Systematic Evaluation of Low-Frequency Plasmaspheric Hiss Wave Generation and Its Effects on Radiation Belt Electron Dynamics

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The excitation of low frequency (LF) plasmaspheric hiss, over the frequency range from 20 Hz to 100 Hz, is systematically investigated by comparing the hiss wave properties with energetic electron injections. Both particle and wave data from the Van Allen Probes during the period from September 2012 to June 2016 are used in the present study. Our results demonstrate that the intensity of LF hiss has a clear day-night asymmetry, and increases with enhanced geomagnetic activity, similar to the behavior of normal hiss (~100 Hz to several kHz). The occurrence rate of LF hiss in association with electron injections is up to 80% in the outer plasmasphere ($L > 4$) on the dayside peaking particularly in the afternoon sector, and the strong correlation extends to lower L shells for more active times. In contrast, at lower L shells ($L < 3.5$), LF hiss is rarely associated with electron injections. The LF hiss with Poynting flux directed away from the equator is dominant at higher magnetic latitudes and higher L shells, suggesting a local amplification of LF hiss in the outer plasmasphere. The averaged electron fluxes are larger at higher L shells where significant LF hiss wave events are observed. Our study indicates that energetic electron injections and their subsequent drift towards the dayside plasmasphere play an important role in local amplification of the LF hiss waves.

We also evaluate pitch angle scattering rates for radiation belt electrons caused by plasmaspheric hiss using the new statistical frequency spectrum including LF hiss. Our results show that the differences are up to a factor of ~5 and are dependent on energy and L-shell compared to the pitch angle scattering rates calculated based on the previously adopted Gaussian frequency distribution without including LF hiss. Consequently, we suggest that realistic hiss wave frequency spectrum including LF hiss should be incorporated into future modeling of radiation belt electron dynamics.