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Timescales of wave-particles interactions in the outer radiation belts: effects of waves and plasma parameters

Oleksiy V Agapitov(1), Didier Mourenas(2), Anton Artemyev(3), Andrii Voshchepynets(1),
(1) SSL UC Berkeley, Berkeley 94720, CA, USA; (2) CEA, DAM, DIF, Arpajon, France;
(3) UCLA, Los Angeles, USA

Electron scattering by chorus and hiss waves is an important mechanism that can lead to fast electron acceleration and loss in the outer radiation belt. Making use of Van Allen Probes measurements, we present the statistical survey of MeV volt electron pitch angle and energy quasi-linear diffusion rates by chorus and hiss waves as a function of L-shell, local time, and AE index, taking into account the local the ratio ωpe/Ωce (where ωpe is the local electron plasma frequency to and Ωce is the local electron gyrofrequency), chorus and hiss wave frequency, wave normal angle, and resonance wave amplitude dependences on latitude. We demonstrate that during disturbed periods, ωpe/Ωce strongly decreases in the night sector, leading to a faster electron loss but also a much faster electron energization in two distinct regions just above the plasmapause and at L 3.0–5.5 (1). We use Van Allen Probes measurements to provide the first comprehensive statistical survey of plasmaspheric hiss-driven quasi-linear pitch-angle diffusion rates and lifetimes of MeV electrons as a function of L*, local time, and AE index, taking into account hiss power, electron plasma frequency to gyrofrequency ratio ωpe/Ωce, hiss frequency at peak power ωm, and cross correlations of these parameters (2). We find that during geomagnetically active periods with hiss observations, ωpe/Ωce and ωm decrease, leading to faster electron loss. We demonstrate that spatiotemporal variations of ωm and ωpe/Ωce with AE, together with wave power changes, significantly affect MeV electron loss, potentially leading to short lifetimes of less than 1 day. A parametric model of MeV electron lifetime driven by AE for L > 2.5 up to the plasmapause is developed and validated using Magnetic Electron Ion Spectrometer (MagEIS) electron flux decay database. Spatiotemporal variations of ωpe/Ωce with AE shape the evolution of electron energization in the outer belt, sometimes leading to very short time scales for quasi-linear MeV volt electron acceleration in agreement with Van Allen Probes observations.

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