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## Summary



Project	1626_Jazan_Border_Survey_Area_03TiePoint
Processed	2021-10-05 14:29:28
Camera Model Name(s)	DSC-RX1RM2_35.0_7952x5304 (RGB)
Average Ground Sampling Distance (GSD)	2.21 cm / 0.87 in

## Quality Check



<b>Images</b>	median of 2833 keypoints per image	
<b>Dataset</b>	10472 out of 10473 images calibrated (99%), all images enabled	
<b>Camera Optimization</b>	0.11% relative difference between initial and optimized internal camera parameters	
<b>Matching</b>	median of 487.417 matches per calibrated image	
<b>Georeferencing</b>	yes, 36 GCPs (36 3D), mean RMS error = 0.037 m	

## Calibration Details



Number of Calibrated Images	10472 out of 10473
Number of Geolocated Images	10473 out of 10473



## Initial Image Positions



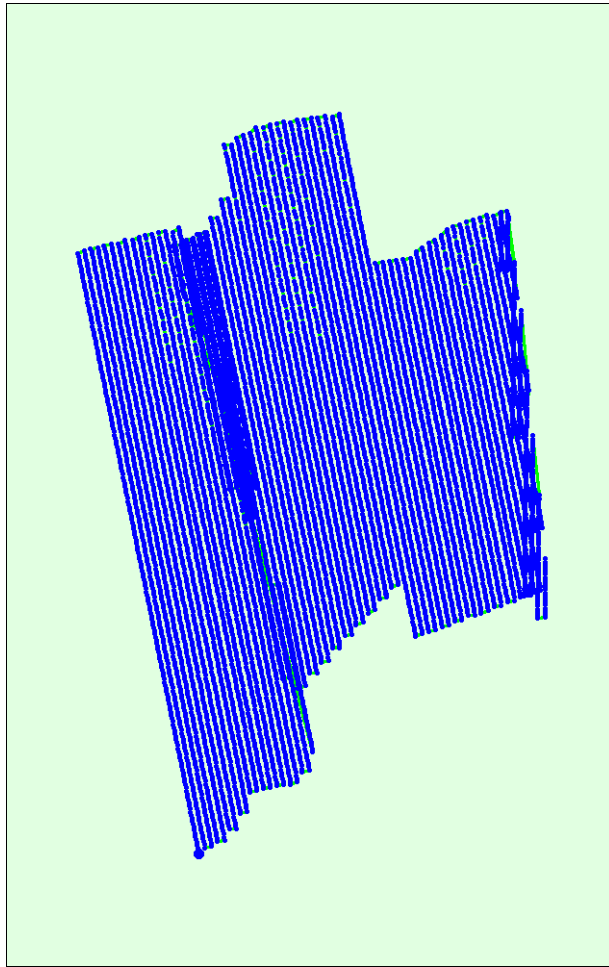
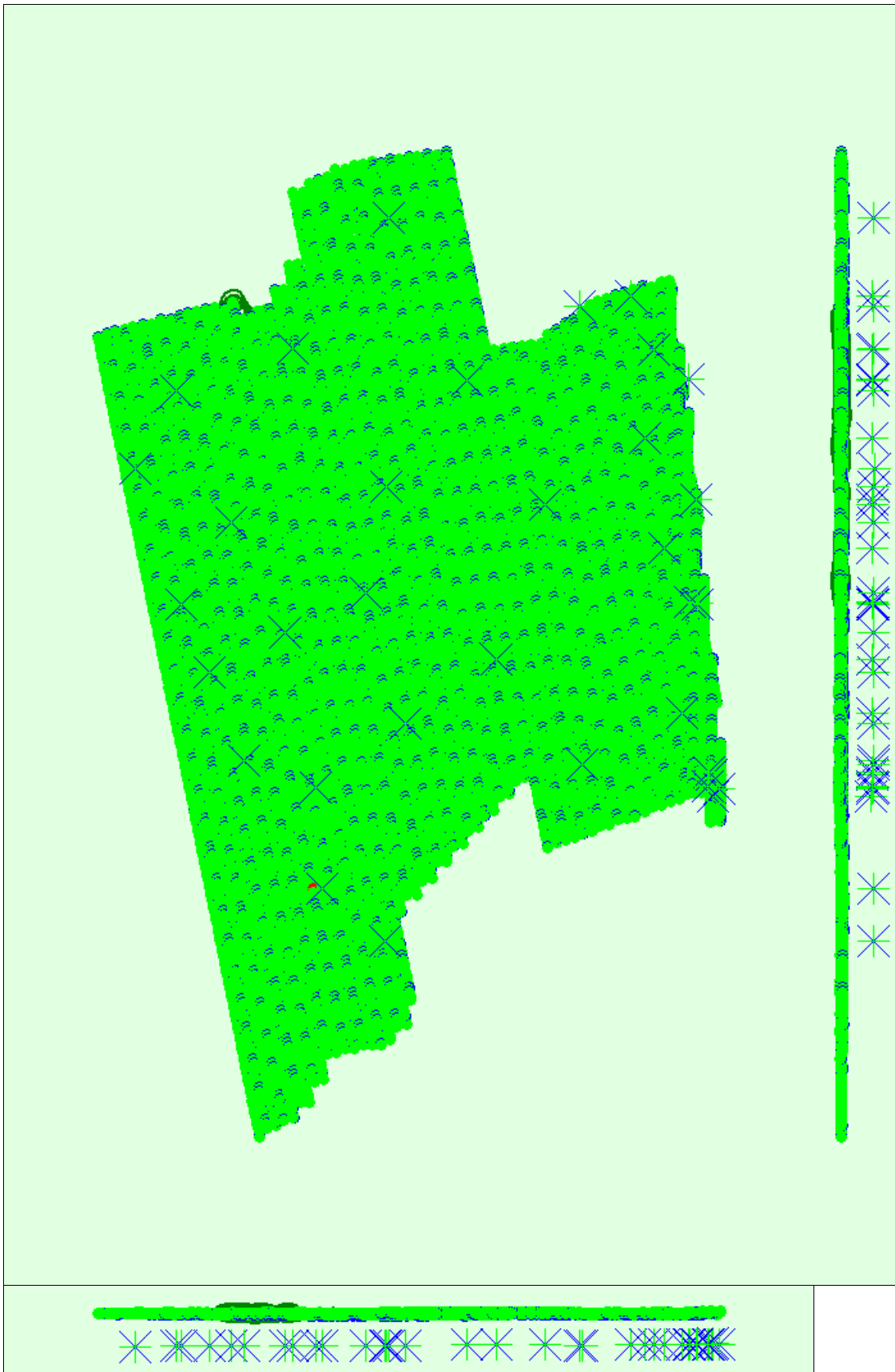


