18th International Symposium on Geodynamics and Earth Tides, Trieste, Italy

Scherneck, Hans-Georg[1]; Engfeldt, Andreas[2]; Freier, Christian[3]; Johansson, Jan M.[1]; Lidberg, Martin[2]; Olsson, Per-Anders[2]; Schilling, Manuel[4]; Timmen, Ludger[4]; Wziontek, Hartmut[5]

Absolute and Continuous Gravity measurements for Glacial Isostatic Rebound

Abstract:

Since 2003 the Nordic Geodetic Commission has pursued a coordinated effort of re-observation at 20 stations for gravity change in Fennoscandia using absolute gravimeters with the aim to contribute to our understanding of Glacial Isostatic Adjustment (GIA) and its implications in Fennoscandia. Observatories where a range of space geodetic techniques are collocated with gravimetry laboratories afford reference stations for the GIA enterprise. The BIFROST project has already presented solutions of 3-D displacement rates covering the area affected by GIA. The challenge to supply an AG network solution of g-dot with a resolution that allows to further constrain GIA models is all but trivial, the effect being dominated by the vertical rate at the surface and the mean density of the mantle. Density and viscosity profiles affect at the second order, unfortunately still near the limit of sensitivity of AG. Thus there is motivation to improve AG. This presentation will have a closer look at the use of continuous measurement with a Superconducting gravimeter in AG campaigns, revisiting the reduction model (tides, atmosphere, wobble) in AG observation analysis.

If a superconducting gravimeter had a simple, linear instrumental drift, its records could be used for instantaneous reduction of absolute gravimeter measurements at drop instances after subtraction of the estimated the drift function. Enablers are: the high resolution and low noise level of SG measurements after low-pass rejection of microseismics; the high precision with which a simple drift function can be determined; a secular, external gravity change is absorbed by the drift model. Instead of models for the AG comprising tides, atmosphere, and polar motion, the demands on modelling the drift is in principle much less critical. Multi-year analysis of tides, atmospheric effects, sea-level variations, and polar motion provides determination of these effects at high spectral resolution, leaving a residual with a standard deviation of 5 nm/s^2. We will also show that microseismic perturbations of an FG5 above a certain threshold can be reduced to a normal, low-noise variance using a broadband seismometer.

This presentation revisits the AG campaigns at Onsala Space Observatory using the approach above. We show limitations due to the more complicated situation for drift in the SG GWR 054. At 95% confidence the drift solution appears confined to a peak-to-peak range of 12 nm/s^2 in six years. This drawback can only be mitigated by careful, proactive maintenance of the cryogenic system.

Preliminary results for estimated offsets between the AG's FG5-220, FG5X-220, and FG5-233 are compared with the results of the international intercomparison campaigns. We also show results from parallel AG campaigns (Onsala, Feb. 2015; Wettzell, Oct. 2013), involving each an FG5 and a novel gravimeter, GAIN, from Humboldt University Berlin using quantum interferometry on free-falling laser-cooled Rubidium atoms. A number of shortcomings of the traditional falling corner cube construction become evident: the creation of a common timescale for the multi sensor combination being afflicted by irregular offsets in the PC clock's time-stamping of FG5 measurements ; the limited isolation from microseismic noise provided by the Super-spring; the limited duty-cycle and resulting

reduced amount of data due to the necessary minimization of mechanical wear. Finally, we will muse upon a projection of Quantum interferometric instruments and SCG's in application to extended AG projects for estimating secular changes of gravity.

[1] Chalmers University of Technology, Onsala Space Observatory, Sweden, hgs@chalmers.se
[2] Lantmäteriet, Gävle, Sweden
[3] Humboldt University, Dept. of Physics, Berlin, Germany
[4] Leibniz University, Inst. f. Erdmessung, Hannover, Germany
[5] Bundesamt für Kartographie und Geodäsie, Leipzig, Germany