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Towards a very High-Resolution Global Gravity Field Model up to degree and order 10800 based on Forward Modelling of the Earth's Topography

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The gravity field plays a crucial role in Earth System Sciences. Access to the entire field on global scale is only possible via mathematical modelling. The heterogeneous gravity field shapes the mean sea level surface and can be used e.g., to determine ocean surface currents, to unify height systems globally, and to map mass distributions that mirror the processes in Earth's interior, such as plate tectonics, mantle convection, seafloor spreading and volcanic eruption. Currently available static global gravity field models are limited in resolution due to the band-limited spectral content of the input data from satellite observations and gravity measurements on the Earth's surface. We can complement such models beyond their current limits using high-resolution digital elevation models (DEMs) and laterally varying density estimates. Here we present a study, where we aim to compute a new very high-resolution topographic gravity field model in terms of harmonic coefficients via direct numerical integration of Newton's law of gravitation using state-of-the-art DEM and density models. This work is a continuation of our previous activities in this field (Ince et al. 2020) and first results of a DFG project GRAV4GEO (GRAVitational field modelling of Earth's topography For GEOdetic and GEOphysical applications). The outcomes of this project will be reduction of the omission error and enhancement of the spectral and spatial resolution of global gravity field models and delivery of topography/density-based gravity information particularly in hard-to reach areas. A third result will be the improved reduction of the gravity measurements for the topographic effect to investigate the residual signal of deeper Earth layers. This should help in the 3D crustal and lithospheric modelling especially in geologically complex areas, Finally, improvement in the accuracy of gravity modelling is expected from using laterally varying density instead of the commonly used averaged density values. With the high-resolution topographic gravity field model delivered at the end of the project, the spatial resolution of recent global gravity field models shall be increased up to ~2 km Uncertainty estimates, which have not been presented in current topographic gravity field models, will be provided. Our project will lead to an improved global gravity field up to degree/order 10800 which will also deliver a more accurate reference surface for global vertical datum and basis for better geophysical modelling especially in the regions of density discontinuities. In this presentation, we will be conveying the first results of the project which uses a laterally varying density model in the development of topographic gravity field model and its contribution to the state-of-the-art model EIGEN-6C4.

Reference:

Ince ES, Abrykosov O, Förste C, and Flechtner F (2020) Forward Gravity Modelling to Augment High-Resolution Combined Gravity Field Models. *Surv. Geop.*, 1-38. doi:10.1007/s10712-020-09590-9