

Measuring the Extent of Error Gravity Anomalies Calculated from GRACE Data within the Area of Poland

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Introduction

International Center for Global Gravity Field Model (ICGEM), under the auspices of the International Association of Geodesy (IAG) is one of six centers operating under the gravitational field of International Gravity Service - International Gravity Field Service (IGFS). ICGEM service offering on their past and the possibility of gaining up to date published data from GRACE observations from different data centers, access to global geopotential models and their visualization. The website contains a module that gives you the opportunity to "own" the calculation of various functions of the gravitational field of Earth. Service spreadsheet provides the user with a choice of reference system, geoid model, determination of the resulting grid and determine filtering (<http://icgem.gfz-potsdam.de/ICGEM/ICGEM.html>).

Idea of the work

The idea was to check if gravity anomalies counted on a basis of GRACE data are accurate enough to use them as a reference for geodetic measurements.

According to the Polish G2 Technical Manual:

Precise levelling → 1 mm means: Gravity anomaly → 1,1milIGala (1,1·10⁻⁵m·s⁻²)

Data

From ICGEM web pages:

Gravity anomalies → Area of Poland → One-degree grid → 2008, 2009, 2010, February and May

Obtained results

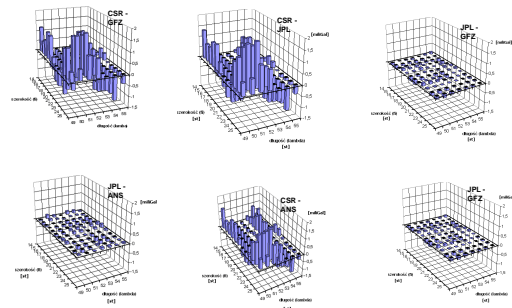
GRACE data from following calculating centers were compared: CSR, GFZ, JPL, DEOS. Results in table 1 (as an example was taken February 2008).

Gravity anomalies differences	Average [milIGala]	Standard deviation [milIGala]
CSR-GFZ	0,0171	0,8186
CSR-JPL	0,0519	0,8207
CSR-DMT-1	0,0289	0,8186
JPL-GFZ	0,0348	0,0806
JPL-DTM-1	0,0230	0,1002
GFZ-DTM-1	0,0118	0,1106

Table 1. Comparison of GRACE data from CSR, GFZ, JPL and DEOS calculating centers.

A conclusion from the first analysis

From Table 1 it can be read that the differences in gravity anomalies in February 2008 taking into account the data calculated by the calculating center CSR are clearly not correlated with the differences between the anomalies calculated by other centers. You can not set a fixed value, which would allow for scaling of the gravity anomalies computed by the center CSR to the anomaly designated by other centers. A scale of differences is shown on charts below:



The differences in gravity anomalies of CSR and other selected centers in which values are exceeding the limit, maps were generated (Fig. 2). In pictures are marked in red areas in which the value of the gravimetric anomaly difference exceeds the limit value according to G2 Technical Manual. Additionally, for more complete visualization of the generated maps of changes, which are marked differences in excess of 0.8 mgal. The value of 0.8 mgal due to error, which causes an error that occurred in connection with different signs the gravity anomalies identified in the grid node (Fig. 3).

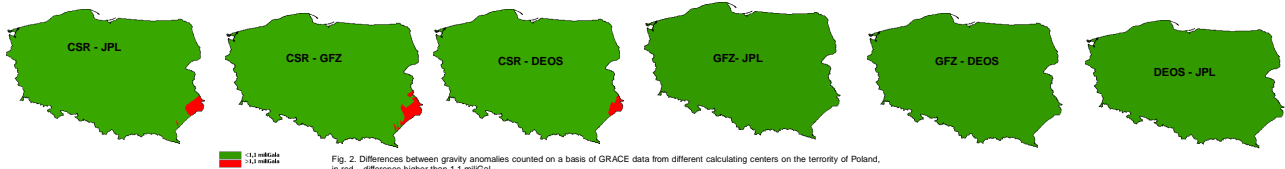


Fig. 2. Differences between gravity anomalies counted on a basis of GRACE data from different calculating centers on the territory of Poland, in red – difference higher than 1,1 milIGala



Fig. 3. Differences between gravity anomalies counted on a basis of GRACE data from different calculating centers on the territory of Poland, in red – difference higher than 0,8 milIGala

Second analysis

As can be seen from figures 2 and 3, distribution of the amplitude differences gravity anomalies is not homogeneous. These differences reach values in excess of 1,1 mgal in the Lublin area. Generally, high values of these differences (greater than 0,8 mgal) occur in the east (the whole province of Lublin and Rzeszow) and the southern Poland (Silesia). It was shown that the comparison of gravity anomalies calculated on the basis of observational GRACE data of individual centers with data from CSR gives the standard deviation of about 0,5, while the rest of the data gives a comparison of the standard deviation of at least eight times smaller.

Situation in Central and North Europe

In the paper the geographical distribution of different gravity anomalies derived from several centers for the area of Central and North Europe in order to check where the values above the level of 1,1 mgal occur.

Distributions were determined for the same data centers, for the following months: February 2008, March 2008, May 2008, November 2008, 2009, March 2009, May 2009, November 2009, 2010, March 2010, May 2010, November 2010 (Figures 3).

Comparison of gravity anomalies were made for the observational data processed by the data center CSR with observational data set processed by the other data centers. Comparison showed the same bias in gravity anomalies. A similar comparison between the gravity anomalies together with the observational data set imputed centers GFZ, JPL and deos not show tolerance of 1,1 mgal.

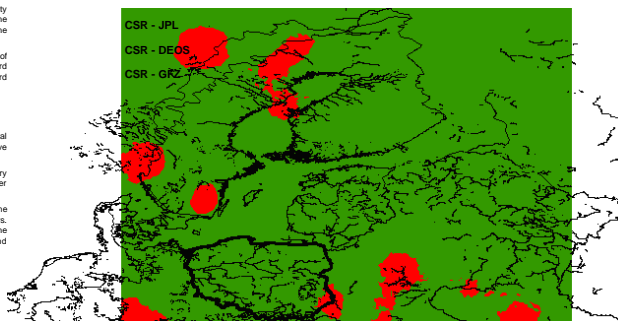


Fig. 3. Differences between gravity anomalies counted on a basis of GRACE data from different calculating centers on the territory of Central and Northern Europe, in red – difference higher than 1,1 milIGala

Conclusions

Previous analyzes have shown that the data made available by the center ICGEM spreadsheets from different centers vary significantly and the analysis of these data requires caution. Information on the models and calculation procedures, posted on the website ICGEM service, does not explain the differences in gravity anomalies presented. Deviation of gravimetric anomaly excess of 1,1 mgal was observed in the region of south-eastern Poland, Scandinavia, Central Ukraine - on the site of the occurrence of oil deposits.

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