Project Details

ROSES ID: NNH05ZDA001N
Selection Year: 2006
Program Element: Focused Science Topic

Topic: Solar wind plasma entry and transport in the magnetosphere

Project Title:
Dynamical data-based modeling of the magnetospheric magnetic field with enhanced spatial resolution

PI Name: Mikhail Sitnov
PI Email: Mikhail.Sitnov@jhuapl.edu
Affiliation: The Johns Hopkins Universtiy Applied Physics Laboratory
Project Member(s):
- Tsyganenko, Nikolai ; Co-I; null
- Ukhorskiy, Aleksandr Y; Collaborator; JHU/APL

Summary:
This project will advance empirical models of the geomagnetic field, making it possible to systematically increase their spatial resolution and to take into account the variable solar wind driving on the timescales involved in storms and substorms. The existing empirical models are global in space, time, and in the amplitude of field variations, and they are fitted to observations using a limited set of custom-tailored basis functions representing each magnetospheric current system. They do not properly reproduce a wide difference in the response of the individual field sources to solar wind driving. Removing these limitations is the main goal of the proposed project. It will be achieved in three steps. First, we will explore the timescales of the response of the main magnetospheric field sources to solar wind density, speed, ram pressure and the interplanetary magnetic field variations. The response functions will be parameterized using simple loading-unloading equations with respect to the solar-wind input. Second, we will implement a spectral technique, in which the fields of individual current systems are expanded into a series of basis functions, taking into account geometrical constraints, imposed on a given current system via its specific boundary conditions. The number of those basis functions can be made sufficiently large, providing the desired flexibility to the model. Combined with a progressive extension of the spacecraft database, that will improve the spatial resolution, maximize the information derived from observations, and minimize the number of a priori assumptions on the structure of the magnetosphere. Third, we will explore the possibility to replace the global time and amplitude fitting with the local one, using the dynamical system approach and modern techniques of the local fitting of data in the phase space, based on the concepts of time delay embedding, nearest neighbors, and conditional probability. An important technical improvement will be the parallelization of the existing and newly developed codes, providing a much faster update of the model using supercomputers. The proposed study will be based on the largest available amount of spacecraft data, using interplanetary and magnetospheric observations and covering more than 50 major storms. The final product, high-resolution dynamical empirical models of the geomagnetic field will serve as a backbone for many applications aimed to quantify the particle entry and transport in the magnetosphere, being particularly useful and efficient for tracing energetic particles from the magnetopause to the ring current and radiation belt regions for different solar wind and geomagnetic activity conditions, including storm and substorm effects. Thus, the proposed project is directly relevant to the Focused Science Topic T3c of the LWS TR&T program.

Publication References:

Summary: no summary

Reference: Sitnov, M. I.; Tsyganenko, N. A.; Ukhorskiy, A. Y.; Brandt, P. C.; (2008), Dynamical data-based modeling of the storm-time geomagnetic field with enhanced spatial resolution, Journal of Geophysical Research: Space Physics, Volume 113, Issue A7, CiteID A07218, doi: 10.1029/2007JA013003