Geophysical Research Abstracts
Vol. 21, EGU2019-349, 2019
EGU General Assembly 2019

Electron diffusion in self-consistent numerical experiments due to whistler-mode wave-particle interactions

Oliver Allanson (1), Clare Watt (2), Heather Ratcliffe (3), Nigel Meredith (4), and Teo Bloch (5)

(1) University of Reading, Meteorology, United Kingdom (o.allanson@reading.ac.uk), (2) University of Reading, Meteorology, United Kingdom (c.e.watt@reading.ac.uk), (3) Centre for Fusion, Space and Astrophysics, Department of Physics, University of Warwick, Coventry, UK (h.ratcliffe@warwick.ac.uk), (4) British Antarctic Survey, Natural Environment Research Council, Cambridge, UK (nmer@bas.ac.uk), (5) University of Reading, Meteorology, United Kingdom (t.bloch@pgr.reading.ac.uk)

The diffusion of electrons in energy and pitch angle space by whistler mode waves is a cornerstone of our current theoretical framework of acceleration and loss in Earth's Outer Radiation Belt. The quasilinear theory of wave-particle interactions provides us with a tractable method to estimate the amount of diffusion that occurs for a range of wave and ambient plasma conditions. However, the whistler mode manifests in different ways throughout the outer belt: naturally generated chorus and hiss waves, and large amplitude nonlinear wave packets; artificially generated transmitter waves; and lightning generated whistler waves. It is likely that, formally speaking, the quasi-linear theory is not applicable in all of these cases. In order to test the theory, we model the interactions between driven whistler-mode waves and ambient background plasma. Specifically, we propagate incoherent, broadband whistler-mode waves through conditions characteristic of equatorial magnetic latitudes in the plasma trough. We explore whether quasilinear diffusion is a reasonable description for different wave amplitudes. Using particle data directly extracted from the particle-in-cell simulation, we find that diffusive response of the plasma due to whistler-mode wave particle interactions is a strong function of phase-space. The mathematical description implicit in the underlying quasilinear theory, i.e. Einstein/classical diffusion such that $variance(X) \propto (\Delta t)^a$ (with $a = 1$ and for X either energy or pitch angle), is not borne out for all energies and pitch angles. We observe different regimes in phase space for which 'super-diffusion' ($a > 1$), 'sub-diffusion' ($a < 1$), and 'negative-diffusion' ($variance(X) \propto -(\Delta t)^a$) occur.