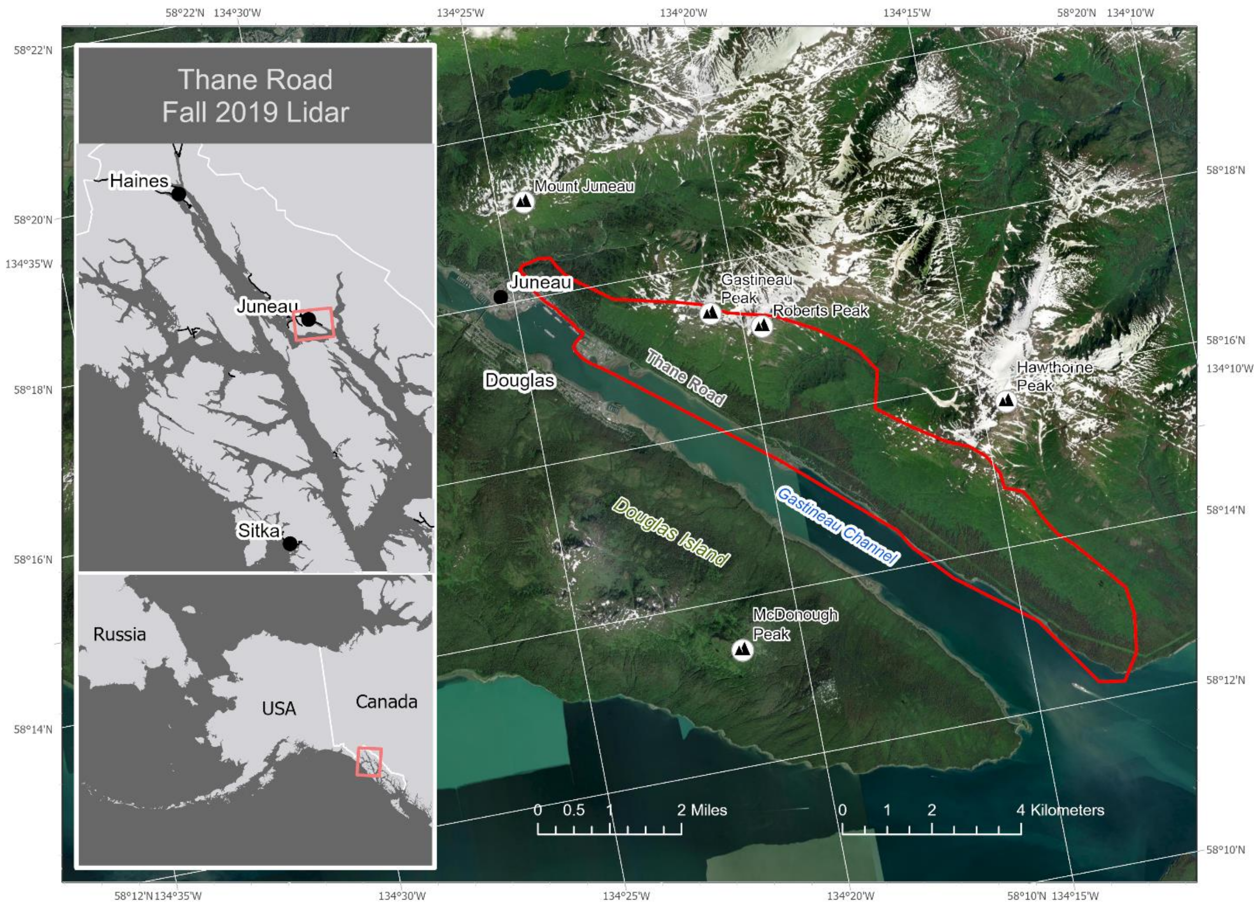
LIDAR-DERIVED ELEVATION DATA FOR THANE ROAD, SOUTHEAST ALASKA, COLLECTED SEPTEMBER 6, 2019

Katreen M. Wikstrom Jones and Gabriel J. Wolken

Raw Data File 2024-16



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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LIDAR-DERIVED ELEVATION DATA FOR THANE ROAD, SOUTHEAST ALASKA, COLLECTED SEPTEMBER 6, 2019

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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 Mount Roberts and Gastineau Peak along Thane Road, Southeast Alaska, during near snow-free ground conditions (cover figure). The survey provides snow-free surface elevations for deriving snow depth distribution models with repeat surveys during snow-covered conditions. Ground control data were collected on September 5, 2019, and aerial lidar data were collected on September 6, 2019, 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 for download on the DGGS website at https://doi.org/10.14509/31278.

