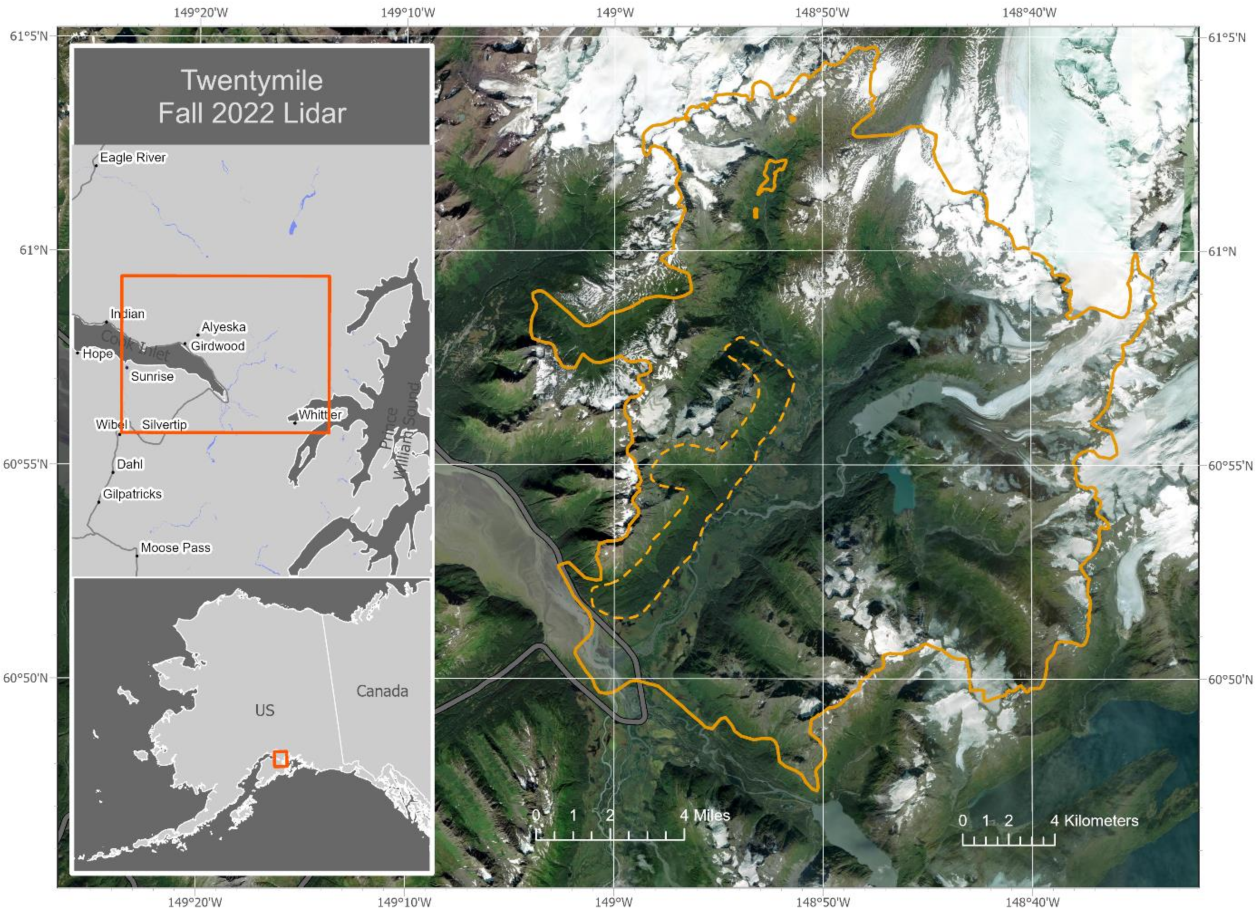
LIDAR-DERIVED ELEVATION DATA FOR THE TWENTYMILE RIVER WATERSHED, SOUTHCENTRAL ALASKA, COLLECTED AUGUST-OCTOBER 2022

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

Raw Data File 2023-3



Location map of survey area.

