2025 Workshop: Collective impacts of Atmospheric Waves and Geomagnetic Disturbances on ITM Variability

Long title
Collective impacts of Atmospheric Waves and Geomagnetic Disturbances on Quiet-time and Storm-time Ionosphere-Thermosphere-Magnetosphere Variability
CEDAR-GEM
Conveners
Xian Lu
Jens Oberheide
Dong Lin
Scott England
Goodwin Lindsay
Shun-Rong Zhang
Dogacan Ozturk
xianl@clemson.edu
Description

Advancing space situation awareness and research towards space weather resilience requires a deep and transformative understanding of the integrated Sun-Earth system. The CEDAR and GEM communities are uniquely positioned to collaboratively study the solar and terrestrial drivers of space weather and their effects “from Sun to mud”. The Ionosphere-Thermosphere-Magnetosphere (ITM) system is highly responsive to external drivers such as varying solar irradiance, solar wind-interplanetary coupling, and to fluctuations from lower levels of the atmosphere. Solar irradiation, recurrent magnetospheric forcing, and planetary waves, tides, and gravity waves with persistent sources, contribute to geospace variability across timescales from years to minutes. Superimposed on the continuous variations are abrupt disturbances triggered by terrestrial events (e.g., thunderstorms, hurricanes, volcanoes, sudden stratospheric warmings), solar flares, and geomagnetic perturbations (e.g., particle precipitation and outflow, field-aligned currents, and heat flux). These processes can occur simultaneously, interacting in complex ways. This session invites presentations of both observational and modeling studies that analyze ITM variability across different scales and sources (solar,

magnetosphere, and lower-atmosphere waves). Contributions exploring their relative importance, ITM responses to impulsive disturbances of both space and terrestrial origin, and potential interactions are particularly welcome. The theme of this session closely aligns with the NSF/ANSWERS solicitation to support collaborative research on space weather and space physics.

Justification

Understanding the variability of the Ionosphere-Thermosphere-Magnetosphere system and its driving forces has a critical implication on low-earth orbiting (LEO) spacecraft operations, satellite industries, aviation radiation, and communications. Fundamental studies of ITM variability drivers will ultimately lead to enhanced predictability of ITM space weather. Physical processes forced from lower-atmosphere activities transport energy and momentum upward via atmospheric waves, while energy deposition via particle precipitation, field-aligned current, and heat flux, add another layer of fierce source. The confluence of energy and momentum in the ITM involves complex cross-scale and cross-boundary dynamical processes, which remains a compelling scientific question. The respective contributions from the lower-atmosphere and space to the variability of ITM have been investigated, while their collective impacts, coupling and interactions, were less explored. This joint CEDAR-GEM workshop provides a unique opportunity to transcend the CEDAR and GEM program boundaries in data analysis, observations, and modeling. It fosters interactive discussions on ITM space weather, bringing together scientists focused on lower-atmosphere forcing with experts specializing in space origins.

This workshop directly addresses two major space weather themes outlined in the new Heliophysics Decadal Survey: 1) System of Systems: Drivers of Space Weather and 2) Space Weather Responses of the Physical System. It closely aligns with the strategic thrusts of the NSF/CEDAR program: 1) Encourage and undertake a systems perspective of geospace to understand global connectivities and causal relationships; 2) Explore exchange processes at boundaries and transitions in geospace to understand the transformation and exchange; and 3) Fuse the knowledge base across disciplines in the geosciences. In addition, by involving modeling expertise, this workshop supports the goal of the GEM program to advance fundamental research towards the construction of a global geospace general circulation (GGCM) model with predictive capability.

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
Workshop format
Short Presentations
Round Table Discussion
Include a virtual component?
Yes
Keywords
Ionosphere-Thermosphere-Magnetosphere, Space Weather, Atmospheric Waves, Predictive Models
View PDF