ABSOLUTE GRAVITY MEASUREMENTS AT THE ALPINE RESEARCH CENTRE IN OBERGURGL (AUSTRIA) IN JUNE 2018

Final Report

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Foreword

This report contains the results of absolute gravity measurements carried out at Alpine Research Centre (University of Innsbruck) in Obergurgl. The measurements took place on the pier 0-173-02 (Figure 1) in June 2018. The absolute gravimeter FG5X#216 was operated by Olivier Francis and Sajad Tabibi from the University of Luxembourg. The measurements are part of an on-going research collaboration between the Geophysics Laboratory of the University of Luxembourg and Christian Ullrich from the Bundesamt für Eich- und Vermessungswesen (Federal Office of Metrology and Surveying) in Vienna, Austria.

We would like to thank Klaus Schallhart for his warm hospitality and help during our measurements.

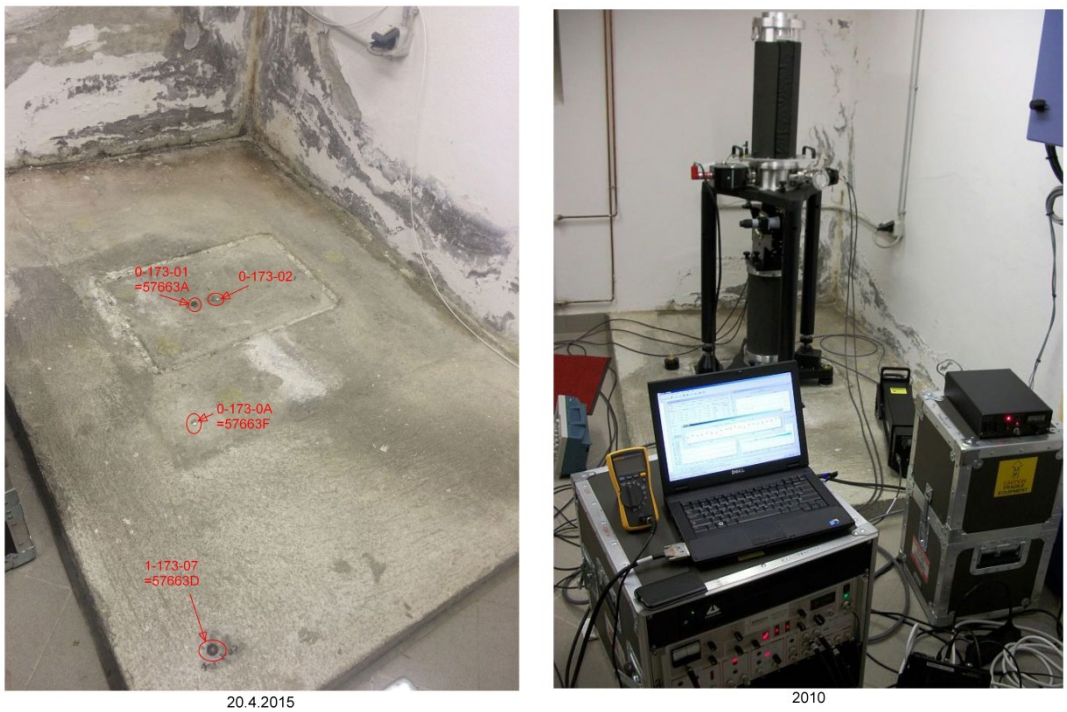

Figure 1. Pier at the Alpine Research Centre (University of Innsbruck) in Obergurgl.

Data processing

Raw data from the absolute gravimeters consist of vectors of time and position of the falling object during the drops. To obtain the gravity value, a linear equation representing the equation of motion is fit to the raw data including the gravity gradient which has been measured with relative meters.

The data processing follows the protocol adopted during absolute gravimeters comparisons at the BIPM in Sèvres (Francis and van Dam, 2003). Geophysical corrections are applied to the raw gravity data: Earth tides using modelled tidal parameters, atmospheric pressure effect using a constant admittance, and the polar motion effect using pole positions from the International Earth Rotation Service (http://hpiers.obspm.fr).

