

Including VLF Wave Interactions in a Comprehensive MHD/Particle Simulation of the Radiation Belts

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Global magnetohydrodynamic (MHD) simulations of the Earth's interaction with the heliospheric environment provide a computationally-tractable means of understanding the large-scale response of the Earth's magnetosphere to driving by the solar wind. Global wave generation and propagation, magnetic reconnection, convection, and the effect of external currents on magnetospheric configuration are all physical features that can be approximated by the MHD method.

Considerable physical insight may be gained by combining global MHD simulations with test particle simulations of the energetic particles comprising the radiation belts. Such simulations have been used to study, for example, the injection of solar energetic particles into Earth's inner magnetosphere, the diffusion and transport of energetic electrons in the outer zone radiation belts, and the access of plasmasheet particles to the stable trapping region around the Earth. However, fully-3d test particle simulations can be computationally expensive, even under the guiding-center approximation, and MHD/test particle simulations generally do not include the effects of higher-frequency (VLF) waves that may be important in describing radiation belt particle acceleration and loss. In this work we describe a new bounce-averaged test particle simulation method that allows tracking the transport and evolution of the radiation belts in response to the global processes described by magnetospheric MHD models, and suggest how these methods can be extended to include the effect of non-MHD waves on the radiation belts.