Quality Report

Generated with Pix4Dmapper version 4.3.31

Important: Click on the different icons for:

Help to analyze the results in the Quality Report

Additional information about the sections

Click here for additional tips to analyze the Quality Report

Summary

Project	08042019_BTL_Take2
Processed	2019-11-05 11:10:29
Camera Model Name(s)	multiSPEC4C_3.6_1280x960 (Green), multiSPEC4C_3.6_1280x960 (Red), multiSPEC4C_3.6_1280x960 (Red edge), multiSPEC4C_3.6_1280x960 (NIR)
Rig name(s)	«Airinov multiSPEC4C 1.1»
Average Ground Sampling Distance (GSD)	13.11 cm / 5.16 in
Area Covered	0.509 km^2 / 50.9144 ha / 0.20 sq. mi. / 125.8772 acres

Quality Check

Images	median of 36490 keypoints per image	✓
Dataset	904 out of 904 images calibrated (100%), 16 images disabled	✓
Camera Optimization	0.14% relative difference between initial and optimized internal camera parameters	✓
Matching	median of 7499.91 matches per calibrated image	✓
Georeferencing	yes, 8 GCPs (8 3D), mean RMS error = 0.042 m	✓

Preview

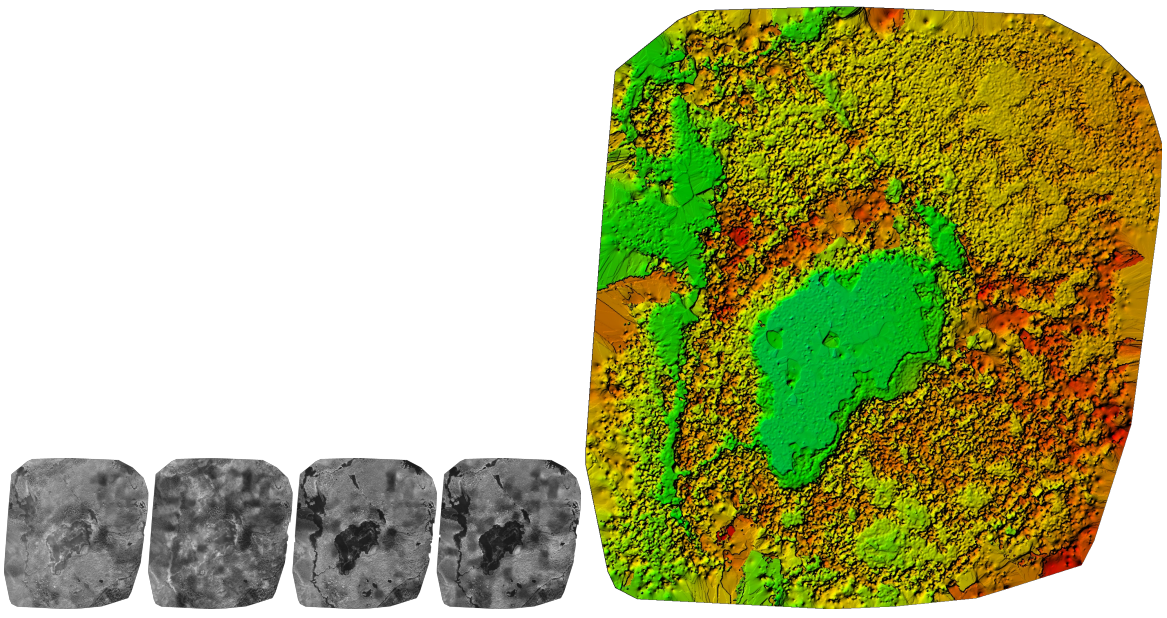


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details

Number of Calibrated Images	904 out of 920
Number of Geolocated Images	920 out of 920

