Project Details

ROSES ID: NNH19ZDA001N
Selection Year: 2019
Program Element: Focused Science Topic

Topic: Magnetospheric and Ionospheric Processes Responsible for Rapid Geomagnetic Changes

Project Title:
Magnetospheric and solar wind conditions for potentially hazardous geomagnetic disturbances

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Summary:
PROJECT GOAL:
The goal of this project is to understand magnetospheric and solar wind conditions for rapid and intense geomagnetic changes, extreme dB/dt events , and to identify responsible processes in the magnetosphere-ionosphere (M-I) system.

SCIENCE QUESTIONS
We will achieve this goal by addressing the following questions:

SQ1.Under what magnetospheric and solar wind conditions do extreme dB/dt events take place?
1a. How are the probability distribution functions (PDFs) of dB/dt characterized in terms of global geomagnetic activity and location, such as magnetic latitude (MLat) and magnetic local time (MLT)?
1b. What ionospheric current system is associated with extreme dB/dt, and to what solar wind condition, if any, is it related?
1c. What plasma sheet processes are associated with extreme dB/dt, and how are they characterized?

SQ2. How are storm-time shock-preceding substorms characterized as a cause of extreme dB/dt events?
2a. Where (MLT and MLat) and when (relative to the shock arrival) does ground dB/dt become large during storm-time shock-preceding substorms? How are such spatio-temporal structures characterized (compared with other types of intense geomagnetic activity)?
2b. How are ionospheric currents distributed and how do they develop? How are they characterized?
2c. How do basic plasma sheet processes (e.g., dipolarizations, convection enhancements, and reconnection) develop in time and space? How are they characterized?

APPROACH:
Those two sets of SQs reflect our bi-directional approach to the project goal: data-oriented search for conditions for extreme dB/dt events (SQ1) and hypothesis-based investigation of relevant processes (SQ2).

For SQ1 we will calculate the PDFs of dB/dt on different time scales using magnetic field data from various stations. We will then address 1a-1c:
1a: We will examine how the PDFs change with geomagnetic indices, and will identify the state of the M-I system (i.e., storms, substorms) under which dB/dt becomes large. By comparing PDFs at different locations, we will identify where (MLT and MLat) dB/dt most likely become hazardous.
1b: We will select extreme dB/dt events based on the PDFs. By examining polar plots of equivalent currents, along with global auroral images if available, we will identify the responsible ionospheric current system and process, and will address if its intensification can be associated with any solar wind structure.
1c: For the extreme events we will examine the timing and location of dipolarizations and convection enhancements, and will address their characteristics.

For SQ2 we will test the hypothesis that storm-time shock-preceding substorms (Group 1) are a significant cause of extreme dB/dt events, and will compare their characteristics with other types of intense geomagnetic activity (Group 2: storm-time shock-preceding convection bays; Group 3: storm-time non-shock-preceding substorms and convection bays; and Group 4: non-storm-time supersubstorms).
2a: We will examine the polar distribution of dB/dt and its evolution, and will address how Group 1 is characterized.
2b: By examining polar plots of equivalent currents, along with global auroral images if available, we will identify how ionospheric currents develop for Group 1, and how it is characterized compared with Groups 2-4.
2c: By examining dipolarizations and convection enhancements in the plasma sheet, we will address how magnetospheric

processes develop for Group 1, and how they are characterized compared with Groups 2-4.

We will use (i) the SuperMAG database for geomagnetic disturbances, (ii) the OMNI database for solar wind conditions, (iii) magnetic field and plasma data from current and past NASA missions as well as other available satellites for plasma sheet processes, and (iv) Polar and IMAGE auroral images for spatio-temporal structures of auroral activity.

Publication References:

no references