Project Details

ROSES ID: NNH17ZDA001N
Selection Year: 2017
Program Element: Focused Science Topic

Topic: Understanding Physical Processes in the Magnetosphere--Ionosphere / Thermosphere / Mesosphere System During Extreme Events

Project Title:
Quantifying deep penetration of energetic electrons and ions in the inner magnetosphere during extreme storms

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Summary:
Science Question:

SQ1. What are the global distribution and dynamics of electric and magnetic fields in the magnetosphere and ionospheric potential during extreme events?

SQ2. What causes the deep penetration of energetic electrons and ions to low L-shells during extreme events?

Relevance:

The proposed study is relevant to Focused Science Topic (4) Understanding Physical Processes in the Magnetosphere--Ionosphere / Thermosphere / Mesosphere System during Extreme Events. This proposal is also relevant to LWS program objective (1) Understand solar variability and its effects on the space and Earth environments with an ultimate goal of a reliable predictive capability of solar variability and response.

Energetic electron and ion transport in the magnetosphere and ionosphere is predominantly determined by global electric and magnetic fields. The plasma pressure produced by energetic electrons and ions also contributes to changing magnetic field configurations and therefore affects the ionospheric potential. Deep penetration of energetic electrons and ions in the inner magnetosphere can impact mid-latitude spacecraft and mid-latitude ground-induced currents (GICs). However, both empirical and pure magnetohydrodynamic (MHD) models often fail to reproduce polar cap potentials and magnetic field configurations due to extreme solar wind and ring current conditions. Furthermore, radial diffusion coefficients derived from statistical electric and magnetic fluctuations are not valid for extreme geomagnetic conditions, making it even more difficult to predict particle transport during extreme events. Thus, these limitations motivate us to use a state-of-the-art model of two-way-coupled global MHD and inner magnetosphere to answer the two science questions

Methodology:

[1] Use the Space Weather Modeling Framework (SWMF) which couples the Comprehensive Inner Magnetosphere and Ionosphere (CIMI) 4-D bounce-averaged kinetic ring current model with the Block Adaptive Tree Solarwind Roe-type Upwind Scheme (BATS-R-US) global MHD magnetospheric model to self-consistently simulate the global electric and magnetic fields, and the ionospheric potential. CIMI will also be used to simulate the transport of ring current electrons, ions, and
[2] Use a guiding-center test particle code to simulate transport of highly and ultra-relativistic electrons that rarely affect the global electric and magnetic field configuration.

[3] Compare observations with simulations and carefully compare between the two simulation models each other to validate and quantify the limitations of each model.

Publication References:

no references