

# 20190810\_BearTrap\_UAV

Processing Report

25 Oktober 2021



# Survey Data

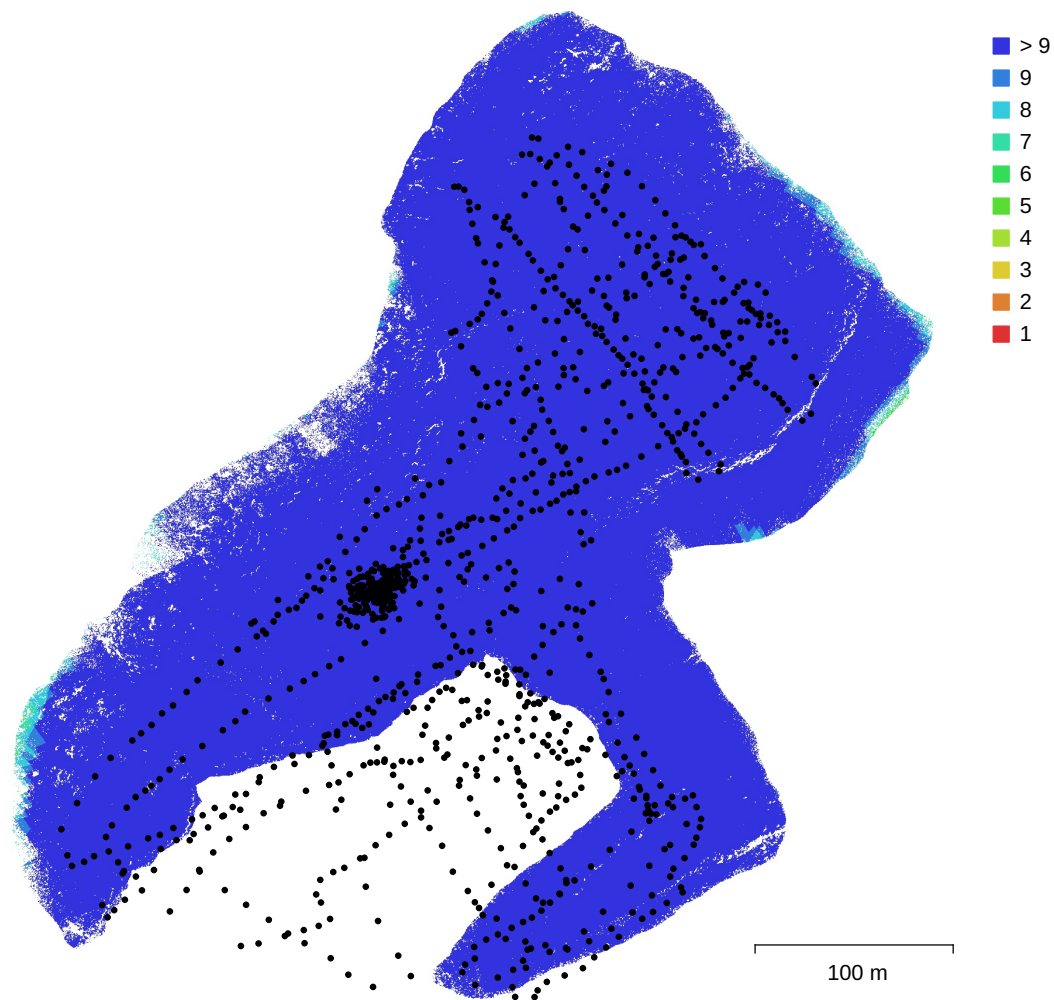


Fig. 1. Camera locations and image overlap.

