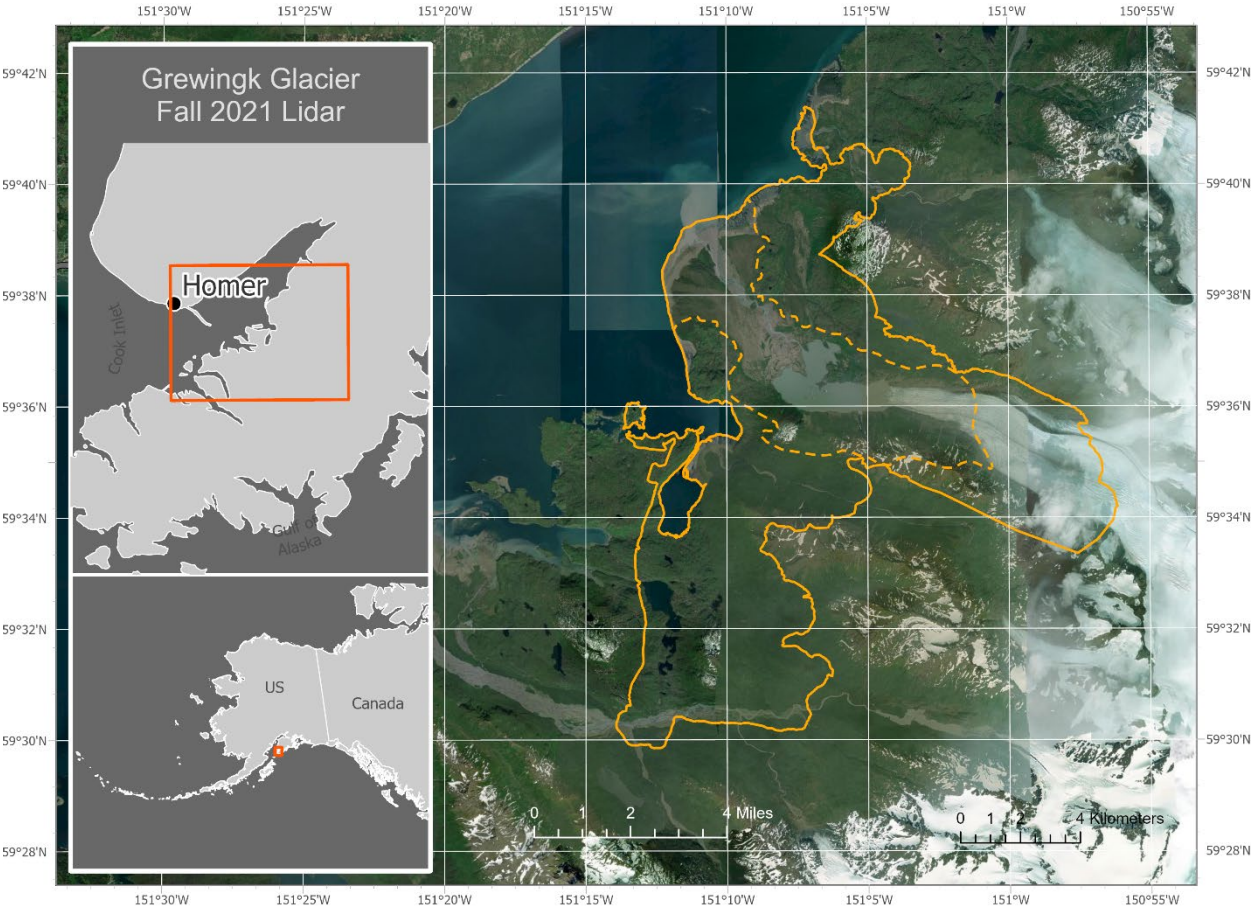
LIDAR-DERIVED ELEVATION DATA FOR LAND NEAR GREWINGK GLACIER AND HALIBUT COVE LAGOON, SOUTHCENTRAL ALASKA, COLLECTED OCTOBER 12-13, 2021

Jenna Zechmann, Katreen Wikstrom Jones, and Gabriel J. Wolken

Raw Data File 2023-2



Location map of survey area with orthometric image.

