Observations and Modeling

CEDAR-GEM

Conveners

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Description

Coupling across atmospheric layers is a fundamental driver of variability in the Magnetosphere-Ionosphere-Thermosphere (MIT) system, shaping both space weather and long-term upper atmospheric trends. Sudden Stratospheric Warmings are well-established drivers of upper atmospheric variability, but growing evidence shows that other episodic disturbances—including volcanic eruptions and tropospheric convection—can also generate large-scale effects, influencing plasma outflows, neutral-plasma interactions, and storm-time responses. More broadly, lower atmospheric variability—including tides, gravity waves, planetary waves, Kelvin waves, and other disturbances—can modulate plasma transport, ionospheric structuring, and even magnetospheric electrodynamics. This session welcomes observational, theoretical, and modeling studies that investigate MIT coupling across spatial and temporal scales, with emphasis on new insights from multi-instrument satellite missions (e.g., ICON, GOLD, COSMIC-2, MMS, THEMIS, Van Allen Probes), ground-based networks, and state-of-the-art models (e.g., WACCM-X, MAGE, TIEGCM, SAMI3). Contributions addressing the roles of energy transfer mechanisms, electrodynamic feedbacks, and interhemispheric asymmetries are particularly encouraged.

Justification

The 2024 Decadal Survey for Solar and Space Physics underscores the need to improve our understanding of how lower atmospheric processes shape ionospheric and magnetospheric variability, particularly in the context of space weather prediction. While previous studies have quantified the effects of tides and planetary waves, emerging research indicates that transient events—including volcanic eruptions, deep convective systems, and rapid neutral density variations—can significantly impact MIT dynamics, modifying plasma instabilities, Traveling Ionospheric Disturbances (TIDs), and high-latitude currents. The resulting electrodynamics signatures can map into the magnetosphere, influencing dynamics both there and at the conjugate magnetic foot point, playing an important role in interhemispheric coupling. However, observational limitations and persistent challenges in modeling cross-scale interactions continue to hinder progress. In particular, standard ionosphere-thermosphere (IT) and ionosphere-magnetosphere (IM) models often struggle to capture the accurate baseline state of the system. For example, prolonged periods of northward IMF can lead to ionospheric erosion, a feature that is frequently missing from initial conditions in simulations. Such omissions directly impact how energy transport and variability originating from the lower atmosphere are interpreted, particularly when examining how these processes drive variability across the coupled MIT system. This session aims to foster collaboration between the CEDAR and GEM communities, bringing together observational and modeling efforts to integrate multi-point datasets with high-resolution simulations. By addressing these observational and modeling gaps, the session will contribute to improved MIT variability forecasts and advance the predictive capabilities of space weather models.

Related to CEDAR Science Thrusts:
Encourage and undertake a systems perspective of geospace
Develop observational and instrumentation strategies for geospace system studies
Fuse the knowledge base across disciplines in the geosciences
Manage, mine, and manipulate geoscience/geospace data and models
Workshop format
Short Presentations
Include a virtual component?
Yes
Keywords
Magnetosphere-Ionosphere-Thermosphere Coupling, Lower Atmospheric Forcing, Cross-Scale Interactions
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