Testing New Quasigeoid for the Czech Republic for Computation of Heights from GPS Observations

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Abstract

For testing of suitability of the new quasigeoid for computation of the heights from GPS observations are used:

1. Stations of the Czech National Geodynamic Network (GEODYN). Quasigeoid fitted to this network is called solution CR2000.
2. Observations on the geoid profile on the territory of the Czech Republic. New quasigeoid was compared with other models (EGM96, EGG97).
3. Points of detailed GPS observations in some regions of the Czech Republic

Introduction

Quasigeoid for the Czech Republic constructed in 1996 (ŠIMEK, 1996) was improved by incorporation better gravity data. This new high-resolution (1´x 1.5´) gravimetric quasigeoid was computed in 1998/99 using terrestrial gravity data and geopotential model EGM96 (PEŠEK, ŠIMEK, 2000) - see Fig.1. The „absolute" accuracy of this gravimetric model is estimated to be about 5 cm or better for the territory of the Czech Republic except for border zones. The accuracy of quasigeoid height differences is about 2 cm and better for baselines 60 km and shorter.

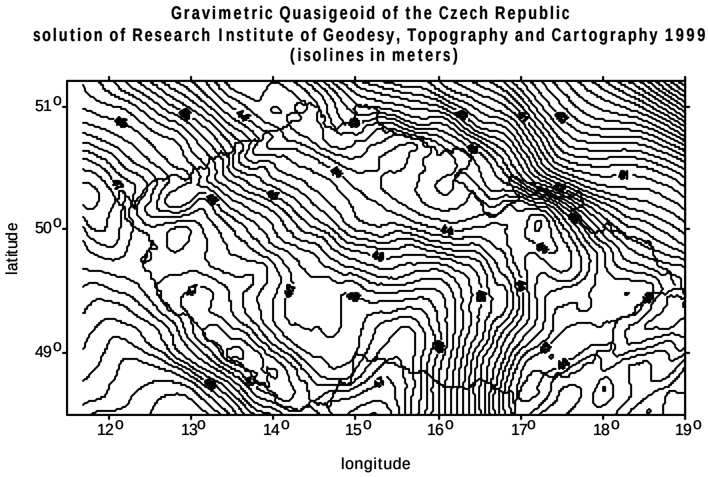

Fig. 1.

This new quasigeoid was derived from mean free-air anomalies in grid 1´x 1.5´ using 1D FFT as a computing method (HAAGMANS et al., 1993). Integration was limited to a spherical distance of 2 degrees. Anomalies of different origin and accuracy were combined as input data. On the territory of the Czech Republic, the mean free-air anomalies in grid 1´x 1.5´ were calculated from Bouguer anomalies, as taken from digitized maps 1:200000, and digital terrain model in grid 100x100m.

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Territory of Poland and Austria was covered by mean free-air anomalies in grid 5´x 5´ and 3´x 5´, respectively. Anomalies in grid 5´x 7.5´ were available for the rest of Europe.

1. Testing on the stations of the Czech National Geodynamic Network (GEODYN)

New quasigeoid was in 2000 fitted to 32 GPS/levelling sites of the Czech National Geodynamic Network by different ways but finally was the quasigeoid „rectified“ by adding a two dimensional cubic polynomial, whose parameters were adjusted from the differences of the quasigeoid and GPS „minus“ levelling heights (PEŠEK, ŠIMEK, 2000) – see Fig. 2.

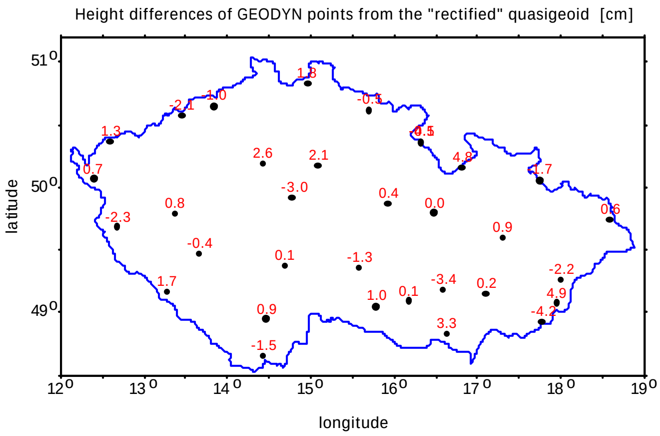

Fig. 2.

This „rectified“ quasigeoid is in the next figures and text abbreviated as solution CR2000 – see Fig.3.

