Project Details

ROSES ID: NNH21ZDA001N
Selection Year: 2021
Program Element: Focused Science Topic

Topic: Pathways of Cold Plasma through the Magnetosphere

Project Title:
Understanding the Sources, Recirculation, and Impacts of Cold Plasma with Self-Consistent Modeling

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Summary:
Science Objectives:
SO1. Understand the factors controlling the refilling rate of the plasmasphere.
SO2. Follow the pathways of cold plasma from its source to the drainage plume, to the magnetotail and back to the plasmasphere region.
SO3. Determine the impacts of cold plasma on reconnection rates and mass loading in the magnetospheric system.

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Methodology:
A combination of global simulation and data analysis will be employed to address our science objectives. In this investigation, a multifluid MHD code (Block-Adaptive-Tree Solar-wind Roe-type Upwind Scheme [BATS-R-US]) combined with a comprehensive inner magnetosphere-ionosphere (CIMI) model will be our main modeling tool. A plasmasphere model has been embedded in the CIMI model. The plasmasphere model calculates spatiotemporal plasmaspheric density distribution considering corotation, convection, daytime refilling, and nightside diffusion. In this investigation, the refilling rate will be estimated by the SAMI3 (Sami3 is Also a Model of the Ionosphere) model. Critical to this investigation is the recent inclusion of a separate plasmasphere fluid in the multifluid BATS-R-US code. That fluid is filled from the CIMI code based on its embedded plasmasphere model. Outside the CIMI domain, the plasmasphere fluid continues to evolve based on the MHD calculation. We thus are able to follow the cold plasma from its source to the plasmasphere region and to the global magnetosphere. Our simulation results will be compared with observations. The main data sets that will be analyzed are the particle and field data from the NASA Van Allen Probes mission. The plasmasphere density can be inferred either from the upper hybrid wave frequency or from the spacecraft potential.

Relevance:
The proposed study is relevant to Focused Science Topic #2: Pathways of Cold Plasma through the Magnetosphere. The investigation directly addresses the Focused Science goals of understanding the sources, evolution, recirculation and impacts of the cold plasma in the magnetosphere. This investigation will improve our predictive capability of the temporal and spatial characteristics of the plasmasphere. Our investigation has significant space weather relevance since the plasmasphere region constitutes a safe haven for spacecraft surface charging. We will perform CIMI-BATS-R-US simulations for events selected by the Focused Science Team. We will also provide simulation support to the team as needed.

Publication References:

no references