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High-order combined compact difference scheme in dynamo simulation

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The geodynamo is the generation process of the geomagnetic field working in the Earth's fluid core. Dynamo process has been understood througth three-dimensional numerical simulation in spite of a fact that we are still far from the parameter regime appropriate to the Earth's core. The Ekman number is the most crucial parameter, which represents the relative importance of the viscosity to the rotation. We must reduce the Ekman number down to at least as low as 10^{-9} to numerically simulate the geodynamo, while we have barely reached 10^{-7} at present. In order to perform dynamo simulation at a lower Ekman number with high accuracy, we have implemented a new numerical scheme, combined compact difference scheme (CCDS), into our dynamo simulation code. A 6th-order three point stencil CCDS is adopted in the radial direction, while a conventional spherical harmonic representation in terms of the angular directions are retained. We carry out benchmark runs of thermal convection without magnetic field (benchmark case 0). As a result, it is confirmed that the CCDS yields fairly good agreement with the benchmark solution. Moreover, solutions by CCDS converge faster than other schemes based on a finite difference with more stencils. We have been implementing CCDS into an MHD simulation code. Initial results of dynamo simulation will be reported.

Keywords: dynamo, numerical simulation, combined compact difference scheme