Real-time global MHD simulation of the solar wind interaction with the earth's magnetosphere

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We have developed a real-time global MHD simulation of the solar wind interaction with the earth's magnetosphere. By adopting the real-time solar wind parameters including the IMF observed routinely by the ACE spacecraft, responses of the magnetosphere are calculated with the MHD code. We adopted the modified spherical coordinates, and the mesh point numbers for this simulation are 56, 58, and 40 for the r, theta, and phi direction, respectively. The simulation is carried out routinely on the super computer system NEC SX-6 at National Institute of Information and Communications Technology, Japan. The visualized images of the magnetic field lines around the earth, pressure distribution on the meridian plane, and the conductivity of the polar ionosphere, can be referred to on the Web site (http://www.nict.go.jp/dk/c232/realtime/).

The results show that various magnetospheric activities are almost reproduced qualitatively. They also give us information how geomagnetic disturbances develop in the magnetosphere in relation with the ionosphere. From the viewpoint of space weather, the real-time simulation helps us to understand the whole image in the current condition of the magnetosphere. To evaluate the simulation results, we compare the AE index derived from the simulation and observations. In the case of isolated substorms, the indices almost agreed well in both timing and intensities. In other cases, the simulation can predict general activities, although the exact timing of the onset of substorms and intensities did not always agree. By analyzing the data and comparing them with observations, we believe that the real-time simulation is being improved continuously and approaching a more realistic magnetosphere.

Utilizing the global MHD simulation data, we also trace the trajectories of solar energetic protons from the upstream side of the solar wind. The results show that protons having energies on the orders of 100 keV and 1 MeV that reach the inner magnetosphere could experience shock drift acceleration at the quasi-perpendicular bow shock when the dynamic pressure of the solar wind increased.