Project Details

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Program Element: Focused Science Topic

Topic: Magnetospheric and Ionospheric Processes Responsible for Rapid Geomagnetic Changes

Project Title:
Modelling the GIC Response from the Solar Wind to the Ground

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Summary:
Objectives
Magnetic storms can cause critical hazardous for our technologies with imposing geomagnetic induced current (GIC) through our infrastructure like power grids, railways, and pipelines. In this project, we aim to address the following issues:

- What are the GIC variations under different geomagnetic conditions. For example, during quiet times, can BBFs (Bursty Bulk Flows) generate substantial GICs; how much GIC can be generated during substorms, and how are they related to substorm strength; how do different types of storms (CME, CIR) generating GICs.
- We extent the studies to extreme storms, such as Carrington-class events or the STEREO-A event.
- We will examine if there are any specific ways in which GICs are pre-conditioned. For example, does a sequence of storms (such as during the Halloween storms) lead to more intense GICs?
- Do GICs generated by different drivers have different GIC distributions and extents. For example, is the GIC from a substorms more spatially confined than that generated by a SSC or a storm?

Methodology:

In this project, we use global MHD magnetosphere, inner magnetosphere, and ionosphere coupled model, OpenGGCM-RCM-CTIM. The model computes
many key electric currents in the magnetosphere and ionosphere (MI) system. In particular, magnetopause and tail currents in the magnetosphere, ring current, field aligned current (FAC) between magnetosphere and ionosphere, and ionosphere currents on 2D shell at 110 km. The latter are represented on a 0.5 (lat) by 3.0 (lon) degree mesh. From the currents, dB/dt on the ground can be calculated in different ways, like Biot-Savart (B-S) integration over equivalent currents or full B-S integration over all MI current systems. Practical time resolution can be as little as 1 second. The models are tested to various degrees separately. Using the models in unison will allow to test the entire chain of processes that lead to GIC. With proper ground data the validity of the approach can be tested. It is important to introduce statistical errors associated with the model. Data assimilation technique will be used to determine these errors in the model. We also use available data such as the ground magnetometers, DMSP, THEMIS/MMS for substorms, IMAGE and ASI cameras for aurora, and more importantly AMPERE which provides direct global and large scale structures of FAC.

Contributions to the FST effort
We will particularly address LWS topic numerical simulations using solar wind MI coupling models with the goal of investigating the role of solar wind in driving GICs as well as analysis of current and historic satellite and ground data sources during extreme GIC times with the goal of discovering any preconditions necessary for extreme GICs.

Publication References:

no references