This report has not been reviewed for technical content or for conformity to the editorial standards of DGGS.

2023
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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LIDAR-DERIVED ELEVATION DATA FOR LAND NEAR GREWINGK GLACIER AND HALIBUT COVE LAGOON, SOUTHCENTRAL ALASKA, COLLECTED OCTOBER 12-13, 2021

Jenna Zechmann[1], Katreen Wikstrom Jones[1], and Gabriel J. Wolken[1]

INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a classified point cloud, digital surface model (DSM), digital terrain models (DTM), and intensity model of land near Grewingk Glacier and Halibut Cove Lagoon, located in Southcentral Alaska (cover figure). Aerial data were collected October 12–13, 2021, and subsequently processed in a suite of geospatial processing software. Ground control data were collected on October 12, 2021. This data supports a paraglacial rock slope destabilization study at Grewingk Glacier and Grewingk Lake and will be used to assess and characterize an ongoing landslide hazard. This data collection is released as a Raw Data File with an open end-user license. All files are available at https://doi.org/10.14509/30958.

LIST OF DELIVERABLES

Classified Points

DSM and DTMs

Intensity Image

Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS used a Riegl VUX1-LR laser scanner integrated with a global navigation satellite system (GNSS) and Northrop Grumman LN-200C inertial measurement unit (IMU). The lidar integration system was designed by Phoenix LiDAR Systems. The sensor can collect up to 820,000 points per second at a range of up to 150 m. The scanner operated with a pulse refresh rate of 100,000 pulses per second in alpine areas and up to 600,000 pulses per second over forested areas at a scan rate between 100 and 200 lines per second. We used a Cessna 180 fixed-wing platform to survey from an elevation of ~100–500 m above ground level, at a ground speed of ~37 m/s, and with a scan angle set from 80 to 280 degrees. The total survey area covers ~145 km^2 (fig. 1).

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Weather Conditions and Flight Times

On October 12, we departed Homer Airport at 1:20 pm and covered the Grewingk valley from Kachemak Bay to the lower Grewingk Glacier (fig. 1). We landed back at Homer Airport at 4:15 pm. On October 13, we departed Homer Airport at 10:00 am and covered a swath from Halibut Cove and lower Halibut Creek south to the river that drains Wosnesenski Glacier. Our return time to Homer Airport was 1:30 pm. The weather throughout the survey was partly cloudy to overcast.

