Absolute Geolocation Accuracy Evaluation of GeoEye-1 Basic Stereo Triplets

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Outline

- Objective
- Product Description and Specifications
- Methodology
- Evaluation Results

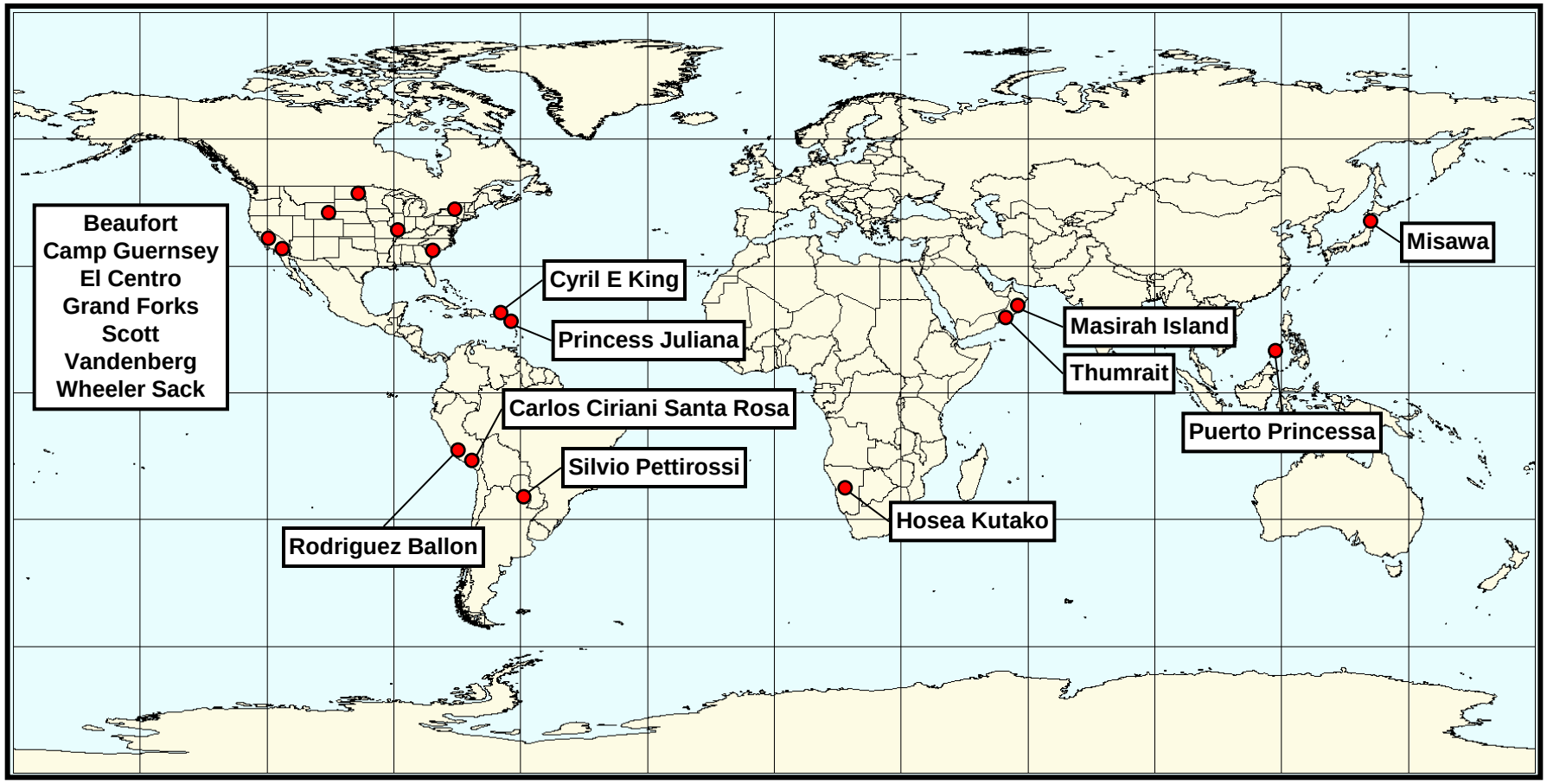
- Bonus: Monitoring Results

Objective

- To estimate the absolute horizontal and vertical geolocation accuracy of a sample of 25 panchromatic GeoEye-1 Basic stereo triplets

