Van Allen Probes and Arase Observations of the Plasma Density at low L: Model Development and Comparisons with Ionospheric Radar and Sounder Data

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The electron density is a fundamental parameter of plasma in the near-Earth space environment, which is crucial to quantifying and modeling a variety of physical processes. A technique has recently been developed using the magnetic and electric field wave power associated with whistler-mode plasmaspheric hiss waves observed by the Van Allen Probes spacecraft to infer the local electron plasma density [1]. Densities inferred through this technique have been recalibrated and validated against Arase observations, using both conjunction events and statistical analyses. A new empirical density model has been developed for the inner zone between $1 < L < 3$ using plasma densities inferred from the upper hybrid resonance on Arase, and hiss-inferred density values from Van Allen Probes [2].

Between $1.5 < L < 3.0$, the equatorial plasma density vs. L profile is equivalent to that of [3]. Inside $L < 1.5$, this dependence changes as the density increases at a faster rate with decreasing L. The variation of the density with magnetic latitude is shown to yield a somewhat flatter profile than some previous models. A clear MLT-dependent variation in the density is identified at low L, which was not identified or modeled in previous efforts. This is consistent with diurnal variation in the ionospheric density, peaking near MLT = 14, and becoming larger in amplitude at lower L.

Here, we explore additional dependencies that have been identified and may be included in future model developments (e.g., F10.7, Season, etc.), and compare to the output of ionospheric models in the regions where the two overlap. Furthermore, we conduct direct comparisons of the hiss-inferred density from Van Allen Probes with ground-based ISR data and ionospheric sounders.

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2. Hartley, D. P., G. S. Cunningham, J.-F. Ripoll, D. M. Malaspina, Y. Kasahara, Y. Miyoshi, S. Matsuda, S. Nakamura, F. Tsuchiya, M. Kitahara, A. Kumamoto, I. Shinohara, and A. Matsuoka (2023), Using Van Allen Probes and Arase observations to develop an empirical plasma density model in the inner zone. Journal of Geophysical Research: Space Physics, 128, e2022JA031012, doi:10.1029/2022JA031012

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