Lidar-derived snow surface elevation data for upper Barry Arm, Southcentral Alaska, collected April 24, 2024

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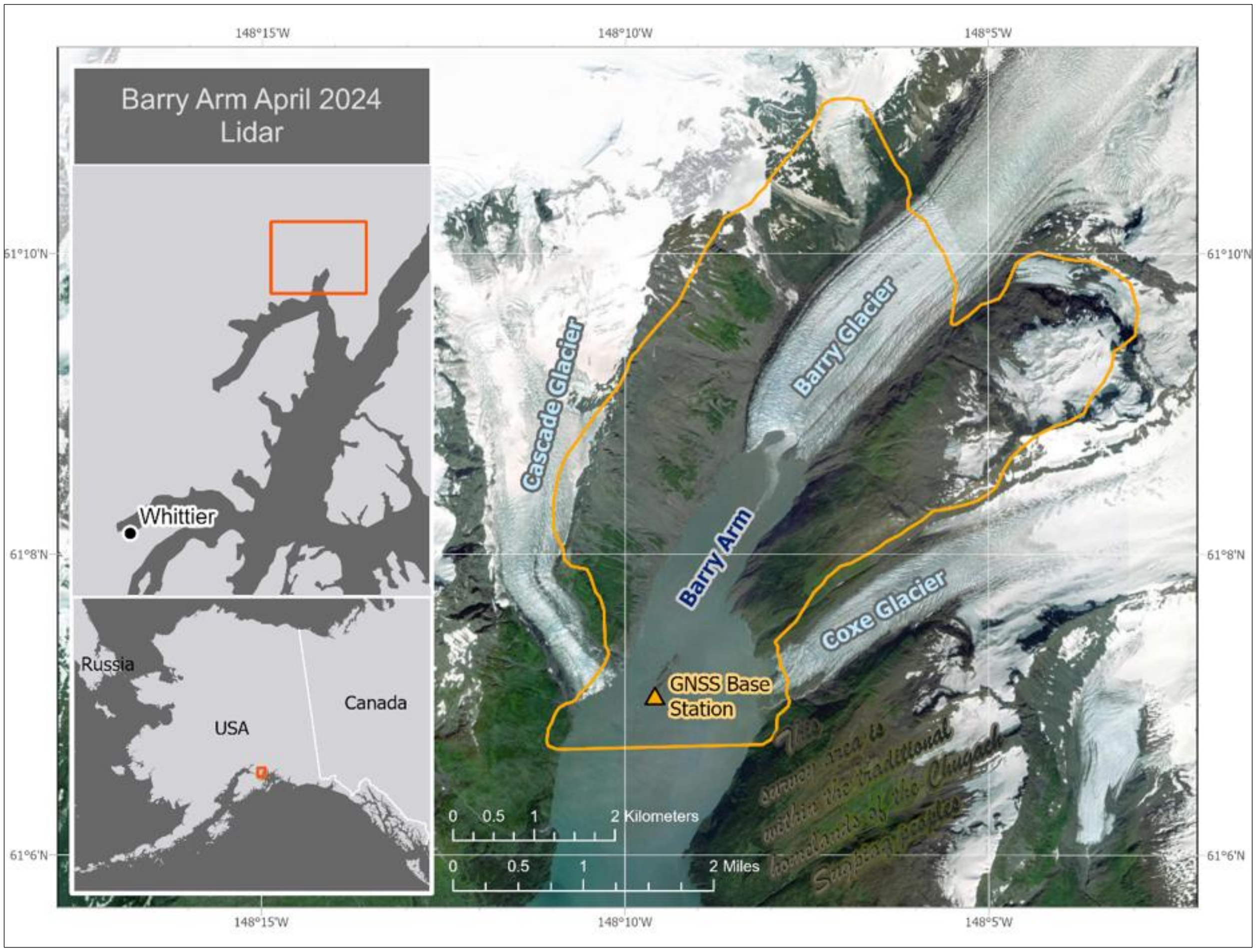
Raw Data File 2026-18



Location map of the survey area.

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Lidar-derived snow surface elevation data for upper Barry Arm, Southcentral Alaska, collected April 24, 2024

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a classified point cloud, a digital surface model (DSM), a digital terrain model (DTM), and an intensity model of Barry Arm, Southcentral Alaska, during near-peak snow height conditions (see cover figure). The survey provides snow surface elevations for use in snowpack studies. Ground control data collected May 5, 2023, and aerial lidar data were collected April 24, 2024. Data were subsequently merged and processed using a suite of geospatial processing software. All files are available to download on the DGGS website at https://doi.org/10.14509/31521.

