PHOTOGRAMMETRY-DERIVED ORTHOIMAGERY AND ELEVATION DATA FOR GOLOVIN, ALASKA, COLLECTED AUGUST 28, 2019

Richard M. Buzard, Keith C. Horen, and Katie Y. Miller

Raw Data File 2022-8

Location map of survey area

This report has not been reviewed for technical content or
for conformity to the editorial standards of DGGS.

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DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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Alaska Division of Geological & Geophysical Surveys (DGGS)
3354 College Road | Fairbanks, Alaska 99709-3707
Phone: 907.451.5010 | Fax 907.451.5050
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PHOTOGRAMMETRY-DERIVED ORTHOIMAGERY AND ELEVATION FOR GOLOVIN, ALASKA, COLLECTED AUGUST 28, 2019

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) collected low-altitude aerial images from an unmanned aerial vehicle (UAV) on August 28, 2019, and used Structure-from-Motion (SfM) photogrammetry to produce a digital surface model (DSM) and orthoimagery of Golovin (fig. 1). The orthoimage and elevation data were collected to assess coastal hazards and changes. We used Trimble Business Center to process the Global Navigation Satellite System (GNSS) data used for positional control. We used Agisoft Metashape to process photogrammetry data. These products are released as a Raw Data File with an open end-user license. All files can be downloaded from https://doi.org/10.14509/30857 or elevation.alaska.gov.

LIST OF DELIVERABLES

- Orthoimagery
- Digital Surface Model (DSM)
- Metadata

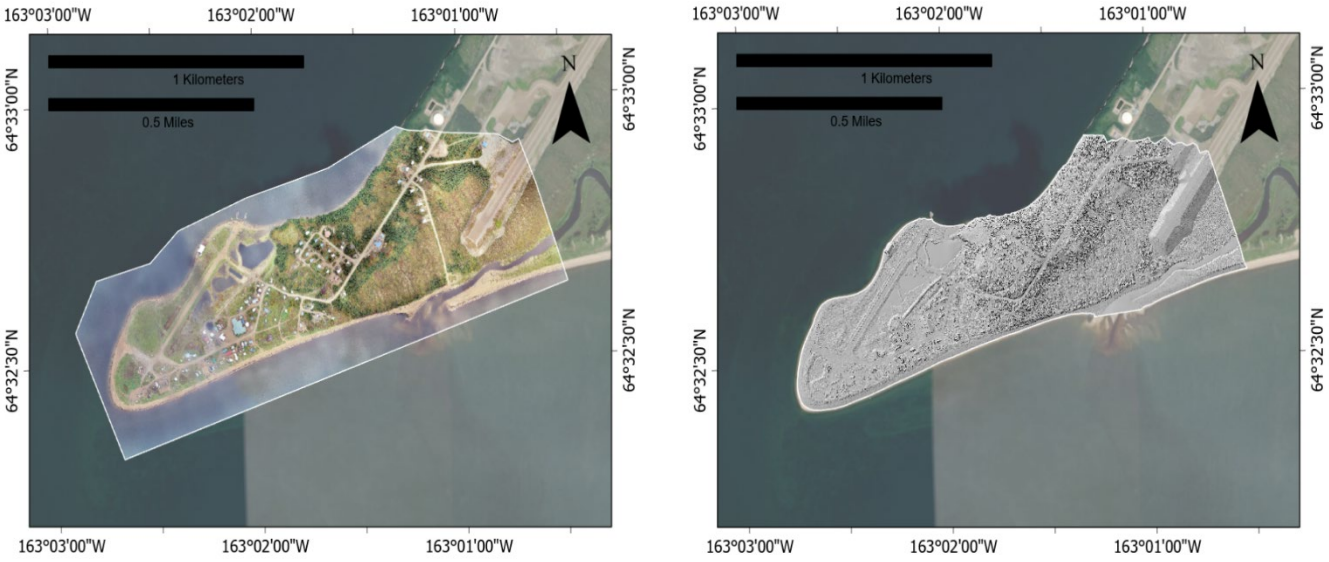

Figure 1. Extent of orthoimage (left) and digital surface model (right) for Golovin.

MISSION PLAN

Aerial Photogrammetric Survey Details

DGGS used a DJI Phantom 4 RTK UAV with a FC6310R camera model (8.8 mm lens) to collect 20-megapixel JPEG photographs (5472 x 3648 pixels per image). We flew the aerial survey with 70 percent sidelap and 80 percent frontlap, 115 m above the ground at between 5.5 and 7.9 m/s, with nadir orientation stabilized using a 3-axis gimbal. This resulted in 1,605 images covering 1.02 km^2 with ground sampling distance (GSD) of 0.03 m.