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

🔍 Computed Image/GCPs/Manual Tie Points Positions





Uncertainty ellipses 1000x 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). Red dots indicate disabled or uncalibrated images. 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	0.010	0.010	0.012	0.005	0.005	0.007

Sigma	0.006	0.007	0.003	0.002	0.002	0.003
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# Bundle Block Adjustment Details



Number of 2D Keypoint Observations for Bundle Block Adjustment	5109894
Number of 3D Points for Bundle Block Adjustment	1719165
Mean Reprojection Error [pixels]	0.072

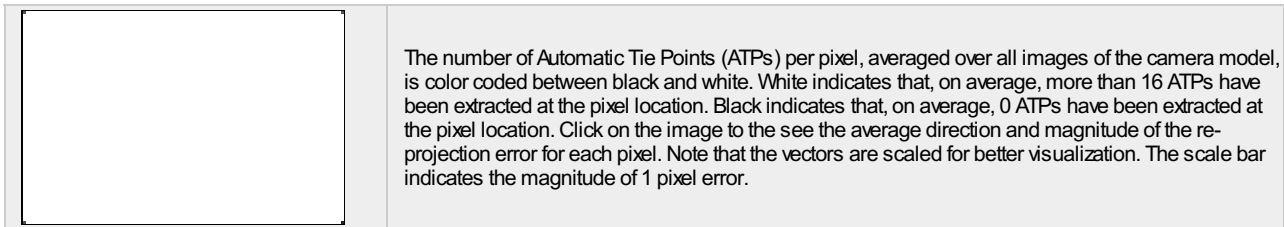
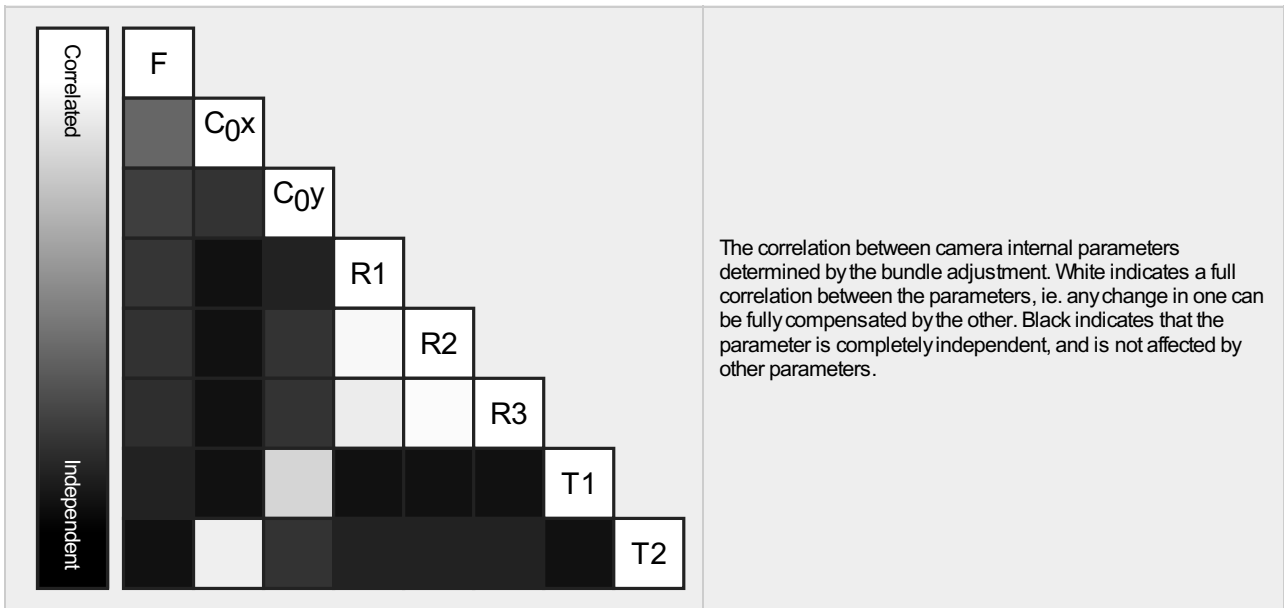
## Internal Camera Parameters

DSC-RX1RM2\_35.0\_7952x5304 (RGB). Sensor Dimensions: 35.000 [mm] x 23.345 [mm]



EXIF ID: DSC-RX1RM2\_35.0\_7952x5304

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	7451.230 [pixel] 32.796 [mm]	3949.280 [pixel] 17.382 [mm]	2642.930 [pixel] 11.633 [mm]	-0.011	0.043	-0.069	0.001	-0.000
Optimized Values	7459.761 [pixel] 32.833 [mm]	3953.032 [pixel] 17.399 [mm]	2654.196 [pixel] 11.682 [mm]	-0.011	0.033	-0.062	0.000	-0.001
Uncertainties (Sigma)	0.217 [pixel] 0.001 [mm]	0.108 [pixel] 0.000 [mm]	0.080 [pixel] 0.000 [mm]	0.000	0.001	0.001	0.000	0.000