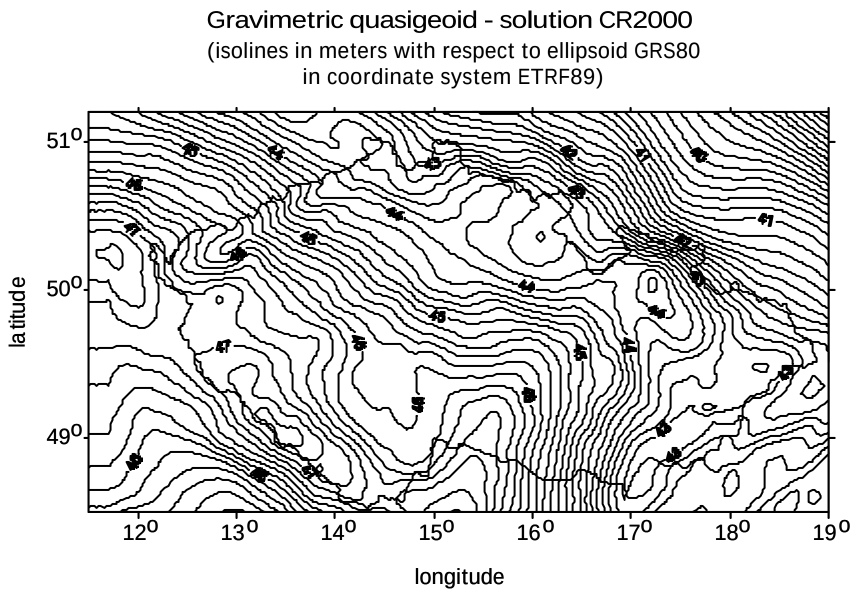

Fig.3.

When we compare both quasigeoids only small differences in central part of the territory are found, but larger differences (> 10 cm) in border zones exist – see Fig. 4.

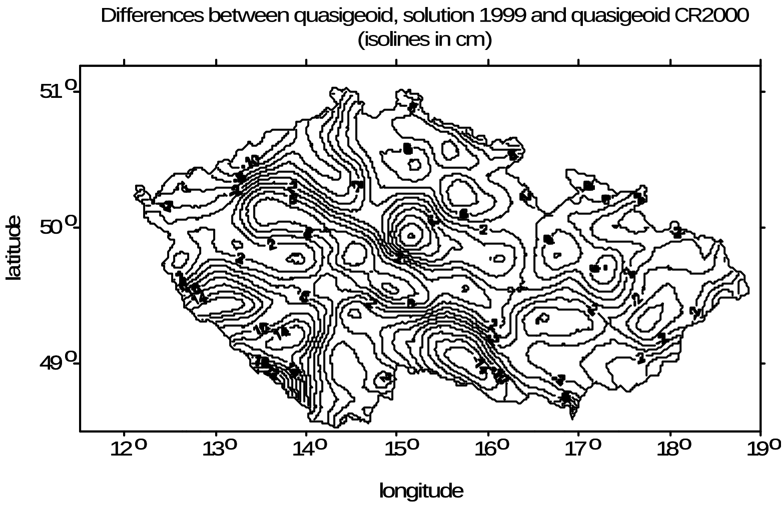

Fig.4.

In case of new CR2000 quasigeoid the post-fit rms error is 2.6 cm and it is essential improvement compared to „nonrectified" version (it was about 5 cm – see Introduction). It brings also more accurate heights determination from GPS/levelling on the territory of the Czech Republic.

But we have to take into consideration that the „rectified" quasigeoid is in this case only an „ad hoc" tool for heights determination because it can reflect some secular changes of heights of the points of GEODYN due to geodynamic processes which are not reflected in officially valid heights.

2. Testing on the geoid profile on the territory of the Czech Republic

The new model CR2000 was further checked by a special precise GPS/levelling profile of 80 km length across the maximum gradient of the quasigeoidal surface in the Czech Republic – see Fig. 5.

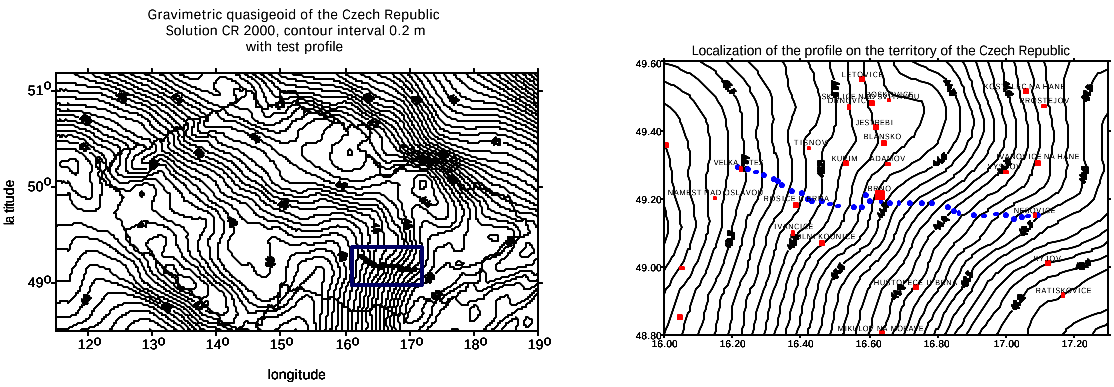

Fig. 5.

