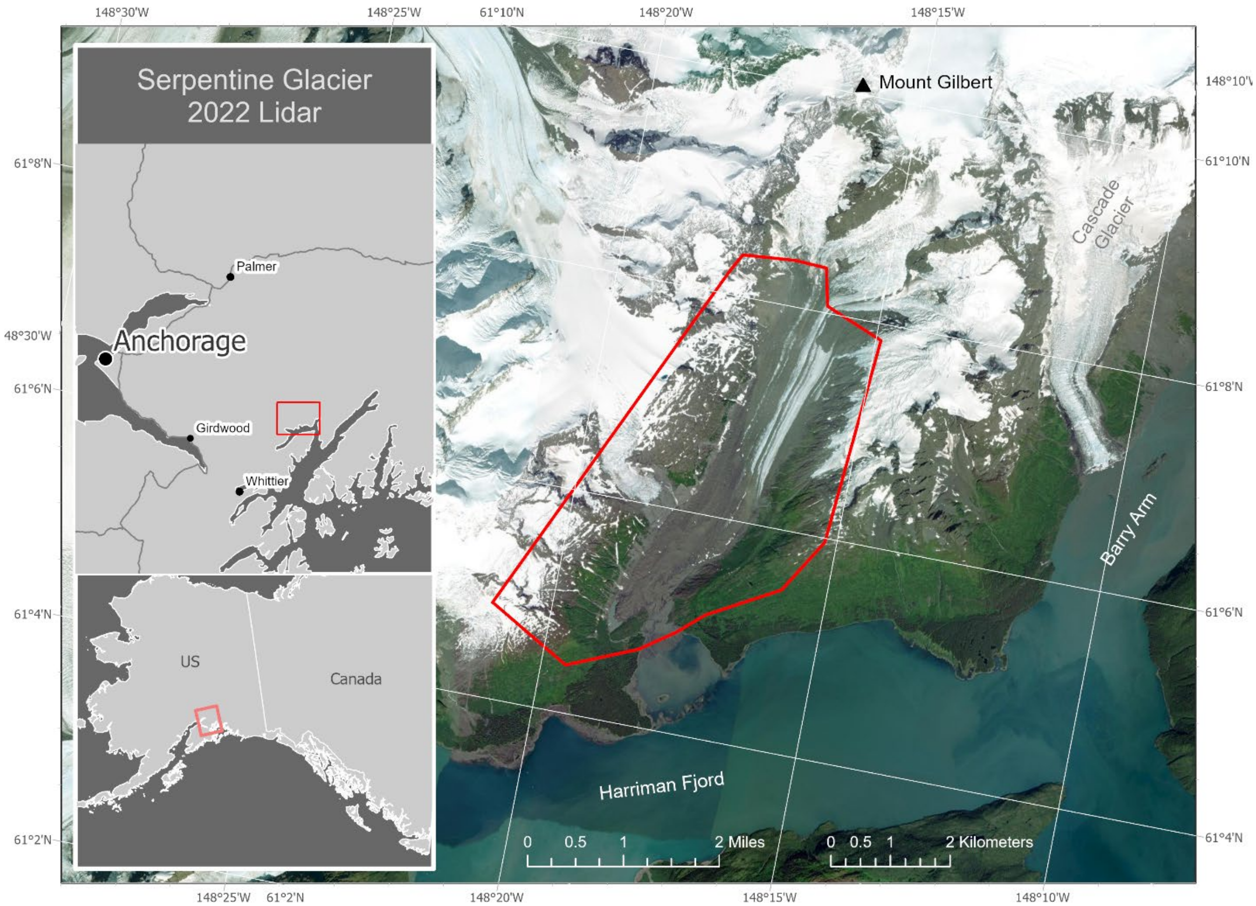
LIDAR-DERIVED ELEVATION DATA FOR LOWER SERPENTINE GLACIER AND ADJACENT SLOPES, SOUTHCENTRAL ALASKA, COLLECTED OCTOBER 14, 2022

