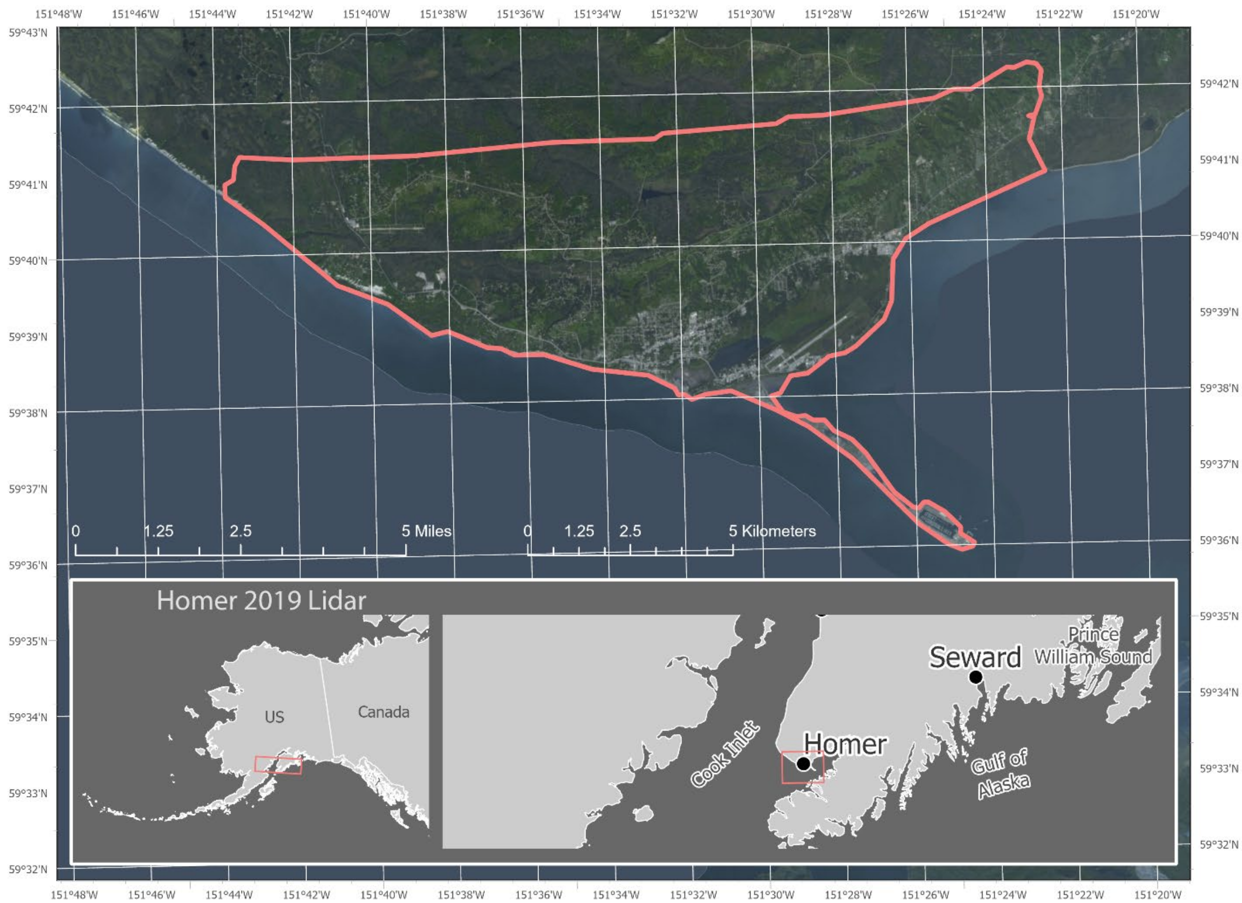
LIDAR-DERIVED ELEVATION MODELS FOR HOMER, ALASKA

J. Barrett Salisbury, Ronald P. Daanen, and Andrew M. Herbst

Raw Data File 2021-2



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DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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LIDAR-DERIVED ELEVATION MODELS FOR HOMER, ALASKA

