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Geoid for Austria - Regional gravity FIELD improved (GARFIELD)

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Introduction

The project GARFIELD is a current initiative for the generation of a new high-quality gravity field solution for the Austrian region. Former solutions still show inconsistencies compared to geoid heights from GPS/leveling campaigns. With new methodical developments, these deficits should be compensated.

The final **aim** of GARFIELD is the generation of a highly precise gravity field for deriving

- geoid heights for a consistent height system as basis for GNSS/leveling,
- deflections of the vertical for civil engineering projects,
- gravity anomalies and disturbances for geophysical interpretations.

To achieve this goals, a proper combination of global and terrestrial data is sought. In tradition of former Austrian geoid solutions, the method of Least Squares Collocation (LSC) is chosen as baseline strategy. Alternatively, a Gauß-Markov model based on Radial Basis Functions will be implemented as complementary approach.

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Data

- Deflections of the vertical (Austria)
- Gravity anomalies (Austria and neighbouring countries)
- GPS/leveling points (Austria)
- Digital Terrain Models (global and regional)
- Earth Gravity Models (EGM) from CHAMP, GRACE, GOCE (satellite-only)

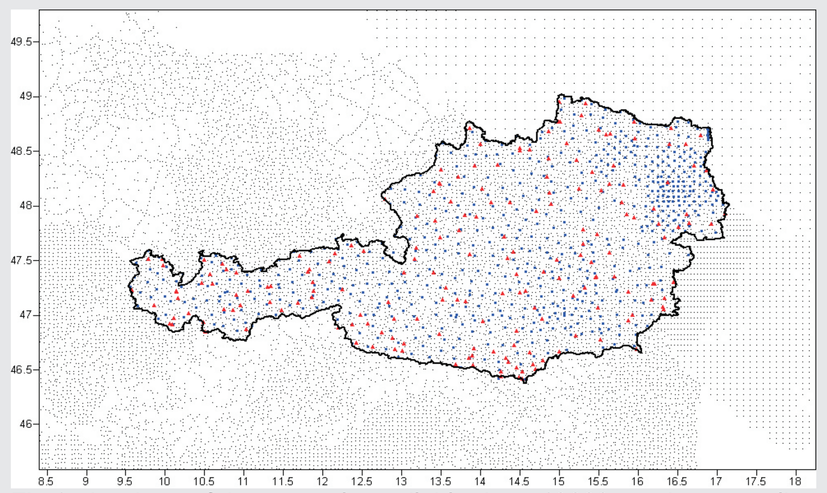
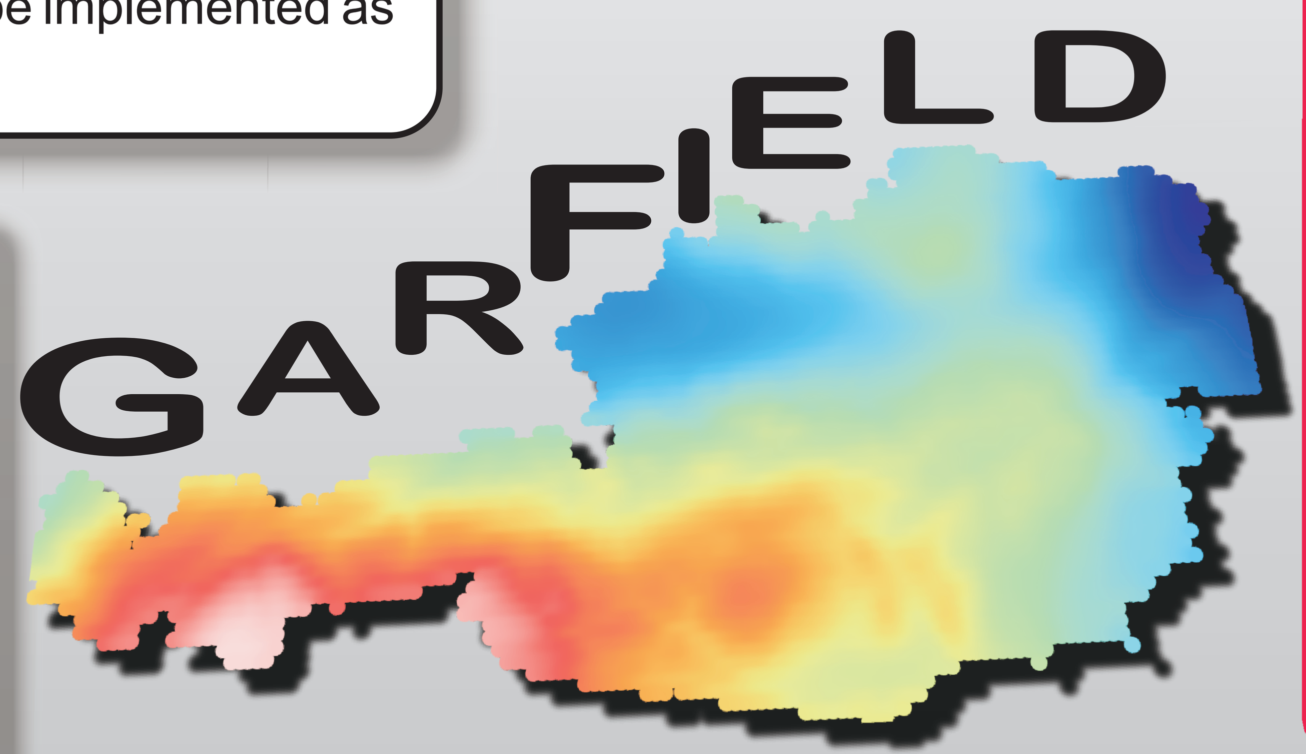