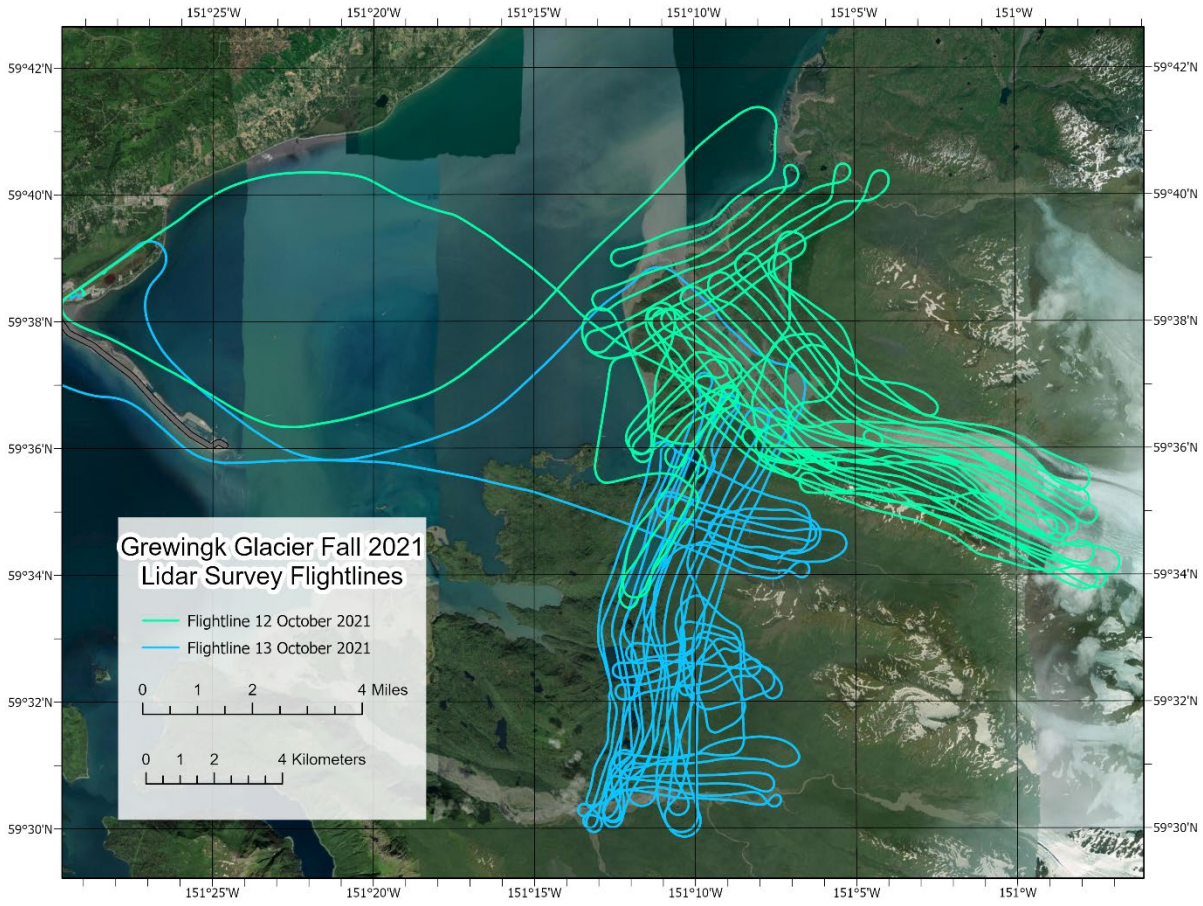

Figure 1. Project flightlines.

PROCESSING REPORT

Lidar Dataset Processing

We processed point data in SDCimport software for initial filtering and multiple-time-around (MTA) disambiguation. MTA errors, corrected in this process, result from ambiguous interpretations of received pulse time intervals and occur more frequently with higher pulse refresh rates. We processed Inertial Measurement Unit (IMU) and Global Navigation Satellite System (GNSS) data in Inertial Explorer, and we used Spatial Explorer software to integrate flightline

information with the point cloud. We calibrated the point data at an incrementally precise scale of sensor movement and behavior, incorporating sensor velocity, roll, pitch, and yaw fluctuations throughout the survey.

We created macros in Terrasolid software and classified points in accordance with American Society for Photogrammetry and Remote Sensing (ASPRS) 2019 guidelines. Once classified, we applied a geometric transformation and converted the points from ellipsoidal heights to GEOID12B (Alaska) orthometric heights.

We used ArcGIS Pro to derive raster products from the point cloud. The DSM was interpolated from maximum return values from the ground, vegetation, and building classes using a binning method. The 1-meter DTM was interpolated from all ground class returns, also using a binning method and minimum values. An additional 20-cm DTM encompassing the northern part of the study area (dashed line in cover image) was produced using triangulation with natural neighbor interpolation. In ArcGIS Pro, we created a 1-meter intensity image by binning and averaging ground, vegetation, and building classes.

Using the ArcGIS Pro Pixel Editor, we hydroflattened both DTMs and the DSM. Water surface elevations were preserved where possible, and interpolation artifacts were replaced with average water surface elevations and smoothed using the Pixel Editor blur tool.

