コアーマントル電磁結合と数十年スケールコア流体運動

浅利 晴紀 [1]; 清水 久芳 [1]; 歌田 久司 [1]
[1] 東大・地震研

Electromagnetic core-mantle coupling and decadal motions of core fluid

Seiki Asari[1]; Hisayoshi Shimizu[1]; Hisashi Utada[1]
[1] ERI, Univ. of Tokyo

Decadal variations of the observed length of day (LOD) are known to be attributable to the angular momentum exchange between the core and mantle. Dynamics of rotating fluid implies that decadal variations of the core angular momentum are likely to result from changes in core fluid motions organized by rigid circular annuli coaxial with the Earth's rotation axis. We develop a general expression of the electromagnetic (EM) core-mantle torque acting on a core annulus in terms of the main magnetic field and core surface flow (including their non-axisymmetric components as well as axisymmetric components). The EM torque is calculated from a time-series model of tangentially geostrophic core surface flow, estimated such as to explain both the geomagnetic and LOD observations. We find that zonal toroidal flow, varying in accordance with the LOD variations with typical periodicity of approximately 60 years, makes a primary contribution to the variations of torques on the annuli. Non-axisymmetric flows are not as variable in time as zonal toroidal flow, and lead to important EM torque only on timescales around 100 years, i.e. somewhat longer than that of the decadal LOD variations. Our analysis points out that, in order for the decadal LOD variations to be explained by the electromagnetic torque, rotations of the annuli should fluctuate on typical timescales of approximately 30 years, shorter than that of the LOD variations. This cannot be caused by the EM torque in itself, because of its property as a friction with spin-up time longer than the fluctuation timescale. In light of the decadal core dynamics, whether this rapid fluctuation can be excited continuously is the key to assess the possibility for the electromagnetic core-mantle coupling to be predominantly responsible for the decadal LOD observations.