Project Details

ROSES ID: NNH07ZDA001N
Selection Year: 2008
Program Element: Focused Science Topic

Topic: Joint Focus Topics with Planetary Science: Extreme Space Weather Events in the Solar System

Project Title:
Extreme Solar Energetic Particle Events: Origin and Impact on the Moon, Mars, and Interplanetary Space Environment

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Summary:
Objectives: This proposal addresses "the quest to understand extreme space weather events and their effects throughout the solar system" formulated in the Focus Topic "Extreme Space Weather Events in the Solar System." The proposed activity is based on interdisciplinary knowledge of solar-heliospheric physics and space environment of the solar system. The scientific question for the proposed work is "What is the frequency of occurrence and the origin of the extreme solar energetic particle (SEP) events and their expected impact on the space environment at Moon, Mars, and interplanetary space." To answer this question we apply the following methodology: We will

1. estimate the expected frequency of occurrence of extreme SEPs using spacecraft data and reconstruct fluxes and fluencies (time integrated fluxes) of these events

2. evaluate space environments produced by the extreme SEP events at Moon, Mars, and in the interplanetary space using an environmental model developed by our team

3. demonstrate an insight as to what the solar conditions that give rise to the fast coronal mass ejections that produce extreme SEPs.

Expected Significance: Our first-cut modeling efforts will contribute toward initiating more detailed research that will lead to a better understanding the space hazards affecting space exploration. The estimation of expected frequency of occurrence of extreme SEPs can be used in designing future manned and robotic space missions.

The normalized response matrix concept we generate will advance the capability of studying the planetary radiation environment in a more systematic way, regardless of energy spectrum and elemental composition of the impinging SEPs. Currently, due to the lack of actual measurements of radiation environment, the understanding of the radiation exposure at the Moon and at Mars is based on transport analyses using different choice of tools. There has been no coherent effort to understand uncertainties in these estimates, which originate from many sources: soil composition and atmospheric profile, nuclear data used in the codes, etc.

The perceived impact of our study on the state of knowledge of the interplanetary space environment is that for the first time we will have a statistical, predictive SEP model that includes the proper distribution function of the events.

The association of the fast coronal mass ejections that produce extreme SEPs with clustering of solar magnetic activity will

stimulate the modeling of the clustering and underlying dynamo mechanisms causing the clustering of solar magnetic fields.

The proposed study will be used to better predict dynamic radiation environments for future NASA robotic and human missions to the Moon, Mars, outer planets, and interplanetary space. It will also provide a scientific basis for the space environment evaluations for the LWS missions such as the Solar Probe and the Heliophysical Explorers as well as for future planetary missions.

Relevance: The proposal is relevant to the Focus Topic 'f' of this AO. It directly addresses the LWS strategic goal 1: "Solar energetic particles and galactic cosmic rays pose major radiation hazards for space hardware and astronauts. Penetrating particle radiation adversely affects aircraft avionics and potentially the health of airline crews and passengers on polar flights. "In support of NASA's Vision for Space Exploration and the national communication, navigation, and transportation infrastructure, the TR&T needs to deliver the understanding and modeling required for useful prediction of the variable solar particulate and radiative environment at the Earth, Moon, Mars, and throughout the solar system."

Publication References:

Summary: no summary

Reference: Ruzmaikin, Alexander; Feynman, Joan; Jun, Insoo; (2011), Distribution of extreme solar energetic proton fluxes, Journal of Atmospheric and Solar-Terrestrial Physics, Volume 73, Issue 2-3, p. 300-307., doi: 10.1016/j.jastp.2009.12.016