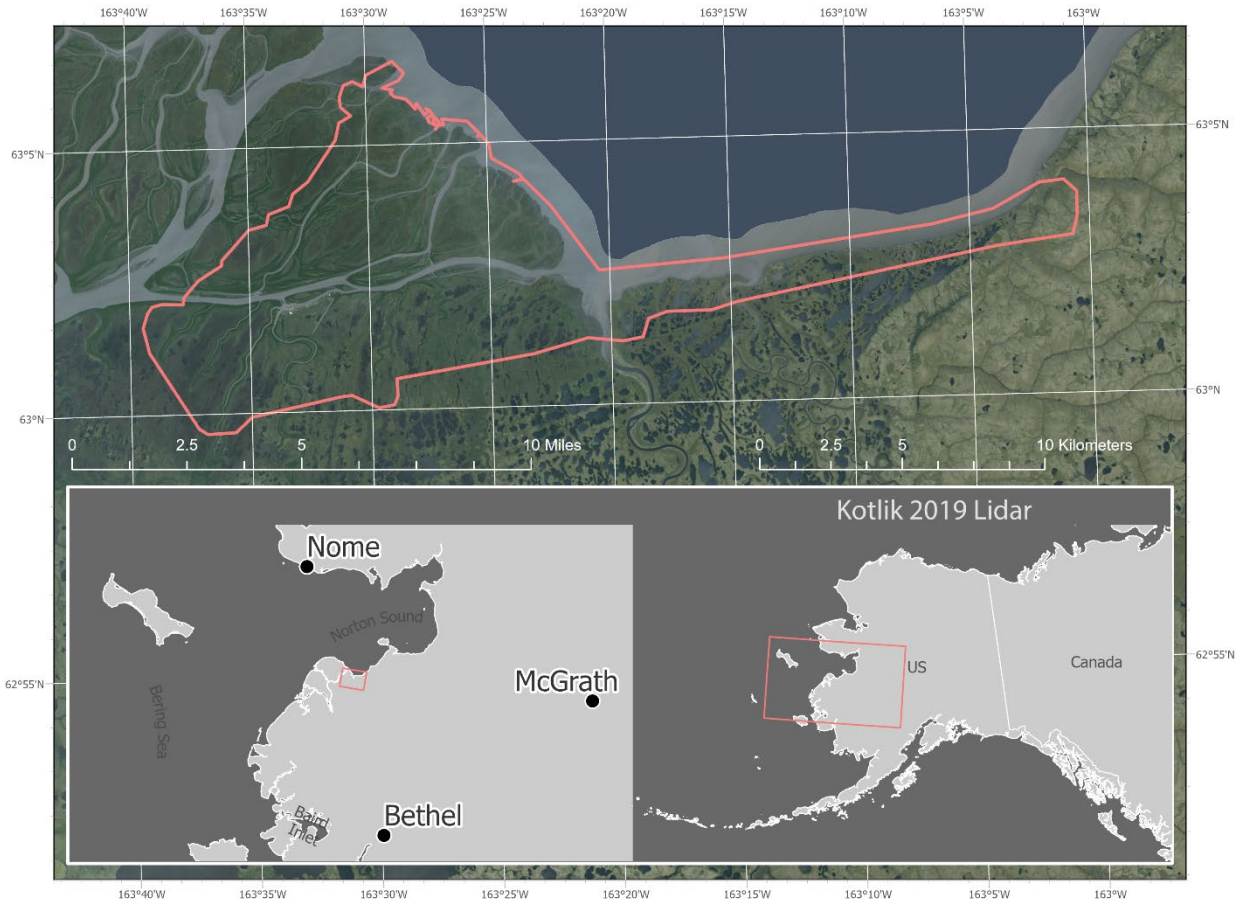
HIGH-RESOLUTION LIDAR DATA FOR KOTLIK, WESTERN ALASKA

Andrew M. Herbst and Ronald J. Daanen

Raw Data File 2020-15



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.

2020
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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HIGH-RESOLUTION LIDAR DATA FOR KOTLIK, WESTERN ALASKA

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a digital terrain model (DTM), surface model (DSM), and intensity model for the area surrounding the community of Kotlik, Alaska. Detailed bare earth elevation data for the Kotlik area support and inform potential infrastructure development and provide critical information required to assess geomorphic activity. Airborne data were collected on August 17, 2019, and subsequently processed in Terrasolid and ArcGIS. Ground control was collected between August 20-22, 2019, by the Alaska Division of Mining, Land, and Water. 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/10.14509/30561.

