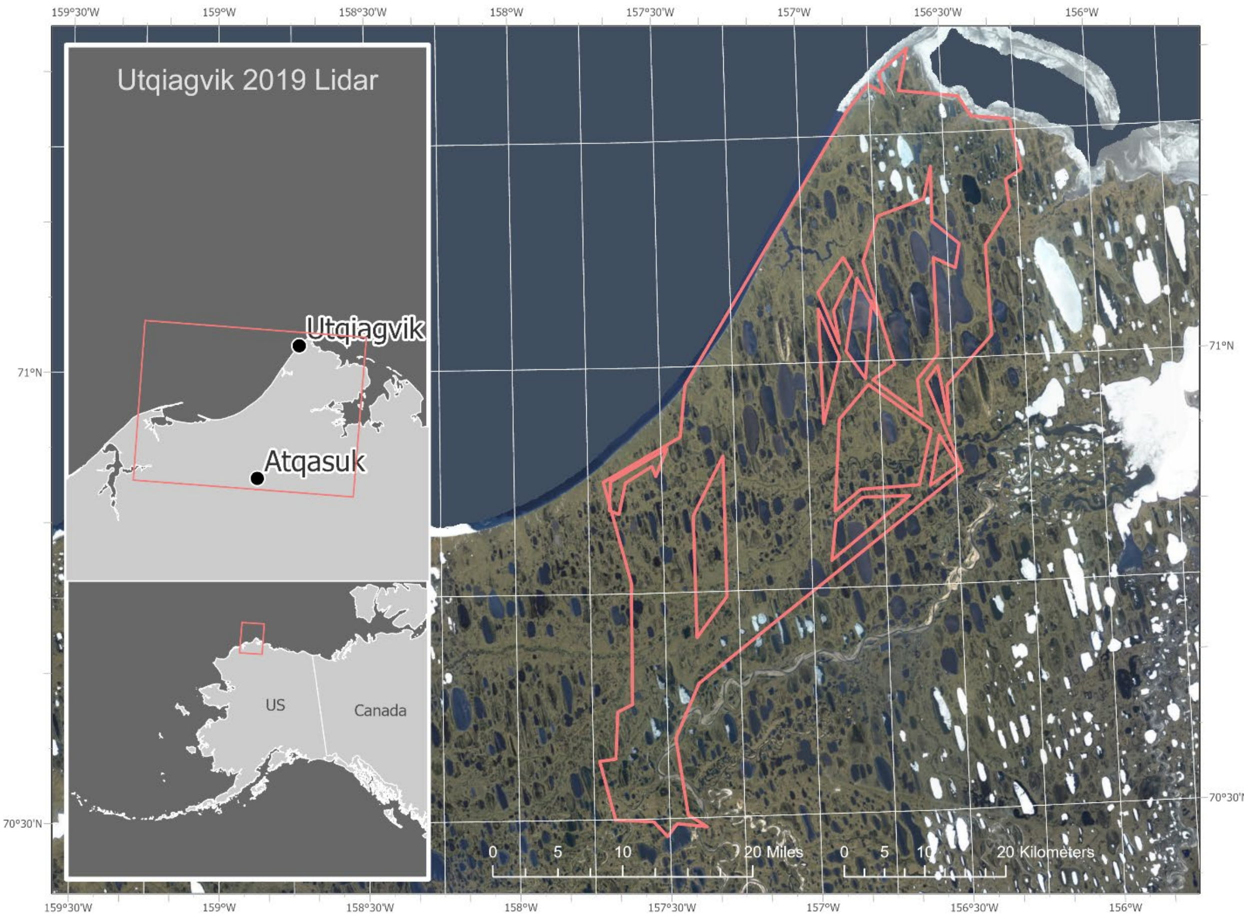
LIDAR-DERIVED ELEVATION DATA FOR THE UTQIAĠVIK–ATQASUK REGION, ALASKA, COLLECTED AUGUST 2019

Andrew M. Herbst and Ronald P. Daanen

Raw Data File 2022-10



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.

