Summary

Project	cca3_2016_rgb_2d
Processed	2020-07-08 16:46:13
Camera Model Name(s)	L1D-20c_10.3_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	0.77 cm / 0.30 in
Area Covered	0.001 km^2 / 0.1265 ha / 0.00 sq. mi. / 0.3128 acres
Time for Initial Processing (without report)	04m:28s

Quality Check

Images	median of 71363 keypoints per image	✓
Dataset	18 out of 23 images calibrated (78%), all images enabled	⚠
Camera Optimization	5.76% relative difference between initial and optimized internal camera parameters	⚠
Matching	median of 1574.72 matches per calibrated image	✓
Georeferencing	yes, no 3D GCP	⚠

Preview

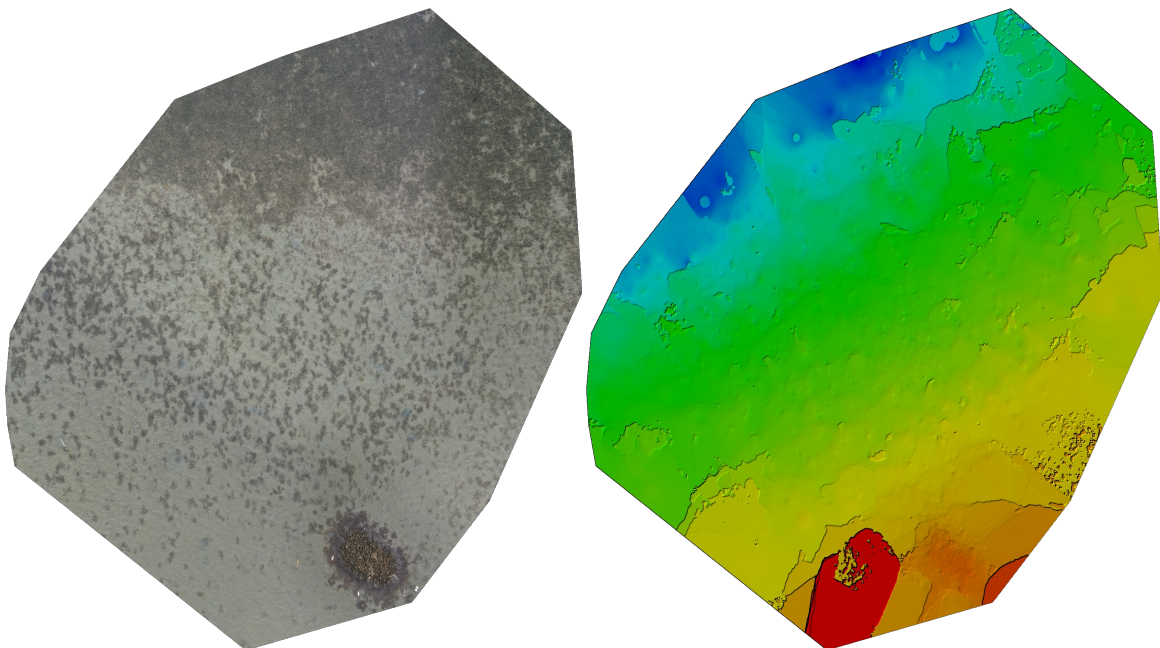**Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.**

