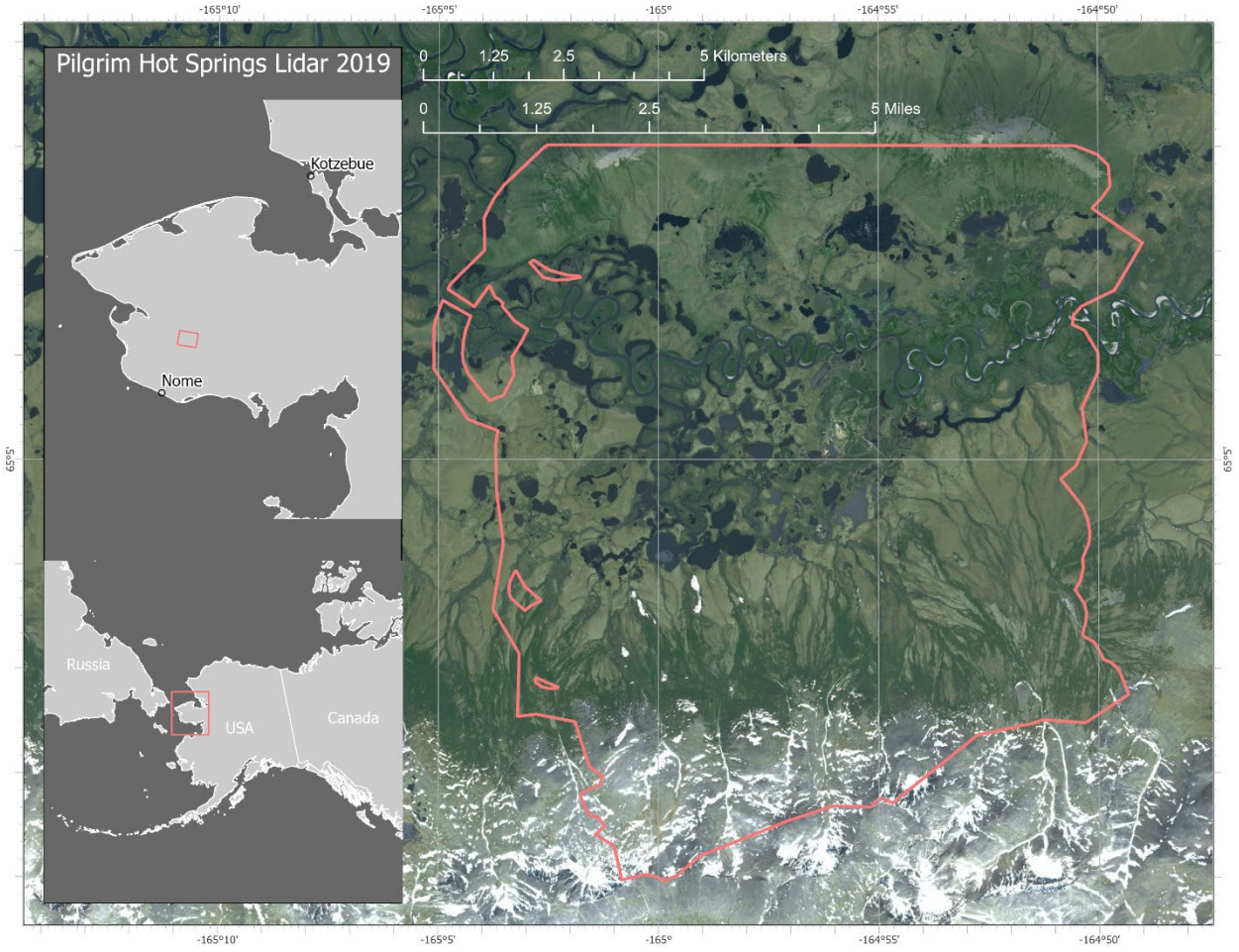
HIGH-RESOLUTION LIDAR DATA FOR PILGRIM HOT SPRINGS, WESTERN ALASKA, COLLECTED AUGUST 15, 2019

Andrew M. Herbst and Ronald J. Daanen

Raw Data File 2021-7



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.

