惑星間空磁場朝夕成分卓越時の昼間側4層沿磁力線電流系を再現する磁気流体シミュレーション

Magnetohydrodynamic simulation reproducing the dayside four-sheet field-aligned current system during IMF B_Y-dominated periods

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When the dawn-dusk component of the interplanetary magnetic field (IMF B_Y) is dominant, in particular, for northward IMF, there often appears a field-aligned current (FAC) system consisting of four longitudinally elongated current sheets in the prenoon or postnoon sector of the ionosphere, depending on the polarity of IMF B_Y. It has been suggested that while the equatorward two sheets are the dayside extension of the ordinary region 1 and region 2 currents, the poleward two sheets are the “cusp” and “mantle” currents on open field lines that are controlled by the IMF B_Y. Although the morphology of the dayside FAC systems including the four-sheet current system is well established, their generation mechanisms are still within the realm of imagination. Very recently, we have been successful in reproducing the four-sheet current system using the high spatial resolution version of the Reproduce Plasma Universe (REPPU) code which solves magnetohydrodynamic equations in the magnetosphere and the ionosphere self-consistently. The simulation run was performed under southward IMF conditions with a clock angle of 120 degrees. To the best of our knowledge, this is the first successful numerical modeling of the four-sheet FAC system. We believe that high resolution in the ionosphere (about 0.6 degrees in arc length) contributed significantly to the successful reproduction. We now plan another simulation run under northward IMF conditions for which the four-sheet structure is expected to appear more distinctively. We report in the presentation the initial results of our analysis. In addition, we discuss the generation mechanisms of the four-sheet current system. Previously, Watanabe and Sofko (2009) proposed a scenario in which lobe-to-closed interchange reconnection that modifys the Dungey cycle plays a central role in producing the four-sheet structure. From our preliminary analysis, the reproduced four-sheet FAC system seems consistent with this scenario.

キーワード：沿磁力線電流、4層構造、惑星間空間磁場BY、MHDシミュレーション
Keywords: field-aligned current, 4-sheet structure, IMF BY, MHD simulation

