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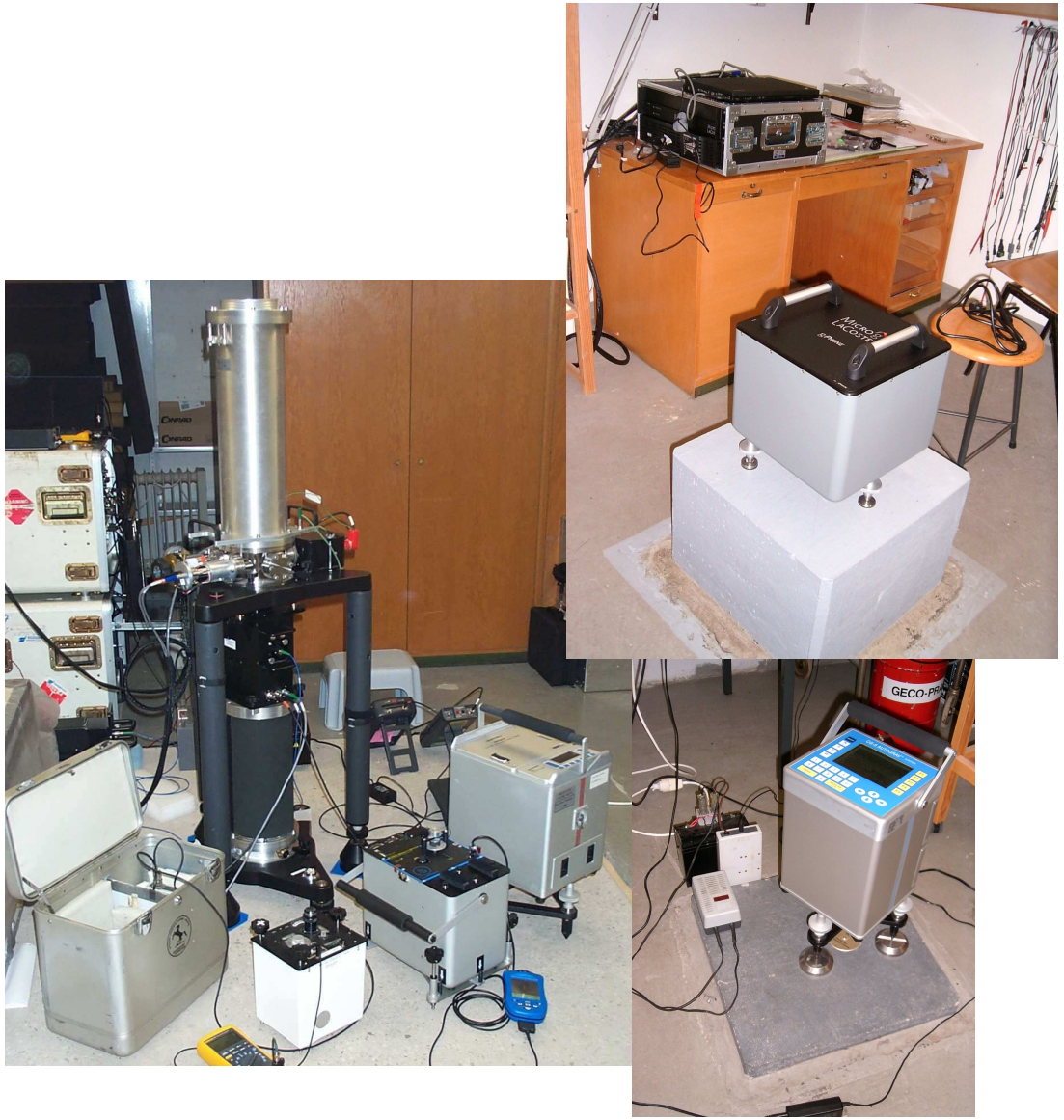
First Experiences with Registrating Spring Gravimeters



Objective:

Find out whether there is any use for registrations
with spring gravimeters with respect to absolute gravimetry.