The g-soft v9.12.04.23 software from Microg-LaCoste Inc. was used for the processing. All the text outputs as well as some figures are compiled in the annexes of this report for future reference.

Vertical Gravity Gradient

The vertical gravity gradient is needed to linearize the equation of motion but also to transfer the measured absolute gravity value from the reference height around 1.3 m to the desired height (1.22 in the present report). Its determination requires relative measurements using a smaller and portable relative gravimeter. We used -1.82 μGal/cm. This value was provided by Christian Ullrich.

Results of the absolute gravity measurements

The FG5X#216 operated from Tuesday 5th of June 2018 at 07:44 UTC until Wednesday 6th of June 2018 at 10:16 UTC. A total of 18 sets of 100 drops every 10 seconds were taken with a rate of 1 set per hour. It represents a total of 1800 drops.

Site	Gravity value/ μGal	Mean Set Standard Deviation/ μGal
AGM @ 1.22 m	**980 239 662.94**	**0.71**

Reference

Francis O., van Dam T.M., Processing of the Absolute data of the ICAG01, Cahiers du Centre Européen de Géodynamique et de Séismologie, vol.22, 45-48, 2003. https://doi.org/10.5281/zenodo.7890604

ANNEXES

STATION: Alpine Research Centre (University of Innsbruck) in Obergurgl			
City:	Obergurgl	Country:	Austria
Location:	Alpine Research Centre	Particularity:	
Situation:	Pier 0-173-02	Remarks:	
Date:	5-6 June 2018		
Code number:	0-173-02		
Latitude:	46.86709 degrees		
Longitude:	11.02489 degrees		
Elevation:	1935.40 m		
Gradient:	-1.82 µgal/cm		
Reference height:	0. 1290 m + 1.2583 m = 1.3873 m		
Meter:	FG5X		
S/N:	216		

Tidal corrections using observed tidal parameters

Polar motion correction			**Air pressure correction**	
X-coordinate	0.1198	Arc seconds	Nominal air pressure:	801.35 mbar
Y-coordinate	0.4459	Arc seconds	Barometric admittance factor:	0.3 µgal/mbar

Gravity

Set gravity mean:	**980 239 662.94**	microgal
Set std. dev.:	**0.71**	microgal
Mean std. dev.:	3.69	microgal
Number of sets:	18	
Number of drops per set:	100	
Drop interval:	10 seconds	
Set interval:	60 minutes	
Nominal/datum height:	1.22 m	
Author: O. Francis		University of Luxembourg
Date: July 31, 2018		

Project file

Micro-g LaCoste g Processing Report
File Created: 07/31/18, 12:47:06

Project Name: OB201806
g Acquisition Version: 9.160516
g Processing Version: 9.120423

Company/Institution:
Operator: Olivier Francis

Station Data
Name: OBERGURGL
Site Code: 0-173-02
Lat: 46.86709 Long: 11.02489 Elev: 1935.40 m
Setup Height: 12.90 cm
Transfer Height: 122.00 cm
Actual Height: 138.73 cm
Gradient: -1.820 µGal/cm
Nominal Air Pressure: 801.35 mBar
Barometric Admittance Factor: 0.30
Polar Motion Coord: 0.1198 " 0.4459 "
Earth Tide (ETGTAB) Selected
Potential Filename: C:\gData\gWavefiles\ETCPOT.dat
Delta Factor Filename: C:\DATA\ABSOLU\DATA\INI\OceanLoad-OBERGURGL.dff
Delta Factors

Start	Stop	Amplitude	Phase Term
0.000000	0.000001	1.000000	0.0000 DC
0.000002	0.249951	1.160000	0.0000 Long
0.721500	0.906315	1.154250	0.0000 Q1
0.921941	0.974188	1.154240	0.0000 O1
0.989049	0.998028	1.149150	0.0000 P1
0.999853	1.216397	1.134890	0.0000 K1
1.719381	1.906462	1.161720	0.0000 N2
1.923766	1.976926	1.161720	0.0000 M2
1.991787	2.002885	1.161720	0.0000 S2
2.003032	2.182843	1.161720	0.0000 K2
2.753244	3.081254	1.07338	0.0000 M3
3.791964	3.937897	1.03900	0.0000 M4

