Comparison of results obtained with a dual sensor superconducting gravimeter

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Extended Abstract

In this extended abstract we sum up some new results regarding gravity observations at the Geodynamic Observatory Moxa (Germany) and refer to already published works (Kroner, 2001; Kroner et al., 2001).

Superconducting gravimeters are a sensitive tool that allows studies of variations in the earth's gravity field fro[...]ese gravimeters are [...] have a mean to

Fig.2: Power spectral density of gravity residuals: a) – lower sensor, – upper sensor, b) – sum of residuals, – difference of residuals.

check the gravity data for arbitrary steps, a problem that occurred in the earlier gravimeter generation. Additional side coils keep the sphere of the upper sensor unit exactly above the lower one. The distance between the sensor units is approx. 20 cm.

From analyses of 27 months of gravity data obtained with the dual sensor superconducting gravimeter at the Geodynamic Observatory Moxa informations are gained about the agreement and the discrepancies between the two data sets. The signal contents is separately compared in the free oscillation band, the tidal frequencies, and in the long-term trend.

1. Free oscillation band and tidal frequencies

In both frequency ranges the data of lower and upper sensor show an almost indistinguishable signal contents. The tidal parameters (amplitude factor d and phase lag D) obtained for the diurnal to ter-diurnal tidal bands and for the long-periodic tides are identical within the error bars (Table 1). The mean power spectra of the residuals (Figure 1) between 0.1 and 50 mHz are close the 'New Low Noise Level' (NLNM; Peterson, 1993). The spectrum of the difference data between the two sensors is characterized by a uniform level between 0.4 and 15 mHz. In general the curve of the difference data is on the same level or only slightly lower

wave	lower sensor		upper sensor	
group	δ	Δ[°]	δ	Δ[°]
O1	1.14932 0.00008	0.1512 0.0039	1.14932 0.00008	0.1505 0.0041
K1	1.13684 0.00006	0.2446 0.0030	1.13685 0.00006	0.2452 0.0031
M2	1.18635 0.00005	1.6250 0.0023	1.18635 0.00005	1.6264 0.0023
S2	1.18437 0.00010	0.3539 0.0049	1.18461 0.00010	0.3481 0.0050
m0	0.627 nm/s²		0.642 nm/s²	

wave	lower sensor		upper sensor	
group	δ	Δ[°]	δ	Δ[°]
SSA	1.14911 0.26270	-4.9813 14.3762	1.16137 0.26126	-2.9399 14.1231
MM	1.17286 0.02183	0.7983 1.0480	1.16744 0.02169	0.8423 1.0458
MF	1.13787 0.00630	0.1540 0.3166	1.13726 0.00626	0.2211 0.3146
MTM	1.15111 0.02105	-1.4269 1.0557	1.15108 0.02091	-1.5692 1.0486
m0	3.814 nm/s²		3.753 nm/s²	

Tab.1: Tidal parameters obtained with ETERNA 3.4 (comp. Wenzel, 1996) for lower and upper sensor, 99/12/19-02

/02/17.

