Topic: Understanding the Response of Magnetospheric Plasma Populations to Solar Wind Structures

Project Title:
Response of magnetospheric keV electron population to solar wind structures

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Project Information:
1-200 keV electrons are one of the primary constituents of the radiation environment which pose a serious risk for satellites due to surface charging. The keV electron fluxes vary on the scale of minutes or shorter, being extremely sensitive to current solar wind driving. We propose to investigate what specific features in the solar wind structures (ICMEs, shocks/sheaths, CIRs, high speed streams, and their combinations) drive the variability of the magnetospheric keV electron population. We will start with the analysis of solar wind and interplanetary magnetic field structures themselves, and then study in details their influence on the variability of keV electrons. The computational view on the responses of keV electron radiation to solar wind structures is now feasible, since necessary data and the Inner Magnetosphere Particle Transport and Acceleration model (IMPTAM) are available.
Science goals and objectives: The proposed research is targeted to specify the variability of the keV electron radiation environment at 2-10 RE in response to the solar wind structures impinging on Earth s magnetosphere with specific focus on variations along GEO and MEO. Three questions will be answered: (1) What are the main effects from the spatial-temporal details of the solar wind structures (ICMEs, shocks/sheaths, CIRs/SIRs, high speed streams, and their combinations) on the transport and acceleration of keV electrons reaching GEO? (2) Are the driving by different solar wind structures and associated transport and acceleration of keV electrons different inside GEO and at MEO? (3) Sources, losses and substorms: What is the most important factor (or combination of factors) for keV electrons dynamics? By answering the science questions, we will understand the keV electrons variability and will significantly increase our predictive abilities.
Methodology: Using Wind and ACE proton kinetic properties as well as ion composition data combined with magnetic field measurements, we will analyze the spatial and temporal details of the structures of interplanetary features impinging on Earth s magnetosphere. Specific solar wind parameters from different solar wind structures will be used for driving IMPTAM for keV electron simulations (Proposed Contributions to the Focused Science Team Effort: The proposal attacks one of the fundamental questions for inner magnetosphere physics and will provide a critical link in our community's ability to understand radiation belt dynamics. The proposal largely contributes to the Objective 2 of the LWS program, Understand how the Earth & respond to dynamic external and internal drivers , by providing the scientific understanding of the keV electron dynamics and the ability to predict it, as a part of the bigger picture of the Heliosphere as a system. The project directly addresses one of the Focused Science Topics (FST), namely, 3) Understanding the Response of Magnetospheric Plasma Populations to Solar Wind Structures. The results of the proposed investigations have the direct relevance to the scientific objectives FST 3 as the improved and validated first principle model IMPTAM capable of predicting the time-dependent response of keV electron population to varying solar wind conditions. Several milestones set for the duration of the proposed project will ensure the successful progress of the research. Validated IMPTAM output in the entire inner magnetosphere and the set of metrics developed for IMPTAM performance will be the important contribution to the FST Effort.

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Citations: