Geophysical Research Abstracts
Vol. 15, EGU2013-1830, 2013
EGU General Assembly 2013

Evidence of coherent drift-resonant acceleration of radiation belt particles by ULF waves

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Evidence is presented for frequent, coherent and powerful accelerations of radiation belt electrons and protons during magnetic storms. Geomagnetic storms are indeed frequently associated with the formation of well developed, multiple bands of energetic electrons inside the inner radiation belt at L=1.1-1.9 and with prominent similar energy structures of protons inside the slot region at L=2.2-3.5. These structures typically from 100 keV up to the MeV range result from coherent interactions of energetic particles with quasi- monochromatic Ultra Low Frequency waves (ULF). These waves are induced by magnetospheric changes due to the arrival of dense solar material and related nightside injections of particles from the outer magnetosphere that destabilize field lines in the inner magnetosphere down to L=1.1. We show that, at the low altitudes of the Demeter spacecraft, these structures are best seen near the South Atlantic Anomaly because of lowering of the belt particle mirror point. As evidenced from ground measurements, energy bands are associated with quasi-sinusoidal ULF Pc5 and Pc4 waves with periods in the 1000 second range for L = 1.1-1.9 and in the 60 second range for L=2.2-3.5. Numerical simulations of the coherent drift resonance of energetic particles with Ultra Low Frequency waves show how the particles are accelerated and how the observed structures build up. The structures are formed for interaction times of the order of 20-40 minutes. For longer resonance times, particles are accelerated at energies higher than 1.5 MeV while lower energy particles are decelerated.