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Methodological improvements of geoid modelling for the Austrian geoid computation

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The geoid computation method of Least Squares Collocation (LSC) is usually applied in connection with the remove-restore technique. The basic idea is to remove, before applying LSC, not only the long-wavelength gravity field effect represented by the global gravity field model, but also the high-frequency signals, which are mainly related to topography, by applying a topographic-isostatic reduction. In the current Austrian geoid solution, an Airy-Heiskanen model with a standard density of 2670 kg/m3 was used.

A close investigation of the absolute error structure of this solution reveals some correlations with topography, which may be explained with these simplified assumptions. On parameter of the remove-restore process to be investigated in this work is the depth of the reference surface of isostatic compensation, the Mohorovicic discontinuity (Moho). The recently compiled European plate Moho depth model, which is based on 3D-seismic tomography and other geophysical measurements, is used instead of the reference surface derived from the Airy-Heiskanen isostatic model. Additionally, the use of of the standard density of 2670 kg/m3 is replaced by a laterally variable (surface) density model. The impact of these two significant modifications of the geophysical conception of the remove-restore procedure on the Austrian geoid solution is investigated and analyzed in detail.

In the current Austrian geoid solution the above described remove-restore concept was used in a first step to derive a pure gravimetric geoid and predicting the geoid height for 161 GPS/levelling points. The difference between measured and predicted geoid heights shows a long-wavelength structure. These systematic distortions are commonly attributed to inconsistencies in the datum, distortions of the orthometric height system, and systematic GPS errors. In order to cope with this systematic term, a polynomial of degree 3 was fitted to the difference of predicted geoid heights and GPS/levelling heights, and the geoid height observations were reduced by this polynomial surface. This "correction term" was added back to the predicted geoid signals afterwards. As an alternative approach, the parameters of the polynomial surface could also be coestimated in the frame of the LSC procedure using a more general formulation of LSC. From a theoretical and methodological point of view, the latter approach is to be favoured, because the a-priori reduction step can be avoided, and the problem is solved consistently in the course of the geoid processing. The benefits of this approach are investigated and shown.