2025 Workshop: Exospheric impacts on MIT Coupling

Long title
Expansion of the Neutral Atmosphere and its Impact on Magnetosphere-Ionosphere-Thermosphere Coupling
CEDAR-GEM
Conveners
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Description

The terrestrial exosphere is the outermost layer of the Earth's atmosphere, extending from the exobase (at around 500 km altitude) to the orbit of the Moon. Neutral hydrogen atoms become the dominant species above an altitude of ~1500km. Imaging of terrestrial exosphere in Lyman-alpha, Energetic neutral atom (ENA), and X-ray have shown spatiotemporal variations in exospheric hydrogen density (NH) across different solar activity levels and during geomagnetic storms, indicating that the exosphere responds dynamically to changes in the space environment.
Upper atmospheric heating during periods of strong solar irradiance and geomagnetic storms increases the number of ballistic and escaping hydrogen atoms entering the exosphere through the exobase, thereby boosting NH initially. Higher exospheric densities increase neural-plasma charge exchange in the ring current, accelerating energy decay and altering magnetospheric energy deposition in the upper atmosphere. After some time, the higher rate of escaping hydrogen atoms depletes NH in the exosphere and upper thermosphere. Consequently, exospheric variability plays a complex role in Magnetosphere-Ionosphere-Thermosphere (MIT) coupling dynamics.
This session will discuss exospheric variability, its physical drivers, and the role of the exosphere in MIT coupling dynamics.

Agenda

[Zoom Link] https://cua.zoom.us/j/84656049502

4:00 - 4:10 **Lara Waldrop**, "Sensing Global Exospheric Structure and Dynamics with NASA's Carruthers Geocorona Observatory"
4:10 - 4:20 **Jochen Zoennchen**, "Comparison of terrestrial exospheric hydrogen 3D distributions at solar minimum and maximum using TWINS Lyman-α observations"
4:20 - 4:30 **Gonzalo Cucho-Padin**, "The role of the dynamic terrestrial exosphere in the storm-time ring current decay"
4:30 - 4:40 **Hyunju Connor**, "Terrestrial Hydrogen Exosphere Variability: MATE-TIMEGCM results"
4:40 - 4:50 **Jaewoong Jung**, "Dynamic exobase conditions and their impact on terrestrial exosphere: MATE-TIMEGCM results"
4:50 - 5:00 **Sang-Yun Lee**, "Role of terrestrial exosphere in MIT coupling: MATE-CIMI-TIMEGCM results"
5:00 - 5:10 **Sarah Luettgen**, "Hydrogen Circulation and Transport in a Coupled Thermosphere-Exosphere Model"
5:10 - 5:20 **Edwin Mierkiewicz**, "Geocoronal Balmer-alpha Line Profile Observations and Forward-Model Analysis"
5:20 - 5:30 **Susan Nossal**, "Multidecadal variation of hydrogen in the thermosphere and exosphere"
5:30 - 5:40 **Lauren Ashworth**, "Seasonal Comparisons of Geocoronal Balmer-α Observations and Forward Modeled WACCM-X and MSIS-00 Simulations"
5:40 - 5:50 **Denny Oliveira**, "Tracking Reentries of Starlink Satellites During the Rising Phase of Solar Cycle 25"

Zoom Info
Topic: [GEM/CEDAR] Exosphere - MIT Coupling
Time: Jun 26, 2025 03:30 PM Eastern Time (US and Canada)
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Justification

Understanding Magnetosphere – Ionosphere – Thermosphere (MIT) Coupling Dynamics has been a key focus of the Heliophysics community. The Sun and Earth's magnetosphere deposit energy into the Ionosphere-Thermosphere (IT) system,

which then distributes the energy across the globe and even feeds energy back to the magnetosphere, thereby modifying the global geospace environment.
Recent studies suggest that IT feedback occurs not only through plasmas but also through outgoing neutral particles. During active periods, the neutral atmosphere expands, influencing exospheric density and, through neutral-ion charge exchange, altering inner magnetospheric dynamics as well as the energy deposition from the magnetosphere to the upper atmosphere.
The terrestrial exosphere coexists with various plasma systems, including the ionosphere, polar wind, plasmasphere, inner and outer magnetosphere, magnetosheath, and regions beyond the bowshock. Neutral-ion charge exchange is a fundamental physical process that occurs ubiquitously throughout the MIT system and beyond. Therefore, interdisciplinary efforts are needed to study the role of exosphere in MIT coupling. The GEM-CEDAR community provides an ideal venue to foster discussions on this important topic.

Related to CEDAR Science Thrusts:
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Explore exchange processes at boundaries and transitions in geospace
Explore processes related to geospace evolution
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Fuse the knowledge base across disciplines in the geosciences
Manage, mine, and manipulate geoscience/geospace data and models
Workshop format
Short Presentations
Keywords
Exosphere, precipitation, MIT coupling
List GEM Focus Groups (if any) you wish to avoid being in concurrent sessions with (due to overlapping research interests)
Magnetospheric Sources of Particle Precipitation and Their Role on Electrodynamic Coupling of Magnetosphere-Ionosphere-Thermosphere Systems
Machine-Learning-based Geospace Environment Modeling
The impact of the cold plasma in magnetospheric physics
Self-consistent inner magnetospheric modeling
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