Three-dimentional magnetohydrodynamic simulation of the sun-solar wind system on thededecahedronal gridpoint model

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The Solar Terrestrial Environment (STE) is constructed from several regions interacting with each other. Each region has its own time scale, spatial scale and physical parameters quite different from those in the other regions. The phenomena that occur in the STE are characterized by such the variables and complex MHD topology emerging there.When we calculate the dynamics of the STE system, it is necessary to make a spheroidal unstructured grid system which covers the whole complex regions. A 3D triangulate grid system made from dodecahedrons which we call dedecahedronal gridpoint model that is the one of the most suitable grid systems that satisfy the above requirement. From a dodecahedron tangent to a sphere we can make triangulate lattice covering a sphere. By piling up many the spheres sharing a same center, we make a 3D gird system which has densely (sparsely) distributed lattice points in the inner (outer) region. This grid structure enables fast and accurate calculations for real systems having a source magnetic field inside, such as the STE system in which the magnetic field originate form the center of the sun or the planets. In our research, we apply the 3D gird system to solve the dynamics of the sun-solar wind system.

We first calculated the potential field of the sun during Carrington Rotation 1915 (from October 15 to November 11, 1996) and 2022 (from October 19 to December 17, 2003) by using conjugate gradient method on the dodecahodronal gridpoint system. We used the photospheric magnetic field in those period observed by the Wilcox Solar Observatory as a boundary condition. In the MHD simulation of the next stage (from 1 to 90 solar radii), this potential field that matches the Wilcox observation of the photospheric field is used as an initial condition. The MHD simulation calculates the time development solution of the solar wind using the Finite Volume TVD scheme that is established by Tanaka[1992]. In this calculation, we set the plasma outflow at the photosphere as a free parameter. As a result, we obtained a solution that reproduces the features of the solar wind in reality.