Katreen Wikstrom Jones, Gabriel J. Wolken, and Ronald P. Daanen

Raw Data File 2023-14



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 LOWER SERPENTINE GLACIER AND ADJACENT SLOPES, SOUTHCENTRAL ALASKA, COLLECTED OCTOBER 14, 2022

Katreen Wikstrom Jones[1], Gabriel J. Wolken[1], and Ronald P. Daanen[1]

INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a classified point cloud, a digital terrain model (DTM), and an intensity model of the unstable slope at Serpentine Glacier, located in Prince William Sound in Southcentral Alaska. Aerial and ground control data were collected on October 14, 2022, and subsequently processed using a suite of geospatial processing software. These data support a paraglacial rock slope destabilization study at Serpentine Glacier 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 can be downloaded free of charge from the DGGS website: https://doi.org/10.14509/31012.

LIST OF DELIVERABLES

Classified Points

DTM

Intensity Image

Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS operates a Riegl VUX1-LR laser scanner integrated with a global navigation satellite system (GNSS) and Northrop Grumman LN-200C inertial measurement unit (IMU). Phoenix LiDAR Systems designed the lidar integration system. The sensor is capable of collecting up to 820,000 points per second at a range of up to 150 m. The scanner operated with a pulse repetition rate of 100,000–400,000 pulses per second at a scan rate between 80 and 160 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 ~24 km^2 (fig. 1).

Weather Conditions and Flight Times

We flew the aerial survey on October 14, 2022, and covered three separate survey areas (Twentymile River, Barry Arm landslide, and Serpentine Glacier) between take-off and landing. The crew departed the Girdwood Airport at approximately 9:30 am and flew the Serpentine Glacier portion from 11:45 am to 12:45 pm. The Serpentine Glacier area was covered from the delta at sea level up to approximately 1200 m above sea level on each side of the valley, paying special attention to the east-facing slope (fig. 1). The return flight landed back at Girdwood Airport at approximately 1 pm. The weather throughout the survey was overcast with a high ceiling.

