Know the Earth…Show the Way

Orbview 3 Relative Accuracy Results and Impacts on Exploitation and Accuracy Improvement

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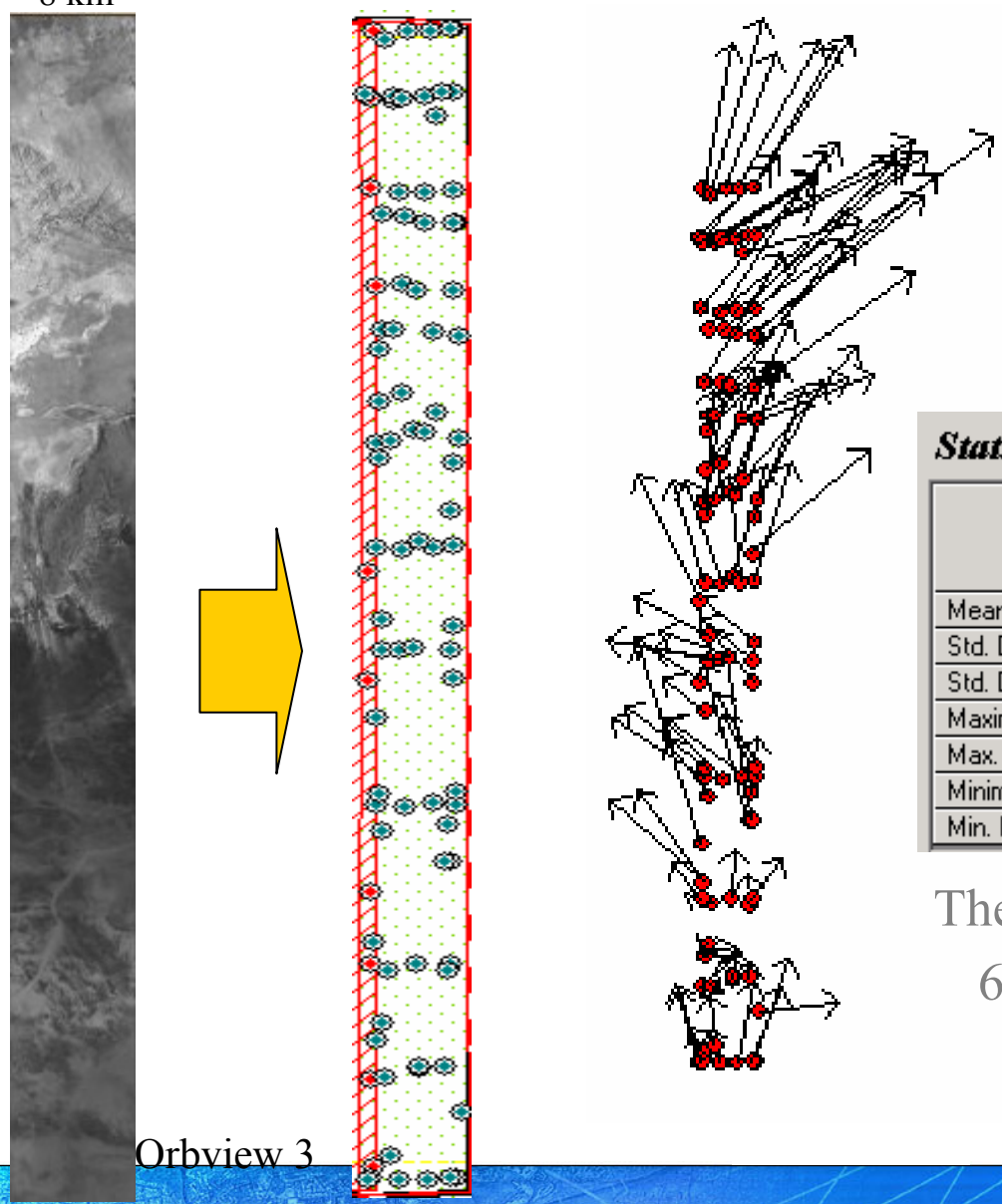
Introduction

In order to better exploit Orbview3, an important new data source, its internal dynamics (or relative accuracy) needs to be understood to standardize production procedures.

NGA therefore undertook a relative evaluation on Orbview3 data to investigate possible errors that may not have been visible or obvious during the traditional CCAP geometric evaluation we performed in Summer 2004.

