2017 Workshop: High Latitude Electrodynamics

Long title

High-Latitude Ionospheric Electrodynamics and Their Impact on the Thermosphere

Conveners

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Description

The session is a tribute to Art Richmond's distinguished career and his contributions to the scientific field. Distributions of high-latitude ionospheric electrodynamic fields such as plasma convection and auroral precipitation have traditionally been represented by empirical models constructed by combining observations taken over a long period of time through sorting and binning according to different geophysical parameters. Though empirical models provide robust representations of the average ionospheric behavior, they are often inadequate to replicate the electrodynamic features pertained to specific geophysical conditions especially during storms. High-latitude ionospheric convection and auroral precipitation are two most important forms of energy input into the thermosphere, which are responsible for producing various thermospheric disturbances during geomagnetic storms. With the expansion of ground-based (e.g., SuperDARN, IS radars, ground magnetometer chains, auroral imagers, and GPS receivers) and satellite (e.g., DMSP, AMPERE, TIMED, COSMIC) observations, along with the advancement in numerical modeling and data assimilation techniques, significant progresses have been made in the understanding of high-latitude ionospheric electrodynamics in recent years. This session focuses new numerical techniques and data assimilation methods to reveal new features of the high-latitude ionosphere. The session solicits papers on modeling and observational studies as well as data assimilation analysis of high-latitude ionospheric electrodynamics to address the following science questions:

1. How do high-latitude ionospheric electrodynamics respond to solar wind and geomagnetic disturbances?

2. How do high-latitude electrodynamics affect the mid- and low-latitude electrodynamics and vice versa?

3. How do ionospheric electrodynamics influence thermospheric dynamics and composition?

Agenda

- Rod Heelis (mini keynote): Describing the High Latitude Ionospheric Convection Pattern (pdf)
- Tomoko Matsuo (mini keynote): History and recent progress of Assimilative Mapping Ionospheric Electrodynamics (AMIE) (pdf)
- Delores Knipp: Putting the 'data' in AMIE's data assimilation (pdf)
- Yining Shi: Determining optimal setting for AMIENext procedure using AMPERE/Iridium data (pdf)
- Aaron Ridley: A new method for creating empirical models of the high-latitude electrodynamics (pdf)
- Bill Archer: Birkeland current boundary flow (pdf)
- Young-Sil Kwak: Steady-state eddy available energy budget in the high-latitude lower thermosphere (pdf)
- Shasha Zou: Solar wind dynamical enhancement and its effects on the high-latitude ionosphere (pdf)
- Alex Chartier: Formation of a polar cap patch observed by GPS tomography, ground and space-borne magnetometers and HF backscatter (pdf)
- Nick Pedatella: Impact of uncertainty in high-latitude electrodynamics on the low-mid latitude ionosphere (pdf)
- Yue Deng: Electric field variability at the high latitudes and its influence on the thermosphere (pdf)
- Gang Lu: Quantifying high-latitude ionospheric variability (pdf)

Justification

High-latitude ionospheric electrodynamics has a profound impact on the upper atmosphere. Intense auroral particle precipitation ionizes neutral gases and modifies ionospheric conductivity; collisions between neutrals and fast-moving ions accelerate the neutral winds and produce Joule frictional heating; and the excess Joule and particle heating causes atmospheric upwelling and changes neutral composition due to the rising of the heavier, molecular-rich air. In addition, impulsive Joule heating launches large-scale atmospheric gravity waves that propagate equatorward toward middle and low latitudes and even into the opposite hemisphere, altering the mean global circulation of the thermosphere. Therefore, a comprehensive understanding of ionospheric electrodynamics is critically important to the coupling of the magnetosphere-thermosphere-ionosphere (MIT) system, which is central to the CEDAR Strategic Thrust #1 (Encourage and undertake a system perspective to geospace), Thrust #2 (Explore exchange processes in interfaces and boundaries), and Thrust #5 (Fuse the knowledge base across disciplines). The session is highly relevant to the 2nd Science Goal of the Heliophysics Decadal Survey on “Determine the dynamics and coupling of Earth’s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs”, and it contributes to the NSF Geospace Plan Goal on Fundamental Scientific Understanding of “How mass, energy, and momentum are transported through the heliosphere, magnetosphere, ionosphere, and thermosphere.” i. Three specific questions will be addressed, which are listed below. ii. We will solicit contributions from the CEDAR community to present their latest numerical modeling and observational research relevant to the session topic based on existing resources. iii. The progress will be measured by a comprehensive assessment of numerical models, observations, and data assimilation techniques that can be applied to improve the understanding of high-latitude ionosphere electrodynamics.

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