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

STATE OF ALASKA
Mike Dunleavy, Governor

DEPARTMENT OF NATURAL RESOURCES
John Boyle, Commissioner

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
David LePain, State Geologist & Director

Publications produced by the Division of Geological & Geophysical Surveys are available to download from the DGGS website (dggs.alaska.gov). Publications on hard-copy or digital media can be examined or purchased in the Fairbanks office:

Alaska Division of Geological & Geophysical Surveys (DGGS)
3354 College Road | Fairbanks, Alaska 99709-3707
Phone: 907.451.5010 | Fax 907.451.5050
dggspubs@alaska.gov | dggs.alaska.gov

DGGS publications are also available at:

Alaska State Library, Historical
Collections & Talking Book Center
395 Whittier Street
Juneau, Alaska 99801

Alaska Resource Library and
Information Services (ARLIS)
3150 C Street, Suite 100
Anchorage, Alaska 99503

Suggested citation:
Zechmann, J.M., Wikstrom Jones, Katreen, and Wolken, G.J., 2023, Lidar-derived elevation data for the Twentymile River watershed, Southcentral Alaska, collected August-October 2022: Alaska Division of Geological & Geophysical Surveys Raw Data File 2023-3, 8 p.
https://doi.org/10.14509/30959

LIDAR-DERIVED ELEVATION DATA FOR THE TWENTYMILE RIVER WATERSHED, SOUTHCENTRAL ALASKA, COLLECTED AUGUST-OCTOBER 2022

Jenna M. Zechmann,[1] Katreen Wikstrom Jones,[1] 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 model (DTM), and intensity model of the Twentymile River watershed, Southcentral Alaska, during snow-free ground conditions from August to October 2022. The survey provides snow-free surface elevations for trail planning and assessing avalanche hazards, among other objectives. Ground control data were collected on August 31, 2022, and aerial lidar data were collected on multiple days from August 29 to October 14, 2022, and subsequently processed in 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/10.14509/30959.

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) 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 200,000–400,000 pulses per second over forested terrain, and 50,000–100,000 pulses per second over alpine terrain, with a scan rate between 80 and 220 lines per second. We used a Cessna 180 fixed-wing aircraft to survey from an elevation of approximately 60–600 m above ground level, at a ground speed of approximately 40 m/s, and with a scan angle set from 80 to 280 degrees. The total survey area covers approximately 488 km^2 (fig. 1).

Weather Conditions and Flight Times

The survey area was accessed by air from the Girdwood-Alyeska and Merrill Field airports in Girdwood and Anchorage. See table 1 for departure and return times and weather conditions.