LIST OF DELIVERABLES

Classified Points

DSM, DTM, and Hydro-Enforced DTM

Intensity Image

Metadata

MISSION PLAN

Airborne Survey Details

DGGS operates a Riegl VUX1-LR lidar integrated with a GNSS and Northrop Grumman IMU system. The integration was designed by Phoenix LiDAR systems. The sensor is capable of collecting up to 820,000 points per second over a distance of 150 m. This survey was flown at a scan rate between 200,000 and 400,000 points per second at a scan rate between 80 and 150 lines per second. This survey was flown with an average elevation of 400 m above ground level and a ground speed of approximately 40 m/s with a fixed-wing aircraft configuration, using a Cessna 185 aircraft. The scan angle was set from 55 to 305 degrees. The total area surveyed was approximately 15 km^2.

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Weather Conditions and Flight Times

The airborne survey was flown on August 17, 2019, aboard a Cessna 185. Flight take-off occurred at 8:00 am from the airport in Unalakleet, Alaska, and landing occurred at 8:02 pm. The aircraft landed at the airstrip in Kotlik, Alaska, twice during the survey, once to refuel and once to restart the base station GPS. The weather throughout the survey was fair and cloudless. A lidar instrument error persisted throughout the entire day, rendering the voltage reading of its batteries inoperable. The operator performed a mid-flight battery swap, which briefly disrupted the flightline record for that take-off/landing. This event was determined to be inconsequential to the quality of the final product of this survey.