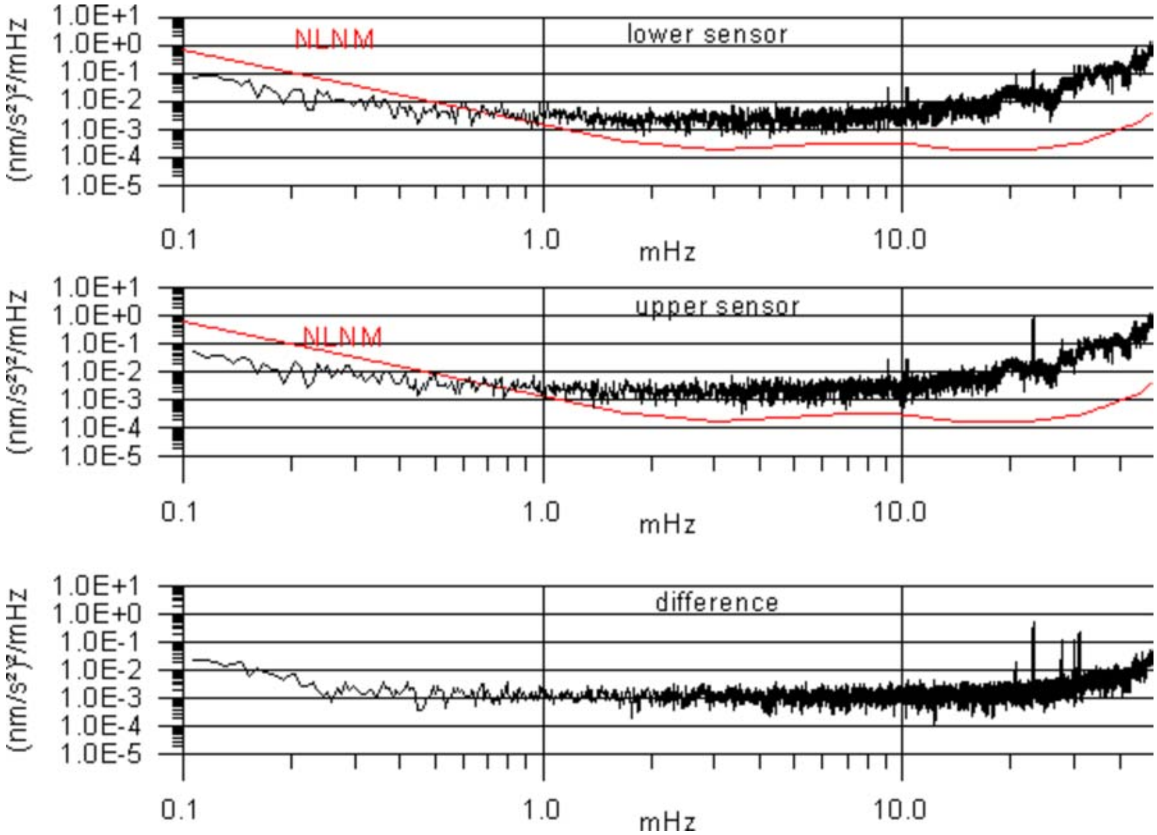


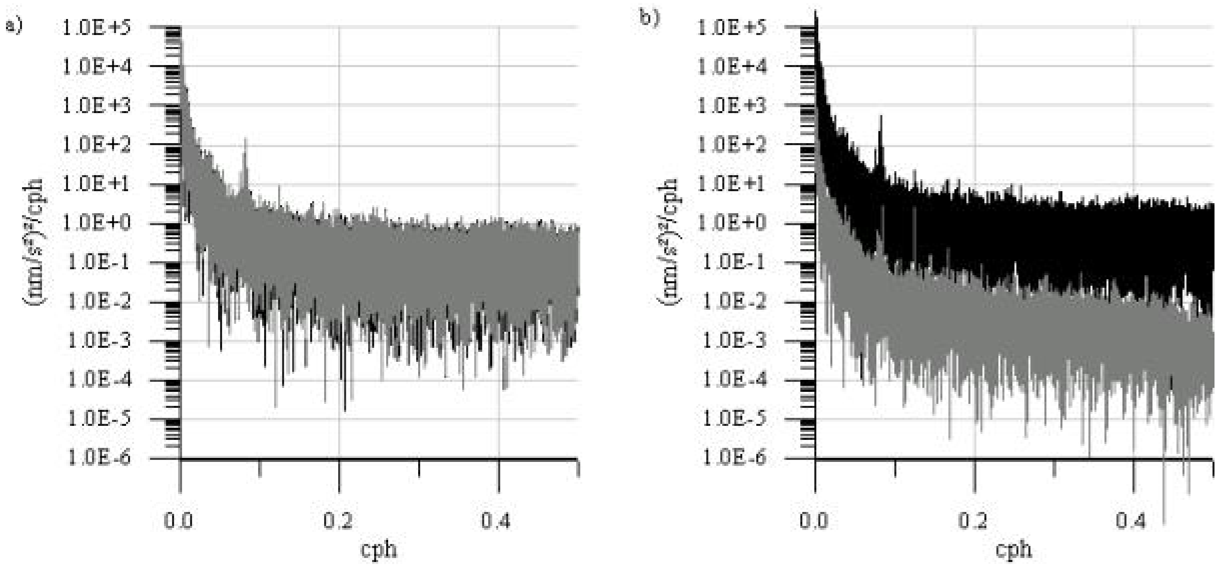
Fig. 1: Mean power spectral density of gravity residuals of lower and upper sensor and their difference for five arbitrary days. For comparison the curve of the NLNM is given (Peterson, 1993). The calculation of the spectra is carried out according to Banka et al. (1997). The peaks at frequencies above 20 mHz cannot be explained yet.

