Project Details

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Selection Year: 2019
Program Element: Focused Science Topic

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

Project Title:
Model-Data Exploration of Hemispherical Asymmetries in the Magnetosphere/Ionosphere System

PI Name: Anthea J. Coster
PI Email: ajc@haystack.mit.edu
Affiliation: Massachusetts Institute of Technology
Project Member(s):
- Wolf, Richard A;Co-I;William Marsh Rice University
- Sazykin, Stanislav;Co-I/Institutional PI;William Marsh Rice University
- Huba, Joseph;Co-I;Syntek Technologies Inc.

Summary:
Science Goals and Objectives: We are proposing a comprehensive effort to explore several salient hemispherical asymmetries in the coupled magnetosphere-ionosphere (MI) system that are related to or driven by specific asymmetries and variability of solar wind/IMF field, higher-order moments and dipole tilt in the intrinsic geomagnetic field, and the resulting dynamical processes in plasma behavior. The project will focus on these unexplained phenomena:
(1) What is the nature of the observed dynamics and spatial distribution (specifically the longitudinal variations) of the sub-auroral polarization stream (SAPS) electric field structures and the storm enhanced density (SED) feature during geomagnetic storms at subauroral and middle latitudes?
(2) What are the drivers and mechanisms causing the observed tongue of ionization (TOI) and related density structures over the polar caps, and the patterns of ExB ionospheric convection pattern, and their observed hemispheric asymmetries?
(3) What processes control the hemispheric asymmetry in both the location and strength of the equatorial anomaly structures as observed during both quiet and disturbed conditions?
An accompanying goal will be further development of the coupled first-principles ionosphere-inner magnetosphere numerical model SAMI3-RCM.
Methodology: The goals will be accomplished by combining theoretical and empirical modeling efforts with a comprehensive observational program. The phenomena to be studied will be characterized (in event studies and statistically) with data analysis at the MIT Haystack Observatory utilizing their extensive GNSS TEC database, their access to SuperDARN observations, solar wind data from ACE, and the new GOLD data. Specific time periods for further analysis will be selected and additional data will be gathered for team analysis from incoherent scatter radars, SuperMAG, Iridium/AMPERE, DMSP, and TIMED GUVI. The simulations part of the project (Rice University and Syntek Technologies) will use the previously developed model SAMI3-RCM. Both components of the model and the coupling will be updated to use the most recent version of the international geomagnetic reference field (IGRF, 2015) model. Currently, the coupled SAMI3-RCM model utilizes an offset dipole geomagnetic model, and although it does a good job of predicting the ionospheric conditions during storm periods in the Northern hemisphere, it does not do as well at predicting conditions in the Southern hemisphere. The goal is by incorporating a more realistic geomagnetic field, the new comprehensive model of the SAMI3-RCM plasmasphere-ionosphere system will capture the observed asymmetries. Model-data comparisons will be an integral part of the model development. As an outcome, we hope to unveil the hemispheric asymmetries that are due to electro-dynamical coupling in the MI system and, in doing so, shed more light on those processes that are driven by other forces.
Contributions to the FST: By improving the geomagnetic field model in the RCM and SAMI3 models, this project will directly address the Key Science Goal 2 of the Decadal Survey: "Determine the dynamics and coupling of Earth s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs." The updated RCM-SAMI3 model will also addresses SSA-4: Physics-based Total Electron Content (TEC) Forecasting Capability and the Decadal Survey s Atmosphere Ionosphere Magnetosphere (AIM) Interactions Science Goal 4: Plasma-Neutral Coupling in a Magnetic Field. The coupled RCM and SAMI3 model, both in its current and final configuration, will be available for team evaluation. This project will also gather data from select time periods for further analysis, and for model verification and data input. Data analysis routines will be developed and provided to the team. At the end of the project the SAMI3-RCM model will be delivered to NASA's CCMC.

Publication References:

no references