

Study of the excitation mechanism of internally driven ULF waves by the drift-bounce resonance with ring current ions based on the Magnetosphere-Ionosphere coupled model

*Tomotsugu Yamakawa¹, Kanako Seki¹, Takanobu Amano¹, Naoko Takahashi¹, Yoshizumi Miyoshi², Aoi Nakamizo³

1. Department of Earth and Planetary Science, School of Science, The University of Tokyo, 2. Institute for Space-Earth Environmental Research, Nagoya University, 3. National Institute of Information and Communications Technology

Internally driven ULF waves can be generated by ring current ions associated with the injection from the magnetotail during substorms. The excitation mechanism and global distribution of ULF waves are keys to understand dynamic variation of the outer radiation belt, since Pc5 ULF waves (1.67-6.67 mHz) can drive radial diffusion of radiation belt electrons [e.g. Elkington et al., 2003]. The drift-bounce resonance [Southwood, 1976] has been considered to be a candidate excitation mechanism. Previous spacecraft observations suggest both drift resonance and drift-bounce resonance excitation of ULF waves [e.g. Dai et al., 2013; Oimatsu et al., 2018]. Recently, Yamakawa et al. [2019] confirmed the drift resonance excitation of Pc5 waves by an isotropic Maxwellian PSD ion injection based on the drift-kinetic model. We also found the drift-bounce resonance excitation of Pc3 waves under asymmetric butterfly type injection [Yamakawa et al., 2020]. However the amplitude of the excited ULF waves is too small compared to spacecraft observations. One possible reason is the damping of field fluctuations at the ionospheric boundary in the model.

In order to improve the ionospheric boundary condition, we have made Magnetosphere-Ionosphere coupling between GEMSIS-RC [Amano et al., 2011] and GEMSIS-POT model [Nakamizo et al., 2012]. We use GEMSIS-RC model in the inner magnetosphere, in which 5D drift-kinetic equation for the PSD of ions and Maxwell equations are solved self-consistently. GEMSIS-POT is an ionospheric model, which solves 2-D electric potential. We use FAC from GEMSIS-RC as an input to GEMSIS-POT for the Region 2 current. The resultant electric field potential is then used as inner boundary condition of GEMSIS-RC. The coupled model enables us to simulate the ion injection from the plasma sheet into the inner magnetosphere. Simulation results have shown the excitation of Pc5 waves in the dayside (drift resonance) and Pc4 waves in the duskside (drift-bounce resonance). We have found that the amplitude of the excited ULF waves are enhanced by improving the ionospheric boundary condition. We will also report on the details of the effects of the boundary condition and R2FAC related electric field on the excitation of ULF waves.

Keywords: ring current, ULF wave, substorm, drift-kinetic model, drift-bounce resonance