2021
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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Suggested citation:
Herbst, A.M., and Daanen, R.P., 2021, High-Resolution lidar data for Pilgrim Hot Springs, western Alaska, collected August 15, 2019: Alaska Division of Geological & Geophysical Surveys Raw Data File 2021-7, 6 p. http://doi.org/10.14509/30659

HIGH-RESOLUTION LIDAR DATA FOR PILGRIM HOT SPRINGS, WESTERN ALASKA, COLLECTED AUGUST 15, 2019

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ABSTRACT

The State of Alaska Division of Geological & Geophysical Surveys (DGGS) produced airborne lidar-derived elevation data for the Pilgrim Hot Springs area, western Alaska. Both aerial lidar and ground control data were collected by DGGS. This data collection is being released as a Raw Data File with an open end-user license. These data were produced in support of active fault detection and geothermal hydrology research in the area. All files can be downloaded from the DGGS website at https://doi.org/10.14509/30659.

INTRODUCTION

LIST OF DELIVERABLES

Classified Points

DSM and DTM

Intensity Image

Metadata

MISSION PLAN

Airborne Survey Details

This dataset includes point cloud data, a digital terrain model (DTM), and a digital surface model (DSM) covering Pilgrim Hot Springs, western Alaska (approximately 47 mi^2). This survey was conducted with a DGGS-operated Riegl VUX1-LR lidar system with an integrated Global Navigation Satellite System (GNSS) receiver and Northrop Grumman inertial measurement unit (IMU) system. The integration was designed by Phoenix LiDAR systems. This survey was flown with a pulse rate between 200,000 and 400,000 pulses/second, at a scan rate between 80 and 150 scans/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 (fig. 1). The scan angle was set from 55 to 305 degrees, centered normal to the bottom of the aircraft.

Weather Conditions and Flight Times

The airborne survey occurred on August 15, 2019, with ground control collected on August 14, 2019. The weather was clear throughout the survey.