Available Gravity Meters:

Scintrex CG3 and CG5 Meter
Micro-g Lacoste gPhone
ZLS Burris Meter
LCR Feedback Meters (old)

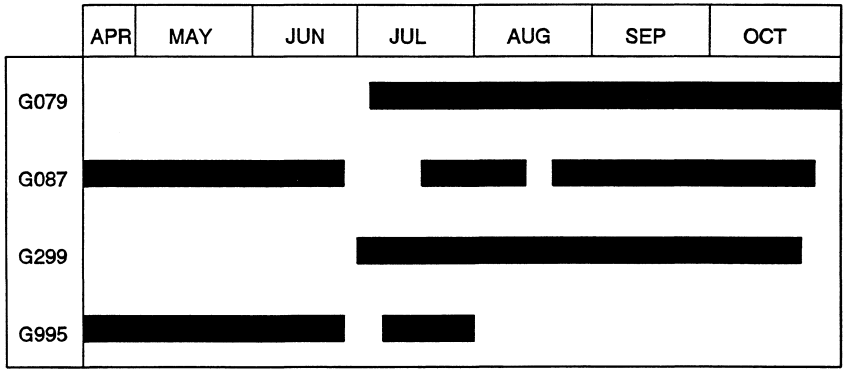
Problems:

Precision and accuracy
Instrumental drift !

Useful Idea:

Quality control of registration by Earth tide analysis

Determining of Earth Tide Parameters



Time spans of Earth tide registrations, Hannover 1992, with old technology

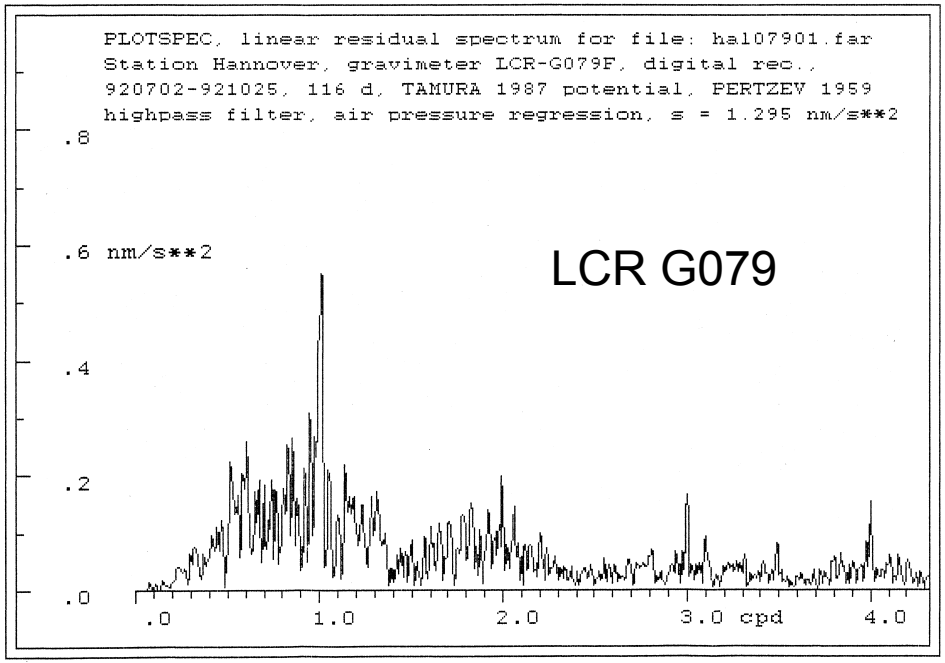
Instr.	Tage	O1		P1K1		M2		S2K2	
		δ	κ [°]	δ	κ [°]	δ	κ [°]	δ	κ [°]
D014	65.3	1.1472	0.11	1.1364	0.26	1.1864	1.66	1.1947	0.55
		±0.0014	±0.07	±0.0010	±0.05	±0.0007	±0.04	±0.0016	±0.08
G079	116.0	1.1491	0.09	1.1376	0.15	1.1854	1.66	1.1897	0.41
		±0.0006	±0.03	±0.0004	±0.02	±0.0003	±0.01	±0.0006	±0.03
G087	157.8	1.1511	0.16	1.1416	0.18	1.1881	1.70	1.1879	0.61
		±0.0015	±0.08	±0.0011	±0.06	±0.0005	±0.03	±0.0012	±0.06
G299	104.5	1.1501	0.18	1.1429	-0.02	1.1856	1.64	1.1933	0.05
		±0.0019	±0.10	±0.0014	±0.07	±0.0007	±0.03	±0.0014	±0.07
G995	96.8	1.1508	0.22	1.1382	0.03	1.1858	1.72	1.1867	0.18
		±0.0010	±0.05	±0.0007	±0.04	±0.0005	±0.02	±0.0011	±0.05
Mittel		1.1497	0.15	1.1393	0.12	1.1863	1.68	1.1905	0.36
		±0.0007	±0.02	±0.0012	±0.05	±0.0005	±0.02	±0.0015	±0.11