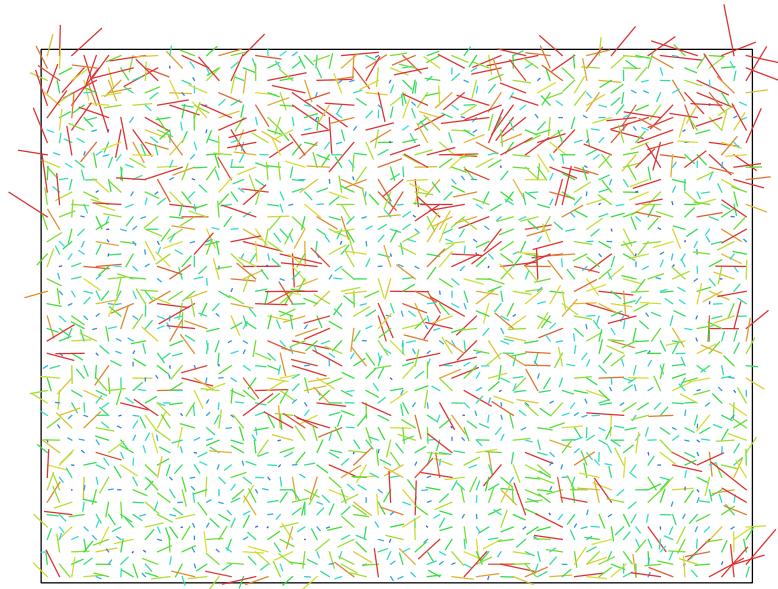
Number of images:	1,032	Camera stations:	1,032
Flying altitude:	57.7 m	Tie points:	1,227,887
Ground resolution:	1.83 cm/pix	Projections:	3,334,730
Coverage area:	0.104 km <sup>2</sup>	Reprojection error:	0.225 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
F1_FC300C (3.61mm)	4000 x 3000	3.61 mm	1.56 x 1.56 $\mu$ m	No
F2L_FC300C (3.61mm)	4000 x 3000	3.61 mm	1.56 x 1.56 $\mu$ m	No
F2H_FC300C (3.61mm)	4000 x 3000	3.61 mm	1.56 x 1.56 $\mu$ m	No
F3L_FC300C (3.61mm)	4000 x 3000	3.61 mm	1.56 x 1.56 $\mu$ m	No
F3H_FC300C (3.61mm)	4000 x 3000	3.61 mm	1.56 x 1.56 $\mu$ m	No

<b>Camera Model</b>	<b>Resolution</b>	<b>Focal Length</b>	<b>Pixel Size</b>	<b>Precalibrated</b>
F4_FC300C (3.61mm)	4000 x 3000	3.61 mm	1.56 x 1.56 $\mu\text{m}$	No
F5L_FC300C (3.61mm)	4000 x 3000	3.61 mm	1.56 x 1.56 $\mu\text{m}$	No
F5H_FC300C (3.61mm)	4000 x 3000	3.61 mm	1.56 x 1.56 $\mu\text{m}$	No

Table 1. Cameras.

# Camera Calibration



0.622826 pix

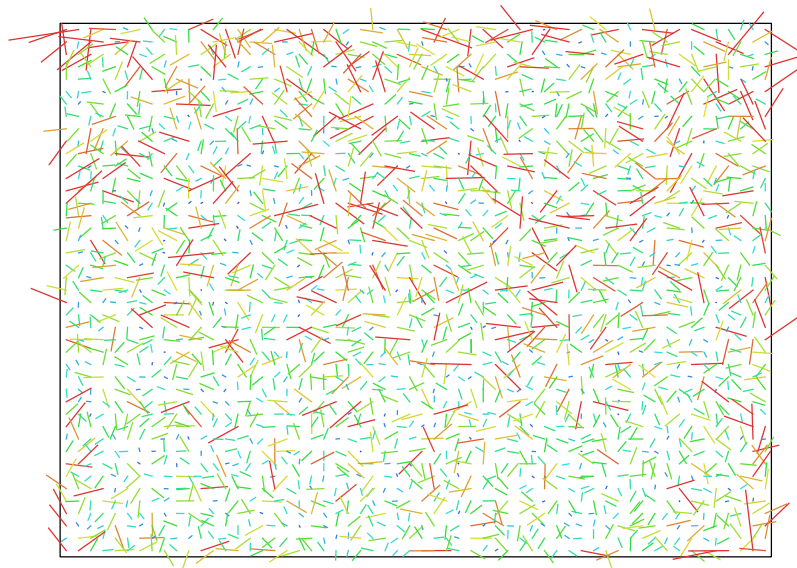
Fig. 2. Image residuals for F1\_FC300C (3.61mm).

## F1\_FC300C (3.61mm)

213 images, rolling shutter

Type	Resolution	Focal Length	Pixel Size
<b>Frame</b>	<b>4000 x 3000</b>	<b>3.61 mm</b>	<b>1.56 x 1.56 <math>\mu</math>m</b>
F:	2695.46		
Cx:	16.9559	B1:	-1.23463
Cy:	25.6767	B2:	-0.0644414
K1:	-0.130114	P1:	-0.000357758
K2:	0.124663	P2:	-0.000327926
K3:	-0.0446251	P3:	0
K4:	0.0163357	P4:	0

# Camera Calibration



0.853588 pix

Fig. 3. Image residuals for F2L\_FC300C (3.61mm).

