
ABSTRACTS (MASTER THESIS)

Study on substorm evolution process by global MHD simulation

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Substorm is a remarkable disturbance occurring in the Earth's magnetosphere. A large amount of energy ($\sim 10^{11}$ W) is consumed in the ionosphere during the substorm. A problem is how the energy comes from. Recent global magnetohydrodynamics (MHD) simulation is capable of reproducing features of auroral substorms. The substorms are known to develop when the interplanetary magnetic field (IMF) is southward and the solar wind speed is high. However, the relationship between the solar wind parameter and the magnitude of the substorm is little known. First, we studied the influence of solar wind condition on the substorm evolution by introducing 3 cases of solar wind speed (300, 500, and 700 km/s) and 5 cases of interplanetary magnetic field (IMF) (-1, -3, -5, -7, and -9 nT). When the solar wind speed is 700 km/s and IMF Bz is -9 nT, the onset occurs earliest the AE index is highest, and the evolution is fastest. Secondly, transport of energy from the solar wind to the ionosphere is examined. It is found that about 1/3 of the solar wind kinetic energy is converted the electromagnetic energy in the cusp-mantle dynamo region. About 1/200 of the solar wind kinetic energy is found to be consumed in the ionosphere. The electromagnetic energy is stored in the lobe during the growth phase, and it is released in the expansion phase. The released energy appears to be insufficient to the electromagnetic energy consumed in the ionosphere. Continuous transport from the cusp-mantle dynamo is found to contribute to the energy supply in to the ionosphere for any solar wind conditions. Thirdly, we studied the influence of the boundary conditions of the global MHD simulation on the evolution of the substorm. The substorm is known to be caused by the consequence of the solar wind-magnetosphere interaction. The contribution from the Earth is not well known. We change the inner boundary that is located on the sphere with a radius of $\sim 3 R_E$. In Case 1, the pressure gradient in the radial direction is introduced, resulting in the acceleration of plasma toward the ionosphere. In Case 2, no pressure gradient is introduced. The simulation in Case 1 results in a rapid development of the auroral electrojet, which is resemble to typical variation of the auroral electrojet as seen by the AL index during the substorm expansion. Case 2 results in a relatively slow development of auroral electrojet. It is concluded that continuous inhalation of plasma from the magnetosphere to the ionosphere may play a role in the rapid development of the auroral electrojet.