Outer core flows and dynamo induced by heterogeneous growth of the inner core of the Earth

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Recent seismological observations suggest longitudinal heterogeneity of seismological wave velocity of the inner core of the Earth, which stimulates a discussion that phase change at the inner core boundary (ICB) does not occur uniformly in the horizontal directions. One of the mechanism explaining heterogeneous growth of the inner core, is that hydrodynamic instability of the inner core surrounded by the phase boundary causes translational motion inside the inner core. The expected amplitude of the motion is 5e-10 m/s,
which is one order of magnitude larger than that of the velocity of uniform growth of the inner core. This suggests that heterogeneous component of the inner core growth dominates the uniform one if this mechanism actually operates in the core of the Earth, However, almost numerical simulations of geodynamo performed so far assume homogeneous buoyancy condition at ICB. In this study, we investigate the characteristics of outer core flows and dynamo action when the inner core grows heterogeneously. By performing numerical experiments of MHD rotating spherical dynamo, the effects of heterogeneous buoyancy condition at ICB are examined, as well as those of the rotation of the inner core. The governing equations of the numerical model is those for MHD Boussinesq fluid. The radius ratio of the inner and outer spherical boundaries is fixed to 0.35, the Ekman number is 1e-4, compositional and magnetic Prandtl numbers are 1, the modified Rayleigh number is 0.075. The compositional boundary conditions at ICB is
either uniform or Y_1^1 spherical harmonics type. The inner core either co-rotates with the mantle, rotates faster than the mantle, or slower. The results of time integrations show that the magnetic field is maintained when the inner core is co-rotating while it decays when the inner core is rotating faster or slower than the mantle. The obtained the magnetic field is dipolar in the case of uniform compositional boundary condition, whereas the magnetic field localizes in the case of Y_1^1 type ICB condition.

Keywords: Heterogeneity, Inner core, Core Mantle boundary