DATA PRODUCTS

- Classified Points
- DSM and DTM
- Intensity Image
- Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS used a Riegl VUX1-LR22 laser scanner with a global navigation satellite system (GNSS) and a Northrop Grumman LN-200C inertial measurement unit (IMU) integrated by Phoenix LiDAR Systems. The sensor can collect up to 1,500,000 points per second at a range of 230 m, or a minimum of 50,000 points per second at 1,000 m (ranges assume ≥ 20 percent natural reflectance). The scanner operated with a pulse refresh rate of 200,000 pulses per second at a scan rate of 80 revolutions per second. We used a Cessna 180 Skywagon fixed-wing platform to survey from an elevation of approximately 200–370 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 29.0 km^2 (cover figure).

Weather Conditions and Collection Times

The survey area was accessed by air (fig. 1) from Merrill Field Airport in Anchorage. Data were collected from 11:40 am to 12:40 pm (AKST). The weather throughout the survey was clear with no wind.

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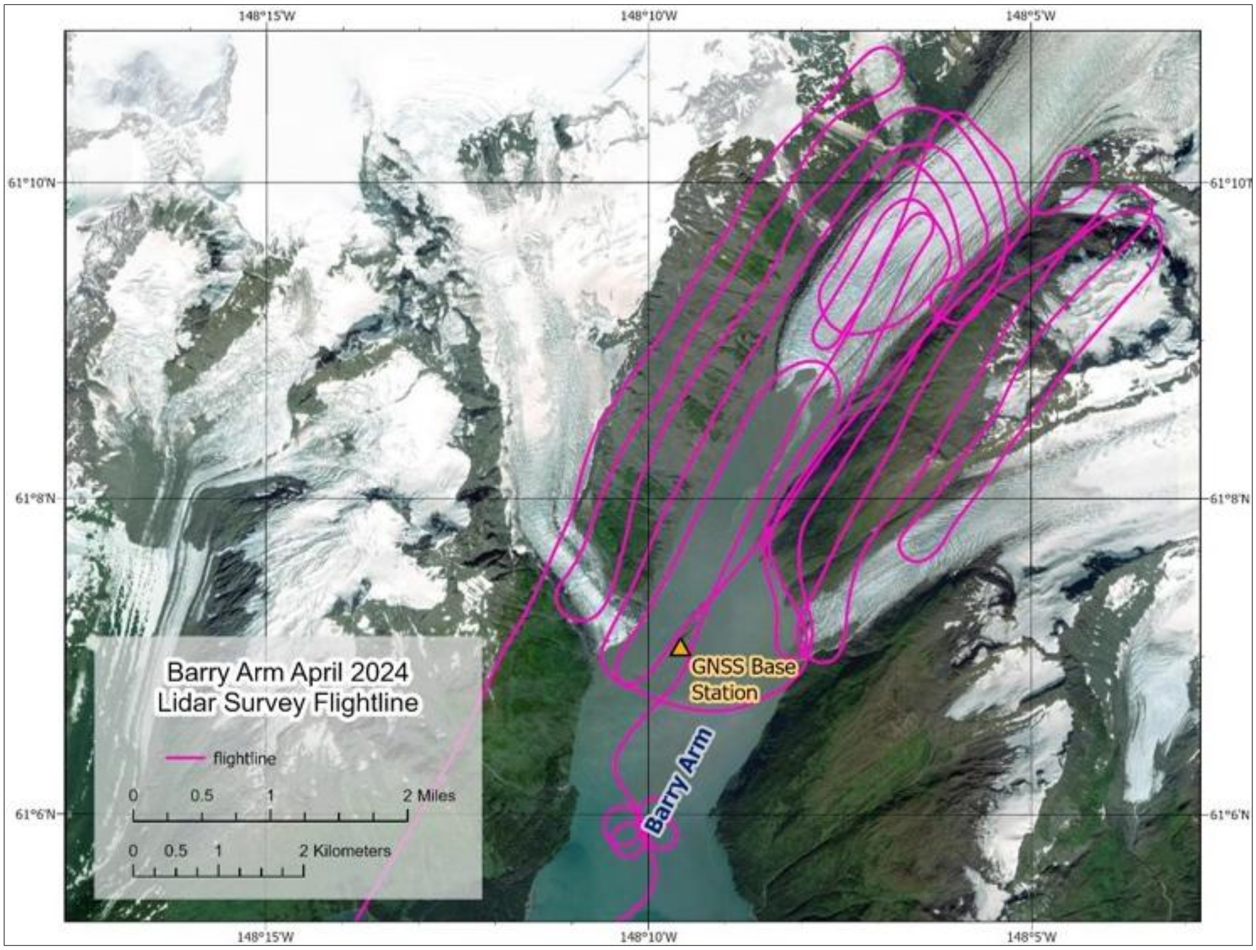

Figure 1. Lidar data collection flight lines

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. For lidar data collection, the average pulse density is 3.4 pulses/m^2, and the average pulse spacing is 54.0 cm.

