ドリフト運動論モデルに基づく環電流イオンとのドリフトバウンス共鳴によって励起される storm-time Pc5 ULF 波動の研究

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

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Storm-time Pc5 ULF waves are electromagnetic pulsations 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 transport of radiation belt electrons [e.g. Elkington et al., 2003]. Promising candidate of excitation mechanism of the storm-time Pc5 waves is the drift-bounce resonance [Southwood, 1976]. Previous spacecraft observations suggest both drift resonance [e.g. Dai et al., 2013] and drift-bounce resonance [e.g. Oimatsu et al., 2018] excitation of ULF waves. Theoretically, Yamakawa et al. [2019] confirmed the drift resonance excitation of storm-time Pc5 waves under the initial condition of phase space density (PSD) with north-south symmetry based on the global drift-kinetic simulation. However, drift-bounce resonance excitation of ULF waves was not detected in the case of the symmetric initial PSD distribution, while this type of resonance was suggested by some spacecraft observations [e.g. Oimatsu et al., 2018]. This study aims to investigate the condition for the excitation of ULF waves associated with drift-bounce resonance based on the global drift-kinetic model.

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 PSD of ring current ions and Maxwell equations are solved self-consistently under the assumption that the first adiabatic invariant is conserved. In order to simulate consequence of ion injection from the plasma sheet, we put 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 asymmetric distribution in pitch angle direction in addition to the background Maxwellian distribution (Case b). 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 [Yamakawa et al., 2019]. In Case b, excitation of the 2nd harmonic poloidal-mode Pc3 ULF waves due to the drift-bounce resonance was also identified in the dusk sector in addition to Pc5 ULF waves. The power spectra of both Pc5 and Pc3 poloidal mode ULF waves show correlation with the local growth rate. Ions contributing to the growth of poloidal mode ULF waves tend to have the pitch angle of about 90 degrees for Pc5 waves and oblique pitch angle for Pc3 waves. We will also report on characteristics of excited ULF waves with a focus of the relative contribution of the drift and drift-bounce resonances.

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