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The use of event-specific models in DREAM3D

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DREAM3D is a 3D Fokker-Planck diffusion code that has been used to model the dynamic evolution of MeV electrons in the radiation belts. The effects of drift-resonant ultra-low frequency (ULF) waves and gyro-resonant very-low frequency (VLF) waves, are modelled with quasilinear theory, which yields a 1D diffusion equation in dipole L at fixed values of the first and second invariants, and a 2D diffusion equation in pitch-angle and momentum at fixed L. The 1D and 2D diffusion equations are decoupled in DREAM3D because the background field is assumed to be a dipole and the ‘cross-terms’ are ignored. The diffusion coefficients are determined by the wave intensity in the ULF and VLF frequency ranges, and historically have been determined by statistical models for the wave intensity that depend on geomagnetic activity. Recently we have shown that the statistical models do not always perform well for a specific event, but ‘event-specific’ models that combine in-situ observations with the statistical models can be used to improve the model. For example, we have used measurements of the low-energy ($\sim$100 keV) population generated by the Van Allen Probes MagEIS instrument to define a low-energy boundary condition for DREAM3D as a function of time and L, and showed that modeling this ‘seed population’ correctly is critical for the model to predict the observed acceleration during the October 2012 storm. Similarly, we combined observations of the equatorial chorus wave intensity from the Van Allen Probes EMFISIS instrument, with precipitation observed by the NOAA POES instrument, to define an event-specific low-band chorus wave intensity. We showed that an event-specific model for the low-band chorus wave intensity is also critical for the model to predict the observed acceleration during the same storm. Our current efforts are aimed at extending our recent work on using event-specific models by incorporating non-dipole field models into DREAM3D for calculating more realistic radial and pitch-angle/momentum diffusion coefficients. In this talk, I will review our earlier results for the October 2012 storm using the dipole field model, present our approach to computing radial diffusion coefficients using the background field models developed by Tsyganenko and co-authors, and new results from DREAM3D using the new radial diffusion coefficients.