2024 Workshop: Multi-scale I-T Dynamics

Long title
Multi-scale Dynamics in the Ionosphere-Thermosphere System
Conveners
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Description

High-resolution network observations by distributed sensors have revealed the existence of strong localized and transient structures between a few 10s and a few 100s km size and several minute durations. Those are referred to as meso-scale structures and have potentially substantial impacts on the ionosphere-thermosphere (I-T) system. The multi-scale (large, meso, small) nature is ubiquitous in the global ionosphere including the cusp, auroral oval, mid latitudes, and equatorial regions. For example, flows and precipitation imposed by the magnetosphere at high latitudes tend to be more intense at meso-scale than at large-scale, and neutral wind has been shown to have strong responses to such meso-scale energy input. Localized fast flows and density structures travel across regions as flow channels and waves, giving rise to coupling across latitude and longitudes and between regions. Meso-scale structures are also important sources of energy since they are often more intense than large-scale background fields. Small size (<~10 km) dynamics are also recognized as a critical component for conductance, and energy dissipation. Coupling over multiple scales is a critical challenge since observational and modeling methodologies for bridging different scales and between regions do not presently exist. This workshop consists of presentations and discussions on a wide range of coupling processes in the I-T system from global to local processes both through empirical and physics-based models in the growing M-I-T observational system, data assimilation, and machine learning to effectively connect the individual resources.

Agenda

Discussions on high-resolution convection

- Daniel Billett (by Larry Lyons): High-resolution SuperDARN campaign in 2024
- Toshi Nishimura: Initial results of the campaign observations: Rapid evolution of flows and aurora
- William Bristow: Is using a statistical model a bad thing?

Short contributed talks

- Michael Hartinger: Sources of Ultra Low Frequency Total Electron Content Perturbations in the Auroral Zone
- Prakash Poudel: Improving Covariance Matrix for Aurora Data Assimilation
- Sneha Yadav: Effects of the polar cap boundary arc on activity
- Larry Lyons: Laydown events: Pc arc “lays down” on oval giving large onset
- Cheng Sheng: Coupling between mesoscale plasma flows and wind

We are no longer soliciting presentations since the session has a full agenda.

Justification

(1) Proposed challenge questions
Our overarching goal is to understand multi-scale coupling processes in the global I-T system. Specifically, we propose to focus on the questions below:
(a) What are quantitative properties of meso-scale and small-scale I-T structures and their relation to magnetosphere driving?
(b) What are their impacts to the large-scale and global I-T system?
(c) How much can we improve physics understanding and reproducibility of multi-scale coupling processes?

(2) How the questions will be addressed
We propose to dedicate one session for discussions with the audience on focused topic. Focused topics will be introduced by a few scene-setting talks, and most of time will be used for open discussions to collect ideas and thoughts to attack the topics and to seek out collaborations.

(3) What resources exist, are planned, or are needed
Growing networks of ground and satellite instruments will be heavily utilized for this activity. Meanwhile, machine learning and data assimilation, and numerical simulations will play critical roles for this study.The proposed activities will be

coordinated with GEM (M-I-T coupling FG, precipitation FG, and transition region FG) by bringing their knowledge and holding joint campaigns.

(4) Relevance to CEDAR Strategic Plan
The proposed study meets three of the strategic trusts in the CEDAR Strategic Plan 2011: (1) Encourage and Undertake a Systems Perspective of Geospace, (2) Explore Exchange Processes at Boundaries and Transitions in Geospace, (3) Explore Processes Related to Geospace Evolution.

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
Include a virtual component?
Yes
Keywords
ionosphere-thermosphere coupling, multi-scale dynamics, density and flow structures, magnetospheric forcing
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