LIDAR-DERIVED SNOW SURFACE ELEVATION DATA FOR DEADHORSE, NORTHERN ALASKA, COLLECTED MAY 10, 2022

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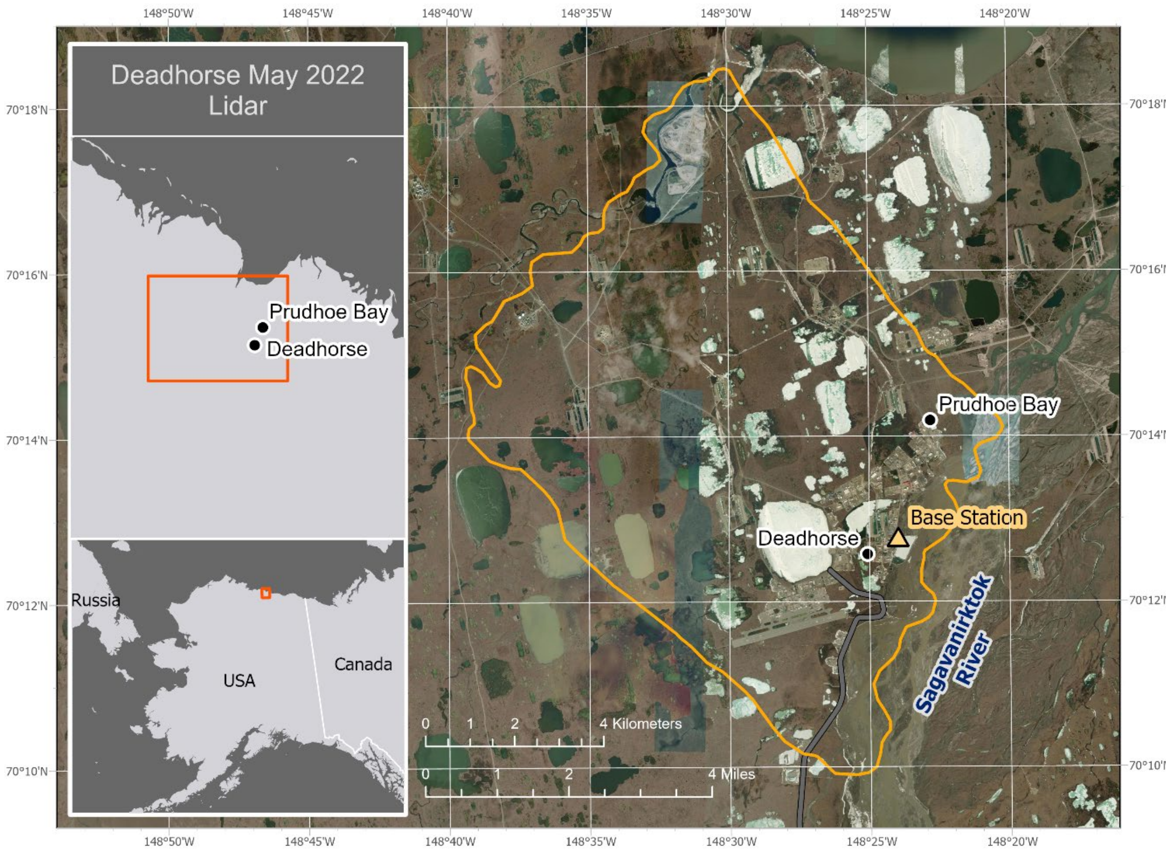
Raw Data File 2024-13



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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Suggested citation:
Zechmann, J.M., Daanen, R.P., Salisbury, J.B., and Wolken, G.J., 2024, Lidar-derived snow surface elevation data for Deadhorse, Northern Alaska, collected May 10, 2022: Alaska Division of Geological & Geophysical Surveys Raw Data File 2024-13, 7 p.
https://doi.org/10.14509/31259

In Memorial

Ronnie Daanen, along with colleagues Justin Germann and Tori Moore and pilot Tony Higdon, passed away in July 2023 in a helicopter crash while conducting fieldwork supporting DGGS's mission on the North Slope. This publication is released in their memory.

LIDAR-DERIVED SNOW SURFACE ELEVATION DATA FOR DEADHORSE, NORTHERN ALASKA, COLLECTED MAY 10, 2022

Jenna M. Zechmann,[1] Ronald P. Daanen[1], J. Barrett Salisbury[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 model (DTM), and an intensity model of Deadhorse, Northern Alaska, during peak snowpack conditions (cover figure). The survey provides snow surface elevations for use in snowpack assessments. Aerial lidar data and ground control data were collected on May 10, 2022, 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/10.14509/31259.

