Geomagnetic Secular Variation Prediction with Thermal Heterogeneous Boundary Conditions

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It has long been conjectured that thermal heterogeneity at the core-mantle boundary (CMB) affects the geodynamo substantially. The observed two pairs of steady and strong magnetic flux lobes near the Polar Regions and the low secular variation in the Pacific over the past 400 years (and perhaps longer) are likely the consequences of this CMB thermal heterogeneity. There are several studies on the impact of the thermal heterogeneity with numerical geodynamo simulations. However, direct correlation between the numerical results and the observations is found very difficult, except qualitative comparisons of certain features in the radial component of the magnetic field at the CMB. This makes it difficult to assess accurately the impact of thermal heterogeneity on the geodynamo and the geomagnetic secular variation.

We revisit this problem with our MoSST_DAS system in which geomagnetic data are assimilated with our geodynamo model to predict geomagnetic secular variations. In this study, we implement a heterogeneous heat flux across the CMB that is chosen based on the seismic tomography of the lowermost mantle. The amplitude of the heat flux (relative to the mean heat flux across the CMB) varies in the simulation. With these assimilation studies, we will examine the influences of the heterogeneity on the forecast accuracies, e.g. the accuracies as functions of the heterogeneity amplitude. With these, we could be able to assess the model errors to the true core state, and thus the thermal heterogeneity in geodynamo modeling.