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Cross-Energy Coupling in the Inner Magnetosphere: Simulations and Comparisons with Van Allen Probe Observations

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The energies of charged particles trapped in the complex near-Earth region called the inner magnetosphere (distances from Earth smaller than ~10 R_E) span approximately six orders of magnitude. We investigate the coupling of these particle populations across multiple scales using our ring current-atmosphere interactions model (RAM), which is two-way coupled with a 3-D equilibrium code (SCB) and a cold plasma model (CPL), developed as part of the SHIELDS framework [1, 2] at Los Alamos National Laboratory (LANL) (http://www.lanl.gov/projects/shields/index.php). The RAM-SCB-CPL model solves the kinetic equation for H^+, He^+, and O^+ ions and electrons using a self-consistently calculated magnetic field in force balance with the anisotropic ring current plasma pressure. It also calculates the cold electron density in the equatorial plane by following the motion of individual flux tubes. It uses an electric field model that includes a corotation potential and a choice of convection potential from a) semi-empirical models, or b) self-consistently calculated electric potential, mapped to the equatorial plane along SCB field lines. We simulate the transport, acceleration, and precipitation of hot (keV) electrons representing the source and seed populations of the radiation belts during geomagnetic storms and substorms. We find that the local acceleration by plasma waves of freshly injected electrons, occurring at the injection boundary, may be significant at energies as low as ~50 keV and could strongly impact the ring current and radiation belt flux enhancements. Model results are compared with high-quality observations from NASA's Van Allen Probes ECT and EMFISIS investigations. The combined effects on magnetosphere dynamics from global transport and wave-particle interactions are discussed, with the goal to provide a better understanding of the cross-energy and cross-region coupling in the inner magnetosphere.

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2. V. K. Jordanova et al., "Specification of the near-Earth space environment with SHIELDS", *J. Atm. Sol.-Terr. Phys*., 26 November 2017, https://doi.org/10.1016/j.jastp.2017.11.006.