## 2D Keypoints Table



	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	2833	487
Mn	1457	27
Max	5795	2209
Mean	2847	488

### 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	1169693
In 3 Images	271426
In 4 Images	103225
In 5 Images	51416
In 6 Images	28724
In 7 Images	17956
In 8 Images	12525
In 9 Images	9380
In 10 Images	7511
In 11 Images	6074
In 12 Images	5233
In 13 Images	4889
In 14 Images	4482
In 15 Images	4635
In 16 Images	4570
In 17 Images	4433
In 18 Images	3950
In 19 Images	3377
In 20 Images	2472
In 21 Images	1612
In 22 Images	919
In 23 Images	392
In 24 Images	139
In 25 Images	69
In 26 Images	30
In 27 Images	15
In 28 Images	9
In 29 Images	4
In 30 Images	2
In 32 Images	2
In 36 Images	1

### 2D Keypoint Matches



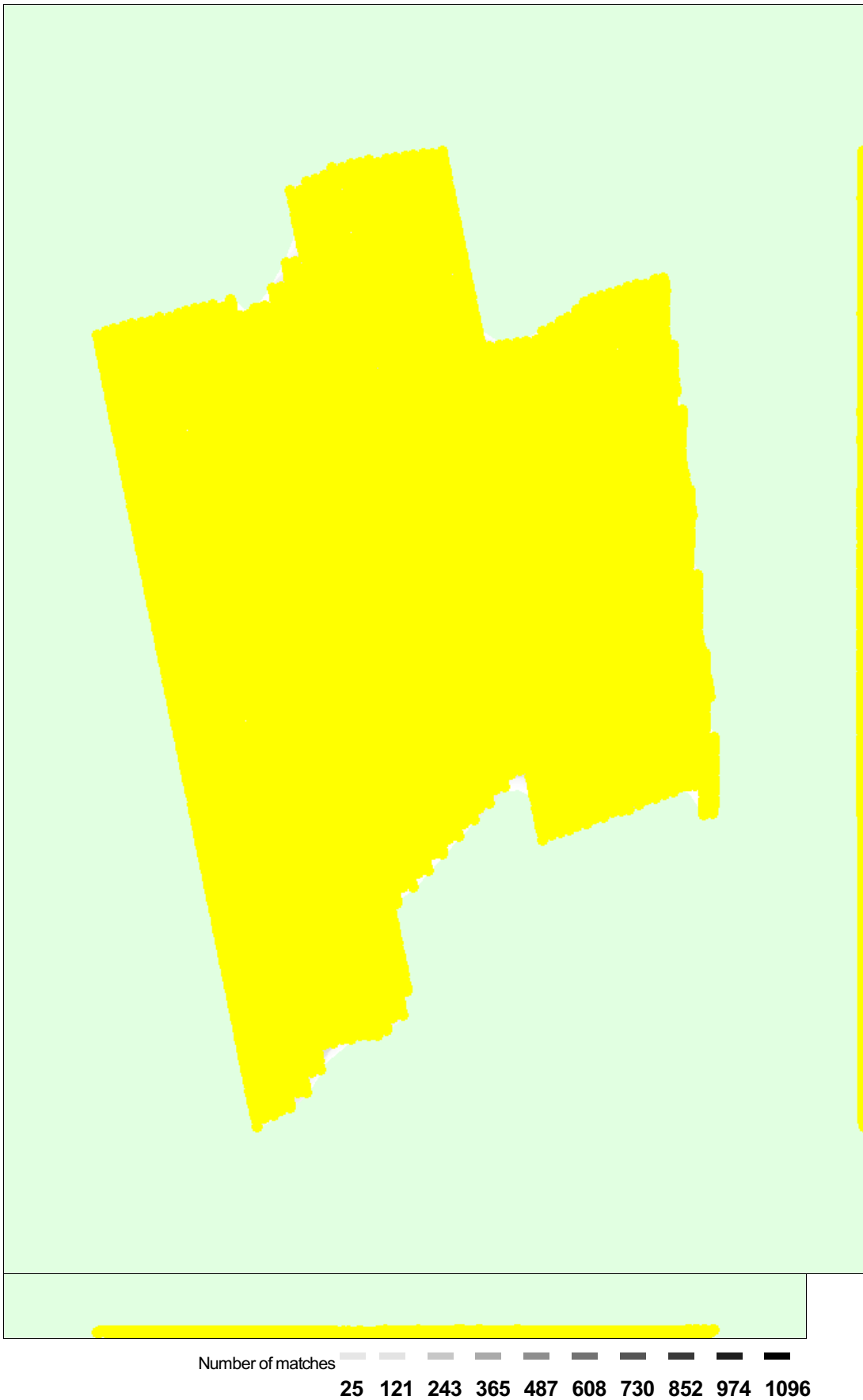


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

## Geolocation Details



## Ground Control Points



GCP Name	Accuracy XYZ [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
GCP65 (3D)	0.020/0.020	0.034	0.011	0.072	0.445	11 / 11
mtp01 (3D)	0.020/0.020	-0.000	0.018	0.009	0.020	8 / 8
mtp02 (3D)	0.020/0.020	0.000	0.005	0.003	0.026	7 / 7
mtp03 (3D)	0.020/0.020	-0.036	0.042	0.010	0.119	8 / 8
mtp04 (3D)	0.020/0.020	-0.014	0.061	0.005	0.179	8 / 8
mtp122 (3D)	0.020/0.020	-0.049	-0.054	0.035	0.184	11 / 11
mtp123 (3D)	0.020/0.020	0.066	0.013	0.018	0.355	9 / 9
TP02_from02 (3D)	0.020/0.020	-0.000	-0.021	0.000	0.041	8 / 8
TP01_from02 (3D)	0.020/0.020	-0.001	-0.032	0.011	0.031	9 / 9
TP03_from02 (3D)	0.020/0.020	0.003	-0.018	-0.006	0.029	12 / 12
TP04_from02 (3D)	0.020/0.020	-0.001	-0.014	0.000	0.035	8 / 8
TP05_from02 (3D)	0.020/0.020	-0.004	-0.020	-0.006	0.025	8 / 8