- End product accuracy assessments
  - No correction for off-nadir angle

25 Stereo Triplets over 17 Test Sites



Collected between 6 February and 17 March 2009.
Product processing dates between 7 February and 18 March 2009.

Definitions of Statistics

- Circular Error 90% (CE90)
  - In horizontal plane
  - Radial error distance centered at zero within which 90% of the data points fall
- Linear Error 90% (LE90)
  - In vertical dimension
  - Absolute value error distance from zero within which 90% of the data points fall

GeoEye-1
Basic Stereo Triplet Product

Processing	Geometry	Swath Width (km)	Nadir GSD (m)	Bit Depth
Basic	Synthetic Pushbroom	~15.2	0.41*	11-bit

* Re-sampled to 0.5 m for commercial customers.

GeoEye Statements	Mono CE90	Stereo CE90	Stereo LE90
GeoEye-1 Specifications (m)**	5	4	6

** Excluding terrain effects, and with >60 elevation angle.

Source: http://www.geoeye.com/CorpSite/assets/docs/brochures/GeoEye-1_Fact_Sheet.pdf, accessed 25 January 2010.

CCAP Absolute Geolocation Accuracy Methodology

- General Approach
  1) Monoscopic CE90
     - Middle triplet image used as monoscopic image
     - Ray intersection with ground-surveyed height
  2) Stereo CE90 and LE90
     - Stereo intersection using first and third triplet images as a pair
- Images / stereo pairs are *not* allowed to adjust during evaluation

CCAP Absolute Geolocation Accuracy Methodology

1) Load image or stereo pair onto workstation with SOCET Set® photogrammetric software

2) Import geometry model support data accompanying imagery

- a) NITF 2.1 Commercial Data Requirements Document (NCDRD) format rigorous sensor metadata
  - Imbedded camera, ephemeris, and attitude information
  - Atmospheric refraction (ATMREF) correction turned “on”
- b) Rational polynomial coefficient (RPC) replacement geometry model metadata

CCAP Absolute Geolocation Accuracy Methodology

3) Compute ground coordinates of checkpoints from test imagery sensor model support data

- Use ground-surveyed control points as checkpoints
- Measure pixel positions (line, sample) of checkpoints
- Hold test imagery fixed (by holding sensor model support data fixed) and allow checkpoint ground coordinates to adjust to pixel measurements using triangulation tool
  - For monoscopic images, height of each checkpoint is fixed to ground-surveyed height (ray intersection with height)
  - For stereo pairs, each checkpoint is allowed to freely adjust (stereo intersection)

CCAP Absolute Geolocation Accuracy Methodology

4) For each checkpoint, subtract ground-surveyed coordinates from test-imagery-derived ground coordinates

- Results in a list of "Δ Easting" and "Δ Northing" values
- For stereo pair, also a list of "Δ Height" values

CCAP Absolute Geolocation Accuracy Methodology

5) For each image or stereo pair, compute error centroid

- Compute mean "Δ Easting" and "Δ Northing" values
  - Convert into horizontal "Δ Radial" value
- For stereo pair, compute mean "Δ Height" value
  - Convert into "absolute-value Δ Height" value

- Additional statistics:
  - Number of checkpoints
  - Maximums & minimums of Δ Easting, Δ Northing, and Δ Height values
  - Standard deviations of Δ Easting, Δ Northing, and Δ Height values

- Each image or stereo pair represented by single data point for CE90 and LE90 estimation

CCAP Absolute Geolocation Accuracy Methodology

Each image or stereo pair represented by single data point for CE90 and LE90 estimation because…