Initial Image Positions

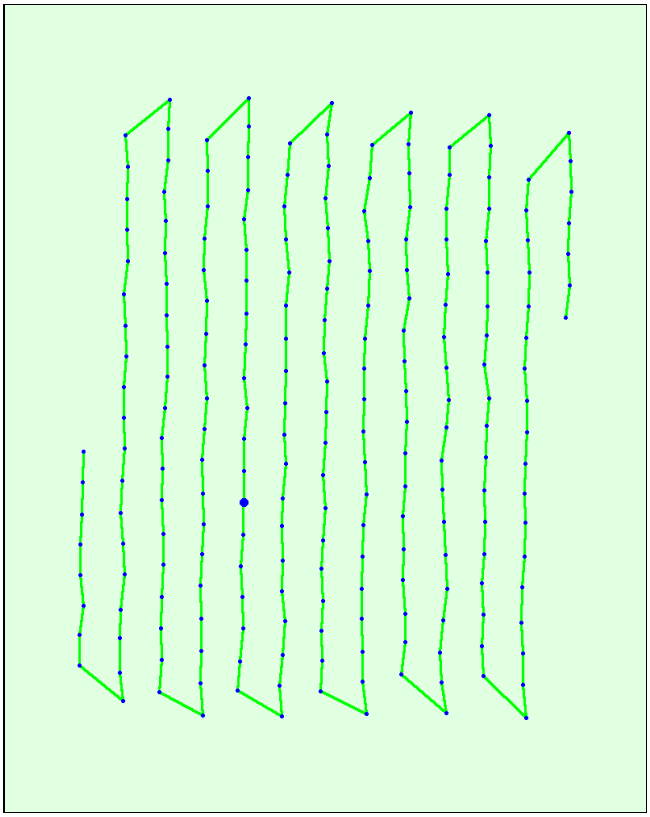


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions

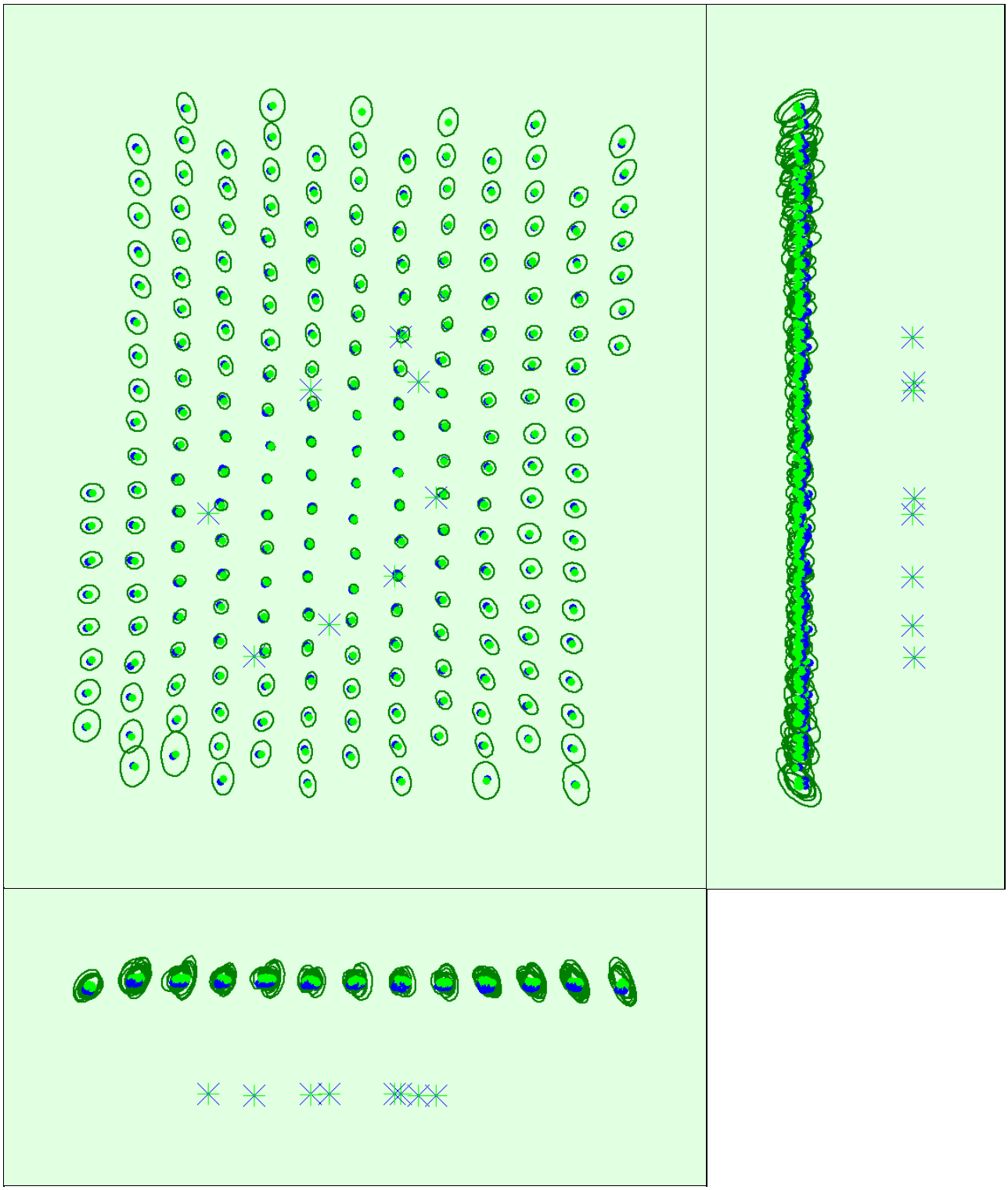


Figure 3: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Red dots indicate disabled 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	0.169	0.188	0.236	0.087	0.076	0.023
Sigma	0.049	0.062	0.067	0.030	0.022	0.011

Overlap

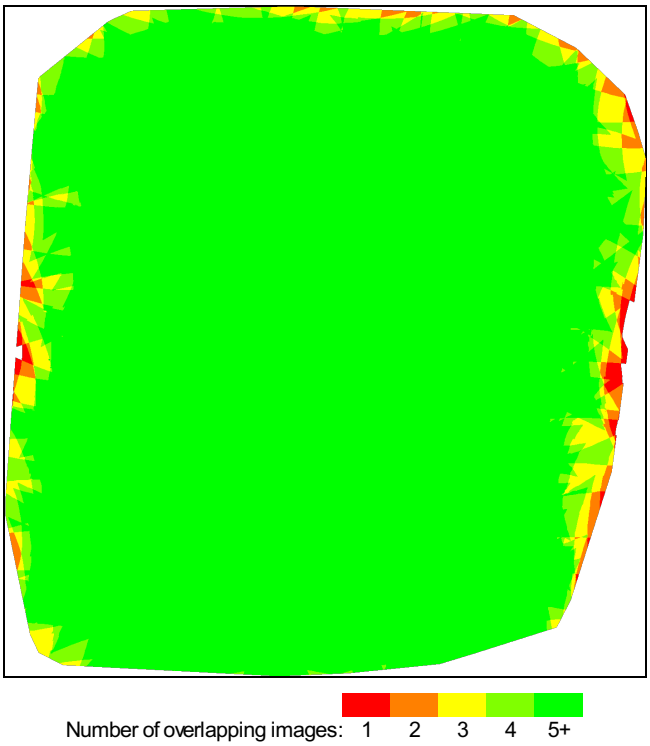


