GEMSIS-RC モデルに基づいた環電流イオンによる storm-time Pc5 ULF 波動の発生機構の研究

山川 智嗣 [1]; 関 華奈子 [2]; 天野 孝伸 [1]; 高橋 直子 [3]; 三好 由純 [4]
[1] 東大・理; [2] 東大理・地球惑星科学専攻; [3] 東大・理; [4] 名大 ISEE

Study of excitation mechanism of the storm-time Pc5 ULF waves by ring current ions based on the GEMSIS-RC simulation

Tomotsugu Yamakawa[1]; Kanako Seki[2]; Takanobu Amano[1]; Naoko Takahashi[3]; Yoshizumi Miyoshi[4]
[1] University of Tokyo; [2] Dept. Earth & Planetary Sci., Science, Univ. Tokyo; [3] Univ. of Tokyo; [4] ISEE, Nagoya Univ.

http://www.sgepss.org/

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 plasma injection from the magnetotail during geomagnetic storms. It is observationally known that these waves typically propagate westward with high azimuthal wave number (m = 30-120) [e.g. Takahashi et al., 1985]. Promising candidates of excitation mechanism of the storm-time Pc5 waves are the drift or drift-bounce resonance [Southwood, 1976]. Although there are some satellite observations to 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. The theoretical studies of the drift or drift-bounce resonance assume the simplified situation such as locally homogeneous parameters, and excitation efficiency in more realistic 3D structure is far from understood due to the difficulty of non-linear global simulations of this mechanism.

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 the phase space density (PSD) of ring current ions and Maxwell equations are solved self-consistently, and the first adiabatic invariant is assumed to be 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 with a Maxwellian velocity distribution of the isotropic temperature 16 keV with a loss cone as an initial condition. The field perturbation at the inner boundary is set to zero and free boundary condition is used at the outer boundary. For PSD, the mirror reflection at the ionosphere is assumed at the inner boundary.

When we start the simulation, the high-pressure region initially set around midnight expands both dawnward and duskward. The expansion is more toward dusk, since the injected ions undergo duskward magnetic drift depending on their energy. The power spectrum of magnetic field fluctuations show that both poloidal and toroidal mode waves in Pc5 frequency range are excited in the dayside dusk sector.These waves are fundamental mode waves with azimuthal wave number m ˜16 propagating westward. The wave excitation coincides with the arrival of drifting ions of 80-120 keV. 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. We will also report on detailed characteristics of the PSD distribution and its relationship with the Pc5 wave growth rate.

References:
Amano et al., J. Geophys. Res., vol.116, No.A2, 216, 2011.
Takahashi et al., J. Geophys. Res., vol.90, No.A2, 1473-1485, 1985.
Dai et al., Geophys. Res. Lett., vol.40, No.16, 4127-4132, 2013.
Yeoman et al., Ann. Geophys., vol.19, No.2, 159-170, 2001.
Southwood, J. Geophys. Res., vol.81, No.19, 3340-3348, 1976.