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Geomagnetic Activity and Spatial Dependence of the Dayside Magnetospheric Average Ion Mass

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1 Extended Abstract

Understanding the elctrodynamic processes that take place in the inner magnetosphere is crucial in the space weather context, mainly during geomagnetically disturbed periods when wave–particle and hot–cold plasma populations interactions take place. Ultra low frequency hydromagnetic and ion cyclotron wave propagation as well as resonance features are influenced by the presence of heavy ions. These ions primarily flow out from the polar ionosphere, and inevitably affect the plasma properties and dynamics.

Information on the average ion mass can be efficiently provided by the combined use of ground-based and satellite measurements. Indeed, the contribution of heavy ions to plasma mass density can be quantified by comparing the plasma mass density with the electron number density. The plasma mass density can be inferred from field line resonance frequencies (FLRs) observations across the European quasi-Meridional Magnetometer Array (EMMA), a meridional network of 27 magnetometer stations extending from Central Italy to North Finland [1, 2]. The extension of EMMA allows one to monitor the plasma mass density in the range of magnetic L-shells 1.5–6.5. Local electron number densities can be derived from electric field measurements made on Van Allen Probes (VAPs) spacecraft using the NURD algorithm [3] developed by the GFZ/UCLA Space Environment Modeling group.

The eccentric orbits of the VAPs (apogee at $\sim 6\ R_E$) represent a great opportunity to obtain electron number density in a geocentric distance range which practically matches the EMMA one. This considerably increases the probability to detect conjunction events in which the location of the satellite matches the location of the estimated plasma mass density. It makes also possible to perform an analysis on the spatial variation of the average ion mass, and to monitor the dynamics of the ion composition during prolonged favorable periods.

We show a statistical survey of the average ion mass during favorable conjunction events. We found that in the plasmasphere the average ion mass is $\simeq 1$ amu for a wide range of geomagnetic activity conditions and geocentric distances, suggesting that the plasmasphere mainly consist of H^+ ions, while the plasmatrough is characterized by a more variable composition. We observed heavy ion mass loading during geomagnetic disturbed period, with a peak in the range 3–4 R_E, a behavior compatible with what is known in the literature as the oxygen torus.

References

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