In Situ Statistical Observations of Pc1 Pearl Pulsations by the Van Allen Probes

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We present here a statistical survey of Pc1 pearl pulsations, a subset of electromagnetic ion cyclotron (EMIC) waves exhibiting a time-modulated structure, contrasted with unstructured EMIC waves observed in situ by the Van Allen Probes spacecraft. These waves have been observed using ground observatories since the mid 1930s, but have rarely been observed in the Earth's magnetosphere, where they are thought to originate. EMIC waves belong to the left-hand circularly polarized transverse wave mode driven by a hot (10s of keV) ion temperature anisotropy which is able to interact with both thermal ion populations and relativistic electrons. The Van Allen Probes offer us an unprecedented amount of data from the heart of the radiation belts where these particle populations interact, and so have provided us the data necessary to analyze this wave mode on a statistical scale. This dataset was compiled from observations spanning 8th September, 2012 through 31st May, 2015, and comprises over 1338 hours of total EMIC wave activity, of which 253 hours exhibited pearl structure. While unstructured EMIC waves demonstrate the predicted behavior of a higher occurrence across the dayside with enhanced wave power at dusk, pearl pulsations occur uniformly across MLT, with a small enhancement in the late morning sector. Pearl pulsations were more often observed during magnetospherically quiet periods, particularly in the late recovery period of geomagnetic storms. Twenty six of the observed wave events demonstrated oscillating wave packets, mostly about the magnetic equator, indicated by the periodic reversal of Poynting flux. The mean excitation frequency of pearl pulsations was observed to be independent of the local cyclotron frequency, and individual wave investigations indicate the modulation period also remained constant for the duration of the event. We examine three possible generation mechanisms: the bouncing wave packet model, modulation by ULF Pc4-5 waves, and the formation of an ion cyclotron resonator, but find evidence within our observations against each proposed model.

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