



**ABSOLUTE GRAVITY MEASUREMENTS IN THE GEOLOGY
BUILDING OF THE UNIVERSITY OF UTAH
SALT LAKE CITY**

Final Report

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Foreword

This report contains the results of absolute gravity measurements carried out on the first floor of the geology building of the campus of the University of Utah in Salt Lake City (USA) in September 2021. The measurements took place on a pre-existing benchmark (Figure 1) that has been apparently occupied with an A-10 absolute gravimeter. No information or documentation about previous occupations are available.

The absolute gravimeter FG5X#302-HC was operated by Olivier Francis from the University of Luxembourg.

The measurements are part of an on-going research project in the Yellowstone National Park with Prof. Tonie van Dam. The Utah site will be used as a reference station to control the reproducibility of the gravity measurements before and after the future field campaigns.



Figure 1. Pier in the geology building on the campus of the University of Utah: storage room first floor.

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 v9.210114 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 (v_{gg}) is needed to linearize the equation of motion but also to transfer the measured absolute gravity value from the reference height around 1.38 m to the desired height (1.30 in the present report). The determination of the v_{gg} requires relative measurements with a small and portable gravimeter above the benchmark at different levels using a stable tripod. We ignore if those measurements have been already made. For now, we used a standard value -3.0 μGal/cm. We recommend to measure the v_{gg} with a SCintrex CG6, for example.

Results of the absolute gravity measurements

The FG5X#302-HC operated for 24 hours from the 7th of September 2021 at 14:20 UTC until the 8th of September 2021 at 14:1040 UTC. A total of 44 sets of 150 drops (1 drop /6 sec) were taken with a rate of 2 sets per hour. It represents a total of 6600 drops. Four sets were eliminated due to excessive noise level.

Site	Gravity value /μGal	Mean Set Standard Deviation /μGal
SLC @ 1.30 m	979 770 127.10	1.59

The mean set standard deviation on the final gravity value is higher than usual. It is due the environmental noise (vibration, human activities,...). The concrete slab may not be thick enough. It is recommended to explore the possibility to find a new site preferably in a basement.

Reference

- Arneitz, P., Meurers, B., Ruess, D., Ullrich, C., Abermann, J., and Kuhn, M.: Gravity effect of glacial ablation in the Eastern Alps - observation and modeling, *The Cryosphere*, 7, 491-498, <https://doi.org/10.5194/tc-7-491-2013>, 2013.
- 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.

ANNEXES

STATION: Salt Lake City			
City:	Salt Lake City	Country:	USA
Location:	Geology Building	Particularity:	
Situation:	A-10 benchmark	Remarks:	Pre-existing
Date:	7-8 September 2021		
Code number:			
Latitude:	40.76639 degrees		
Longitude:	-11.84136 degrees		
Elevation:	1436.0 m		
Gradient:	-3.0 µgal/cm		
Reference height:	0.126 m + 1.260 m = 1.386 m		
Meter:	FG5X		
S/N:	302 HC		
Tidal corrections using theoretical body tides and ocean loading model			
Polar motion correction		Air pressure correction	
X-coordinate	0.2411	Arc seconds	Nominal air pressure: 852.22 mbar
Y-coordinate	0.3173	Arc seconds	Barometric admittance factor: 0.30µgal/mbar
Gravity			
Set gravity mean:	979 770 127.10	microgal	
Set std. dev.:	1.59	microgal	
Mean std. dev.:	4.95	microgal	
Number of sets:	44		
Number of drops per set:	150		
Drop interval:	6 seconds		
Set interval:	30 minutes		
Nominal/datum height:	1.30 m		
Author: O. Francis	University of Luxembourg		
Date: November 18, 2021			

Project file

Micro-g LaCoste g Processing Report
File Created: 11/18/21, 15:09:44

Project Name: SLC20210907
g Acquisition Version: 7.070307
g Processing Version: 9.210114