Classified Point Cloud

Classified point cloud data are provided in compressed LAZ format. Data are classified in accordance with ASPRS 2019 guidelines (table 1) and contain return and intensity information. For ground points, the average pulse spacing is 52 cm, and the average point density is 3.69 pts/m^2 (fig. 2).

Table 1. Pointcloud class code definitions.

Class Code	Description
1	Unclassified
2	Ground
3	Low Vegetation (>0.2, ≤0.5 meters above the ground)
4	Medium Vegetation (>0.5, ≤3 meters above the ground)
5	High Vegetation (>3, ≤40 meters above the ground)
6	Building
7	Low Noise
9	Water
18	High Noise

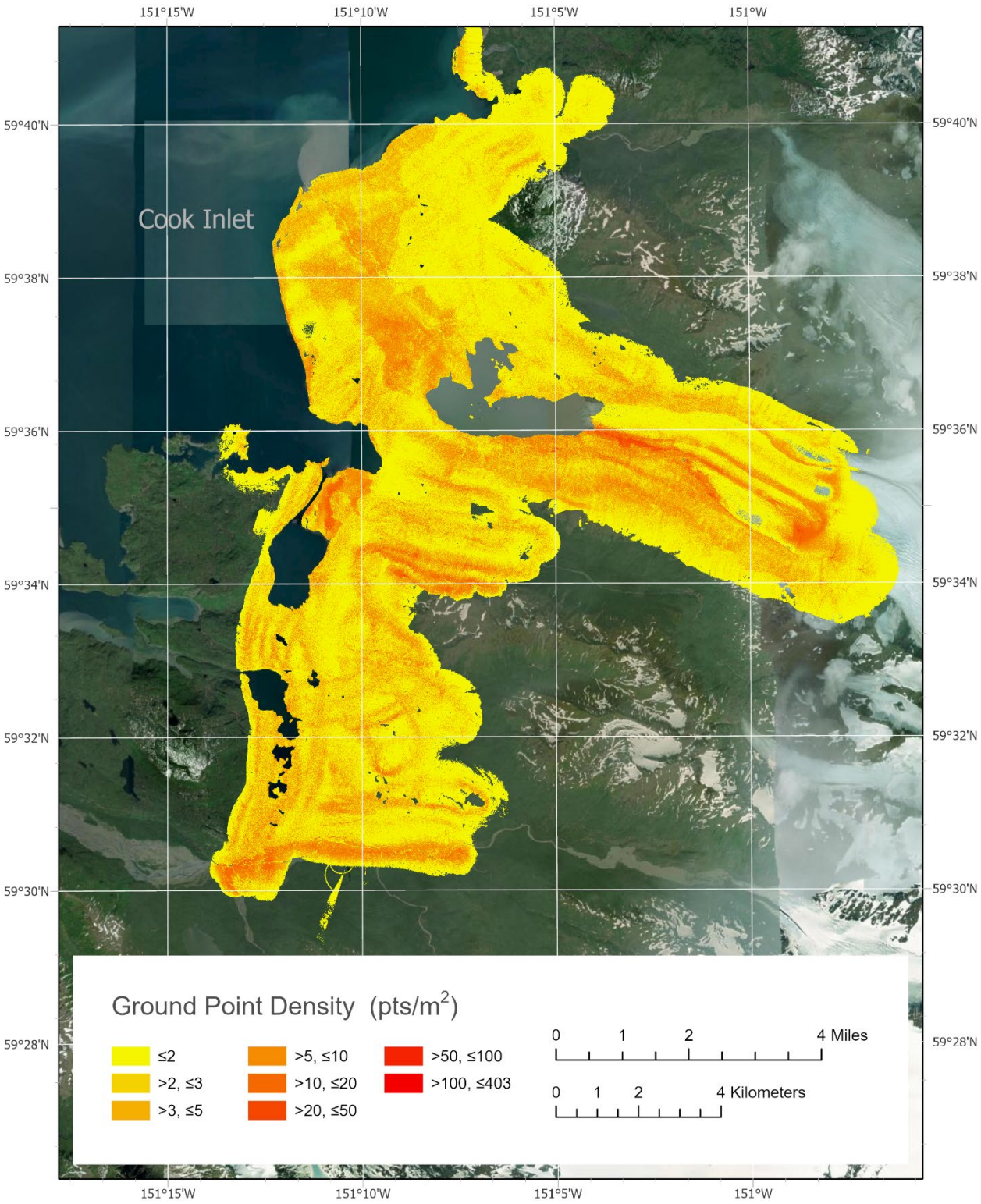

Figure 2. Ground point density for the survey, displayed as a 1-meter raster.

Digital Surface Model

The DSM represents surface elevations, including heights of vegetation, buildings, powerlines, etc. The DSM is a single-band, 32-bit GeoTIFF file of 1-meter resolution. No Data value is set to -3.40282306074e+38 (32-bit, floating-point minimum).

Digital Terrain Models

The DTMs represent bare earth elevations, excluding vegetation, bridges, buildings, etc. We produced two DTMs, one provided under the name 'DTM' and the other labeled 'DTM-detail.' Both DTMs are single-band, 32-bit float GeoTIFF files, of 1-meter ('DTM') or 20-cm ('DTM-detail') resolution. No Data value is set to -3.40282306074e+38.

Lidar Intensity Image

The lidar intensity image depicts the relative amplitude of reflected signals contributing to the point cloud. Lidar intensity is primarily a function of scanned object reflectance in relation to the signal frequency, is dependent on ambient conditions, and is not necessarily consistent between separate scans. The intensity image is a single-band, 32-bit float GeoTIFF file of 1-meter resolution. No Data value is set to -3.40282306074e+38.

SURVEY REPORT

Ground Survey Details