Fig.1 A subset of the currently available data: 13689 gravity anomalies (black), 672 deflections of the vertical (blue) and 192 GPS/leveling observations (red).

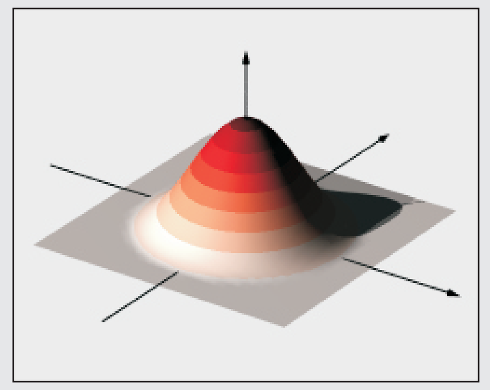


Radial Basis Functions

For the new regional Austrian geoid solution, a Gauß-Markov model shall be established, which is parametrized with Radial Basis Functions (RBF). This model can be solved with least squares adjustment.

Similarities to LSC:

- Various kinds of gravity observations can be handled,
- inhomogenous data distribution.



Advantages:

- Data amount is not a limiting factor,
- the location/density of RBF can be chosen according to the local signal variability,
- optimum weighting of different datasets can be achieved by variance component estimation.

Revised Remove-Restore

Previous Austrian geoid solutions included basically two steps of data reduction of

- long-wavelength signals by a global EGM,
- short-wavelength signals by a topographic-isotatic reduction.

In the revised version, the remove-restore concept is extended:

- Development of topographic masses in gravitational potential spherical harmonics (Fig. 2),
- modification of EGM to avoid a double consideration of topographic masses,
- account for atmospheric corrections.

