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Variability of the energetic particle population in the Earth's magnetosphere as a result of geomagnetic disturbances

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The Earth's energetic particle environment consists of several components of the ionizing radiation: galactic cosmic rays (GCRs), solar energetic particles (SEP), and particles populating two radiation belts. Of those, it is SEPs and GCRs that are critical for evaluating the safety of space operations performed in the LEO altitude range.

According to the current paradigm, GCRs are produced by diffusive shock acceleration in supernova remnants (e.g., Blandford & Eichler 1987) from which they diffuse to fill the whole galaxy. The composition of GCRs is dominated by H⁺ and He²⁺ (e.g., Simpson 1983; Mewaldt 1994). In order to be observed at the Earth, these charged particles have to penetrate the electromagnetic fields of the heliosphere, which is a region around the Sun extended further than 100 AU, and dominated by the solar-wind plasma and by the interplanetary magnetic field (IMF). SEPs are energetic particles ejected by the Sun in events that are correlated with coronal mass ejections (CMEs) and solar flares (e.g., Reames 1999).

GCR and SEP particles with energies below 100 MeV/n are effectively shielded by the Earth's magnetosphere (Badavi et al. 2011; Vainio et al. 2008; Badhwar 1997). Transmission of these particles is usually described in terms of the cutoff rigidity. Since the cutoff rigidity depends on the geomagnetic field, a perturbation of the magnetosphere during an active time can result in a variability of the cutoff.

In this presentation we will address fundamental questions of the variability of the geospace radiation environment due to GCRs and SEPs in response to that of the Earth's magnetosphere. That will be done by modeling of propagation of SEPs and GCRs in the magnetosphere using our Adaptive Mesh Particle Simulator (AMPS), which is a global Monte Carlo particle code describing dynamics of the relativistic particles affected by the geomagnetic field. We will present results of our calculations of fluxes and energy spectra of SEPs and GCRs in the altitude range starting from GEO, and going down to LEO during quiet and active solar conditions.

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