Ocean Load ON, Filename: C:\DATA\ABSOLU\DATA\INI\OceanLoad-OBERGURGL.olf

Waves:	M2	S2	K1	O1	N2	P1	K2	Q1	Mf	Mm	Ssa
Amplitude (µGal):	1.447	0.478	0.134	0.135	0.294	0.047	0.125	0.037	0.000	0.000	0.000
Phase (deg):	56.2	28.4	71.9	-188.8	73.5	84.3	26.6	-131.8	0.0	0.0	0.0

Instrument Data
Meter Type: FG5
Meter S/N: X216
Factory Height: 125.83 cm
Rubidium Frequency: 10000000.00000 Hz
Laser: WEO100 (187)
ID: 632.99117754 nm (0.25 V)
IE: 632.99119473 nm (-0.25 V)
IF: 632.99121259 nm (-0.65 V)
IG: 632.99123023 nm (-1.03 V)
IH: 632.99136890 nm (-1.63 V)
II: 632.99139822 nm (-1.38 V)
IJ: 632.99142704 nm (-1.15 V)
Modulation Frequency: 8333.350 Hz

Processing Results

Date: 06/05/18
Time: 20:03:31
DOY: 156
Year: 2018
Time Offset (D h:m:s): 0 0:0:0
Gravity: 980239662.94 µGal
Set Scatter: 0.71 µGal
Measurement Precision: 0.17 µGal
Total Uncertainty: 0.17 µGal
Number of Sets Collected: 18
Number of Sets Processed: 18
Set #s Processed: 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18
Number of Sets NOT Processed: 0
Set #s NOT Processed:
Number of Drops/Set: 100
Total Drops Accepted: 1788
Total Drops Rejected: 12
Total Fringes Acquired: 1100
Fringe Start: 2
Processed Fringes: 1030
GuideCard Multiplex: 4
GuideCard Scale Factor: 250

Acquisition Settings
Set Interval: 60 min
Drop Interval: 10 sec
Number of Sets: 18
Number of Drops: 100

Gravity Corrections
Earth Tide (ETGTAB): 4.12 µGal
Ocean Load: -0.14 µGal
Polar Motion: -0.62 µGal
Barometric Pressure: 0.77 µGal
Transfer Height: 30.45 µGal
Reference Xo: -0.02 µGal

Uncertainties
Sigma Reject: 3.00
Earth Tide Factor: 0.000
Average Earth Tide Uncertainty: 0.00 µGal
Ocean Load Factor: 0.00
Average Ocean Load Uncertainty: 0.00 µGal
Barometric: 0.00 µGal
Polar Motion: 0.00 µGal
Laser: 0.00 µGal
Clock: 0.00 µGal
System Type: 0.00 µGal
Tidal Swell: 0.00 µGal
Water Table: 0.00 µGal
Unmodeled: 0.00 µGal
System Setup: 0.00 µGal
Gradient: 0.000 µGal (0.000 µGal/cm)

Comments:
Files Merged:
OB20180605.fg5
OB20180605a.fg5
OB20180605b.fg5
OB20180605c.fg5

Set File

Source Data Filename: OB201806
g Acquisition Version: 9.160516
g Processing Version: 9.120423

