2026 Workshop: Whole-Atmosphere Coupling and ITM Responses

Long title
Whole-Atmosphere Coupling Across the Ionosphere-Thermosphere-Magnetosphere (ITM) System in Response to Terrestrial and Space Weather Forcing
Conveners
Xian Lu
Federico Gasperini
Haonan Wu
Brenna Royersmith
xianl@clemson.edu
Description

The Ionosphere-Thermosphere-Magnetosphere (ITM) system responds dynamically to both terrestrial weather from below and space weather from above. This session explores the relative roles and interplay of atmospheric waves—such as tides, planetary waves, and gravity waves—and external drivers, including solar irradiance, solar wind, and geomagnetic activity, in shaping global ITM dynamics and variability. Particular emphasis is placed on disturbances originating from polar vortex dynamics and sudden stratospheric warming (SSW) events, volcanic eruptions, tropospheric convection, as well as geomagnetic storms and magnetospheric energy deposition events. We invite observational, theoretical, and modeling studies that investigate coupling across spatial and temporal scales, with contributions from satellite missions (e.g., ICON, GOLD, AWE, COSMIC-2, MMS), ground-based networks (e.g., SuperDARN, GNSS, ISRs, lidars, Fabry-Perot interferometers, magnetometer arrays), sophisticated models (e.g., WACCM-X, TIEGCM, GITM, SAMI3, MAGE) and advanced techniques (e.g., data assimilation, machine learning). This session encourages cross-disciplinary collaboration to improve understanding of whole-atmosphere coupling and its impact on electrodynamics, composition, thermospheric structure, and their contributions to space weather.

Justification

Understanding the variability of the Ionosphere-Thermosphere-Magnetosphere (ITM) 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 session 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 and 2) Explore exchange processes at boundaries and transitions in geospace to understand the transformation and exchange.

Related to CEDAR Science Thrusts:
Encourage and undertake a systems perspective of geospace
Explore exchange processes at boundaries and transitions in geospace
Fuse the knowledge base across disciplines in the geosciences
Workshop format
Short Presentations
Round Table Discussion
Keywords
Whole Atmosphere Coupling, Atmospheric Waves, Geomagnetic Storms, ITM Variability
View PDF