- …test sites have varying number of checkpoints
- …absolute checkpoint errors for metric, narrow field-of-view sensors tend to be similar in magnitude and direction throughout an image
- …goal of evaluation is to estimate CE90 and LE90 error statistics for populations of images and stereo pairs, not individual images and stereo pairs

CCAP Absolute Geolocation Accuracy Methodology

6) Estimate CE90, and for stereo pairs, LE90

- CCAP uses non-parametric estimator ("Percentile Method")
- Sort "Δ Radial" or "absolute-value Δ Height" values in ascending order
- Cut-off at 90th percentile
  - For n data points, 0.9*n + 0.5 defines position in ordered list
  - Linearly interpolate from ordered list as required

- Additional statistics:
  - Number of images or stereo pairs
  - Maximums and minimums of centroid values
  - Standard deviations of centroid values

90th Percentile Estimator for Ordered Statistics

Given n ordered data points $x_{(1)}, x_{(2)}, \ldots, x_{(n)}$,

where $x_{(i)} = \Delta r_{(i)}$ for CE90 and $x_{(i)} = abs(\Delta h_{(i)})$ for LE90.

Then,

$$CE90 \text{ or } LE90 = (1 - f) * x_{(i)} + f * x_{(i+1)}$$

where

$i =$ integer part of $0.9 * n + 0.5$, and

$f =$ fractional part of $0.9 * n + 0.5$.

GeoEye-1 Basic Stereo Triplet Evaluation Results

25 stereo triplets delivered, but because of metadata glitch…

Beaufort not evaluated for mono

Rodriguez Ballon not evaluated for stereo.

