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Combined regional gravity model of the Andean convergent subduction zone and its application to lithospheric modelling in active plate margins

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Comparison of global GOCE gravity models with terrestrial gravity data reveals large systematic differences in South America, which can be attributed to a low data quality of the terrestrial data. Correspondingly, these large inconsistencies are also reflected when comparing GOCE models with pre-GOCE combined global models such as EGM2008. Therefore, it could be assumed that lithospheric models of the study region, which did not yet include GOCE, are also affected with long to medium wavelength errors.

In a joint effort of geodesy and geophysics, a regional gravity field model for the Andean convergent subduction zone is computed as a combination of satellite gravity data from GOCE and GRACE, terrestrial gravity data of the study region, as well as satellite altimetry in the adjacent Pacific ocean.

In a first step, the ground data (gravity anomalies and associated heights) are validated against external information, such as global GOCE gravity models (within the limited spectral band captured by the global models), and ACE2 digital terrain model regarding the height information attached to the terrestrial gravity data base. For the validation of ground gravity data, the high-frequency signal content (mainly contained in terrestrial data) is reduced consistently by a topographic-isostatic reduction.

The optimum combination of terrestrial gravity anomalies and GOCE satellite gravity is achieved by Least Squares Collocation, taking - as much as possible – error information of the input data into account. Also the omission error related to non-resolved high-frequency gravity signal of the satellite data is considered adequately. As a result, not only a combined regional gravity field model, but also associated error information is derived. The resulting model is validated against external gravity data and also regarding plausibility of geophysical interpretation.

Finally, lithospheric density modelling applying the IGMAS+ software is performed based on this new gravity field model, and the resulting density model is compared to a model of the pre-GOCE area, thus evaluating the impact of GOCE on geophysical modelling of the lithosphere. It will be shown that artefacts in EGM2008 could be identified and eliminated especially in regions with no or very poor terrestrial data. Therefore, we conclude that with this regional gravity field model large-to medium-scale lithospheric modelling of the whole Andes region has now become possible.