Analysis of measurements collected in gravity laboratory in Józefosław Observatory during 2007-2010

MARCIN BARLIK, MARCIN RAJNER, TOMASZ OLSZAK

mrajner@gik.pw.edu.pl

Department of Geodesy and Geodetic Astronomy
Warsaw University of Technology

Katedra Geodezji i Astronomii Geodezyjnej
Politechnika Warszawska

Abstract

ASTRO-GEODETIC Observatory in Józefosław (near Warszawa) is equipped with two gravimeters for different purposes. Continuously recording LCR ET-26 spring gravimeter (since 2002) serves for determination of accurate local tidal coefficients and investigation of environmental effects such as atmospheric and ocean influence on gravity. FG5 no. 230 ballistic gravimeter (since 2005) is operated periodically - once a month. Frequently measurements allows us for study non-tidal gravity changes caused mainly by local and continental hydrology. In this paper we present some advantages of using two types of gravity measurements. During calibration process the gravity records from ballistic gravimeter are used for determination of scale factor of spring gravimeter. On the other hand ballistic gravimeter utilizes local tidal model determined from spring gravimeter for obtaining non-tidal series. Long series of synchronous measurements were used for determination of background noise, atmospheric (admittance factor), ocean and hydrological effect on gravity changes. The results from both gravimeters is presented and their agreement is discussed.

Figure 1. *LCR and FG5 gravimeters in Józefosław.*

Activities

Calibration of spring gravimeter using AG measurements

Raw observations of LCR are presented in Fig. 2 along with FG5 periodically taken measurements.

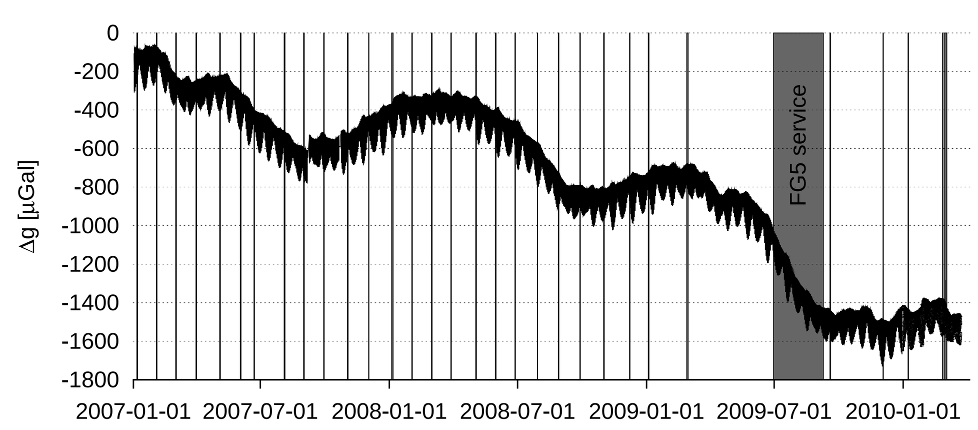

Figure 2. *Raw observations of LCR gravimeter. Vertical bars represents FG5 measurements.*

The results for particular series and AG measurements length are presented in Fig. 3.

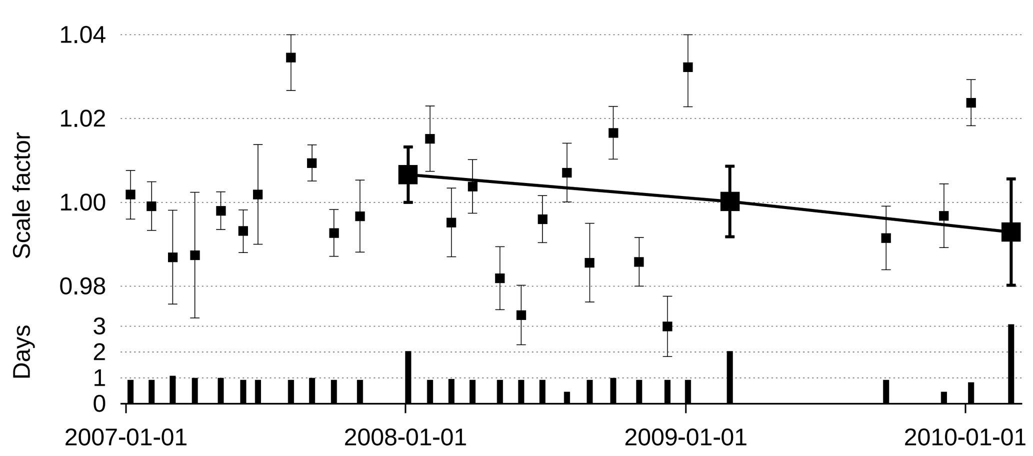

Figure 3. *Scale factor values - upper graph, for sessions of minimum 2 days length has bigger marks. Number of FG5 measurements days and RMS of LCR residuals.*

Tidal parameters determination

Tidal gravity parameters in diurnal and semi-diurnal bands are computed using international standard data processing techniques. We used 40 months (2007-2010) of continuous gravity measurements. The standard deviation of least square adjustment reached $0.98\,\mathrm{nm/s^2}$.