We collected ground control and checkpoints on October 12, 2021. We deployed a Trimble R10-2 GNSS receiver with an internal antenna at a temporary benchmark on the Grewingk Glacier fan delta (59° 38' 27.39" N; 151° 12' 13.338" W). It provided a base station occupation and real-time kinematic (RTK) corrections to points we surveyed with a rover Trimble R10-2 GNSS receiver (internal antenna). We collected a total of 178 ground control and checkpoints for calibration and to assess the vertical accuracy of the point cloud. All points were collected on bare earth.

Coordinate System and Datum

We processed and delivered all data in NAD83 (2011) UTM5N and vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

We did not measure horizontal accuracy for this collection.

Vertical Accuracy

We achieved a vertical accuracy of 3.9 cm average magnitude offset between the lidar point cloud and 178 ground control points by performing a rubbersheet correction (app. A). In addition, we evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 8.0 cm RMSE.

Data Consistency and Completeness

This is a complete release dataset. There was no over-collect except for aircraft turns that were eliminated from the dataset. The data quality is consistent throughout the survey, save for

two small (~0.1 km^2) data gaps located along Halibut Creek and in the southeast corner of the study area.

ACKNOWLEDGMENTS

The area of this survey is on the traditional homelands of the Dena'ina people. These data products were funded by RWTH-Aachen University through a grant from the German Research Foundation and the State of Alaska and collected and processed by DGGS. We are grateful to Bretwood "Hig" Higman for assistance with ground-based surveying. We also thank Clearwater Air for their aviation expertise and contribution to these data products. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

APPENDIX A: GROUND CONTROL POINTS (POST-CORRECTION)

