Excitation mechanism of storm-time Pc5 ULF waves by ring current ions

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Storm-time Pc5 ULF waves have been considered to be generated by ring current particles associated with plasma injection into the inner magnetosphere during magnetic storms. It is generally believed that ULF waves drive radial diffussion of radiation belt relativistic electrons (e.g., Shprits et al., 2008). Therefore, it is important to know how Pc5 ULF waves are generated by ring current ions to understand the acceleration mechanism of radiation belt electrons. One primary excitation mechanism of storm-time Pc5 waves is the resonance occurring between the drifting and bouncing motions of ring current ions (Southwood, 1976). Although the drift-bounce resonance excitation of these waves is shown by many observations (e.g., Ozeke and Mann, 2008), fundamental features of the excitation mechanism such as the growth rate and necessary phase space density (PSD) distributions is far from understood. One of the reason is due to difficulty of non-linear global simulations of the excitation mechanisms.

In order to simulate the excitation mechanism 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 equation are solved self-consistently, and the first adiabatic invariant is assumed to be conserved. In order to simplify injection model, we set a localized high pressure region around midnight consisting of O^+ ions which have a Maxwellian velocity distribution of the temperature 16 keV (O^+ ion) with a loss cone. In addition, the presence of a background cold dense plasma, which is fixed to the initial condition is assumed. The fixed boundary condition for the field quantities is used, and the mirror reflection at the ionosphere is assumed at the inner boundary.

We investigate the power spectrum of magnetic field fluctuations, and it is shown that primarily poloidal mode (Br) is excited from duskside to afternoon magnetic local times. The frequency of the excited waves matches the expectation from the drift-bounce resonance conditions for the locally dominant O^+ ions estimated from the simulated PSD. It is also found that poloidal mode wave propagates westward from 1800 to 1200 MLT associated with the westward transport of O^+ ions. We also investigate the local PSD distribution, and the systematic modulation of the ion pitch angle distribution associated with the phase of excited waves are confirmed. Detailed correspondence of the PSD distributions and the wave properties will be also performed.

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