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Understanding the Radiation Belt Dropouts During May 2017 storm by VERB simulations

The Earth's outer radiation belt is a highly dynamic region populated by energetic electrons that can pose potential threats to the satellites running in outer space. Among the most dramatic variations is the radiation belt dropout, defined as MeV electron fluxes drop by orders of magnitude within a short timescales. Two main mechanisms have been proved to explain these losses: electromagnetic ion cyclotron (EMIC) waves scattering and outward transport across the magnetopause (MP), also known as MP shadowing. However, the relative contribution of these processes during storm-time conditions is still unknown. In this study, we investigate a dropout event observed by the Van Allen Probes during the intense geomagnetic storm of May 2017. The electron flux shows significant losses during the storm main phase, with a pronounced butterfly pitch angle distribution structure, indicating a strong influence of MP shadowing. Phase space density profiles are further analyzed to reveal the real loss mechanisms. Then, simulations are performed with the Versatile Electron Radiation Belt (VERB) code to quantitatively assess the role of each mechanism. Specifically, different MP models are implemented and used to reproduce the observed electron losses. In parallel, the contribution of EMIC waves is quantified by enabling or disabling EMIC-driven pitch-angle diffusion (with other drivers held fixed) and comparing the resulting loss signatures.

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