Company/Institution:
Operator: MGL

Station Data

Name: SALT LAKE CITY
Site Code: Geology Laboratory First Floor
Lat: 40.76639 Long: -111.84136 Elev: 1436.00 m
Setup Height: 12.60 cm
Transfer Height: 130.00 cm
Actual Height: 138.60 cm
Gradient: -3.000 μ Gal/cm
Nominal Air Pressure: 852.22 mBar
Barometric Admittance Factor: 0.30
Polar Motion Coord: 0.2411 " 0.3173 "
Earth Tide (ETGTAB) Selected
Potential Filename: C:\gData\gWavefiles\ETCPOT.dat
Delta Factor Filename: D:\ABSOLU\DATA\INI\OceanLoad-SALT LAKE CITY.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: D:\ABSOLU\DATA\INI\OceanLoad-SALT LAKE CITY.olf

Waves: M2 S2 K1 O1 N2 P1 K2 Q1 Mf Mm Ssa
Amplitude (μ Gal): 0.767 0.252 1.740 1.047 0.111 0.534 0.049 0.204 0.000 0.000 0.000
Phase (deg): 151.1 44.2 60.1 73.9 210.3 60.8 16.0 83.7 0.0 0.0 0.0

Instrument Data

Meter Type: FG5
Meter S/N: 302HC
Factory Height: 126.00 cm
Rubidium Frequency: 10000000.00617 Hz
Laser: WEO100 (236)
ID: 632.99117754 nm (0.60 V)
IE: 632.99119473 nm (0.30 V)
IF: 632.99121259 nm (0.00 V)
IG: 632.99123023 nm (-0.30 V)
IH: 632.99136890 nm (4.00 V)
II: 632.99139822 nm (5.00 V)
IJ: 632.99142704 nm (6.00 V)
Modulation Frequency: 8333.330 Hz

Processing Results

Date: 09/08/21
Time: 01:51:12
DOY: 251
Year: 2021
Time Offset (D h:m:s): 0 0:0:0
Gravity: 979770127.10 μGal
Set Scatter: 1.59 μGal
Measurement Precision: 0.24 μGal
Total Uncertainty: 1.84 μGal
Number of Sets Collected: 48
Number of Sets Processed: 44
Set#sProcessed: 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,25,26,27,28,29,30,31,32,33,35
,37,38,40,41,42,43,44,45,46,47,48
Number of Sets NOT Processed: 4
Set #s NOT Processed: 24,34,36,39
Number of Drops/Set: 150
Total Drops Accepted: 5637
Total Drops Rejected: 963
Total Fringes Acquired: 1100
Fringe Start: 2
Processed Fringes: 1041
TDC Fringe Divider: 1024