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic.
Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint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

Bundle Block Adjustment Details

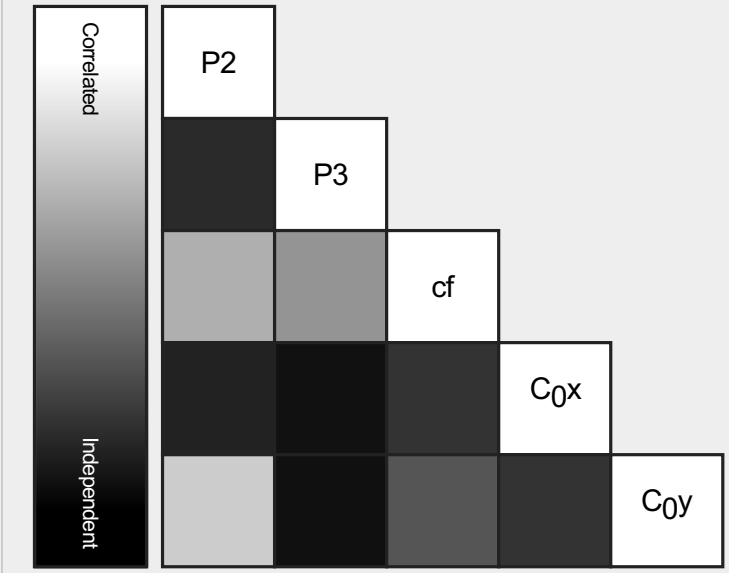
Number of 2D Keypoint Observations for Bundle Block Adjustment	2121474
Number of 3D Points for Bundle Block Adjustment	763298
Mean Reprojection Error [pixels]	0.271

