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Simultaneous Simulation of the Solar Energetic Protons and the Forbush Decrease in Galactic Cosmic Ray Flux Following the 14 July 2017 Event

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Galactic Cosmic Rays (GCRs) are a source of major radiation hazards in space, therefore the forecast and nowcast of their spectrum time evolution during the passage of Coronal Mass Ejections (CMEs) is a desired part of radiation hazard prediction models. GCRs are generated in galactic sources and propagate until they approach the heliopause, where their Local Interstellar Spectrum (LIS) can be used as boundary condition in GCR models.

To simulate GCRs prior to the eruptive event, we need to: (a) determine the LIS at the heliopause; (b) determine the steady-state spectrum in the Inner Heliosphere (IH); (c) and model the time evolution of GCR spectra throughout the IH. Our model employs the modulation potential to quantify the average energy loss of GCRs inside the heliosphere and map the LIS to smaller heliocentric distances by accordingly reducing the LIS energies and correcting the phase volume. This provides the boundary condition for GCRs at the outer boundary of the computational domain in our model (2-6 AU). Voyager-1 measurements are used to determine the LIS, with the modulation potential evaluated either from the GALPROP-HelMod framework or from the model by Corti et al (2019).

The Poisson bracket scheme is used to solve the particle transport both for the steady-state and eruption phases, with the dynamical state of the solar wind plasma and interplanetary magnetic field simulated within the Space Weather Modeling Framework of the University of Michigan. The refined SPECTRUM model, developed by the University of Alabama, will be used to compute the GCR diffusion coefficient. The CME event of July 14, 2017, for which we have already demonstrated the SEP production results, is simulated by superposing the erupting magnetic configuration by Gibson-Low (1998) with the parameters found with the Eruptive Event Generator by the Gibson-Low tool. Synthetic results for three-day evolution of GCRs at 1 AU will be compared with Oulu neutron monitor data (see figure below), as well as data from AMS-02.

Collaboration(s)

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