Acquisition Settings

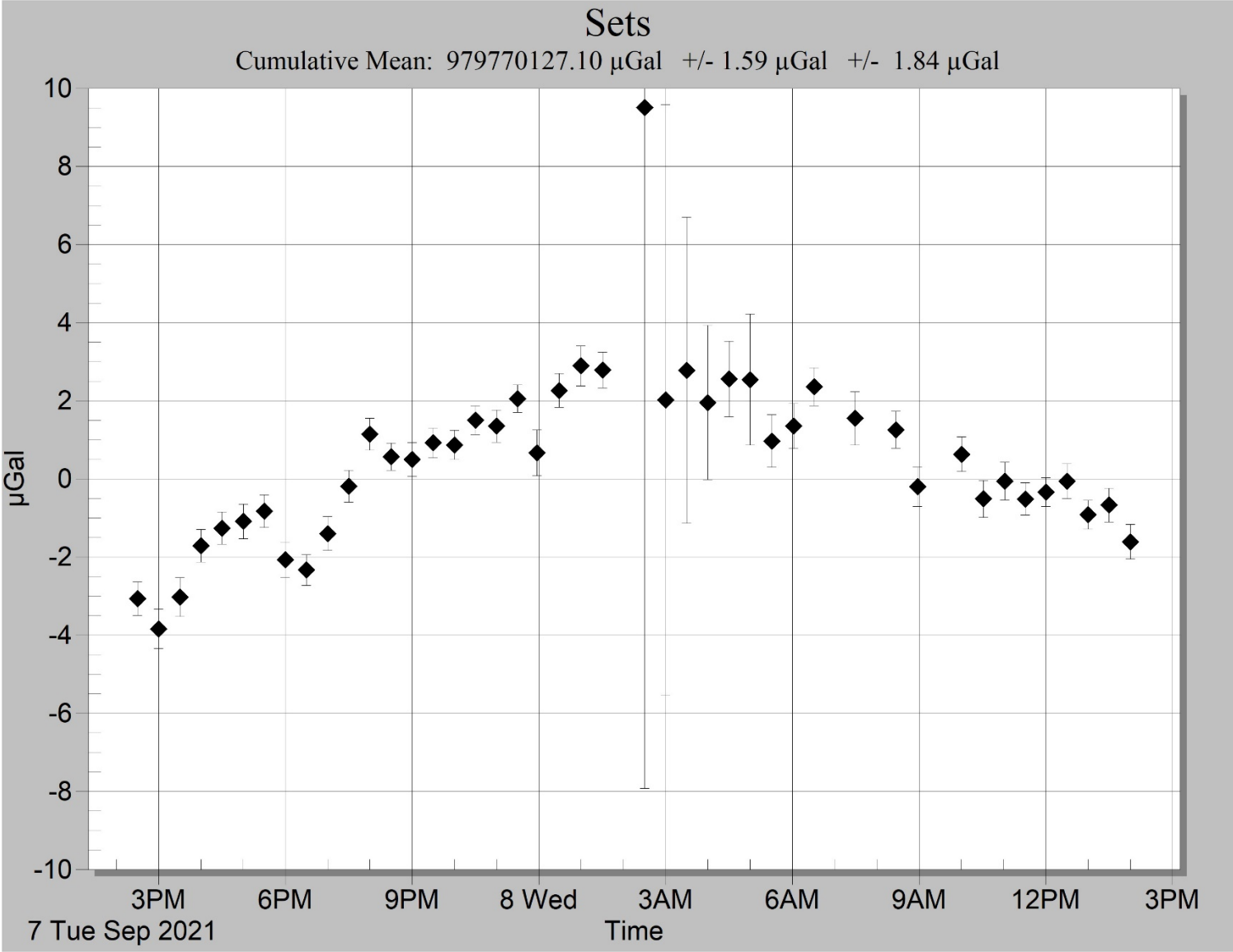
Set Interval: 30 min
Drop Interval: 6 sec
Number of Sets: 48
Number of Drops: 150