## F2L\_FC300C (3.61mm)

206 images, rolling shutter

Type	Resolution	Focal Length	Pixel Size
<b>Frame</b>	<b>4000 x 3000</b>	<b>3.61 mm</b>	<b>1.56 x 1.56 <math>\mu</math>m</b>
F:	2696.46		
Cx:	17.5822	B1:	1.81995
Cy:	23.7123	B2:	-0.252053
K1:	-0.138032	P1:	-0.000422865
K2:	0.142122	P2:	-0.000297397
K3:	-0.0627408	P3:	0
K4:	0.0230907	P4:	0

# Camera Calibration

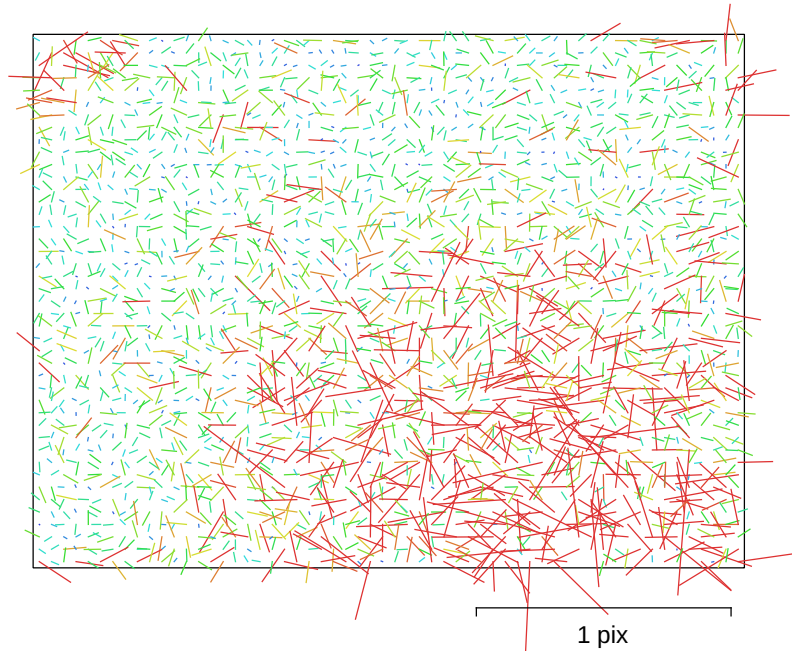


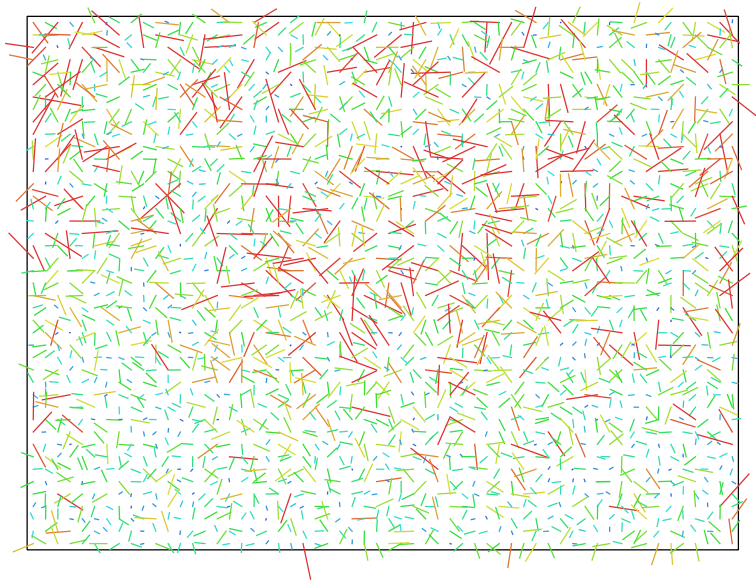
Fig. 4. Image residuals for F2H\_FC300C (3.61mm).

## F2H\_FC300C (3.61mm)

35 images, rolling shutter

Type	Resolution	Focal Length	Pixel Size
<b>Frame</b>	<b>4000 x 3000</b>	<b>3.61 mm</b>	<b>1.56 x 1.56 <math>\mu\text{m}</math></b>
F:	2690.36		
Cx:	17.1206	B1:	3.19148
Cy:	23.6194	B2:	-0.484077
K1:	-0.134365	P1:	-0.000628493
K2:	0.141507	P2:	-0.000394355
K3:	-0.0669254	P3:	0
K4:	0.026354	P4:	0

# Camera Calibration



0.743248 pix

Fig. 5. Image residuals for F3L\_FC300C (3.61mm).

