R006-05
A 会場 ：11/25 PM2 （15:30-18:15）
16:30～16:45

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Magnetic storms of a weakly magnetized planet based on global inner magnetospheric simulations

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Intrinsic magnetic field of terrestrial planets is one of the important factors that determine the space environment near the planet and the magnetospheric structure. Earth's intrinsic magnetic field strength has decreased by 9% over the past 150 years and by ~30% over the past 2000 years [Olson and Amit, 2006]. The decrease may change not only the quasi-static state of near-Earth space environment but also the development of magnetic storms. A previous study examined the influence of the intrinsic magnetic field on auroral substorms using global MHD simulations [Ebihara et al., 2020]. However, the effect of intrinsic magnetic field strength on the development of magnetic storms is still unclear, because kinetic processes, which are not included in the MHD approximation, are dominant in the inner magnetosphere.

We investigated the development of magnetic storms and ring current, using the magnetosphere-ionosphere coupled model [Yamakawa et al., 2023], which combines GEMSIS-RC [Amano et al., 2011], cold plasmaspheric module, and GEMSIS-POT [Nakamizo et al., 2012]. In GEMSIS-RC, the 5D drift kinetic equation is solved self-consistently with Maxwell equations. GEMSIS-POT solves ionospheric potential for the height-integrated ionosphere. In the coupled model, motions of cold plasma in the plasmasphere are also included based on a continuity equation. Simulations were conducted for three cases: the present Earth (Case 1), a planet with a weak (2/3 of Case 1) intrinsic magnetic field and high ionospheric conductivity (Case 2), and with the weak magnetic field and standard (the same as Case 1) ionospheric conductivity (Case 3). Case 1, 2, and 3 correspond to Run 1, 3, and 5 in Ebihara et al. [2020], respectively. For each case, we applied R1-FAC to the ionosphere and set the temperature and density of the plasma sheet, according to the corresponding run.

The development of the ring current was investigated in detail for Cases 1-3. SYM-H index was calculated with the Dessler-Parker-Sckopke equation. The results show that the intensities of magnetic storms are in the following order: Case 3 >Case 2 >Case 1. We also found that SYM-H declines more rapidly in Cases 2 and 3 compared to Case 1. This is because the ring current development in the azimuthal direction is faster in the weak magnetic field cases than Case 1, because the distance from the planet is smaller at the same magnetic field strength. In Case 3, the ionospheric conductivity and plasma convection are as strong as in Case 1, although the scale of the dipole is smaller, which allows ions to inject more efficiently and results in the most intense and rapidly developing magnetic storm. Because the outer boundary conditions on the nightside, i.e., the temperature and density of the plasma sheet, were derived from the results of the MHD simulation runs corresponding to each case [Ebihara et al., 2020], changes in the size of the simulation box can alter the properties of the injected ions, which may affect the results. By comparing the results from two different simulation boxes, the characteristics of the model and the validity of the conclusions will be also discussed.