Gravity Monitoring at the Conrad Observatory

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Absolute gravity measurements (AG) at Conrad Observatory (CO) were performed by the absolute gravimeter FG5-242 since 2010. The results were affected by abnormal Helium concentration in the gravity laboratory originating from small but permanent liquid Helium loss of the superconducting gravimeter (SG). Therefore, all gravity measurements of FG5-242 are checked for the clock influence and analyzed together with the SG results.

AGs use Rubidium(Rb)-oscillators for exact time referencing. Atmospheric He typically causes a frequency increase of about 1 mHz/yr (Van Westrum 2014). If an AG operates site-by-site with a SG the Rb-oscillator might be exposed to abnormal He environment. This causes a strong increase of the pulse frequency associated with apparent gravity decrease if the frequency shift remains uncorrected.

Permanent He gas flow into the laboratory due to evaporation of liquid He inside the SG dewar causes sufficient gas concentration within the laboratory. After removing the oscillator from the abnormal He environment, the frequency recovers the nominal value following an exponential decay (Van Westrum 2014). The oscillator frequency problem was unknown before Van Westrum (2014) quantified the effects.

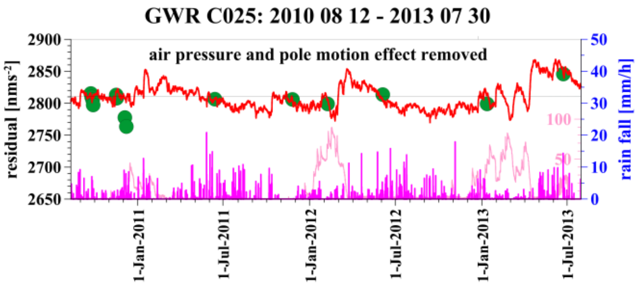

Figure 1: Comparison of AG and SG residuals. Red: SG residuals, green: AG observations, magenta: hourly rainfall, pink: snow level [cm].

Therefore, all gravity measurements of FG5-242 ever performed were reprocessed carefully trying to eliminate the effect of the oscillator frequency shift where possible. Corrections were based on the clock offsets detected at the BEV metrology department detected since 2011. Fig. 1 compares the AG (set average over individual AG observations, green dots) and SG residuals (red) dominated by local hydrological processes. Repeated Rb-oscillator calibrations since October 2011 provide more reliable results. The AG confirms the extremely low SG drift rate and the relevance of the hydrological effects observed at CO. The first two series in 2010 clearly reflect the He influence, which is also visible e.g. in the calibration experiment of May 2012 (Fig. 2, top).

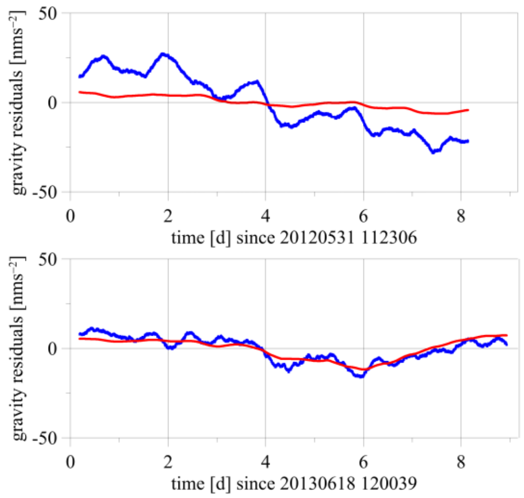

Figure 2: Calibration experiments at CO in May/June 2012 (top) and June 2013 (bottom). Contrary to 2013, the AG Rb-oscillator was exposed to abnormal He in 2012. Residuals (moving average, 1001 samples): SG (red), AG drops (blue).

This situation has improved since the AG Rb-oscillator is separated from the gravity laboratory as in June 2013 (Fig. 2, bottom): AG and SG residuals now fit together almost perfectly contrary to the earlier experiments.

References:
Van Westrum, D., Bianchi, T., Billson, R., Ellis, B., Niebauer, T.M. and Rohner, H., The effect of helium contamination on rubidium clock references in absolute gravity meters. In: Peshekhonov, V.G. (ed) Proceedings of the IAG Symposium on Terrestrial Gravimetry: Static and Mobile Measurements (TG-SMM2013), Saint Petersburg, Russia, 17–20 September 2013. State Research Center of Russia Elektropribor, St Petersburg, 2014, pp 125–130.

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