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used lidar to produce digital terrain models (DTM), a digital surface model (DSM), and an intensity model for Homer, Alaska. Detailed bare earth elevation data for Homer were collected and processed for use in a landslide hazard resiliency project for the City of Homer. Data coverage includes neighboring Kachemak City. Lidar and Global Navigation Satellite System (GNSS) data were collected on June 3, 2019, and subsequently processed using TerraSolid™ and ArcGIS™. The Alaska Division of Mining, Land, & Water (DMLW) Survey Section conducted a targeted Ground Control Survey for this project on June 19–20, 2019. These data are being released as a Raw Data File with an open end-user license. All files can be downloaded for free from the DGGS publications website at https://doi.org/10.14509/30591.

LIST OF DELIVERABLES

Classified Points
Digital Surface Model (DSM)
Digital Terrain Model (DTM)
Hydro-Flattened DTM
Lidar Intensity Image
Metadata

MISSION PLAN

Aircraft and Instrument

DGGS operates a Riegl VUX1-LR laser scanner with a GNSS and Northrop Grumman Inertial Measurement Unit (IMU). The integration was designed by Phoenix LiDAR systems. The sensor can collect up to 820,000 points per second over a 150 m range. We flew the instrument with a repetition rate of 400,000 pulses per second, a scan speed of 200 revolutions per second, at approximately 200 m above ground level, and at a ground speed of approximately 40 meters per second with a fixed-wing Cessna 185. The scan look angle operated between 55 and 305 degrees. The total data coverage is approximately 98 km^2.

Weather Conditions and Flight Times

DGGS collected lidar data on June 3, 2019, initiating the GNSS base station at 08h48 and flying from 10h15 to 15h35 with a 15-minute refuel at 14h15. The sky was clear with light, easterly winds. Heavy air traffic precluded sufficient scanning of the southwestern portion of Beluga Lake

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and an area southeast of the Homer Airport runway (along Kachemak Drive). The low-quality data at the southwest end of Beluga Lake has been clipped and flattened to lake level.