## F3L\_FC300C (3.61mm)

147 images, rolling shutter

Type	Resolution	Focal Length	Pixel Size
<b>Frame</b>	<b>4000 x 3000</b>	<b>3.61 mm</b>	<b>1.56 x 1.56 <math>\mu\text{m}</math></b>
F:	2703.81		
Cx:	17.0555	B1:	2.88361
Cy:	12.8983	B2:	-0.276416
K1:	-0.134771	P1:	-0.000268998
K2:	0.129844	P2:	0.000371564
K3:	-0.0484933	P3:	0
K4:	0.0172693	P4:	0

# Camera Calibration

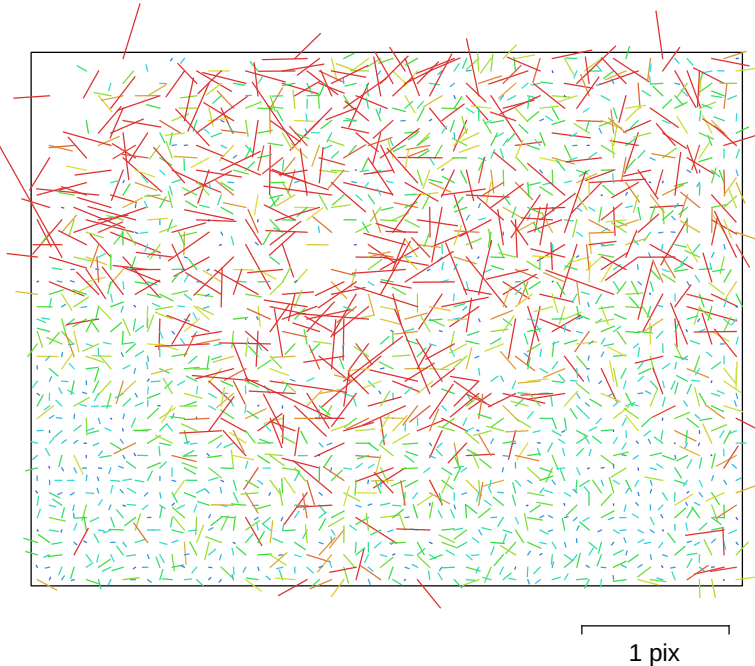


Fig. 6. Image residuals for F3H\_FC300C (3.61mm).

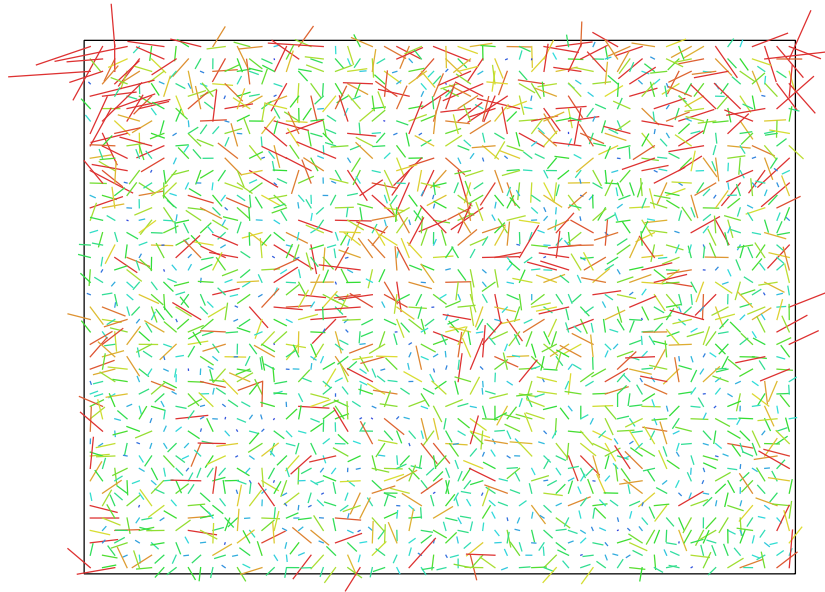
## F3H\_FC300C (3.61mm)

14 images, rolling shutter

Type	Resolution	Focal Length	Pixel Size
<b>Frame</b>	<b>4000 x 3000</b>	<b>3.61 mm</b>	<b>1.56 x 1.56 <math>\mu\text{m}</math></b>
F:	2692.15		
Cx:	16.9916	B1:	8.68924
Cy:	10.9433	B2:	-1.57862
K1:	-0.128205	P1:	-0.00014108
K2:	0.105238	P2:	0.000298044
K3:	-0.012986	P3:	0
K4:	-0.000700213	P4:	0



# Camera Calibration



0.547398 pix  
Fig. 7. Image residuals for F4\_FC300C (3.61mm).

