Forecasts of geomagnetic secular variation using core surface flow models

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The International Geomagnetic Reference Field (IGRF) is a standard mathematical description in terms of spherical harmonic coefficients, known as the Gauss coefficients, for the Earth's main magnetic field and its secular variation. We submit a candidate model to the next IGRF revision, the 13th generation of IGRF for Secular Variation from 2020 to 2025 (IGRF-13SV), relying on our strong points, such as geodynamo numerical simulation, data assimilation, and core surface flow modeling.

Fluid motion near the core surface can be estimated from distribution of geomagnetic field at the core-mantle boundary (CMB) and its temporal variation. Any constraint on the core flow, such as tangentially geostrophic flow or tangentially magnetostrophic flow, is often imposed on the core flow modeling. It should be noted, however, that core flow models used for data assimilation are to be obtained on a condition appropriate for numerical geodynamo simulations, in which the Ekman number, for example, would be much larger than that for the Earth. Therefore, we adjust typical time-scale of a geodynamo model (Takahashi 2012, 2014) to that of real geomagnetic secular variation as given by Christensen and Tilgner (2004).

In the present study, we investigate behaviors of secular variation of geomagnetic field for some core surface flow models. We use fluid velocity (and fluid acceleration) to forecast geomagnetic secular variations through numerical simulations based on a kinematic dynamo only near the CMB.