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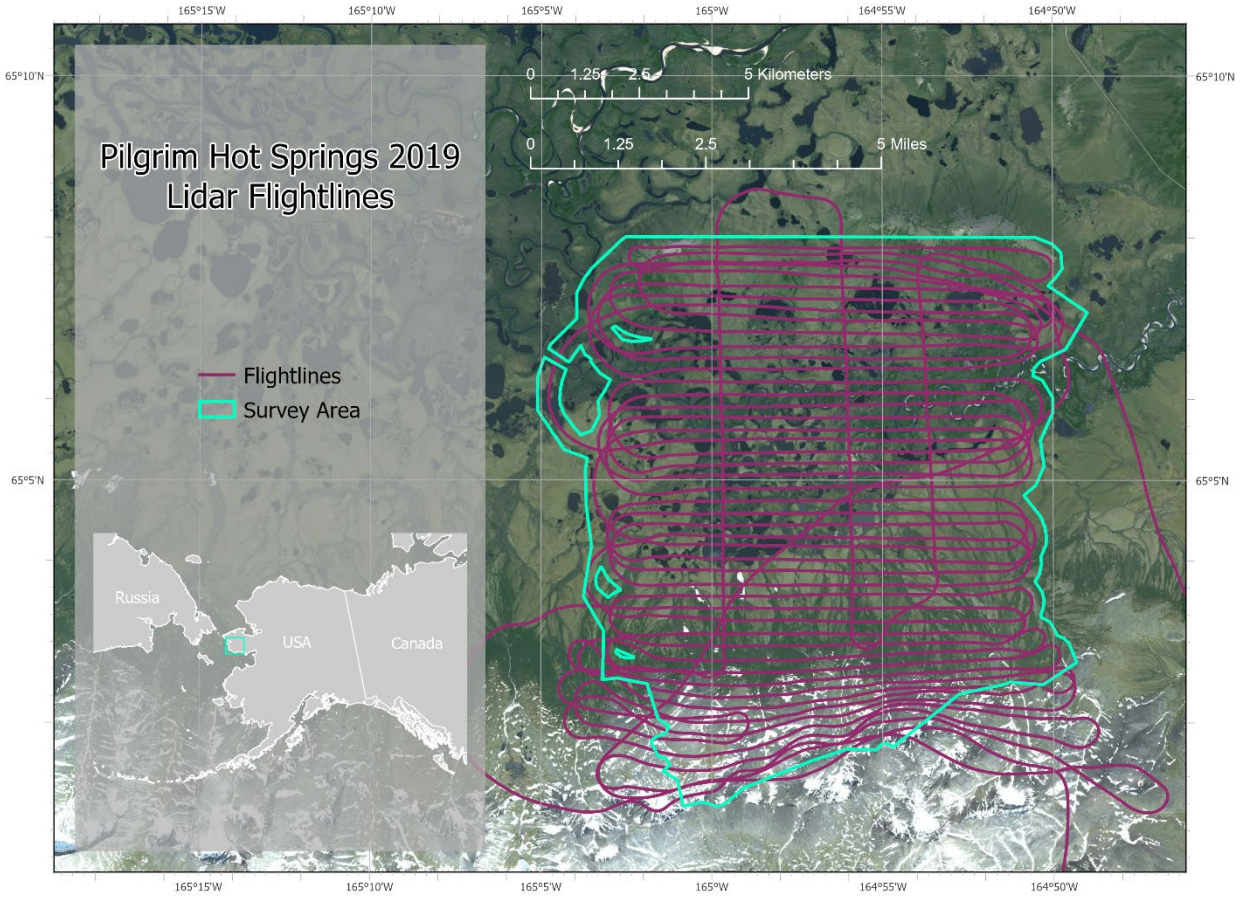

Figure 1. Project flightlines.

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 the American Society for Photogrammetry and Remote Sensing (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 mean binning method. The DSM was likewise interpolated from only the first returns for all classes. An intensity image was produced in ArcMap using 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 point spacing was 27 cm and the average density was 13.92 pts/m^2 (fig. 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, including heights of vegetation, buildings, bridges, etc. The DSM is a single band, 32-bit GeoTIFF file, with a ground sample distance of 1 meter. NoData 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 meters. NoData 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. NoData value is set to -3.40282306074e+038 (32-bit, floating-point minimum).

SURVEY REPORT

Ground Survey Details

Trimble R8 and R9 real-time kinematic GNSS systems were used to collect 62 combined checkpoints and control points for the project. Points were adjusted for accuracy according to Online Positioning User Service (OPUS) corrections in Trimble Business Center.

Coordinate system and Datum

All data were processed and delivered in NAD83 (2011) UTM3N and vertical datum NAVD88, GEOID12B.

