



## **A 6-year Geophysical Westward Rotary Motion in the Earth: Kinematics and Dynamics**

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A 6-year oscillation was previously found in the Earth's length-of-day variation  $\Delta\text{LOD}$ . Recent research (Ding & Chao, EPSL, 2018) also found clear 6-year signals in the global GPS surface displacement field and geomagnetic variations of sectoral spherical-harmonic pattern of degree-2 order-2 (Y22), a result obtained through the array-processing OSE stacking scheme. The same 6-year periodicity is similarly detected in the variations of C22 and S22, the degree-2 order-2 Stokes coefficients of the Earth's gravitational field. These signals are observed to be related in tight synchronicity in their calendar timing (w.r.t. the maximum phases), which is consistent with, and strongly corroborated by, the following chain scenario that we propose: The mantle-inner core gravitational coupling gives rise to a rotational mode of 6-year axial torsional libration mode of the inner core dictated by the Y22 density anomalies in terms of the corresponding sectoral quadrupoles (or equivalently the equatorial ellipticities) of the (lower) mantle and inner core. The resultant angular momentum exchange between the inner core and mantle manifests as the 6-year oscillation in  $\Delta\text{LOD}$  as observed. The libration, presumably excited by geodynamo motions, forces into action a pressure wave-2 propagating westward through the fluid outer core with the periodicity of 6 years in half-cycle (or 12 years to complete one full cycle), which in turn produces the said surface GPS and geomagnetic variations, as well as those in C22 and S22. This scenario may interestingly reflect certain behavior of the non-linear fluid dynamics of harmonic motions under rotation. Our findings incidentally corroborate a positive density anomaly for the lower-mantle Large Low-Shear-Velocity Provinces that is of the Y22 spatial configuration.