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Numerical simulation of geodynamo with HPCs

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Since magnetohydrodynamic (MHD) numerical geodynamo simulations in three-dimensinal spherical shell with super computer were started, about 18 years have passed. Many useful results have been obtained by the present. For example, MHD dynamo solution in nonlinear process, reproduce of magnetic dipole field like the Earth, and reversal of magnetic polarity. Inside the core cannot be observed directly, so knowledge from numerical simulations is very useful to understand core convection and geodynamo.

However, physical properties or non-dimensional parameters are very different from them in the Earth's core, due to limitation of present super computers. To understand the realistic core convection and geodynamo, physical properties or parameters, especially viscosity or Ekman number, should be closed to the real value in numerical simulations.

Factors from outside the core, not inside the core, for example climatic change, probably affect geomagnetic field variation, but this point is seldom considered in numerical simulations. To understand geomagnetic field variation and predict it, those factors are important.

In next generation HPCs, coupling geodynamo simulation with mantle convection simulation may become actual. Of course, then the parameters in each simulations are restricted. However, useful results are probably obtained to understand the connection among surface, mantle, and core activity.

We will talk about the directivity of geodynamo simulation studies associated with development of next generation HPCs.