Therefore, only sample sizes of 24

GeoEye-1 Basic

Mono Horizontal Accuracy

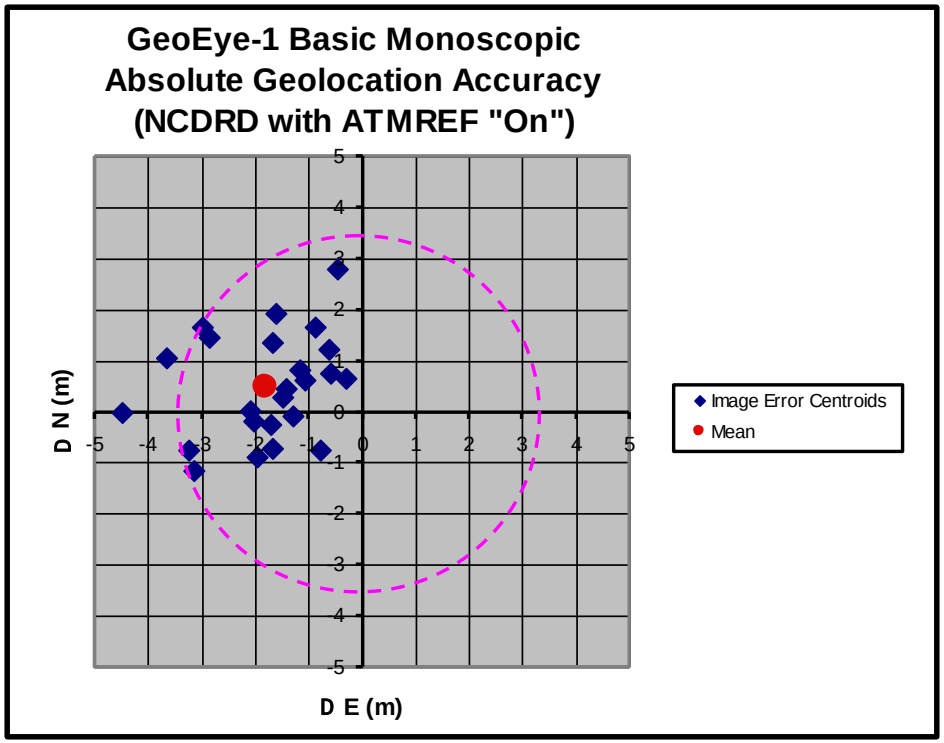
Test Site	CPs	Image	Mean Δ E (m)	Mean Δ N (m)	Δ r (m)
Japan, Misawa	11	JA_MS_2009_02_14_1509612	-4.5	0.0	4.5
Japan, Misawa	11	JA_MS_2009_03_08_1510931	-1.7	1.4	2.1
Namibia, Hosea Kutako	11	WA_HK_2009_02_26_1509846	-1.4	0.5	1.5
Namibia, Hosea Kutako	16	WA_HK_2009_03_17_1512167	-1.2	0.8	1.4
Netherlands Antilles, Princess Juliana	11	NT_PJ_2009_02_11_1508747	-2.9	1.5	3.2
Netherlands Antilles, Princess Juliana	11	NT_PJ_2009_02_22_1509646	-0.9	1.7	1.9
Oman, Masirah Island	31	MU_MI_2009_02_14_1509610	-2.0	-0.9	2.1
Oman, Thumrait	19	MU_TH_2009_02_09_1508622	-3.0	1.7	3.4
Paraguay, Silvio Pettirossi	17	PA_SP_2009_02_12_1509005	-1.6	1.9	2.5
Paraguay, Silvio Pettirossi	15	PA_SP_2009_03_17_1512374	-0.6	1.2	1.4
Peru, Carlos Ciriani Santa Rosa	20	PE_CR_2009_02_11_1508820	-0.5	2.8	2.8
Peru, Rodriquez Ballon	24	PE_RB_2009_02_06_1508534	-0.6	0.7	1.0
Philippines, Puerto Princessa	15	RP_PP_2009_02_21_1509838	-0.8	-0.8	1.1
United States, Camp Guernsey	19	US_CG_2009_02_22_1509835	-2.1	0.0	2.1
United States, Camp Guernsey	18	US_CG_2009_03_05_1510676	-1.5	0.3	1.5
United States, Camp Guernsey	18	US_CG_2009_03_08_1510935	-1.3	-0.1	1.3
United States, El Centro	20	US_EC_2009_02_12_1508955	-1.7	-0.3	1.7
United States, Grand Forks	15	US_GF_2009_02_08_1508593	-3.2	-0.8	3.3
United States, Grand Forks	16	US_GF_2009_02_19_1509608	-1.1	0.6	1.2
United States, Grand Forks	15	US_GF_2009_03_02_1510482	-1.7	-0.7	1.8
United States, Scott	23	US_ST_2009_02_12_1508958	-2.0	-0.2	2.0
United States, Vandenberg	10	US_VB_2009_02_10_1509010	-3.1	-1.2	3.4
United States, Wheeler Sack	12	US_WS_2009_02_08_1508586	-3.7	1.1	3.8
U.S. Virgin Islands, Cyril E King	10	VQ_CK_2009_02_25_1509842	-0.3	0.6	0.7

- 24 middle stereo triplet images
- NCDRD support data
- ATMREF correction “on”

Mean (m)	-1.8	0.5	2.2
Standard Deviation (m)	1.1	1.0	1.0
Maximum (m)	-0.3	2.8	4.5
Minimum (m)	-4.5	-1.2	0.7

GeoEye-1 Basic

Mono Horizontal Accuracy (n=24)



