Plasmaspheric hiss wave amplitudes inferred from low-altitude measurements of energetic electrons

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The Van Allen radiation belts represent a risk to humans and satellites orbiting these regions, and so it is important to have predictive capabilities of their dynamic behavior. The flux of energetic electrons in the outer radiation belt can vary by several orders of magnitude in a few hours, which is due to an imbalance between source and loss processes mainly caused by the interaction between high-energy electrons and magnetospheric waves. Accurate modeling of these waves is key to understand the variability of this environment. Statistical wave models are commonly the input to diffusion simulations, which are broadly used to study the effect of magnetospheric waves on the energetic particles that populate the radiation belts. The statistical nature of these wave models, however, may not be capable of reproducing the real and instantaneous distribution of some wave events, which are therefore left out from the diffusion simulations. In the present study we address this issue by presenting a novel technique capable of inferring the instantaneous wave amplitude from low-altitude measurements of energetic trapped and precipitating electrons. More specifically, we use electron measurements from the Medium Energy Proton and Electron Detector (MEPED) instruments onboard the POES spacecraft, which have the advantage of providing broad coverage in L-shell and magnetic local time within the inner magnetosphere. In contrast, in-situ wave observations used to build the previously mentioned statistical wave models are taken from satellites with orbits that have limited coverage. More specifically, we use the measurements of energetic electrons from the POES spacecraft to infer the amplitude of plasmaspheric hiss waves, which are an incoherent whistler mode emission commonly found within the dense plasmasphere and dayside plasmaspheric plumes. Hiss waves have been shown to be responsible for the formation of the slot that appears between inner and outer radiation belts, and they can also contribute to the scattering of energetic electrons during active times, or to the slow decay of the outer radiation belt that follows geomagnetic storms.

In this study we evaluate the performance of the technique described above applied to hiss waves by comparing the wave amplitudes inferred from POES electron data with in-situ conjunctive wave observations from the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) instruments onboard the Van Allen Probes. Additionally, we study the sensitivity of the methodology to its input parameters: the wave frequency spectrum, the plasma density, and the electron energy spectrum. This new technique represents a step forward towards the development of an instantaneous global plasmaspheric hiss wave model, which may be key to study the dynamic variability of the electron radiation environment.