Internal Camera Parameters

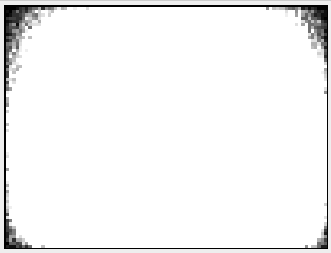
multiSPEC4C_3.6_1280x960 (Green). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

EXIF ID: multiSPEC4C_3.6_1280x960

	Poly[0]	Poly[1]	Poly[2]	Poly[3]	Poly[4]	c	d	e	f	Principal Point x	Principal Point y
Initial Values	0.000000	1.000000	0.028743	-0.382359	0.000000	1560.00	0.00	0.00	1560.00	640.00	480.00
Optimized Values	0.000000	1.000000	0.016460	-0.375653	0.000000	1577.50	0.00	0.00	1577.50	647.63	544.11
Uncertainties (Sigma)			0.001184	0.001956		2.34	0.00	0.00	2.34	0.13	0.12



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.



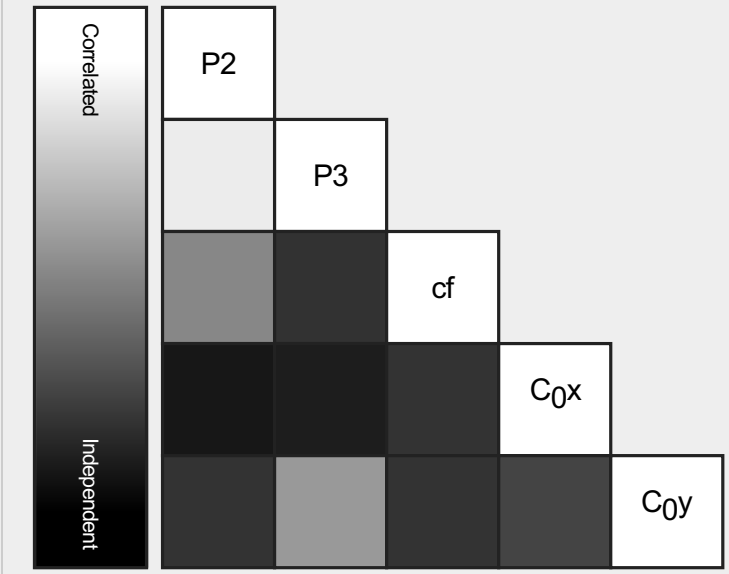
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the 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.

Internal Camera Parameters

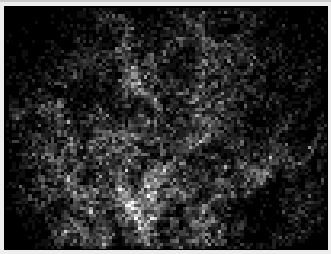
multiSPEC4C_3.6_1280x960 (Red). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

EXIF ID: multiSPEC4C_3.6_1280x960

	Poly[0]	Poly[1]	Poly[2]	Poly[3]	Poly[4]	c	d	e	f	Principal Point x	Principal Point y
Initial Values	0.000000	1.000000	0.028743	-0.382359	0.000000	1560.00	0.00	0.00	1560.00	640.00	480.00
Optimized Values	0.000000	1.000000	0.020157	-0.383356	0.000000	1594.46	0.00	0.00	1594.46	639.44	529.42
Uncertainties (Sigma)			0.004382	0.007346		2.56	0.00	0.00	2.56	0.50	0.48



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.



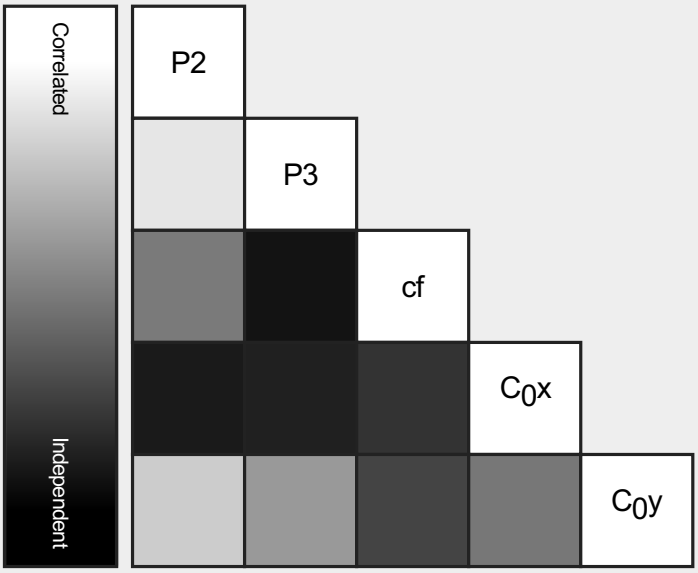
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the 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.