GCP	Easting (m)	Northing (m)	Checkpoint Z (m)	Pointcloud Z (m)	Dz (m)
1	601256.5	6612787.1	4.642	4.720	0.078
2	601256.7	6612796.3	4.635	4.700	0.065
3	601270.4	6612791.3	5.927	5.880	-0.047
4	601270.4	6612791.3	5.926	5.880	-0.046
5	601272.2	6612793.1	5.899	5.800	-0.099
6	601275.5	6612793.4	5.760	5.680	-0.080
7	601461.8	6611714.0	3.994	4.010	0.016
8	601463.8	6611700.2	3.960	3.990	0.030
9	601473.7	6611656.3	4.670	4.500	-0.170
10	601478.8	6611622.8	4.628	4.590	-0.038
11	601479.2	6611634.9	4.592	4.590	-0.002
12	601481.2	6611605.3	4.356	4.390	0.034
13	601487	6611582.8	4.407	4.390	-0.017
14	601491.9	6611561.2	4.518	4.460	-0.058
15	601495.1	6611542.7	4.635	4.630	-0.005
16	601498.1	6611508.5	4.540	4.560	0.020
17	601501.7	6611480.4	4.495	4.520	0.025
18	601507.5	6611454.9	4.874	4.880	0.006
19	601508.4	6611438.1	4.670	4.740	0.070
20	601514.9	6611397.1	4.366	4.380	0.014
21	601523.4	6611373.9	4.159	4.210	0.051
22	601528.1	6611361.0	3.949	3.990	0.041
23	601538.3	6611340.5	3.974	4.030	0.056
24	601542.7	6611329.1	3.900	3.920	0.020
25	601549	6611314.5	3.867	3.890	0.023
26	601558.1	6611291.6	3.906	3.890	-0.016
27	601562.2	6611279.6	3.905	3.920	0.015
28	601566.2	6611267.3	3.862	3.860	-0.002
29	601571.1	6611253.2	3.908	3.920	0.012
30	601576.4	6611234.6	3.865	3.890	0.025
31	601581	6611218.7	3.948	3.940	-0.008
32	601585.4	6611196.2	3.941	3.950	0.009
33	601589.5	6611173.7	3.909	3.950	0.041
34	601595.3	6611151.2	4.033	4.000	-0.033
35	601597.6	6611138.6	3.907	3.870	-0.037
36	601603.2	6611116.1	3.934	3.930	-0.004
37	601607.7	6611098.3	3.957	4.010	0.053
38	601612.7	6611077.6	3.987	4.040	0.053

GCP	Easting (m)	Northing (m)	Checkpoint Z (m)	Pointcloud Z (m)	Dz (m)
39	601617.6	6611056.4	3.913	3.930	0.017
40	601622.8	6611034.5	3.898	3.930	0.032
41	601629.0	6611010.3	4.007	3.980	-0.027
42	601634.2	6610989.2	4.018	4.020	0.002
43	601639.1	6610962.0	3.854	3.830	-0.024
44	601644.1	6610941.1	3.927	3.920	-0.007
45	601647.5	6610925.9	3.975	3.970	-0.005
46	601650.1	6610917.6	4.005	4.000	-0.005
47	601655.5	6610905.4	4.078	4.100	0.022
48	601670.6	6610878.9	4.470	4.430	-0.040
49	601713.1	6610796.3	5.325	5.320	-0.005
50	601727.5	6610794.5	6.474	6.330	-0.144
51	601730.3	6610789.4	6.381	6.290	-0.091
52	601737.3	6610774.0	6.571	6.570	-0.001
53	601745.2	6610767.2	6.052	6.090	0.038
54	601979.5	6603913.8	12.497	12.380	-0.117
55	602002.2	6603908.6	12.846	12.880	0.034
56	602004.1	6603896.3	15.812	15.930	0.118
57	602005.6	6603895.2	16.099	16.470	0.371
58	602522.6	6607446.3	3.803	3.670	-0.133
59	602524.8	6607454.0	4.180	4.150	-0.030
60	602529.9	6607455.9	4.241	4.360	0.119
61	602618.7	6606799.7	1.970	2.030	0.060
62	602627.9	6606799.7	2.401	2.480	0.079
63	602647.2	6606793.3	2.271	2.280	0.009
64	602653.8	6606791.4	2.443	2.430	-0.013
65	602662.0	6606787.8	2.514	2.470	-0.044
66	602680.1	6606785.2	2.568	2.540	-0.028
67	602707.5	6606761.7	4.072	4.050	-0.022
68	602718.9	6606756.6	4.113	4.090	-0.023
69	602727.1	6606745.1	4.698	4.650	-0.048
70	602732.4	6606741.7	4.663	4.620	-0.043
71	602741.6	6606741.1	4.910	4.860	-0.050
72	602743.2	6605459.4	1.563	1.490	-0.073
73	602743.8	6605464.8	1.948	2.020	0.072
74	602751.0	6605468.4	2.695	2.630	-0.065
75	602755.9	6606738.9	5.119	5.090	-0.029
76	602760.4	6605492.4	2.090	2.140	0.050
77	602762.9	6605509.0	1.637	1.690	0.053

