Physical processes of dayside region 2 field-aligned currents associated with substorms: An MHD modeling

Tomoki Hanaoka[1]; Masakazu Watanabe[2]; Shigeru Fujita[3]; Takashi Tanaka[4]; Ken T. Murata[5]; Hiroyuki Shinagawa[5]
[1] Earth and Planetary Sciences, Kyushu Univ; [2] Earth & planetary Sci., Kyushu Univ.; [3] none; [4] SERC, Kyushu Univ.; [5] NICT

Field-aligned currents (FACs) are the electric currents that flow along magnetic field lines between the ionosphere and the magnetosphere. The FACs located on the poleward side of the auroral oval are called region 1, while those located on the equatorward side are called region 2. Of the two FAC systems, the latter region 2 FACs were found to be closed not only on the nightside inner edge of the plasma sheet but also on the dayside magnetopause [Tanaka, 1995]. Tanaka concluded that the nightside region 2 FACs are driven by the increased pressure in the inner magnetosphere. However, he did not survey the generation mechanism of the dayside region 2. In our previous work, in order to investigate dayside region 2 FACs, we performed MHD simulation and analyzed the current systems in detail. We found that dayside region 2 FACs are also driven by the plasma pressure gradient and their energy source is the thermal energy of the plasma. The plasma flow that drive dayside region 2 is the dayside extension of the earthward flow in the nightside plasma sheet. We demonstrated basic properties of the dayside region 2 currents such as energy conversion processes.

In this study, we further examine the dayside region 2 development in the course of substorms. The earthward flow on the nightside changes drastically at the substorm onset, so the nightside region 2 also changes at the substorm onset [Tanaka et al, 2010]. One aim of this study is to clarify whether such time evolution also exists in the dayside region 2 system. In order to achieve this goal, we examine the simulation results in more detail using a newly-developed visualization tool. We examine the spatial and temporal evolution of plasma flow, current density, Poynting flux etc. and discuss the role dayside region 2 in substorm development.

References

Tanaka, T. (1995), Generation mechanisms for magnetosphere ionospherecurrent systems deduced from a three dimensional MHD simulation ofthe solar wind magnetosphere ionosphere coupling processes, J. Geophys.Res., 100, 12,057, doi:10.1029/95JA00419.

Tanaka, T., A. Nakamizo, A. Yoshikawa, S. Fujita, H. Shinagawa, H. Shimazu, T. Kikuchi, and K. K. Hashimoto (2010), Substorm convection and current system deduced from the global simulation, J. Geophys. Res., 115, A05220,doi:10.1029/2009JA014676.