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An efficient analytic method to derive geoids from geodynamic models

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It is well known that mantle circulation processes in the Earth's interior generate large-scale density anomalies which influence the Earth's external gravity field. Therefore, gravity provides an important constraint for geodynamic modelling, especially as new space born gravity missions are providing increasingly accurate observations of the Earth's gravity field. However, not only the density anomalies themselves (Poisson equation) but also the flow-induced dynamic topography at the surface and the CMB must be taken into account, which requires the determination of the generated stress field (Stokes equation). Here we present a highly efficient computational implementation of the relevant equations.

Using a spherical harmonic approach and a radial discretization, we solve the equations analytically to derive the instantaneous flow and stress field as well as the dynamic topography and gravitational potential of a given density structure. The solution for a unit density anomaly is called 'kernel' and provides, in combination with geodynamic and seismic observations, a powerful and illustrative tool to explain the origin of the variations in the observed Earth's geoid.

We will present applications of our analytic modelling techniques to large scale density perturbations derived from global circulation modelling of the Earth's mantle as well as seismic tomography.