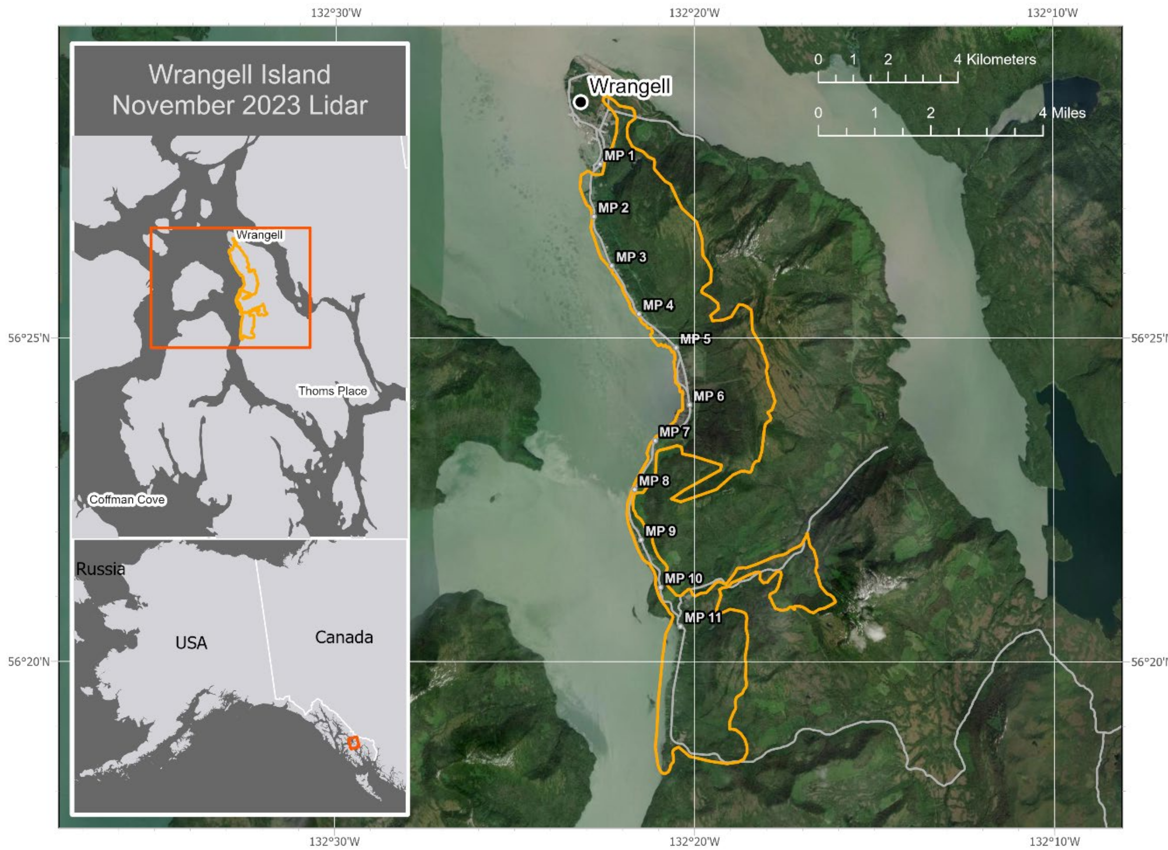
LIDAR-DERIVED ELEVATION DATA FOR WRANGELL ISLAND, SOUTHEAST ALASKA, COLLECTED NOVEMBER 28-29, 2023

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

Raw Data File 2024-1



Location map of the survey area.

