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GOCE gravity gradient data for lithospheric modeling - From well surveyed to frontier areas

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We explore how GOCE gravity gradient data can improve modeling of the Earth's lithosphere and thereby contribute to a better understanding of the Earth's dynamic processes. The idea is to invert satellite gravity gradients and terrestrial gravity data in the well explored and understood North-East Atlantic Margin and to compare the results of this inversion, providing improved information about the lithosphere and upper mantle, with results obtained by means of models based upon other sources like seismics and magnetic field information. Transfer of the obtained knowledge to the less explored Rub' al Khali desert is foreseen. We present a case study for the North-East Atlantic margin, where we analyze the use of satellite gravity gradients by comparison with a well-constrained 3D density model that provides a detailed picture from the upper mantle to the top basement (base of sediments). The latter horizon is well resolved from gravity and especially magnetic data, whereas sedimentary layers are mainly constrained from seismic studies, but do in general not show a prominent effect in the gravity and magnetic field. We analyze how gravity gradients can increase confidence in the modeled structures by calculating a sensitivity matrix for the existing 3D model. This sensitivity matrix describes the relation between calculated gravity gradient data and geological structures with respect to their depth, extent and relative density contrast. As the sensitivity of the modeled bodies varies for different tensor components, we can use this matrix for a weighted inversion of gradient data to optimize the model. This sensitivity analysis will be used as input to study the Rub' al Khali desert in Saudi Arabia. In terms of modeling and data availability this is a frontier area. Here gravity gradient data will be used to better identify the extent of anomalous structures within the basin, with the goal to improve the modeling for hydrocarbon exploration purposes.