

3-D MHD model of the solar wind-interplanetary space combining system with improved energy equation

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Existing global models of the solar-wind/IMF expanding to the Earth's orbit are basically grounded in the idea of 'source surface.' It is widely accepted that the sector structure and the solar wind speed are primarily controlled by the magnetic field at the source surface and the so-called 'expansion factor.' On the other hand, 3-D MHD model is still off from practical use because both of scientific and technical problems. One of the former problems is the reproduction of supersonic solar-wind.

From the viewpoint of the physics of the solar wind, coronal heating and outward acceleration mechanisms are invoked to explain the supersonic evolution of the solar wind. Since the mechanism responsible for the heating/acceleration is still one of the primary subjects of the physics of the solar wind, many MHD models have taken into account their effects by incorporating additional source terms corresponding to promising candidates such as thermal conductions, radiation losses and wave pressures. However there are few MHD models considering or testing the effects of the expansion factor, which determines the solar-wind speed in the series of source surface models.

In this study we newly incorporate the flux tube expansion rate into the MHD equation system including heat source function in the energy equation. Applying the unstructured grid system, we achieved the dense grid spacing at the inner boundary, which enable us to adopt realistic solar magnetic fields, and a size of simulation space of 1AU. Photospheric magnetic field data is used as the inner boundary condition.

The simulation results are summarized as: (1) The variation of solar wind speed is well controlled by the structure of magnetic fields at and little above the solar surface and (2) Far above the solar surface, the interface between high and low speed flows evolves to a structure suggestive of CIRs. Comparing the data from simulation with the actual solar wind data obtained by spacecrafts, we will discuss the future improvement of our model. Non-stationary phenomena such as CMEs are still beyond of this study.