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

2024
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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LIDAR-DERIVED ELEVATION DATA FOR WRANGELL ISLAND, SOUTHEAST ALASKA, COLLECTED NOVEMBER 28-29, 2023

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a classified point cloud, digital surface model (DSM), digital terrain model (DTM), and an intensity model of slopes above the Zimovia Highway on Wrangell Island, Southeast Alaska, during leaf-off conditions (cover figure). The survey provides snow-free surface elevations for use in landslide hazard assessment following a November 20, 2023, debris flow that occurred near Milepost 11 of the Zimovia Highway and tragically claimed the lives of six people. Ground control data were collected June 26–30, 2023 (Zechmann and others, 2023), and aerial lidar data were collected November 28–29, 2023, and subsequently merged and processed using a suite of geospatial processing software. This data collection is released as a Raw Data File with an open end-user license. All files are available to download on the DGGS website at https://doi.org/10.14509/31106.

LIST OF DELIVERABLES

Classified Points
DSM and DTM
Intensity Image
Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS used a Riegl VUX1-LR22 laser scanner integrated with a global navigation satellite system (GNSS) and Northrop Grumman LN-200C inertial measurement unit (IMU) designed by Phoenix LiDAR Systems. The sensor can collect a maximum of 1,500,000 points per second at a range of 150 m or a minimum of 50,000 points per second at a range of 640 m. The scanner operated with a pulse refresh rate of 800,000 pulses per second over forested terrain and 200,000 pulses per second over alpine terrain, with a scan rate between 50 and 200 lines per second. We used a Bell 206 helicopter to survey from an elevation of approximately 180–360 m above ground level, at a ground speed of approximately 30 m/s, and with a scan angle set from 80 to 280 degrees. The total survey area covers approximately 40.1 km^2.

Weather Conditions and Flight Times

The survey area was accessed by air from Juneau International Airport and Wrangell Airport (fig. 1). See table 1 for data collection start and end times and weather conditions.

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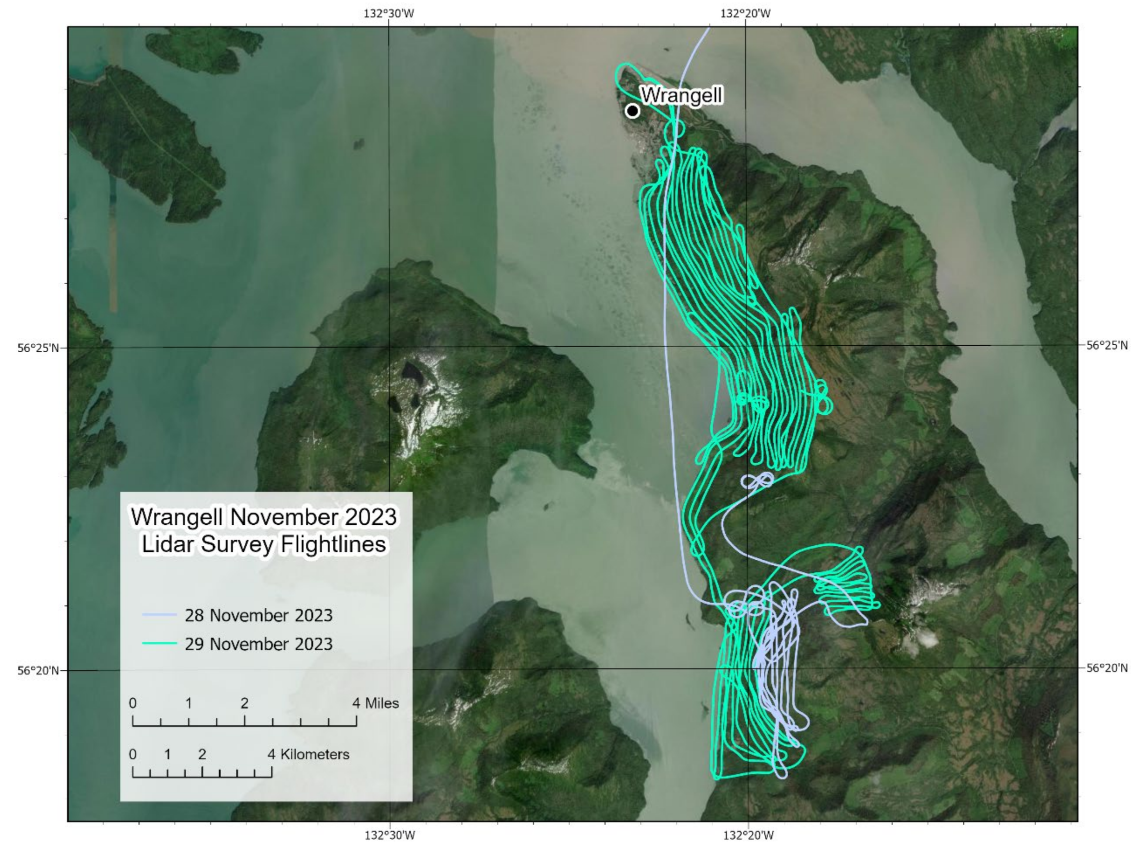

