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On the variability of EMIC waves and the importance of ion composition

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Electromagnetic ion cyclotron (EMIC) waves play an important role in relativistic electron losses in the radiation belts through diffusion via resonant wave-particle interactions. Electron resonance with EMIC waves, and hence diffusion, is sensitive to both the wave spectrum and the plasma properties. For instance, increasing the electron density decreases the minimum resonant energy and allows diffusion at larger pitch angles, providing a mechanism by which near-equatorial mirroring electrons can be removed. Similarly, for wave frequencies that approach the respective ion cyclotron frequency from below, the minimum resonant energy can be reduced.

We present statistical models of electron diffusion by EMIC waves calculated by averaging observation specific diffusion coefficients constructed using Van Allen Probe EMIC wave observations including the observed spectra and plasma density [1,2]. The resulting diffusion coefficients therefore capture a wider range of wave-particle interactions than previous models which are calculated using average observations.

The resonant interactions between EMIC waves and radiation belt electrons also depend on the cold ion composition. However, there is a great deal of uncertainty in the composition in the inner magnetosphere due to difficulties in direct flux measurements. Here we show by adopting three previously used ion compositions that the losses of relativistic and ultra-relativistic electrons from the belts by EMIC waves depends on the ion composition. We find that the decay of the ultrarelativistic electron flux is most sensitive to the helium fraction, and the strongest agreement between global simulations and Van Allen Probes observations is found at low helium fractions. We suggest that more observations of the cold ion composition would significantly help understand and set constraints on the decay of ultrarelativistic electrons in the radiation belts.

1. J. P. J. Ross, S. A. Glauert, R. B. Horne, C. E. J. Watt, & N. P. Meredith, “On the variability of EMIC waves and the consequences for the relativistic electron radiation belt population”, *Journal of Geophysical Research: Space Physics*, 126, e2021JA029754. https://doi.org/10.1029/2021JA029754.

2. J. P. J. Ross, S. A. Glauert, R. B. Horne, C. E. Watt, N. P. Meredith, & E. E. Woodfield, “A new approach to constructing models of electron diffusion by EMIC waves in the radiation belts”, *Geophysical Research Letters*, 47, e2020GL088976. https://doi.org/10.1029/2020GL088976.