Project Details

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Program Element: Focused Science Topic

Topic: Causes and Consequences of Hemispherical Asymmetries in the M-I-T System

Project Title:
Causes of interhemispheric asymmetries in the ionosphere

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Summary:
SCIENCE GOALS AND OBJECTIVES
Knowing the ionospheric plasma condition is important for space weather applications such as predicting the occurrence of plasma depletions and associated irregularities affecting communication and navigation systems. The ionospheric plasma distribution strongly depend on the neutral winds, electric fields and thermospheric composition changes driven by magnetosphere-ionosphere-thermosphere coupling, by upward propagating planetary waves and tides, and is also modulated by Earth s magnetic field. Interhemispheric asymmetries in the plasma distribution exist which cannot be explained by the seasonal variation of solar radiation. Similarly, hemispheric asymmetries are evident in many observed quantities of the magnetosphere and ionosphere even after taking account of the interplanetary magnetic field (IMF) orientations and seasonal effects. Furthermore, the lower atmosphere has inherent interhemispheric differences due to the non-uniform excitation and propagation condition of waves and tides, which impact the ionosphere and thermosphere from below. So far, what causes the interhemispheric asymmetries in the ionosphere remains largely elusive. Disentangling the important drivers and mechanisms leading to interhemispheric asymmetric plasma distribution is the focus of the proposed investigation.
The proposed investigation will advance our understanding of the response and interaction of the ionosphere to interhemispheric asymmetries in the MI coupling and in the lower atmospheric tidal and planetary wave forcing. It focuses on three science questions that are central to Focused Science Topic #4 Causes and consequences of hemispherical asymmetries in the Magnetosphere-Ionosphere-Thermosphere System :
(1) How can the interhemispheric asymmetries in the field-aligned currents and Joule heating be characterized during quiescent and disturbed conditions?
(2) What are the important processes through which the ionosphere responds to and interacts with the asymmetric magnetospheric forcing?
(3) How large is the contribution from the asymmetric lower atmospheric dynamics to the overall ionospheric asymmetry and what are the important pathways?

METHODOLOGY
This investigation will combine data analysis with the state-of-the-art Whole Atmosphere Community Climate Model-eXtended (WACCM-X). WACCM-X with specified dynamics by reanalysis data will be employed to simulate the coupling between the lower atmosphere and the thermosphere-ionosphere system. Numerical experiments will be conducted to delineate the effects from the lower atmosphere. The interhemispheric asymmetries in field-aligned currents (FAC) will be characterized by analyzing the AMPERE magnetometer data. To describe the interhemispheric asymmetries in the Joule heating we will use the Assimilative Mapping of Ionospheric Electrodynamics (AMIE) procedure and the AMPERE FAC forcing in WACCM-X with different auroral conductance descriptions, e.g., DMSP/SSUSI observations, and empirical aurora models. The interhemispheric asymmetry in the ionosphere will be characterized by analyzing GPS-TEC, COSMIC and evening GOLD electron density, and once available COSMIC-2 and ICON data. WACCM-X simulations will be conducted to investigate the ionospheric response and interaction of the lower atmosphere and the MI coupling. The simulated interhemispheric asymmetries in the ionosphere via dynamics, composition and electrodynamic changes will be evaluated by model-data intercomparison of e.g., O/N2 from TIMED/GUVI, GOLD and the upcoming ICON, ion drifts from DMSP, CNOF/S, and the upcoming COSMIC-2 and ICON.

PROPOSED CONTRIBUTION TO THE FOCUSED SCIENCE TEAM
This investigation supports the LWS program goal of understanding which drivers generate the observed asymmetries and improve physics-based understanding of time-evolving structural changes in ionospheric electron density between hemispheres . We will share the AMIE, WACCM-X and data analysis results.

Publication References:

no references