Internal Camera Parameters

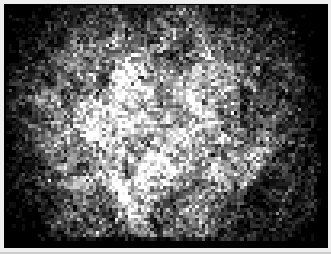
multiSPEC4C_3.6_1280x960 (Red edge). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

EXIF ID: multiSPEC4C_3.6_1280x960

	Poly[0]	Poly[1]	Poly[2]	Poly[3]	Poly[4]	c	d	e	f	Principal Point x	Principal Point y
Initial Values	0.000000	1.000000	0.028743	-0.382359	0.000000	1560.00	0.00	0.00	1560.00	640.00	480.00
Optimized Values	0.000000	1.000000	0.020006	-0.380964	0.000000	1582.06	0.00	0.00	1582.06	611.57	502.55
Uncertainties (Sigma)			0.003607	0.006292		2.45	0.00	0.00	2.45	0.41	0.39



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.



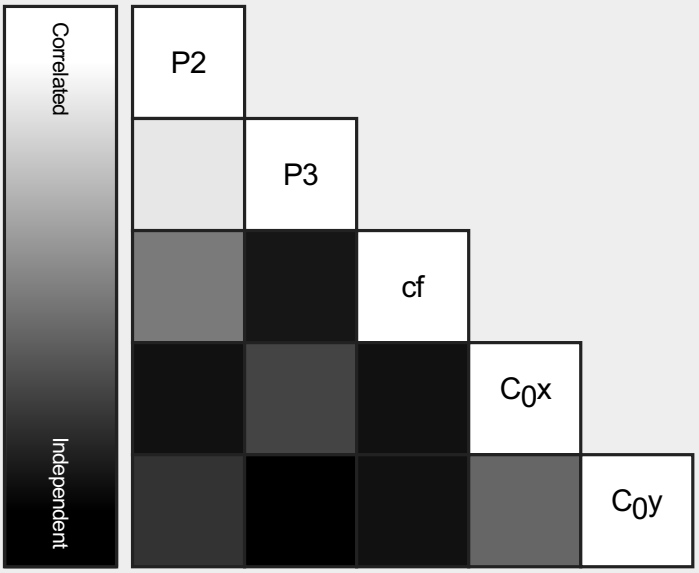
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the 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.

Internal Camera Parameters

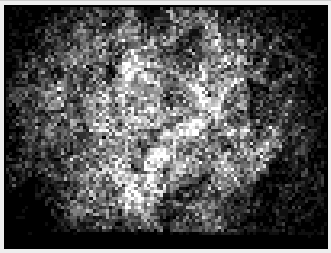
multiSPEC4C_3.6_1280x960 (NIR). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

EXIF ID: multiSPEC4C_3.6_1280x960

	Poly[0]	Poly[1]	Poly[2]	Poly[3]	Poly[4]	c	d	e	f	Principal Point x	Principal Point y
Initial Values	0.000000	1.000000	0.028743	-0.382359	0.000000	1560.00	0.00	0.00	1560.00	640.00	480.00
Optimized Values	0.000000	1.000000	0.024277	-0.389201	0.000000	1596.18	0.00	0.00	1596.18	648.39	464.01
Uncertainties (Sigma)			0.003762	0.006547		2.48	0.00	0.00	2.48	0.43	0.40



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.

