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The Official Austrian Geoid Solution 2008

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Introduction

A new Austrian geoid and quasi-geoid model was computed as a combined solution of local terrestrial gravity field observations and global gravity field information based on data from the satellite gravity mission GRACE. Compared to the former Austrian geoid models, the accuracy could be significantly improved mainly due to the substantially enhanced quality of the input data, and several methodological developments.

The validation of the solution was performed by means of independent GPS/levelling information and the comparison with the European quasi-geoid model. The estimated geoid accuracy is in the order of 2-3 cm over the whole Austrian territory.

Input Data

Terrestrial Data

Fig. 1 shows the distribution of the local data used for the geoid solution:

- gravity anomalies (gray; 14001 stations, approx. 4 x 4 km average distance
- deflections of the vertical (red; 672 stations)
- GPS/levelling observations (blue; 170 stations).

Global Gravity Model

As global gravity field information, the GRACE satellite-only model EIGEN-GL04S complete to degee/order 70 has been used.

Digital Terrain Model

A new digital terrain model (DTM) with a resolution of 44 x 49 m was assembled as a combination of highly accurate regional DTMs of Austria and Switzerland, complemented by data of the Shuttle Radar Topography Mission (SRTM) in the neighbouring countries. Since SRTM reflects surface heights, a correction using Corine Land Cover (CLC90) data had to be applied. Fig. 2 shows the deviations of the orthometric height information assigned to the gravity field stations from the DTM, demonstrating very good consistency.

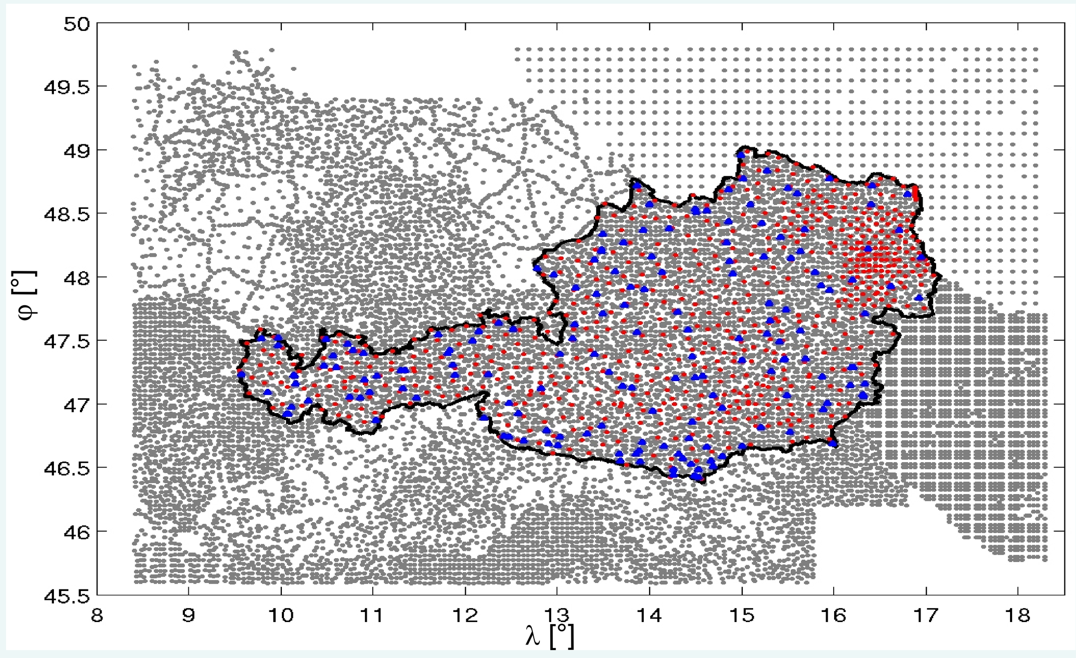

Fig.1: *Terrestrial data: gravity anomalies (gray), deflections of the vertical (red), GPS/levelling observations (blue).*