Different tests, performed on much larger datasets, were undertaken to search out any systematic issues that we could then look deeper into as time permits. This is an early look at those results…

Orbview 3 pan image control point efficiency investigation



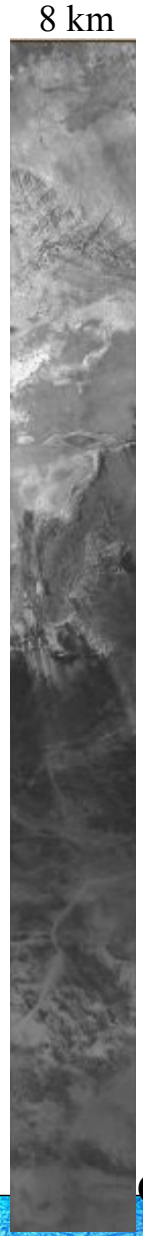
Base-line RPC Evaluation:
No control points

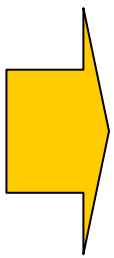
Statistics: ***Points:*** 93

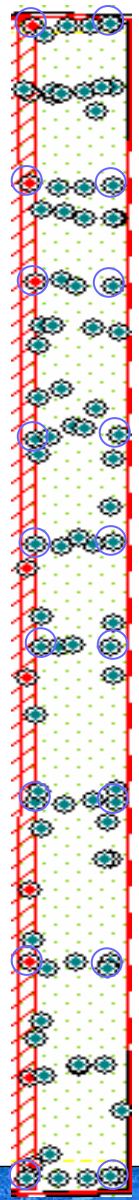
	Latitude residual (meters)	Longitude residual (meters)	Height residual (meters)	Straight line residual (meters)
Mean	2.41	0.97	0.00	3.26
Std. Dev.(68)	1.46	2.19	0.00	1.74
Std. Dev.(90)	2.40	3.61	0.00	2.87
Maximum	5.63	6.65	0.00	8.25
Max. Point ID	302601	783101	102601	783101
Minimum	-0.28	-2.84	0.00	0.33
Min. Point ID	202701	462701	102601	202701

The CE90 of the image using M+.9p is 6.1 meters (relative to the control).

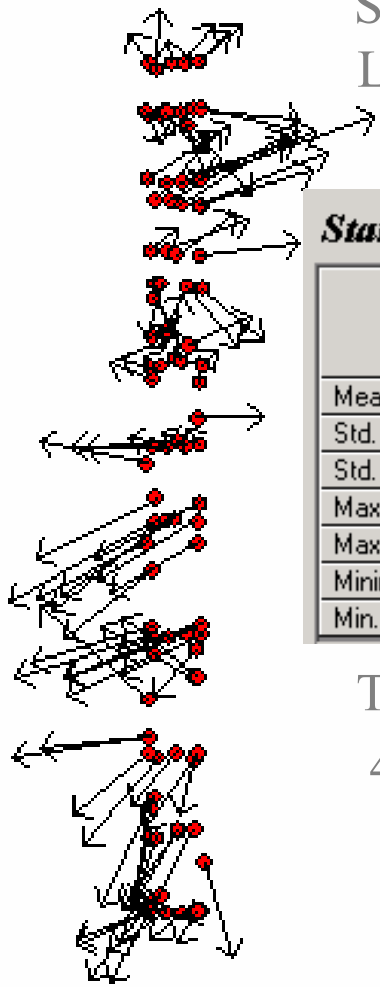
Orbview 3 pan image control point efficiency investigation