Calibration Details

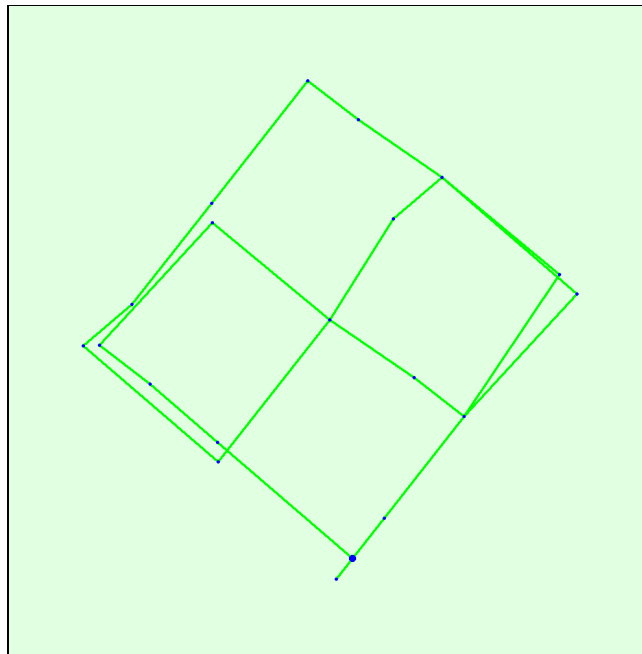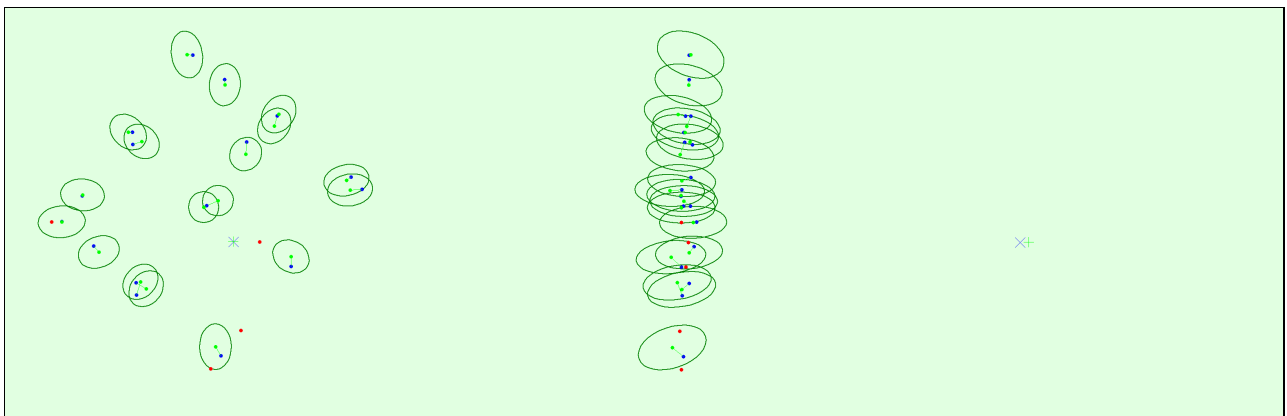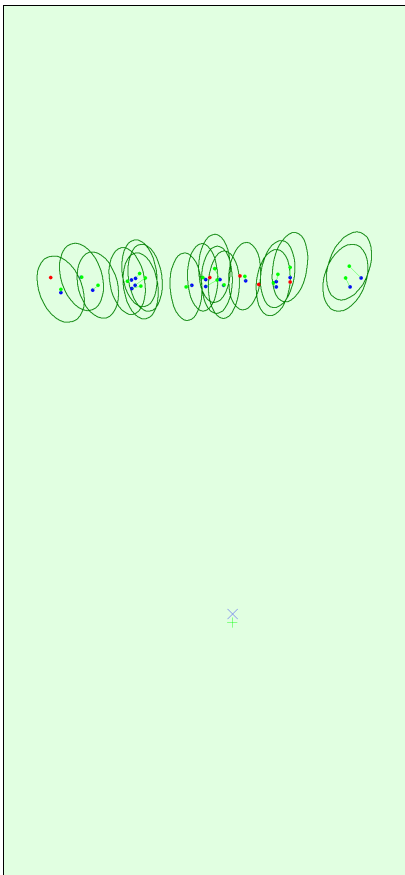|	
Number of Calibrated Images	18 out of 23
Number of Geolocated Images	23 out of 23

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 1x 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]	Camera Displacement X [m]	Camera Displacement Y [m]	Camera Displacement Z [m]
Mean	1.627	1.583	3.001	1.258	1.138	1.581	0.034	0.032	0.056
Sigma	0.237	0.219	0.030	0.012	0.019	0.029	0.008	0.005	0.020