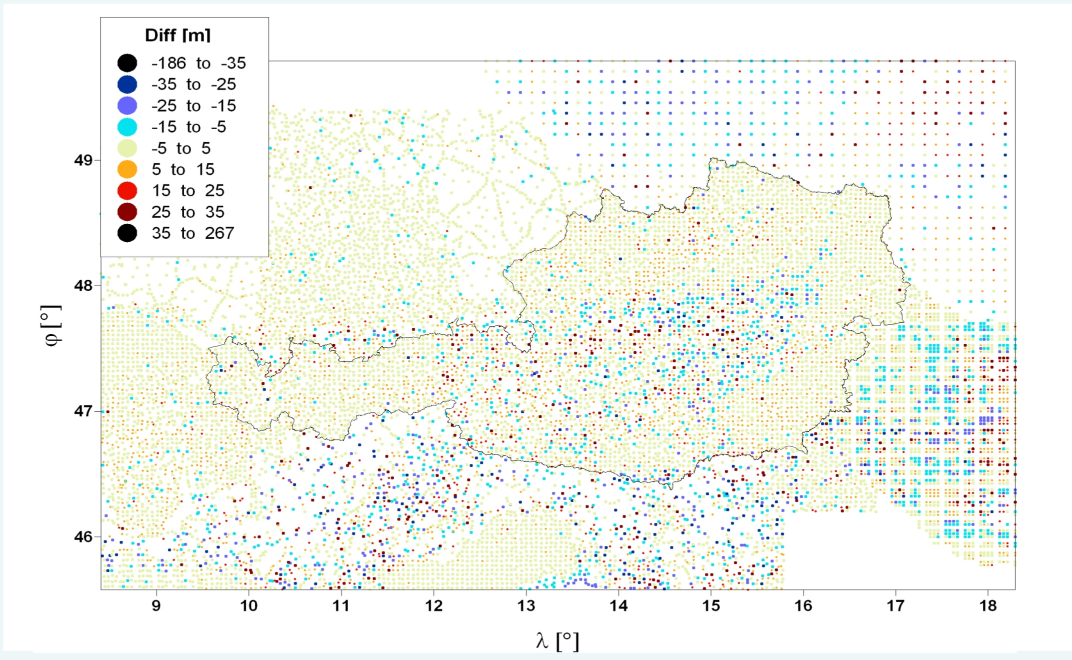

Fig.2: *Height accuracy [m] of new DTM.*

Geoid Computation

The final geoid solution was computed appyling Least Squares Collocation (LSC), and using the remove-restore technique. The basic idea is to remove the long-wavelength gravity field effect represented by the global gravity field model EIGEN-GL04S, and the high-frequency signals, which are mainly related to topography, by a topographic-isostatic reduction (Airy-Heiskanen model with a standard density of 2670 kg/m^3). After reduction all quantities refer to the co-geoid.

The reduced gravity anomalies have been used to derive an empirical covariance function and to adapt the parameters of a Tscherning-Rapp covariance function used as analytic covariance model.

One key aspect is the optimum relative weighting of the input data, especially concerning the GPS/levelling observations. This weighting has been performed by analysis of the residuals after application of the LSC. This information has then been used as noise covariance model in a second processing step.

