Project Details

ROSES ID: NRA-NNH04ZSS001N
Selection Year: 2005
Program Element: Focused Science Topic

Topic: To determine the mechanisms responsible for the formation and loss of new radiation belts in the slot region in response to geo-effective solar wind structures.

Project Title:
Radial Diffusion Coefficients for use in Radiation Belt Models

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Summary:
Understanding radial diffusion, particularly in the slot region and in the outer-zone, is a crucial element in the development of physics-based models of radiation belt electrons. The main objectives of this proposal are (1) to derive and numerically test radial diffusion coefficients in these regions, (2) to use observations and simulations to better quantify the ULF perturbations that drive the radial diffusion, and (3) to develop a software package of radial diffusion coefficients for use in radiation belt models. We propose to obtain quasilinear radial diffusion coefficients from recent analytic work by Brizard and Chan [Physics of Plasmas, 2001, 2004], and to perform simulations of test particles moving in analytic ULF wave fields to test these quasilinear coefficients numerically. Effects of non-axisymmetric magnetospheric magnetic fields and off-equatorial particle distributions will be considered. We also propose to carry out test-particle simulations of radiation belt electron motion in the electromagnetic fields of the Lyon-Fedder-Mobarry (LFM) global-MHD simulation code. These MHD-particle simulations would include effects of radial diffusion by MHD waves, convective transport by sudden compressions of the magnetosphere, and losses by magnetopause shadowing. We propose validation tests where MHD waves produced by the LFM code are compared with other calculations of magnetospheric MHD waves and with magnetometer measurements of ULF waves. Results will be used to evaluate how well the analytic quasilinear coefficients describe radial diffusion of radiation belt electrons, and to develop the code package of radial diffusion coefficients. We envision a hierarchy of diffusion coefficients, ranging from a simple power law dependence in L-shell, to more sophisticated coefficients which use a power spectral density calculated from global MHD simulations or from arrays of ground-based magnetometer data for a given set of solar wind inputs. The radial diffusion software package would be made available to the radiation belt community, for use in radiation belt models and for validation tests of those models. By providing a better quantitative understanding of radial diffusion and by developing software to implement the resulting radial diffusion coefficients, the proposed effort would contribute directly to the LWS TR&T goal of "developing and validating usable, quantitative models that describe the dynamic evolution of the radiation belt slot region and the adjacent outer zone flux peak."

Publication References:

no references