Effects of core electrical conductivity on core surface flow models

*Masaki Matsushima[1]

1. Department of Earth and Planetary Sciences, School of Science, Tokyo Institute of Technology

The Earth possesses its intrinsic magnetic field, which is generated and maintained by convective motions in the fluid core, known as dynamo action. As found in the induction equation, the temporal change of magnetic field is given by a summation of three terms; the motional induction, the advection, and the diffusion terms. The magnetic diffusion term can be much smaller than the others, and therefore it can be neglected for the magnetic field with length scale of outer core size and with time scales much shorter than magnetic diffusion time. Moreover, the stress-free boundary condition has been imposed at the core-mantle boundary (CMB). Most of core surface flow models have been obtained so far on the frozen-flux approximation, in which the magnitude of core electrical conductivity is equivalent to infinity. In reality, however, there exists a viscous boundary layer at the CMB, in which contribution of magnetic diffusion to temporal changes of geomagnetic field can never be neglected. Hence, to estimate core surface flows, the effect of magnetic diffusion is explicitly incorporated inside the boundary layer and the viscous force is presumed to be influential in considering force balance inside the boundary layer (Matsushima, 2015). Below the boundary layer, the effect of magnetic diffusion is assumed to be much less than the others, as in the frozen-flux hypothesis, and the tangentially geostrophic constraint or the tangentially magnetostrophic constraint is imposed. In this method, core electrical conductivity can play an important role in estimating core surface flows. The temporal variations in the radial component of magnetic field, B_r, at the CMB are caused by magnetic diffusion only because of the no-slip condition for core flows there. The second partial derivative of B_r with respect to the radius has thus relation to core electrical conductivity. This suggests that core electrical conductivity can be important to infer B_r inside the core. Furthermore, on the tangentially magnetostrophic constraint, the electrical current density, which is connected with the Lorentz force, has relation to core electrical conductivity. In this presentation, effects of core electrical conductivity on core surface flow models are investigated for various values of core electrical conductivity, which are still controversial.

Keywords: core electrical conductivity, core surface flow, secular variation, geomagnetic field