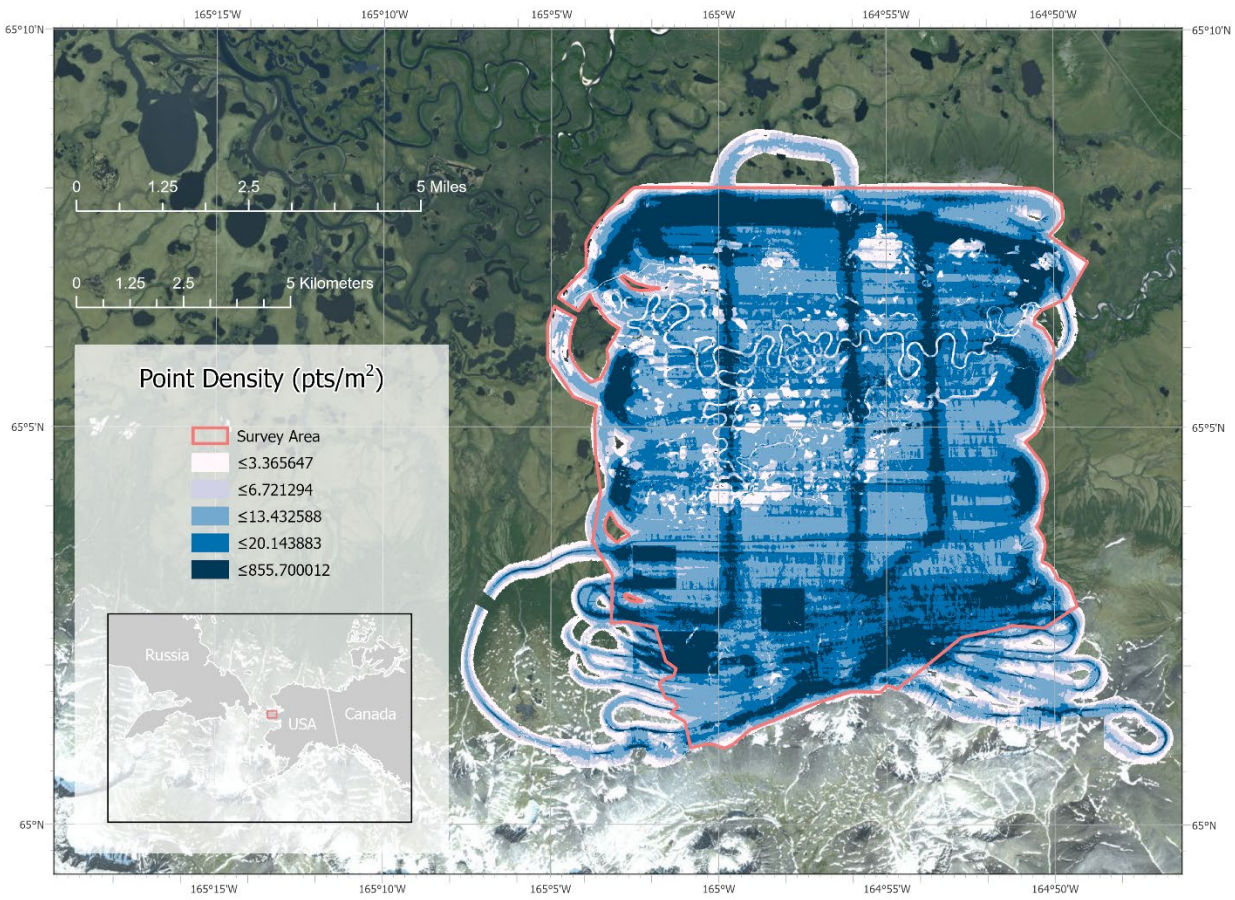

Figure 2. Ground point density for the survey displayed as a 1-meter raster.

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

Thirty-one ground control points were used to determine a 0.11 m average offset from the point cloud (app. 1), which was corrected with a uniform z-transformation of the lidar data. Point cloud accuracy was measured using 31 checkpoints to determine a root-mean-square error of 0.087 m for the project (app. 2). Relative accuracy for this dataset has been evaluated as the interswath consistency, measured by comparing tie line points within swath overlap areas. The interswath root-mean-square error was calculated to be 0.008 meters.

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.