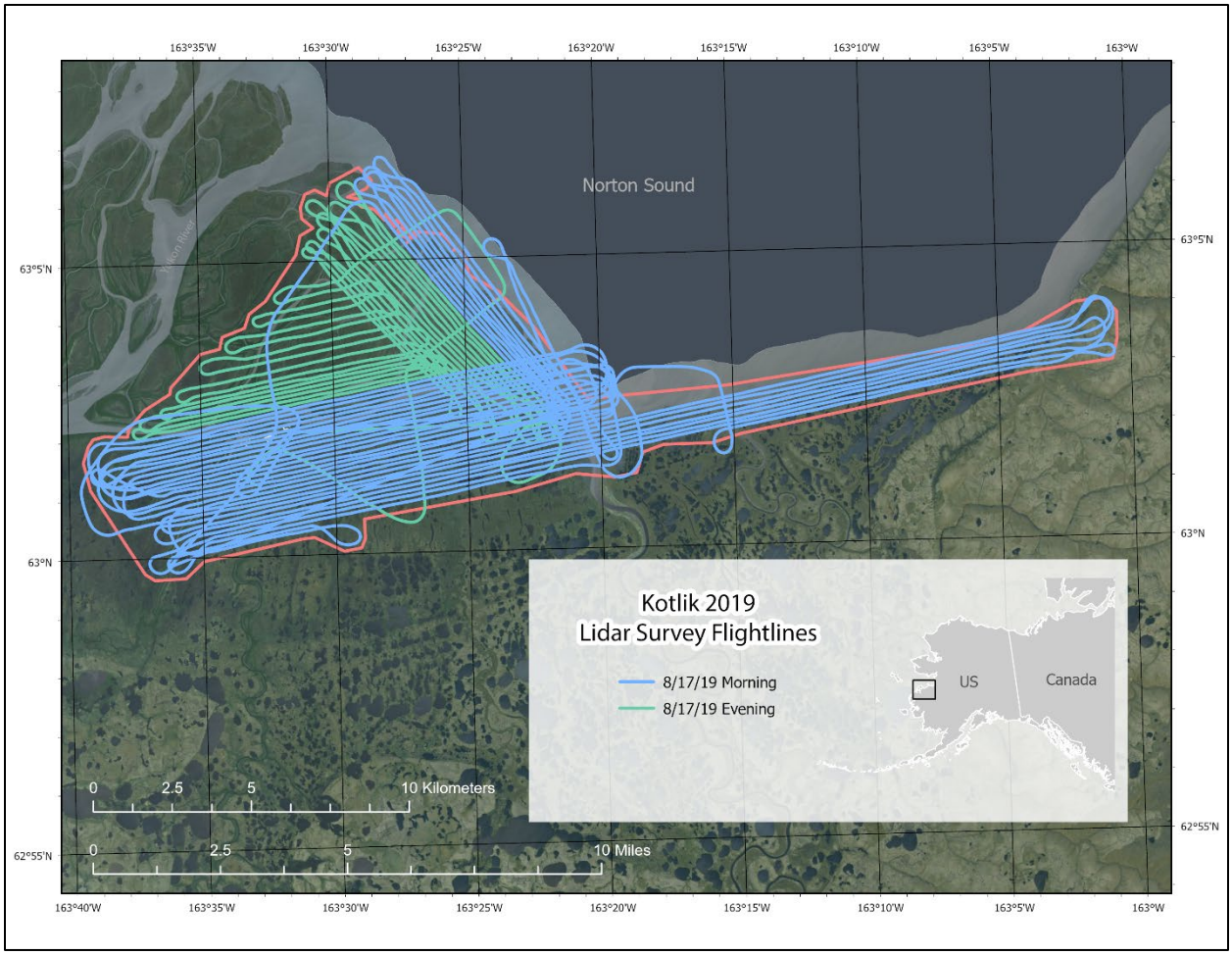

Figure 1. Project flightlines.

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. IMU and GPS data were 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 ASPRS 2014 guidelines, using macros designed in Terrasolid software. Careful attention was given to the interpolation of the project's ground surface to compensate for inconsistent penetration through low vegetation as a function of the scan angle. Once classified, points underwent a geometric transformation and were converted from ellipsoidal heights to GEOID12B (Alaska) heights.

Raster products were derived from the point cloud, using ArcMap. The DTM was interpolated from all ground class returns using a tin-based method. The DTM was also used to produce a separate hydroflattened raster, incorporating hydrography polygons from the AK SDMI IFSAR dataset. The DSM was likewise interpolated from only the first returns for all classes. An intensity image was also produced in ArcMap, using closest-to-mean binning.

Classified Point Cloud

Classified point cloud data is 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 pulse spacing was 24.8 cm and the average density was 16.25 pts/m^2. Elevation surfaces interpolated from areas with a point density of fewer than 4pts/m^2 were classified as nodata.

Digital Surface Model

The DSM represents surface elevations, for example, heights of vegetation, buildings, bridges, etc. The DSM is a single band, 32-bit GeoTIFF file, with a ground sample distance of 0.5 meters. 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 0.5 meters. 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 0.5 meters. No Data value is set to -3.40282306074e+038 (32-bit, floating-point minimum).

Hydro-Enforced DTM

The hydro-enforced DTM represents bare earth surfaces that have undergone a selective "flattening" process, where elevation values for any hydrologic features and any hydrologic obstacles (bridges, culverts, etc.) were replaced with neighboring pixel values. The hydro-enforced DTM is a single-band, 32-bit float GeoTIFF file, with a ground sample distance of 0.5 meters. No Data value is set to -3.40282306074e+038.