## F4\_FC300C (3.61mm)

231 images, rolling shutter

Type	Resolution	Focal Length	Pixel Size
<b>Frame</b>	<b>4000 x 3000</b>	<b>3.61 mm</b>	<b>1.56 x 1.56 <math>\mu</math>m</b>
F:	2697.64		
Cx:	17.152	B1:	7.02105
Cy:	8.53792	B2:	-0.442918
K1:	-0.133028	P1:	-0.000255335
K2:	0.12318	P2:	0.000640683
K3:	-0.0410802	P3:	0
K4:	0.0140825	P4:	0

# Camera Calibration

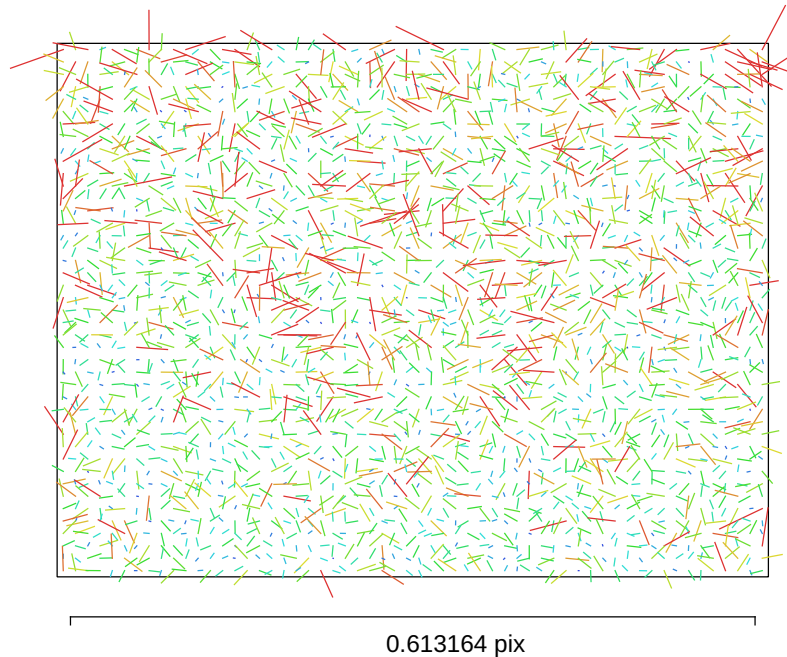


Fig. 8. Image residuals for F5L\_FC300C (3.61mm).

## F5L\_FC300C (3.61mm)

147 images, rolling shutter

Type	Resolution	Focal Length	Pixel Size
<b>Frame</b>	<b>4000 x 3000</b>	<b>3.61 mm</b>	<b>1.56 x 1.56 <math>\mu\text{m}</math></b>
F:	2701.96		
Cx:	16.7898	B1:	4.57319
Cy:	11.0061	B2:	-0.679855
K1:	-0.13764	P1:	-0.000470323
K2:	0.136285	P2:	0.00057986
K3:	-0.0563988	P3:	0
K4:	0.0206207	P4:	0