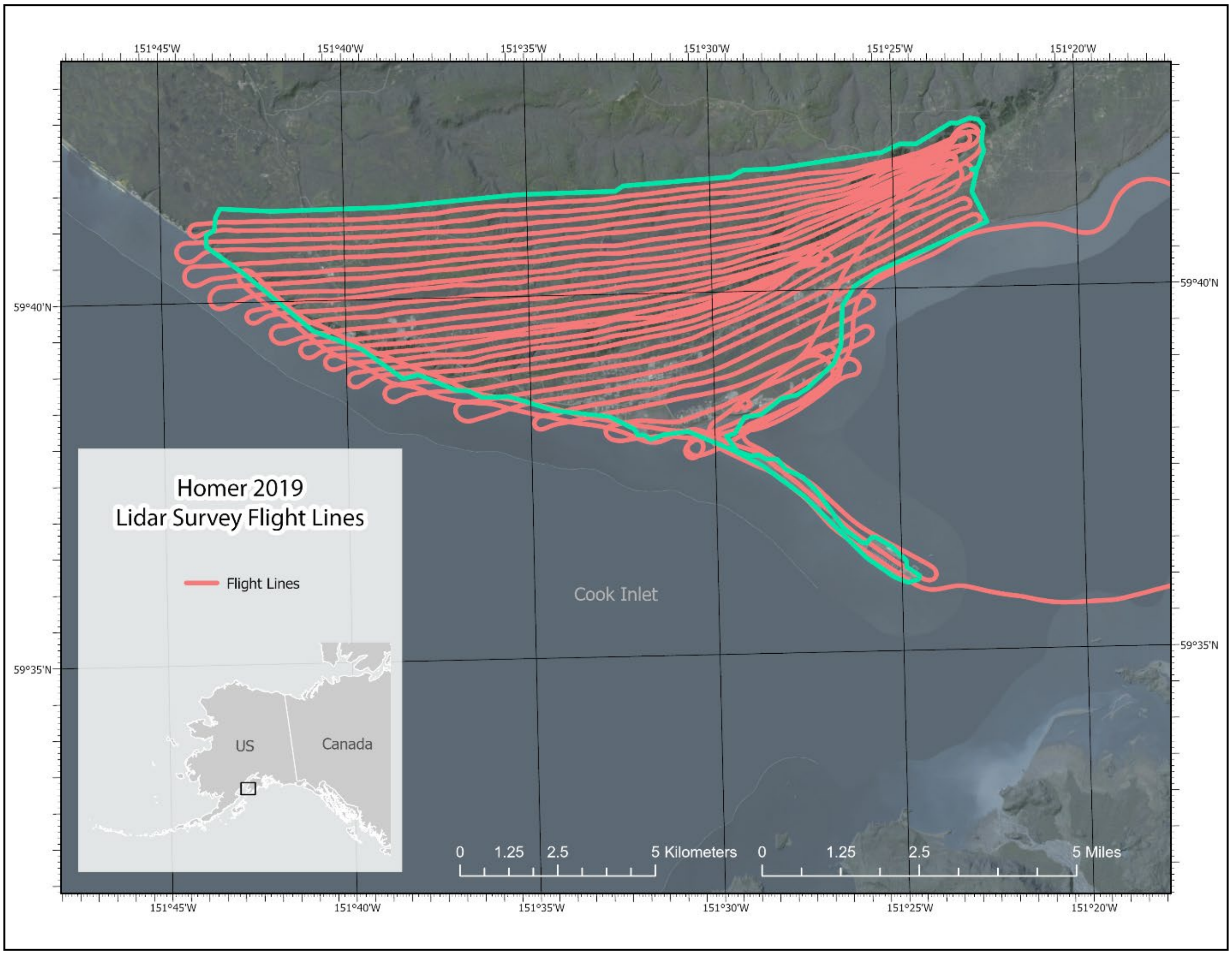

Figure 1. Project flight lines.

PROCESSING REPORT

Lidar Dataset Processing

DGGS processed raw data by first using SDCImport™ to apply range thresholding, reflectance thresholding, and missed-time-around (MTA) disambiguation for preliminary point cloud noise filtering. We coupled in-flight IMU and GNSS data in Inertial Explorer™ to produce flight trajectory data and coupled the trajectory data with the raw point cloud in Spatial Explorer™.

We then used Terrasolid™ to calibrate point cloud data using tielines for roll, pitch, and yaw of the aircraft during the survey. We completed this process first for all points, then on a per-flight-line basis. For additional calibration, we identified interswath fluctuations in preliminarily-classified ground points using overlapping tielines. We classified the point cloud in accordance with American Society for Photogrammetry and Remote Sensing (ASPRS) guidelines using project-tailored macros, resulting in a ground points class, as well as low, medium, and high vegetation (0.01–0.3 m, 0.3–5 m, and 5–60 m heights above the ground, respectively). Misclassified points were manually reclassified in post-processing QA/QC. We eliminated all low points and air points from the dataset and manually identified some buildings under dense vegetation, particularly in areas of complex terrain. We hydro-flattened the Bridge Creek Reservoir, Beluga Lake, and Lampert Lake to specified elevations. Lastly, we converted the point cloud from ellipsoidal to orthometric heights using GEOID 12B, then uniformly adjusted the dataset to maintain a mean offset of 0 m with collected ground control.

All derivative products were created in ArcMap. The DTM and DSM were produced using point triangulation with nearest-neighbor interpolation. The DTM was derived from all returns for ground classified points, while the DSM used first returns for all non-noise classes. A lidar intensity image was created from first returns of all classes using 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. Elevation surfaces interpolated from areas with a point density of fewer than 4 pts/m^2 were classified as “no data.”