2022
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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LIDAR-DERIVED ELEVATION DATA FOR THE UTQIAĠVIK–ATQASUK REGION, ALASKA, COLLECTED AUGUST 2019

Andrew M. Herbst[1] and Ronald P. Daanen[1]

INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a classified point cloud, digital terrain model (DTM), surface model (DSM), and intensity model for an area including the communities of Utqiaġvik and Atqasuk. The data were collected in support of the Alaska Strategic Transportation and Resources (ASTAR) program for the purpose of investigating the potential for future road infrastructure connecting the communities. Aerial lidar data were collected between August 19 and 23, 2019, and subsequently 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 can be downloaded free of charge from the DGGS website: https://doi.org/10.14509/30870.

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 integrated with a global navigation satellite system (GNSS) and Northrop Grumman LN-200C inertial measurement unit (IMU). The lidar integration system was designed by Phoenix LiDAR Systems. The sensor can collect up to 820,000 points per second over a distance of 150 m. This survey was flown with a pulse refresh rate of 400,000 pulses per second, at a scan rate between 80 and 220 lines per second. This survey was flown with an average elevation of 200 m above ground level and a ground speed of approximately 30 m/s with a fixed-wing configuration, using a Cessna 180. The scan angle was set from 80 to 280 degrees. The total area surveyed was approximately 1,595 km^2 (615 mi^2; fig. 1).

WEATHER CONDITIONS AND FLIGHT TIMES

Aerial lidar was collected between August 19 and 23, 2019. Seven flightlines collected on the evening of August 22 yielded too large a file for our software to process and the points from those lines are not represented in our final product.

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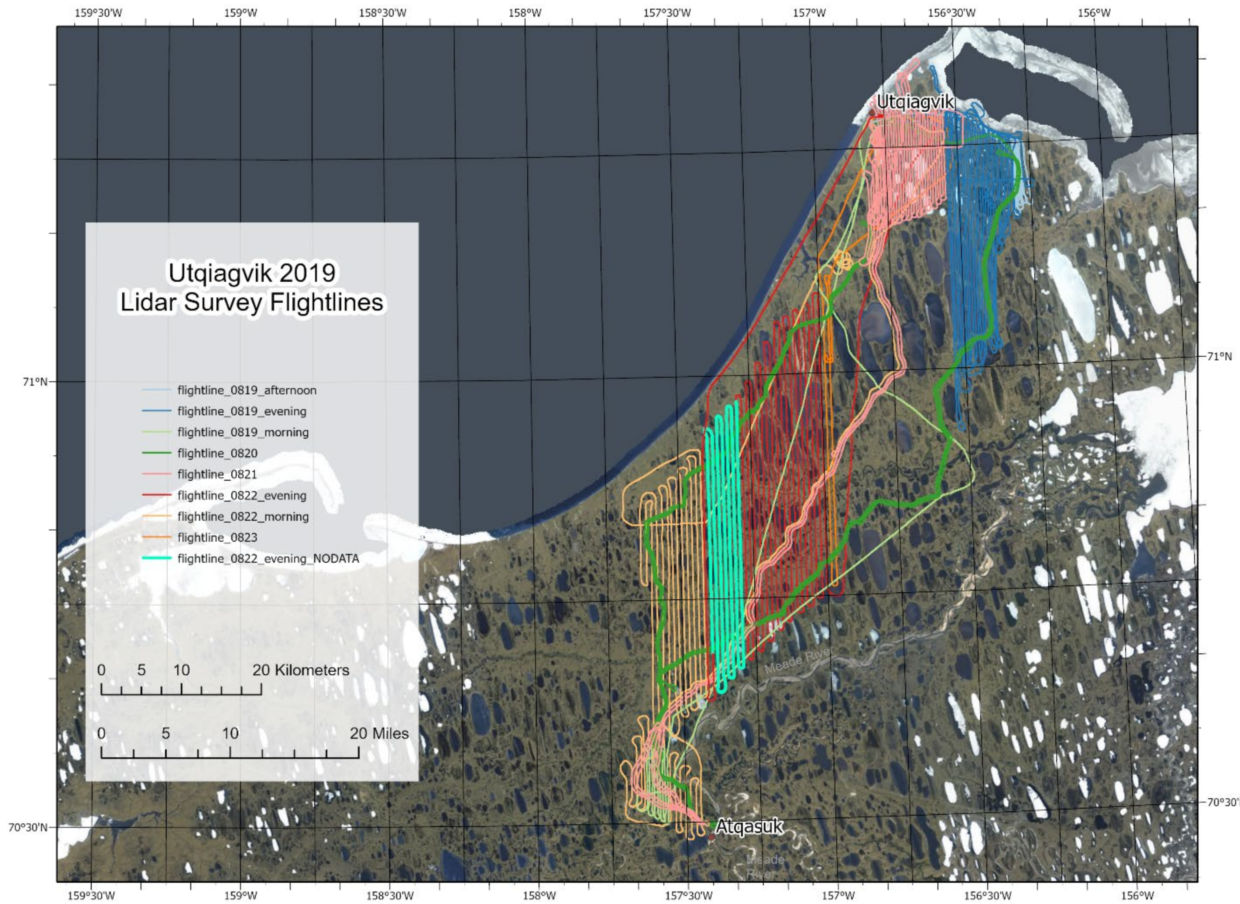

