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On the permanent tide and the Earth dynamical ellipticity

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As other relevant quantities related to the Earth dynamics, the Earth dynamical ellipticity is influenced by tidal effects. In particular, it is affected by the permanent tide due to the time independent part of the Earth redistribution tidal potential. Hence, it is necessary to distinguish between its tide-free and non tide-free values (e.g., Burša 1995) when determining it from observations (e.g., Marchenko & Lopushanskyi 2018). This question is seldom considered in Earth rotation studies. For example, neither IAU2000/AIU2006 nutation/precession model nor IERS Conventions specify explicitly whether the dynamical ellipticity is a zero-tide parameter or not. However, current accuracy goals might be sensitive to that difference.

Within the framework of a Hamiltonian approach (Baenas, Escapa, & Ferrándiz 2019), we present a consistent treatment of the influence of the permanent tide on the dynamical ellipticity. In particular, we develop an analytical expression of the redistribution tidal potential based on Andoyer canonical variables and a semi-analytical theory of the orbital motions of the Moon and the Sun, following the same procedure as that given in Kinoshita (1977).

This method allows obtaining an expression of the zero frequency term of the redistribution tidal potential that updates that of Zadro & Marussi (1973), usually employed in reporting parameters of common relevance to Astronomy, Geodesy, & Geodynamics (e.g., Burša 1995, Groten 2004). In addition, it clarifies the procedure that must be followed in order that the dynamical ellipticity, fitted to the observations, contains the effects of the permanent tide avoiding in this way potential inconsistencies.