Sensitivity analysis of crustal correction for calculation of lithospheric mantle density from gravity data - DTU Orbit (31/12/2018)

**Sensitivity analysis of crustal correction for calculation of lithospheric mantle density from gravity data**

We investigate how uncertainties in seismic and density structure of the crust propagate to uncertainties in mantle density structure. The analysis is based on interpretation of residual upper-mantle gravity anomalies which are calculated by subtracting (stripping) the gravitational effect of the crust from the observed satellite gravity field data (GOCE Direct release 3). Thus calculated residual mantle gravity anomalies are caused mainly by a heterogeneous density distribution in the upper mantle. Given a relatively small range of expected compositional density variations in the lithospheric mantle, knowledge on uncertainties associated with incomplete information on crustal structure is of utmost importance for progress in gravity modelling.

Uncertainties in the residual upper-mantle gravity anomalies result chiefly from uncertainties in (i) seismic VP velocity–density conversion for the crust and (ii) uncertainties in the seismic crustal structure (thickness and average VP velocities of individual crustal layers, including the sedimentary cover). We examine the propagation of these uncertainties into determinations of lithospheric mantle density and analyse both sources of possible uncertainties by applying different velocity-to-density conversions and by introducing variations into the crustal structure which correspond to typical resolution of high-quality and low-quality seismic models. We apply our analysis to Siberia (the West Siberian Basin and the Siberian Craton) for which a new regional seismic crustal model, SibCrust, has recently become available. For the same region, we also compute upper-mantle gravity and density anomalies based on three global crustal models (CRUST 5.1, CRUST 2.0 and CRUST 1.0) and compare the results based on four different crustal models.

A large uncertainty in the VP-to-density conversion may result in the uncertainty in lithospheric mantle density anomalies of ca. 0.02–0.03 g cm−3 (i.e. 0.5–1 per cent, which is comparable to compositional density anomalies expected for continental lithosphere mantle). Similar values of uncertainties may be caused by a 0.2 km s−1 error in average crustal VP velocities or by a 2 km uncertainty in the Moho depth. One of the largest uncertainties is caused by errors in thickness of the sedimentary layer, and a 2 km error leads to ca. 0.03 g cm−3 error in lithospheric mantle densities. Large deviations (locally ±10 km) of the Moho depth in global crustal models (CRUST 5.1, CRUST 2.0 and CRUST 1.0) from the high-resolution regional seismic model of the crust, SibCrust, may produce artefact residual mantle gravity anomalies of up to ±150 mGal locally, caused by large errors in crustal gravity corrections. These errors in gravity anomalies produce up to ca. 0.04 g cm−3 (ca. 1.2 per cent) errors in density of the lithospheric mantle, which may well correspond to the amplitude of real density anomalies in the mantle. Our results demonstrate that gravity modelling alone cannot reliably constrain the crustal structure, including the Moho depth and thickness of sediments.

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