The role of inertia in the growth of equatorially antisymmetric flow during the polarity reversals in geodynamo model

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The Earth has a magnetic field with a dominant dipole moment that is nearly parallel to the axis of Earth's rotation. Paleomagnetic measurements have shown that the geomagnetic field has reversed its polarity many times. It is widely accepted that the geomagnetic field is sustained by flow motion in the Earth's outer core, so-called dynamo action. Many geodynamo simulations in a rotating spherical shell have been carried out to investigate the physical process of geomagnetic polarity reversals. Then, the equatorially antisymmetric flow during reversals is found to be stronger than that during stable periods (Li *et al.*, 2002). This equatorially antisymmetric flow is suggested to play an important role in reversals (Olson *et al.*, 2004). On the other hand, convective motions in a rotating spherical shell have characteristics that the equatorially symmetric flow is dominant due to the effect of rotation. These characteristics of the flow indicate that there is modulation mechanism to control convective motions during reversals. The purpose of the present study is to clarify the mechanism of growth of the equatorially antisymmetric flow during polarity reversals.

We have performed numerical simulations of geodynamo in a rotating spherical shell modeled on the Earth's outer core. The ratio of the inner to outer core radii is set to 0.35. Dimensionless numbers are set to Ekman number $E = 6\times10^{-4}$, Prandtl number $Pr = 1$, magnetic Prandtl number $Pm = 5$, and modified flux Rayleigh number $Ra_f = 2000$. We have obtained results producing 11 polarity reversals for 75 magnetic diffusion time.

We have analyzed the energy flux transferred between the equatorially symmetric and antisymmetric flow. The results show that the energy flux transferred to the antisymmetric flow is generally small. The buoyancy flux for the antisymmetric flow is almost one-third of that for the symmetric flow. The energy flux transferred to the antisymmetric flow increases toward a polarity reversal in the following order. (i) The energy conversion rate from the symmetric flow to the magnetic field decreases, (ii) the energy conversion rate from the symmetric flow to the antisymmetric flow by the advection increases, and (iii) the energy injection by the buoyancy force into the antisymmetric flow increases. As a result of (i)-(iii), the energy of the antisymmetric flow increases. The largest contribution to the energy flux transferred to the antisymmetric flow is found to be caused by the energy conversion due to the advection.

Keywords: Dipole reversal, Geodynamo simulation, Energy balance

