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The geocenter motion from decadal to geological time-scales: geophysical modelling

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Among the coefficients of the spherical harmonics expansion of elasto-gravitational deformations, the degree-one has particular characteristics related to geodesy as well as to mechanics. It is linked to the position of the Earth centre of mass and is strongly dependent on the choice of the origin of the reference frame. We investigate here the geocenter motion, that is to say the geometric centre of the translated external surface with respect to the centre of mass, for different internal excitation sources at different time-scales.

At decadal time-scale, we find that the geocenter motion induced by geostrophic pressures within the fluid core acting at both the core-mantle and inner core boundaries is at a level of 0.1 mm/yr.

At secular time-scale, geocenter motions induced by post-glacial rebound have been shown to be at the level of $-0.4 - 0.2$ mm/yr

Finally, at geological time-scale, we quantify degree-one deformations induced by internal loads within the mantle. We use a simple model in which we assume that subducted plates sink vertically through the mantle, and in which upwelling domes are stable over the last 120 Ma. We found that, although the associated geocenter secular motion is one order of magnitude smaller than the one induced by post-glacial rebound, there is a significant discrepancy of about a few hundred meters between the centre of figure and the centre of mass of the Earth. Is it possible to detect, at the present time, with geodetic measurements, such a permanent translation?