Orbview 3



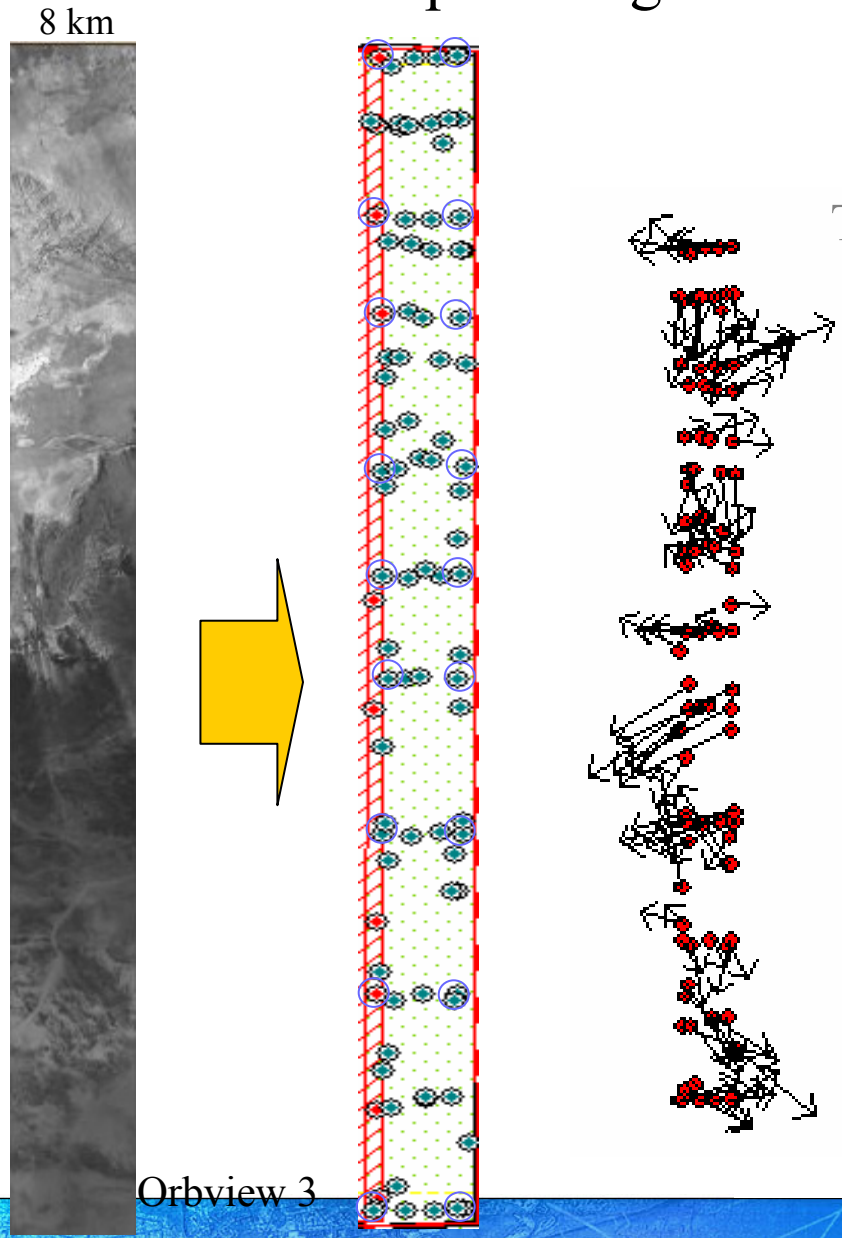
Socet Set two parameter RPC solve:
Line/Sample offset: 15m (1) sigma
2 x 9 control pattern

Statistics: ***Points:*** 93

	Latitude residual (meters)	Longitude residual (meters)	Height residual (meters)	Straight line residual (meters)
Mean	-0.52	-0.44	-0.20	2.40
Std. Dev.(68)	1.43	2.14	0.34	1.13
Std. Dev.(90)	2.35	3.52	0.55	1.85
Maximum	2.71	5.04	0.68	5.37
Max. Point ID	302601	783101	833001	783101
Minimum	-3.20	-4.20	-0.75	0.46
Min. Point ID	202701	462701	112601	632701

The CE90 of the image using M+.9p is 4.2 meters (relative to the control).

Orbview 3 pan image control point efficiency investigation



Socet Set six parameter RPC solve:
Line/Sample offset: 15m (1) sigma
Terms, CLS, CLL,CSL,CSS: .001 (1) sigma
2 x 9 control pattern

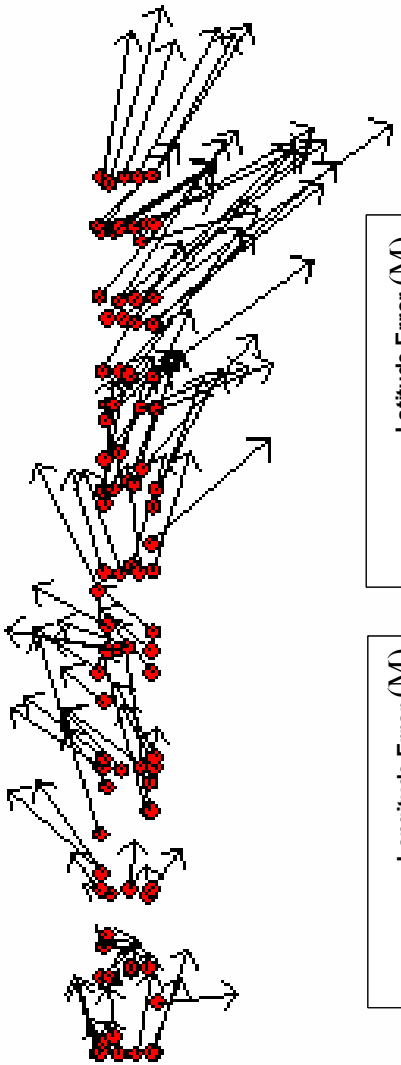
Statistics: ***Points:*** 93

	Latitude residual (meters)	Longitude residual (meters)	Height residual (meters)	Straight line residual (meters)
Mean	-0.38	-0.12	0.00	1.82
Std. Dev.(68)	1.21	1.54	0.27	0.79
Std. Dev.(90)	1.99	2.53	0.44	1.30
Maximum	3.51	2.89	0.69	3.70
Max. Point ID	302601	783101	833001	483101
Minimum	-2.71	-3.35	-0.48	0.33
Min. Point ID	833001	483101	353001	602701

