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Improved determination of the three first-degree Earth gravity coefficients using SLR, DORIS and GPS observations

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The very low-degree Earth's gravity coefficients, associated with the largest-scale mass redistribution in the Earth's fluid envelope (atmosphere, oceans and continental hydrology), are the most poorly known. In particular, the three first-degree geopotential terms are important, as they relate to intrinsic Earth's mass references: gravitational coefficient (GM) of the Earth (degree 0), geocenter motion (degree 1), Earth's figure axis orientation (degree 2). This paper presents a self-consistent determination of these three characteristics of the Earth.

The main objective is to deal with the remaining sources of altimetry satellite orbit uncertainties affecting the fundamental record of sea surface height measurements. In particular, the analysis identifies the modeling errors, which should be mitigated when estimating the geocenter coordinates from SLR, DORIS, or GPS observations. The long-term behavior of the degree-0 and 2 spherical harmonics is also observed over the 35-year period 1984-2018 from the long-time history of satellite laser tracking to geodetic spherical satellites. From the analysis of the evolution of these two coefficients, constraints regarding the Earth's rheology and uncertainties in the value of GM could be inferred. Overall, the influence of the orbit characteristics, solar radiation pressure modeling errors, SLR station biases and its unbalanced tracking network, measurement modeling errors (troposphere wet biases, non-tidal deformations) is also discussed.