

Empirical/physical-based modeling of three-dimensional outer radiation belt for real-time operation

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Radiation belt electrons are controlled by various processes occurring in the earth's magnetosphere. Time and spatial scales of the processes are very broad, so it is difficult to demonstrate dynamics of electron radiation belts by only one physics-based model. Coupling of several models would be necessary to demonstrate radiation belt dynamics.

There are various empirical models to estimate the conditions of the earth's magnetosphere. If we can appropriately couple these empirical models, we might be able to reproduce the temporal variation of the geospace condition, and apply it to solve dynamics of radiation belt electrons using physics-based model. Based on this idea, we are developing the three dimensional radiation belt model coupling both empirical models for global dynamics, and physics-based models for electron kinetic dynamics, in order to forecast energetic electron environment at any location in magnetosphere.

In this talk we will introduce a provisional version of the three-dimensional (global) radiation belt model. This model couples two empirical models and one physics-based model to form the global radiation belt model. Empirical models used here calculate three-dimensional magnetic field configuration (Tsyganenko model TS04) and an energetic electron distribution $j(L,E)$, where L is a L -value, E is an electron kinetic energy. Both models can be driven by real-time solar wind data set. As a physics-based model, we use a guiding-centered test-particle model, which calculates trajectories of energetic test-electrons in the three-dimensional magnetic field. The global radiation belt model imports real-time solar wind data, and calculates the magnetic field configuration and energetic electron flux distribution in L and E using empirical models. The test-particle model, which is the physics-based model, expands the electron flux distribution in L coordinate into that in the three dimensional GSM coordinate in earth's magnetosphere, by tracing adiabatic trajectories of test-electrons with energy E .

By tracing all of test-electrons distributed in outer radiation belt region, the model enables us to calculate phase space density in three-dimensional outer radiation belt. The model with higher-versions is expected to incorporate particle scattering processes corresponding to radial diffusion, pitch angle scattering, and nonlinear acceleration. The goal of this model is to demonstrate the temporal variation of three dimensional electron radiation belt governed by many kinds of electron scattering processes for real-time operation.

Keywords: electron radiation belt, numerical modeling, test-particle simulation