Data-driven model for the dynamics of the outer radiation belt in inner magnetosphere

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Energetic particles in Earth's geomagnetic fields and in solar energetic particle events can damage satellites operating in geospace. All satellites at geosynchronous, medium Earth, and low Earth orbits are at risk from the energetic particles. Electrons with energy about a few keV, which are generally transported from plasma sheet into the outer radiation belt, can cause surface charging of satellites, resulting in an electrostatic discharge and component damage. Higher energy electrons can cause internal satellite charging which also induces the electrostatic discharge that gives damage on dielectric material in the satellite. So electron radiation belts, which suddenly enhance their flux intensity more than 1000 times within a day through substorms and geomagnetic storms, pose a threat to satellites operating in the geospace. Forecasting the Earth's radiation belts are in great demand these days in terms of satellite risk management.

Now we are developing a data-driven model to calculate the electron phase space density of the outer radiation belt in inner magnetosphere. The model consists of some empirical models and physical models. Tsyganenko model for the geomagnetic fields, Weimer model for the electric potential fields to reproduce three-dimensional electric fields for plasma convective motion, and a radial diffusion model for adiabatic scattering are utilized to demonstrate trajectories of radiation belt electrons. Plasma sheet model (Tsyganenko-Mukai model) is used to estimate the boundary condition of the outer radiation belt. Further we are planning to import nonadiabatic local acceleration/loss models including nonlinear scattering processes. All models are driven by solar wind parameters, such as the wind speed, density, and interplanetary magnetic fields. We introduce the solar wind data-driven model that aims for empirical/physical-based realtime forecast for the outer radiation belt.

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