Timescales of electrons wave-particle interactions with chorus and hiss in the outer radiation belts: the Van Allen Probes results

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Whistler-mode hiss waves generally determine MeV electron lifetimes inside the plasmasphere. 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 ω_{pe}/Ω_{ce}, hiss frequency at peak power ω_m, and cross correlations of these parameters. We find that during geomagnetically active periods with hiss observations, ω_{pe}/Ω_{ce} and ω_m decrease, leading to faster electron loss. We demonstrate that spatio-temporal variations of ω_m and ω_{pe}/Ω_{ce} with *AE*, together with wave power changes, significantly affect MeV electron loss, potentially leading to short lifetimes of less than one 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. The spatio-temporal variations of ω_{pe}/Ω_{ce} with *AE*, together with wave power and frequency changes, strongly affect 1-MeV electron lifetimes, potentially leading near $L^* = 2.6$ to very short lifetimes of less than ~1 day during active periods with $AE > 500$ nT (down to ~6 hours for $AE > 1000$ nT), and explaining the observations reported in (Claudepierre et al., Geophys. Res. Letters, 2020) without requiring additional electromagnetic ion cyclotron (EMIC) waves to reach such small lifetimes.

A parameterization of MeV electrons lifetimes due to hiss-driven pitch-angle scattering has been developed, valid for AE = 0 up to 1100-1200 nT at $2.6 < L^* < 3.5$ and up to 900-1000 nT at $L^* = 3.5 - 4.5$ inside the plasmasphere. The plasma- and wave-based lifetimes are in good agreement with recent measured electron lifetimes from the Van Allen Probes (Claudepierre et al., Geophys. Res. Letters, 2020) in the region of efficient electron scattering by hiss waves (from L^*~2.6 up to the plasmapause) between L^*=2.6 and L^*=3.9 for AE = 0 up to 400 nT at least. Therefore, this recalculated lifetime model can explain the behavior of 1-MeV electrons in the L^* range from 2.6 to ~3.9, and it can be used as a realistic estimation of hiss contribution to electron precipitation rates above $L^* = 3.8$ or at higher electron energies, where the contributions from EMIC and chorus waves may become significant.