

# Body Tides of a Convecting, Laterally Heterogeneous, and Aspherical Earth

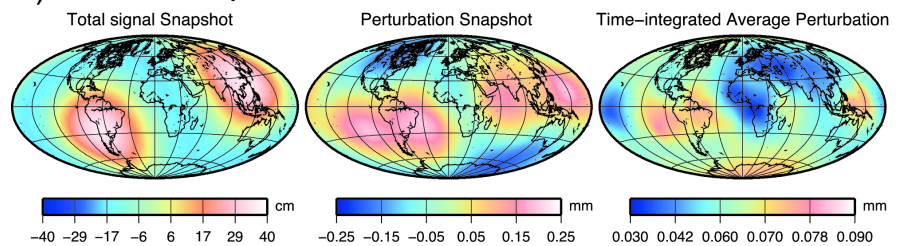
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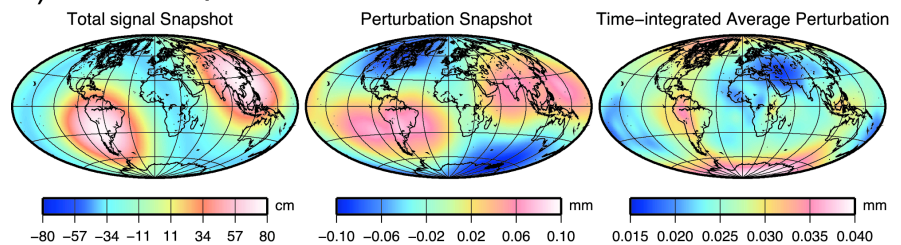
Precise knowledge of Earth's body tides is crucial for correcting geodetic positioning measurements, satellite gravity surveys, and superconducting gravimeters with nanogal (nGal) precision. With this aim, body tides are generally computed assuming a radially (or elliptically) stratified Earth. However, seismic tomography surveys and fluid dynamic studies show that thermal convection within Earth's mantle produces significant lateral heterogeneity exemplified by superplumes, superswells, and subducting slabs. To determine the influence of this heterogeneity on body tides, we used a tomographic model to constrain lateral variations in mantle density and rigidity. This heterogeneity drives convective flow that deflects Earth's surface and core-mantle boundaries by a few kilometers; we used a viscous flow model (the CIG-supported spherical convection code *CitomS*) to constrain this dynamically supported asphericity. After

verifying this complete Earth model using geoid observations, we used the spectral element method to determine how Earth's body tides are perturbed compared to a spherical Earth. We find maximum radial perturbations of surface and geoid displacements of 0.3 and 0.1 mm, respectively, and tidal gravity variations of 150 nGal. The amplitude of tidal gravity perturbations depends strongly on location and is greatest above large mantle density anomalies: e.g., large dense slabs (South America, Indonesia, Marianas), hot spots (Hawaii, Iceland), and the East African Rift. Predicted gravity perturbations are 100 times larger than the present precision of superconducting gravimeters and are comparable in magnitude to the unexplained residue observed at some gravimeter stations after tidal corrections. While this residue has been attributed to unmodeled loading from ocean tides, body tide perturbations caused by convection-induced mantle heterogeneity may contribute to this observed residue.

## A) Surface displacement



## B) Geoid displacement



## C) Gravity on the deformed surface

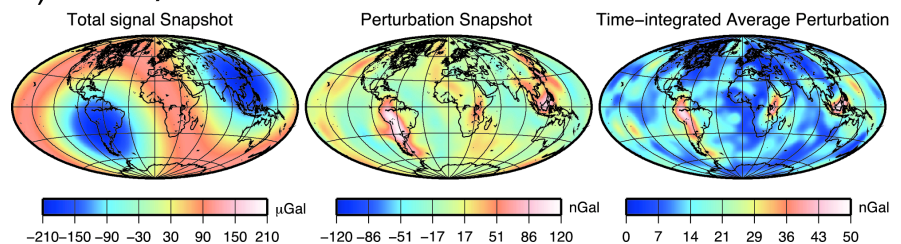


Figure 1. a) Surface displacements, (b) geoid displacements, and (c) gravity variations induced by the tide-generating potential on a given date or integrated over time. Left: Maps of the tidal responses for the PREM Earth model, on 23 November 2007 at 1800 UTC. Middle: Maps of additional tidal perturbations (on the same date) that are due to lateral heterogeneities in the mantle and to topographies on the surface and on the CMB, as calculated using the CIG-supported *CitomS* code. Right: Maps of the mean integration of the perturbations over 1 year.

## Reference

Métivier, L., and C.P. Conrad (2008), Body tides of a convecting, laterally heterogeneous, and aspherical Earth, *J. Geophys. Res.*, *113*, B11405, doi:10.1029/2007JB005448.