Quality Report

Pix4D

> ⚠ **Important**: Click on the different icons for:
>
> ❓ Help to analyze the results in the Quality Report
>
> ℹ Additional information about the sections

> 💡 Click here for additional tips to analyze the Quality Report

Summary ℹ

Project	Bachelor RGB kamera
Processed	2021-03-24 14:14:44
Camera Model Name(s)	FC2403_4.5_4056x3040 (RGB)
Average Ground Sampling Distance (GSD)	1.53 cm / 0.60 in
Area Covered	0.085 km^2 / 8.4766 ha / 0.03 sq. mi. / 20.9570 acres
Time for Initial Processing (without report)	01h:48m:52s

Quality Check ℹ

❓ **Images**	median of 47999 keypoints per image	✅
❓ **Dataset**	871 out of 871 images calibrated (100%), all images enabled	✅
❓ **Camera Optimization**	9.88% relative difference between initial and optimized internal camera parameters	⚠
❓ **Matching**	median of 11918.3 matches per calibrated image	✅
❓ **Georeferencing**	yes, 8 GCPs (8 3D), mean RMS error = 0.021 m	✅

❓ Preview ℹ

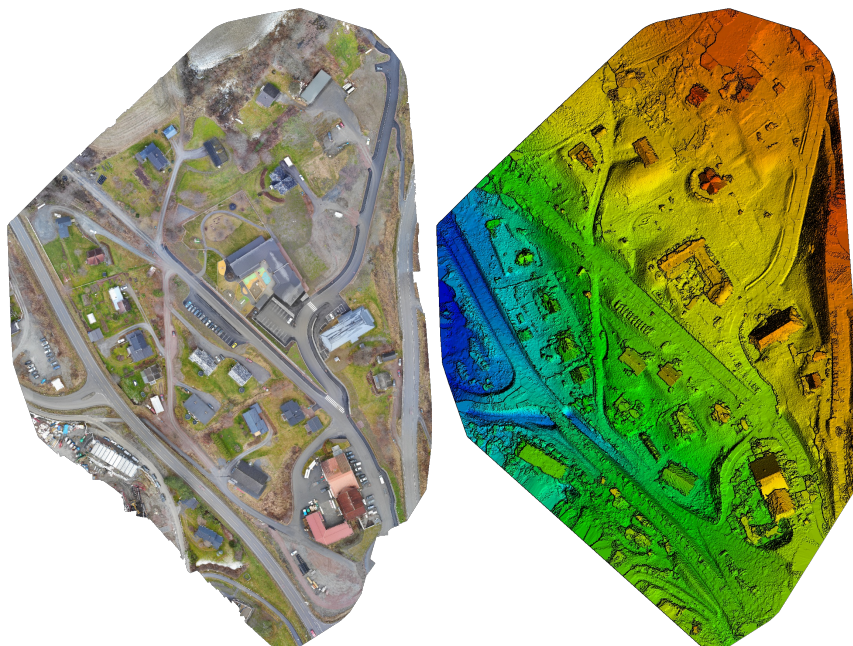**Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.**

Calibration Details

Number of Calibrated Images	871 out of 871
Number of Geolocated Images	871 out of 871

