Project Details

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Topic: Characterization of the Earth's Radiation Environment

Project Title:
Effect of solar variability on the geospace radiation environment

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Summary:
The aim of the proposed investigation is to characterize the time-varying Earth s radiation environment due to SEP and CGRs, and response of this environment to their temporal variability affected by the Sun. In order to achieve these goals we will determine fluxes and energy spectra of SEP and GCRs in the region starting from the magnetopause to the LEO s altitudes.

In this investigation we will analyze energetic proton spacecraft observations, and use them for the model validation. The necessary modeling that will be performed as a part of the proposed study includes two major components: 1) kinetic simulation of SEP and GCRs by tracing them in the magnetosphere starting from the magnetopause to the LEO s altitudes, and 2) MHD modeling of the magnetosphere to obtain the global variations of magnetic and electric fields.

The novel feature of our approach is that the necessary modeling of the magnetosphere, SEP, and GCRs will be performed simultaneously as two part of the same model run, where a magnetic field acting upon energetic particles will be time-dependent and updated as modeling of the magnetospheric plasma progresses.

Distribution and energy spectra of SEP and GCRs in the magnetosphere will be determined by tracking their trajectories starting from the magnetopause where they are injected into the magnetosphere. Flux and energy spectrum of SEP at the magnetopause will be derived from modeling of the SEP propagation from the Sun to the Earth performed with the Field-Line-Advection Model for Solar Particle Acceleration (FLAMPA) model. Parameters of GCRs at the magnetopause will be specified with the ISO-15390 model.

Propagation of SEP and CGRs inside the magnetosphere will be simulated with the Adaptive Mesh Particle Simulator (AMPS) that will trace their trajectories as they move inside the magnetosphere. Electric and magnetic fields that are needed for calculating of these trajectories will be derived from MHD modeling of the magnetosphere conducted with a global MHD model BATSRUS. At altitudes bellow the lower limit of the BATSRUS simulation domain we will use the IGRF magnetic field model, and neglect an effect of the electric field on energetic particle propagation.

The model results will be validated by comparing the calculated SEP and GCRs fluxes and energy spectra with observation of high-energy proton fluxes made at different locations in the magnetosphere, which includes GOES EPEAD (0.74 900 MeV) and GOES HEPAD (330 700 MeV, > 700 MeV) measurements in GEO, Van Allen Probes RPS (50 MeV to 2 GeV) and REPT (above 100 MeV) inside GEO, and ISS AMS-02 at LEO.

The proposed research program is focused on assessment of the geospace radiation environment starting from ISS s altitudes of 300-400 km, and up to GEO. It combines both modeling of the SEP, GCRs, and the magnetospheric plasma with the spacecraft energetic proton observations for tuning and validating of the employed models. The proposed work addresses fundamental questions of the temporal variability of the geospace radiation environment that has important implications for evaluating effects of the solar variability, GCRs and SEP on performance and operation in space in a varying environment. The most important contribution of the proposed work to the Focused Team Effort will be characterization of the geospace radiation environment due to SEP and GCRs during quiet, active, and extreme conditions, which is important for understanding of the dynamics of the inner radiation belt, and for assessing of the spacecraft radiation environment due to energetic protons. All above makes the proposed investigation relevant to the Focus Science Topic Characterization of the Earth Radiation Environment supported by LWS.

Publication References:

no references