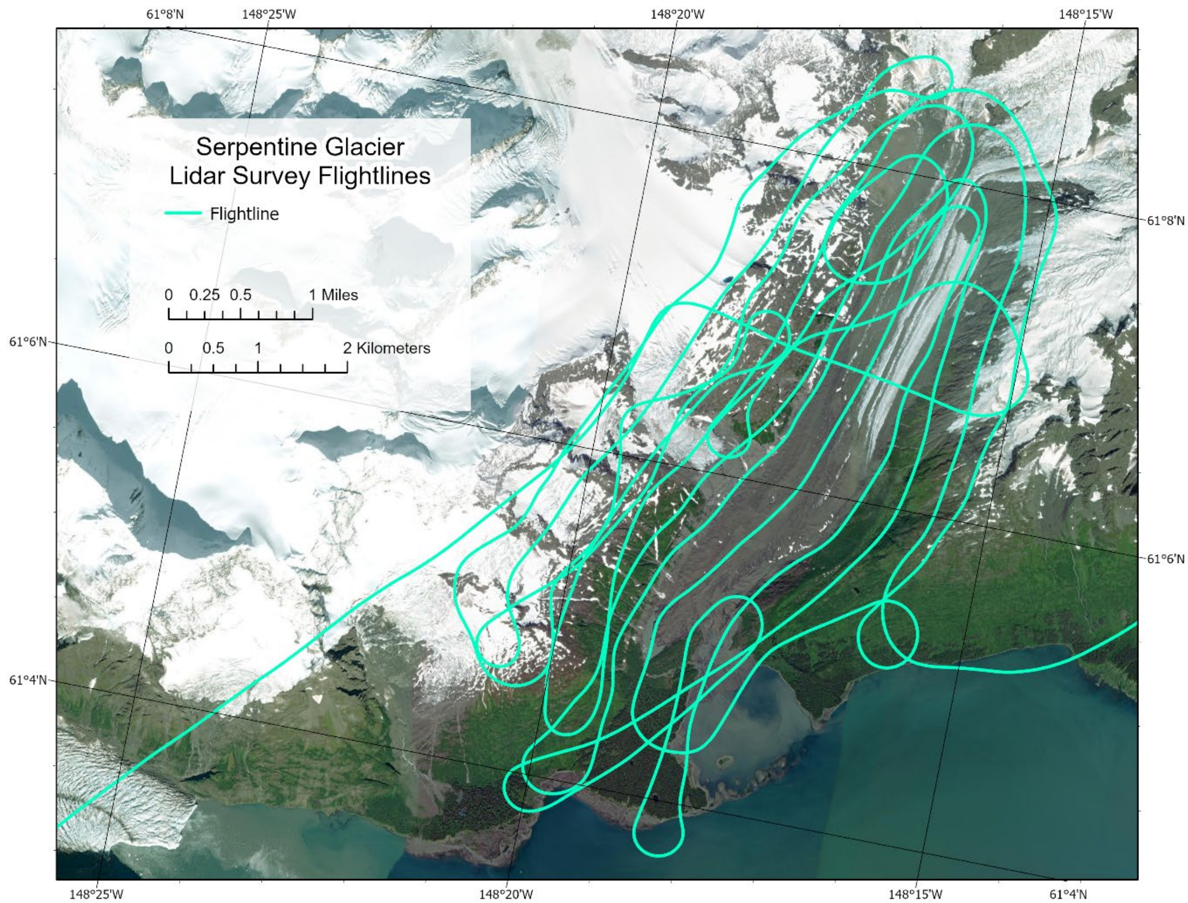

Figure 1. Project flightlines.

PROCESSING REPORT

Lidar Dataset Processing

Point data were processed in SDCimport software for initial filtering and multiple-time-around (MTA) disambiguation. MTA errors, corrected in this process, are the result of ambiguous interpretations of received pulse time intervals and occur more frequently with higher pulse refresh rates. Inertial Measurement Unit (IMU) and Global Navigation Satellite System (GNSS) data were processed in Inertial Explorer, and Spatial Explorer software was used 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 the American Society for Photogrammetry and Remote Sensing (ASPRS) 2019 guidelines (table 1). Once classified, a geometric transformation was applied, and the points were converted from ellipsoidal heights to GEOID12B (Alaska) orthometric heights.

ArcGIS Pro was used to derive raster products from the point cloud. The 0.20-meter DTM was interpolated from all ground class returns using a triangulated-irregular network (TIN) method and minimum values. In ArcGIS Pro, we produced a 0.5-meter intensity image by binning and averaging ground and unclassified points, which include vegetation points.

Classified Point Cloud

Classified point cloud data are provided in compressed LAZ format. This dataset only includes ground points and unclassified points; low and high noise points are excluded. Potential vegetation points remain within the unclassified points class. The average nominal pulse spacing is 3.8 cm, and the average nominal point density is 7.9 pts/m^2. The average nominal point density for ground points is 5.4 pts/m^2 (fig. 2).

Table 1. Point cloud class code definitions.

Class Code	Description
1	Unclassified
2	Ground

Digital Terrain Models

The DTM represents bare earth elevations, excluding vegetation, bridges, buildings, etc. The DTM is a single-band, 32-bit float GeoTIFF file of 0.20-meter resolution. No Data value is set to -3.40282306074e+38 (32-bit, floating-point minimum).

Lidar Intensity Image

The lidar intensity image describes the relative amplitude of reflected signals contributing to the point cloud. Lidar intensity is largely 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 0.5-meter resolution. No Data value is set to -3.40282306074e+38.