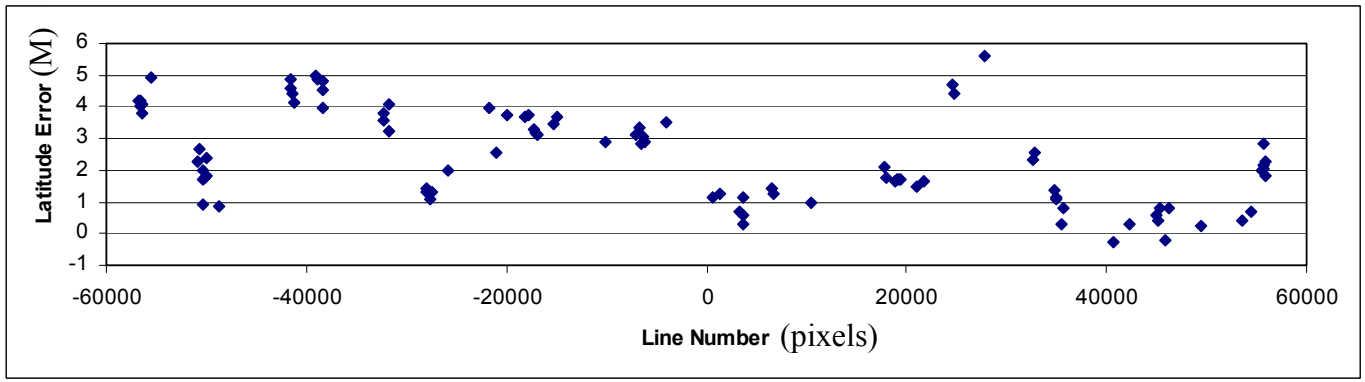
The CE90 of the image using M+.9p is 3.1 meters (relative to the control).

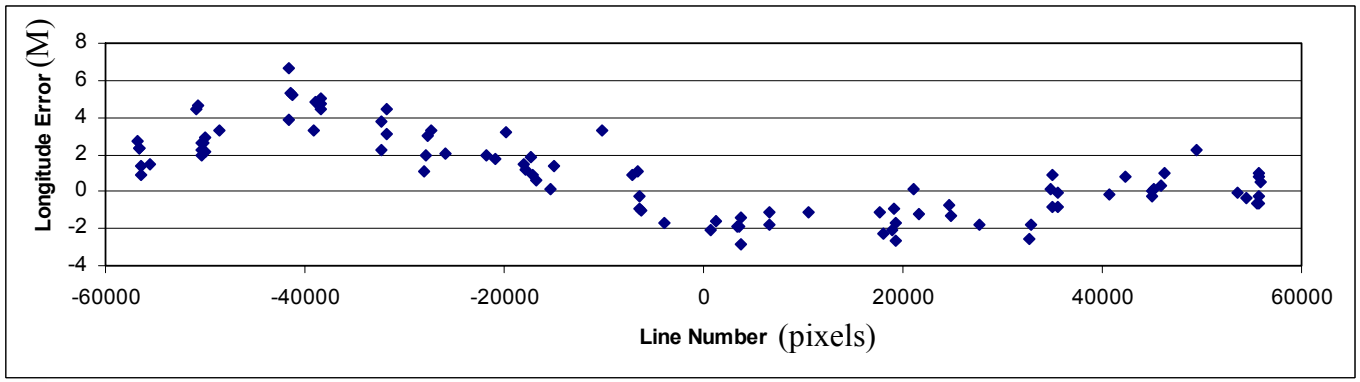
For long strips such as this, using current methods of RPC adjustment, this is the best we can do. Localized systematic biases will remain. We call this the attitude drift.

Orbview 3 pan image attitude drift investigation



The graphs break down horizontal vector error into latitude error and longitude error. The X axis is a function of time or line number. Graphs show attitude drift from a different perspective.