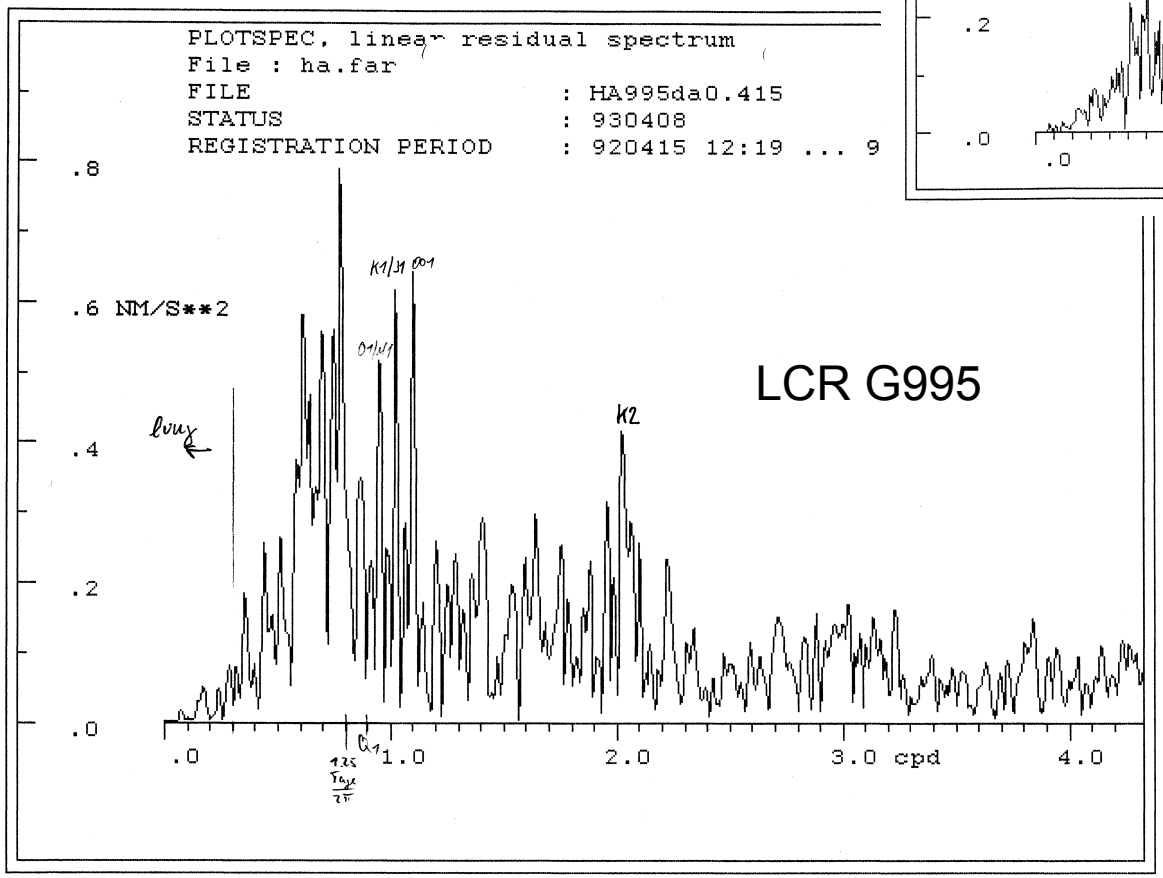
Assuming an error
in the amplitude factor of 0.001
and in the phase lead of 0.05°