# Camera Calibration

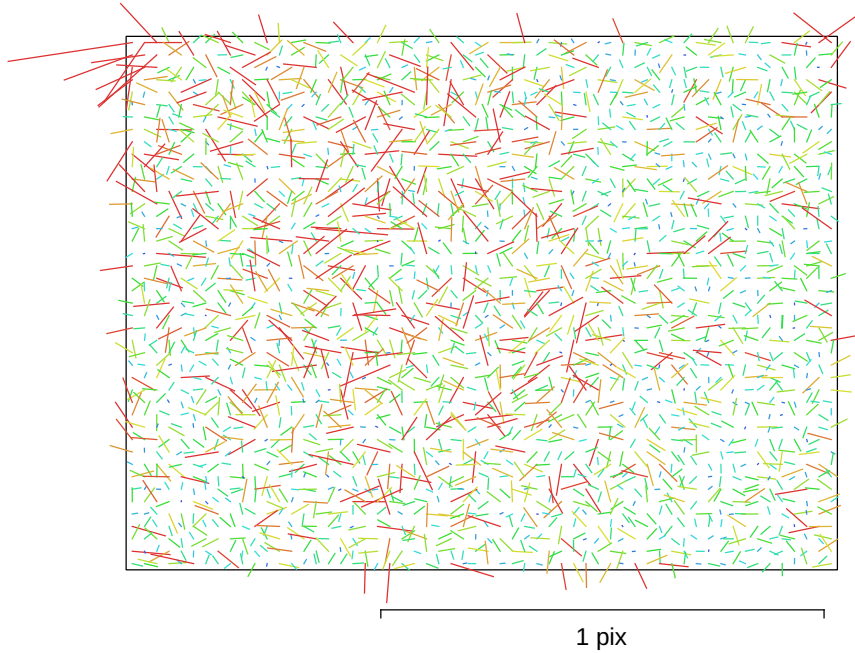


Fig. 9. Image residuals for F5H\_FC300C (3.61mm).

## F5H\_FC300C (3.61mm)

39 images, rolling shutter

Type	Resolution	Focal Length	Pixel Size
<b>Frame</b>	<b>4000 x 3000</b>	<b>3.61 mm</b>	<b>1.56 x 1.56 <math>\mu\text{m}</math></b>
F:	2693.86		
Cx:	18.2037	B1:	6.22746
Cy:	10.5749	B2:	-1.32046
K1:	-0.135568	P1:	-0.000185377
K2:	0.127981	P2:	0.000539286
K3:	-0.0463431	P3:	0
K4:	0.0157969	P4:	0