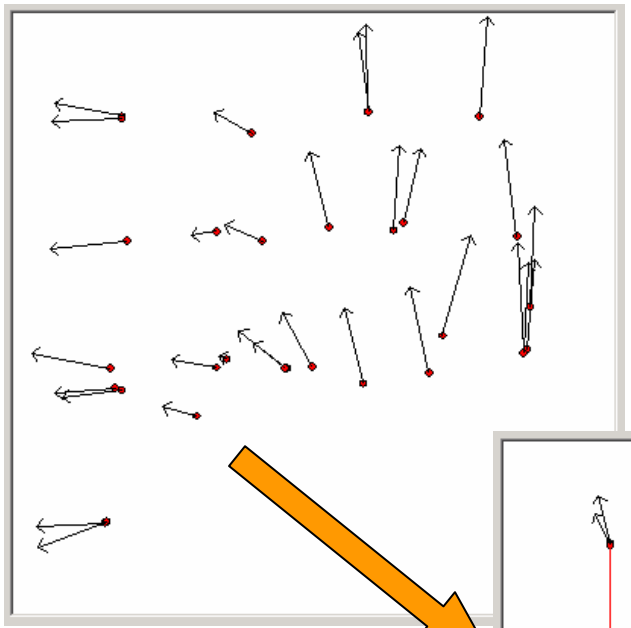




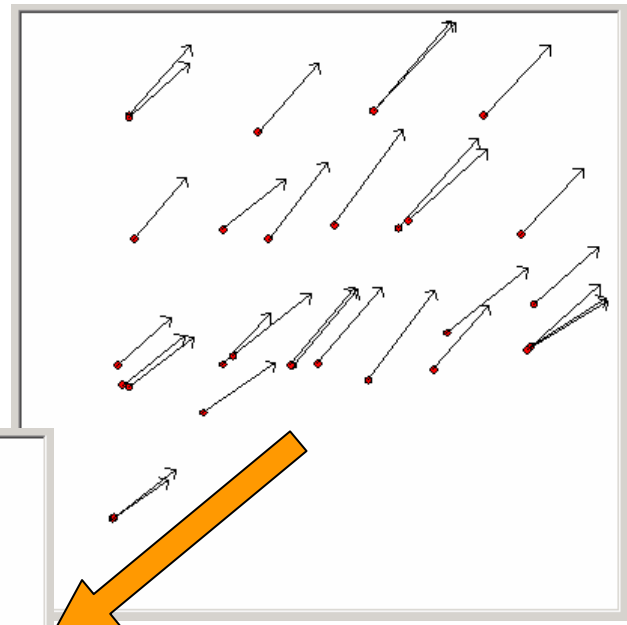
CCAP: Utapao Stereo Evaluation

Evaluation results show how attitude drift can affect stereo accuracy

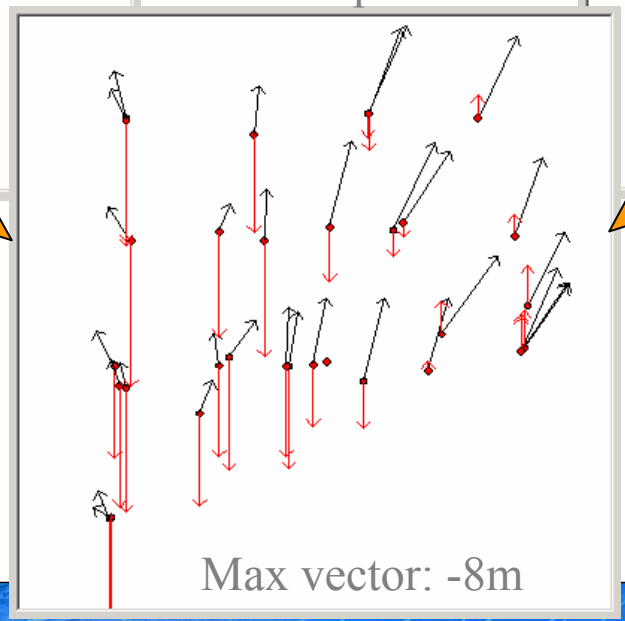
Stereo image 1 with attitude drift



Stereo image 2 with bias



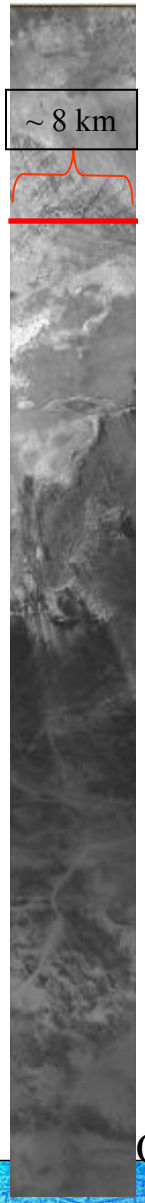
Stereo pair



Stereo evaluation shows vertical tilt

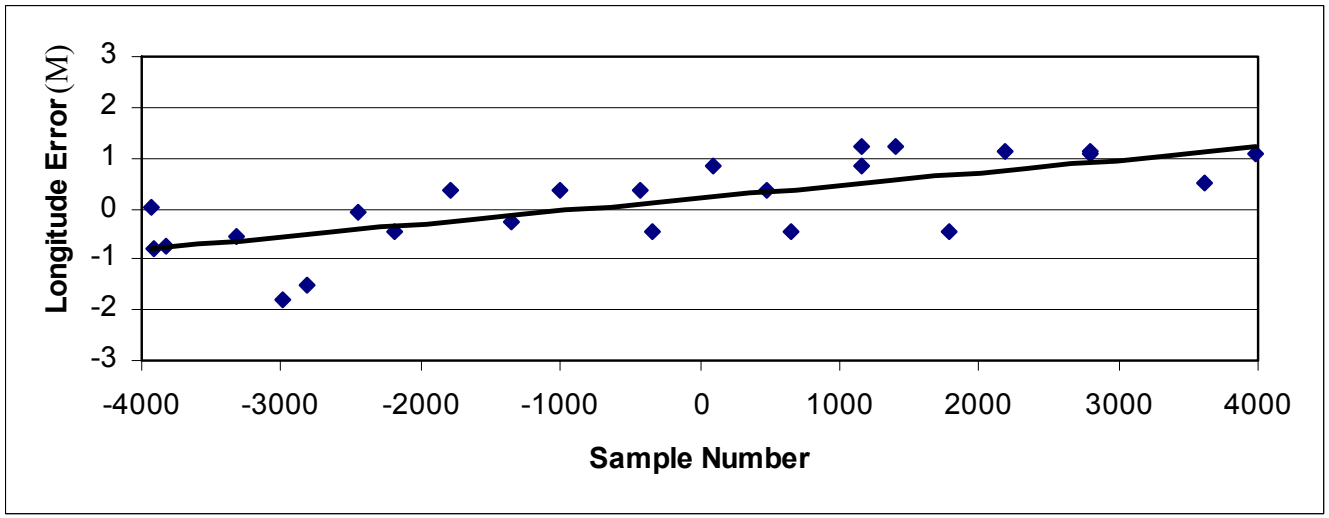
