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Whistler-Mode Waves Sorted Relative to the Plasmapause Location: A Comparison Between "Hard" and "Soft" Plasmapause Gradients

David P. Hartley* [(1)], Jean-Francois Ripoll [(2)], David M. Malaspina [(3, 4)], Scott Thaller [(5)], Evan Tyler [(6)], Elvis Fusina [(6)], Ivar Christopher [(1)], and Ondřej Santolík [(7, 8)]

(1) University of Iowa, Iowa City, IA, USA; e-mail: david-hartley@uiowa.edu
(2) CEA, DAM, DIF, Arpajon, France
(3) Astrophysical and Planetary Sciences Department, University of Colorado, Boulder, CO, USA
(4) Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, USA
(5) Orion Space Solutions, An Arcfield Company, Louisville, CO, USA
(6) College of St. Scholastica, Duluth, MN, USA
(7) Institute of Atmospheric Physics, Prague, Czech Republic
(8) Charles University, Prague, Czech Republic

Whistler-mode waves are often categorized by L, MLT, latitude, and geomagnetic activity. However, more recent studies have retained the fundamental physical coupling between wave properties and the plasma density by parameterizing whistler-mode wave properties by their location relative to the plasmapause. The plasmapause is frequently used as a metric for separating different whistler-mode wave types. This can be problematic, as only ~50% of Van Allen Probe half-orbits contain a density gradient that would be categorized as the plasmapause, using the definition of a drop in the density by a factor of 5 within half an L-shell (i.e., a "hard" plasmapause). For the remaining half-orbits, the boundary between the plasmasphere and plasmatrough is ill-defined, with weak density gradients that can span large distances (i.e., a "soft" plasmapause). These data are often excluded from statistical studies, resulting in whistler-mode wave property databases constructed using only data from intervals when the plasmapause is "hard". The result is a potential bias towards specific geomagnetic conditions, wave amplitudes, and therefore particle scattering, acceleration, and precipitation.

Here, whistler-mode wave properties are compared between cases of "hard" and "soft" plasmapause boundaries, providing a new perspective on the wave environment in this region. For orbits where a "hard" plasmapause is identified, we find that the sharp density gradient is statistically co-located with the 100 cm^{-3} density threshold, L_{100}, allowing for the use of L_{100} as a proxy for the plasmapause location. In these cases, we observe a sharp reduction in whistler-mode wave power at L_{100}, indicating a clear spatial boundary for hiss waves associated with the density gradient at the "hard" plasmapause. However, in "soft" cases where no gradient-identified plasmapause exists, whistler-mode wave power reduces much less abruptly at L_{100}, with significant wave power extending much further - indicative of the outward extension of hiss/exo-hiss. We find that whistler-mode wave power near L_{100} can be up to an order of magnitude larger in the case of "soft" plasmapauses compared to "hard" plasmapauses. This significant wave power is unaccounted for if waves are parameterized relative to the gradient-identified plasmapause, and the "soft" plasmapause cases are disregarded. Furthermore, even under similar geomagnetic activity, there can be significant differences in the location of L_{100} for "hard" vs. "soft" plasmapause cases. These differences in both wave power and plasmapause boundary location may lead to inaccurate inputs to wave-particle interaction models.