

## 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 Particle Event Modeling

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**Summary:**

Neutron monitors are ground-based instruments that record the by-products of collisions between cosmic rays and molecules in Earth's atmosphere. At a rate of roughly 15 events per solar cycle, the Sun emits cosmic rays with sufficient energy (GeV range) and intensity to increase radiation levels on Earth's surface, resulting in a "Ground Level Enhancement" (GLE). A coordinated array of neutron monitors remains our best tool for studying and specifying these most extreme of solar particle events.

There are several reasons why modeling of GeV cosmic rays is relevant to NASA LWS:

- The GeV particles provide a particularly clear view of the particle injection profile at the Sun and of transport processes in interplanetary space, by virtue of their very high speed, comparatively large scattering mean free path, and the precise 3D directional information from the neutron monitor network, which is crucial for disentangling the injection profile from transport effects.
- For radiation hazard to pilots and air crews, GeV particles are the only ones that matter, because less energetic particles do not raise radiation levels on Earth's surface or at aircraft altitudes.
- While it is rightly asserted that particles in the tens of MeV energy range pose the most serious radiation hazard to unprepared astronauts, the astronauts would likely take shelter behind radiation shields during major solar events. However, it is unlikely the shields will be adequate to stop particles in the GeV range, and therefore an understanding of these particles is still of significance for mission planning.

We propose two tasks of relevance to the LWS Focused Science Topic "Extreme Space Weather Events in the Solar System."

- We will capitalize on our detailed analysis of past GLEs (e.g., Bastille event, Easter event, January 20, 2005 event), an analysis that has already forced us to include interplanetary magnetic field geometry beyond the orbit of Earth. We are uniquely positioned to extend this modeling to the orbits of Mars and Jupiter.
- We will use neutron monitor observations to model new events of Solar Cycle 24 as they occur, including expected effects at the orbits of Mars and Jupiter. (Based on historic averages, 3-4 GLE should occur during the term of this proposal, but if the Sun should not cooperate, we will instead extend our modeling to mid-size GLE of Cycle 23 that we have not previously considered.)

This project directly addresses NASA's strategic goals, in particular Strategic Sub-goal 3B: "Understand the Sun and its effects on Earth and the solar system" and Research Objective 3B.1: "Understand the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium."

**Publication References:**

no references