LIST OF DELIVERABLES

Classified Points
DSM and DTM
Intensity Image
Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS used a Riegl VUX1-LR laser scanner with a global navigation satellite system (GNSS) and Northrop Grumman LN-200C inertial measurement unit (IMU) integrated by Phoenix LiDAR Systems. The sensor can collect a maximum of 820,000 points per second at a range of 215 m or a minimum of 50,000 points per second at a range of 820 m (ranges assume ≥ 20 percent natural reflectance). The scanner operated with a pulse refresh rate of 200,000-400,000 pulses per second at a scan rate of 100-200 revolutions per second. We used an R-44 helicopter to survey from an elevation of approximately 100–160 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 100.8 km^2.

Weather Conditions and Flight Times

The survey area was accessed by air (fig. 1) from Deadhorse Airport. Data collection occurred from 2:50 pm to 5:00 pm (AST). Weather throughout the survey was overcast with light wind.

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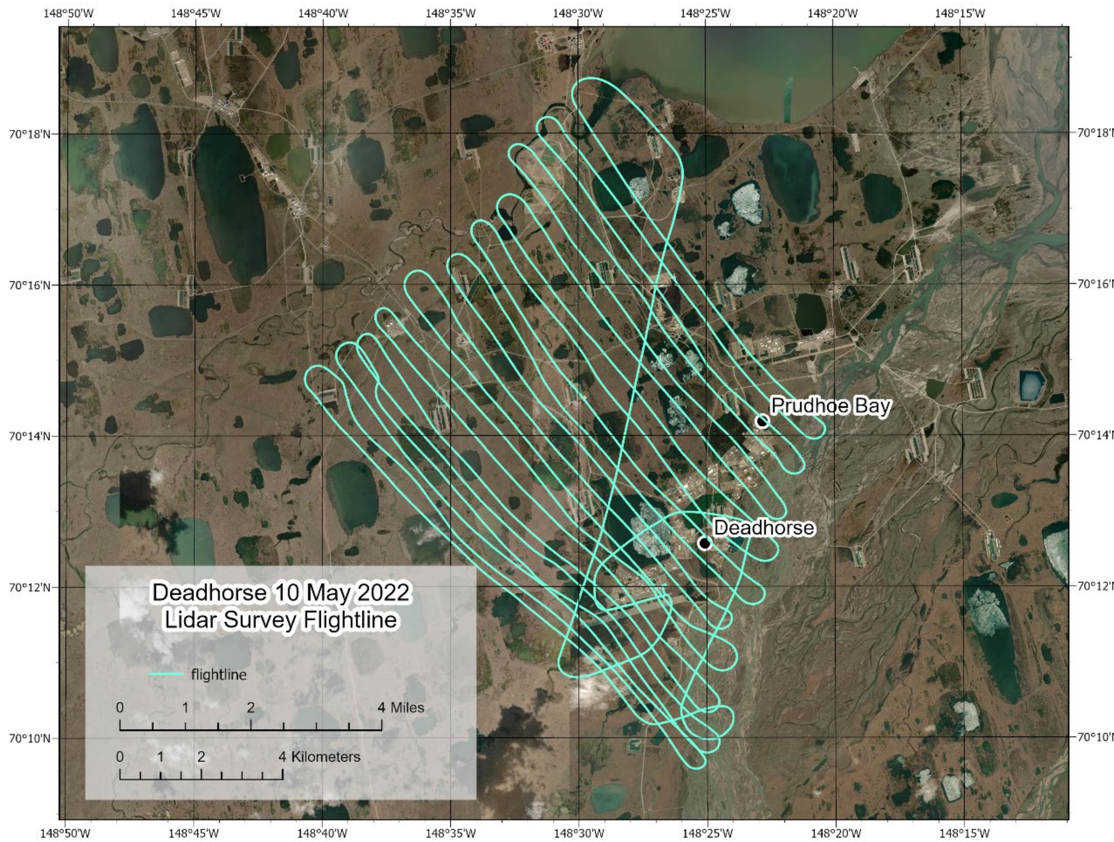

Figure 1. Lidar data collection flightline.

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 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 the lidar data collection, the average pulse density is 6.75 pulses/m^2, and the average pulse spacing is 38.5 cm.

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 the maximum ground, vegetation, bridge deck, overhead structure, 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. We also produced a 50-cm 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 classified ground points, the average point density (fig. 2) is 4.90 pts/m^2, and the average spacing is 45.2 cm.

Table 2. Point cloud class code definitions.

