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Decoupling the crustal and mantle gravity signature at subduction zones with satellite gravity gradients: case study Sumatra

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The GOCE satellite mission of the European Space Agency has delivered an unprecedented view of the gravity field of the Earth. In this data set, the strongest gravity gradient signals are observed at subduction zones in the form of a dipole. Despite numerous studies on subduction zones, it is still unclear what is causing this strong signal. Is the source of the observed dipole situated in the crust, mantle, or a combination of these?

We have constructed a 3D geometry of the Sumatra slab using the global SLAB1.0 model. This geometry is substituted in a global upper mantle model WINTERC5.4, a product of the ESA Support to Science Element: 3DEarth. The density in the subducting crust, mantle, or a combination of both is fitted to the gravity gradients at satellite height. Lateral varying Green's functions are used to compute the gravity gradients from the densities. In the case of a combined crust/mantle model, spectral information of the sensitivity of satellite gradients is used to construct a weighted inversion.

Preliminary results show that crustal mass transport (mostly from the overriding plate) in the direction of the subducting plate is mostly responsible for the negative anomaly observed in between the trench and the volcanic arc. This signal is, however, not visible along the complete subduction zone. Most crustal transport is seen where normal subduction takes place. Oblique subduction shows less crustal transport and more intra-crustal faulting. The satellite gravity gradients show high sensitivity to this particular crustal signature and therefore can be used to analyze subduction zones globally.