Statistical Properties of Plasmaspheric Hiss from Van Allen Probes

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Plasmaspheric hiss is a whistler-mode wave that is typically observed in the high-density regions of the plasmasphere, or in plasmaspheric plumes. This wave mode has been shown to play an important role in driving particle dynamics in the inner magnetosphere, namely pitch angle scattering of radiation belt electrons resulting in a net depletion as particles temporarily populate the bounce loss cone and are subsequently lost to the atmosphere. It is widely believed that this is the primary mechanism for causing the slot region between the inner and outer radiation belts. One well-established theory is that plasmaspheric hiss originates from whistler-mode chorus waves penetrating into the plasmasphere at high latitudes from a source location close to the equatorial plane at larger L shells. This source mechanism has been shown to be able to reproduce typical hiss wave power, frequency range, and spatial structure.

Previous studies have reported both an approximately field-aligned, and a highly oblique, population of plasmaspheric hiss waves only at larger L shells. Here, a statistical investigation of plasmaspheric hiss wave properties from the Van Allen Probes EMFISIS instrument is performed over a range of different L shells within the plasmasphere. The results of this analysis show that the wave normal direction of plasmaspheric hiss is predominantly field aligned at larger L shells, with a bimodal distribution, consisting of a more field aligned and a highly oblique component, becoming apparent only at smaller L shells. Investigation of this oblique population reveals that it is most prevalent at $L<3$, frequencies with $f/f_{ce}>0.01$ (or $f>700$ Hz), low geomagnetic activity, and between 1900 and 0900 MLT. This structure is similar to that reported for oblique chorus waves in the equatorial region outside of the plasmasphere, perhaps suggesting a causal link between the two wave populations.

The plausibility of this link has been tested using the HOTRAY ray tracing code, with results indicating that it is indeed plausible for chorus waves generated at oblique angles to become field aligned at high latitudes before entering the plasmasphere to be observed as oblique plasmaspheric hiss at low L shells. These new results highlight the variable distribution in both power spectral density and wave normal angle of two discrete plasmaspheric hiss wave modes that must be considered in future studies if we are to gain a more complete understanding, and accurate predictive capability, of particle interactions with plasmaspheric hiss.