Figure 1. Lidar data collection flightlines.

Table 1. Data collection start and end times and weather conditions for the lidar collection survey.

Date	Start time (AKST)	End time (AKST)	Weather conditions
November 28, 2023	1:00 pm	1:50 pm	Overcast with mid-level clouds
November 29, 2023	8:10 am	10:30 am	Overcast with moderate winds
November 29, 2023	11:00 am	11:10 am	Overcast with high winds

PROCESSING REPORT

Lidar Dataset Processing

We processed point data in Spatial Explorer 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. IMU and GNSS data were processed in Inertial Explorer, and flightline information was integrated with the point cloud in Spatial Explorer. 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 the American Society for Photogrammetry & Remote Sensing (ASPRS) 2019 guidelines (ASPRS, 2019). Once classified, we applied a geometric transformation and converted the points from ellipsoidal heights to GEOID12B (Alaska) orthometric heights.

Raster products were derived from the point cloud in ArcGIS Pro. A 50-cm DSM was interpolated from maximum return values from ground, vegetation, bridge deck, and building classes using a binning method and maximum values. A 50-cm DTM was interpolated from all ground class returns using a binning method and minimum values. We also produced an intensity image for the entire area using average binning in ArcGIS Pro, with no normalization or corrections applied.

Classified Point Cloud

Classified point cloud data are provided in LAZ format. Data are classified following ASPRS 2019 guidelines (table 2) and contain return and intensity information. For all ground points, the average point spacing is 49.0 cm, and the average density is 4.16 pts/m^2 (fig. 2).

Table 2. Point cloud class code definitions.

Class Code	Description
1	Unclassified
2	Ground
3	Low Vegetation, ≥0.0m, <0.5m
4	Medium Vegetation, ≥0.5m, <3m
5	High Vegetation, ≥3m, ≤60m
6	Building
7	Low Noise
17	Bridge Deck
18	High Noise
30	Noise (manually classified)

Digital Surface Model

The DSM represents surface elevations, including heights of vegetation, buildings, powerlines, bridge decks, etc. The DSM is a single-band, 32-bit GeoTIFF file of 50 cm resolution. No Data value is set to -3.40282306074e+38 (32-bit, floating-point minimum).

Digital Terrain Model

The DTM represents bare earth elevations, excluding vegetation, bridge decks, buildings, etc. The DTM is a single-band, 32-bit GeoTIFF file of 50 cm resolution. No Data value is set to -3.40282306074e+38.

Lidar Intensity Image

The lidar intensity image describes the relative amplitude of reflected signals contributing to the point cloud. Lidar intensity is (1) primarily a function of scanned object reflectance in relation to the signal frequency, (2) dependent on ambient conditions, and (3) not necessarily consistent between separate scans. The intensity image is a single-band, 16-bit unsigned GeoTIFF file of 50-cm resolution. No Data value is set to 0.