The Austrian Geoid

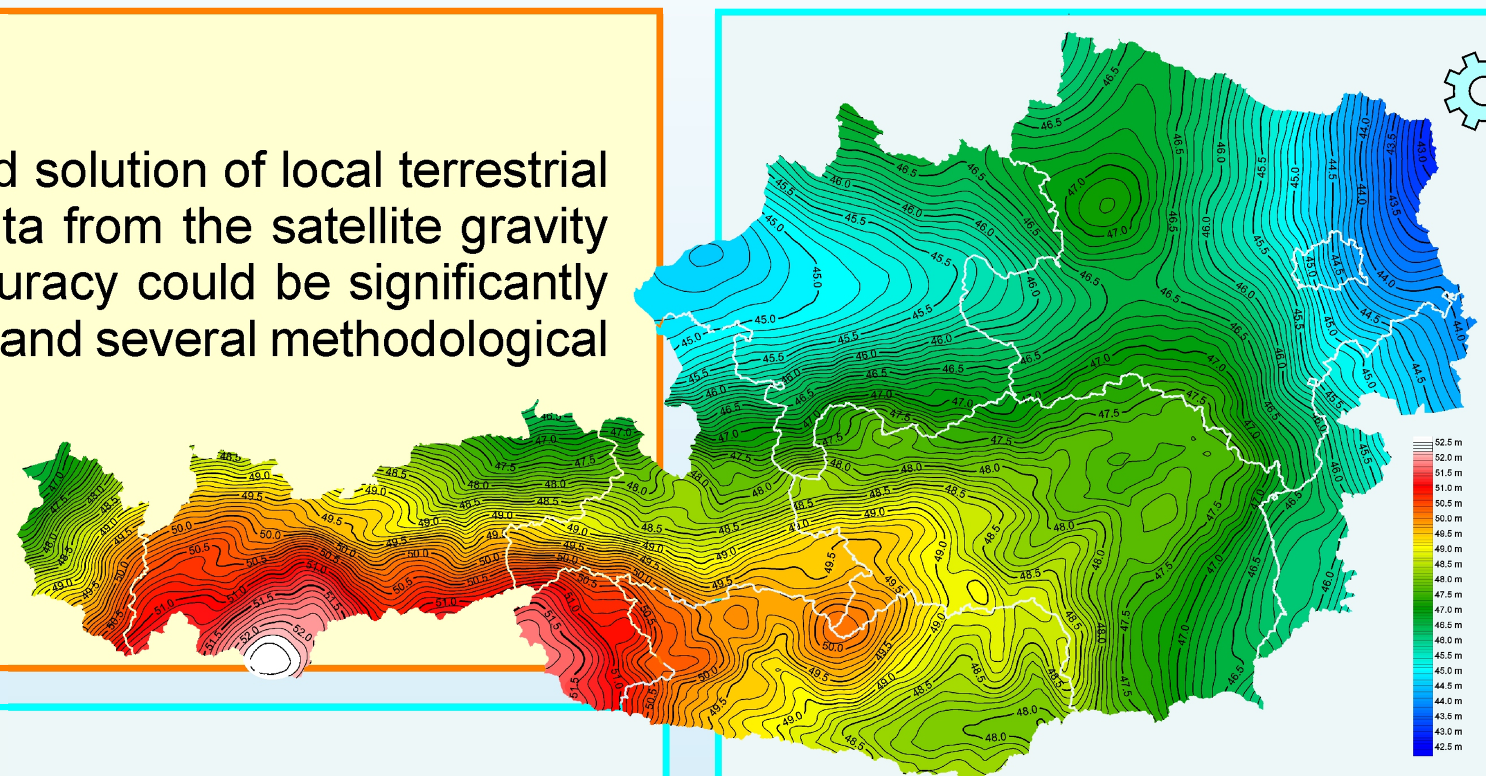

Fig.3: *The new Austrian geoid [m].*

Fig. 3 shows the final Austrian geoid model after performing the restore step consistently. It is defined in ETRS89, and refers to the ellipsoid GRS80.

Fig. 4 displays the corresponding error estimates. The accuracy of this new solution can be estimated to be of the order of 2 to 3 cm, with a significant degradation in the border regions due to the insufficient input data distribution (cf. Fig. 1).

This error estimate is originally based on the formal errors of the LSC procedure, but has been re-scaled using the standard deviation of the residuals at selected GPS/levelling control points, and thus can be considered as a realistic estimate for the total error.

Fig. 5 shows the improvements of the new solution with respect to the former official BEV geoid model, which is a purely astro-geodetic solution dating from 1987.

