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Combined Radiation Belt - Plasma Sheet System Modeling

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Recent years have given rise to numerous mathematical models of the Earth's radiation belt dynamics. Driven by observations at geosynchronous orbit (GEO) where satellites (e.g. GOES and LANL) provide extensive in-situ measurements, radiation belt models usually take into account only diffusion processes in the energetic electron belts (100 keV and greater), leaving aside the dynamics of colder source population (tens of keV). Such models are able to reconstruct the radiation belt state, but they are not capable of predicting the electron dynamics at GEO, where many communication and navigation satellites currently operate.

In this work we present combined four-dimensional electron radiation belt - plasma sheet model accounting for adiabatic advective transport, radial diffusion due to interaction with ULF waves, local acceleration of electrons, scattering into the atmosphere, magnetopause shadowing, and adiabatic effects due to contraction and expansion of the magnetic field. The developed model is applicable to energetic, relativistic and ultrarelativistic electrons as well as to source electron population. The model provides spatial particle distribution allowing us to compare and validate the model with multiple satellite measurements at different MLT sectors (e.g. Van Allen Probes, GOES, LANL, THEMIS). The model can be helpful for the prediction of crucial for satellite operators geosynchronous electron fluxes and electron radiation belt dynamics including the heart of the outer belt, slot region and inner belt.