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A proof of the cancellation of the redistribution tidal potential effects on the rotation of an elastic Earth model

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The gravitational action of the Moon and the Sun on the elastic Earth originates a redistribution of its mass. In turn, this redistribution is responsible of an additional term in the gravitational potential energy of the system, commonly referred to as tidal potential of redistribution.
Its effects on the Earth rotation were previously discussed in Escapa et al. (2004) and Lambert & Mathews (2006). A numerical approach was followed in those works to show that for an elastic Earth model, assumed to be spherical and non-rotating in the undeformed state, there is no net contribution to the motion of the figure axis. This result is consistent with the corresponding one deduced from the torque approach, where one can derive analytically that the redistribution torque for that elastic Earth model vanishes (e.g., Krasinsky 1999). However, it is far from being a trivial question to recover the same result when working directly with the tidal potential of redistribution, as in Escapa et al. (2004) or Lambert & Mathews (2006).
In this investigation we revisit the issue, enhancing and completing former results by Escapa et al. (2004). In particular, we aim at proving, by analytical means, that the redistribution tidal potential of the former elastic Earth model does not affect its rotational motion. To this end we expand that potential in terms of an Andoyer-like set of canonical variables, and then compute the torque associated to it. This choice was motivated by the suitability of this set of variables to extend our calculations to the nutations of other different elastic or anelastic Earth models, through the Hamiltonian framework (e.g., Ferrándiz et al. 2012). We show the exact cancellation of the derived expressions as a consequence of certain properties fulfilled by the expansions of the orbital motion of the perturbing bodies.

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