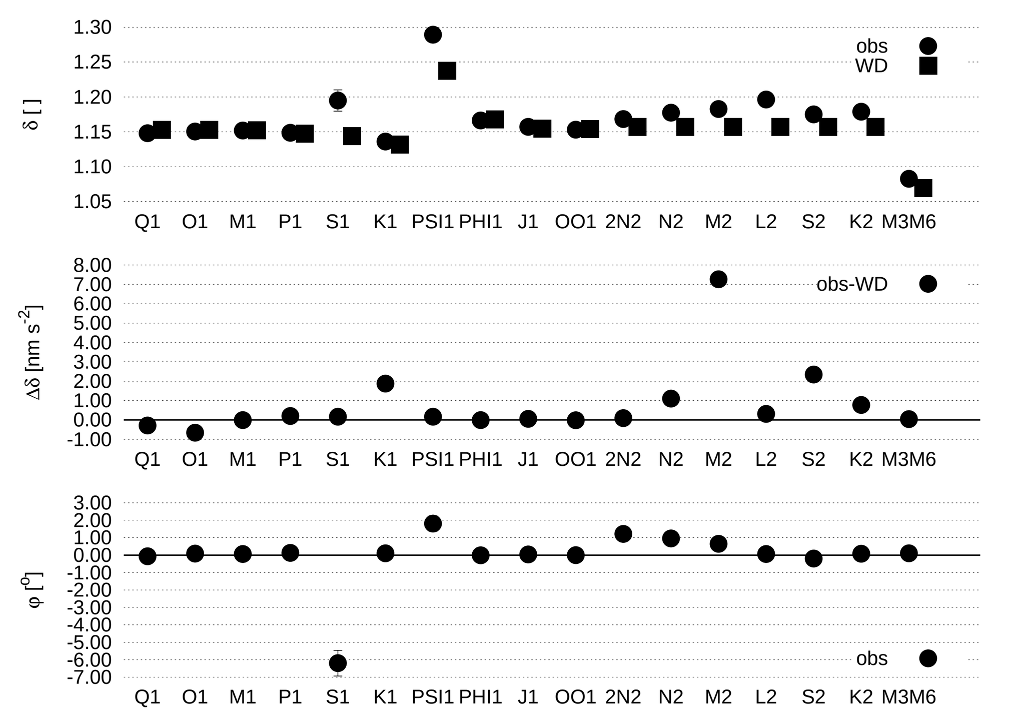

Figure 4. *Amplitude factors, difference in amplitude factors relative to Wahr-Dehant tidal model and phases for main tidal constituent estimated from measurements (pressure correction applied).*

Atmosphere influence on gravity

We computed pressure admittance as simple regression coefficient on basis of LCR measurements. Using moving data windowing we examined seasonal behaviour of pressure admittance factor which is presented in Fig. 5.

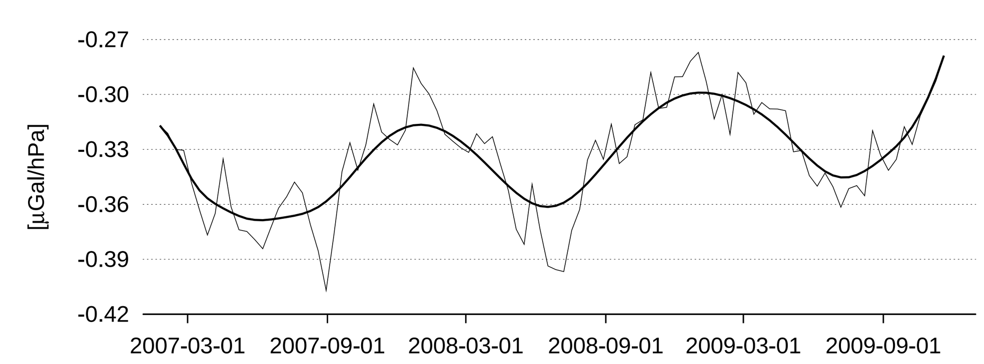

Figure 5. *Seasonal variation of atmospheric pressure admittance factor and differences between using mean and time-dependent values for gravity correction.*

Ocean loading

In Fig. 4 one can see significant discrepancies between determined and predicted from model body tide especially for M_2 constituent. Computing indirect effect using most recent ocean models (we do not differentiate them here, as they give similar results) greatly reduces this differences.