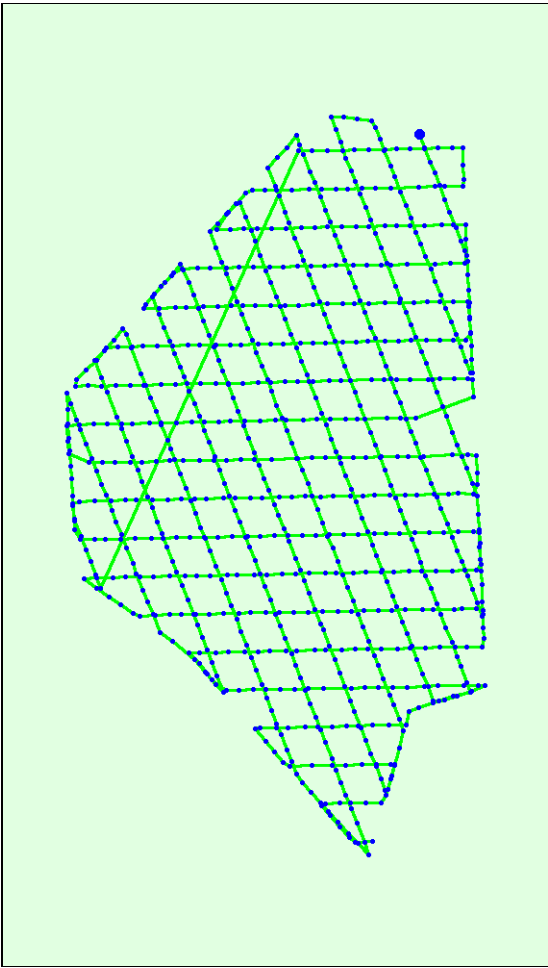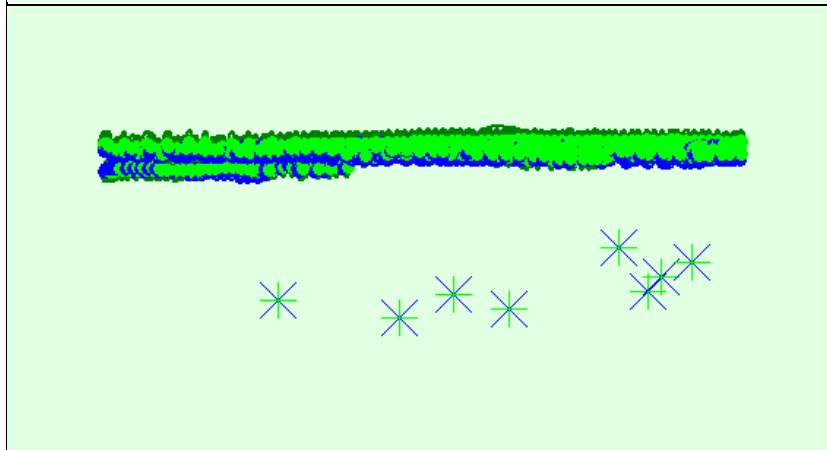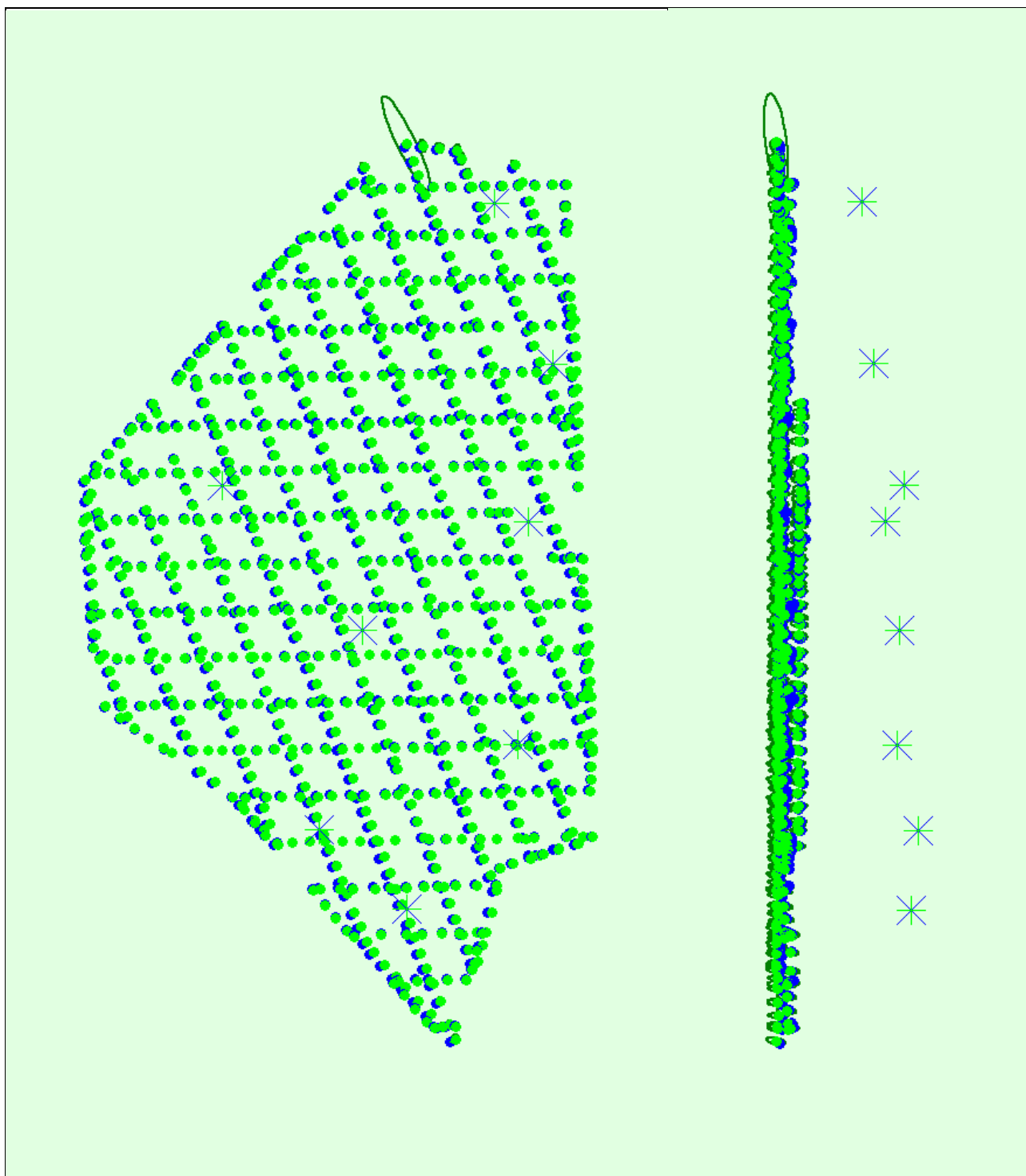**Initial Image Positions**

Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions

Uncertainty ellipses 100x magnified

Figure 3: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Dark green ellipses indicate the absolute position uncertainty of the bundle block adjustment result.

⍰ Absolute camera position and orientation uncertainties ⓘ

	X [m]	Y [m]	Z [m]	Omega [degree]	Phi [degree]	Kappa [degree]
Mean	0.011	0.011	0.033	0.012	0.013	0.004
Sigma	0.004	0.007	0.005	0.004	0.013	0.002

⍰ Overlap ⓘ

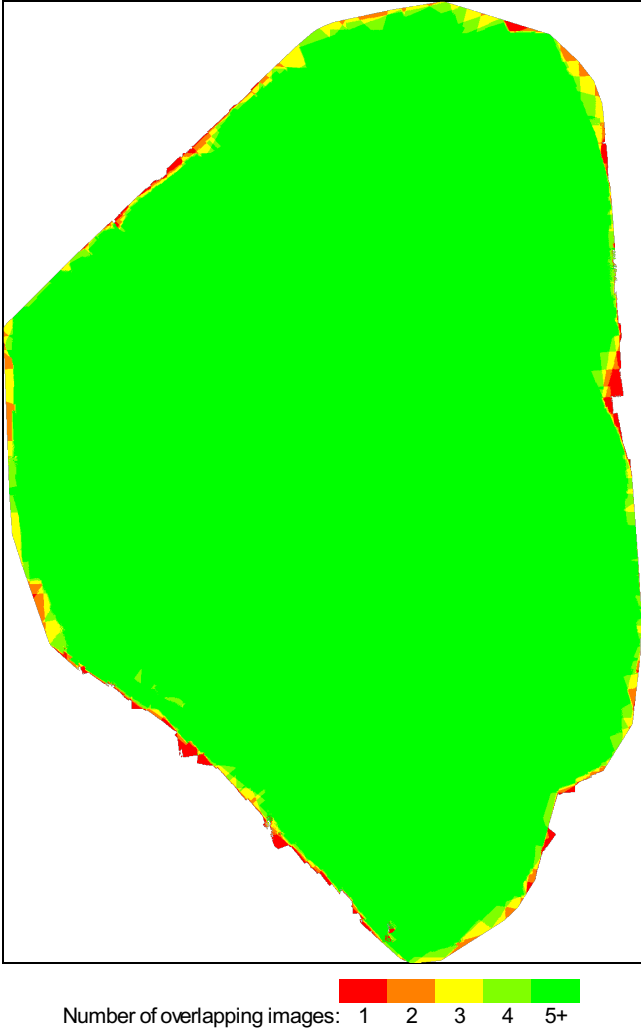Number of overlapping images: 1 2 3 4 5+

Figure 4: Number of overlapping images computed for each pixel of the orthomosaic.
Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint matches).