Overlap
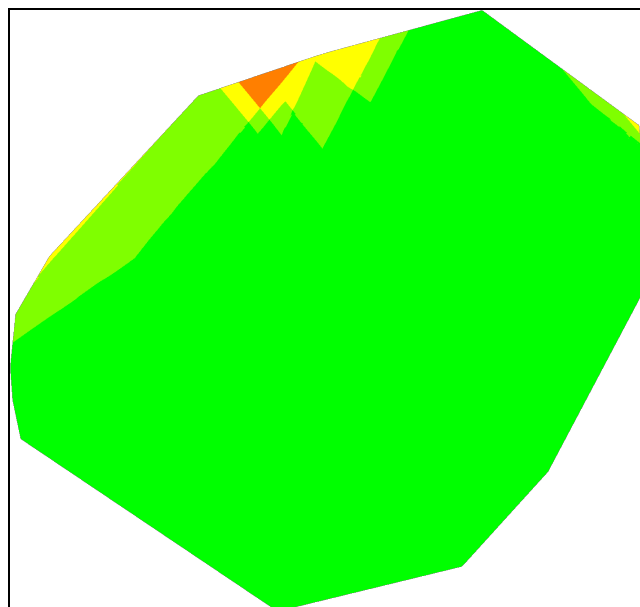
Number of overlapping images: 1 2 3 4 5+

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).
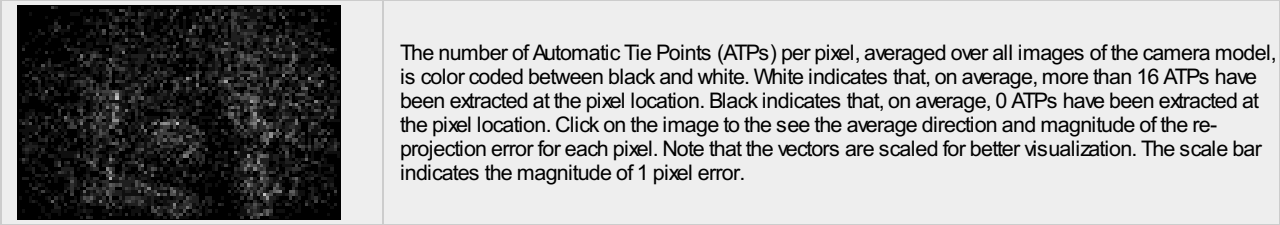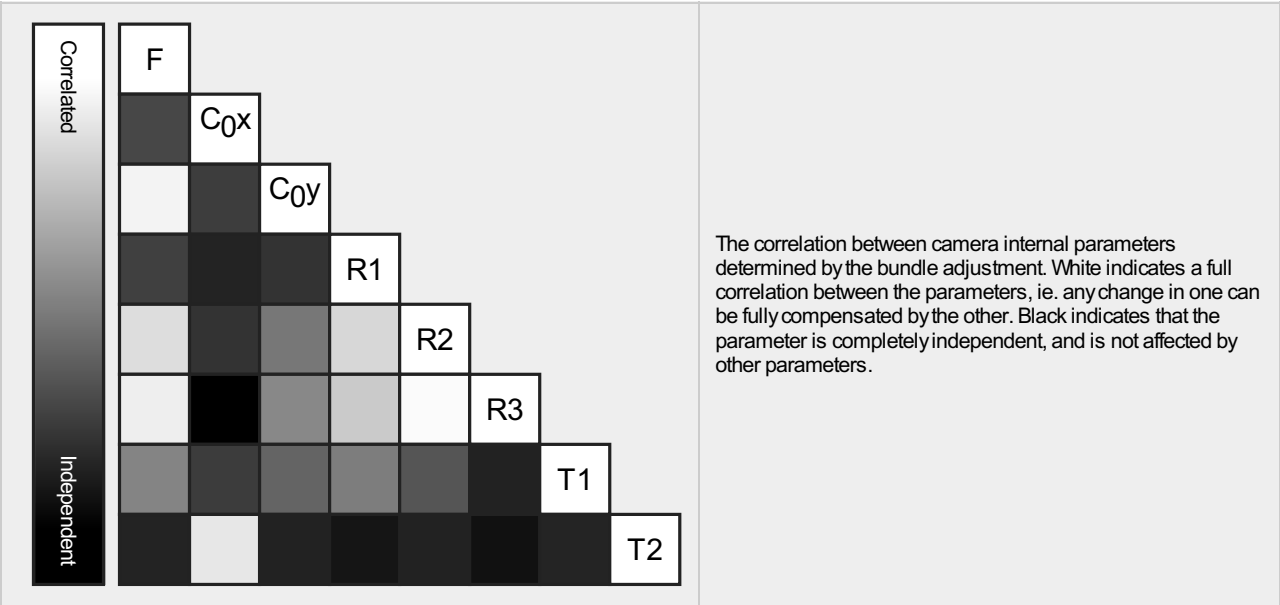
Bundle Block Adjustment Details

