Project Details

ROSES ID: NNH19ZDA001N
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Program Element: Focused Science Topic

Topic: Magnetospheric and Ionospheric Processes Responsible for Rapid Geomagnetic Changes

Project Title:
Space weather electromagnetic pulse impacts on modern smart cities and Internet of Things technologies: Observations and modeling of fast and small-scale induced currents in the context of GICs

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Summary:
We combine ground and space-based magnetometer observations with the University of Michigan s Space Weather Modeling Framework (SWMF) and the University of Utah s time-domain, full-vector Maxwell s equations geomagnetic field-ionosphere model to characterize the properties of fast (The objective is to identify in 1-second ground-magnetometer data large dB/dt intervals, place them into solar wind and geomagnetic context (storm and substorm correlation) and characterize the spectral properties of the events at previously under-studied high-frequency (on the order of Hz) signatures. We will analyze decades of magnetometer data from scores of stations. Our recent studies have found: (1) that a significant fraction (40%) of the largest dB/dt events are not associated with substorms and (2) many of the largest dB/dt within the E3/GIC time domain are preceded and/or accompanied by large and more rapid fluctuations (E2). From this list, we will identify events that have both LEO (e.g., Swarm, FAST) and magnetospheric satellite (e.g., Van Allen Probes, MMS, THEMIS) observations. Though mapping uncertainties and the need to have broad conjunction criteria will make it difficult to find the same event on the ground and in space, we will characterize the field signatures (e.g., dipolarizations, compressions) and wave properties of the space-based observations to place the events into global context. We will then model select intervals with both models to understand the current and ionospheric electric field structures responsible for the fast and GIC signatures.
We will address all three primary objectives ((1) determine the space context of dB/dt, (2) characterize their temporal and spatial scales, and (3) using observations and models estimate the ideal spacing of ground-based observations) of the Magnetospheric and Ionospheric Processes Responsible for Rapid Geomagnetic Changes FST.
We contribute to five of the seven types of listed investigations: (1) Observational and numerical approaches for determining variations of GIC; (2) Numerical simulations to investigate drivers of GICs, (3) New indicators of GIC activity, (4) Analysis of satellite and ground data during GIC times; and (5) Modeling of conditions related to GICs.
Our Metrics and Milestones include developing a complete list and statistics of large dB/dt including a large number that occur outside of traditional GIC storm events, their corresponding space weather conditions, and a set of modeled events using both the UM and Utah models to examine the full-range of scales. We will work closely with the TST that overlap with our objectives to provide opportunities for reproducibility as well as unique data-model comparisons.

Publication References:

no references