Bundle Block Adjustment Details ⓘ

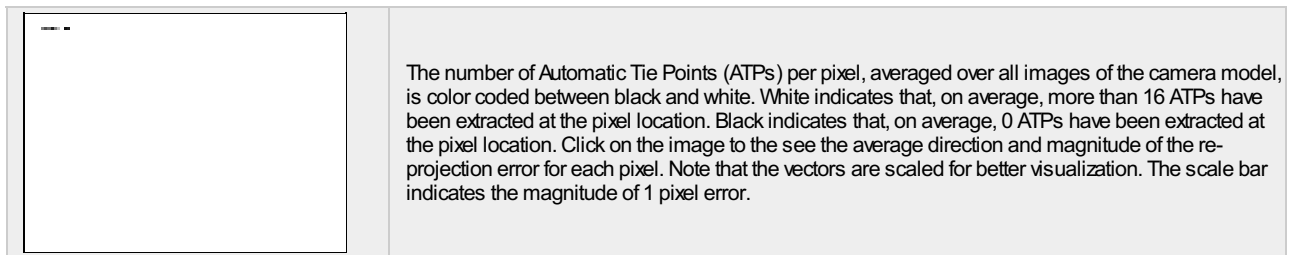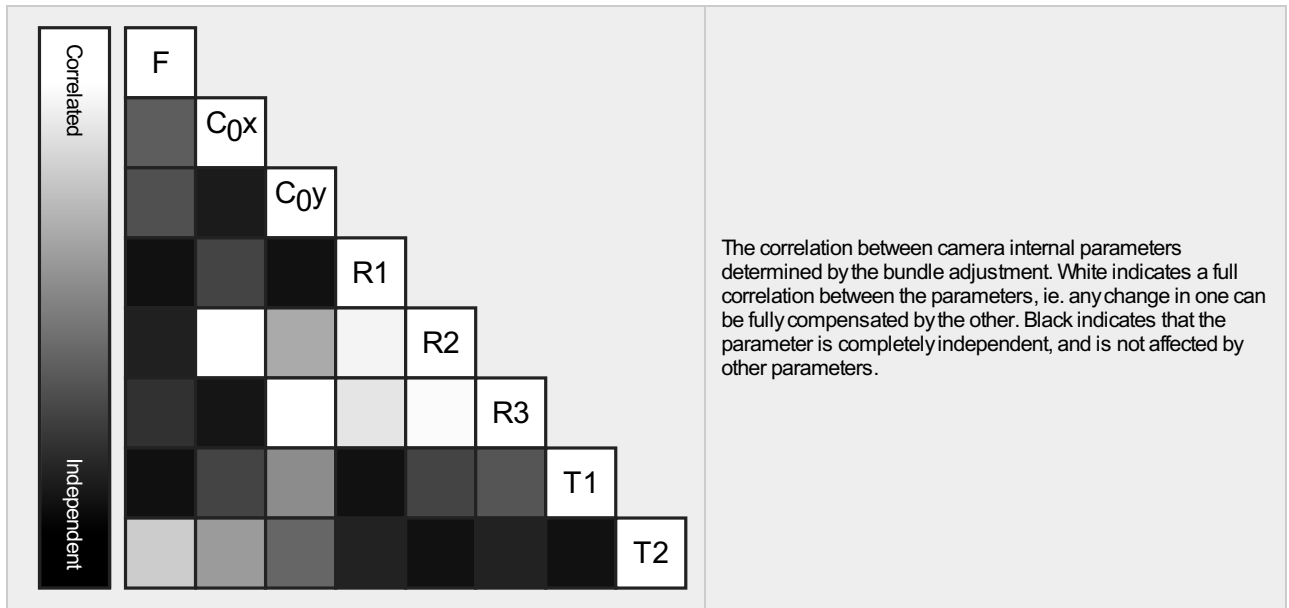| Number of 2D Keypoint Observations for Bundle Block Adjustment	10277315
Number of 3D Points for Bundle Block Adjustment	3365093
Mean Reprojection Error [pixels]	0.179

