Project Details

ROSES ID: NNH18ZDA001N
Selection Year: 2018
Program Element: Focused Science Topic

Topic: Understanding the Response of Magnetospheric Plasma Populations to Solar Wind Structures

Project Title:
Characterization of M-I coupling electron populations and ionospheric altitude dependence on solar wind conditions and structures

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Summary:
Magnetospheric-ionospheric (M-I) coupling plasma populations are some of the most important in the magnetosphere. They are a primary means through which solar wind (SW) energy and dynamics are transmitted to the ionosphere-thermosphere-mesosphere (ITM). They are also the primary means through which the ITM feeds back to the magnetosphere and are often the source population for higher energy magnetospheric particle populations. Having an accurate understanding of these populations, the M-I interface, and how these populations depend on SW drivers and structures and on ionospheric conditions is critical to understanding the effects that SW structures have on the magnetosphere.

We propose to develop and provide an empirical model for the dependence and range of variability of M-I coupling electrons, including precipitating, ionospheric, and mirroring populations, with unprecedented detail (including energy spectra) based on SW and geomagnetic conditions. Additionally, utilizing the same data, an empirical model for ionospheric scale height and heights at which various energy electrons deposit their energy will be developed. Finally, the database used to create the models will also be used to determine the effects specific SW structures have on these populations and ionospheric height characteristics.

The main science goals and objectives of our proposed effort are to:
1) fully characterize the electrons involved in M-I coupling in the ~5-30,000 eV range and develop an empirical model for their dependence on SW and geomagnetic conditions;
2) characterize the ionospheric scale height in auroral latitudes and develop an empirical model for their dependence on SW and geomagnetic conditions;
3) determine how specific solar wind structures affect the M-I coupling electron populations and ionospheric scale height.

The proposed study will utilize the full, nearly 13-year, mission data from the FAST satellite to develop a database of full pitch angle distribution electron data over the pertinent energy range and SW, geomagnetic and footpoint/conjugate footpoint illumination conditions. This database will be used to develop an empirical model for the expected and range of spectra for precipitating, mirroring and ionospheric electrons based on SW and other conditions. A separate empirical model of ionospheric height characteristics will also be developed from the same database by examining the variations in partial mirroring near the loss cone boundary angles. Finally, FAST passes during case studies of SW structures (shocks, CME, etc) interacting with the magnetosphere will be examined and compared to the empirical model output to determine the effects these structures have on the M-I coupling electron populations (and ionospheric height characteristics).

This proposed effort is directly relevant to and will directly and indirectly contribute to the FST. In particular, it will develop a highly improved empirical model for very important magnetospheric plasma populations as a function of SW and geomagnetic conditions. It will also examine case studies utilizing both the empirical models and actual data. The resulting database and empirical models will also be useful to the FST for validating and providing inputs for other models of SW-M-ITM coupling and dynamics, even for times and events outside of the FAST mission. Case study analysis of both the empirical model results and similar events in the FAST database for events selected by other members of the FST are also part of the scope of the proposed effort, and the models will be made generally available to the community. Comparison to the compiled database will also provide a means evaluating intrinsic errors for extreme events both in our models and those of other FST members. Metrics and milestones of success will include completing the database, implementation of the empirical models, individual case studies and comparison of model output to individual FAST pass data.

Publication References:

no references