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Chorus acceleration of ultra-relativistic radiation belt electrons during periods of low plasma density

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Satellite observations show that electrons in the Van Allen radiation belts can have energies in excess of 7 MeV. The Van Allen Probes mission not only provided measurements of ultra-relativistic radiation belt electrons, but also simultaneous observations of plasma waves, allowing for the routine inference of total plasma number density. Based on a year of observations from 2015, we show that the electron plasma density has a controlling effect over local chorus acceleration to ultra-relativistic energies, which occurs only when the plasma number density drops down to very low values (~10 cm^{-3}). Results from a Versatile Electron Radiation Belt (VERB) simulation show that a reduced electron plasma density allows chorus waves to efficiently resonate with electrons up to ultra-relativistic energies, producing enhancements from 100s of keV up to >7 MeV via local diffusive acceleration. We analyse statistically the observed chorus wave power during ultra-relativistic enhancement events, considering the contribution from both upper and lower band chorus waves. The Versatile Electron Radiation Belt (VERB) model is also used to recreate an ultra-relativistic electron acceleration event and simulation results are compared to observations, showing close agreement in the evolution when the reduction in electron plasma density is taken into account. The PINE density model allows for the investigation of global magnetospheric density changes during this event. We therefore analyze the how the global cold plasma density changes during ultra-relativistic enhancement events and compare to in-situ point measurements of the plasma density.