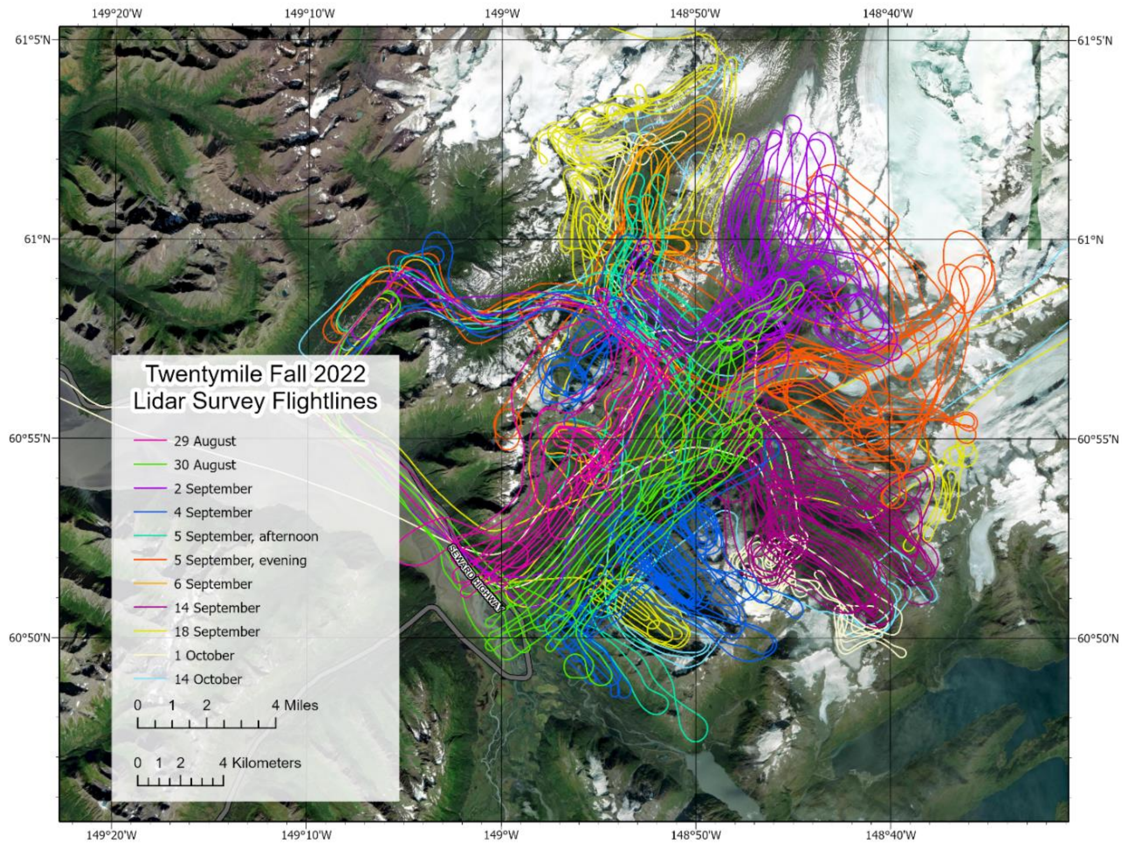


Figure 1. Project flightlines.

Table 1. Departure times, return times, and weather conditions for the lidar collection survey.

Date	Departure time (AKST)	Return time (AKST)	Weather conditions
29 August	3:30 pm	6:00 pm	Clear, no wind
30 August	10:00 am	11:30 am	Partly cloudy
30 August	12:00 pm	1:00 pm	Partly cloudy
2 September	12:30 pm	3:00 pm	Partly cloudy, no wind
2 September	3:30 pm	5:00 pm	Partly cloudy, no wind
4 September	10:30 am	1:30 pm	Partly cloudy
4 September	2:00 pm	2:30 pm	Partly cloudy
5 September	4:30 pm	6:30 pm	Partly cloudy
6 September	9:30 am	12:30 pm	Partly cloudy
6 September	1:00 pm	2:00 pm	Partly cloudy
6 September	4:30 pm	6:00 pm	Partly cloudy
14 September	11:00 am	3:00 pm	Partly cloudy
18 September	10:00 am	2:00 pm	Partly cloudy
18 September	3:00 pm	4:30 pm	Partly cloudy
1 October	12:30 pm	2:30 pm	Partly cloudy
14 October	9:30 am	1:00 pm	Partly cloudy

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 per 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.

We used ArcGIS Pro to derive raster products from the point cloud. A 50 cm DSM was interpolated from maximum return values from the ground, vegetation, bridge deck, and building classes using a binning method. A 50 cm DTM was interpolated from all ground class returns using a binning method and minimum values. An additional 20 cm DTM was produced for the area within the dashed line (cover figure), using a triangulation interpolation. We produced an intensity image using average binning in ArcGIS Pro.

Classified Point Cloud

Classified point cloud data are provided in LAS format. Data are classified in accordance with ASPRS 2019 guidelines (table 2) and contain return and intensity information. The average pulse spacing for non-noise returns is 26.9 cm and the average pulse density is 13.8 pts/m^2. For ground points, the average point spacing is 59.6 cm and the average density is 2.82 pts/m^2. Within the dashed line (cover image), the average pulse spacing and density is 20.7 cm and 23.24 pts/m^2, respectively, and the average ground point spacing and density is 64.4 cm and 2.41 pts/m^2.

Table 2. Point cloud class code definitions.

Class Code	Description
1	Unclassified
2	Ground
3	Low Vegetation, ≥0.05m, <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, etc. The DSM is a single-band, 32-bit GeoTIFF file of 50-centimeter resolution. No Data value is set to -9999.

Digital Terrain Model

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 50-centimeter ('DTM') or 20-cm ('DTM-detail') resolution. The higher-resolution DTM file covers an area identified as a scientific priority. No Data value is set to -9999.

