On the possible scenario of thermal evolution of Earth’s core with high thermal conductivity in a coupled core-mantle evolution model

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The thermal conductivity measurement of iron alloy from high P-T physics suggested to range from 60 to 150 W/m/K under temperature and pressure condition in Earth’s core [e.g. Gomi et al., 2013]. The previous study by Nakagawa and Tackley [2015] indicated that the CMB heat flow was just only 6 TW and, as a result, the magnetic evolution would be failed with high thermal conductivity and colder CMB temperature (~3500 K) caused by large adiabatic temperature gradient across the Earth’s core (~1 K/km) [Labrosse, 2015]. Here we assume smaller adiabatic temperature gradient across the Earth’s core (0.5 to 0.7 K/km taken from lower-bound value in Ichikara et al. [2014]) as well as high thermal conductivity of Earth’s core set as 120 W/m/K. For the successful scenario of a coupled core-mantle thermal evolution matching the current size of the inner core and continuous magnetic field generation, the CMB heat flow at the present time-scale would be around 12 TW because the CMB temperature is still high (~4000 K) for finding the current size of the inner core and the age of the inner core would be 1.2 billion year, which seems to be a bit older age of inner core compared to other studies [Labrosse, 2015; Davis, 2015]. To find the successful scenario of thermal evolution of Earth’s core, the adiabatic temperature gradient across the Earth’s core prescribed by Grueneisen parameter and bulk modulus would be quite important in terms of high CMB heat flow than could find the continuous magnetic evolution under the high thermal conductivity. With the lastest update of core-mantle evolution, the adiabatic temperature across Earth's core would be consistent with the range found from first principle calculation rather than that used in the core evolution models approximated heat transfer across the CMB.

Keywords: Earth's core, Heat flow across the core-mantle boundary, Adiabatic temperature gradient, Thermal conductivity

