Distributions of Wave Power in the Inner Magnetosphere as Organized by Plasmapause Location

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Plasma waves observed in the ELF and VLF frequency range are known to be responsible for significant acceleration, loss, and scattering of charged particles in the inner terrestrial magnetosphere. Relevant wave modes include whistler-mode waves (e.g. chorus, hiss), magnetosonic waves, Doppler-shifted kinetic Alfvén waves, and kinetic-scale electric field structures (e.g. double layers, phase space holes). Many of these waves play a critical role in predictive models of inner magnetosphere dynamics, including radiation belt dynamics. Further, many such models use statistical maps of wave power as inputs, with wave power organized by distance from Earth (often using L-values), magnetic local time (MLT), and geomagnetic activity.

However, plasma wave power is more naturally organized by the location of plasma boundaries (such as the plasmapause). These boundaries represent abrupt changes in plasma conditions that enforce differences in wave growth and propagation between spatially adjacent regions. Sorting wave power by L can obscure the role of plasma boundaries in wave growth and propagation, and can result in wave maps with artificially broad spatial distributions of wave power or non-physical spatial overlap of wave modes.

We construct statistical maps of several plasma wave modes, organized by plasmapause location (also MLT, MLAT, and geomagnetic activity), to explore the distribution of plasma waves in the inner magnetosphere with respect to the plasmapause. We compare plasmapause-sorted wave maps with traditional L-sorted wave maps, and find that: (1) Plasmapause-sorting produces more distinct spatial separation of wave modes and, in some cases, narrower spatial distributions of wave power. (2) Plasmapause-sorting reveals variations in wave properties with distance from the plasmapause that can lead to new insights into the physics of wave growth and propagation, while L-sorting washes out these variations.

We use Van Allen Probes data for this study because of the unprecedented measurement accuracy, cadence, and spatial/temporal coverage afforded by the Van Allen Probes mission.