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Topographic coupling at core-mantle boundary in rotation and orientation changes of the Earth

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We study coupling mechanisms at the core-mantle boundary (CMB) of terrestrial bodies of the Solar system, and in particular, calculate the pressure torque acting on the topography of the CMB. The CMB topography is usually considered to have a smooth spherical or elliptical shape, however, in reality it is bumpy (for the Earth, the CMB mountains and valleys represent local height differences of the order of a kilometer). The torque related to the topography is due to an incremental flow in the core at the CMB with respect to the Poincare fluid motion when the nutations are considered. The additional pressure and the torque depend on the shape of the CMB and can be related to the spherical harmonic coefficients of the CMB topography. We follow the philosophy of the computation of Wu and Wahr [Geophys. J. Int., 128(1), 18-42, 1997] and determine the coefficients of the velocity field in the core at the CMB in terms of the topography coefficients.

We confirm that some topography coefficients may enhance length-of-day changes and nutations at selected frequencies, and show that these increased rotation variations are due to resonance effects with inertial waves in the incremental core flow. The total torque therefore sensitively depends on the geometry of the CMB. Enhancements of rotation variations were previously shown with an example in Wu and Wahr (1997), but their use of numerical values did not allow deciding whether the enhancements were due to the topography amplitudes themselves or to some resonance effect. Here we show that these enhancements are not an artifact of the choice of the topography but rather a general fact for some frequencies close to inertial wave frequencies. However, for frequencies far from the inertial wave frequencies, the contribution to nutation might still be related to a large amplitude of the topography.