Project Details

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Program Element: Focused Science Topic

Topic: Studies of the Global Electrodynamics of Ionospheric Disturbances

Project Title:
Global Ionospheric Electrodynamics and Its Influence on the Thermosphere

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Summary:
Because the ionosphere and magnetosphere are intrinsically coupled via magnetic field lines, the distributions of ionospheric electrodynamic fields are strongly controlled by dynamical processes taking place in the magnetically conjugate regions, such as the rate of magnetic reconnection at the magnetopause and in the magnetotail, and the energization and precipitation of magnetospheric plasmas. Ionospheric electrodynamics has a profound impact on the thermosphere. During geomagnetic storms, strong electric fields and currents driven by magnetospheric forcing produce enhanced Joule heating and energetic particle precipitation in the auroral zone. Consequently, the conductivity of the ionosphere is increased, the neutral winds are accelerated, the thermosphere is heated, and its composition is modified. In order to gain quantitative understanding of the dynamical coupling between the ionosphere and thermosphere, it is critically important to be able to describe and quantify the ionospheric conductivity, electric fields, and currents as accurately in space and time as possible. This proposal will directly tackle one specific challenge outlined by the LWS program concerning the global ionospheric electrodynamics. Toward that end, we propose to address the following outstanding scientific questions: (1) How does auroral conductivity affect ionospheric properties such as electric fields, currents, and Joule heating? (2) How do the global distributions of ionospheric electrodynamic fields vary with geomagnetic activity? (3) How does ionospheric electrodynamics influence thermospheric dynamics?

The main goal of this proposal is to quantitatively characterize storm-time ionospheric electrodynamics based on various space and ground based observations, together with advanced data assimilation techniques and numerical simulations. This investigation will make extensive use of data from both current and past NASA missions, including TIMED, IMAGE, and Polar, leveraged by other space and ground based observations, in order to obtain the most realistic specification of global ionospheric electrodynamic fields under different solar wind and geomagnetic conditions by applying the Assimilative Mapping of Ionospheric Electrodynamics (AMIE) procedure. We will also use the Thermosphere-Ionosphere- Electrodynamics General Circulation Model (TIEGCM) to delineate the various physical processes affecting the thermosphere. Numerical experiments will be conducted to determine how the different specifications of ionospheric electrodynamic fields affect thermospheric dynamics globally.

The proposal directly addresses the Focus Science Topic (FST) 3.1.3 (Studies of the Global Electrodynamics of Ionospheric Disturbances) and also contributes to the LWS Strategic Goal 4 (Deliver understanding and predictive models of upper atmospheric and ionospheric responses to changes in solar electromagnetic radiation, and to coupling above and below). It is highly relevant to the 2nd high-level science goal of the Heliophysics Decadal Survey: Determine the dynamics and coupling of Earth s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs , and to NASA s Strategic Goals to explore the physical processes in the space environment from the Sun to the Earth and to develop the knowledge and capability to detect and predict extreme conditions in space to protect life and society as outlined in the Heliophysics Science and Technology Roadmap for 2014-2033. Our proposal is fully in line with these high-priority science objectives. The proposed investigation will advance our understanding of electrodynamical processes in the near-earth space environment, a critical step toward a more reliable specification, and eventual forecast, of ionospheric and thermospheric disturbances.

Publication References:

no references