Three dimensional MHD simulation of the solar wind and CME structures

Ryuho Kataoka[1]; Toshikazu Ebisuzaki[2]; Masayoshi Kojima[3]; Munetoshi Tokumaru[4]
[1] RIKEN; [2] Advanced Computing Center, RIKEN; [3] STE Lab., Nagoya Univ.; [4] STE Lab., Nagoya Univ.

Geomagnetic storms are driven by largely southward interplanetary magnetic field (IMF). The motivation of this study is to develop a new solar wind simulation code capable of predicting such a southward IMF. As a first step, we developed a global magnetohydrodynamic (MHD) code to investigate the solar wind structures. The inner boundary is located at 50 Rs where the global solar wind velocity map obtained from IPS (interplanetary scintillation)-CAT analysis is applied to drive a steady state solar wind structures. The outer boundary is located beyond 1 AU where the free boundary condition is applied. In this paper, we focus on multiple coronal mass ejection (CME) events in July 2004 and December 2006. The CMEs have largely southward IMF and cause large geomagnetic storms. Interestingly, from the in-situ observation by ACE spacecraft at L1 point, many of the CMEs form two-bump structures in the IMF magnitude with turbulent IMF nearby. In our simulation, transient and localized perturbation is applied at the inner boundary using several different methods to mimic the propagating CMEs and to investigate the generation mechanism of the microstructures. Using the background solar wind as observed by the IPS, we successfully simulated how the CMEs propagate interacting with the actual background solar wind. Based on the simulation results, we report the generation mechanisms of the two-bump structures possibly associated with rarefaction waves, and adjacent turbulent IMF structures possibly associated with Rayleigh-Taylor instabilities.