Number of 2D Keypoint Observations for Bundle Block Adjustment	30975
Number of 3D Points for Bundle Block Adjustment	13300
Mean Reprojection Error [pixels]	0.176

Internal Camera Parameters

🗄 **L1D-20c_10.3_5472x3648 (RGB). Sensor Dimensions: 12.825 [mm] x 8.550 [mm]**

EXIF ID: L1D-20c_10.3_5472x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	4470.830 [pixel] 10.479 [mm]	2770.870 [pixel] 6.494 [mm]	1698.700 [pixel] 3.981 [mm]	0.009	0.040	-0.050	-0.003	0.002
Optimized Values	4213.246 [pixel] 9.875 [mm]	2731.601 [pixel] 6.402 [mm]	1807.375 [pixel] 4.236 [mm]	-0.001	-0.004	0.006	-0.001	-0.002
Uncertainties (Sigma)	55.046 [pixel] 0.129 [mm]	8.640 [pixel] 0.020 [mm]	38.448 [pixel] 0.090 [mm]	0.007	0.024	0.030	0.001	0.001

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	71363	1575
Min	50334	187
Max	82086	3386
Mean	67326	1721

3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	10774
In 3 Images	1614
In 4 Images	456
In 5 Images	222
In 6 Images	105
In 7 Images	67
In 8 Images	28
In 9 Images	17
In 10 Images	13
In 11 Images	3
In 12 Images	1

2D Keypoint Matches

Uncertainty ellipses 100x magnified

Number of matches

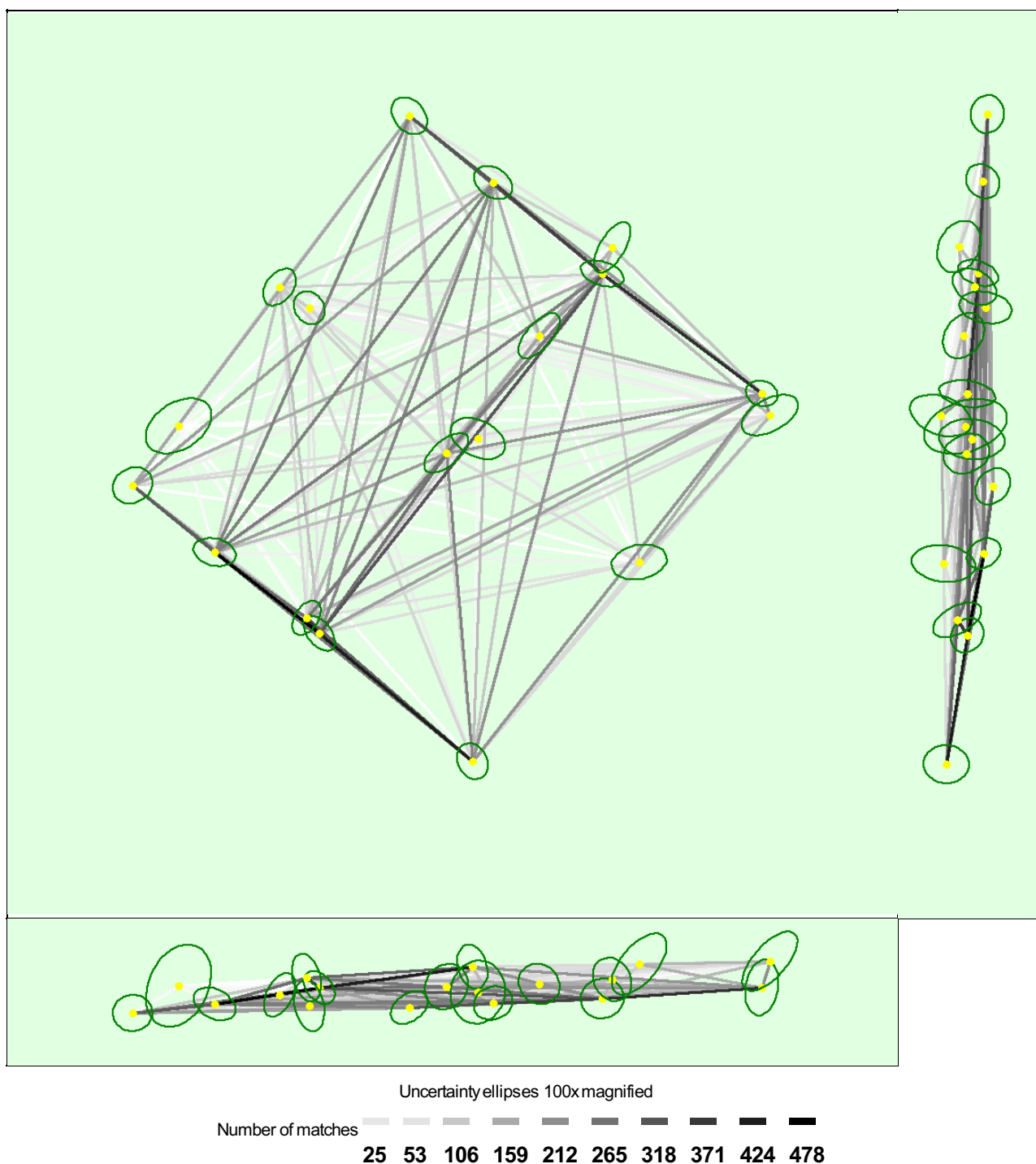**25   53   106   159   212   265   318   371   424   478**

