The role of a laterally varying density contrast for gravity inversion of the Moho depth

Peter Haas, Joerg Ebbing, Wolfgang Szwillus, and Philipp Tabelow
Kiel University, Institute of Geosciences, Kiel, Germany (peter.haas@ifg.uni-kiel.de)

We present a new inverse approach to invert satellite gravity gradients for the Moho depth under consideration of a laterally varying density contrast between crust and mantle. The inverse problem is linearized and solved with the classical Gauss-Newton algorithm in a spherical geometry. To ensure stable solutions, the Jacobian is smoothed with second-order Tikhonov regularization. During the inversion, the Moho depth is discretized into tesseroids by reference Moho depth and density contrast, from which the gravitational effect can be calculated. As a computational benefit, the Jacobian is calculated only once and afterwards weighted with the laterally varying density contrast. We look for a Moho depth model that simultaneously explains the gravity gradient field and a least misfit to existing seismic Moho depth determinations. We perform the inversion both on regional and global scale.

The laterally varying density contrast is based on different tectonic units, which are defined by independent global geological and geophysical data, such as regionalization of dispersion curves. This is beneficial in remote areas, where seismic investigations are very sparse and the crustal structure is to a large extent unknown. Applying the inversion to the Amazonian Craton and its surroundings shows a lower density contrast at the Moho depth for the continental interior compared to oceanic domains. This is in accordance with the tectono-thermal architecture of the lithosphere. The inverted values of the density vary between 300-450 kg/m$^3$. The inverted Moho depth shows a clear separation between the Sao Francisco Craton and shallower Amazonian Craton.

Gravity inversion with a laterally varying density contrast requires a uniform reference Moho depth. On a global scale, we utilize our inversion to estimate a reference Moho depth that is in accordance with crustal buoyancy. The inverted density contrasts show a similar trend like the regional study area. The inverted Moho depth shows expected tectonic features. Our method of computing the Jacobian once and weighting with lateral variable density contrasts is a valuable optimization of standard gravity inversion.