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Validation of static global gravity field models from CHAMP, GRACE and GOCE with ground data in Poland

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Since 2000, when first satellite gravity mission CHAMP has started, an increasing number of global gravity field models (GGMs) are developed. The launch of GRACE and GOCE has been the main conductor of becoming these models more and more detailed and accurate. The models that are mainly derived from satellite measurements are widely used in modern geodesy for numerous applications such as geoid computation or gravity reduction.

The gravity field models differ from each other in terms of spatial resolution which is connected with maximum degree/order of spherical harmonics as well as data used for their determination. Some of the models are set up based on observations from the CHAMP, GRACE or GOCE only while the others combine data from one or several missions with ground-based observations.

The proper choice of a global geopotential model in geodetic applications depends on how such a model fits the gravity field of the area of interest. The main objective of our research is a comparison and validation of selected models from three satellite missions (CHAMP, GRACE, GOCE) over area of Poland with ground-based gravimetric measurements.

For the comparisons we chose over a dozen global gravity field models with different spatial resolution and input data. Our analyses concern Bouguer's gravity anomalies. As a reference dataset for validation of the models we use ground-based gravity measurements for points located in Poland. The points where these observations have been made are divided into three groups: points of Polish Reference Frame POLREF (with relative gravity measurements), points of polish gravimetric network POGK (with absolute gravity measurements) and points located in Tatra Mountains. First two groups contain stations from the whole area of the country while the last one covers only a small highlands region.

In this study we compute the Bouguer's anomalies for every point in two ways: i) with the use of different GGMs – we call them calculated anomalies and ii) with the use of ground-based gravimetric observations – we call them measured anomalies. Next we determine the differences between calculated and measured values as well as their basic statistics (minimum, maximum, mean, standard deviation, RMS). The evaluation of the accuracy of each model is based on the analysis of these differences which is conducted for all points together as well as for each group of stations separately.

In our research we attempt to answer the question which of considered models gives the smallest residuals in relation to ground data for the whole area of Poland and for a specific region of highlands. We also show the impact of the degree/order on the value of Bouguer's anomalies, their standard deviation as well as differences between calculated and measured anomalies.