Lidar Intensity Image

The lidar intensity image describes 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, 16-bit unsigned GeoTIFF file of 0.5-meter resolution. No Data value is set to -9999.

SURVEY REPORT

Ground Survey Details

The Alaska Division of Mining, Land, and Water (DMLW) collected ground control points on August 31, 2022. They deployed a Trimble R12 GNSS receiver at an unnamed survey marker (0.5 in steel rod in a 4 in pipe casing) offset from the south side of the Alaska Railroad Portage Depot parking lot. It provided a two-hour base station occupation and real-time kinematic (RTK) corrections to points they surveyed with a rover Trimble R12i GNSS receiver (internal antenna). DMLW collected 24 ground control points and check points to use for calibration and to assess the vertical accuracy of the point cloud. Most points were collected on bare earth or paved surfaces. However, ground control points 9, 17, 18, and 24 (appendix 1) were collected in forest and shrubland.

Coordinate System and Datum

We processed and delivered all data in NAD83 (2011) UTM6N and vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

We did not measure horizontal accuracy for this collection.

Vertical Accuracy

We measured a mean offset of -0.0048 m between 24 control points and the point cloud (appendix 1). Because of trivial offset, we did not perform any vertical transformation of the lidar point data. The non-vegetated vertical accuracy (NVA) of the point cloud ground class was found using a Triangulated Irregular Network approach. We calculated the project NVA to have a root mean square error (RMSE) of 6.7 cm (appendix 1). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 8.4 cm RMSE.

Data Consistency and Completeness

This is a full-release dataset. Data quality is consistent throughout the survey, save for a gap in coverage in a deep valley in the northwest part of the survey area, and over some glaciated areas where there were few returns due to ground cover conditions.