SURVEY REPORT

Ground Survey Details

Ground control points were collected June 26–30, 2023, by the Alaska Division of Mining, Land and Water (DMLW), supporting an earlier, island-wide lidar survey performed in July of the same year. They deployed a Trimble R12 GNSS receiver to provide a base station occupation and real-time kinematic (RTK) corrections to points they surveyed with a rover Trimble R12i GNSS receiver/TSC5 controller. Benchmark HH-2 (PID BBDX58), located on the Heritage Harbor breakwater in Wrangell, served as the base station location. DMLW collected 257 ground control points and checkpoints to use for calibration and to assess the vertical accuracy of the point cloud, 59 of which overlapped with the November 2023 survey area. Checkpoints were collected in forest, shrubland, grassland, sphagnum bog, bare earth, and paved surfaces.

Coordinate System and Datum

We processed and delivered all data in NAD83 (2011) UTM8N and vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

We measured a mean offset of +62.1 cm between 19 control points and the point cloud (app. 1). This offset was reduced to -0.9 cm in non-vegetated areas (app. 2) and +8.2 cm in vegetated areas (app. 3) by applying a rubber-sheet vertical correction to the lidar point data. We used 40 checkpoints to determine the vertical accuracy of the point cloud ground class using a Triangulated Irregular Network (TIN) approach. The project vertical accuracy has a root mean square error (RMSE) of 5.5 cm in non-vegetated areas (app. 2) and 10.6 cm in vegetated areas (app. 3). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 8.2 cm RMSE.