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) designed by Phoenix LiDAR Systems. The sensor can collect a maximum of 820,000 points per second at a range of 150 m or a minimum of 50,000 points per second at a range of 820 m (ranges assume ≥ 20% natural reflectance). The scanner operated with a pulse refresh rate of 50,000–400,000 pulses per second and with a scan rate of 80–220 revolutions per second. We used a Bell 206 Jet Ranger helicopter platform to survey from an elevation of approximately 130 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 33.7 km^2.

Weather Conditions and Flight Times

The survey area was accessed by air (fig. 1) from the Juneau International Airport. Data collection occurred between 5:10 pm and 7:00 pm (ADT), and the weather throughout the survey was clear with no wind.

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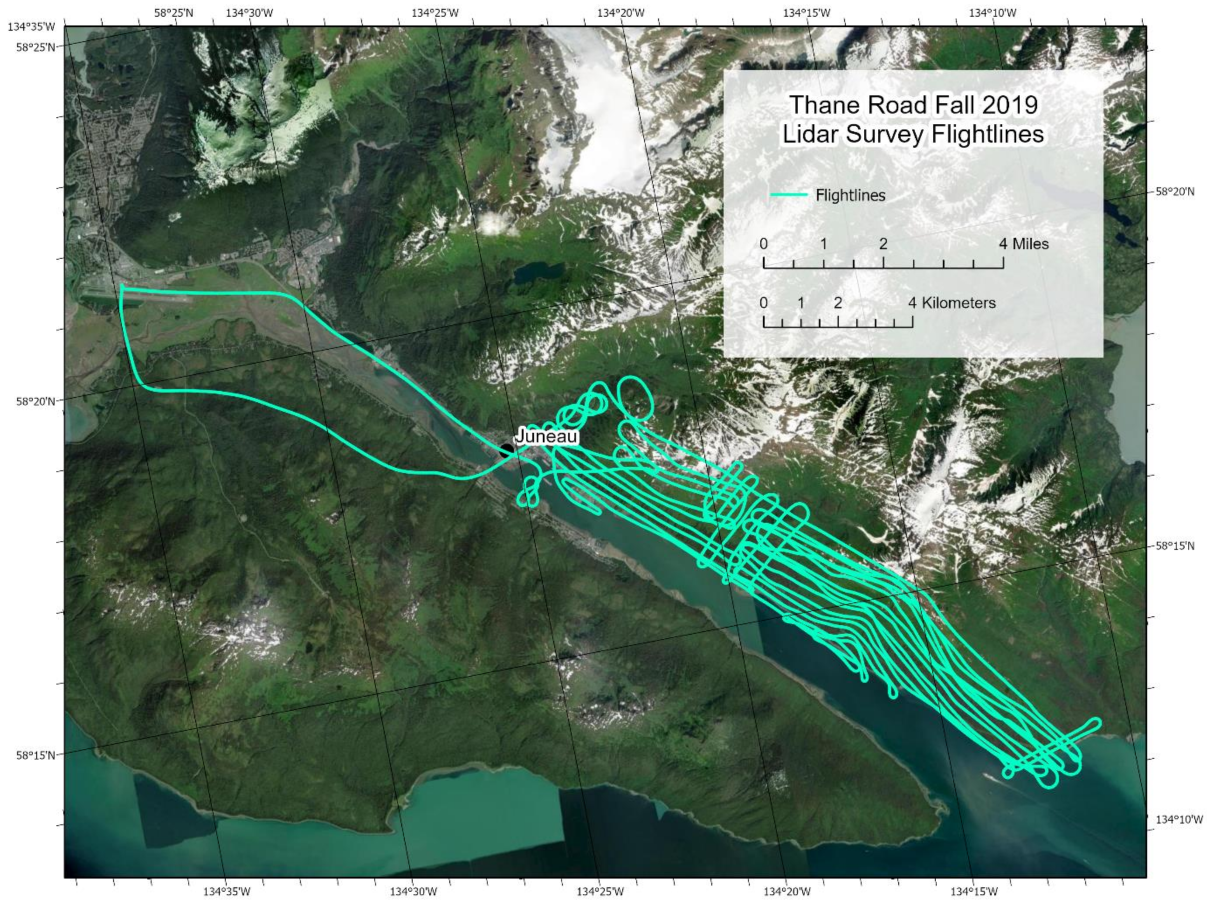

Figure 1. Lidar data collection flightlines.

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. 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 17.6 pulses/m^2 and the average pulse spacing is 23.8 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 1-m DSM was interpolated from ground, vegetation, bridge deck, and building classes using a triangulation method. A 1-m DTM was interpolated from all ground class returns using a triangulation method. We also produced a 1-m intensity image for the entire area using average binning, with no normalization or corrections applied.