Camera Rig «Airinov multiSPEC4C 1.1» Relatives. Images: 904

	Transl X [m]	Transl Y [m]	Transl Z [m]	Rot X [degree]	Rot Y [degree]	Rot Z [degree]
multiSPEC4C_3.6_1280x960 (Green)	Reference Camera					
multiSPEC4C_3.6_1280x960 (Red)						
Initial Values	0.000	0.015	0.000	0.000	0.000	0.000
Optimized values	0.000	0.015	0.000	0.410	-0.070	-0.318
Uncertainties (sigma)				0.029	0.030	0.004
multiSPEC4C_3.6_1280x960 (Red edge)						
Initial Values	0.015	0.000	0.000	0.000	0.000	0.000
Optimized values	0.015	0.000	0.000	0.293	-0.287	-0.524
Uncertainties (sigma)				0.024	0.025	0.004
multiSPEC4C_3.6_1280x960 (NIR)						
Initial Values	0.015	0.015	0.000	0.000	0.000	0.000
Optimized values	0.015	0.015	0.000	0.644	0.119	-0.635
Uncertainties (sigma)				0.024	0.026	0.004

2D Keypoints Table

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	36490	7500
Min	17581	7
Max	47808	19220
Mean	35678	7119

2D Keypoints Table for Camera multiSPEC4C_3.6_1280x960 (Green)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	36443	8977
Min	17581	1186
Max	45257	19220
Mean	35559	8958

2D Keypoints Table for Camera multiSPEC4C_3.6_1280x960 (Red)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	40220	452
Min	17659	7
Max	47028	3433
Mean	36381	690

2D Keypoints Table for Camera multiSPEC4C_3.6_1280x960 (Red edge)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	40412	1427
Min	17707	202
Max	47164	6032
Mean	35028	1823

2D Keypoints Table for Camera multiSPEC4C_3.6_1280x960 (NIR)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	41255	782
Min	18996	134
Max	47808	5529
Mean	36747	1527

Median / 75%/ Maximal Number of Matches Between Camera Models

	multiSPEC4C_3... (Green)	multiSPEC4C_3.6... (Red)	multiSPEC4...(Red edge)	multiSPEC4C_3.6... (NIR)
multiSPEC4C_3.6_1280x960 (Green)	125 / 674 / 10309	35 / 145 / 2609	71 / 326 / 4091	67 / 286 / 4001
multiSPEC4C_3.6_1280x960 (Red)		25 / 81 / 850	28 / 111 / 1760	24 / 120 / 2065
multiSPEC4C_3.6_1280x960 (Red edge)			80 / 268 / 2686	124 / 447 / 3211
multiSPEC4C_3.6_1280x960 (NIR)				108 / 386 / 2026

3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	515851
In 3 Images	125308
In 4 Images	50309
In 5 Images	25680
In 6 Images	15258
In 7 Images	9342
In 8 Images	6216
In 9 Images	4213
In 10 Images	3033
In 11 Images	2110
In 12 Images	1616
In 13 Images	1220
In 14 Images	908
In 15 Images	659
In 16 Images	448
In 17 Images	375
In 18 Images	278
In 19 Images	169
In 20 Images	115
In 21 Images	95
In 22 Images	44