Set	Time	DOY	Year	Gravity	Sigma	Error	Uncert	Tide	Load	Baro	Polar	Transfer		Refxo	Tilt	Diffraction		SelfAttract		Temp	Pres	Chan5	Chan6	Chan7	Chan8	Chan9	Chan10		Accept	Reject	
1	07:52:15	156	2018	980239663.497				3.504	0.356	0.356	-33.292	-0.729	0.619	-0.617	30.449	-0.018	0.000	0.000	0.000	32.437	803.412		-0.007	227.990		48.938	0.000	0.000	0.000	97	3
2	08:52:23	156	2018	980239663.078				3.727	0.373	0.373	-27.280	-0.552	0.639	-0.617	30.449	-0.018	0.000	0.000	0.000	32.018	803.480		-0.006	214.280		35.930	0.000	0.000	0.000	100	0
3	11:09:52	156	2018	980239663.802				3.636	0.365	0.365	1.442	0.385	0.542	-0.617	30.449	-0.018	0.000	0.000	0.000	32.021	803.155		-0.006	202.606		26.242	0.000	0.000	0.000	99	1
4	12:09:52	156	2018	980239664.151				3.721	0.372	0.372	17.949	0.764	0.441	-0.617	30.449	-0.018	0.000	0.000	0.000	31.935	802.821		-0.006	199.000		18.570	0.000	0.000	0.000	100	0
5	13:09:52	156	2018	980239663.349				3.303	0.334	0.334	33.486	0.968	0.310	-0.617	30.449	-0.017	0.000	0.000	0.000	31.963	802.384		-0.006	199.337		18.520	0.000	0.000	0.000	98	2
6	14:09:52	156	2018	980239662.935				3.217	0.322	0.322	45.247	0.937	0.239	-0.617	30.449	-0.017	0.000	0.000	0.000	31.924	802.148		-0.006	198.510		19.930	0.000	0.000	0.000	100	0
7	15:09:52	156	2018	980239663.290				3.636	0.364	0.364	50.840	0.666	0.300	-0.617	30.449	-0.017	0.000	0.000	0.000	31.953	802.349		-0.006	202.710		9.510	0.000	0.000	0.000	100	0
8	16:09:48	156	2018	980239662.727				3.562	0.358	0.358	48.820	0.216	0.381	-0.617	30.449	-0.017	0.000	0.000	0.000	31.947	802.618		-0.006	206.162		12.657	0.000	0.000	0.000	99	1
9	17:13:00	156	2018	980239662.562				3.479	0.350	0.350	38.163	-0.340	0.612	-0.617	30.449	-0.017	0.000	0.000	0.000	31.832	803.390		-0.006	200.182		3.657	0.000	0.000	0.000	99	1
10	17:46:24	156	2018	980239663.339				3.207	0.321	0.321	29.534	-0.620	0.729	-0.617	30.449	-0.017	0.000	0.000	0.000	32.152	803.780		-0.006	201.040		4.880	0.000	0.000	0.000	100	0
11	18:46:29	156	2018	980239663.876				5.215	0.522	0.522	9.850	-1.016	0.910	-0.617	30.449	-0.017	0.000	0.000	0.000	32.007	804.385		-0.006	199.460		7.050	0.000	0.000	0.000	100	0
12	19:46:30	156	2018	980239663.429				3.314	0.333	0.333	-12.557	-1.199	1.075	-0.617	30.449	-0.017	0.000	0.000	0.000	31.983	804.933		-0.006	194.071		5.010	0.000	0.000	0.000	99	1
13	04:57:50	157	2018	980239661.511				4.116	0.412	0.412	-28.635	0.342	1.091	-0.617	30.449	-0.017	0.000	0.000	0.000	31.658	804.986		-0.006	180.770		-10.360	0.000	0.000	0.000	100	0
14	05:57:48	157	2018	980239661.447				3.584	0.360	0.360	-22.772	-0.080	1.106	-0.617	30.449	-0.017	0.000	0.000	0.000	31.851	805.037		-0.006	181.970		-6.869	0.000	0.000	0.000	99	1
15	06:57:55	157	2018	980239662.335				3.739	0.374	0.374	-20.151	-0.442	1.152	-0.617	30.449	-0.017	0.000	0.000	0.000	31.917	805.189		-0.006	183.340		-5.170	0.000	0.000	0.000	100	0
16	07:57:59	157	2018	980239662.539				3.808	0.383	0.383	-19.634	-0.650	1.175	-0.617	30.449	-0.017	0.000	0.000	0.000	31.959	805.266		-0.006	187.020		0.576	0.000	0.000	0.000	99	1
17	08:57:51	157	2018	980239662.060				3.723	0.374	0.374	-19.386	-0.650	1.295	-0.617	30.449	-0.017	0.000	0.000	0.000	31.940	805.667		-0.006	196.606		-2.747	0.000	0.000	0.000	99	1
18	09:57:55	157	2018	980239662.839				3.948	0.395	0.395	-17.522	-0.446	1.323	-0.617	30.449	-0.017	0.000	0.000	0.000	31.991	805.759		-0.006	193.240		-3.380	0.000	0.000	0.000	100	0