→ 0.19 µGal max.
0.06 µGal average

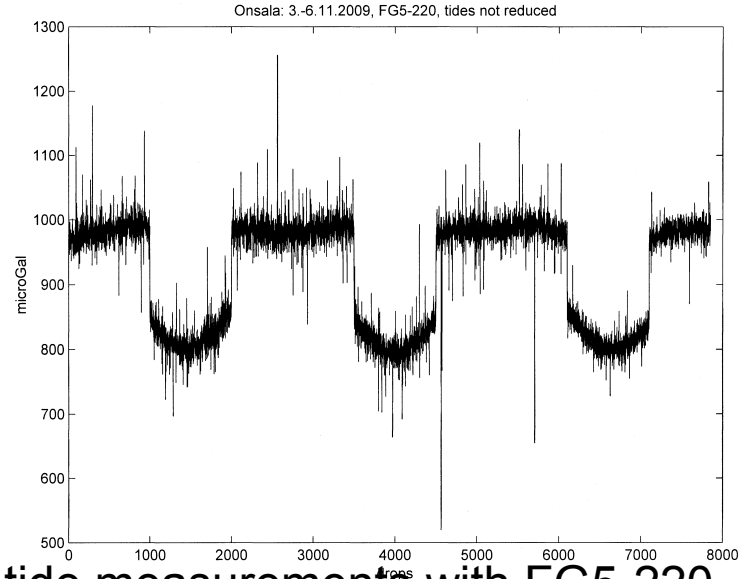
error in the Earth tide reduction
(calculate for whole 1994,
Hannover)

Fourier spectra of the adjustment residuals show the quality of the registration

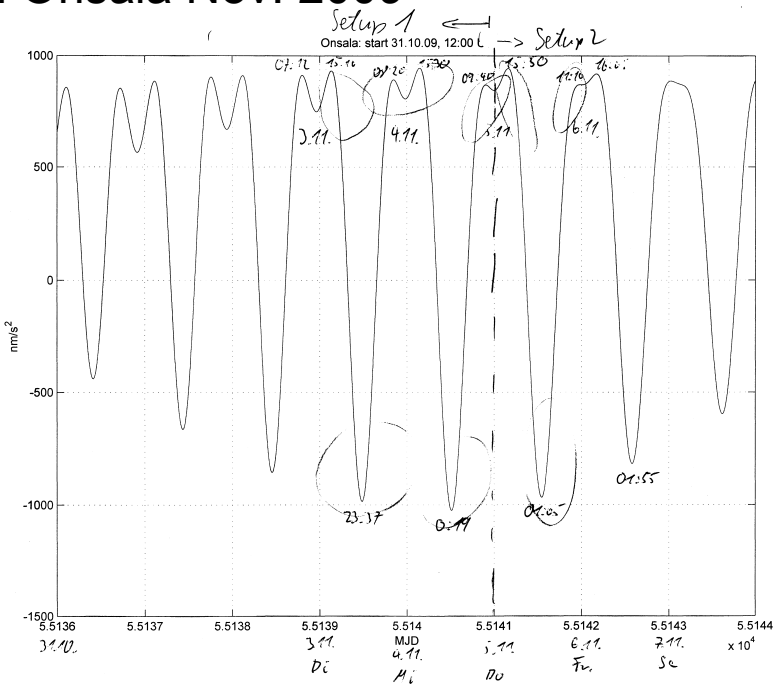




Calibration Transfer to Stationary Superconducting Gravimeters



Earth tide measurements with FG5-220 in Onsala Nov. 2009



Fit between FG5 measurements and predicted (for FG5 reductions)
Earth tide signal:

