FLUID FLOW NEAR THE EARTH'S CORE SURFACE DERIVED FROM GEOMAGNETIC FIELD MODELS

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Earth's core surface flow models have been estimated from geomagnetic field models to understand a realistic geodynamo mechanism, to investigate the thermal structure at the core surface, and to constrain the effect of core-mantle boundary (CMB) on the fluid flow. Most of core flow models estimated so far have relied on the so-called frozen-flux hypothesis, in which magnetic lines of force move as if they are frozen-in core fluid elements, and the magnetic diffusion term has been neglected in the induction equation. It should be noted that thickness of a boundary layer had been neglected, although the flow must vanish at the CMB on the no-slip boundary condition.
In the meantime, we have examined contribution to temporal variations in the magnetic field near the core surface. Below the boundary layer at the CMB, the magnetic diffusion is much smaller than the magnetic induction as presumed in the frozen-flux approximation. Inside the boundary layer, however, the magnetic diffusion is found to be more significant than the magnetic diffusion. This means that the frozen-flux hypothesis does not necessarily hold when a significant boundary layer appears at the CMB. Helical structure corresponding to upwellings and downwellings is clearly found inside the boundary layer.
Hence we have presented an approach to derive fluid flow near the CMB from geomagnetic field models. We presume that the magnetic diffusion as well as the magnetic induction contributes to temporal variations in the magnetic field inside the boundary layer, and that the magnetic diffusion is neglected below the boundary layer as in the frozen-flux approximation. The radial component of the magnetic field is given in form of a truncated Taylor expansion, whereas the radial dependence of horizontal components of fluid flow is represented in terms of the boundary layer compatibility condition.

Fluid flow, core surface, secular variation

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