# Ground Control Points

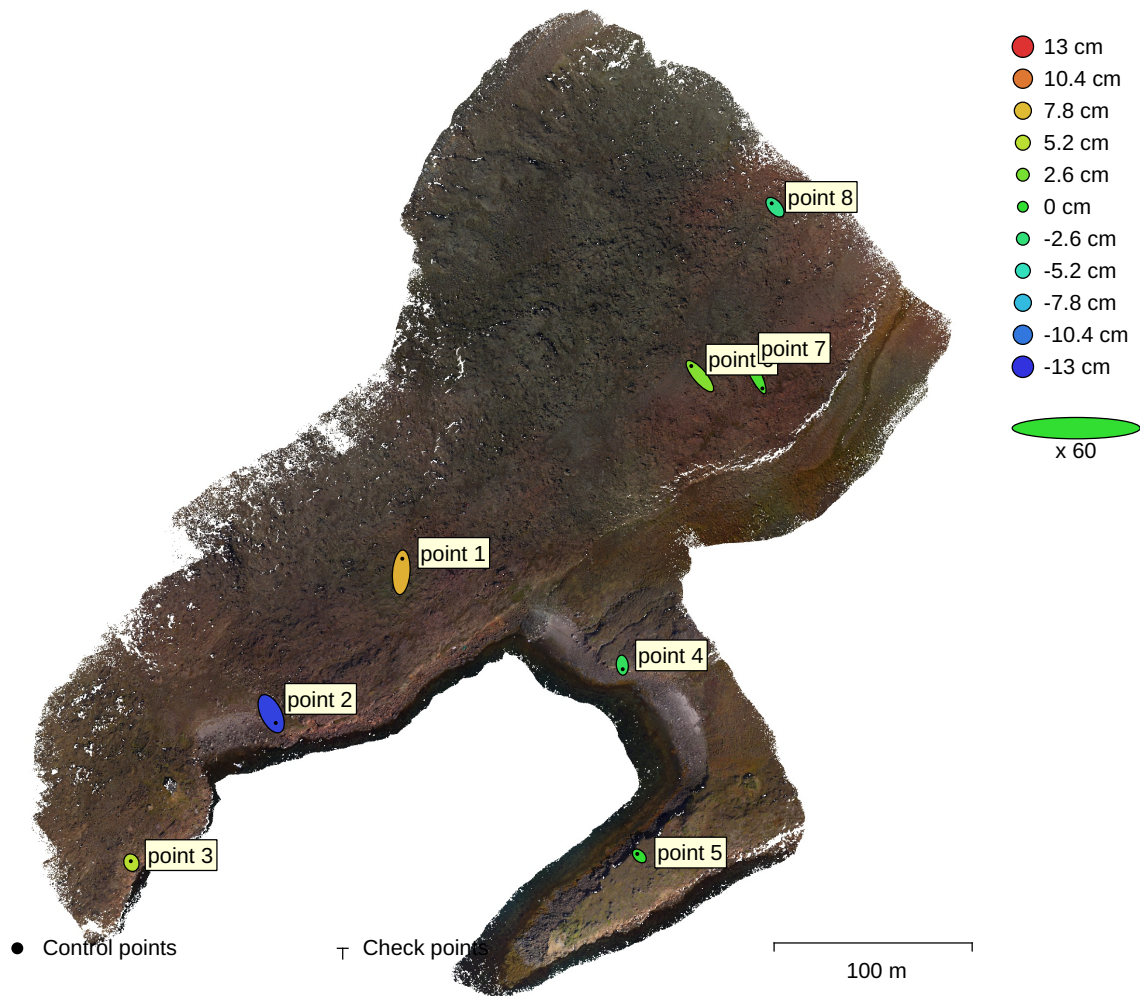


Fig. 10. GCP locations and error estimates.

Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.  
 Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
8	7.97513	15.7272	5.82338	17.6337	18.5704

Table 2. Control points RMSE.

X - Longitude, Y - Latitude, Z - Altitude.

<b>Label</b>	<b>X error (cm)</b>	<b>Y error (cm)</b>	<b>Z error (cm)</b>	<b>Total (cm)</b>	<b>Image (pix)</b>
point 1	1.76563	22.8846	8.27093	24.3974	1.084 (93)
point 2	7.67661	-15.5234	-12.394	21.296	1.505 (56)
point 3	-0.97975	2.41679	5.12392	5.74938	1.160 (41)
point 4	0.696519	-6.83886	-1.59636	7.05716	0.578 (60)
point 5	-3.42359	3.328	-0.0768653	4.77519	0.853 (72)
point 6	-14.4599	16.9516	3.10475	22.4964	0.779 (79)
point 7	13.9003	-28.6568	0.992734	31.8656	1.348 (56)
point 8	-5.59458	6.4673	-3.13692	9.10854	1.992 (23)
<b>Total</b>	<b>7.97513</b>	<b>15.7272</b>	<b>5.82338</b>	<b>18.5704</b>	<b>1.122</b>

Table 3. Control points.  
X - Longitude, Y - Latitude, Z - Altitude.