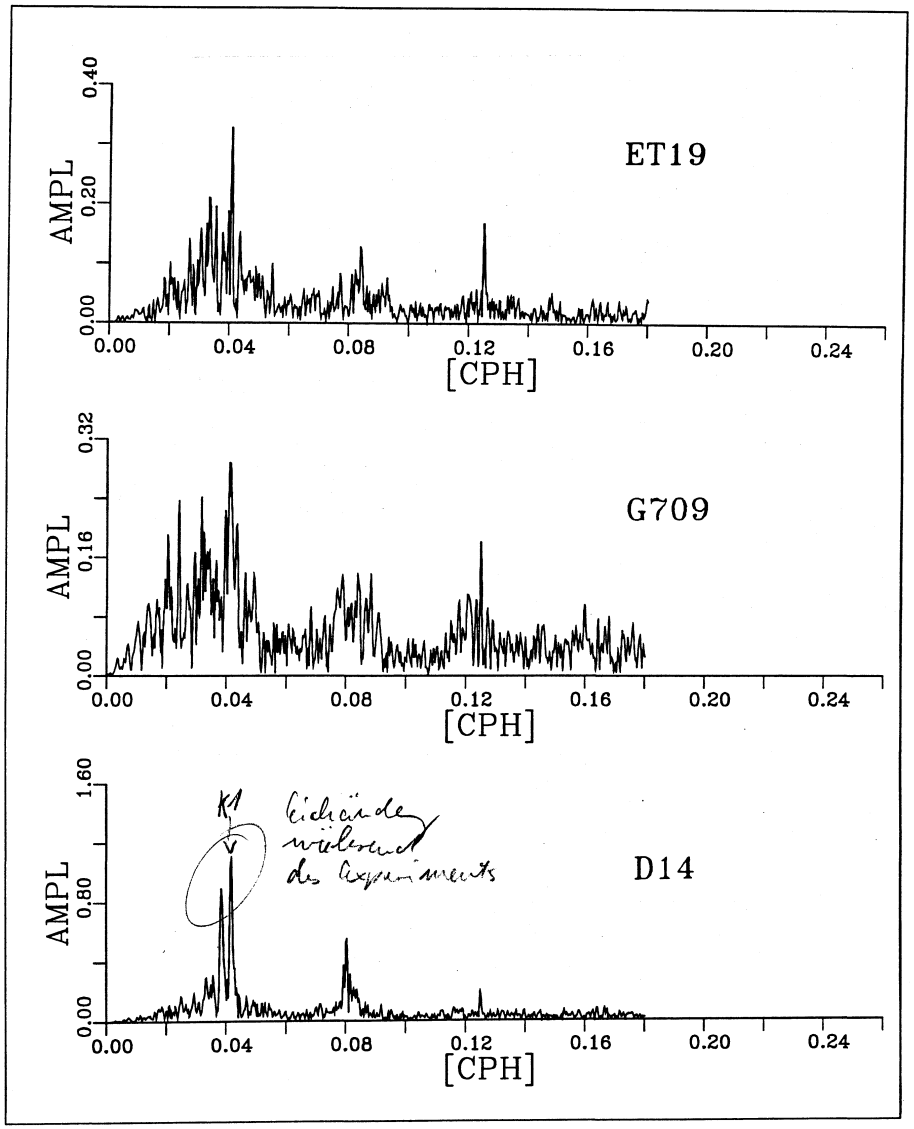
0.99744 ±0.00001

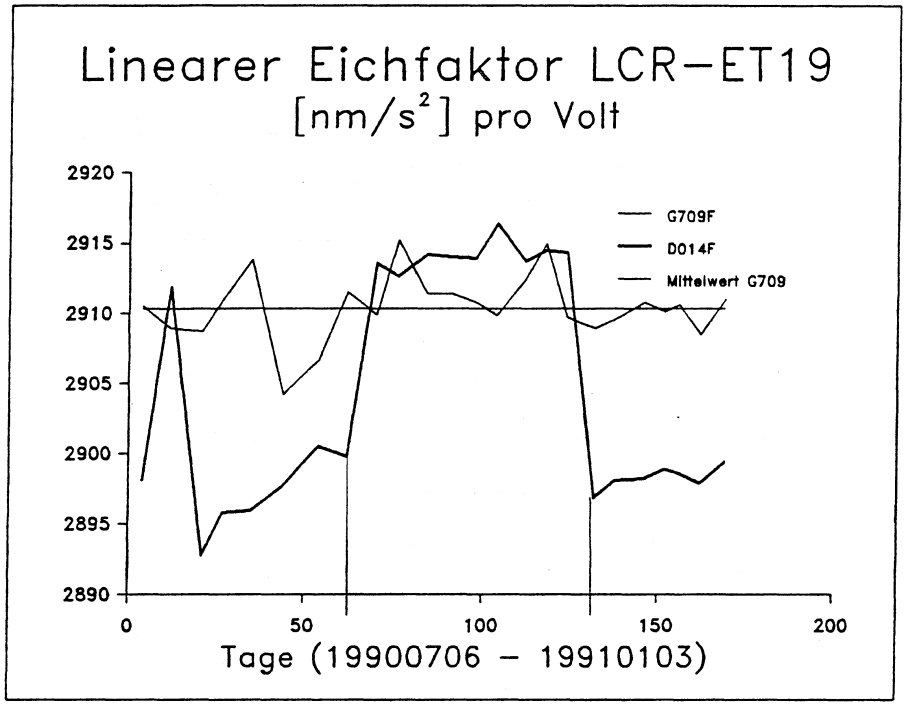
Fit between FG5 measurements and GWR054 registration:

-77.6038 ±0.15 µGal/Volt

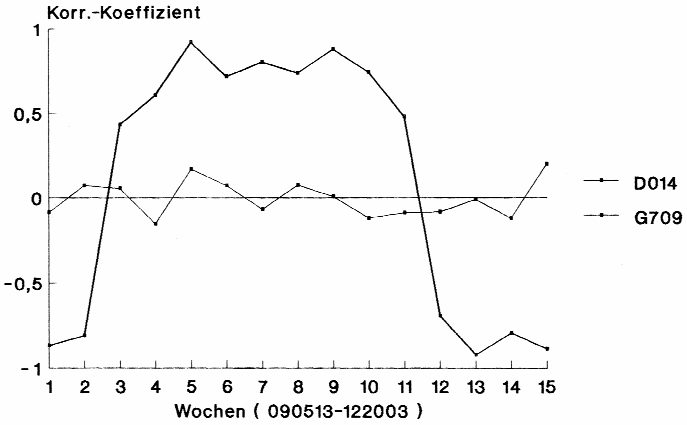
Control of the calibration stability with a more stable reference signal: ET19 at BFO Schiltach

Control level ~1 to $2 \cdot 10^{-3}$





Korrelationsuntersuchung
Residuen D014 und G709 mit synth. Gezeiten



Block	Referenz	Unbekannte		Std.abw.	n Min.
		D014	SCG		
ASSE_12	G709	1.00235		0.00022	5996
	G709		1.07199	0.00019	
	D014		1.06906	0.00011	
ASSE_4	G709	0.99562		0.00045	2160
	G709		1.06923	0.00025	
	D014		1.07610	0.00027	
ASSE_5	G709	1.01057		0.00050	1777
	G709		1.08056	0.00034	
	D014		1.07256	0.00040	
ASSE_678	G709	1.00238		0.00016	7230
	G709		1.06976	0.00010	
	D014		1.06808	0.00011	

