Project Details

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Project Title:
The Importance of Solar Energetic Ions for the Magnetosphere

PI Name: Robert L. Richard
PI Email: atn@g.ucla.edu
Affiliation: University of California, Los Angeles
Summary:
Solar energetic particles (SEPs) are electrons, protons, or heavy ions that are accelerated due to solar activity. Solar flares and interplanetary shocks associated with coronal mass ejections (CMEs) are the most important sources of these particles. SEP ions can be a major source of energetic particles for the Earth .s magnetosphere. We know several ways energetic ions can reach magnetospheric field lines. To understand the entry of these ions into the magnetosphere and to model it more quantitatively we need more detailed calculations of SEP entry and transport in realistic models of the magnetosphere and its interaction with the solar wind. One approach to quantifying ion entry and identify its mechanisms is to follow a large number of test ions in magnetic and electric field models of the magnetosphere. We have used global magnetohydrodynamic (MHD) models of the magnetosphere to obtain the magnetospheric fields for particle tracing calculations. Test particles (protons, electrons or heavy ions) were launched upstream of the magnetosphere in the solar wind at energies between 0.1 and 50 MeV. We have performed calculations for idealized steady and slowly varying interplanetary magnetic field (IMF) conditions; that is, the IMF was held steady or changed over an interval of half an hour. Often, however, SEPs accompany interplanetary shocks that cause disturbed, rapidly varying magnetospheric conditions. The coupling of SEPs with a shocked magnetosphere can strongly enhance ion entry. The goal of this proposal is to understand and quantitatively model this enhanced ion entry process. We will perform MHD simulations of the magnetosphere in which it is struck by a shock. Then we will calculate the trajectories of test ions in these field models. The question we wish to address is how ions enter a shocked, rapidly varying magnetosphere, because under these conditions ions can penetrate the inner magnetosphere in large numbers. The entry process may not resemble that for steady and slowly varying IMF. We will evaluate transport into the magnetosphere, especially into the inner magnetosphere, and precipitation at the Earth. Energetic particle measurements by geosynchronous satellites will be used to evaluate the features seen in the model results, such as a strong increase in SEP transport into the inner magnetosphere in the shocked case.

Publication References:

Summary: no summary

Reference: Richard, R. L.; El-Alaoui, M.; Ashour-Abdalla, M.; Walker, R. J.; (2002), Interplanetary magnetic field control of the entry of solar energetic particles into the magnetosphere, Journal of Geophysical Research (Space Physics), Volume 107, Issue A8, CiteID 1184, DOI 10.1029/2001JA000099, doi: 10.1029/2001JA000099