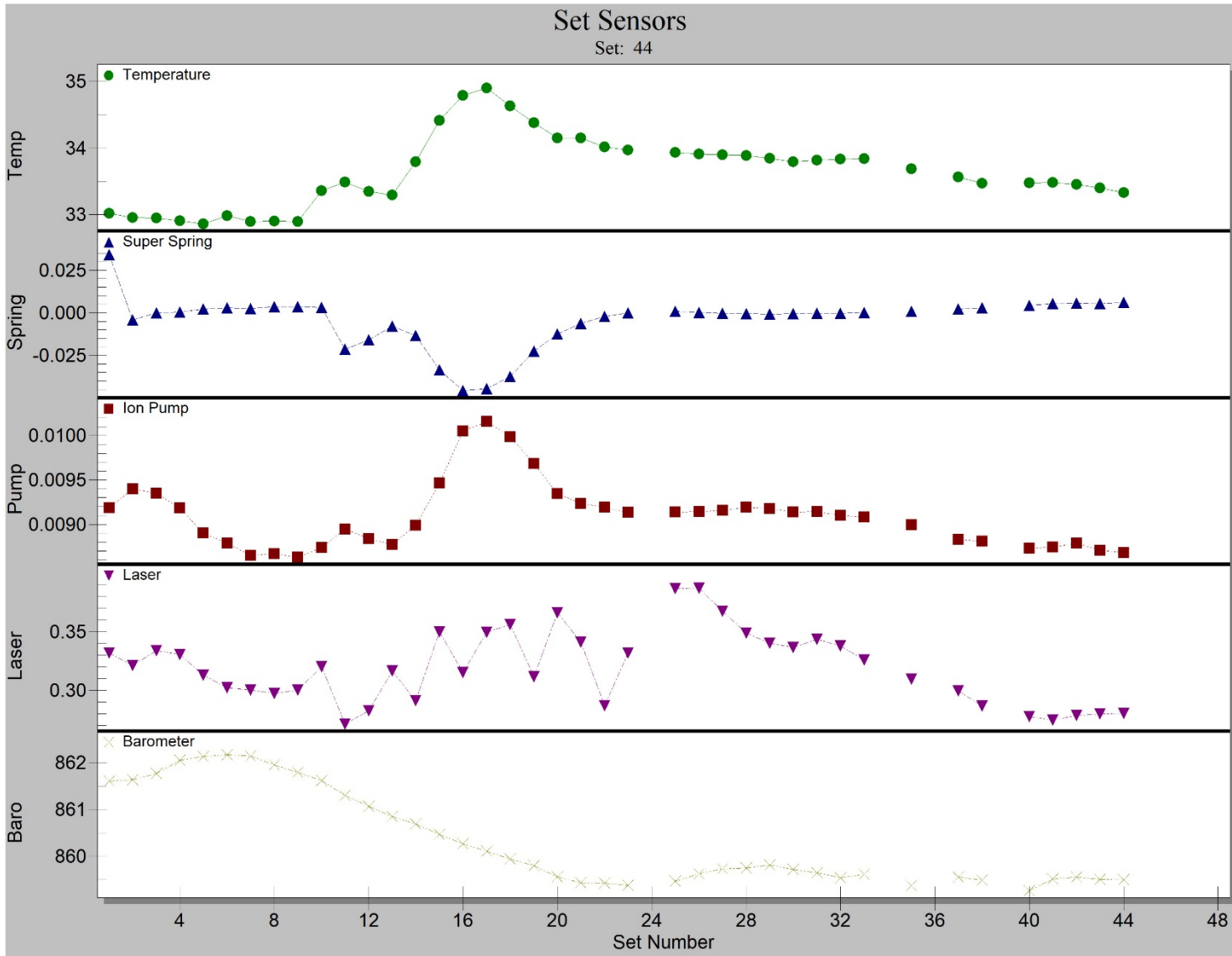
Gravity Corrections

Earth Tide (ETGTAB): -7.23 μGal
Ocean Load: 0.02 μGal
Polar Motion: -3.88 μGal
Barometric Pressure: 2.42 μGal
Transfer Height: 25.80 μGal
Reference Xo: -0.13 μGal

Uncertainties

Sigma Reject: 2.50
Earth Tide Factor: 0.001
Average Earth Tide Uncertainty: 0.01 μGal
Ocean Load Factor: 0.10
Average Ocean Load Uncertainty: 0.00 μGal
Barometric: 1.00 μGal
Polar Motion: 0.05 μGal
Laser: 0.01 μGal
Clock: 0.50 μGal
System Type: 1.00 μGal
Tidal Swell: 0.00 μGal
Water Table: 0.00 μGal
Unmodeled: 0.00 μGal
System Setup: 1.00 μGal
Gradient: 0.258 μGal (0.030 $\mu\text{Gal/cm}$)