We hydro-conditioned the DTM and DSM in ArcGIS Pro by masking the shoreline and assigning any pixels located underwater an elevation of 0 m asl. This assigned elevation value does not account for tide activity, so the shoreline may appear abrupt in some areas.

Classified Point Cloud

Classified point cloud data are provided in LAZ format. Data are classified following ASPRS 2019 guidelines (table 1) and contain return and intensity information. For classified ground points (fig. 2), the average point density is 4.63 pts/m^{2}, and the average spacing is 46.5 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, ≤60m
6	Building
7	Low Noise
14	Wire Conductor
18	High Noise

Digital Surface Model

The DSM represents surface elevations, including heights of vegetation, buildings, powerlines, bridge decks, etc. The DSM is a single-band, 32-bit GeoTIFF file of 1-m 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, etc. The DTM is a single-band, 32-bit GeoTIFF file of 1-m 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 1-m resolution. No Data value is set to 0.

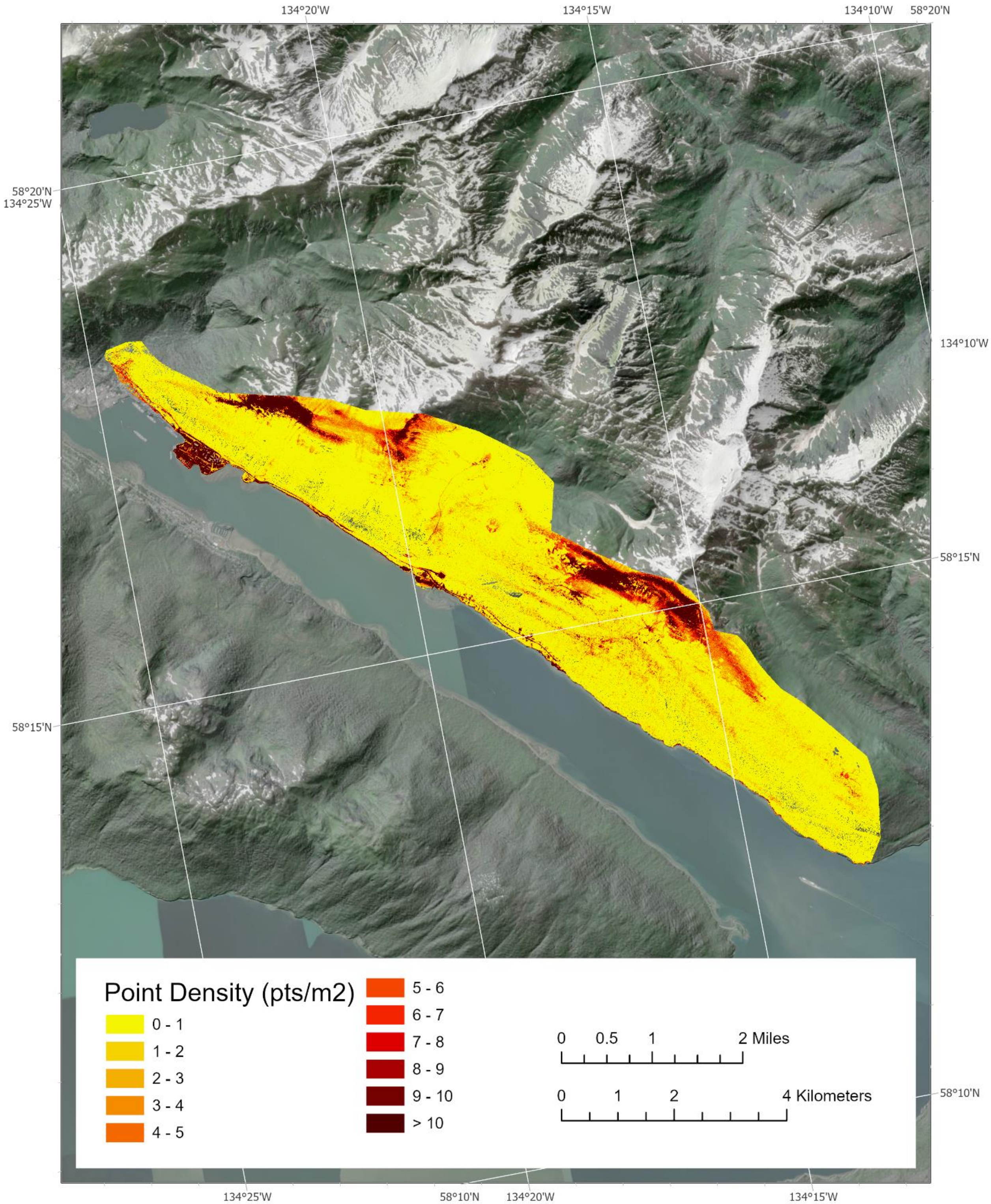

Figure 2. Ground point density for the survey displayed as a raster.