Pseudo least-squares ray minimization on unadjusted images

Orbview 3 pan sensor - line scaling error investigation



All evaluation points measured with the same line number

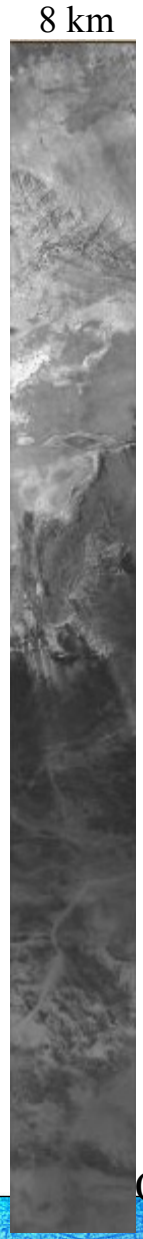
Plot and graph show subtle but systematic longitude error

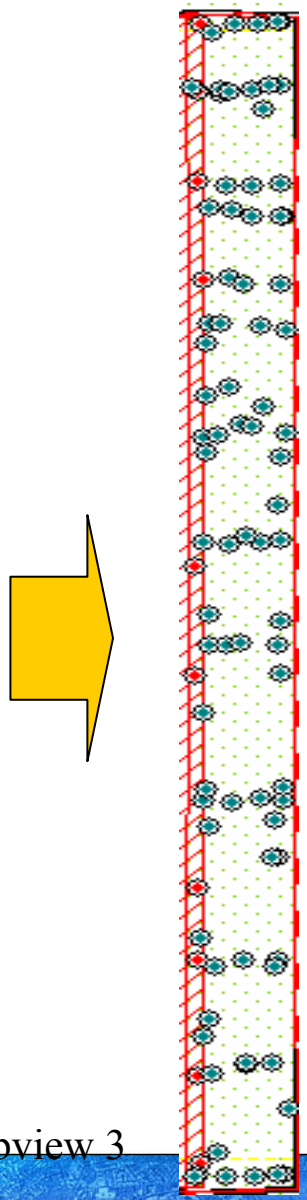


Data set reveals the sensor line scale error
which is similar to a small focal length error