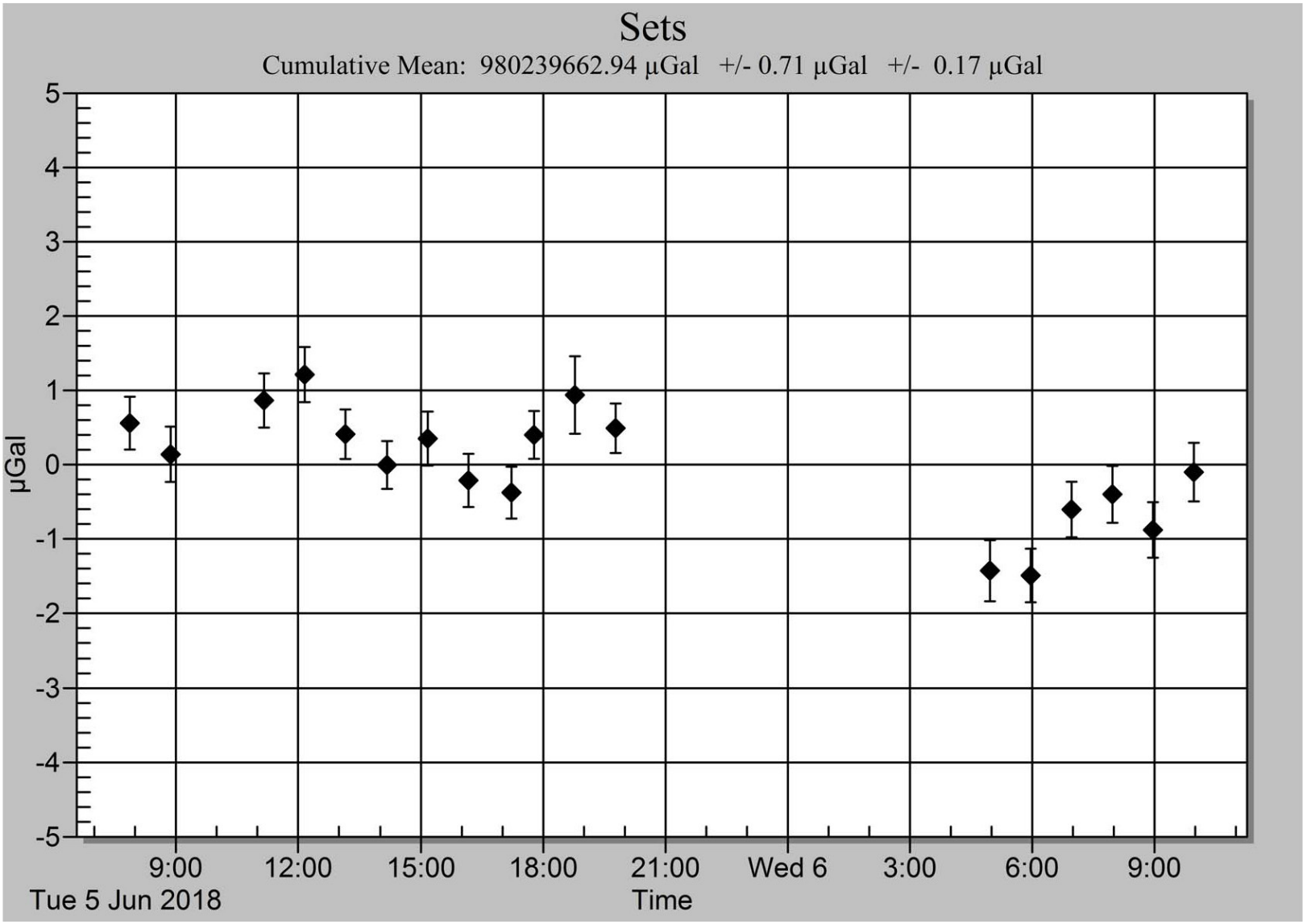

Figure 2. Plot of the set gravity values (1 set = 100 drops).

