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Time dependent corrections to absolute gravity determinations in the establishment of modern gravity control

Przemyslaw Dykowski and Jan Krynski
Institute of Geodesy and Cartography, Geodesy and Geodynamics, Warsaw, Poland (przemyslaw.dykowski@igik.edu.pl)

The establishment of modern gravity control with the use of exclusively absolute method of gravity determination has significant advantages as compared to the one established mostly with relative gravity measurements (e.g. accuracy, time efficiency). The newly modernized gravity control in Poland consists of 28 fundamental stations (laboratory) and 168 base stations (PBOG14 – located in the field). Gravity at the fundamental stations was surveyed with the FG5-230 gravimeter of the Warsaw University of Technology, and at the base stations – with the A10-020 gravimeter of the Institute of Geodesy and Cartography, Warsaw. This work concerns absolute gravity determinations at the base stations.
Although free of common relative measurement errors (e.g. instrumental drift) and effects of network adjustment, absolute gravity determinations for the establishment of gravity control require advanced corrections due to time dependent factors, i.e. tidal and ocean loading corrections, atmospheric corrections and hydrological corrections that were not taken into account when establishing the previous gravity control in Poland. Currently available services and software allow to determine high accuracy and high temporal resolution corrections for atmospheric (based on digital weather models, e.g. ECMWF) and hydrological (based on hydrological models, e.g. GLDAS/Noah) gravitational and loading effects. These corrections are mostly used for processing observations with Superconducting Gravimeters in the Global Geodynamics Project. For the area of Poland the atmospheric correction based on weather models can differ from standard atmospheric correction by even ± 2 μGal. The hydrological model shows the annual variability of ± 8 μGal. In addition the standard tidal correction may differ from the one obtained from the local tidal model (based on tidal observations). Such difference at Borowa Gora Observatory reaches the level of ± 1.5 μGal. Overall the sum of atmospheric and hydrological effects and tidal model uncertainty easily exceeds the Total Uncertainty of the A10-020 gravimeter which makes these effects vital for current and future absolute gravity determinations for the needs of the gravity control.
This work presents the variability of the atmospheric, hydrological and tidal corrections based on selected models for the area of Poland, especially for the time period of the survey of base stations of the gravity control in Poland in 2012 and 2013. The discrepancies between simplified corrections and the advanced ones are presented showing the importance of the use of advanced corrections. Additionally a time series of 5 years of absolute gravity determinations with the A10-020 gravimeter on laboratory and field stations at Borowa Gora Observatory test network has been analyzed to access the observed variation of gravity with the use of advanced correction models. Also gravity measured in two epochs on a few PBOG14 stations were used to examine the determined gravity difference. The analysis of the A10-020 data includes metrological calibrations as well as traceability to the ICAG and ECAG campaigns.