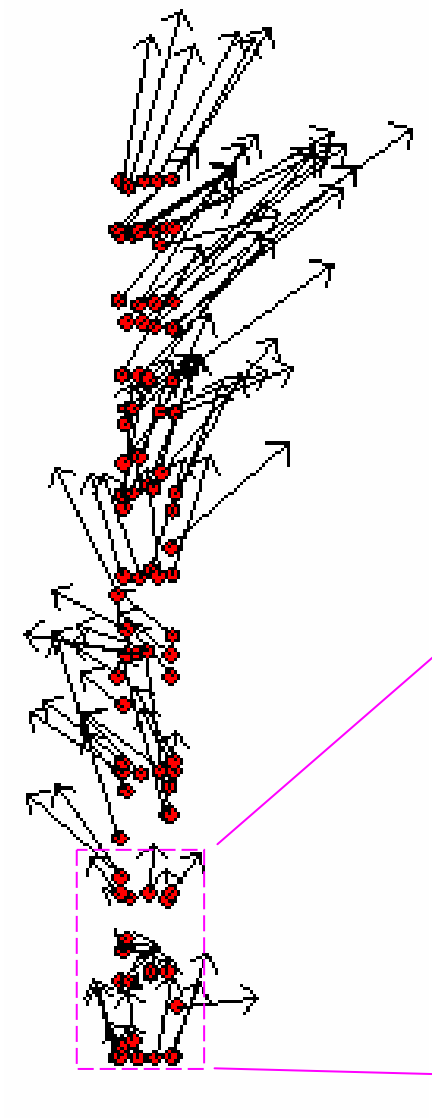
Orbview 3

Orbview 3 pan image line scale error detection

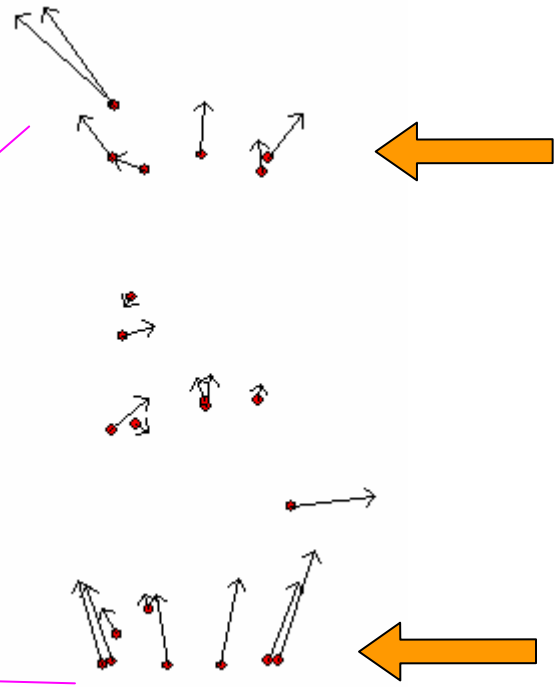




Orbview 3

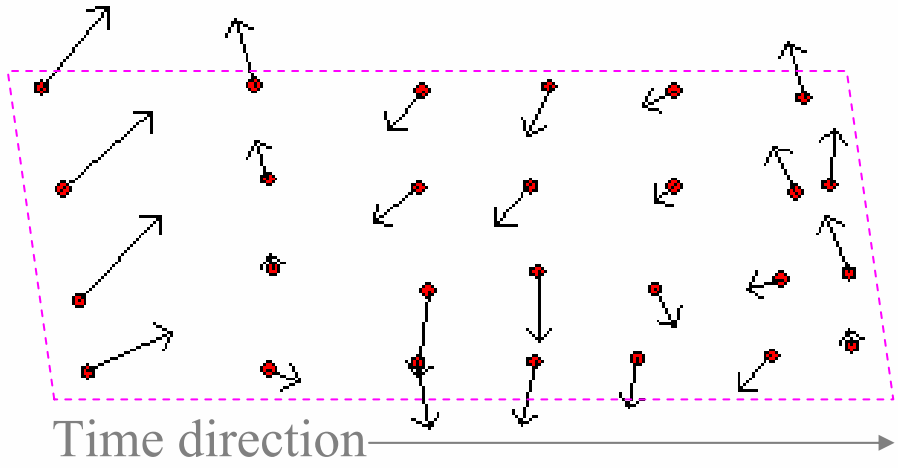


More evidence of the pan image line scale error detected in control point efficiency investigation