Weather and Photo Conditions

DGGS conducted flights on August 28, 2019, from 09:00 AM to 11:30 AM AKDT. The operator returned the UAV five times to change batteries. The weather throughout the survey was overcast with light wind. There was light rain during approximately the first hour of the survey. No abnormalities were observed during the flights.

SURVEY AND PROCESSING REPORT

Ground Survey Details

DGGS set up a GNSS base station using the Trimble R10 receiver sampling at 5 Hz. The base was installed over a temporary benchmark near known, but unrecovered, benchmark USLM 3651 1970 with a published solution (found at https://www.ngs.noaa.gov/OPUS/getDatasheet.jsp?PID=BBDJ67&ts=18215132934). This provided real-time kinematic (RTK) corrections to the Trimble R8s GNSS receiver (ground rover). The corrected base position was derived using the Online Positioning User Service (found at http://www.ngs.noaa.gov/OPUS/). The R8s positions were updated using post-processing kinematic (PPK) corrections in Trimble Business Center. DGGS measured 36 photo-identifiable ground control points (GCPs) with the ground rover, 18 of which were utilized for georeferencing during processing. The remaining 18 were reserved for quality control checks.

Photogrammetric Dataset Processing

During the survey, the UAV maintained RTK connection. Within the UAV GNSS receiver settings, the lever arm correction is automatically applied and camera GNSS coordinates are written to the image metadata in WGS84 ellipsoid. Yaw, pitch, and roll information are not written to the image metadata. During processing we update UAV positions using an X, Y, and Z shift from the initial to corrected base position.

DGGS processed the data in Agisoft Metashape Professional software (Version 1.6.3 build 10732). We masked image corners where shadows and image warping were disruptive. Processing steps included aligning images, identifying GCPs, manually cleaning the sparse point cloud, optimizing the bundle block adjustment (refining camera position and lens distortion parameters), constructing the dense point cloud, building the DSM, and creating the orthomosaic image. During processing, we used 18 GCPs to create the model, leaving 18 GCPs as horizontal and vertical check points.

Orthoimagery

The orthoimage is a three-band (red, green, blue), 8-bit unsigned GeoTIFF file with a GSD of 0.027 m per pixel; the "No Data" value is set to 0.

Digital Surface Model

The DSM represents surface elevations such as the height of vegetation and buildings. We filtered the dense cloud to remove low confidence points with less than five contributing combined depth maps. Since water bodies can introduce noise, we manually delineated the river, pond, and beach boundaries to restrict the DSM to land only. Boundaries were identified using both visual selection from collected aerial images and point confidence. The DSM is a single-band, 32-bit floating point GeoTIFF file with a GSD of 0.054 m; the "No Data" value is set to -3.4028231 x 10^{38}.

ACCURACY REPORT

Coordinate System and Datum

All data were processed and delivered in NAD83 (2011) UTM Zone 3N and vertical datum NAVD88 (GEOID12B).

