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Challenges and Innovations in Data Assimilation for Radiation Belts

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A striking feature of the radiation belts is that values of observed electron fluxes and modeled phase space density (PSD) vary by several orders of magnitude. This extremely wide range may present certain problems for standard data assimilation methods, such as the Kalman filter and its various implementations. In this study, we rely on log-transformed PSD and subsequent nonlinear modifications to Kalman-filter—type methods, to make it more efficient for assimilating data in the radiation belts by using a 1-D diffusion model and observations from multiple satellites. We present sensitivity simulations using synthetic data, as well as actual satellite observations using the conventional data assimilation algorithms, on the one hand, and algorithms developed in this study, on the other.