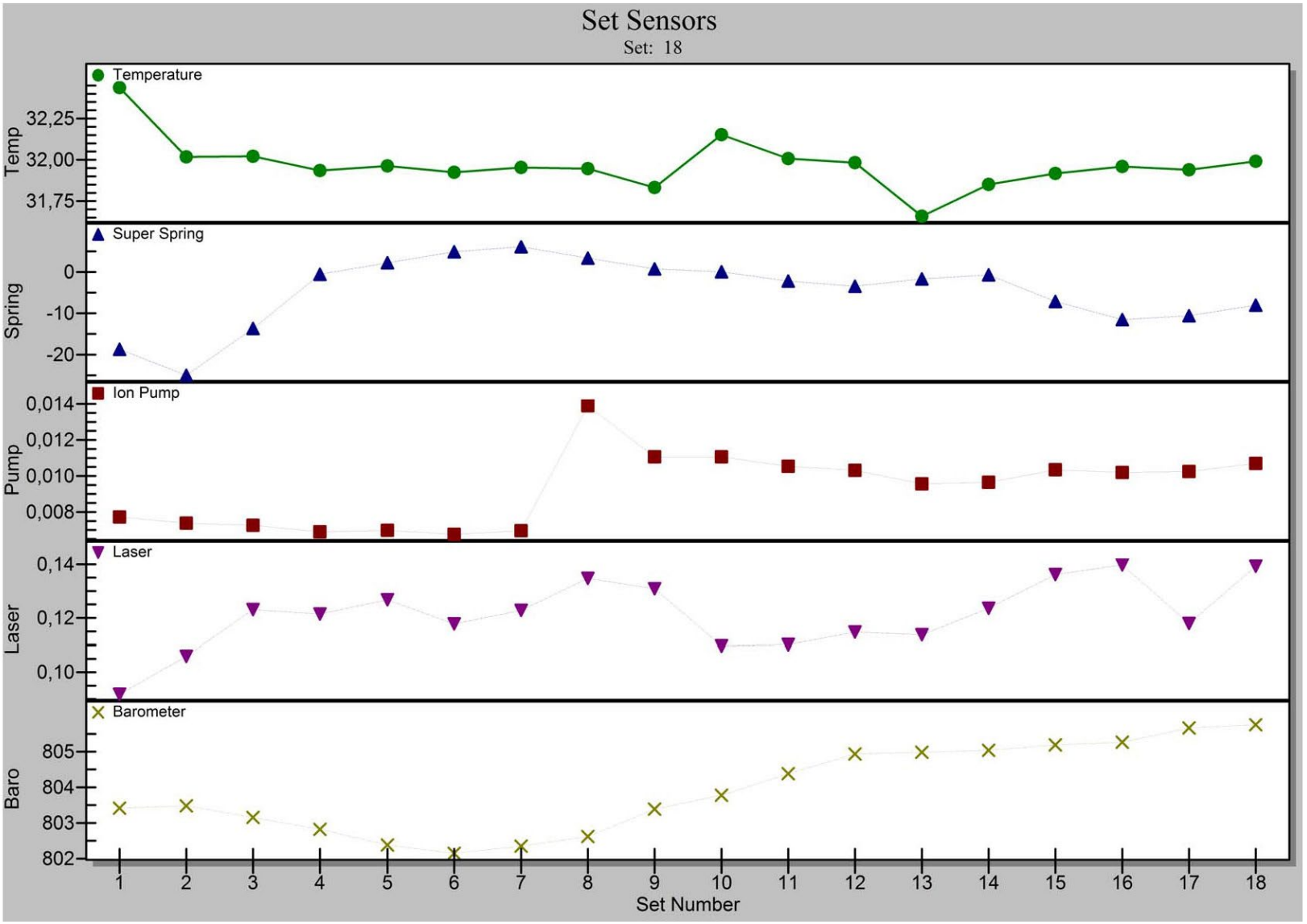

Figure 3. Plot of the set sensor parameters (1 set = 100 drops).