Figure 1. Project flightlines. Note the flightlines labeled "flightline_0822_evening_NODATA", which did not yield point data in this delivery.

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 imprecise 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 used to integrate flightline information with the point cloud in Spatial Explorer software. The point data were calibrated at an incrementally precise scale of sensor movement and behavior, incorporating sensor velocity, roll, pitch, and yaw fluctuations throughout the survey.

Points were classified in accordance with American Society for Photogrammetry and Remote Sensing (ASPRS) 2014 guidelines, using macros designed in Terrasolid software. Once classified, points underwent a geometric transformation and were converted from ellipsoidal heights to GEOID12B (Alaska) orthometric heights.

Raster products were derived from the point cloud using ArcGIS Pro. The DTM was interpolated from all ground class returns using a TIN-based method. The DSM was likewise interpolated from only the first return points. An intensity image was also produced in ArcGIS Pro, using closest-to-mean binning.

Classified Point Cloud

Classified point cloud data are provided in this collection in compressed LAZ format. Data are classified in accordance with ASPRS 2014 guidelines and contain return and intensity information. The average ground point spacing was 34 cm and the average density was 8.51 pts/m^2 (fig. 2).

Digital Surface Model

The DSM represents surface elevations including heights of vegetation, buildings, bridges, and other structures. The DSM is a single band, 32-bit GeoTIFF file, with a ground sample distance of 1 meter. No Data value is set to -3.40282306074e+038.

Digital Terrain Model

The DTM represents surface elevations of ground surfaces, excluding vegetation, bridges, buildings, etc. The DTM is a single-band, 32-bit float GeoTIFF file, with a ground sample distance of 1 meter. No Data value is set to -3.40282306074e+038.

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 with a ground sample distance of 1 meter. No Data value is set to -3.40282306074e+038 (32-bit, floating-point minimum).

SURVEY REPORT

Ground Survey Details

Ground survey points from an UMIAQ, LLC, collection in September 2018, were used as control and checkpoint data for this dataset. These survey data were originally gathered in support of a USGS 3DEP funded lidar project, headed by Quantum Spatial (now NV5 Geospatial).

Coordinate System and Datum

All data were processed and delivered in NAD83 (2011) UTM8N and vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

