実証型宇宙天気統合システムの開発

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Development of an automated space weather forecasting system

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Solar wind including coronal mass ejections (CMEs) is a main driver of various space weather disturbances. MHD modeling of the solar wind is a powerful tool to understand the solar-terrestrial environment and to forecast space weather of the circum-terrestrial space, as well as that of other planets.

We developed a MHD modeling system of inner heliosphere on the basis of minimal input, namely, time series of daily synoptic observation of the photospheric magnetic field. The time series of MHD parameters at the Earth position is passed to a radiation belt model [Miyoshi et al. 2004] for forecasting of radiation belt electron ﬂux. These programs are executed everyday on a server in STEL, Nagoya University and the results are uploaded on the web site (http://st4a.stelab.nagoya-u.ac.jp/susanoo/). This system is named as Space-weather-forecast-Usable System Anchored by Numerical Operations and Observations (SUSANOO).

For the input of the solar wind model, we adopt near-real-time synoptic maps obtained with ground-based solar observations (Global Oscillation Network Group project). Using each synoptic map, we calculate global coronal magnetic field with potential field source surface model, and obtain two-dimensional maps of solar wind MHD parameters on the source surface (r=2.5Rs) from empirical relations. The time series of two dimensional solar wind maps are extrapolated radially and imposed to the inner boundary of MHD model of the inner heliosphere as a rotating and time-varying boundary condition. Then we can execute MHD simulation, and obtain MHD parameters at any arbitrary point in the inner heliosphere. The numerical domain is set in an area from 25 solar radii to 2 AU so that the execution of MHD simulation of 1 day takes about 0.5 hour in a 1 CPU workstation.

For the purpose of the validation of the solar wind model, we performed MHD simulation for three years (2007-2009) and the results were compared with in situ observations of ACE at 1 AU, as well as those of Venus Express and Mars Express at Venus and Mars orbits, respectively. The comparisons show that the numerical results can be used for detection of stream interfaces and that the obtained MHD parameters can reproduce the in situ observations conducted in large separation angles. The real-times simulation result will be used for the operation planning of Sprint-A mission [Terada et al. submitted to this meeting] and its data interpretation for atmospheric escape from Venus, Mars, and Mercury responding to variation of the solar wind parameters. We will also discuss other methods of the validation and the scores of our models.

Coronal mass ejections (CMEs) are alternative sources of space weather disturbances. We also have been developing a MHD model combining the solar wind MHD model with a CME model proposed by Kataoka et al. [2009]. We will show the automation method of CME injection to the MHD simulation.

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