On the quasigeoid solutions for the Ukraine and Moldova area

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Introduction

Goal:

New quasigeoid computations with accuracy <5-10 cm for the adjustment of the Ukrainian geodetic network and further conversion of ellipsoidal heights into normal heights.

Computations:

- 1) The gravimetry-only Ukrainian quasigeoid UQG2006 was constructed from the following two data sets: (a) digitized gravity anomalies and (b) gravity anomalies in the Black Sea area derived from altimetry data of TOPEX/POSEIDON, ERS-1, ERS-2, JASON-1, ENVISAT, and GFO missions (1992 - 2005 yr). Terrain reductions were based on the 1'x1' DTM GEBCO.
- 2) The combined UQG2007 solution was evaluated from heterogeneous data: the above-mentioned gravimetry data plus ~3000 GPS-leveling quasigeoid heights. Terrain reductions were derived from the 3"x3" digital terrain model SRTM3.
- 3) Comparison of UQG2007 with *independent* GPS/leveling data leads to agreement with rms < 4cm. Comparison of the UQG2007 quasigeoid with the global gravity model EGM2008 (2190,2190) leads to accordance within 10 cm.

AVISO corrected SSH from Topex/Poseidon, ERS1, ERS2, GFO, Jason1, and Envisat altimetry (1992-2005) at grid points (3'x3')



Geoid heights from Topex/Poseidon, ERS1, ERS2, GFO, Jason1, Envisat and BGI gravimetry



Set 1: Gravity anomalies from Topex/Poseidon, ERS1, ERS2, GFO, Jason1, Envisat and BGI gravimetry



Set 2: Bouguer anomalies at grid points (2'x3')



Set 3: Distribution of GPS/leveling data of different orders



Histograms of differences between UQG2006 quasigeoid and GPS/leveling data of different orders



Adopted (3"x3") DTM SRTM3 according to Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2006 (http://srtm.csi.cgiar.org).



Classical terrain reduction based on the SRTM3 DTM transformed to the Baltic 1977 height system







UQG2007 quasigeoid combined solution from altimetry, gravimetry, and GPS/leveling data (Baltic height system 1977)



Differences between GPS/leveling data (1st & 2nd orders) and UQG2007 quasigeoid. Rms: 2.8cm; Mean: -0.1cm; Min: -11.3cm; Max: 12.2cm



Differences between GPS/leveling data (3rd order) and UQG2007 quasigeoid. Rms: 4.8cm; Mean: -0.4cm; Min: -15.1cm; Max: 16.2cm



Differences between GPS/leveling data (4th order) and UQG2007 quasigeoid. Rms: 5.9cm; Mean: -0.6cm; Min: -19.7cm; Max: 17.7cm



Comparison of quasigeoids with GPS/leveling data in the Crimea area



Differences between UQG2007 quasigeoid and the EGM08 (2190,2190) gravity field. Std: 0.13m; Mean: 0.34m; Min: -0.19m; Max: 0.89m



Datum shift transformation from the EGM2008 model to the UQG2007 quasigeoid (Baltic 1977 height system)

 $\Delta X \cos \varphi \cos \lambda + \Delta Y \cos \varphi \sin \lambda + \Delta Z \sin \varphi$



Differences between UQG2007 and EGM2008 after datum shift transformation. Std: 0.10m; Mean: 0.00m; Min: -0.66m; Max: 0.56m



Datum shift transformation from the EGG97 quasigeoid to GPS/leveling data given in the Baltic 1977 height system (Carpathians area)



Conclusions

- The use of the Tikhonov regularization method applied to updated gravimetry, terrain, and GPS/leveling data leads to stable and significantly improved quasigeoid solutions UQG2006 and UQG2007 for the Ukraine and Moldova area.
- The gravimetry-only solution UQG2006 was used successfully for the detection of gross errors in GPS/leveling data given in the Baltic 1977 height system.
- The combined UQG2007 solution fits significantly better to independent GPS/leveling control points than UQG2006: rms fits < 4cm improve up to 50%. Observed improvement of accuracy (to the level of about 5 cm in the Ukraine and Moldova area) can be explained partly by the application of 3"x3" DTM SRTM3 for terrain reductions.
- Comparison of the UQG2007 quasigeoid with the global gravity model EGM2008 (2190,2190) leads to accordance within 10 cm in terms of standard deviation. Great differences are observed in Carpathian and Crimean mountains with values up to 50 cm.

Thank you for your attention!