GEMSIS 環電流-放射線帯モデル結合に基づく Pc5 波動による相対論的電子の動径方向輸送の特性に関する研究

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Study on radial transport of relativistic electrons by Pc5 waves in the inner magnetosphere based on the GEMSIS-RC and RB models

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Acceleration mechanisms to cause drastic variation of the Earth's outer radiation belt are one of outstanding problems of the magnetospheric researches. While the radial diffusion of the electrons driven by ULF waves in Pc5 frequency range has been considered as one of the candidate mechanisms, it is pointed out that the radial transport of relativistic electrons by ULF waves is not necessarily reach the radial diffusion limit and collective motion of the outer belt electrons can exhibit large deviations from the radial diffusion [Ukhorskiy et al., JATSP, 2008]. If the radial transport deviate from the diffusion limit, one cannot deny the contribution of Pc5 radial transport simply by the radial profile of the electron phase space density. Thus it is important to understand the form of radial transport of electrons under realistic ULF distribution in the inner magnetosphere. We have developed a physics-based model for the global dynamics of the ring current (GEMSIS-RC model). The GEMSIS-RC model is a self-consistent numerical simulation code solving the five-dimensional collisionless drift-kinetic equation for the ring-current ions in the inner-magnetosphere coupled with Maxwell equations [Amano et al., JGR, 2011].

We applied the GEMSIS-RC model for simulation of global distribution of ULF Pc5 waves. Comparison between runs with/without ring current ions show that the existence of hot ring current ions can deform the original sinusoidal waveforms. The deformation causes the energy cascade to higher frequency range (Pc4 and Pc3 ranges). The cascade is more pronounced in the high beta case. It is also shown that the existence of plasmapause strengthens ULFs outside the plasmapause and widens the MLT region where the E_r (toroidal) component is excited from initially-given E_phi (poloidal) component. In order to investigate the characteristics of radial transport of relativistic electrons, we then use the global magnetic and electric fields variation obtained by the GEMNIS-RC model as input field models for the test particle simulations of radiation belt electrons (GEMSIS-RB) [Saito et al., JGR, 2010]. The combination of GEMSIS-RC and RB models reproduced rapid radial transport by the drift resonance for simple monochromatic wave inputs as theoretically expected. On one hand, collective motion of the relativistic electrons shows deviations from the radial diffusion limit for large amplitude case due to finite system size. We will discuss a possible threshold of the Pc5 amplitude to cause the deviations.