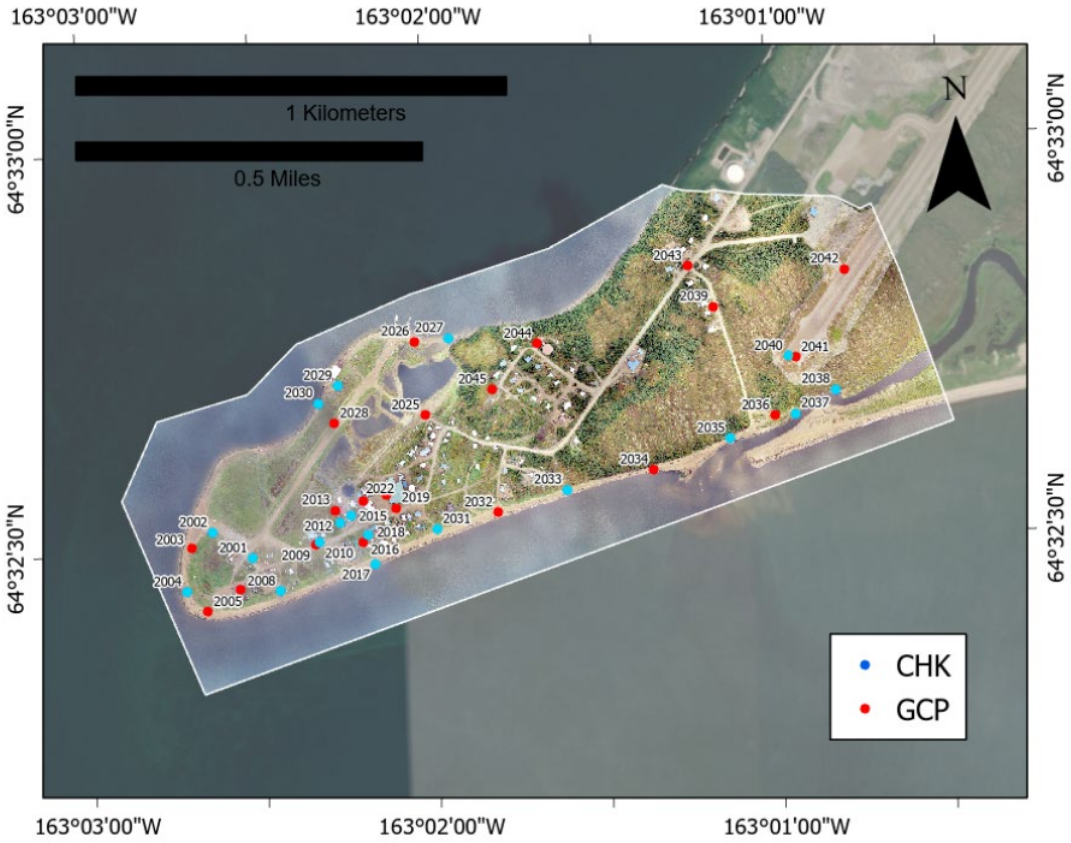

Figure 2. Location of photo-identifiable ground control points (GCP; red) and check points (CHK; blue).

Horizontal Accuracy

We quantify the horizontal accuracy of the DSM and orthoimage by comparing the known locations of 18 photo-identifiable check points measured with GNSS against their modeled locations in the photogrammetric products (fig. 2). These are independent checkpoints not used in processing. X and Y errors are calculated as the root-mean-square (RMS) error of offsets. The total horizontal error is the root-sum-square error of X and Y RMS errors, 0.032 m (table 1).

Vertical Accuracy

We assess the vertical accuracy of the DSM using the same check points. The RMS error of Z offsets is 0.035 m (table 1). The total error of the DSM (X, Y, and Z) is 0.045 m.

Data Consistency and Completeness

DGGS visually inspected the orthoimage for data errors such as shifts, seamline mismatches, and water noise overlapping land. There were no significantly erroneous areas that required repair. Visual errors common to these SfM photogrammetry products include discontinuous powerlines, blurriness near high-angle features such as buildings, and distortion at water boundaries. Bright objects, such as metal roofs and white paint, can cause overexposure and lead to spurious elevation points.

Table 1. Check point coordinates and offsets from orthoimagery and DSM.

Check Point	Easting	Northing	Elevation	X Offset (m)	Y Offset (m)	Z Offset (m)	GNSS X/Y Error (m)	GNSS Z Error (m)
2001	593894.004	7158813.894	3.768	-0.028	-0.010	0.026	0.016	0.021
2002	593802.297	7158873.316	2.637	0.014	-0.042	0.072	0.018	0.024
2004	593742.153	7158735.147	3.492	0.025	0.010	0.011	0.019	0.026
2008	593960.069	7158737.076	4.699	-0.063	-0.011	0.043	0.020	0.028
2010	594048.894	7158849.365	4.436	-0.033	0.004	0.027	0.019	0.028
2012	594097.245	7158896.593	5.190	-0.023	-0.012	0.052	0.019	0.026
2015	594122.002	7158911.689	4.887	-0.019	-0.010	0.003	0.020	0.030
2017	594179.802	7158800.651	2.584	0.001	0.011	-0.011	0.018	0.025
2018	594162.940	7158866.139	4.419	-0.029	-0.023	0.013	0.017	0.025
2027	594348.821	7159324.713	2.182	-0.051	-0.001	0.024	0.019	0.031
2029	594090.652	7159214.978	1.924	-0.016	-0.015	0.050	0.016	0.027
2030	594046.755	7159173.275	2.382	-0.044	-0.042	0.030	0.016	0.027
2031	594321.886	7158881.515	4.114	-0.006	0.021	-0.026	0.015	0.025

Check Point	Easting	Northing	Elevation	X Offset (m)	Y Offset (m)	Z Offset (m)	GNSS X/Y Error (m)	GNSS Z Error (m)
2033	594625.711	7158973.032	3.411	-0.035	-0.006	-0.027	0.016	0.024
2035	595004.141	7159093.771	3.385	-0.014	0.043	0.004	0.016	0.025
2037	595154.817	7159150.673	2.067	-0.010	0.048	-0.009	0.017	0.026
2038	595247.911	7159206.875	3.204	-0.008	-0.011	0.095	0.017	0.025
2040	595137.519	7159284.828	16.738	-0.033	-0.034	0.012	0.025	0.033
			Mean	-0.021	-0.004	0.022	0.018	0.026
			Standard Deviation	0.022	0.025	0.032	0.002	0.003
			Range	0.088	0.090	0.122	0.010	0.012
			Root Mean Square Error	0.021	0.024	**0.031**	0.002	0.003
			Total Error	**0.032**		**0.045**	**0.004**	
				(XY)		**(XYZ)**	**(XYZ)**	

ACKNOWLEDGMENTS

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