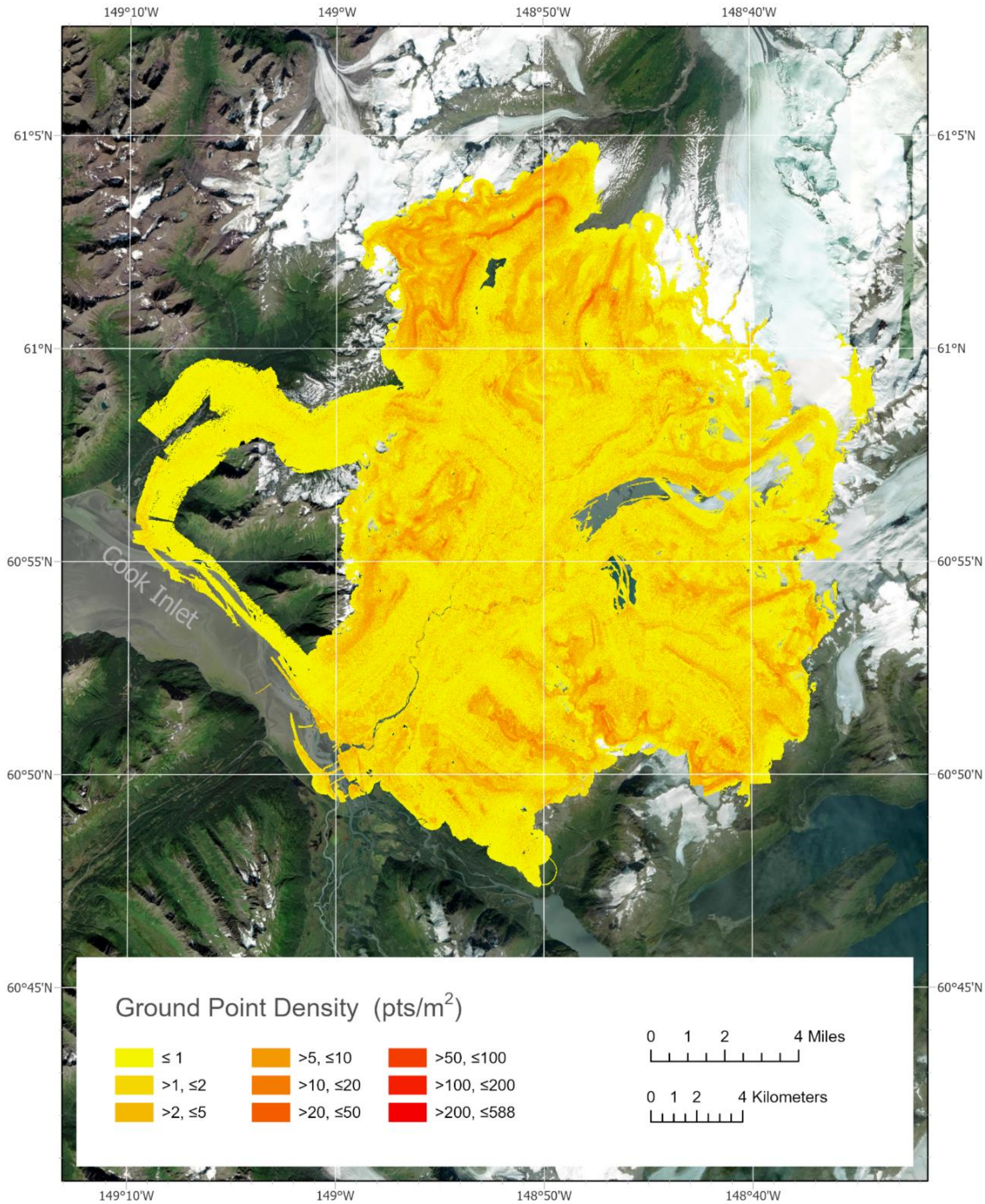


Figure 2. Ground point density for the survey displayed as a 1-meter raster.

ACKNOWLEDGMENTS

The area of this survey is the traditional homelands of the Dena'ina people. We partnered with U.S. Forest Service to cost-share the acquisition of lidar data in an area of mutual interest. We thank Clearwater Air for their aviation expertise and contribution to these data products and the Alaska Division of Mining, Land, and Water for collecting 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, 2019, LAS Specification 1.4 - R15. https://www.asprs.org/wp-content/uploads/2019/07/LAS_1_4_r15.pdf

APPENDIX 1: GROUND CONTROL POINTS

GCP	Easting (m)	Northing (m)	Checkpoint Z (m)	Pointcloud Z (m)	Dz (m)
1	392363.266	6745992.880	8.489	8.502	0.013
2	392325.435	6746298.809	8.781	8.703	-0.078
3	390997.380	6748151.674	10.190	10.201	0.011
4	390985.213	6748164.693	10.188	10.209	0.021
5	390972.858	6748179.138	10.146	10.168	0.022
6	390958.337	6748195.232	10.136	10.164	0.028
7	390937.987	6748195.630	10.226	10.258	0.032
8	391002.566	6748113.846	8.139	8.251	0.112
9	390998.457	6748082.675	8.185	8.298	0.113
10	392122.221	6747011.294	10.420	10.403	-0.017
11	392127.650	6746995.238	10.238	10.233	-0.005
12	392137.892	6746971.209	10.024	9.985	-0.039
13	392150.395	6746941.698	10.030	9.989	-0.041
14	392164.006	6746898.601	8.882	8.876	-0.006
15	392167.339	6746884.215	8.661	8.667	0.006
16	392172.330	6746871.142	8.794	8.784	-0.010
17	392178.449	6746944.065	7.112	7.204	0.092
18	392145.433	6746997.422	6.837	6.963	0.126
19	392366.086	6746008.366	8.701	8.652	-0.049
20	392321.552	6746192.357	9.984	9.898	-0.086
21	392317.013	6746197.400	10.128	10.048	-0.080
22	392314.865	6746212.062	10.134	10.054	-0.080

GCP	Easting (m)	Northing (m)	Checkpoint Z (m)	Pointcloud Z (m)	Dz (m)
23	392311.677	6746234.367	10.127	10.047	-0.080
24	392333.985	6746207.715	8.788	8.667	-0.121
Average dz (m)	-0.0048				
Minimum dz (m)	-0.121				
Maximum dz (m)	0.126				
Average magnitude error (m)	0.0528				
Root mean square error (m)	0.0665				
Standard deviation	0.0677				