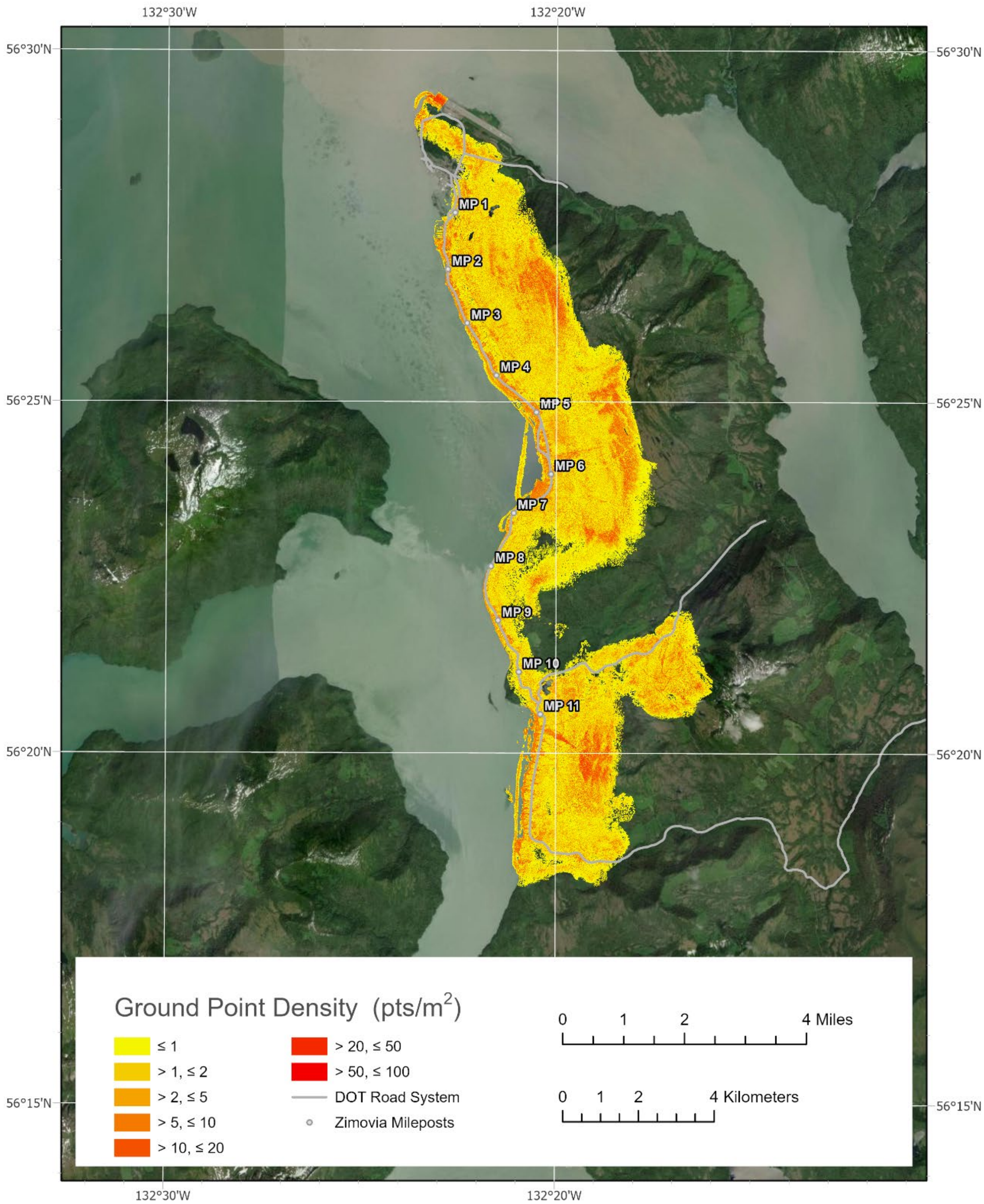

Figure 2. Ground point density for the survey displayed as a 1-meter raster.

Data Consistency and Completeness

This is a full-release dataset. There was no over-collect. Data quality is consistent throughout the survey.

ACKNOWLEDGMENTS

This survey area is on the traditional homelands of the Stikine Tlingit people. This work was funded by the Disaster Relief Fund under the Governor's declared disaster order on November 21, 2023. Funding was made available to DGGS by the Alaska Department of Military and Veterans Affairs' Division of Homeland Security and Emergency Management. We thank Coastal Helicopters for their aviation expertise and contribution to these data products, Joe Delabrue of the U.S. Forest Service for logistical help, and David Ciampa and Amy Helkenn of the Alaska Division of Mining, Land and Water for providing ground control points. 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.

REFERENCES

The American Society for Photogrammetry & Remote Sensing (ASPRS), 2019, LAS Specification 1.4 - R15. https://www.asprs.org/wp-content/uploads/2019/07/LAS_1_4_r15.pdf

Zechmann, J.M., Wikstrom Jones, K.M., and Wolken, G.J., 2023, Lidar derived elevation data for Wrangell Island, Southeast Alaska, collected July 2023: Alaska Division of Geological & Geophysical Surveys Raw Data File 2023-28, 14p. https://doi.org/10.14509/31098

APPENDIX 1: GROUND CONTROL POINTS

GCP	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Dz (m)
1	661190.532	6259765.520	6.434	6.899	0.465
2	664332.874	6247664.636	32.768	33.509	0.741
3	662822.893	6250829.371	8.649	9.293	0.644
4	664416.102	6253386.508	15.501	16.133	0.632
5	663609.366	6255696.322	6.591	6.953	0.362
6	661661.855	6258454.968	7.872	8.255	0.383
8	662475.216	6261963.199	23.650	24.130	0.480
16	667665.815	6248020.426	469.791	470.669	0.878
21	664772.463	6243871.224	40.469	41.413	0.944
***1**	661175.208	6259760.100	6.281	6.759	0.478
***9**	661167.455	6259713.129	4.129	4.600	0.471
***13**	664416.478	6247829.805	45.561	46.190	0.629
***17**	662807.692	6250848.927	3.826	4.589	0.763
***21**	663583.244	6255606.885	7.120	7.414	0.294
***33**	661175.206	6259760.092	6.267	6.758	0.491
***43**	667934.323	6250146.822	70.997	71.579	0.582
***50**	664785.334	6243866.375	41.161	42.129	0.968
***51**	664802.357	6243886.354	40.949	41.891	0.942
***52**	664416.486	6247829.807	45.539	46.188	0.649
Average dz (m)	0.621				
Minimum dz (m)	0.294				
Maximum dz (m)	0.968				
Average magnitude error (m)	0.621				
Root mean square error (m)	0.653				
Standard deviation	0.206				