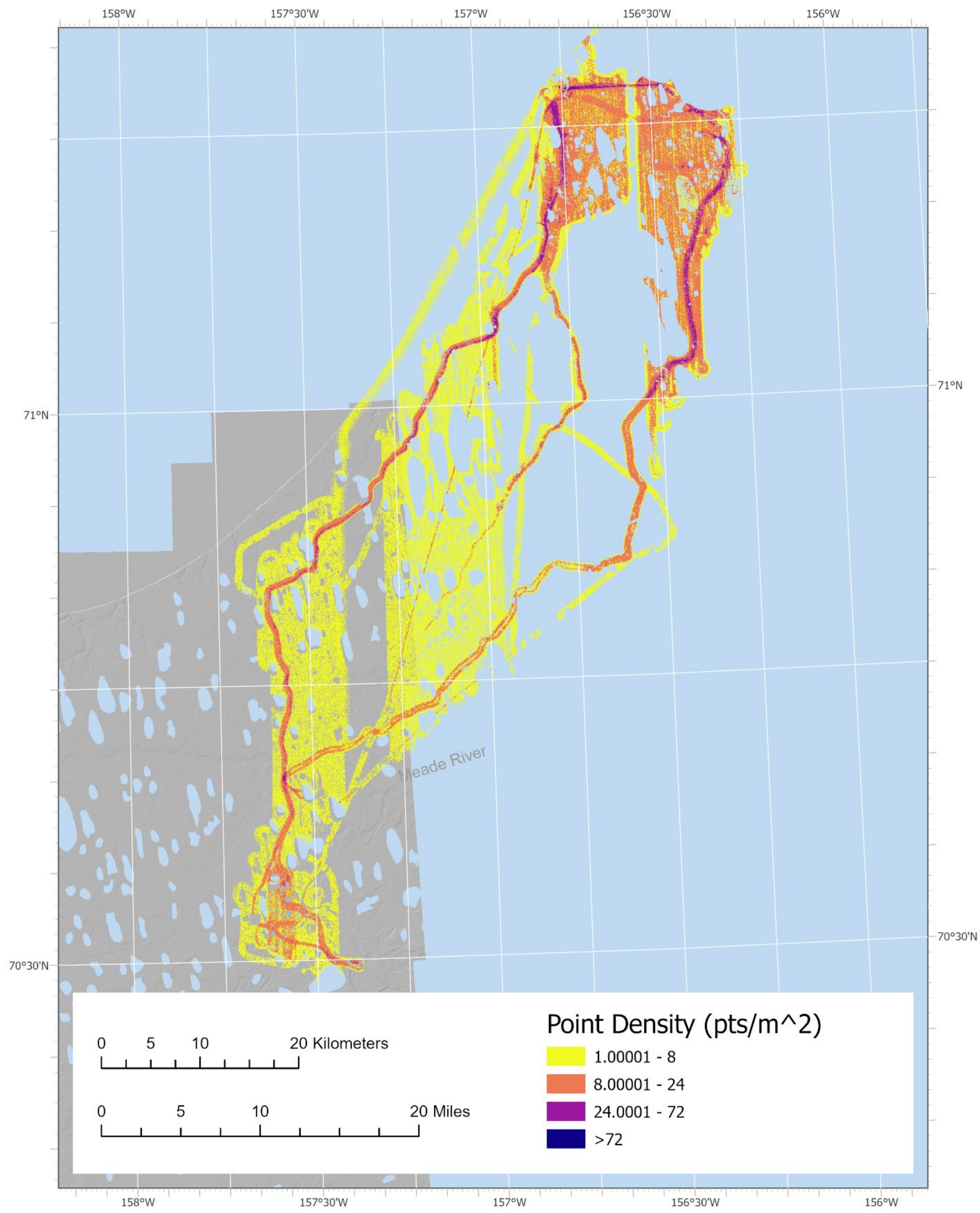

Figure 2. Ground point density for the survey displayed as a 1-meter raster.

Vertical Accuracy

A mean offset of -25.5 cm was measured between 19 control points and point cloud ground returns (appendix 1). This offset was reduced to 0.001 cm by performing a vertical transformation of the lidar point data. Thirty-three check points were used to determine the non-vegetated vertical accuracy (NVA) of the point cloud ground class, using a TIN-based approach. Project NVA was calculated to have a root mean square error (RMSE) of 5.2 cm (appendix 2). Relative accuracy for this dataset was evaluated as the interswath overlap consistency and was measured at 0.95 cm RMSE.

Data Consistency and Completeness

This is a partial data release and contains all data collected except from the seven flightlines shown in figure 1. There is no over collect. The data quality is consistent throughout the survey.

