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:
Investigation of Interhemispheric Asymmetries in High-Latitude Magnetosphere-Ionosphere Coupling Processes

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Summary:
1. Science Goals and Objectives
The main goal of this study is to understand the causes and effects of asymmetries in the Magnetosphere-Ionosphere coupling processes. This proposal is motivated by the recent studies conducted by the team members, in which the observational and modeling work built upon hypotheses that the interhemispheric differences in temporal response, spatial extent and intensity of magnetic field variations, current systems, and convection patterns may occur due to external drivers and their complex interactions with each other. We propose to further test these hypotheses by systematically applying them to more extensive and integrated sets of data and simulations available today. The specific science questions are as follows:
1) How do the spatiotemporal characteristics, and magnitudes of interhemispheric asymmetries at high latitudes as observed in magnetic field variations, current systems and convection patterns change with different drivers?
2) What are the relative contributions of the external drivers to the asymmetric MIC processes?
3) How much electromagnetic energy is transferred by each of these MIC processes to the Thermosphere system?

2. Technical Approach and Methodology
The proposed work will utilize data from spacecraft and ground-based instruments that cover high latitudes in both hemispheres, which include field and particle data from spacecraft in the solar wind and magnetosphere and over polar regions in low earth orbits, magnetic field data from the ground magnetometers and SuperDARN radars at interhemispheric conjugate locations. These data sets will be used to characterize asymmetries in magnetic field perturbations, current systems and convection patterns and their coupling dynamics with the thermosphere. To model the solar wind interaction with the coupled M-I-T system and analyze the global response to different drivers, we will use the BATS-R-US and RIM models. These models will return the global plasma flow and pressure profiles in the magnetosphere, FACs, particle flux, characteristic energies, electric potentials on top of the ionosphere, and ground magnetic perturbations. The convection and auroral precipitation obtained from the global MHD modeling will be used to drive GITM to obtain plasma and neutral densities, temperature and velocity. In addition, idealized simulations will be conducted to analyze the effects of different solar wind and IMF drivers.

3. Relevance and Perceived Significance
The proposed study will advance the understanding of origin and propagation of interhemispheric asymmetries and associated magnetosphere-ionosphere-thermosphere (M-I-T) coupling processes employing a system-wide approach. Unlike other studies, this work aims to quantitatively analyze the effects of asymmetries across three different domains in the near-Earth environment. The proposal team will make use of newly deployed ground magnetometers, therefore will employ unprecedented measurement data to analyze asymmetries and guide the modeling approach. The proposed research will have important implications for understanding M-I-T coupling processes and space weather forecasting by extensively investigating the role of external drivers. This proposal directly addresses the Focused Science Topic #4 of the LWS program: "Causes and Consequences of Hemispherical Asymmetries in the Magnetosphere - Ionosphere - Thermosphere System". In addition, the majority of the proposed work is related to studies on M-I-T coupling processes due to transient phenomena related to the solar wind, one of the major external drivers. Therefore, this proposal also addresses the Focused Science Topic #3: "Magnetospheric and Ionospheric Processes Responsible for Rapid Geomagnetic Changes".

Publication References:

no references