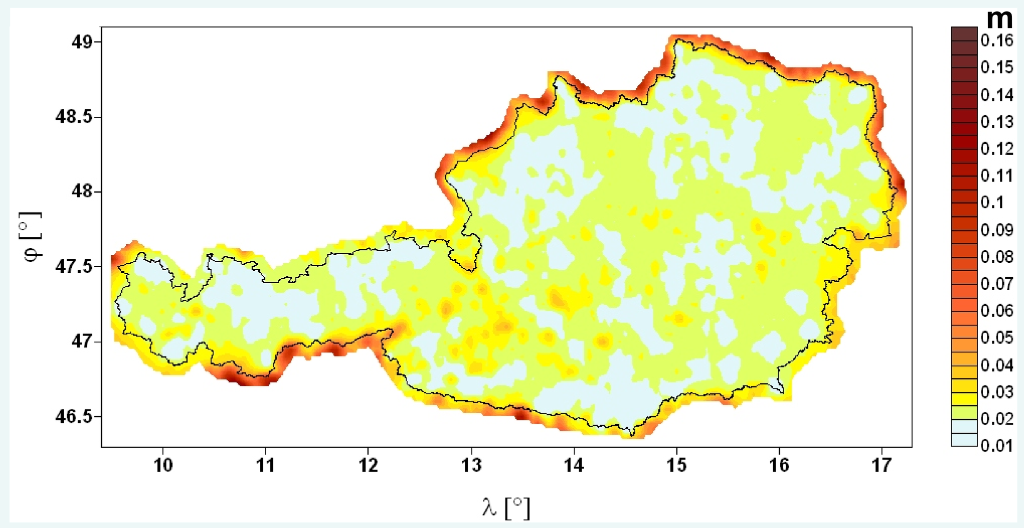

Fig.4: *Estimated absolute accuracy of the new Austrian geoid [m].*

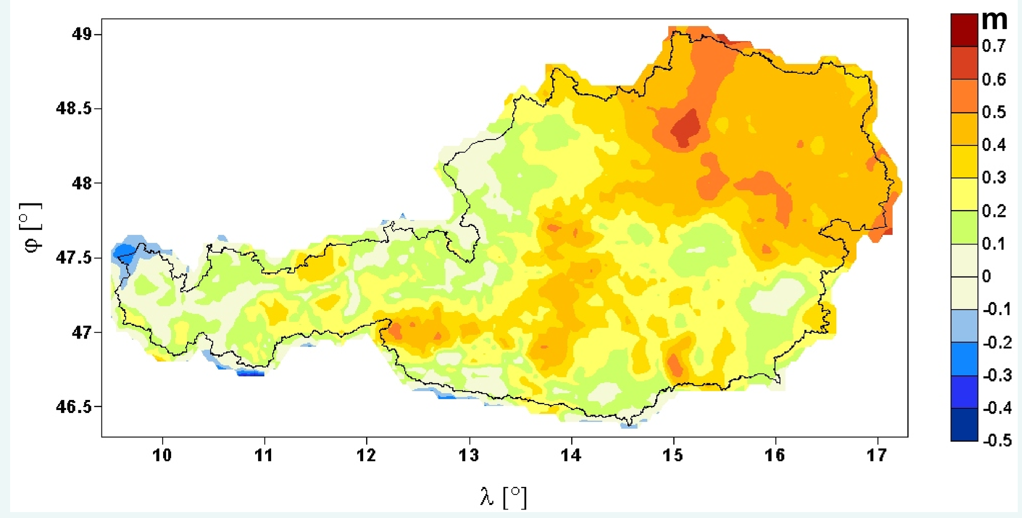

Fig.5: *Differences between the new Austrian geoid model and the former official BEV geoid [m].*

Validation

Deviations at GPS/Levelling Stations

Fig. 6 shows the deviations of the geoid solution at the 170 stations of the highly precise GPS/levelling observations (resulting from GPS long-term measurements), which have been included in the geoid solution. The standard deviation is 2.2 cm.

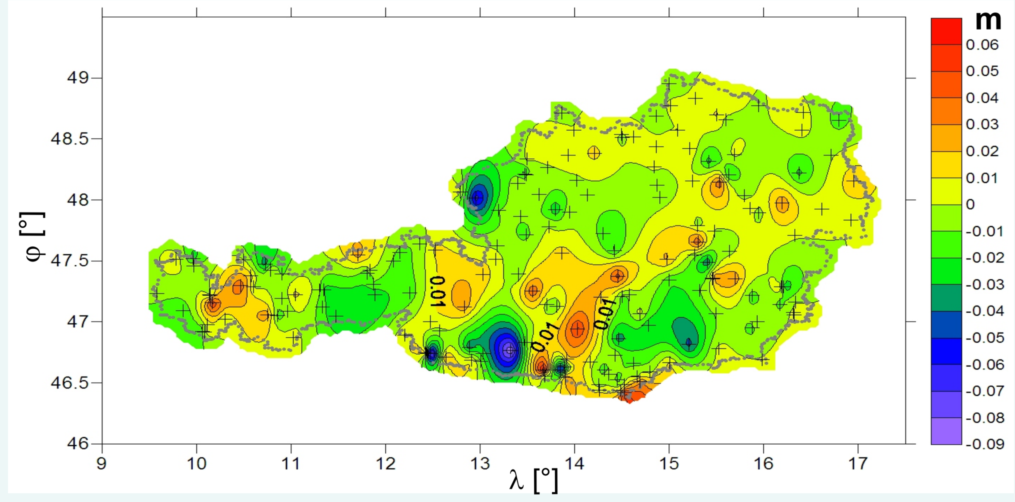

Fig.6: *Deviations from highly precise GPS/levelling observations [m].*

Independent GPS/Levelling Observations

The new Austrian geoid solution was also re-evaluated based on 700 independent GPS/levelling observations in the Western part of Austria, which have not been included in the geoid solution. Fig. 7 shows the differences. The standard deviation is 4 cm. In the near future these validation stations will cover the whole Austrian territory.