Class Code	Description
1	Unclassified
2	Ground
3	Low Vegetation, ≥0.0m, <0.2m
4	Medium Vegetation, ≥0.2m, ≤1m
6	Building
7	Low Noise
14	Wire
17	Bridge Deck
18	High Noise
19	Overhead structure (pipes, vehicles)
30	Noise (manually classified)

Digital Surface Model

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

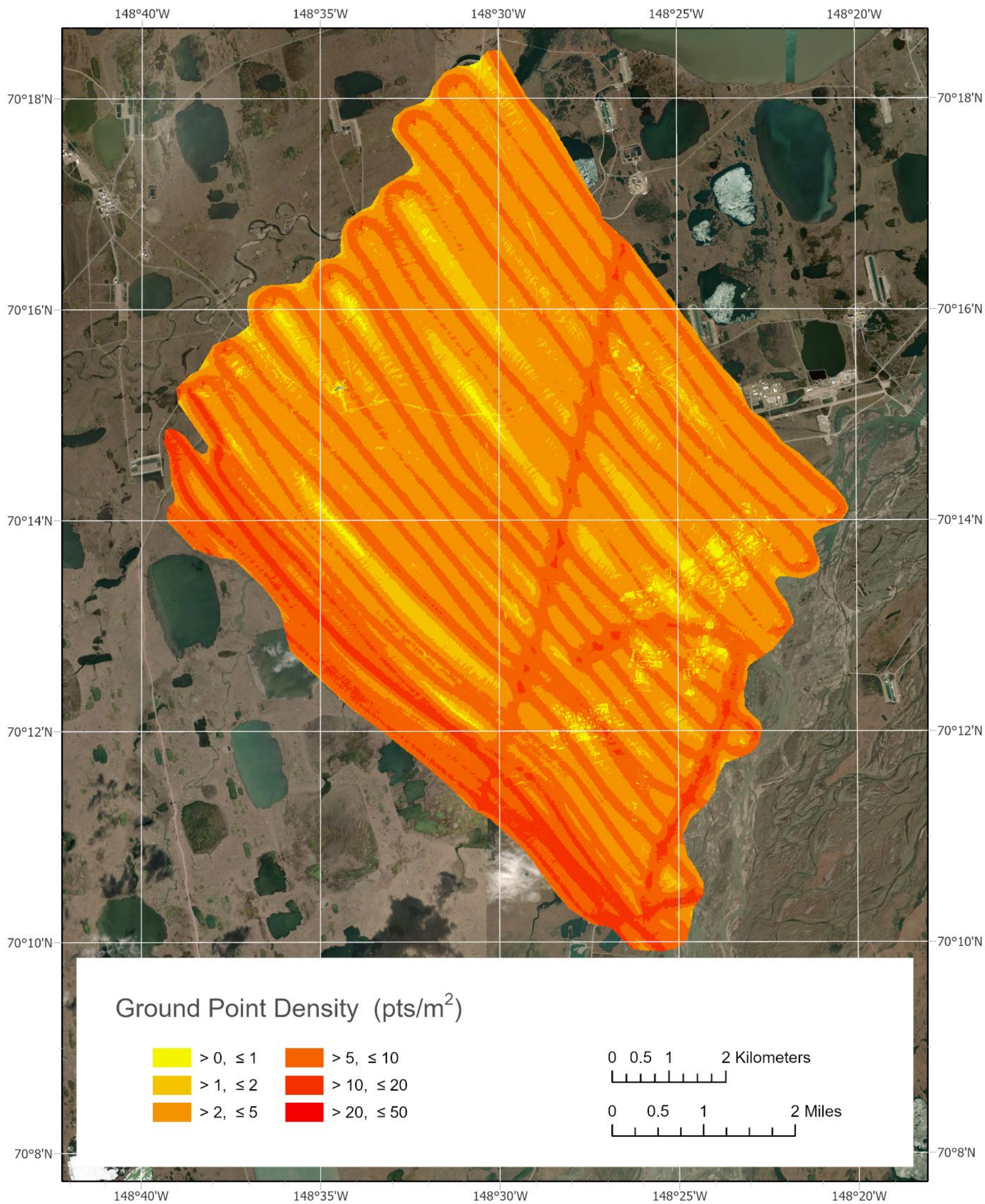

Figure 2. Ground point density for the survey displayed as a raster.

SURVEY REPORT

Ground Survey Details

Ground control points were collected on May 10, 2022. We deployed a Trimble R10 GNSS base receiver to provide a base station occupation and real-time kinematic (RTK) corrections to points we surveyed with a rover Trimble R10 GNSS receiver/Mesa3 controller. A levee along the Sagavanirktok River served as the base station location (cover figure). We collected 51 ground control points and checkpoints to use for calibration and to assess the vertical accuracy of the point cloud. Checkpoints were collected on bare earth (hardpack, pavement, and gravel).

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 offset of +263.2 cm between 26 control points and the point cloud (app. 1). This offset was reduced to -1.3 cm (app. 2) by applying a constant vertical correction to the lidar point data. We used 25 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 5.7 cm (app. 2). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 4.1 cm RMSE.

