CONSTRAINTS ON THE STRUCTURE AND DYNAMICS OF THE EARTH'S DEEP INTERIOR INFERRED FROM NUTATION OBSERVATIONS

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ABSTRACT. The gravitational torque applied on the Earth by the other celestial bodies generates periodic variations in the orientation of the Earth's rotation axis in space which are called nutations. This motion has two normal modes, the Free Core Nutation (FCN) and the Free Inner Core Nutation (FICN), of which the frequencies and dampings depend directly on the Earth's interior structure and dynamics (e.g. Mathews et al. 1991a, 1991b, Mathews & Shapiro 1992). Both normal modes are characterized by differential rotations of the inner core, the outer core, and the mantle. Their natural frequencies are thus directly affected both by the strength of the mechanical coupling at the outer core boundaries and by the way the three regions deform due to the action of centrifugal forces. Similarly, the damping of the modes reflects the energy dissipated both through the couplings at the outer core boundaries and through anelastic deformation. The mechanical coupling can be of several physical origins such as gravitational, electromagnetic, viscous, or pressure/topographic couplings. Due to the high precision of the nutation observations, obtained from the Very Long Baseline Interferometry (VLBI) technique, the frequency and damping of the normal modes can be estimated from the resonance effect they induce on the forced nutations (Mathews et al. 2002, Koot et al. 2008, 2010). Interpretation of these estimated natural frequencies and dampings allows then for insights into the deep Earth's physical properties. In this talk, we review the constraints that have been inferred from nutation observations on deep Earth's properties such as the intensity of the magnetic field at the outer core boundaries (Buffett et al. 2002, Koot et al. 2010, Buffett 2010a), the viscosity of the core fluid close to those boundaries (Mathews & Guo 2005, Deleplace & Cardin 2006, Koot et al. 2010), the chemical stratification at the top of the core (Buffett 2010b), and the viscosity of the inner core (Koot & Dumberry 2011). We also present an estimation of the atmospheric contributions to nutations and their implications for the estimation of deep Earth's properties from nutation observations (Koot & de Viron 2011).

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