ULF waves and their influence on radiation belt dynamics in Earth’s magnetosphere

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Recent observations from the Van Allen Probes mission have established that Pc3-5 ultra-low-frequency (ULF) waves can energize ions and electrons via drift-resonance and drift-bounce resonance. The extent to which these waves contribute to the space weather of the belts is relatively poorly understood and requires sophisticated modelling and characterization of the dominant wave modes that arise in the development and recovery phase of geomagnetic storms. Despite more than four decades of observations and theoretical analysis of ULF waves, there is no framework for accurately assessing the global distribution of ULF waves and their influence on the ring current.

In this presentation, we describe a new global model of ULF waves that incorporates non-dipolar geomagnetic fields. The model is constrained using the GCPM of cold plasma density model and a specification of the ionosphere using the IRI and MSIS models. An algorithm is applied to adjust the initial plasma state to a quasi-static equilibrium that is then driven by a global convection electric field and ULF wave source. For specific observations by the Van Allen Probes and ARASE mission, the effect of these ULF waves on radiation belt ions and electrons is evaluated utilizing test-particle methodology and Liouville’s theorem, which enables the phase space density to be followed and compared one-for-one with the satellite observations.