Project Details

ROSES ID: NNH13ZDA001N
Selection Year: 2013
Program Element: Focused Science Topic

Topic: Connection between Solar Interplanetary Structures and the response of Earth's radiation belts

Project Title:
Drift Phase Sructure as a Diagnostic of Different Radial Transport Mechanisms in the Outer Radiation Belt

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Summary:
Goals and Objectives:
We hypothesize three main mechanisms of radial transport for relativistic electrons in the outer radiation belt: (1) incoherent scattering in the drift invariant, (2) impulsive events, and (3) monochromatic ULF oscillations. The relative importance of these mechanisms is unknown in general, and it is likely that the relative importance of each is quite different for different kinds of solar wind driving. For example, a coronal mass ejection (CME) might very well bring about more of (2), while a high speed stream (HSS) may stimulate more of (1) and (3). Drift phase structure is a critical diagnostic of these mechanisms. Mechanism 1 should lead to little or no detectable drift phase structure and it is the only listed mechanism necessarily compatible with the widely-assumed quasilinear radial diffusion. Mechanism 2 should lead to coherent drift phase bunching across a large range of energies and pitch angles (i.e., particles with very different drift periods). Mechanism 3 should lead to drift phase bunching only over a narrow range of energies and pitch angles corresponding to drift frequencies near the frequency of ULF oscillation. A superposition of many interactions with a series of randomly-phased impulses (e.g., Falthammar, 1968) or monochromatic waves (e.g., Albert, 2010, JGR) will lead to outcomes sufficiently similar to quasilinear radial diffusion that the quasilinear formulation can be retained. However, it is not known what proportion of radial transport should be attributed to each mechanism in general or for specific kinds of interplanetary drivers. We will estimate how often we observe drift-phase bunching at and near geostationary orbit, and whether it is coherent across energies and pitch angles (mechanism 3), if it is confined to a narrow range of drift periods (mechanism 2), or if it is incoherent across energies and pitch angles (mechanism 1). We will categorize radiation belt events by their interplanetary driver to determine whether CMEs, HSS, or corotating interaction regions lead to systematically different kinds of radial transport in the outer zone.

Methodology:
We will survey recent GOES observations, which have energy and angle resolution with high rate time sampling (1 minute or better, and thus shorter than the drift period). We will complement this survey with SCATHA data, which cover a larger L range, and include on-board plasma and field measurements. We will supplement these analyses with data from Van Allen Probes, which provide greater radial extent, but lack the stationary sentrycapability of the GOES vehicles.

Relevance:
Our proposal addresses Focused Science Topic (c) Connection between Solar Interplanetary Structures and the response of Earths radiation belts. Our proposed research will delineate radial transport mechanisms for the radiation belt electrons in the outer zone, and identify which mechanism, if any, is systematically dominant for different kinds of solar wind driving.

Publication References:

no references