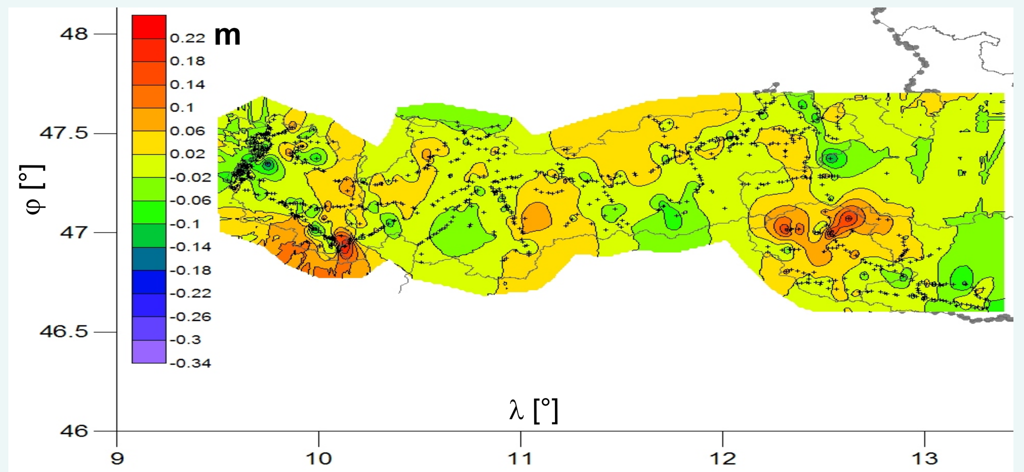

Fig.7: *Deviations from indepentent GPS/levelling observations [m] in Western part of Austria.*

European Quasi-Geoid Model

In addition to a geoid model also a consistent quasi-geoid solution was computed. This quasi-geoid was validated against a European quasi-geoid solution (Denker et. al, 2008). Fig. 8 shows the differences between these two quasi-geoid solutions in the Austrian territory. There is a small correlation with the topography.

Denker et al. (2008): A New European Gravimetric Quasigeoid EGG2008. Poster presented at the IAG Symposium GGEO 2008, Chania, Crete, Greece.

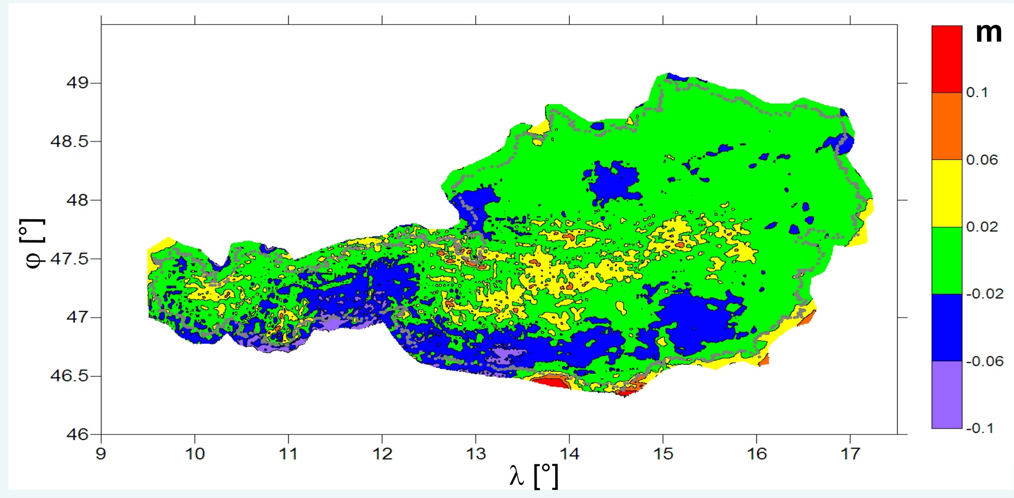

Fig.8: *Deviations from European quasi-geoid model [m].*

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