Study of characteristics of storm-time Pc5 ULF waves excited by the drift-bounce resonance with ring current ions based on the global drift-kinetic simulation

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Storm-time Pc5 waves are electromagnetic fluctuations in the inner magnetosphere with the frequency of 1.67-6.67 mHz, and are considered to be generated by ring current ions associated with the injection from the magnetotail during substorms. The excitation mechanism and global distribution of Pc5 waves are keys to understand dynamic variation of the outer radiation belt, since Pc5 waves are considered to contribute to the radial diffusion of radiation belt electrons [e.g. Elkington et al., 2003]. Promising candidates of excitation mechanism of the storm-time Pc5 waves are the drift or drift-bounce resonance [Southwood, 1976]. Although previous spacecraft observations suggest the resonant excitation [e.g., Dai et al., 2013; Yeoman and Wright., 2001], there are other possibilities such as periodic pressure inhomogeneity formed by time-dependent injections. Theoretically, Yamakawa et al. [2019] confirmed the drift resonance excitation of storm-time Pc5 waves in 3D dipole structure based on the drift-kinetic simulation. However, in what kind of situation the drift resonance is switched to the drift-bounce resonance is far from understood.

In order to simulate the excitation of the storm-time Pc5 waves, we perform a kinetic simulation for ring current particles using GEMSIS-RC model [Amano et al., 2011], in which five-dimensional drift-kinetic equation for the phase space density (PSD) of ring current ions and Maxwell equations are solved self-consistently under assumption that the first adiabatic invariant is conserved. In order to simulate consequence of ion injection from the plasma sheet, we set a localized high-pressure region around midnight consisting of H+ ions. We compare two cases of the initial velocity distribution; the Maxwellian velocity distribution with the isotropic temperature of 16 keV (Case a) and the velocity distribution with the phase bunching in the southern hemisphere due to the bounce motion of ions in addition to the background Maxwellian distribution (Case b). For the Case b, we changed the strength of the initial phase bunching to investigate the conditions for drift-bounce resonance to be dominant.In Case a, the simulation results show the drift resonance excitation of both poloidal and toroidal mode waves in Pc5 frequency range in the dayside dusk sector. These waves are fundamental mode waves with azimuthal wave number m ~ - 20 propagating westward. Global distribution of the excited Pc5 waves indicates that they are excited where the local growth rate resultant from the positive PSD gradient in energy is positive. In Case b, excitation of the second harmonic poloidal-mode Pc4 ULF waves due to the drift-bounce resonance was identified in the dayside dusk sector in the strong bunching case. We will also report on characteristics of excited ULF waves and their dependence on the initial bunching strength of injected ions with a focus of the relative contribution of the drift and drift-bounce resonances.

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