TP06_from02 (3D)	0.020/0.020	-0.003	-0.024	-0.000	0.036	8 / 8
TP07_from02 (3D)	0.020/0.020	-0.000	-0.021	-0.004	0.029	9 / 9
TP08_from02 (3D)	0.020/0.020	-0.015	-0.026	-0.005	0.055	7 / 7
TP09_from02 (3D)	0.020/0.020	-0.010	-0.011	-0.004	0.050	8 / 8
mtp124 (3D)	0.020/0.020	-0.036	0.042	0.010	0.119	8 / 8
mtp125 (3D)	0.020/0.020	-0.014	0.061	0.005	0.179	8 / 8
TP01_from05 (3D)	0.020/0.020	-0.037	-0.049	0.018	0.197	8 / 8
TP02_from05 (3D)	0.020/0.020	0.007	0.055	-0.002	0.091	8 / 8
TP03_from05 (3D)	0.020/0.020	0.078	-0.039	0.022	0.229	8 / 8
TP04_from05 (3D)	0.020/0.020	0.013	0.020	0.006	0.031	8 / 8
TP05_from05 (3D)	0.020/0.020	-0.002	0.033	-0.003	0.032	8 / 8
TP06_from05 (3D)	0.020/0.020	0.002	0.015	0.003	0.018	8 / 8
TP07_from05 (3D)	0.020/0.020	0.009	0.006	0.006	0.029	4 / 4
TP08_from05 (3D)	0.020/0.020	-0.005	0.032	-0.005	0.060	8 / 8
TP_Area_03_01 (3D)	0.020/0.020	0.012	-0.014	-0.023	0.066	8 / 8
TP_Area_03_02 (3D)	0.020/0.020	0.021	-0.018	-0.037	0.090	8 / 8
TP_Area_03_03 (3D)	0.020/0.020	-0.029	0.016	-0.009	0.084	8 / 8
TP_Area_03_04 (3D)	0.020/0.020	-0.002	-0.001	-0.024	0.064	8 / 8
TP_Area_03_05 (3D)	0.020/0.020	0.013	0.002	-0.013	0.027	8 / 8
TP_Area_03_06 (3D)	0.020/0.020	-0.030	0.012	-0.333	5.014	8 / 8
TP_Area_03_07 (3D)	0.020/0.020	0.025	-0.017	-0.037	0.071	8 / 8
TP_Area_03_08 (3D)	0.020/0.020	0.021	-0.010	-0.031	0.055	8 / 8
TP_Area_03_09 (3D)	0.020/0.020	-0.012	-0.006	-0.023	0.062	8 / 8
TP_Area_03_10 (3D)	0.020/0.020	-0.027	-0.023	-0.057	0.705	8 / 8
<b>Mean [m]</b>		-0.000625	0.000690	-0.010834		
<b>Sigma [m]</b>		0.025559	0.028946	0.058614		
<b>RMS Error [m]</b>		0.025566	0.028954	0.059606		