Pre-CCAP: Holloman Evaluation; Mean Bias removed

Data set shows the attitude drift and sensor line scale error



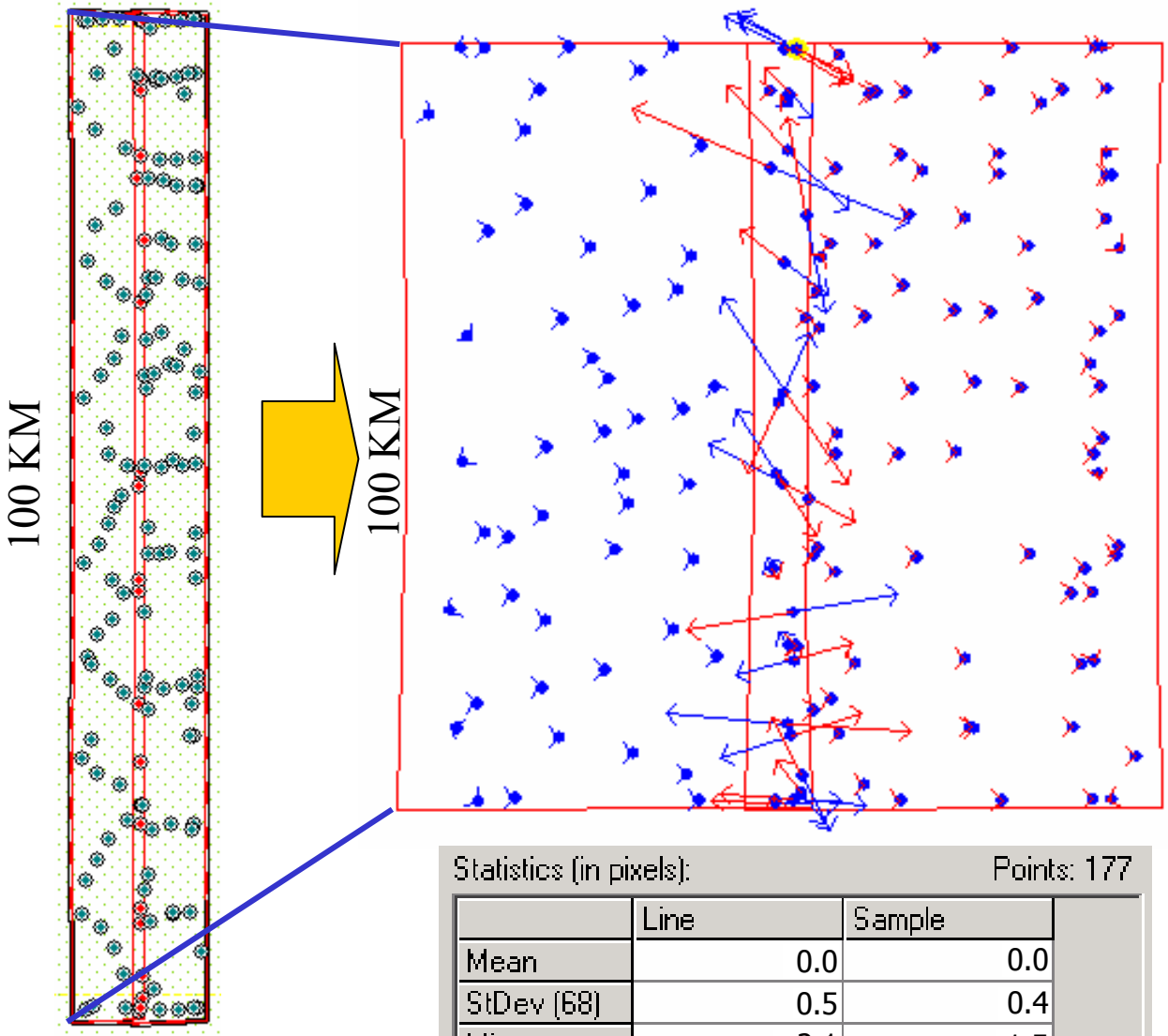
Orbview 3 image: 649051op

Statistics: ***Points:*** 27

	Latitude residual (meters)	Longitude residual (meters)	Height residual (meters)	Straight line residual (meters)
Mean	0.00	0.00	0.00	0.00
Std. Dev.(68)	1.59	1.17	0.00	1.53
Std. Dev.(90)	2.62	1.92	0.00	2.52
Maximum	2.59	2.75	0.00	1.70
Max. Point ID	26	25	1	18
Minimum	-2.59	-1.36	0.00	-3.56
Min. Point ID	18	17	1	25

☑ Remove means from vectors Datum: WGS84

Orbview 3 pan image overlap residual analysis



Statistics (in pixels): Points: 177

	Line	Sample
Mean	0.0	0.0
StDev (68)	0.5	0.4
Min	-2.1	-1.5
Max	2.2	1.5

Images have been controlled using the 2 X 9 pattern on both images and triangulated using 6-parameter RPC adjustment. The vectors represent remaining image shear with a maximum of 4 pixels.

Summary

The overall absolute accuracy of Orbview 3 is very good!

Three types of error that should be considered when controlling or triangulation Orbview3 sensor data:

1. Absolute Error: Bias
2. Relative Error: Attitude Drift
3. Interior Orientation Error: Image Line Scaling Error

We feel that these errors are relatively small in comparison to those generated by the per-pixel repositioning that occurs from elevation errors within the orthorectification process.

Solutions, Future Efforts, and Considerations

NGA and ORBIMAGE are working together to determine mechanisms to minimize relative errors.

In addition, further research into factors that may be correlated with these addressed errors will be ongoing in hopes of refining them “upstream”.

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Comments and questions...