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The effect of VLF transmitter waves on the inner belt and slot region

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During large geomagnetic storms, high energy electrons can be transported into the slot region and the inner radiation belt. In the slot region the electrons can persist for days to weeks, while in the inner belt the timescales are much longer and can reach years. Understanding the decay process involved is therefore of great importance from both a physical and practical point of view since enhanced fluxes of relativistic electrons can damage satellites. It has been shown that wave-particle interactions play a significant role in electron precipitation though pitch-angle scattering, removing electrons from the belts. At low L shells in the inner belt, hiss waves are of low amplitude and are ineffective at electron scattering. VLF waves from the ground based VLF transmitters are found to permeate the ionosphere into the plasmasphere on the nightside. Along with MLT variation, these signals are highly localised above their source transmitter. Additionally, these waves are at well-defined frequencies with minimal bandwidth, $\sim$100Hz. Owing to their higher frequency than hiss, 18.3-26.7kHz, and their high amplitude, VLF waves can be more effective at electron pitch-angle scattering in the inner belt. In this study we explorer the geographic and MLT dependence of transmitter wave power and how this effects electron diffusion. We use data from Van Allen probe, RBSP-A, to construct global models of the wave power and a corresponding electron diffusion coefficients for each individual transmitter. Previous studies have typically averaged coefficients over MLT and longitude to incorporate into 3D based Fokker-Planck radiation belt models. With the global distribution now available we check the validity of this approach by constructing an MLT and longitude dependent electron pitch-angle diffusion model. Decay timescales are calculated and comparisons made with previous averaged results. Electron lifetimes in the slot region can be reduced by an order of magnitude at low energies, $\sim$100keV, with the inclusion of the VLF transmitter waves. Further in, their effect is strongest for higher energy electrons, $\sim$800keV, but their electron lifetime reduction is more modest. The operation of NWC, a transmitter in west Australia, is able to partially fill the drift loss cone and consequently give ‘wisp’ features in electron intensity that are consistent with DEMETER observations.