0 out of 2 check points have been labeled as inaccurate.

Check Point Name	Accuracy XYZ [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
GCP86		-0.1444	-0.5226	-0.5270	0.0410	8 / 8
GCP74		-17.6813	-15.9692	0.6633	0.0141	8 / 8
<b>Mean [m]</b>		-8.912827	-8.245898	0.068188		
<b>Sigma [m]</b>		8.768463	7.723290	0.595145		
<b>RMS Error [m]</b>		12.502976	11.297966	0.599039		

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



Mn Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-4.14	0.00	0.00	0.00

-4.14	-3.31	0.00	0.00	0.00
-3.31	-2.48	0.00	0.00	0.00
-2.48	-1.66	0.02	0.00	0.00
-1.66	-0.83	0.07	0.00	0.01
-0.83	0.00	50.93	51.46	48.71
0.00	0.83	48.99	48.47	50.52
0.83	1.66	0.00	0.05	0.33
1.66	2.48	0.00	0.02	0.23
2.48	3.31	0.00	0.00	0.10
3.31	4.14	0.00	0.00	0.11
4.14	-	0.00	0.00	0.00
<b>Mean [m]</b>		0.715157	1.775708	-0.822135
<b>Sigma [m]</b>		0.046646	0.046646	0.193342
<b>RMS Error [m]</b>		0.716676	1.776321	0.844564

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]	0.717865	1.774301	-0.841217

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]	99.68	99.71	93.01
[-2.00, 2.00]	99.94	99.95	97.21
[-3.00, 3.00]	100.00	99.99	98.45
<b>Mean of Geolocation Accuracy [m]</b>	0.032415	0.032415	0.048978
<b>Sigma of Geolocation Accuracy [m]</b>	0.037166	0.037166	0.071131

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

Geolocation Orientational Variance	RMS [degree]
Omega	1.061
Phi	0.559
Kappa	0.967

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: Intel(R) Xeon(R) W-3245 CPU @ 3.20GHz RAM: 128GB GPU: NVIDIA GeForce RTX2080 Ti (Driver: 30.0.14.7168)
Operating System	Windows 10 Education, 64-bit

### Coordinate Systems

Image Coordinate System	WGS 84
Ground Control Point (GCP) Coordinate System	WGS 84 / UTM zone 38N
Output Coordinate System	WGS 84 / UTM zone 38N



## Processing Options



Detected Template	No Template Available
Keypoints Image Scale	Rapid, Image Scale: 0.125
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