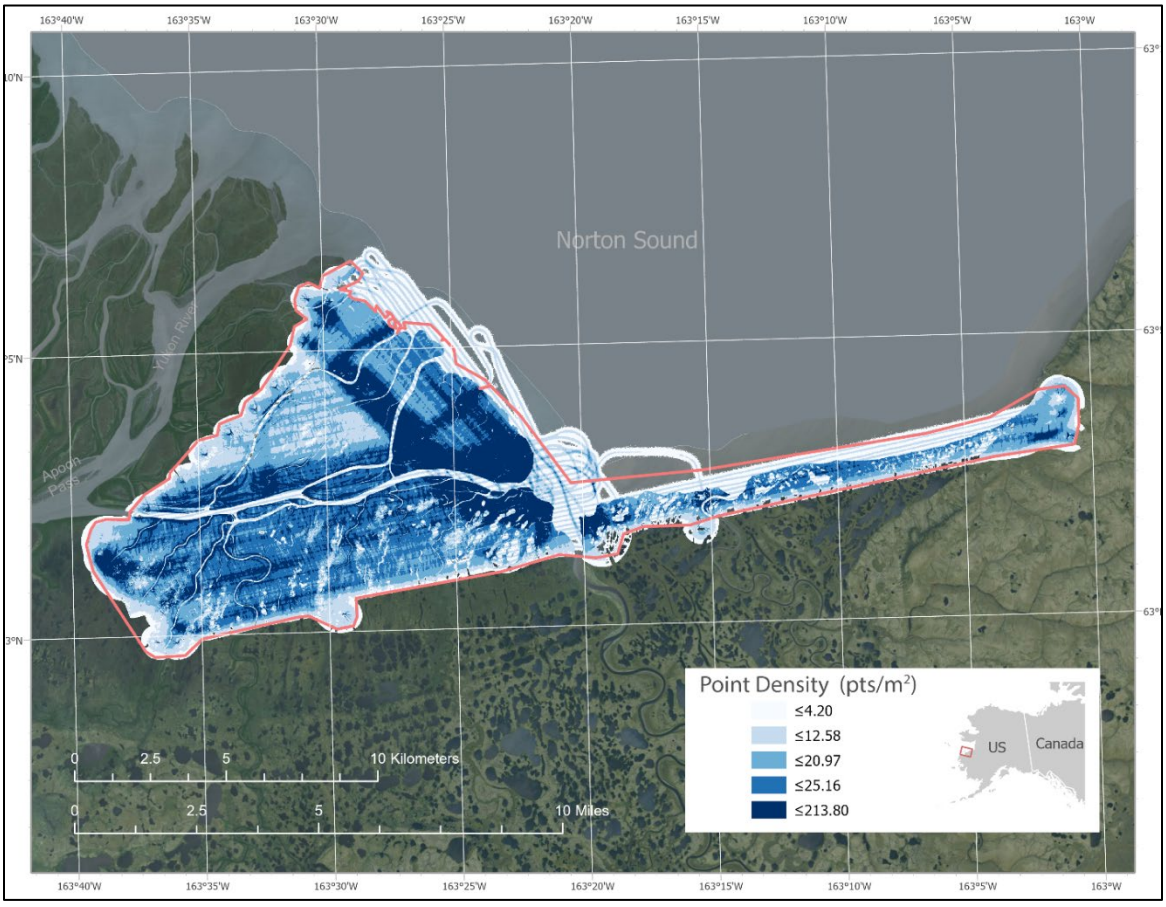

Figure 2. Ground point density for the survey displayed as a 1-meter raster.

SURVEY REPORT

Ground Survey Details

Licensed surveyors from the Alaska Division of Mining, Land and Water acquired surveyed ground control August 20-22, 2019 in an approximate 2-mile radius around the town of Kotlik. Ninety-four points were collected, including 42 bare earth, 18 forested, 33 low-vegetation, and 1 urban surface points.

Coordinate system and Datum

All data were processed and delivered in NAD83 (CORS96) UTM3N and vertical datum NAVD88 with a geoid correction following the latest GEOID12B for Alaska.

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

Forty-two bare earth checkpoints 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 8.2 cm. Using the same approach, fifty-two vegetated points were used to determine the vegetated vertical accuracy (VVA) of the point cloud ground class. Project VVA was evaluated at 25.2 cm RMSE, with an average elevation difference of +21.2 cm.

Data Consistency and Completeness

This data release is complete, and there is no over collect except for the aircraft turns that were eliminated from the dataset. The data quality is consistent throughout the survey.

ACKNOWLEDGMENTS

These data were paid for by the State of Alaska and collected and processed by DGGS. A ground survey was conducted for quality control by the Alaska Division of Mining, Land and Water, and supported by the Native Village of Bill Moore's Slough and the Native Village of Kotlik.

APPENDIX: CHECKPOINTS

Non-Vegetated :

No	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	573867.958	6989183.109	2.969	3.060	+0.091
2	574178.043	6989724.239	3.791	3.720	-0.071
3	574185.478	6989737.151	3.764	3.690	-0.074
4	574194.015	6989750.130	3.724	3.660	-0.064
5	574202.362	6989763.834	3.697	3.640	-0.057
6	574210.986	6989777.831	3.704	3.690	-0.014
7	574219.651	6989791.888	3.667	3.610	-0.057
8	574227.689	6989805.618	3.641	3.590	-0.051
9	574236.428	6989820.115	3.670	3.610	-0.060
10	574244.865	6989833.620	3.708	3.640	-0.068
12	598603.815	6993637.767	3.835	3.930	+0.095
13	597177.949	6992965.052	3.207	3.270	+0.063
14	595176.099	6992434.486	2.648	2.610	-0.038
15	593418.456	6992125.088	3.111	3.190	+0.079
16	592219.569	6992023.796	3.073	3.140	+0.067
17	590574.302	6991841.859	2.321	2.400	+0.079
18	588464.948	6991220.182	2.410	2.460	+0.050
19	584781.659	6990685.687	2.201	2.310	+0.109
20	578028.658	6992498.978	2.288	2.430	+0.142
21	574603.985	6990897.246	2.099	2.280	+0.181
22	572976.083	6989795.669	2.840	2.910	+0.070
23	572744.938	6989683.160	3.341	3.290	-0.051
24	572773.222	6989016.133	3.066	3.020	-0.046
25	572761.967	6989242.955	3.765	3.710	-0.055
26	572759.898	6989260.650	3.825	3.770	-0.055
27	572758.012	6989276.199	3.891	3.850	-0.041
28	572756.041	6989291.953	3.799	3.760	-0.039
29	572754.588	6989308.956	3.906	3.860	-0.046
30	572753.260	6989324.555	3.999	3.950	-0.049
31	572751.929	6989341.316	4.154	4.110	-0.044
32	573060.911	6990118.148	2.738	2.670	-0.068
33	573794.303	6990270.103	2.918	2.850	-0.068
34	574416.704	6990562.234	2.892	2.800	-0.092
35	574458.318	6990610.256	3.087	3.050	-0.037