⍰ Internal Camera Parameters

🗄 FC2403_4.5_4056x3040 (RGB). Sensor Dimensions: 6.554 [mm] x 4.913 [mm] ⓘ

EXIF ID: FC2403_4.5_4056x3040

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2

Initial Values	2829.444 [pixel] 4.572 [mm]	2011.017 [pixel] 3.250 [mm]	1529.792 [pixel] 2.472 [mm]	-0.021	-0.001	0.015	0.000	-0.001
Optimized Values	3109.204 [pixel] 5.024 [mm]	2033.857 [pixel] 3.287 [mm]	1539.020 [pixel] 2.487 [mm]	0.002	-0.026	0.027	0.000	-0.001
Uncertainties (Sigma)	2.129 [pixel] 0.003 [mm]	0.095 [pixel] 0.000 [mm]	0.082 [pixel] 0.000 [mm]	0.000	0.001	0.001	0.000	0.000

The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.

The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

2D Keypoints Table

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	47999	11918
Min	20337	499
Max	76372	23388
Mean	47117	11799

3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	2042229
In 3 Images	634862
In 4 Images	279704
In 5 Images	147001
In 6 Images	82499
In 7 Images	49497
In 8 Images	31800
In 9 Images	22112
In 10 Images	15888
In 11 Images	11368
In 12 Images	8699
In 13 Images	6592
In 14 Images	5186
In 15 Images	4190
In 16 Images	3465

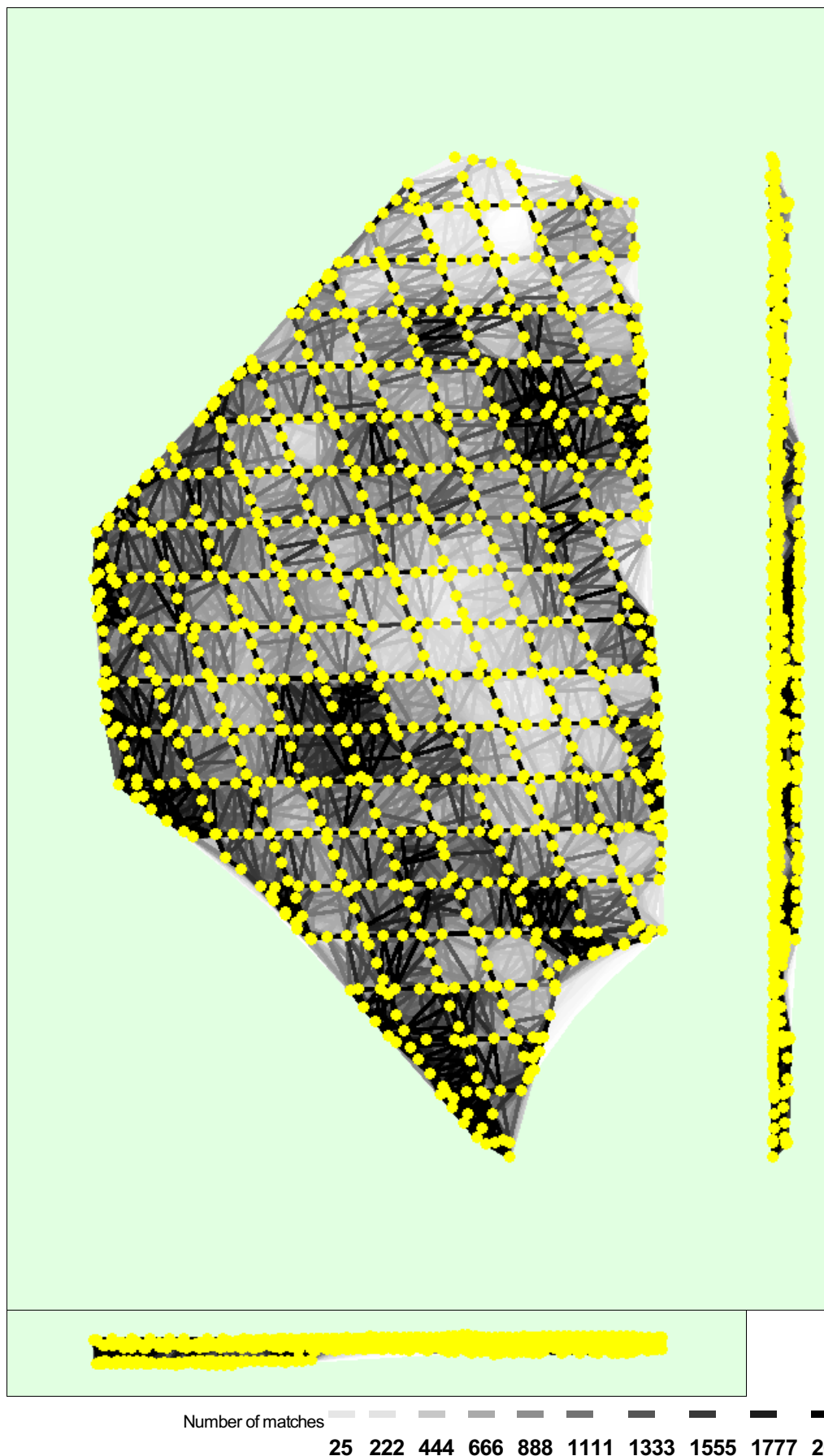| In 17 Images	2833
In 18 Images	2268
In 19 Images	2034
In 20 Images	1608
In 21 Images	1381
In 22 Images	1210
In 23 Images	1051
In 24 Images	957
In 25 Images	816
In 26 Images	755
In 27 Images	654
In 28 Images	556
In 29 Images	503
In 30 Images	396
In 31 Images	384
In 32 Images	322
In 33 Images	281
In 34 Images	222
In 35 Images	218
In 36 Images	205
In 37 Images	148
In 38 Images	151
In 39 Images	130
In 40 Images	120
In 41 Images	86
In 42 Images	97
In 43 Images	75
In 44 Images	77
In 45 Images	51
In 46 Images	58
In 47 Images	66
In 48 Images	46
In 49 Images	45
In 50 Images	34
In 51 Images	38
In 52 Images	26
In 53 Images	17
In 54 Images	17
In 55 Images	17
In 56 Images	9
In 57 Images	6
In 58 Images	6
In 59 Images	10
In 60 Images	7
In 61 Images	3
In 62 Images	3
In 63 Images	2
In 65 Images	2

