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Core-mantle gravitational coupling strength and electromagnetic coupling parameters at the inner core boundary inferred from the observed 6 year oscillation in length of day

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Previous published works indicated that the axial mantle-inner core gravitational (MICG) coupling mode can thoroughly explain the 6 year oscillation in length of day (LOD), while the interannual 6 year torsional oscillations (SYTOs) within the fluid outer core were detected and these SYTOs seem to be responsible for the 6 year oscillation in LOD through transferring the angular momentum from fluid core to mantle, however the exact excitation mechanism of these SYTOs recurrence period remains to be not clear. To explain the possible excitation mechanism of SYTOs, this work adopts the idea that inner core to-and-fro swing like a simple pendulum, under the action of gravitational coupling torque from mantle, excites the SYTOs. Using the angular momentum equations consisting of Earth's solid parts (i.e. mantle and inner core) with core-mantle gravitational coupling and electromagnetic coupling torques, this work further derives the theoretical eigen-period formula of MICG mode under the effects of core-mantle electromagnetic (EM) coupling, and revises the previous period formula of MICG mode in which the EM coupling effects were not involved. This work correlates the core-mantle gravitational coupling strength (Γ) with the EM coupling at the inner core boundary (ICB) through the observed 6 year period in LOD. In this work, the lower bound of Γ ($>6.5\times10^{19}$Nm) and the upper value (2.43×10^{3}Nm^{-3}s) of EM coupling at the ICB are obtained. When the fluid core conductivity at the ICB is currently 1.5×10^{6}S/m, this work indicates that the radial magnetic field at the ICB should be smaller than 3.9mT. This work is helpful to further accurately estimate Γ value, electrical conductivity and magnetic field at the ICB.