SURVEY REPORT

Ground Survey Details

Ground control points were collected on September 5, 2019. We deployed a Trimble R7 GNSS receiver with Zephyr-2 antenna at benchmark AI4980 in downtown Juneau to provide a base station occupation and real-time kinematic (RTK) corrections to points we surveyed with a rover Trimble R8-4 GNSS receiver (internal antenna). We collected 30 ground control points and checkpoints for calibration and to assess the vertical accuracy of the point cloud. Checkpoints were collected on bare earth (gravel or pavement).

Coordinate System and Datum

We processed and delivered all data in NAD83 (2011) UTM8N and vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

We measured a mean offset of -5.4 cm between 24 control points and the point cloud (app. 1). This offset was reduced to +4.8 cm (app. 2) by applying a constant vertical correction to the lidar point data. We used six 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 mean absolute error (MAE) of 9.1 cm (app. 2). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured a root mean square error of 10.0 cm.

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. Data quality is consistent throughout the survey.

ACKNOWLEDGMENTS

These data products were funded by the U.S. Geological Survey, Alaska Electric Light & Power Company, and the State of Alaska and collected and processed by DGGS. We thank Coastal Helicopters for their aviation 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/wpcontent/uploads/2019/07/LAS_1_4_r15.pdf

APPENDIX 1: GROUND CONTROL POINTS

Ground Control Point	Easting (m)	Northing (m)	GCP Z (m)	Point Cloud Z (m)	Elevation Difference dZ (Point Cloud Z – GCP Z) (m)
1	534535.234	6462691.699	62.641	62.440	-0.201
2	534527.046	6462686.312	62.880	62.720	-0.160
3	534525.648	6462675.176	62.837	62.620	-0.217
4	534515.894	6462674.456	62.898	62.760	-0.138
5	534870.453	6463033.681	79.470	79.770	0.300
6	534822.410	6463026.084	77.654	77.930	0.276
7	534802.736	6463019.249	77.285	77.500	0.215
8	535277.518	6461683.385	7.217	7.170	-0.047
9	535804.359	6461033.844	18.369	18.170	-0.199
10	535811.063	6461041.414	18.486	18.470	-0.016
11	535832.159	6461049.815	19.311	19.280	-0.031
12	535846.094	6461065.255	19.965	19.930	-0.035
13	536333.209	6460672.078	8.790	8.700	-0.090
14	536325.016	6460682.747	8.796	8.700	-0.096
15	537614.359	6459665.059	17.085	17.040	-0.045
16	537619.593	6459662.537	17.115	17.030	-0.085
17	539655.866	6457802.101	6.157	6.040	-0.117
18	539652.033	6457797.245	4.976	4.840	-0.136
19	539663.320	6457812.218	7.121	7.020	-0.101
20	539650.189	6457823.880	7.341	7.230	-0.111
21	539628.178	6457853.810	7.869	7.690	-0.179
22	536590.947	6460460.985	9.547	9.530	-0.017
23	536601.542	6460450.448	9.322	9.290	-0.032
24	536611.355	6460439.882	9.024	8.990	-0.034
Average elevation difference (dZ) (m)	-0.054				
Minimum dZ (m)	-0.217				
Maximum dZ (m)	0.300				
Average magnitude error (m)	0.120				
Root mean square error (m)	0.145				
Standard deviation (m)	0.137				

APPENDIX 2: CHECK POINTS

Check Point	Easting (m)	Northing (m)	GCP Z (m)	Point Cloud Z (m)	Elevation Difference dZ (Point Cloud Z – GCP Z) (m)
1	534896.294	6463037.094	80.780	81.170	0.390
2	535284.272	6461671.170	7.227	7.240	0.013
3	536336.550	6460669.091	8.776	8.740	-0.036
4	537606.814	6459675.295	17.562	17.540	-0.022
5	539637.821	6457834.903	7.562	7.490	-0.072
6	536622.473	6460427.783	8.607	8.620	0.013
Average elevation difference (dZ) (m)	0.048				
Minimum dZ (m)	-0.072				
Maximum dZ (m)	0.39				
Average magnitude error (m)	0.091				
Absolute mean error (m)	0.091				
Standard deviation (m)	0.171				