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Uncertainty budget of solid Earth data reductions to global gravity models

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Solid Earth applications of satellite gravity models commonly involve some type of data reduction - i.e. forward modelling the gravity effect of known mass distributions to isolate an anomaly from the observed field, which is then attributed to the enquired phenomenon. The adopted "known masses" suffer from the uncertainties arising from the non-modelled variance in the shape of geological bodies and the density distribution therein. These uncertainties are propagated to the reduced gravity field, superimposed to the formal errors provided with the gravity model. Given the different origin between formal errors of satellite global gravity models (GGM), arising from observation and noise models, and the contribution of geophysical data reductions, we aimed at assessing the comprehensive error characteristics of reduced-GGMs.

In order to do so, we computed a set of common reductions (topography, crustal layers, mantle inhomogeneities) using a combination of spectral- and space-domain forward modelling. Uncertainties in the input quantities (depths and densities) were propagated trough Monte Carlo methods.
Geometries were constrained by a topography-bedrock-ice model (Earth2014), by a global layered model of the lithosphere (LITHO1.0), and by local higher detail models of the crust and sediments, where available. Depth uncertainties, if not provided with the input data, were assigned according to method-specific assumptions. Estimates of density and its variance come from probability distributions fitted to literature data, from petrophysical relationships (e.g. velocity-composition-temperature) and from worst-case assumptions where no sufficient data is available.

We report the outcome of a set of global models, at a resolution and spectral content coherent with the currently available satellite-only GGMs. We resort to global uncertainty maps and to the familiar representations employed in GGM sensitivity assessments (e.g. degree error curves). Different combinations of data reductions were applied, simulating the interest in different anomalies (e.g. by correcting either for the crust or the mantle).