Global MHD simulation of Jovian magnetosphere with recent supercomputer systems for observations and micro scale simulations

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Planetary magnetospheres are very large, while phenomena within them occur on meso- and micro-scales. These scales range from 10s of planetary radii to kilometers. To understand dynamics in these multi-scale systems numerical simulations have been performed by using the supercomputer systems. We have studied the magnetospheres of Jupiter by using 3-dimensional magnetohydrodynamic (MHD) simulations for a long time, however, we have only obtained the phenomena not reaching the limits of the MHD approximation and simulation results under the specific solar wind conditions.

Recently thanks to the progress of supercomputer system, we can perform the simulation of Jovian magnetosphere with 1000 times large grid points of our previous simulation in 10 years ago. In other words, 1000 times cases of the our previous simulation can be performed at present. Considering these situations, it may be possible to connect the high resolution global (macro) simulation with micro simulation in the Jovian magnetosphere. In addition, performing a lot of parameter survey type simulations make quantitative comparison study of simulations and observations. Thus, in this study we perform the high-resolution simulation of Jovian magnetosphere to connect the electro-hybrid simulation, and low-resolution simulation under the various solar wind conditions to compare the Hisaki and Juno observation results.

For the high-resolution simulation to avoid the numerical effect to the simulation results from the irregular grid spacing, we simulated the global magnetosphere using the regular Cartesian gird with 0.15 RJ grid spacing and 7 RJ inner boundary. From these simulation settings, we can provide the magnetic field around 20 RJ from Jupiter as a background field of electro-hybrid simulation. To examine these simulation results, we found the wavy configuration along the magnetopause. This is the first time to see the wavy configuration in our global Jovian magnetospheric simulation and the wavy configuration seems to be caused by the Kelvin Helmholtz instability. In our previous simulation the resolution is not enough to catch the configuration.

In the parameter survey type simulations, we have obtained a lot of simulation results with 0.01 ˜0.09 nPa solar wind dynamic pressure and some IMF cases. These simulation data are open for the registered user to download the raw data. Comparing these data with Hisaki observation results, the relation of changing the solar dynamic pressure with emission of aurora is examined.