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. Dark green ellipses indicate the relative camera position uncertainty of the bundle block adjustment result.

Relative camera position and orientation uncertainties

	X [m]	Y [m]	Z [m]	Omega [degree]	Phi [degree]	Kappa [degree]	Camera Displacement X [m]	Camera Displacement Y [m]	Camera Displacement Z [m]
Mean	0.008	0.008	0.010	0.059	0.058	0.027	0.007	0.007	0.012
Sigma	0.002	0.001	0.003	0.006	0.005	0.004	0.002	0.001	0.004

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
gcp_8 (3D)	5.000/ 10.000	0.044	-0.033	0.758	0.533	10 / 10

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	44.44	44.44	83.33
0.00	3.00	55.56	55.56	16.67
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]		-0.020612	0.017374	-0.422190
Sigma [m]		0.515815	0.580013	0.352757
RMS Error [m]		0.516227	0.580273	0.550165

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.

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	21.948

Phi	22.526
Kappa	145.931

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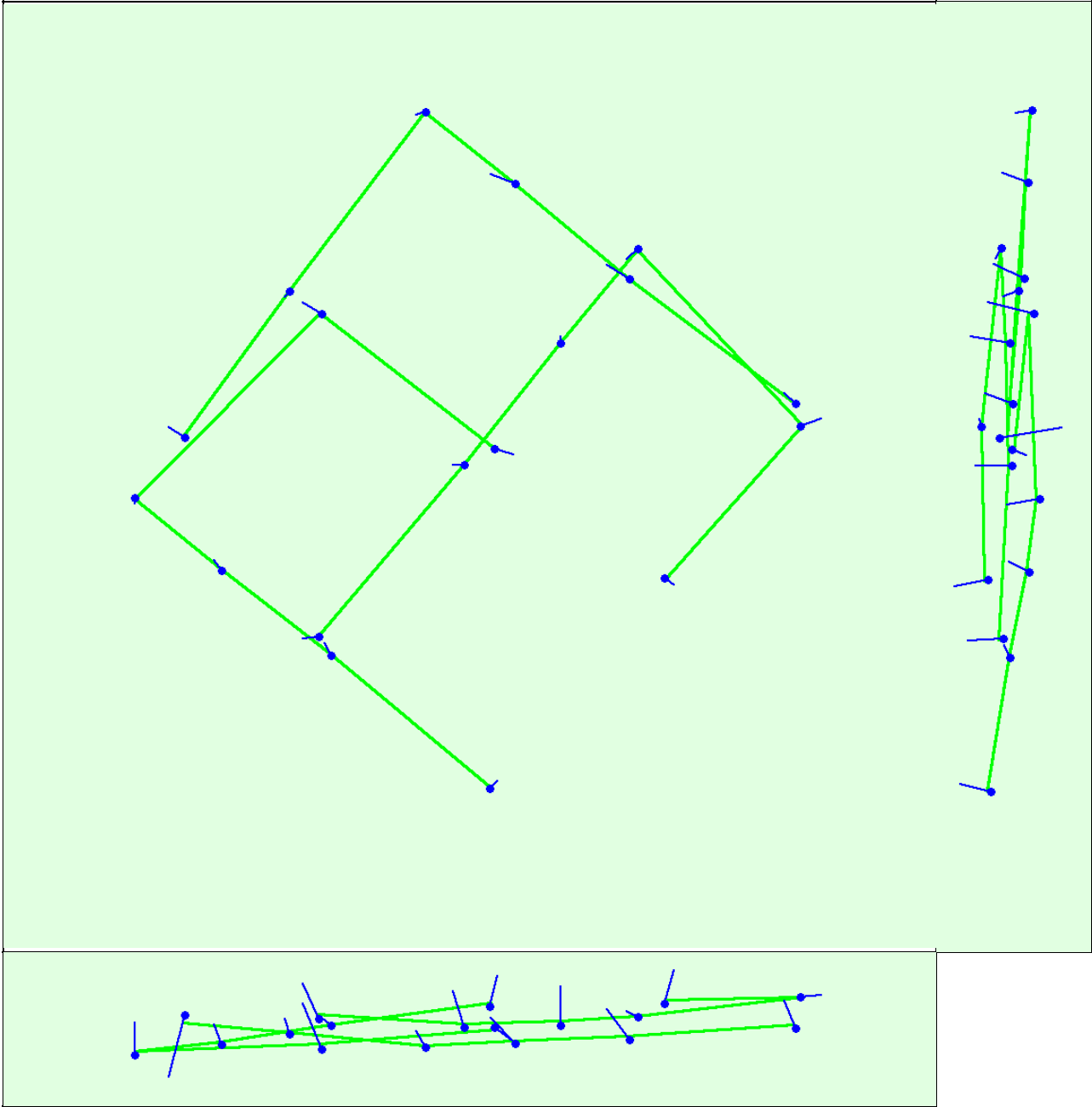
Rolling Shutter Statistics

Figure 6: Camera movement estimated by the rolling shutter camera model. The green line follows the computed image positions. The blue dots represent the camera position at the start of the exposure. The blue lines represent the camera motion during the rolling shutter readout, re-scaled by a project dependant scaling factor for better visibility.

Median Camera Speed	2.6662 [m/s]
Median Camera Displacement During Sensor Readout)	0.3169 [m]
