Contribution ID: **31** Type: **Invited Speaker / Conférencier invité**

Modelling Van Allen Probes Observations of ULF waves and Outer Radiation Belt Electron Dynamics

Monday 16 June 2014 15:45 (30 minutes)

Pc5 waves with toroidal and poloidal electric fields are ubiquitous in Earth's magnetosphere and are often present in the recovery phase of geomagnetic storms. We present results of simulations of Pc5 wave-particle interactions and show how they can be used to explain Cluster (1) and Van Allen Probes (2) observations of shock-initiated outer radiation belt electron flux enhancements and modulations. Theory suggests Pc5 waves are capable of producing such modulations over energies that range from 10's of keV to greater than 1MeV. Using a model of ULF waves, and constraints from satellite observations, we show that solar wind pressure pulses can excite Pc5-range ULF waves and, through drift-resonance interaction, energize electrons in the outer belt. We examine the electron response to pressure-pulse excited waves by evolving electron phase space density in a kinetic transport model that ingests time series from the wave model. The kinetic simulations reveal various features of the interaction, including prompt adiabatic energization by the pressure pulse, drift echoes of this signature at the location of virtual satellites placed in the model, and enhancements and modulations in phase space density that are in agreement with observations.

1. Zong, Q.-G et al., "Energetic electron response to ULF waves induced by interplanetary shocks in the outer radiation belt", J. Geophys. Res, 114, A10204, doi:10.1029/2009JA014393 (2009).
2. Claudepierre, S.G. et al., "Van Allen Probes observation of localized drift resonance between poloidal mode ultra-low frequency waves and 60 keV electrons", Geophys. Rev. Lett., 40, p.4491-4497, doi:101002/grl.50901 (2013).

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Session Classification: (M2-1) ePOP Satellite Mission II - DASP / Mission satellitaire ePOP II - DPAE

Track Classification: Atmospheric and Space Physics / Physique atmosphérique et de l'espace (DASP-DPAE)