In 23 Images	26
In 24 Images	14
In 25 Images	7
In 26 Images	3
In 28 Images	1

2D Keypoint Matches

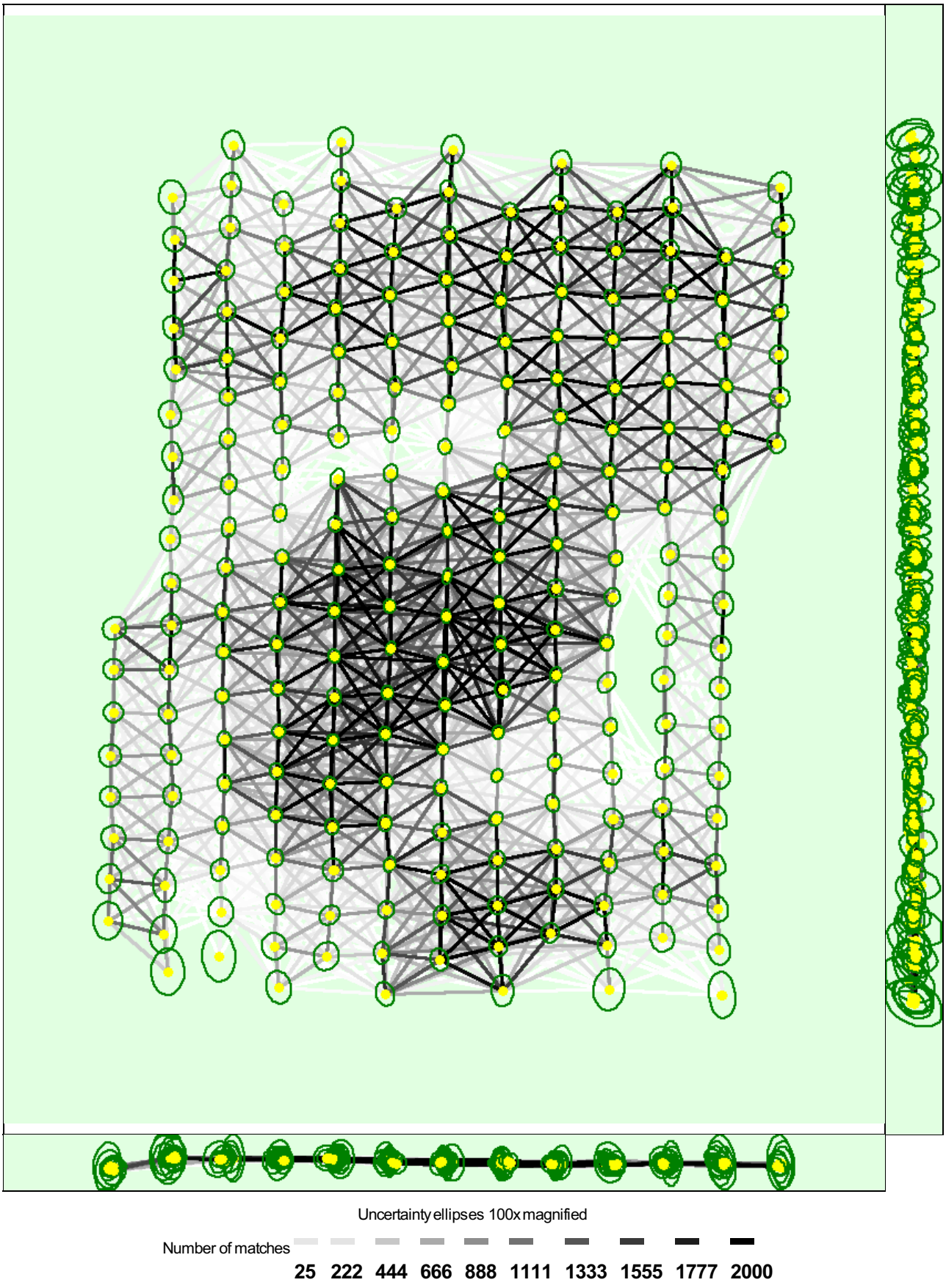


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the

images. Bright links indicate weak links and require manual tie points or more images. 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]
Mean	0.068	0.080	0.085	0.052	0.042	0.012
Sigma	0.018	0.024	0.037	0.021	0.015	0.006

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
gcp2 (3D)	0.020/ 0.020	0.060	0.023	0.112	0.523	6 / 6
gcp3 (3D)	0.020/ 0.020	-0.002	-0.001	0.079	0.756	7 / 7
gcp4 (3D)	0.020/ 0.020	0.009	-0.032	-0.079	0.493	9 / 9
gcp5 (3D)	0.020/ 0.020	-0.039	0.007	-0.005	0.665	8 / 8
gcp6 (3D)	0.020/ 0.020	0.019	0.032	0.104	0.438	7 / 7
gcp7 (3D)	0.020/ 0.020	0.036	-0.033	-0.002	0.517	6 / 6
gcp8 (3D)	0.020/ 0.020	-0.048	0.042	0.065	0.549	5 / 5
17c (3D)	0.020/ 0.020	-0.010	-0.004	-0.053	0.294	5 / 5
Mean [m]		0.003121	0.004401	0.027583		
Sigma [m]		0.033991	0.025672	0.067706		
RMS Error [m]		0.034134	0.026046	0.073109		

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 [%]
-	-8.60	0.00	0.00	0.00
-8.60	-6.88	0.00	0.00	0.00
-6.88	-5.16	0.00	0.00	0.00
-5.16	-3.44	0.00	0.44	0.00
-3.44	-1.72	2.21	6.64	0.44
-1.72	0.00	50.33	44.25	50.88
0.00	1.72	47.01	25.88	47.35
1.72	3.44	0.44	22.79	1.33
3.44	5.16	0.00	0.00	0.00
5.16	6.88	0.00	0.00	0.00
6.88	8.60	0.00	0.00	0.00
8.60	-	0.00	0.00	0.00
Mean [m]		-1.911851	0.395066	-4.282779
Sigma [m]		0.681056	1.563066	0.717010
RMS Error [m]		2.029535	1.612220	4.342384

