

Investigating the upper and lower energy cutoffs of EMIC-wave driven precipitation events

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For some time theoretical modelling has shown that electromagnetic ion cyclotron (EMIC) waves should play an important role in the loss of relativistic electrons from the radiation belts, through precipitation of the electrons into the polar ionosphere. However, there are limited direct experimental observations of relativistic electron precipitation occurring, despite the indirect evidence for its importance.

Relativistic electron resonance takes place through "anomalous resonance" where the electron overtakes the wave. Until recently, it was thought that EMIC wave scattering interactions were limited to electrons with energies greater than 1-2 MeV. Recent theoretical modelling [Omura et al., JGR, 2012] has suggested that this lower limit may be as small as 100 keV when considering EMIC waves more like those experimentally observed (i.e. non-constant frequency which ramps with time on one second timescales). Using data from the POES satellites we confirm the presence of lower energy (<1 MeV) electron precipitation most likely driven by EMIC waves.

We report on a continuing study that determines the typical flux impacting the ionospheric D-region during EMIC-driven precipitation events, and the effect this has on ionospheric conditions. We examine a very large set of EMIC-driven electron precipitation events detected using data from the POES satellite constellation [Carson et al., JGR, 2013] and determine the typical precipitating electron and proton fluxes.

As part of this study, we investigate the response of the MEPED instruments on-board the POES satellites to better characterise the EMIC-driven precipitation. Using the results of a previously reported Monte-Carlo simulation of the MEPED electron and proton telescopes [Yando et al., JGR, 2011], we characterise the typical energy range and flux for both the precipitating electrons and protons observed in these events. We go on to show that such events will produce very significant D-region changes detectable using the ground-based Antarctic-Arctic Radiation-belt (Dynamic) Deposition - VLF Atmospheric Research Consortium (AARDDVARK) worldwide VLF receiver network.

Keywords: EMIC waves, electron precipitation, POES spacecraft, AARDDVARK, radiation belts, particle precipitation