Study on Effects of Ionospheric Polarization Field and Inner Boundary Conditions on Magnetospheric Dynamics and Substorm Processes in Global MHD Simulation

*中溝 葵[1]、吉川 顕正[2,3]、田中 高史[3]
*Aoi Nakamizo[1], Akimasa Yoshikawa[2,3], Takashi Tanaka[3]

1. 情報通信研究機構　電磁波計測研究所、2. 九州大学大学院理学研究院、3. 九州大学国際宇宙天気科学・教育センター
1. Applied Electromagnetic Research Institute, National Institute of Information and Communications Technology, 2. Faculty of Science, Kyushu University, 3. International Center for Space Weather Science and Education (ICSWSE)

Global MHD simulation is an effective way to investigate the Solar Wind-Magnetosphere-Ionosphere system. Among various handlings and parameterizations in the global simulations, they are related to processes which cannot be described by MHD or which have not been fully understood, we especially place importance on the descriptions for low-altitude region (the M-I coupling part and inner boundary conditions) and we expect that they largely control the dynamics of the M-I system. In order to advance our physical understanding of the M-I system from the viewpoints of the above interests, we investigate the responses of magnetosphere and substorm processes for different treatments of low-altitude region.

Our investigation is generally classified into two categories; (A) the one in the context of the M-I coupling algorithm and (B) the other in the context of the inner boundary conditions imposed on MHD variables.
As for (A), the currently and commonly used algorithm is as follows; the FACs (rotB) of the MHD region are inputted to a potential solver embedded at the ionosphere altitude with prescribed conductance distribution, then calculated electric field is mapped back to the MHD region as the velocity field. In the present study, as the first step, we investigate the effect of inhomogeneity of ionospheric Hall conductance distribution. The background of this direction is the recently proposed concept of ionospheric control [Yoshikawa et al, 2008; 2013a, Nakamizo et al., SGEPSS, 2013] based on generalized theory for ionospheric polarization/Cowling channel formations [Yoshikawa et al, 2008; 2013b]
As for (B), normally either the Neumann or Dirichret conditions are selected for MHD variables (plasma density/pressure, velocity, deviation components of magnetic field from the intrinsic field). Other adjustments, representing particle precipitations, neutral wind friction, polar wind, and so on, are included. In the present study, we perform simulations with different pairs of boundary conditions for MHD variables.
In this presentation, we compare and discuss the obtained results.

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