Digital Surface Model

DSMs represent surface elevations as they appear to the naked eye. They include the 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

DTMs represent surface elevations of ground surfaces, achieved by penetrating or flattening any vegetation, bridges, buildings, and other non-ground features. 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.

Hydro-Flattened DTM

The hydro-flattened DTM represents bare earth surfaces which have undergone a selective "flattening" process, where elevation values for any hydrologic features are replaced with a consistent, appropriate pixel (elevation) value. 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.

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).

SURVEY REPORT

Ground Control and Accuracy

The Alaska Division of Mining, Land, & Water Survey Section collected 79 points in a targeted Ground Control Survey in Homer on June 19–20, 2019.

Coordinate System and Datum

All data are processed and delivered in UTM5 NAD83 (2011) 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

The relative accuracy for this dataset is 10.38 cm RMSE, calculated as the interswath consistency. The non-vegetated vertical accuracy for classified ground point data is a root mean square error of 3.1 cm. The average pulse spacing is 18.56 cm and the average point density is 29 points per square meter.

Data Consistency and Completeness

This is a partial release dataset. After the refuel stop, the survey moved across Kachemak Bay to scan the north-facing flank of the Grewingk Glacier valley (the site of a 1967 landslide into the proglacial lake). Data covering the Grewingk Glacier landslide scar will be published separately. However, data quality portrayed here for Homer and Kachemak is consistent throughout the entire dataset.

ACKNOWLEDGMENTS

These data were collected and processed by the Alaska Division of Geological & Geophysical Surveys staff with funding by the Federal Emergency Management Agency (FEMA) through Cooperating Technical Partnership (CTP) with the City of Homer and AK DGGS under federal grant number CTP EMS-2018-CA-00016-S01.

