Effects of core electrical conductivity on the modeling of core surface flow in a magnetostrophic state

Masaki Matsushima[1]
[1] Dept Earth & Planetary Sciences, Tokyo Tech

Convective motions in the liquid outer core generate and maintain the Earth's magnetic field. It is possible to estimate fluid motions near the core surface from spatial distribution of the geomagnetic field and its temporal change known as secular variations. Many core surface flow models have been estimated so far on the basis of the frozen-flux hypothesis, where the magnetic diffusion term in the induction equation is neglected. It should be pointed out, however, that contribution of magnetic diffusion to temporal changes of geomagnetic field cannot be neglected in a viscous boundary layer at the core-mantle boundary (CMB). Hence, a unique approach to the modeling of core surface flow has been devised by Matsushima (GJI, 2015). In the method, magnetic diffusion within the viscous boundary layer is assumed to be influential in secular variations of geomagnetic field, whereas it is neglected below the boundary layer. Matsushima (2015) adopted the tangentially geostrophic constraint for the core flow below the viscous boundary layer.

Matsushima (SGEPSS, 2016) took into account the dynamic effect of magnetic field, and investigated core surface flow based on the tangentially magnetostrophic constraint. It turned out that the core surface flow estimated under influence of the magnetic field is definitely different from that on the geostrophic constraint. The electrical conductivity of core fluid is of significance in estimating a core surface flow. In fact, the Lorentz force depends on the electrical conductivity. Also, contribution of magnetic diffusion to temporal change of geomagnetic field depends on magnitude of magnetic diffusivity, or the electrical conductivity of core fluid. Furthermore, the radial component of the geomagnetic field just within the core is calculated from the radial component and its partial derivatives with respect to the radius, using a Taylor expansion at the core surface; the second derivative is obtained from the magnetic diffusion at the core surface. Hence, in this presentation, the effect of electrical conductivity of core fluid on core surface flow modeling is investigated.