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Effects of thermal conductivity on thermal and magnetic evolution of Earth's core

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Recent high pressure experiments and theory suggested that the thermal conductivity of Earth‘s core material could be much higher value compared to 15 years ago, which varies from 40 W/mK [Stacey and Anderson, 2001] to 150 W/mK [e.g. Pozzo et al., 2012; de Koker, 2012]. The thermal conductivity of Earths core directly affects the adiabatic heat flow from the core. When the heat flow across the core-mantle boundary (CMB) is smaller than the adiabatic heat flow, the magnetic activity of Earths core cannot account for the thermal convection only (secular cooling). In order to explain continuous magnetic history suggested from the paleomagnetism constraint [e.g., Aubert et al., 2009], the compositional effects caused by inner core growth would be important. Here we investigate thermal and magnetic evolution of Earth‘s core based on a coupled model of thermo-chemical multiphase mantle convection and global heat balance of Earth‘s core [Nakagawa and Tackley, 2010; 2012]. Main conclusion is that the magnetic evolution of Earth‘s core is slightly influenced by the thermal conductivity of Earth‘s core because the CMB heat flow calculated from mantle convection is generally higher than the adiabatic heat flow from the core, which ranges 5 to 15 TW. For the case that the thermal conductivity of Earth‘s core could be assumed as 200 W/mK, the continuous magnetic evolution caused by dynamo actions would be maintained by the compositional convection due to the inner core growth.

Keywords: thermal conductivity, thermal evolution, magnetic evolution, core-mantle heat flow, compositional convection