ACKNOWLEDGMENTS

These data products were funded by the U.S. Bureau of Land Management and the State of Alaska's Arctic Strategic Transportation and Resources (ASTAR) project. We thank Clearwater Air, Inc., for their professional and expert flight services.

APPENDIX 1: GROUND CONTROL POINTS

GCP	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	579365.9	7909631	13.676	13.64	-0.036
2	579647.8	7912021	2.818	2.84	0.022
3	583181.5	7911959	6.051	6.02	-0.031
4	582012.8	7914634	3.754	3.76	0.006
5	578618.1	7910709	13.235	13.2	-0.035
6	580362.1	7911027	9.354	9.29	-0.064
7	579855.1	7912170	5.881	5.86	-0.021
8	581232.6	7912785	7.712	outside*	*
9	580479.2	7912500	6.791	6.77	-0.021
10	557596.9	7822615	25.125	25.09	-0.035
11	584489.8	7909294	7.263	7.35	0.087
12	579350.4	7909619	13.88	13.97	0.09
13	581217.8	7912808	5.998	outside*	*
14	595571.1	7906546	3.006	3.23	0.224
15	557626.5	7822617	26.494	26.43	-0.064
16	558485.8	7821084	27.206	outside*	*
17	583600.9	7911212	6.81	6.8	-0.01
18	595556.5	7906491	3.548	3.51	-0.038
19	584807.8	7908496	7.68	7.63	-0.05
Average dz (m)	0.001				
Minimum dz (m)	-0.064				
Maximum dz (m)	0.224				
Average magnitude error (m)	0.052				
Root mean square error (m)	0.073				
Standard deviation (m)	0.075				

**"outside" indicates a ground control point which exists outside the geographic extent of the lidar data.*

APPENDIX 2: CHECK POINTS

Check Point	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	579901	7906884	9.695	9.68	-0.015
2	578653.9	7910687	13.27	13.25	-0.02
3	580766.4	7912291	8.943	8.97	0.027
4	583855.9	7910798	6.906	6.82	-0.086
5	583767	7916321	3.998	4	0.002
6	595585.1	7906528	3.821	3.8	-0.021
7	584763.3	7908495	7.887	7.85	-0.037
8	579675.5	7910929	10.178	slope**	*
9	580552.4	7911453	5.908	5.84	-0.068
10	580980.4	7912339	9.327	outside*	*
11	583058	7915625	3.823	3.84	0.017
12	580712.6	7912849	6.083	outside*	*
13	579270.1	7911565	4.396	4.39	-0.006
14	558503.4	7819078	30.504	outside*	*
15	558532.9	7821063	25.908	outside*	*
16	579887.5	7906872	9.595	9.71	0.115
17	580575.2	7911453	4.241	4.22	-0.021
18	583871.4	7910808	6.124	6.15	0.026
19	582124.2	7913408	4.211	outside*	*
20	584814.6	7908483	7.305	7.34	0.035
21	558493.6	7819008	32.399	outside*	*
22	558968.5	7820054	31.096	outside*	*
23	584154.2	7916172	3.245	3.33	0.085
24	587981.9	7918891	1.985	outside*	*
25	590894.6	7907130	3.93	3.84	-0.09
26	587425.3	7906286	9.367	9.43	0.063

Check Point	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
27	558535	7819054	32.013	outside*	*
28	582096.2	7912268	6.692	outside*	*
29	589352	7907432	4.93	4.89	-0.04
30	581534.4	7912206	9.073	outside*	*
31	579144.3	7911234	8.825	8.88	0.055
32	583152.3	7911969	5.495	outside*	*
33	580236.9	7910996	9.407	9.4	-0.007
Average dz (m)	0.001				
Minimum dz (m)	-0.09				
Maximum dz (m)	0.115				
Average magnitude error (m)	0.042				
Root mean square error (m)	0.052				
Standard deviation (m)	0.054				

**"outside" indicates a ground control point which exists outside the geographic extent of the lidar data.*

***"slope" indicates a ground control point collected where the slope exceeds 50 degrees.*