Electron Precipitation from EMIC waves: Evidence of Sub-MeV EMIC-Driven Precipitation

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1. Extended Abstract

It has long been predicted through theory that Electromagnetic Ion Cyclotron Waves (EMIC) should drive significant energetic electron precipitation from the radiation belts into the lower ionosphere. However, until recently there have been surprisingly few experimental observations to confirm this. In the last few years, we have combined observations from multiple experiments to substantiate the link between such waves and electron precipitation. In particular, we have shown that POES observations of precipitation events can be directly linked to EMIC wave observations seen on the ground [1]. We have shown that as many as 90% of such POES precipitation triggers correspond to nearby EMIC waves, for both Halley and Athabasca magnetometers. For some time it has been thought that EMIC waves are very important sources of relativistic and ultra-relativistic electron losses from the outer radiation belt, but that the nature of the anomalous cyclotron resonance means that the electrons scattered must have extremely high minimum energies. However, there are a growing body of experimental case studies reporting that the lower energies in the precipitation might be hundreds of keV rather than >1MeV. One example, is a set of case-studies [2] that combined EMIC observations from the Van Allen Probes, POES satellite measurements of precipitation, plus ground-based data from the AARDDVARK network.

We have now undertaken a new study [3] to confirm that such lower-energy electron scattering from EMIC waves is indeed occurring. By contrasting electron precipitation data from POES with DEMETER high-energy resolution precipitating flux measurements and EMIC wave observations, we have the clearest case study yet with EMIC waves scattering electrons with fluxes peaking at ~250 keV. Undertaking a large study of many of the POES precipitation triggers with the expected EMIC-scattering characteristics [4], we find that the precipitated electron fluxes typically peak at ~300 keV, with only ~11% of events peaking in the 1-4 MeV range. This finding suggests that EMIC-driven electron precipitation events may play a more significant role in the loss of medium energy radiation belt electrons than previously thought, in addition to those losses at relativistic energies. While apparently inconsistent with cyclotron resonance, our findings are consistent with predictions made by non-resonant scattering [5], and potentially represent a direct confirmation of this theoretical work.

2. References

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