Geophysical Research Abstracts
Vol. 20, EGU2018-19690, 2018
EGU General Assembly 2018

Towards a 3D model of the Sumatra slab using combined gravity and gravity gradients constrained with seismic tomography

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Satellite-derived gravity and gravity gradient models can provide new insights with respect to traditional seismic and tomographic models, with regard to geometry and density distributions of subducting plates. These satellite-derived gravity gradient models have been used in modelling of several different subduction zones, but not yet for the Sumatra subduction zone. There, the gravity models can shed light on the shape of the plate, and whether a slab tear is present or not under northern Sumatra. Gravity gradient tensor invariants contain information from all gravity gradient components, but are non-directional, which makes them useful for modelling curved subduction zones.
We use combined terrestrial-satellite-derived gravity and gravity gradients (XGM2016) to model the density and thickness distributions of the Sumatra slab in 3D. A spectral forward modelling method is used to identify signals related to the slab. Spectral analysis will determine the optimal spherical harmonic bandwidth that contains most of the slab signal. The synthetic slab is created using a top-slab surface model combining information from seismic information and tomography models. The slab is modelled as a bilinear deforming slab with along-dip varying thickness and density and along-strike voxels. Furthermore, we include a slab conduction model to determine the 3D density structure of the slab and an isostatic compensation model for the density in the mantle. Different external models are incorporated: high-resolution topography, high-resolution sediment models, a crustal model, top-slab surface geometry, and oceanic lithosphere age for first-order slab thickness estimates. An iterative algorithm is used to find the slab geometry and density distribution that fits the observations. A sensitivity analysis is performed to quantify the error in the used models (e.g. Moho depths) and their implications on the final slab model. After an extended Bouguer correction, we observed a different signal for the second tensor invariants in northern Sumatra, which might be related to the different tectonic framework.