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Characteristics of drift resonance in the outer radiation belt with Pc5 waves based on GEMSIS-RC and RB simulations

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Radial transport of relativistic electrons due to Ultra Low Frequency (ULF) waves in the Pc5 frequency range (1.67mHz - 6.67mHz) is one of important candidates to accelerate and decelerate the outer radiation belt electrons. It is considered as a result of the drift resonance process caused by a resonant interaction between the magnetic drift motion of electrons in the dipole-dominated magnetic field configuration and the electromagnetic fluctuations of Pc5 waves. The Pc5 amplitude decreases rapidly with decreasing radial distance, and the recent studies has pointed out that the efficiency of radial transport caused by the Pc5 waves can be highly depending on the characteristics of the waves [e.g., Ukhorskiy and Sitnov, 2008]. They indicated that collective motion of the outer belt electrons can exhibit large deviations from radial diffusion. Thus, it is important to understand the fundamental behavior of collective motion of the electrons against the Pc5 waves in the inner magnetosphere.

In this study, we combine two simulation models of the inner magnetosphere: GEMSIS-RC (ring current) and RB (radiation belt) models. The GEMSIS-RC model is a self-consistent and kinetic numerical simulation code solving the five-dimensional collisionless drift-kinetic equation for the ring-current ions in the inner-magnetosphere coupled with Maxwell equations [Amano et al., 2011]. The GEMSIS-RB code conducts test particle trajectory tracings of relativistic electrons in arbitrary magnetic and electric field configurations [Saito et al., 2010]. Hence, we can conduct Pc5 wave simulation with GEMSIS-RC, and then the obtained time variations of the magnetic and electric fields are used as an input to GEMSIS-RB code to understand the transport of relativistic electrons due to the Pc5 waves. For simplicity, we investigated effects of monochromatic wave on the drift resonance. Using the simulation results, we evaluated between radial profiles of electron phase space density. The results show that the resonant electrons continuously obtain or lose energy, but the range of energy variation due to the drift resonant scattering of relativistic electrons are wider in the simulation than in the simple theoretical estimations. It is also shown that these electrons have local peaks in the radial distribution in phase space density. This implies the non-linear effect due to the variation of electrons' drift velocity must be considered in the radiation belt.

Keywords: Radiation belt electrons, Drift resonance, Pc5 waves, GEMSIS-RC and RB simulations