A dynamical model of the heliosphere with the adaptive mesh refinement

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A change in the heliospheric environment plays an important role in the modulation of the galactic cosmic rays; the magnetic field structure and the speed of the solar wind affect the cosmic ray transport in the heliosphere. Since the heliospheric environment is affected by the solar wind activities, we have been developing a framework for simulating the heliosphere by using MHD simulations.
The simulation code is based on SFUMATO code (Matsumoto 2007), which employs the block-structured adaptive mesh refinement (AMR) technique. The solar wind model gives the inner boundary condition of the simulations, and it is based on the model of Kataoka et al. (2009) and Shiota et al. (2014). The solar wind model adopted here is reconstructed by the observation of the solar magnetic fields. At this moment, the refinement criterion of AMR grid is only a function of the distance from the Sun. Our model reproduces the Parker spiral owing to the solar rotation.
We also measured the performance of the simulation code for massively parallel calculations. In the case of 1024/2048 cores calculations, our code exhibits parallel ratios of 99.945-99.982% and parallel efficiencies of 73.4-86.4%, depending on the implementation of a refinement manner. Such a high scalability is demonstrated even by a flat MPI parallelization.

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