APPENDIX 1. CONTROL POINTS

Number	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	503703.878	7218097.483	4.973	5.040	0.067
2	503649.164	7218143.976	5.258	5.310	0.052
3	503625.573	7218188.073	4.925	4.980	0.055
4	503573.001	7218600.977	4.952	4.990	0.038
5	503560.189	7218666.124	4.812	4.920	0.108
6	503540.102	7218718.466	5.258	5.290	0.032
7	503563.601	7218768.335	5.574	5.740	0.166
8	503658.812	7218804.373	5.025	5.150	0.125
9	503719.533	7218824.089	5.149	5.270	0.121
10	503761.246	7218833.978	4.883	4.940	0.057
11	503861.460	7218909.163	4.920	4.960	0.040
12	503957.781	7218996.531	4.857	4.990	0.133
13	504042.793	7219059.576	4.914	5.040	0.126
14	504109.987	7219072.728	5.327	5.470	0.143
15	504157.601	7219089.806	5.502	5.550	0.048
16	504180.730	7219119.014	4.123	4.180	0.057
17	503545.945	7218861.500	5.312	5.420	0.108
18	503478.666	7219009.436	4.601	4.740	0.139
19	503415.808	7219056.588	4.817	5.070	0.253
20	503361.058	7219116.104	4.939	5.240	0.301
21	503297.875	7219141.310	4.571	4.930	0.359
22	503413.996	7218598.676	5.700	5.760	0.060
23	503397.047	7218550.073	5.216	5.280	0.064
24	503401.099	7218530.192	5.209	5.290	0.081
25	503387.213	7218488.279	5.223	5.320	0.097
26	503362.208	7218428.584	4.720	4.910	0.190
27	503284.009	7218459.250	4.646	4.770	0.124
28	503254.094	7218470.398	4.682	4.760	0.078
29	503229.915	7218482.195	4.605	4.670	0.065
30	503126.062	7218456.030	4.332	4.440	0.108
31	503110.431	7218455.493	4.255	4.330	0.075

Average dz (m)	0.112
Minimum dz (m)	0.032
Maximum dz (m)	0.359
Average magnitude (m)	0.112
Root mean square (m)	0.135
Standard deviation (m)	0.076

APPENDIX 2. CHECKPOINTS

Number	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	503681.026	7218116.757	5.062	5.020	-0.042
2	503630.105	7218161.748	5.083	5.020	-0.063
3	503574.179	7218578.425	5.093	5.050	-0.043
4	503571.315	7218636.820	4.734	4.690	-0.044
5	503552.094	7218678.700	4.750	4.690	-0.060
6	503551.343	7218748.208	5.475	5.500	0.025
7	503584.602	7218780.386	4.805	4.760	-0.045
8	503692.638	7218818.247	4.856	4.800	-0.056
9	503744.280	7218830.310	5.026	5.110	0.084
10	503786.750	7218846.373	5.055	4.960	-0.095
11	503906.306	7218951.968	4.752	4.740	-0.012
12	504007.614	7219034.216	5.104	5.230	0.126
13	504071.599	7219079.588	5.177	5.120	-0.057
14	504119.277	7219097.393	5.403	5.370	-0.033
15	504176.789	7219094.489	4.998	4.960	-0.038
16	503542.897	7218852.777	5.322	5.380	0.058
17	503508.226	7218871.342	4.758	4.750	-0.008
18	503479.100	7219047.097	4.823	4.670	-0.153
19	503372.827	7219102.661	4.634	4.880	0.246
20	503312.129	7219132.910	4.650	4.870	0.220
21	503419.213	7218605.933	5.542	5.520	-0.022
22	503421.781	7218590.445	5.976	5.940	-0.036
23	503409.900	7218539.350	5.627	5.610	-0.017
24	503398.798	7218518.426	5.169	5.140	-0.029
25	503381.035	7218451.175	5.226	5.200	-0.026
26	503355.837	7218433.090	4.878	4.990	0.112
27	503264.828	7218464.975	4.756	4.710	-0.046
28	503232.307	7218477.119	4.622	4.560	-0.062
29	503147.751	7218461.717	4.396	4.440	0.044
30	503122.653	7218492.332	3.555	3.470	-0.085
31	503107.109	7218399.449	4.696	4.580	-0.116

Average dz (m)	-0.009
Minimum dz (m)	-0.153
Maximum dz (m)	0.246
Average magnitude (m)	0.068
Root mean square (m)	0.087
Standard deviation (m)	0.088