Test Site	Sorted Δ r (m)	Test Image
U.S. Virgin Islands, Cyril_E_King	0.7	VQ_CK_2009_02_25_1509842
Peru, Rodriquez Ballon	1.0	PE_RB_2009_02_06_1508534
Philippines, Puerto Princessa	1.1	RP_PP_2009_02_21_1509838
United States, Grand Forks	1.2	US_GF_2009_02_19_1509608
United States, Camp Guernsey	1.3	US_CG_2009_03_08_1510935
Paraguay, Silvio Pettirossi	1.4	PA_SP_2009_03_17_1512374
Namibia, Hosea Kutako	1.4	WA_HK_2009_03_17_1512167
Namibia, Hosea Kutako	1.5	WA_HK_2009_02_26_1509846
United States, Camp Guernsey	1.5	US_CG_2009_03_05_1510676
United States, El Centro	1.7	US_EC_2009_02_12_1508955
United States, Grand Forks	1.8	US_GF_2009_03_02_1510482
Netherlands Antilles, Princess Juliana	1.9	NT_PJ_2009_02_22_1509646
United States, Scott	2.0	US_ST_2009_02_12_1508958
United States, Camp Guernsey	2.1	US_CG_2009_02_22_1509835
Japan, Misawa	2.1	JA_MS_2009_03_08_1510931
Oman, Masirah Island	2.1	MU_MI_2009_02_14_1509610
Paraguay, Silvio Pettirossi	2.5	PA_SP_2009_02_12_1509005
Peru, Carlos Ciriani Santa Rosa	2.8	PE_CR_2009_02_11_1508820
Netherlands Antilles, Princess Juliana	3.2	NT_PJ_2009_02_11_1508747
United States, Grand Forks	3.3	US_GF_2009_02_08_1508593
United States, Vandenberg	3.4	US_VB_2009_02_10_1509010
Oman, Thumrait	3.4	MU_TH_2009_02_09_1508622
United States, Wheeler Sack	3.8	US_WS_2009_02_08_1508586
Japan, Misawa	4.5	JA_MS_2009_02_14_1509612