than the curves of the residuals. This indicates that in this frequency range instrumental noise dominates. The power spectral density of the data at frequencies below 0.14 mHz (= 0.5 cph) is given in Figure 2a. These spectra are no mean spectra, but were calculated from the total 27 months of data. In addition the power spectrum of the sum and the difference of the gravity data is shown (Fig. 2b). The spectra are characterized by a flat level between 0.15 cph (0.04 mHz) and 0.5 cph (0.14 mHz) and a rising level below 0.15 cph. In the semi-diurnal band energy due to tides is still left in the data. The sum and the difference spectrum show the same features, but the levels of the curves clearly differ from those of the single gravity data sets. The curve of the difference spectrum is about one order of magnitude below and the one of the sum spectrum about one order of magnitude above the level of upper and lower senor. This result indicates that to a certain extent the data of the two gravimeter sensors have an identical signal contents. The source of this energy is not clear. It could be environmental influences like hydrologically-induced effects that affect the whole spectral range of observation without having peaks at distinct frequencies. In order to clarify this result similar spectra should be calculated for other superconducting gravimeters with a dual sensor system and compared with the Moxa spectra.

Finally, for both, the free oscillation band as well as for the frequency bands of the short-periodic tides the tendency is discernable that the data of the lower sensor are slightly less noisier than the data of the upper sensor. The opposite is valid for the long-periodic tidal bands.

2. Long-term variations

When tides, modeled polar motion and barometric pressure influence are removed from the data, a linear long-term trend of both residual curves emerges. The drift rate of the lower sensor is about 44 nm/s²/a, the upper sensor shows a drift about 26 nm/s²/a. There is no explanation available yet of this different drift behaviour. The comparison between drift-free residuals and the polar motion signal shows a good agreement. An adjustment of the polar motion signal to the residuals yields an amplitude factor of 1.15±0.05 for the lower sensor and of 1.16±0.06 for the upper sensor.
The difference curve between the data of lower and upper sensor with only the different long-term trend removed has a peak-to-peak amplitude of about 20 nm/s² and contains a conspicuous long-periodic variation in the range of about one year (Fig. 3). A similar variation can be found in air temperature. Since it is known that the gravimeter acts as a gradiometer with regard to hydrological fluctuations in the observatory surroundings (Kroner, 2001), it can be assumed that the correlation with air temperature goes back to soil moisture changes which are strongly correlated to saisonal air temperature variations. Longer data sets and the calculation of the water budget for Moxa Observatory will give more information about this.



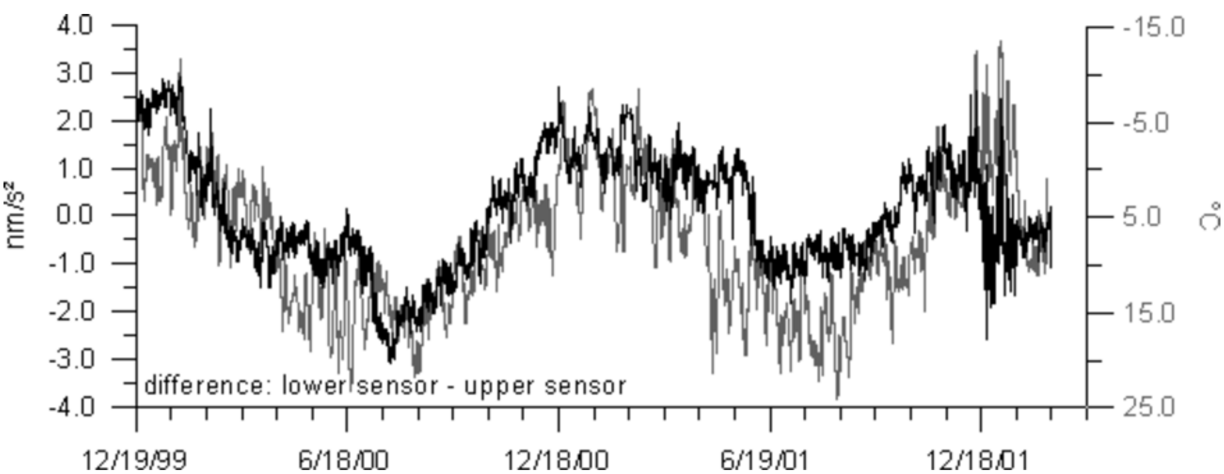


Fig. 3: Difference of gravity residuals and comparison with air temperature, 99/12/19-/02/02/17.

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