Geophysical Research Abstracts
Vol. 21, EGU2019-9577, 2019
EGU General Assembly 2019

Modeling transport and loss of ring current electrons during 17 March 2013 storm using the VERB-4D code

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Ring current electrons (1-100 keV) provide from 10 to 25% of the ring current energy during storms, contribute to radiation belt electron loss and acceleration by exciting chorus waves and may lead to satellite surface charging. Many questions regarding transport and loss of the electrons still remain open primarily due to lack of global in-situ satellite observations, and physical models of the electron dynamics in the inner magnetosphere are required to understand the driving processes in detail. One issue that complicates modeling the dynamics of the ring current electrons consist in unknown uncertainties of the input parameters such as boundary conditions, global magnetic and electric fields, electron loss rates or diffusion coefficients, and the plasmapause location.

In this work, we use the four-dimensional Versatile Electron Radiation Belt (VERB-4D) code to understand the mechanisms which control the ring current electron dynamics and study the sensitivity of the model to the uncertainties in the input parameters during the geomagnetic storm that occurred on 17 March 2013. We set up spatial outer boundary conditions at the geostationary orbit (GEO) since the errors in the boundary conditions can be significantly reduced by using an extensive dataset of electron flux measurements. By using statistical models of the flux at GEO, we estimate an approximate confidence interval of the model and show that the Van Allen Probe observations fit in the confidence interval for radial distances above 3.5 Earth's radii. By varying other input parameters, we show that the model results are most sensitive to the global electric field and electron lifetimes. The agreement between the model and data also indicates that the global convective transport can explain the dynamics of the ring current electrons inside GEO during 17 March 2013 storm.