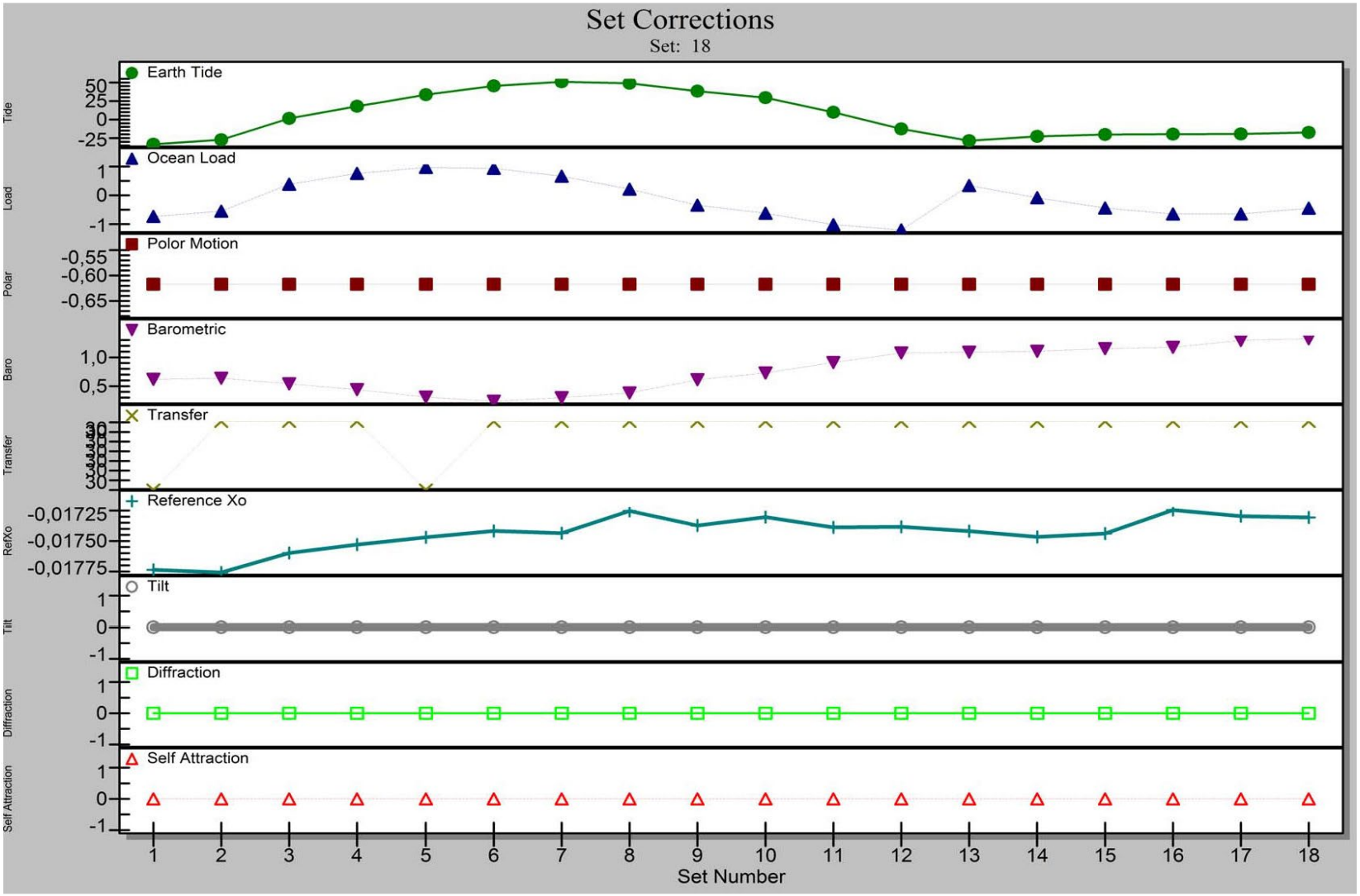

Figure 4. Plot of the set corrections values (1 set = 100 drops).