Lateral temperature variation through ICB to CMB in geodynamo simulations

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Resent seismic observations suggests that inner core has a seismic anisotropy. This seismic anisotropy suggests aspherical growth of the inner core, and slow viscous deformation of the inner core and latent heat distribution by flow motion are expected to be the origin of the aspherical growth of the inner core. To explain inner core anisotropy and aspherical growth of the inner core, a number of dynamo simulations has been performed with prescribed boundary conditions at ICB to take into account the inner core heterogeneity. To represent thermal structure of the ICB self-consistently, geodynamo simulations are performed with considering the heat equation throughout the inner and outer core.

In the present model, we assume that the inner core is electrically insulated and co-rotate with mantle to compare the results with the simulation without considering the inner core. To compare simulations with the boundary condition at ICB, we assume no heat sources in the outer core. For the thermal boundary condition at CMB, a homogeneous heat flux is applied. To simplify the model, we assume that the same thermal diffusivity for the inner core and outer core. To sustain the average temperature in the outer core, a constant heat source is introduced in the inner core. We compare the simulations results with the simulations results using fixed heat flux or temperature condition at ICB. We performed four cases of the simulations with changing Rayleigh number to investigate dependency of the thermal structure on the Rayleigh number.

The results show that the time averaged thermal structure at ICB is likely to the simulation results with homogeneous heat flux boundary conditions. The time averaged lateral temperature variation is approximately 26% of the average temperature difference between ICB and CMB, while lateral heat flux variation is only 6% of the average heat flux at the ICB. We also observe small scale temperature and heat flux variations; however, these components vary with time. In addition, the length scale of the heat flux variation is smaller than the temperature variation at ICB. Furthermore, There is small dependence of the Y_2^0 component of the temperature variation on the Rayleigh number. This lateral temperature variation also generate intense lateral variation at CMB. We observe that temperature inside of the tangent cylinder is higher than the other area. This variation increasing with the Rayleigh number, while the temperature variation is homogenized with increasing the Rayleigh number. This temperature variation at CMB is not observed in the simulations without magnetic field, and meridional circulation inside of the tangent cylinder in the dynamo case is stronger than the non-magnetic cases. we conclude that the Lorentz force near the ICB sustains the meridional circulation and lateral temperature variation at ICB and ICB.

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