GCP	Easting (m)	Northing (m)	Checkpoint Z (m)	Pointcloud Z (m)	Dz (m)
78	602763.4	6606743.0	5.256	5.250	-0.006
79	602763.4	6605503.2	1.735	1.800	0.065
80	602859.5	6605938.7	2.796	2.750	-0.046
81	602860.8	6605929.6	2.472	2.490	0.018
82	602863.4	6605954.3	2.960	2.950	-0.010
83	602864.2	6605919.3	2.670	2.690	0.020
84	602874.2	6605970.6	2.972	2.900	-0.072
85	602875.6	6605901.0	2.938	2.930	-0.008
86	602881.4	6605968.5	2.583	2.550	-0.033
87	602882.1	6605881.5	2.760	2.710	-0.050
88	602885.9	6605721.8	3.233	3.300	0.067
89	602886.5	6605960.9	2.393	2.390	-0.003
90	602886.6	6605864.0	2.553	2.470	-0.083
91	602888.1	6605717.0	3.429	3.440	0.011
92	602889.0	6605954.1	2.338	2.360	0.022
93	602889.3	6605855.7	2.369	2.260	-0.109
94	602891.3	6605946.8	2.284	2.300	0.016
95	602892.2	6605725.7	3.212	3.300	0.088
96	602892.7	6605733.7	2.286	2.310	0.024
97	602895.3	6605718.1	3.758	3.690	-0.068
98	602895.8	6605926.4	2.251	2.260	0.009
99	602896.1	6605747.3	2.408	2.510	0.102
100	602899.0	6605897.3	2.031	2.060	0.029
101	602900.8	6605908.4	2.058	2.200	0.142
102	602901.1	6605918.4	2.155	2.160	0.005
103	602901.7	6605753.4	2.590	2.600	0.010
104	602902.3	6605846.7	2.419	2.420	0.001
105	602904.6	6605840.6	2.454	2.420	-0.034
106	602907.3	6605819.1	2.371	2.320	-0.051
107	602907.6	6605815.3	2.305	2.270	-0.035
108	602907.7	6605827.9	2.394	2.350	-0.044
109	602907.8	6605834.8	2.382	2.340	-0.042
110	602909.1	6605841.3	2.444	2.410	-0.034
111	602909.4	6605851.2	2.505	2.460	-0.045
112	602909.9	6605764.9	1.920	1.990	0.070
113	602909.9	6605865.9	2.562	2.530	-0.032
114	602910.6	6605859.7	2.499	2.470	-0.029
115	602920.3	6605788.3	1.942	1.980	0.038
116	602922.4	6605800.2	2.307	2.280	-0.027