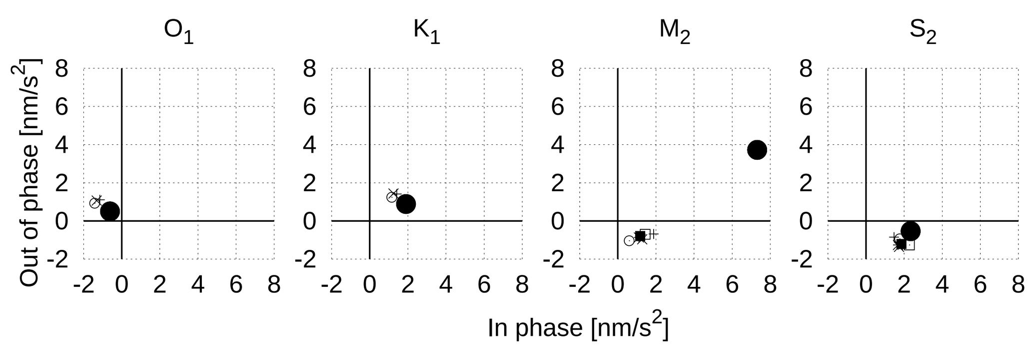

Figure 6. *Phasor plots for residual values (subtracted body tides, filled circle) and residua corrected for ocean loading using most recent models (other marks).*

Hydrological effects

AG values show periodical variation. Part of seasonal signal can be explained by loacal and global water storage (Fig. 7).

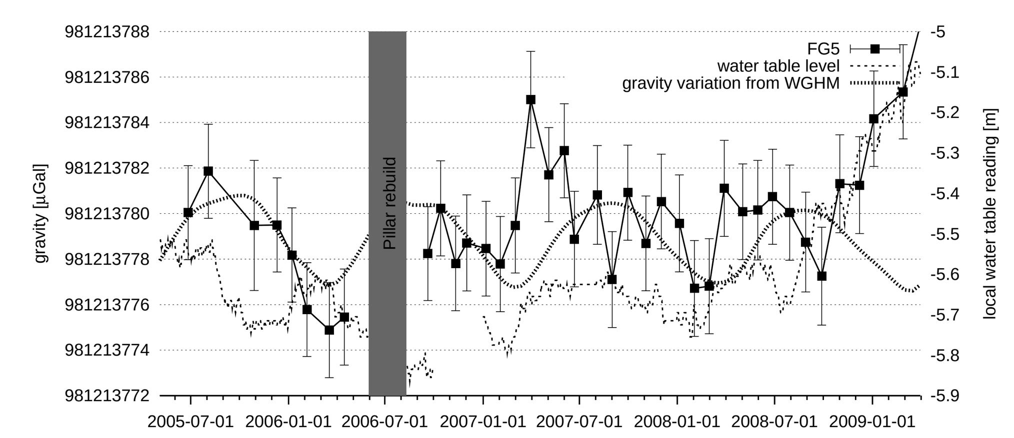

Figure 7. *AG measurements compared to gravity change due continental water storage and local water table level variation.*

Background noise

We investigated in background noise (containing instrumental noise) on basis of raw observation (1 min sampling). Here we present daily standard deviation from records where tide and polynomial of 9^{th} degree were subtracted.

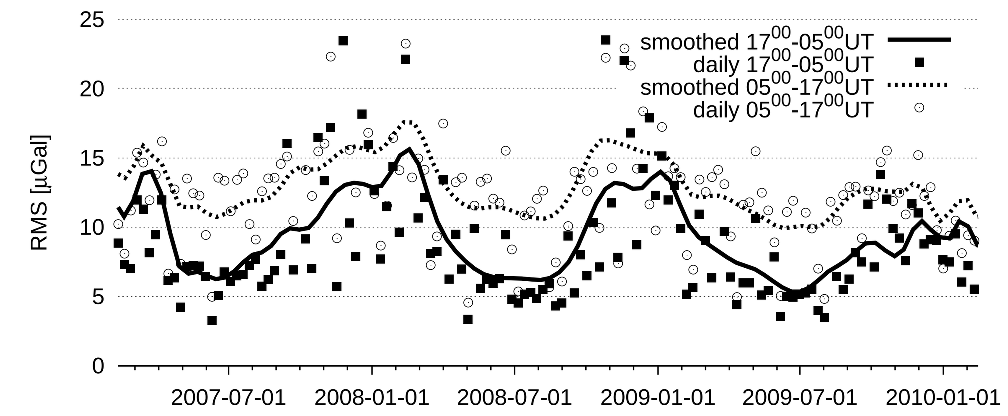

Figure 8. *Daily and smoothed (Beziér curve) RMS for day and night.*

Conclusions

MEASUREMENTS with *LCR-ET* and *FG5* provides high quality gravity values. Carefulness in processing and long series of collected data allows for investigation in weak environmental signals - pressure and ocean loading, hydrological signals. Combining those results with records from different instruments (meteo, GNSS, water table level and soil moisture observations) in Józefosław Observatory makes it unique place in Poland for geodetic, geodynamic and geophysics studies.

Acknowledgments

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