Calibration transfer to GWR TT70:

Asse salt mine,
about 2 weeks parallel registration in 1992

E_{lin} = -53.54 ±0.05 µGal/Volt

Examining of available tidal reduction models for JILAg-3 measurements:

Yunnan/China 1992

Referenzsignal	Eichfaktor für das in Xia-guan registrierte Signal		Mittel (gewichtet)
	Block I (7.0 Tage)	Block II (2.7 Tage)	
synth. Modell	0.9958 ±0.0001	0.9964 ±0.0002	0.9960
beob. Modell (MELCHIOR et al. 1985)	1.0146 ±0.0001	1.0162 ±0.0001	1.0150
Differenz			-0.0190

After Earth tide analysis and signal quality check:
investigating other effects in the residual signal,
e.g. from hydrosphere or atmosphere

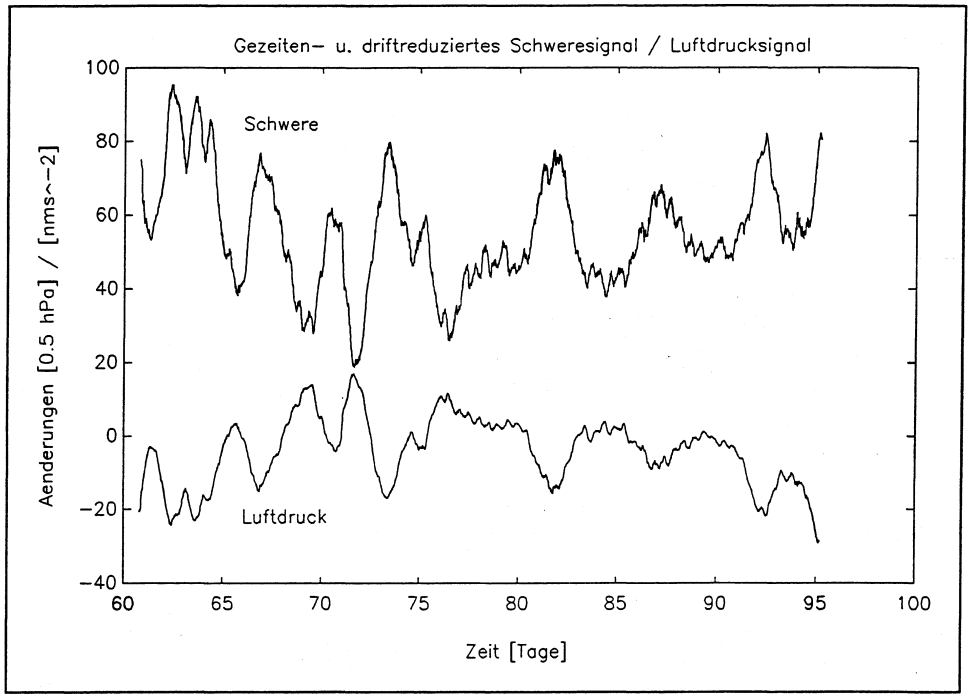


Abb. 8.4: Gegenüberstellung des gezeiten- und driftreduzierten Schweresignals (35 Tage, LCR-G079) und des Luftdrucksignals (in [0.5 hPa]) in der Schweremeßstation

Can spring gravimeters show realistically hydrological events (fast changes)?

Open questions for me:

Is it possible to find the
Mf tidal signal
(~6 µGal amplitude in Hannover)
in my registration?
What is the drift behavior of the gravimeter springs?

How accurate can I transfer the gravimeter calibration (from the Hannover Calibr. System) to a stationary gravimeter?

Can I determine improved Earth tide reduction models for some of the important absolute gravimetry stations?