GCP	Easting (m)	Northing (m)	Checkpoint Z (m)	Pointcloud Z (m)	Dz (m)
117	603412.7	6610805.5	39.617	39.740	0.123
118	603450.7	6610788.3	40.226	40.230	0.004
119	603468.5	6610778.0	40.491	40.480	-0.011
120	603487.8	6610775.0	40.969	40.980	0.011
121	603507.2	6610768.6	41.198	41.270	0.072
122	603519.7	6610761.7	41.707	41.730	0.023
123	603540.4	6610734.6	41.969	41.960	-0.009
124	603564.1	6610717.8	42.329	42.330	0.001
125	603586.7	6610698.9	42.413	42.410	-0.003
126	603600.8	6610691.1	42.734	42.720	-0.014
127	603623.0	6610673.2	43.306	43.290	-0.016
128	603639.4	6610657.0	43.595	43.580	-0.015
129	603661.3	6610633.3	43.948	43.960	0.012
130	603670.8	6610622.0	44.158	44.180	0.022
131	603690.0	6610594.6	44.629	44.570	-0.059
132	603707.4	6610580.4	44.734	44.740	0.006
133	603722.7	6610566.4	44.809	44.780	-0.029
134	603737.0	6610548.7	45.018	44.970	-0.048
135	603749.9	6610533.3	45.353	45.430	0.077
136	603776.5	6610512.1	45.888	45.920	0.032
137	603796.6	6610499.3	46.535	46.590	0.055
138	603815.5	6610484.0	46.932	46.970	0.038
139	603821.2	6610470.7	47.199	47.210	0.011
140	603841.2	6610445.8	47.782	47.810	0.028
141	603869.0	6610429.8	48.353	48.380	0.027
142	603887.2	6610412.7	48.732	48.700	-0.032
143	603898.2	6610407.0	48.980	48.860	-0.120
144	603906.8	6610401.1	48.518	48.520	0.002
145	603926.7	6610383.3	49.216	49.190	-0.026
146	603945.9	6610370.5	49.609	49.580	-0.029
147	603964.7	6610357.0	49.910	49.860	-0.050
148	603979.5	6610344.3	50.207	50.230	0.023
149	603995.7	6610334.5	50.234	50.250	0.016
150	604013.3	6610315.9	50.755	50.800	0.045
151	604016.9	6610300.6	51.004	51.000	-0.004
152	604019.6	6610281.5	51.184	51.210	0.026
153	604021.3	6610266.9	51.375	51.360	-0.015
154	604026.2	6610253.6	51.553	51.570	0.017
155	604028.8	6610237.7	51.763	51.840	0.077

GCP	Easting (m)	Northing (m)	Checkpoint Z (m)	Pointcloud Z (m)	Dz (m)
156	604030.6	6610098.6	52.894	52.870	-0.024
157	604031.3	6610107.8	52.831	52.800	-0.031
158	604032.6	6610140.7	52.663	52.610	-0.053
159	604033.2	6610166.2	52.501	52.490	-0.011
160	604033.2	6610181.5	52.380	52.360	-0.020
161	604033.3	6610213.3	52.079	52.070	-0.009
162	604033.4	6610124.1	52.716	52.700	-0.016
163	604033.9	6610197.6	52.234	52.210	-0.024
164	604988.1	6609265.2	52.395	52.370	-0.025
165	604989.4	6609269.9	52.399	52.340	-0.059
166	604997.5	6609275.8	52.057	52.080	0.023
167	605007.2	6609279.8	51.799	51.790	-0.009
168	605016.9	6609291.9	51.691	51.720	0.029
169	605023.0	6609297.7	51.690	51.700	0.010
170	605032.7	6609306.1	51.509	51.550	0.041
171	605037.6	6609311.4	51.565	51.580	0.015
172	605046.0	6609314.6	51.437	51.430	-0.007
173	605052.7	6609320.0	51.416	51.410	-0.006
174	605059.8	6609326.6	51.419	51.430	0.011
175	605066.3	6609330.1	51.395	51.390	-0.005
176	605076.4	6609325.9	50.425	50.470	0.045
177	605088.2	6609332.5	50.445	50.440	-0.005
178	605101.1	6609339.1	50.212	50.200	-0.012
Average dz (m)	0.001				
Minimum dz (m)	-0.170				
Maximum dz (m)	0.371				
Average magnitude error (m)	0.039				
Root mean square error (m)	0.056				
Standard deviation	0.056				