*Non-vegetated checkpoints from the Wrangell Island July 2023 survey were repurposed as GCPs. GCP and checkpoint numbers are from Wrangell Island July 2023 survey RDF 2023-28 appendices 1-3 (https://doi.org/10.14509/31098).

APPENDIX 2: NONVEGETATED CHECK POINTS

Check Point	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Pointcloud Z (m)	Dz (m)
2	664420.405	6247819.743	45.273	45.212	-0.061
3	664416.482	6247829.808	45.556	45.473	-0.083
8	661175.216	6259760.100	6.276	6.291	0.015
10	661144.506	6259801.022	5.564	5.592	0.028
11	661134.744	6259835.947	2.681	2.753	0.072
12	664420.39	6247819.736	45.281	45.210	-0.071
14	664344.257	6247675.496	34.129	34.127	-0.002
15	664292.853	6247665.676	30.964	31.026	0.062
16	662835.592	6250884.603	8.720	8.710	-0.010
18	664412.276	6253401.05	14.869	14.902	0.033
19	664436.244	6253416.538	15.871	15.895	0.024
20	663586.549	6255632.696	7.545	7.546	0.001
22	661668.493	6258460.207	8.506	8.507	0.001
23	661607.287	6258478.990	2.703	2.708	0.005
25	662472.957	6261957.106	23.530	23.511	-0.019
34	664416.479	6247829.795	45.557	45.472	-0.085
39	664416.486	6247829.801	45.557	45.471	-0.086
40	664416.490	6247829.812	45.558	45.472	-0.086
45	667637.360	6248034.404	467.415	467.502	0.087
Average dz (m)	-0.009				
Minimum dz (m)	-0.086				
Maximum dz (m)	0.087				
Average magnitude error (m)	0.044				
Root mean square error (m)	0.055				
Standard deviation (m)	0.056				

APPENDIX 3: VEGETATED CHECK POINTS

Check Point	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Pointcloud Z (m)	Dz (m)
78	661188.843	6259745.231	5.008	5.107	0.099
79	661163.712	6259737.654	4.853	5.016	0.163
80	661229.031	6259732.045	6.101	6.125	0.024
81	664352.603	6247692.345	34.429	34.565	0.136
82	662822.302	6250873.882	6.582	6.69	0.108
84	664414.593	6253407.873	14.504	14.654	0.15
85	664435.208	6253398.2	15.985	16.17	0.185
86	664409.924	6253376.571	15.289	15.372	0.083
88	663596.42	6255676.882	7.020	7.155	0.135
89	663595.073	6255692.526	7.048	7.093	0.045
90	663604.848	6255691.94	6.455	6.46	0.005
91	663585.595	6255590.48	6.728	6.773	0.045
92	661672.989	6258464.789	7.492	7.729	0.237
93	661609.035	6258499.075	4.084	4.125	0.041
95	662449.873	6261956.781	22.616	22.59	-0.026
96	662460.247	6261952.096	21.964	22.077	0.113
97	662468.880	6261942.576	22.189	22.194	0.005
135	667935.278	6250169.121	70.516	70.591	0.075
136	667942.531	6250159.169	70.855	70.895	0.04
156	664787.500	6243872.030	40.720	40.704	-0.016
157	664810.891	6243888.221	40.399	40.471	0.072
Average dz (m)	0.082				
Minimum dz (m)	-0.026				
Maximum dz (m)	0.237				
Average magnitude error (m)	0.086				
Root mean square error (m)	0.106				
Standard deviation (m)	0.069				