Magnetic field intensification by lateral variation of the core-mantle boundary heat flow in numerical dynamos

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We have performed a study of 3-D numerical dynamo simulation to examine the effects of lateral variation of boundary heat flux on magnetic field intensity. We impose a non-uniform heat flow pattern given by a single spherical harmonic, mostly $Y_2{}^2$. Varying the amplitude of boundary heat flow inhomogeneity, it is found that strong heterogeneity with equatorial symmetry enhances the efficiency of dynamo action and the intense magnetic field ensues. It is in striking contrast to the previous study at higher Ekman number, in which dynamo ceases with strongly heterogeneous heat flow. Core flow is very much time-dependent where the boundary heat flow exceeds the average because of the extra power, whereas convection is less time-dependent in the region where heat flow is smaller than the average. The magnetic Reynolds number remains unchanged irrespective of the amplitude of the imposed heat flux. As a result, efficient magnetic field generation occurs at longitudes where heat flux is smaller than the average by increasing the effective magnetic Reynolds number. It is suggested that the strong magnetic field due to large heterogeneity of the lowermost mantle induced by a mantle plume is a characteristic feature during long magnetic polarity epoch such as Cretaceous Normal Superchron.