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:
Predicting Energetic Ions in the Inner Magnetosphere

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Summary:
Energetic ions in the inner magnetosphere can be destructive to human technology. The modeling of these ions using basic physical principles is a major goal of the Living with a Star (LWS) program. A significant component of the energetic ion population can originate from solar energetic particles (SEPs) which can penetrate the magnetosphere. Because the number of energetic ions (greater than 100 keV) is much less than the number of thermal ions, they can be treated as test particles and can be followed in magnetic and electric field models. Ion acceleration at the bow shock and the magnetotail can also, at times, contribute to the energetic particle population of the inner magnetosphere. The goal of this proposal is to understand the population of the inner magnetosphere, particularly the slot region, by SEPs and accelerated solar wind ions. We will follow SEP test particles in the electric and magnetic fields from global magnetohydrodynamic (MHD) simulations of the magnetosphere. SEP test particles, based on measured upstream ion distributions will be launched in MHD simulations driven by solar wind measurements during the same interval. Even though SEPs can flood the inner magnetosphere the number entering that region compared to the number of particles upstream is small. To obtain penetration into the slot region between the inner and outer radiation belts (2-3 earth radii) will involve significant changes in this approach. Following ions backward in time can be used to identify regions accessible to energetic particles from the solar wind but does not yield their overall distribution. To obtain high-resolution maps of SEPs in the slot region, we propose to combine backwards and forward calculations. In addition we will also launch from secondary sources , that is, distributions of particles will be launched within magnetospheric boundaries based on the distribution in location, energy and pitch angle of an initial run of test particles starting from the solar wind. This process will be repeated for particles penetrating into the inner magnetosphere to obtain significant penetration into the slot region. Because it is difficult to extend the MHD inner boundary closer than about 2 earth radii, the MHD result will be supplemented by an analytic inner region field model (a dipole plus a perturbation) based on the MHD results. We will also study additional acceleration of the ions that penetrate into the inner magnetosphere due to ULF waves. We will determine the sources of energetic ion in the inner magnetosphere and the relative contributions of SEPs and energized solar wind particles. We will determine the conditions under which ions enter the inner magnetosphere in large numbers and the detailed process by which they become trapped. We will determine the energization mechanisms acting on the ions. The goal is the develop a model that can predict fluxes of energetic ions in the inner magnetosphere based on upstream solar wind conditions based on physical principles. We will also investigate idealized storm time intervals to understand quantitatively the dependence of the process of injection into the inner magnetosphere on basic parameters. Finally we will use our results to construct a simple predictive model.

Publication References:

no references