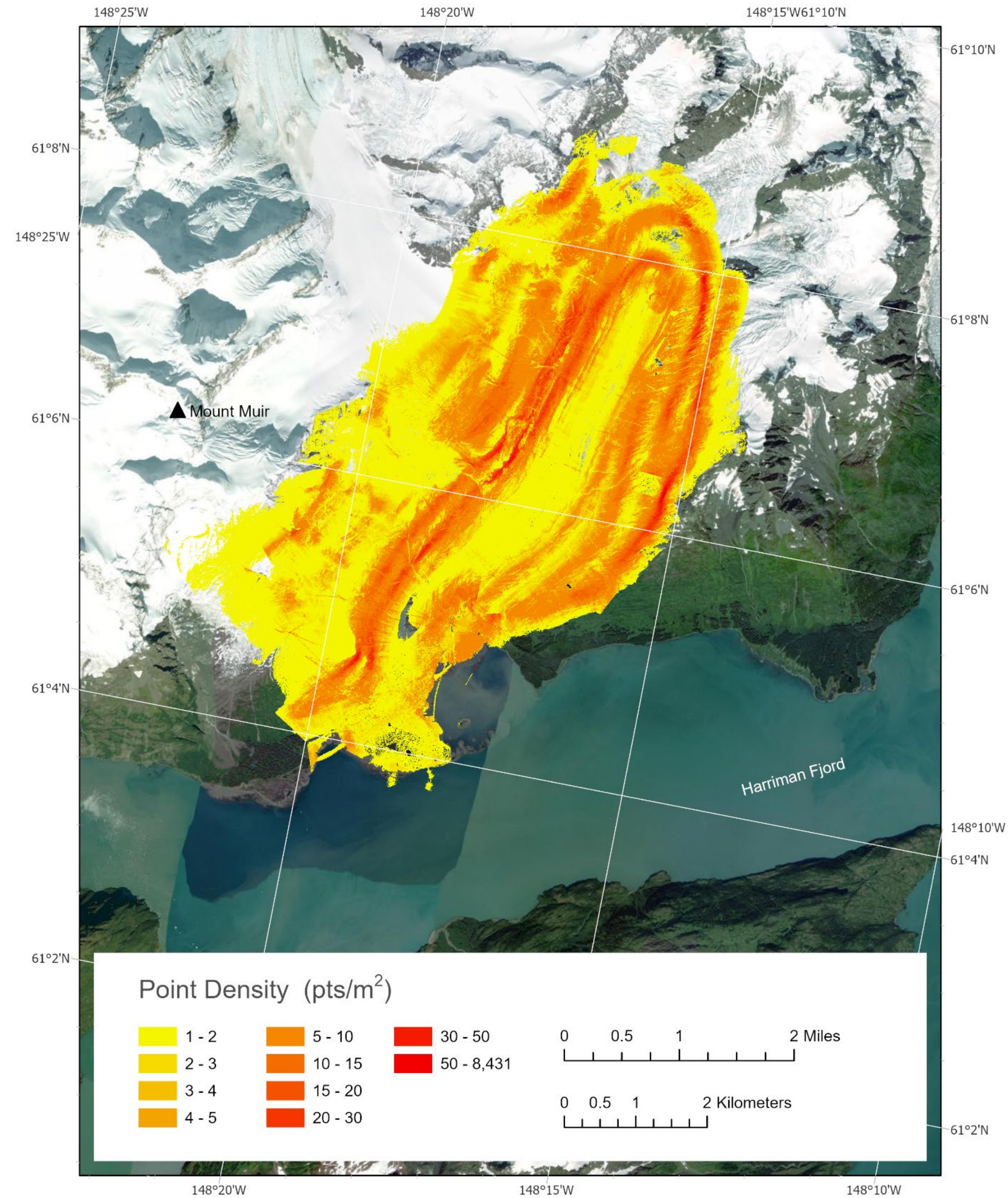

Figure 2. Ground point density for the survey displayed as a 1-meter raster.

SURVEY REPORT

Ground Survey Details

We collected ground control and checkpoints on October 14, 2022. A Trimble R10-2 GNSS receiver with an internal antenna was deployed at a temporary benchmark on the Serpentine Glacier fan delta (61° 5' 2.9796" N; 148° 18' 6.44" W). Real-time kinematic (RTK) corrections from the base station were applied to points surveyed with a rover Trimble R10-2 GNSS receiver (internal antenna). Forty-six ground control and checkpoints were used 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) UTM6N and vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

We measured a mean vertical offset of 44.1 cm between 36 control points and the point cloud (appendix 1). Ten checkpoints were used to determine the non-vegetated vertical accuracy (NVA) of the point cloud ground class using a TIN-based approach. A final accuracy of -0.2 cm was achieved by performing a vertical transformation of the lidar point data. Project NVA was calculated to have a root mean square error (RMSE) of 3.5 cm (appendix 2). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 0.9 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.

