2023 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. Small size (<~10 km) dynamics including turbulence are also recognized as a critical component for Global Navigation Satellite System (GNSS) signal scintillation, conductance, and energy dissipation. The multi-scale (large, meso, small) nature is ubiquitous in the global ionosphere including the cusp, polar cap, 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 that cascades down to small-scale structures and forms density irregularities.

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 solicits presentations 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

10:00-12:00 PDT, Thursday 6/29

Room: Westcoast

List of presentations

- **Matt Zettergren** (Embry-Riddle) Local-scale modeling of the stability and structuring of mid-latitude flow channels during large geomagnetic storms
- **Toshi Nishimura** (BU) Ground-based observations of the 27 March 2014 storm
- **Cheng Sheng** (UTA) GITM simulations of the 27 March 2014 storm
- **Christine Gabrielse** (Aerospace) Precipitating Energy Flux, Energy and Conductance from THEMIS All Sky Imagers
- **Leslie Lamarche** (SRI) Spectra of plasma irregularities around polar cap patches
- **Enrique Rojas** (Cornell) Fluid Farley-Buneman simulations
- **Mike Hartinger** (for Xueling Shi) (SSI, VT) Joule heating related to ULF waves using SuperDARN
- **Russell Cosgrove** (SRI) An electromagnetic calculation of electric field mapping that finds very unexpected results
- **Larry Lyons** (UCLA) Mesoscale polar cap flow channels
- **Sneha Yadav** (UCLA) Auroral streamers and overshielding at equatorial latitudes

Walk-in presentations

- **Jun Liang** (U of Calgary) TREx
- **Leslie Lamarche** (SRI) Polar cap flow

Zoom link

For online attendees, please be advised that the quality of zoom broadcasting will be affected by internet connection on site. It may be difficult to hear people away from microphones. The Q&A time is prioritized to the in-person attendees.

https://bostonu.zoom.us/j/9667592300?pwd=WWxpUUhQNVZUUTBaNU9CQlFjeDExZz...

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:
Explore exchange processes at boundaries and transitions in geospace
Fuse the knowledge base across disciplines in the geosciences
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