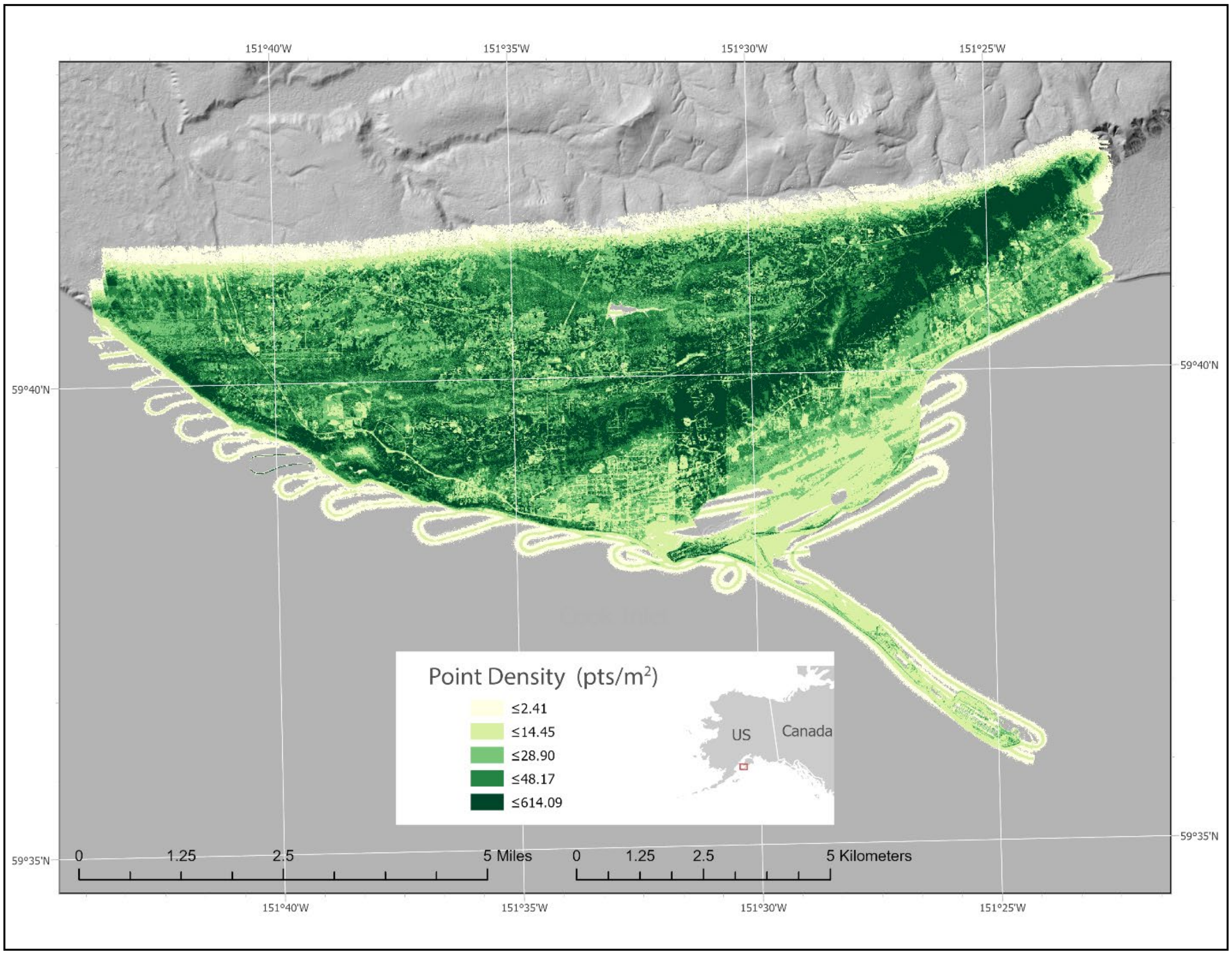

Figure 2. Point density displayed as 1-meter raster for the survey.

Appendix 1. Checkpoints

Number	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz Elevation Difference (m)
BE_5004	580635.927	6612533.982	53.735	53.75	0.015
BE_5011	577684.323	6613704.249	221.075	221.07	-0.005
BE_5013	582089.658	6612343.381	22.083	22.08	-0.003
BE_5058	581728.378	6616717.417	285.834	285.85	0.016
BE_5066	583843.713	6615651.758	357.632	357.67	0.038
BE_5073	586770.381	6617829.908	425.181	425.2	0.019
BENCHMARK_BM 4	589714.493	6608107.084	7.712	7.71	-0.002
NAIL_NAIL 3	588041.324	6615621.985	28.434	28.54	0.106
URBAN_5008	579796.212	6612613.893	67.457	67.41	-0.047
URBAN_5010	577672.012	6613710.098	221.541	221.52	-0.021
URBAN_5034	588021.495	6615616.825	28.081	28.09	0.009
URBAN_5051	580326.407	6614882.079	284.171	284.15	-0.021
URBAN_5068	585452.944	6616387.049	344.232	344.22	-0.012
URBAN_5072	586768.984	6617806.595	424.992	425.01	0.018
BE_5006	579733.917	6612602.377	64.482	64.47	-0.012
BE_5037	589369.308	6616889.273	75.511	75.48	-0.031
BE_5044	584781.612	6614377.014	56.403	56.39	-0.013
BE_5052	580330.363	6614870.042	283.271	283.25	-0.021
BE_5069	585443.523	6616397.515	343.668	343.7	0.032
PK_PK 1	583850.691	6615639.49	357.836	357.86	0.024
PK_PK 2	580636.745	6612538.878	53.408	53.42	0.012
URBAN_5023	587575.238	6609392.438	7.495	7.46	-0.035
URBAN_5043	584801.463	6614351.444	54.461	54.46	-0.001
URBAN_5061	581850.268	6615457.607	328.778	328.78	0.002

Average dz (m)	0.003
Minimum dz (m)	-0.047
Maximum dz (m)	0.106
Average magnitude (m)	0.021
Root mean square error (m)	0.03
Standard Deviation (m)	0.031