ACKNOWLEDGMENTS

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APPENDIX 1: GROUND CONTROL POINTS

GCP	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	dZ[1] (m)
1	429775.06	6772849.293	5.47	6	0.53
2	429774.753	6772834.531	5.1	5.67	0.57
3	429768.085	6772833.841	4.923	5.36	0.437
4	429769.309	6772871.082	5.71	6.14	0.43
5	429771.663	6772878.276	5.839	6.29	0.451
6	429779.324	6772883.328	5.762	6.15	0.388
7	429791.358	6772898.333	5.833	6.33	0.497
8	429906.643	6772929.27	6.658	7.09	0.432
9	429927.341	6772942.168	7.929	8.39	0.461
10	429934.798	6772946.554	8.004	8.46	0.456
11	429942.241	6772947.64	8.084	8.55	0.466
12	429963.172	6772928.757	8.294	8.68	0.386
13	429966.916	6772909.507	7.999	8.39	0.391
14	429969.211	6772881.968	7.546	7.98	0.434
15	429975.183	6772883.869	7.439	7.83	0.391
16	429976.59	6772849.277	6.996	7.37	0.374
17	429975.136	6772843.779	7.025	7.48	0.455
18	429985.245	6772838.333	6.944	7.41	0.466
19	429988.994	6772821.607	6.896	7.33	0.434
20	429976.949	6772795.108	6.388	6.84	0.452
21	429970.886	6772776.334	6.247	6.63	0.383
22	429961.968	6772753.419	5.808	6.18	0.372
23	429973.307	6772742.111	5.795	6.26	0.465
24	429958.804	6772710.441	5.171	5.57	0.399
25	429945.307	6772701.172	5.038	5.44	0.402
26	429917.179	6772684.966	4.579	4.94	0.361
27	429879.539	6772691.026	4.093	4.51	0.417
28	429848.787	6772699.31	3.708	4.13	0.422
29	429833.463	6772702.296	3.897	4.31	0.413
30	429822.328	6772751.214	4.362	4.93	0.568
31	429819.616	6772769.365	4.854	5.28	0.426
32	429791.049	6772823.081	4.744	5.28	0.536
33	429808.063	6772843.066	5.71	6.22	0.51
34	429824.574	6772854.839	5.752	6.16	0.408
35	429831.314	6772866.001	5.977	6.38	0.403
36	429843.468	6772918.137	5.948	6.43	0.482
Average dZ (m)	0.441				

GCP	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	dZ[1] (m)
Minimum dZ (m)	0.361				
Maximum dZ (m)	0.57				
Average magnitude error (m)	0.441				
Root mean square error (m)	0.444				
Standard deviation (m)	0.053		[1]dZ is the difference (Laser Z – Known Z)		

APPENDIX 2: CHECKPOINTS

Checkpoint	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	dZ[1](m)
1	429782.389	6772858.711	5.536	5.52	-0.016
2	429766.089	6772828.702	4.982	4.97	-0.012
3	429863.598	6772914.799	6.314	6.32	0.006
4	429963.601	6772933.377	8.261	8.27	0.009
5	429971.384	6772864.732	7.305	7.27	-0.035
6	429981.235	6772808.945	6.635	6.62	-0.015
7	429976.932	6772725.679	5.505	5.54	0.035
8	429855.278	6772701.638	3.749	3.71	-0.039
9	429790.506	6772799.795	4.97	5.05	0.08
10	429842.061	6772889.995	6.405	6.37	-0.035
Average dZ (m)	-0.002				
Minimum dZ (m)	-0.039				
Maximum dZ (m)	0.08				
Average magnitude error (m)	0.028				
Root mean square error (m)	0.035				
Standard deviation (m)	0.037		[1]dZ is the difference (Laser Z – Known Z)		