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Energetic Electron Precipitation Driven by Magnetospheric Waves: ELFIN CubeSat Observations and Simulations

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Wave-particle interactions play an important role in the loss process of energetic particles trapped in the planetary magnetospheres. UCLA's Electron Losses and Fields Investigation (ELFIN) is a dual CubeSat mission to evaluate energetic particle precipitation from the Earth's radiation belts into upper atmosphere by providing particle measurements with unprecedentedly high resolution in both pitch angle and energy. We present a few interesting conjunction events where energetic electron precipitation is measured together with magnetospheric waves (e.g., whistler mode waves, electromagnetic ion cyclotron waves) from near-equatorial and mid-latitude satellites (e.g., THEMIS, Arase, Van Allen Probes, etc.) and/or energetic particle precipitation from other Low-Earth-Orbiting satellites (e.g., POES/MetOp, FIREBIRD, etc.). These multi-point measurements are used to identify the drivers that lead to the energetic electron precipitation features (e.g., energy spectra, pitch angle distributions, precipitation rates) observed by ELFIN. We further quantify energetic electron precipitation using physics-based simulations (e.g., quasilinear and test particle simulations) based on the observed wave and plasma parameters to evaluate the quantitative roles of various magnetospheric waves in energetic electron precipitation. Since the dual ELFIN CubeSats provided excellent coverage in an extensive region of the Earth's magnetosphere over the past several years, we present the statistical results of energetic electron distribution at low altitudes based on the ELFIN observations, including their energy dependence, pitch angle distribution, and spatial distribution. Our findings are critical to reveal the underlying physics of the observed energetic electron precipitation and evaluate energy inputs from the magnetosphere into the upper atmosphere through wave-particle interactions, not only at Earth, but also at other magnetized planets.

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