2D Keypoint Matches

Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

Number of matches

25 222 444 666 888 1111 1333 1555 1777 2000

Geolocation Details

Ground Control Points

GCP Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
GCPl1 (3D)	0.020/ 0.020	0.007	-0.016	0.042	1.073	39 / 39
GCPl8 (3D)	0.020/ 0.020	0.002	-0.028	-0.006	1.397	53 / 53
GCPl2 (3D)	0.020/ 0.020	0.008	-0.011	-0.056	1.249	45 / 45
GCPl3 (3D)	0.020/ 0.020	-0.018	0.028	0.045	1.105	44 / 44
GCPl4 (3D)	0.020/ 0.020	-0.021	0.025	0.005	1.236	26 / 26
GCPl5 (3D)	0.020/ 0.020	0.023	-0.014	-0.020	1.107	16 / 16
GCPl6 (3D)	0.020/ 0.020	0.008	0.021	0.006	1.183	27 / 27
GCPl7 (3D)	0.020/ 0.020	-0.007	-0.004	-0.014	0.946	62 / 62
Mean [m]		0.000213	0.000029	0.000218		
Sigma [m]		0.013755	0.020070	0.030926		
RMS Error [m]		0.013757	0.020070	0.030927		

Localisation accuracy per GCP and mean errors in the three coordinate directions. The last column counts the number of calibrated images where the GCP has been automatically verified vs. manually marked.