Differences between levelled normal heights and the heights obtained from the differences of GPS and geoids (EGM96, EGG97, CR2000) show that the most stable and most close to the curvature of differences for given profile are those for quasigeoid CR2000. Its use for heights computations from „good" GPS observations is about 1.2 cm. Similarly the quasigeoid EGG97 proves the same accuracy (1.1 cm). Geoid EGM96 gives for heights computations on given territory accuracy more than 3 cm with distinct systematic trend (KOSTELECKÝ et al., 2001) – see Figure 6.

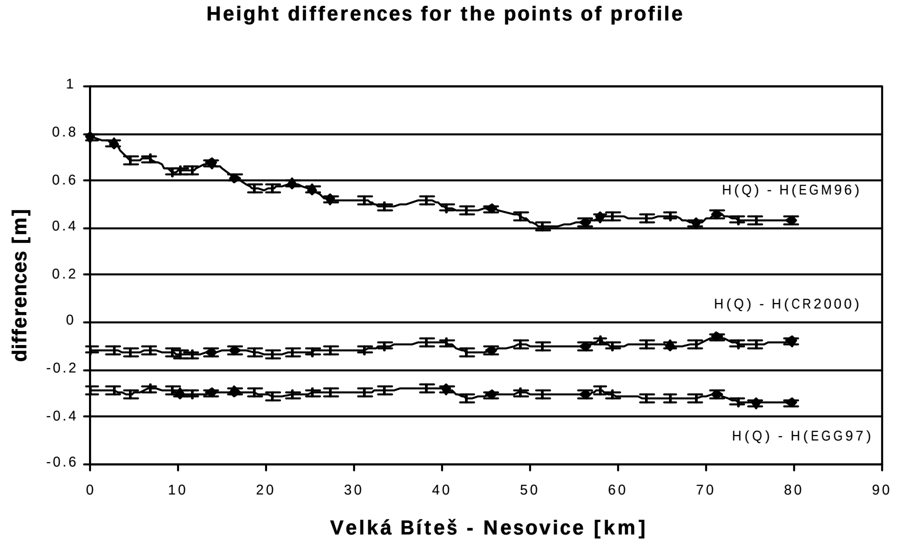

Fig. 6.

3. Testing on the points of detailed GPS observations in some regions of the Czech Republic

The accuracy of the new quasigeoid model CR2000 was still assessed by 432 GPS/levelling points determined within the systematic ETRF densification (details in EUREF 2001 National Report of the Czech Republic). The rms error of the height component of these points is estimated to be 1.5 – 2 cm.

The differences between the new quasigeoid model and GPS/levelling results for these points are in Figure 7.

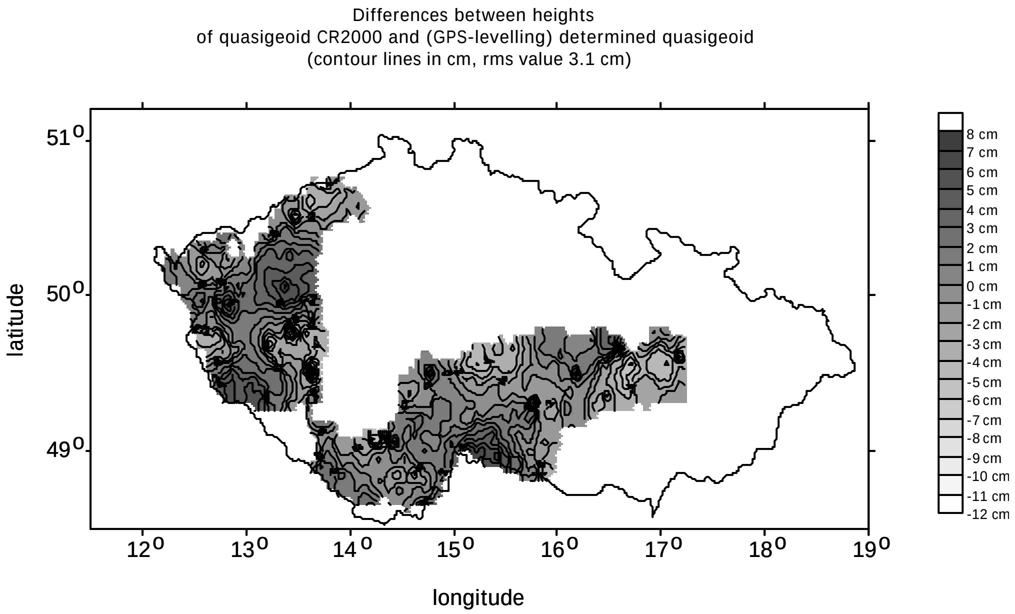

Fig. 7

Acknowledgment

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