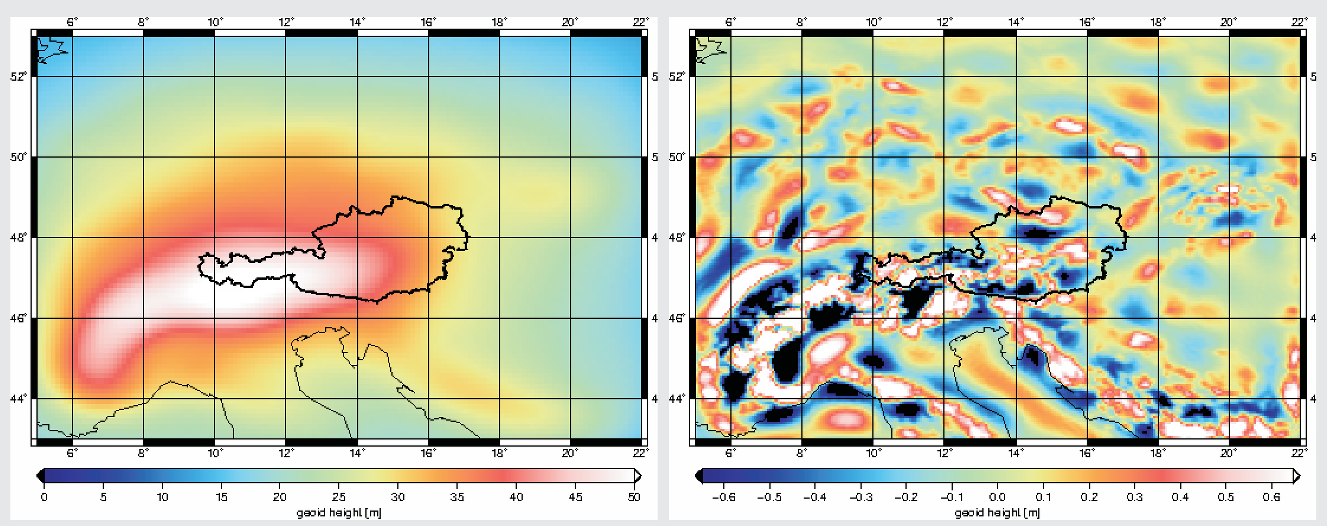


Fig.2 Development of the topographic potential in spherical harmonics from a detailed DTM. Left: topographic effect from degree/order 0 to 249; right: topographic effect from D/O 250 to 2190.

Least Squares Collocation

The last Austrian geoid solution has deficiencies particularly in the transition band between low- (from satellite data) and high-frequency (from ground data) signals. To overcome this, GOCE gradient observations shall be used as direct observations.

The key issues within this project are:

- Optimum filtering of the GOCE Level-2 gradients,
- proper stochastic modeling of the measurement error,
- consistent reduction of terrestrial and satellite data (remove-restore),
- determination of a consistent covariance function for terrestrial and satellite data,
- introducing the full variance/covariance information of state of the art gravity models,
- optimum relative weighting of the different observation types.

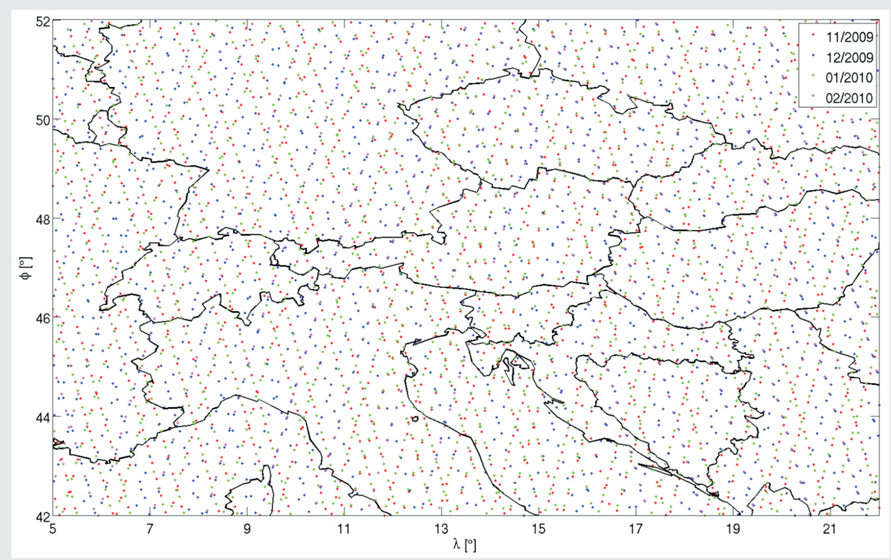


Fig.3 Distribution of GOCE observations over central Europe from November 2009 to February 2010.