Median Rolling Shutter Readout Time	127.184 [ms]

Initial Processing Details

System Information

Hardware	CPU: Intel(R) Core(TM) i7-7700 CPU @ 3.60GHz RAM: 32GB GPU: AMD Radeon Pro WX 3100 (Driver: 23.20.15018.16), Intel(R) HD Graphics 630 (Driver: 23.20.16.4973)
Operating System	Windows 10 Enterprise, 64-bit

Coordinate Systems

Image Coordinate System	GCS_WGS_1984 (EGM96 Geoid)
Output Coordinate System	NAD_1983_2011_StatePlane_North_Carolina_FIPS_3200 (EGM96 Geoid)

Processing Options

Detected Template	2D Full
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, yes

Point Cloud Densification details

Processing Options

Image Scale	multiscale, 1/2 (Half image size, Default)
Point Density	Optimal
Minimum Number of Matches	3
3D Textured Mesh Generation	no
LOD	Generated: no
Advanced: Image Groups	group1
Advanced: Use Processing Area	yes
Advanced: Use Annotations	yes
Time for Point Cloud Densification	05m:41s
Time for Point Cloud Classification	06s
Time for 3D Textured Mesh Generation	NA

Results

Number of Generated Tiles	1
Number of 3D Densified Points	1616477
Average Density (per m^3)	4290.68

DSM, Orthomosaic and Index Details

Processing Options

DSM and Orthomosaic Resolution	1 x GSD (0.774 [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
Raster DTM	Generated: yes Merge Tiles: yes
DTM Resolution	5 x GSD (0.774 [cm/pixel])
Time for DSM Generation	59s
Time for Orthomosaic Generation	03m:07s
Time for DTM Generation	28s
Time for Contour Lines Generation	00s

Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s