No	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
36	574603.194	6990405.435	3.510	3.430	-0.080
37	574464.739	6990420.286	4.091	4.030	-0.061
38	573629.933	6987032.341	2.832	2.860	+0.028
39	573778.754	6986925.466	3.681	3.860	+0.179
40	578134.043	6993767.708	2.231	2.370	+0.139
41	578165.532	6995228.166	2.188	2.350	+0.162
42	582003.493	6991239.788	2.274	2.280	+0.006
	Average dz (m)	0.004			
	Minimum dz (m)	-0.092			
	Maximum dz (m)	0.181			
	Average magnitude (m)	0.071			
	RMSE (m)	0.081			
	Standard Deviation (m)	0.082			

Vegetated:

No	Easting (m)	Northing (m)	known Z (m)	Laser Z (m)	Dz (m)
1	574267.571	6989833.144	2.787	2.950	+0.163
4	598626.677	6993615.487	3.046	3.430	+0.384
5	598628.741	6993611.991	2.938	3.060	+0.122
6	597183.272	6992930.105	2.686	2.980	+0.294
7	595154.939	6992443.205	2.325	2.490	+0.165
8	593415.432	6992162.994	2.757	3.110	+0.353
9	592212.140	6992066.380	2.657	2.830	+0.173
10	592219.795	6992007.582	3.013	3.270	+0.257
11	588470.677	6991235.253	2.159	2.370	+0.211
12	582663.128	6992285.829	2.021	2.350	+0.329
13	579368.653	6995578.261	2.036	2.390	+0.354
14	578038.776	6992509.213	2.287	2.760	+0.473
15	578018.735	6992518.116	2.517	2.720	+0.203
16	576342.292	6991864.428	2.486	2.660	+0.174
17	574611.435	6990881.533	1.969	2.170	+0.201
18	574621.986	6990884.187	2.079	2.280	+0.201
19	572316.207	6990352.146	2.677	2.990	+0.313
20	572321.900	6990401.161	2.698	2.720	+0.022
21	572970.395	6989791.613	3.037	3.260	+0.223
22	572738.216	6989698.134	3.117	3.470	+0.353
23	572706.046	6989673.879	3.129	3.110	-0.019

No	Easting (m)	Northing (m)	known Z (m)	Laser Z (m)	Dz (m)
24	572784.729	6989037.235	3.285	3.540	+0.255
25	572796.829	6989037.831	2.834	3.110	+0.276
26	573024.809	6990004.658	3.291	3.440	+0.149
27	573010.894	6990001.750	2.744	3.000	+0.256
28	572740.504	6989908.575	2.203	2.470	+0.267
29	572746.740	6989897.038	2.702	2.810	+0.108
30	573054.878	6990114.709	2.724	2.750	+0.026
31	573148.714	6990070.764	5.056	4.950	-0.106
32	573165.198	6990069.442	2.970	3.030	+0.060
33	573856.528	6989852.442	2.868	3.260	+0.392
34	573854.063	6989849.536	3.019	3.320	+0.301
35	574418.237	6990582.192	2.362	2.710	+0.348
36	574472.261	6990617.604	2.415	2.430	+0.015
37	574617.931	6990457.588	3.723	3.700	-0.023
38	574625.067	6990463.240	3.625	3.700	+0.075
39	572094.316	6990685.062	2.225	2.370	+0.145
42	576809.498	6992017.127	2.379	2.530	+0.151
43	576810.294	6992004.441	2.528	2.770	+0.242
44	578134.123	6993767.685	2.252	2.360	+0.108
45	578585.963	6996236.733	1.994	2.190	+0.196
46	578335.728	6991161.675	2.517	3.170	+0.653
47	580045.401	6990479.531	2.681	2.920	+0.239
48	580741.326	6991703.991	2.303	2.560	+0.257
49	579236.902	6991896.388	2.368	2.610	+0.242
50	577131.692	6990647.965	2.716	2.920	+0.204
51	577127.534	6990649.968	2.627	2.750	+0.123
52	576172.839	6990691.436	2.430	2.710	+0.280
	Average dz (m)	0.212			
	Minimum dz (m)	-0.106			
	Maximum dz (m)	0.653			
	Average magnitude (m)	0.218			
	RMSE (m)	0.252			
	Standard deviation (m)	0.137			