Data Consistency and Completeness

This is a full-release dataset. There was no over-collect, and data quality is consistent throughout the survey, save for gaps over bodies of water.

ACKNOWLEDGMENTS

This survey area is on the traditional homelands of the Iñupiat peoples. A National Science Foundation grant, federal award No, funded this work. ICER-1928237 made to the University of Alaska, with the State of Alaska as a sub-recipient under sub-award number UA 21-0135. We thank Pollux Aviation for their expertise and contribution to these data products. The views and conclusions contained in this document are those of the authors. They 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

APPENDIX 1: GROUND CONTROL POINTS

GCP	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
BaseStation	447126.218	7790278.420	12.118	14.918	2.800
scp002	447158.948	7790271.826	10.986	13.545	2.559
scp004	447291.533	7790273.774	9.078	11.770	2.692
scp006	447436.202	7790275.129	9.187	11.854	2.667
scp008	447864.062	7792652.639	12.451	14.942	2.491
scp010	447851.837	7792687.008	12.339	14.894	2.555
scp012	447834.104	7792771.493	12.445	14.972	2.527
scp014	447882.892	7792647.297	11.919	14.479	2.560
scp016	446895.274	7791679.836	13.488	16.108	2.620
scp018	445134.553	7791081.214	13.659	16.200	2.541
scp020	445701.377	7789964.768	13.799	16.506	2.707
scp022	445725.178	7790000.872	13.814	16.533	2.719
scp024	445706.764	7789995.731	13.829	16.509	2.680
scp026	444748.449	7789215.265	15.975	18.516	2.541
scp028	444726.555	7789221.292	16.164	18.822	2.658
scp030	445236.861	7788932.491	16.675	19.256	2.581
scp032	446375.947	7788960.755	15.930	18.610	2.680
scp034	446369.245	7788973.800	15.955	18.620	2.665
scp036	446409.411	7788958.346	15.948	18.603	2.655
scp038	445877.996	7787850.210	15.844	18.405	2.561
scp040	445819.190	7787723.455	15.918	18.538	2.620
scp042	446471.990	7790260.995	12.435	15.105	2.670
scp044	446513.711	7790258.116	12.808	15.480	2.672
scp046	446570.620	7790261.194	12.864	15.532	2.668
scp048	446552.072	7790275.121	12.949	15.622	2.673
scp050	446509.391	7790269.688	12.880	15.552	2.672
Average elevation difference (dZ) (m)	2.632				
Minimum dZ (m)	2.491				
Maximum dZ (m)	2.800				
Average magnitude error (m)	2.632				
Root mean square error (m)	2.633				
Standard deviation (m)	0.073				

APPENDIX 2: CHECK POINTS

Check Point	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Pointcloud Z (m)	Elevation Difference (Corrected Pointcloud Z – Checkpoint Z) (m)
scp001	447134.985	7790272.082	12.124	12.103	-0.021
scp003	447218.245	7790271.092	9.320	9.348	0.028
scp005	447358.744	7790274.450	9.363	9.398	0.035
scp007	447522.951	7790259.135	9.635	9.594	-0.041
scp009	447861.653	7792666.753	12.365	12.244	-0.121
scp011	447845.487	7792719.250	12.510	12.432	-0.078
scp013	447818.747	7792807.398	12.253	12.166	-0.087
scp015	446859.181	7791703.505	13.185	13.113	-0.072
scp017	446921.709	7791685.198	13.462	13.421	-0.041
scp019	445178.153	7791091.964	13.767	13.668	-0.099
scp021	445715.450	7789973.518	13.919	13.940	0.021
scp023	445728.497	7790033.476	13.888	13.955	0.067
scp025	444730.020	7789207.561	16.057	15.976	-0.081
scp027	444745.603	7789235.393	16.166	16.156	-0.010
scp029	445238.932	7788946.856	16.816	16.789	-0.027
scp031	445222.314	7788942.863	16.614	16.634	0.020
scp033	446350.961	7788972.809	15.951	16.007	0.056
scp035	446400.899	7788965.228	15.938	15.988	0.050
scp037	445886.525	7787862.868	15.797	15.757	-0.040
scp039	445868.286	7787828.487	15.842	15.782	-0.060
scp041	446497.275	7790269.029	12.800	12.837	0.037
scp043	446486.937	7790255.636	12.521	12.578	0.057
scp045	446540.865	7790259.597	12.874	12.920	0.046
scp047	446566.390	7790271.838	12.966	12.989	0.023
scp049	446534.957	7790271.266	12.991	13.003	0.012
Average elevation difference (dZ) (m)	-0.013				
Minimum dZ (m)	-0.121				
Maximum dZ (m)	0.067				
Average magnitude error (m)	0.049				
Root mean square error (m)	0.057				
Standard deviation (m)	0.056				