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]	-1.865626	0.277855	-4.287937

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]	98.23	78.54	100.00
[-2.00, 2.00]	100.00	99.56	100.00
[-3.00, 3.00]	100.00	100.00	100.00
Mean of Geolocation Accuracy [m]	1.944597	1.944597	4.247367
Sigma of Geolocation Accuracy [m]	0.228140	0.228140	0.553848

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

Geolocation Orientational Variance	RMS [degree]
Omega	4.562
Phi	4.683
Kappa	173.604

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) CPU E5-1650 v3 @ 3.50GHz RAM: 32GB GPU: NVIDIA Quadro M4000 (Driver: 23.21.13.8816)
Operating System	Windows 10 Pro, 64-bit

Coordinate Systems

Image Coordinate System	WGS 84
Ground Control Point (GCP) Coordinate System	WGS 84 / UTM zone 6N (EGM96 Geoid)
Output Coordinate System	WGS 84 / UTM zone 6N (EGM96 Geoid)

Processing Options

Detected Template	No Template Available
Keypoints Image Scale	Full, Image Scale: 2
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: yes
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Alternative Internal Parameters Optimization: All External Parameters Optimization: All Rematch: Auto, no
Rig «Airinov multiSPEC4C 1.1» processing	optimize relative rotation using a subset of secondary cameras

Point Cloud Densification details

Processing Options

Image Scale	multiscale, 1 (Original image size, Slow)

Point Density	Optimal
Minimum Number of Matches	3
3D Textured Mesh Generation	yes
3D Textured Mesh Settings:	Resolution: High Resolution Color Balancing: no
LOD	Generated: no
Advanced: 3D Textured Mesh Settings	Sample Density Divider: 1
Advanced: Image Groups	Green, Red, Red edge, NIR
Advanced: Use Processing Area	yes
Advanced: Use Annotations	yes
Time for Point Cloud Densification	13m:36s
Time for Point Cloud Classification	NA
Time for 3D Textured Mesh Generation	24m:14s

Results

Number of Generated Tiles	1
Number of 3D Densified Points	7880383
Average Density (per m^3)	4.2

DSM, Orthomosaic and Index Details

Processing Options

DSM and Orthomosaic Resolution	1 x GSD (13.1 [cm/pixel])
DSM Filters	Noise Filtering: yes Surface Smoothing: no
Raster DSM	Generated: yes Method: Inverse Distance Weighting Merge Tiles: yes
Orthomosaic	Generated: yes Merge Tiles: no GeoTIFF Without Transparency: no Google Maps Tiles and KML: no
Grid DSM	Generated: yes, Spacing [cm]: 100
Raster DTM	Generated: yes Merge Tiles: yes
DTM Resolution	5 x GSD (13.1 [cm/pixel])
Contour Lines Generation	Generated: yes Contour Base [m]: 0 Elevation Interval [m]: 10 Resolution [cm]: 100 Minimum Line Size [vertices]: 20
Radiometric calibration with reflectance target	yes
Index Calculator: Reflectance Map	Generated: yes Resolution: 1 x GSD (13.1 [cm/pixel]) Merge Tiles: no
Index Calculator: Indices	green, red, red_edge, nir, ndvi
Index Calculator: Index Values	Polygon Shapefile [cm/grid]: 400
Time for DSM Generation	23m:34s
Time for Orthomosaic Generation	13m:56s
Time for DTM Generation	31s
Time for Contour Lines Generation	01s
Time for Reflectance Map Generation	47m:06s
Time for Index Map Generation	04m:18s

Camera Radiometric Correction

Camera Name	Band	Radiometric Correction Type	Reflectance target
multiSPEC4C_3.6_1280x960	Green	Camera and Sun Irradiance	✓

multiSPEC4C_3.6_1280x960	Red	Camera and Sun Irradiance	✅
multiSPEC4C_3.6_1280x960	Red edge	Camera and Sun Irradiance	✅
multiSPEC4C_3.6_1280x960	NIR	Camera and Sun Irradiance	✅