# Digital Elevation Model

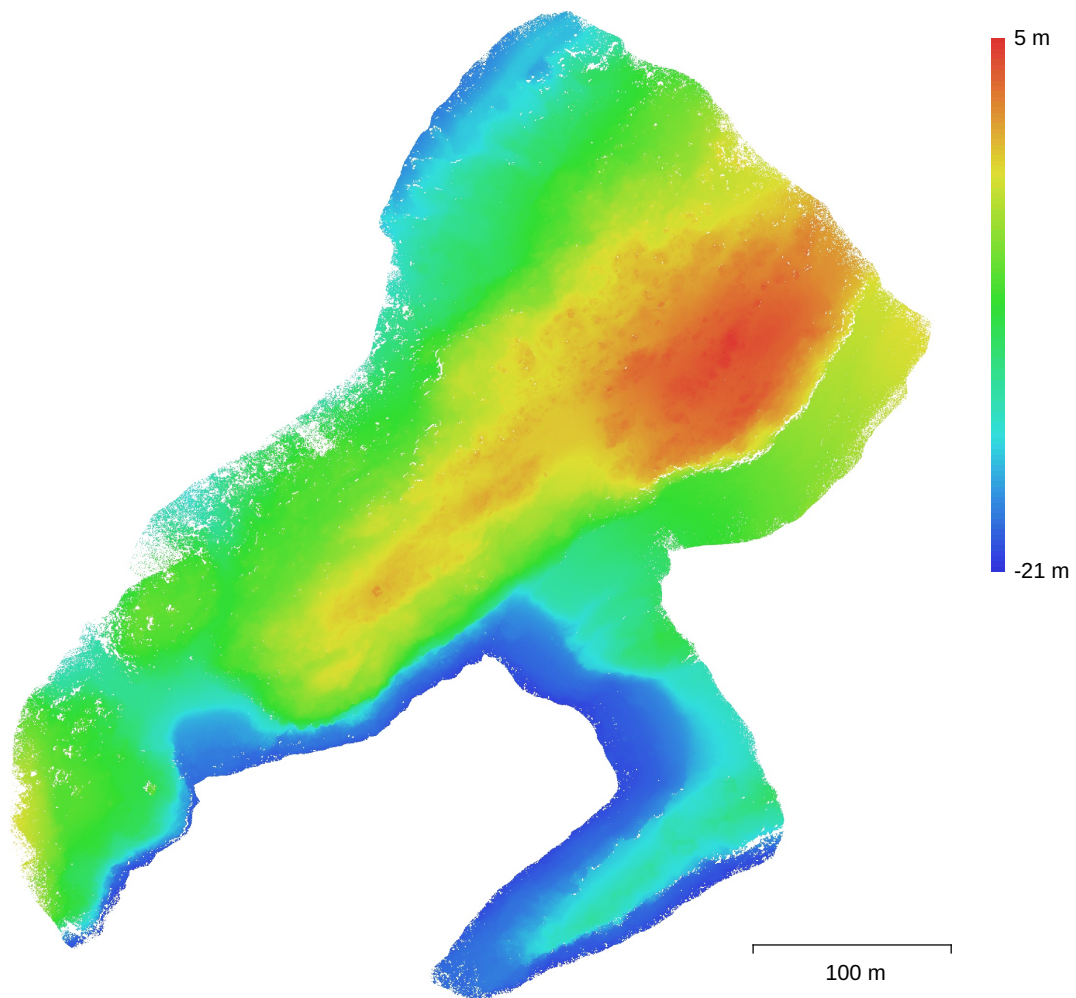


Fig. 11. Reconstructed digital elevation model.

Resolution: 1.83 cm/pix  
Point density: 0.297 points/cm<sup>2</sup>

# Processing Parameters

## General

Cameras	1032
Aligned cameras	1032
Markers	8
Coordinate system	WGS 84 + EGM96 height
Rotation angles	Yaw, Pitch, Roll

## Point Cloud

Points	1,227,887 of 6,529,790
RMS reprojection error	0.101989 (0.225177 pix)
Max reprojection error	1.30856 (2.97438 pix)
Mean key point size	2.17656 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	6.66492

## Alignment parameters

Accuracy	High
Generic preselection	No
Reference preselection	No
Key point limit	0
Tie point limit	60,000
Exclude stationary tie points	No
Guided image matching	No
Adaptive camera model fitting	No
Matching time	1 days 9 hours
Matching memory usage	7.79 GB
Alignment time	3 hours 3 minutes
Alignment memory usage	4.37 GB

## Optimization parameters

Parameters	f, b1, b2, cx, cy, k1-k4, p1, p2
Fit additional corrections	Yes
Adaptive camera model fitting	No
Optimization time	15 minutes 50 seconds
Software version	1.7.1.11797
File size	710.99 MB

## Depth Maps

Count	1011
<b>Depth maps generation parameters</b>	
Quality	Ultra High
Filtering mode	Mild
Processing time	8 hours 47 minutes
Memory usage	7.85 GB
Software version	1.7.1.11797
File size	16.15 GB

## Dense Point Cloud

Points	325,236,191
Point colors	3 bands, uint8

## Depth maps generation parameters

Quality	Ultra High
Filtering mode	Mild
Processing time	8 hours 47 minutes
Memory usage	7.85 GB

**Dense cloud generation parameters**

Processing time	11 hours 32 minutes
Memory usage	48.24 GB
Software version	1.7.1.11797
File size	9.08 GB

**DEM**

Size	40,608 x 42,264
Coordinate system	WGS 84 + EGM96 height

**Reconstruction parameters**

Source data	Dense cloud
Interpolation	Disabled
Processing time	3 minutes 12 seconds
Memory usage	264.00 KB
Software version	1.7.1.11797
File size	1.24 GB

**Orthomosaic**

Size	25,333 x 27,154
Coordinate system	WGS 84 + EGM96 height
Colors	3 bands, uint8

**Reconstruction parameters**

Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Enable ghosting filter	Yes
Processing time	3 hours 10 minutes
Memory usage	11.69 GB
Software version	1.7.1.11797
File size	13.85 GB

**System**

Software name	Agisoft Metashape Professional
Software version	1.7.1 build 11797
OS	Linux 64 bit
RAM	125.62 GB
CPU	Intel(R) Core(TM) i7-9800X CPU @ 3.80GHz
GPU(s)	Quadro P1000