Absolute Geolocation Variance

Min Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-15.00	0.00	0.00	0.00
-15.00	-12.00	0.00	0.00	0.00
-12.00	-9.00	0.00	0.00	0.00
-9.00	-6.00	0.00	0.00	0.00
-6.00	-3.00	0.00	0.00	0.00
-3.00	0.00	51.21	46.04	50.75
0.00	3.00	48.79	53.96	49.25
3.00	6.00	0.00	0.00	0.00
6.00	9.00	0.00	0.00	0.00
9.00	12.00	0.00	0.00	0.00
12.00	15.00	0.00	0.00	0.00
15.00	-	0.00	0.00	0.00
Mean [m]		-1.030750	-0.093829	-0.916911
Sigma [m]		0.570551	0.533543	0.655482
RMS Error [m]		1.178123	0.541731	1.127112

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times the maximum accuracy of all the images. Columns X, Y, Z show the percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the initial and computed image positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

Geolocation Bias	X	Y	Z
Translation [m]	-1.030750	-0.093829	-0.916911

Bias between image initial and computed geolocation given in output coordinate system.

Relative Geolocation Variance

Relative Geolocation Error	Images X [%]	Images Y [%]	Images Z [%]
[-1.00, 1.00]	100.00	100.00	100.00
[-2.00, 2.00]	100.00	100.00	100.00
[-3.00, 3.00]	100.00	100.00	100.00
Mean of Geolocation Accuracy [m]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

Images X, Y, Z represent the percentage of images with a relative geolocation error in X, Y, Z.

Geolocation Orientational Variance	RMS [degree]
Omega	0.880
Phi	0.647
Kappa	5.199

Geolocation RMS error of the orientation angles given by the difference between the initial and computed image orientation angles.

Initial Processing Details

System Information

Hardware	CPU: AMD Ryzen 5 4600H with Radeon Graphics RAM: 63GB GPU: AMD Radeon(TM) Graphics (Driver: 27.20.1023.1001), AMD Radeon RX 5600M (Driver: 27.20.1023.1001)
Operating System	Windows 10 Home, 64-bit

Coordinate Systems

Image Coordinate System	WGS 84 (EGM 96 Geoid)
Ground Control Point (GCP) Coordinate System	ETRS89 / UTM zone 32N (EGM 96 Geoid)
Output Coordinate System	ETRS89 / UTM zone 32N (EGM 96 Geoid)

Processing Options

Detected Template	No Template Available
Keypoints Image Scale	Full, Image Scale: 1
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: no
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Standard Internal Parameters Optimization: All External Parameters Optimization: All Rematch: Auto, no

Point Cloud Densification details

Processing Options

Image Scale	multiscale, 1 (Original image size, Slow)
Point Density	Optimal
Minimum Number of Matches	6
3D Textured Mesh Generation	yes
3D Textured Mesh Settings:	Resolution: Medium Resolution (default) Color Balancing: no
LOD	Generated: no
Advanced: 3D Textured Mesh Settings	Sample Density Divider: 1
Advanced: Image Groups	group1
Advanced: Use Processing Area	yes
Advanced: Use Annotations	yes
Time for Point Cloud Densification	11h:13m:53s
Time for Point Cloud Classification	NA
Time for 3D Textured Mesh Generation	20m:53s

Results

Number of Processed Clusters	2
Number of Generated Tiles	6
Number of 3D Densified Points	122222898
Average Density (per m^3)	3847.88

DSM, Orthomosaic and Index Details

Processing Options

DSM and Orthomosaic Resolution	1 x GSD (1.53 [cm/pixel])
DSM Filters	Noise Filtering: yes Surface Smoothing: yes, Type: Sharp
Raster DSM	Generated: yes Method: Inverse Distance Weighting Merge Tiles: yes
Orthomosaic	Generated: yes Merge Tiles: yes GeoTIFF Without Transparency: no Google Maps Tiles and KML: no
Grid DSM	Generated: yes, Spacing [cm]: 2
Raster DTM	Generated: yes Merge Tiles: yes
DTM Resolution	5 x GSD (1.53 [cm/pixel])
Time for DSM Generation	01h:53m:16s
Time for Orthomosaic Generation	49m:48s
Time for DTM Generation	08m:02s
Time for Contour Lines Generation	00s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s

Camera Radiometric Correction

Camera Name	Band	Radiometric Correction Type	Reflectance target
FC2403_4.5_4056x3040	Red Green Blue	Camera Only	n/a