We created a macro (an ordered list of point classification commands tailored to this dataset) in Terrasolid software and classified points according to the American Society for Photogrammetry & Remote Sensing (ASPRS) 2025 guidelines (ASPRS, 2025). 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 ground and vegetation 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 a 50-cm intensity image 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 2025 guidelines (table 1) and contain return and intensity information. For classified ground points, the average point density (fig. 2) is 3.2 pts/m^2, and the average spacing is 55.9 cm.

Table 1. 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, ≤40m
7	Low Noise
18	High Noise
30	Noise (manually classified)

Digital Surface Model

The DSM represents surface elevations, including vegetation heights. 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 or snow-surface elevations, excluding vegetation. 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, 32-bit GeoTIFF file of 50-cm resolution. No Data value is set to -3.40282306074e+38.

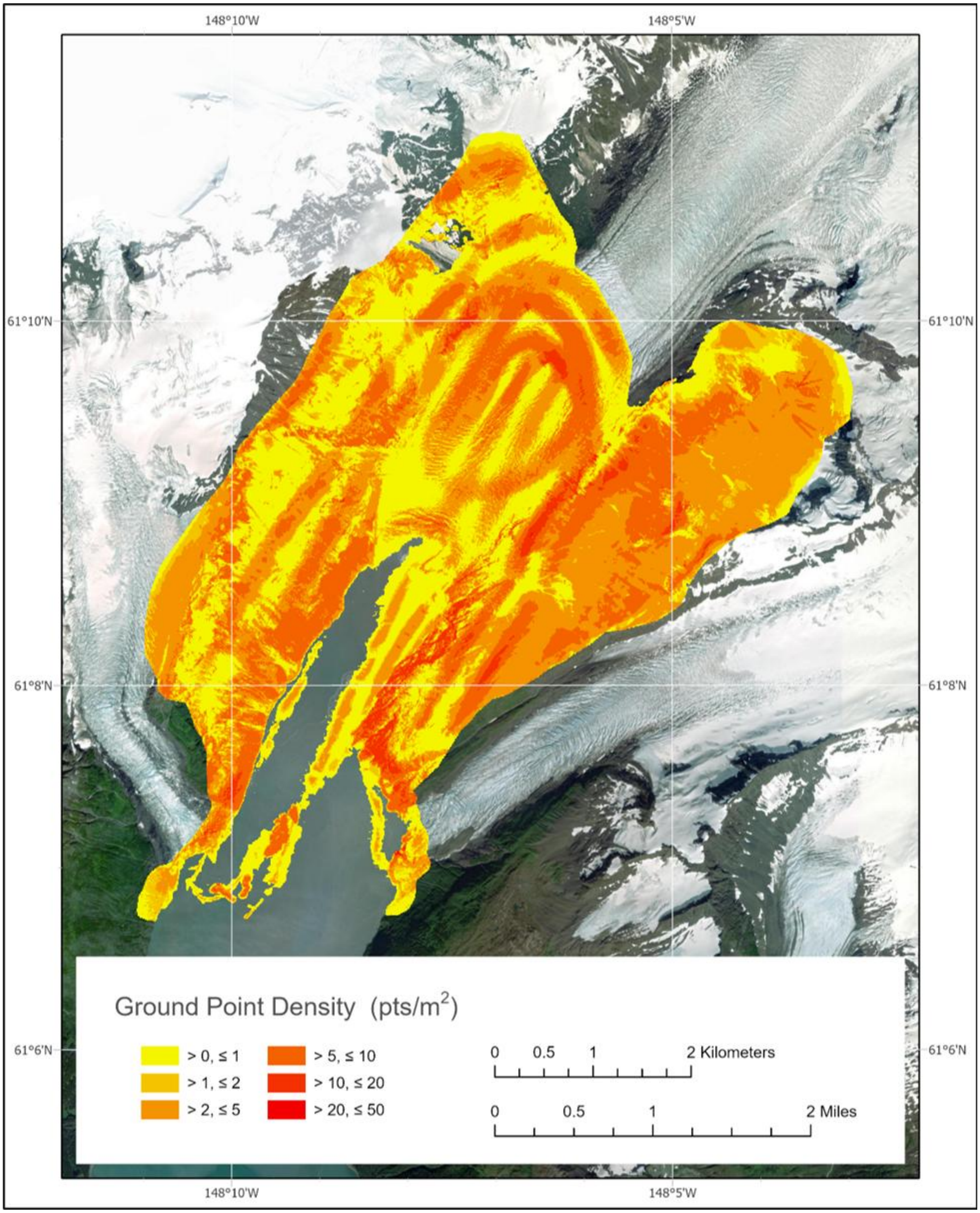

Figure 2. Ground point density for the survey displayed as a raster.