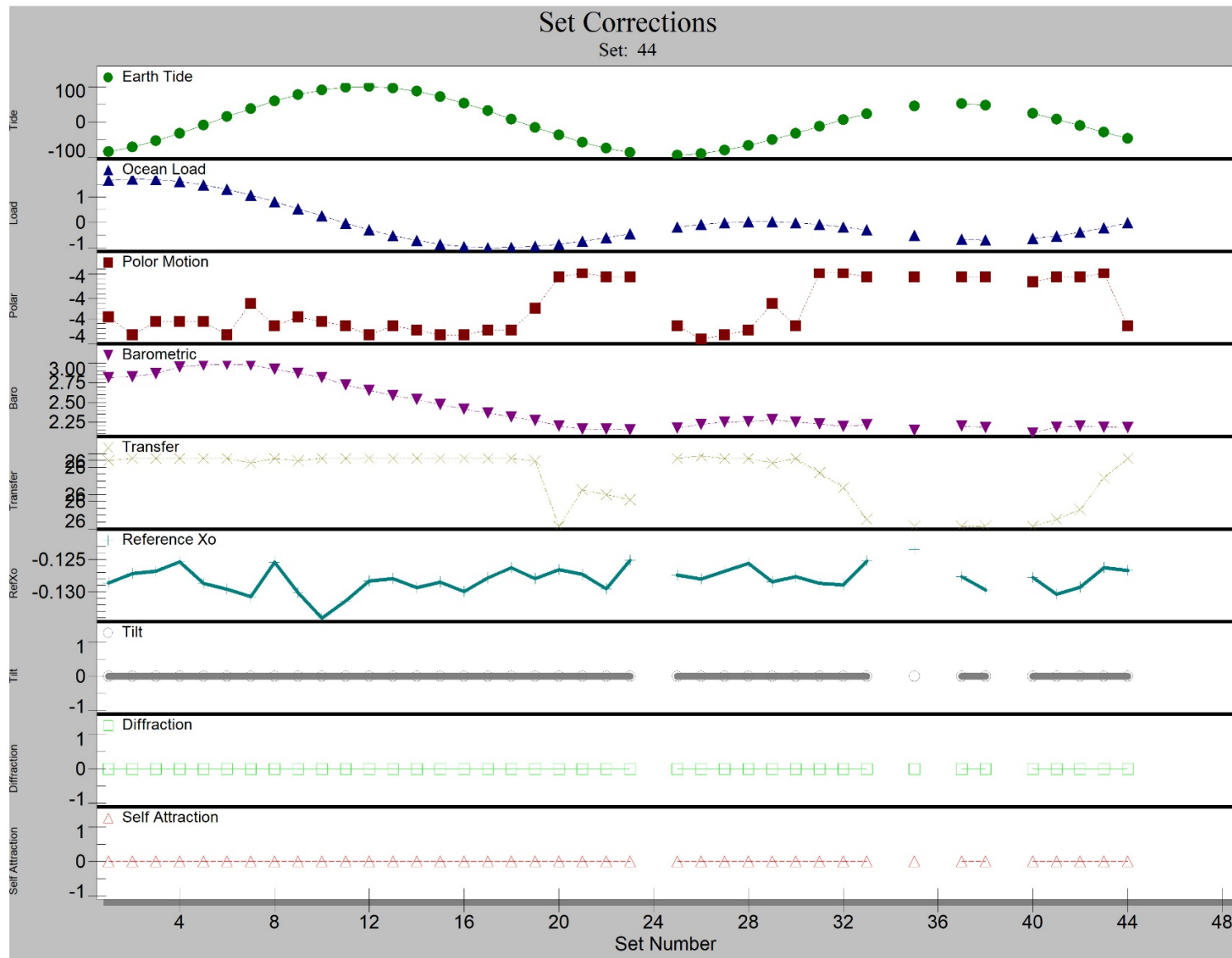


Figure 4. Plot of the set corrections values (1 set = 150 drops).