SURVEY REPORT

Ground Survey Details

Ground control points were collected on May 5, 2023. We deployed a Trimble R10-2 GNSS base receiver on a bedrock island in Barry Arm (cover figure) and surveyed points with a rover Trimble R10-2 GNSS receiver/Mesa controller within the survey area. We collected 130 ground control points and checkpoints, of which 19 were used for this lidar acquisition; the remainder were excluded due to snow cover, either during ground control point collection or lidar collection. The checkpoints and ground control points used for this lidar survey were collected on bare earth.

For a GNSS base station occupation to later correct lidar survey flightlines, on April 24, 2024, we set up a Trimble R10-2 on a bedrock island in Barry Arm (fig. 1).

Coordinate System and Datum

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

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

We measured a mean elevation offset of +30.6 cm between 10 control points and the point cloud (tables A1-1, A1-2). This offset was reduced to -1.5 cm (tables A2-1, A2-2) by applying a constant vertical correction to the lidar point data. We used nine checkpoints to determine the vertical accuracy of the point cloud ground class using a Triangulated Irregular Network (TIN) approach. The project's vertical accuracy has a root mean square error (RMSE) of 14.0 cm (tables A2-1, A2-2). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 6.8 cm RMSE.

Data Consistency and Completeness

This is a full-release dataset. There was no over-collect. Data quality is consistent throughout the survey, save for gaps over areas of wet snow and ice, where pulses at high incidence angles (greater than approximately 20 degrees) yielded few returns.

ACKNOWLEDGMENTS

This survey area is within the traditional homelands of the Chugach Sugpiaq peoples. The United States Geological Survey grant # G21AC10362-00 funded this work. We thank Clearwater Air for their 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.

REFERENCES

The American Society for Photogrammetry & Remote Sensing (ASPRS), 2025, LAS Specification 1.4 - R16. https://publicdocuments.asprs.org/las-v14-r16-2025

APPENDIX: SURVEY CONTROL AND CHECKPOINTS

Table A1-1. Vertical ground control points

GCP Point Name	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
GCP107	437530.348	6776484.939	8.044	8.578	0.534
GCP109	437546.819	6776489.962	12.571	12.917	0.346
GCP111	437552.531	6776485.454	12.163	12.098	-0.065
GCP114	437581.525	6776514.456	17.651	18.264	0.613
GCP119	437605.125	6776534.466	23.161	23.499	0.338
GCP121	437592.498	6776564.054	30.789	31.023	0.234
GCP122	437601.763	6776568.119	31.671	32.094	0.423
GCP123	437586.985	6776587.990	33.673	34.121	0.448
GCP126	437599.926	6776599.488	35.046	35.160	0.114
GCP129	437610.599	6776599.681	33.836	33.910	0.074

Table A1-2. Vertical ground control point summary

Vertical Ground Control Point Summary Statistic	Calculated Value (m)
Average elevation difference (dZ) (m)	0.306
Minimum dZ (m)	-0.065
Maximum dZ (m)	0.613
Average magnitude error (m)	0.319
Root mean square error (m)	0.368
Standard deviation (m)	0.215

Table A2-1 Vertical checkpoints

Check Point Name	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Point Cloud Z (m)	Elevation Difference (Corrected Point Cloud Z – Checkpoint Z) (m)
gcp106	437523.774	6776481.505	8.780	8.748	-0.032
gcp108	437540.171	6776487.054	11.251	11.383	0.132
gcp112	437565.545	6776507.951	18.312	18.590	0.278
gcp113	437570.736	6776502.505	16.658	16.502	-0.156
gcp116	437586.385	6776523.799	18.782	18.863	0.081
gcp117	437601.124	6776537.684	23.691	23.568	-0.123
gcp118	437604.031	6776541.898	24.663	24.568	-0.095
gcp124	437580.618	6776580.910	34.289	34.149	-0.140
gcp127	437602.743	6776597.136	34.918	34.842	-0.076

Table A2-2. Vertical checkpoint statistics

Vertical Checkpoint Statistic	Calculated Value (m)
Average elevation difference (dZ) (m)	-0.015
Minimum dZ (m)	-0.156
Maximum dZ (m)	0.278
Average magnitude error (m)	0.124
Root mean square error (m)	0.140
Standard deviation (m)	0.148