Estimated Mono CE90 = 3.4 m

GeoEye-1 Basic

Stereo Horizontal Accuracy

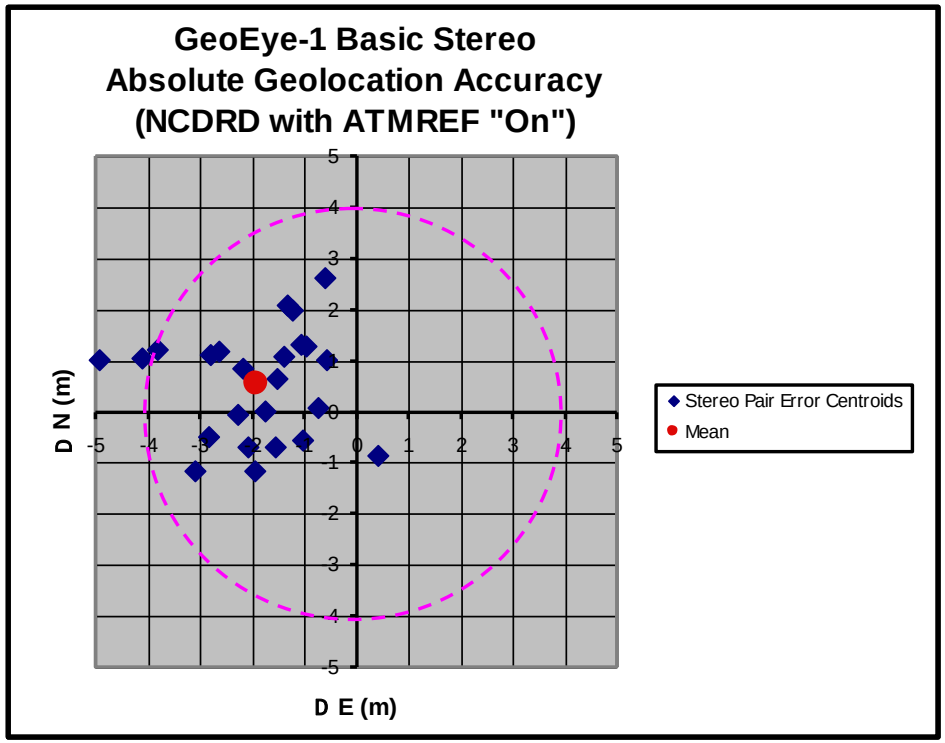
Test Site	CPs	Stereo Pair	Mean Δ E (m)	Mean Δ N (m)	Δ r (m)
Japan, Misawa	11	JA_MS_2009_02_14_1509613_14	-4.9	1.0	5.0
Japan, Misawa	11	JA_MS_2009_03_08_1510930_32	-2.6	1.2	2.9
Namibia, Hosea Kutako	11	WA_HK_2009_02_26_1509844_45	-1.2	2.0	2.4
Namibia, Hosea Kutako	16	WA_HK_2009_03_17_1512166_68	-1.0	1.3	1.6
Netherlands Antilles, Princess Juliana	10	NT_PJ_2009_02_11_1508745_46	-2.8	1.1	3.0
Netherlands Antilles, Princess Juliana	11	NT_PJ_2009_02_22_1509645_49	-1.4	1.1	1.8
Oman, Masirah Island	31	MU_MI_2009_02_14_1509609_11	-1.6	-0.7	1.7
Oman, Thumrait	18	MU_TH_2009_02_09_1508621_23	-2.8	-0.5	2.9
Paraguay, Silvio Pettirossi	17	PA_SP_2009_02_12_1509004_06	-1.3	2.1	2.5
Paraguay, Silvio Pettirossi	15	PA_SP_2009_03_17_1512373_75	-1.1	1.3	1.7
Peru, Carlos Ciriani Santa Rosa	20	PE_CR_2009_02_11_1508818_19	-0.6	2.6	2.7
Philippines, Puerto Princessa	17	RP_PP_2009_02_21_1509837_39	0.4	-0.9	0.9
United States, Beaufort	16	US_BE_2009_02_08_1508588_90	-0.6	1.0	1.2
United States, Camp Guernsey	19	US_CG_2009_02_22_1509834_36	-1.9	-1.1	2.2
United States, Camp Guernsey	18	US_CG_2009_03_05_1510674_75	-1.5	0.7	1.7
United States, Camp Guernsey	18	US_CG_2009_03_08_1510936_37	-2.3	-0.1	2.3
United States, El Centro	20	US_EC_2009_02_12_1508956_57	-1.8	0.0	1.8
United States, Grand Forks	14	US_GF_2009_02_08_1508591_92	-3.8	1.2	4.0
United States, Grand Forks	16	US_GF_2009_02_19_1509606_07	-1.0	-0.6	1.2
United States, Grand Forks	15	US_GF_2009_03_02_1510483_84	-3.1	-1.2	3.3
United States, Scott	23	US_ST_2009_02_12_1508959_60	-2.1	-0.7	2.2
United States, Vandenberg	10	US_VB_2009_02_10_1508706_08	-2.2	0.9	2.4
United States, Wheeler Sack	12	US_WS_2009_02_08_1508585_87	-4.1	1.1	4.2
U.S. Virgin Islands, Cyril E King	8	VQ_CK_2009_02_25_1509840_41	-0.7	0.1	0.8

- 24 stereo triplet pairs
- NCDRD support data
- ATMREF correction “on”

Mean (m)	-1.9	0.5	2.3
Standard Deviation (m)	1.2	1.1	1.1
Maximum (m)	0.4	2.6	5.0
Minimum (m)	-4.9	-1.2	0.8

GeoEye-1 Basic

Stereo Horizontal Accuracy (n=24)



Test Site	Sorted Δ r (m)	Test Image
U.S. Virgin Islands, Cyril_E_King	0.8	VQ_CK_2009_02_25_1509840_41
Philippines, Puerto Princessa	0.9	RP_PP_2009_02_21_1509837_39
United States, Grand Forks	1.2	US_GF_2009_02_19_1509606_07
United States, Beaufort	1.2	US_BE_2009_02_08_1508588_90
Namibia, Hosea Kutako	1.6	WA_HK_2009_03_17_1512166_68
United States, Camp Guernsey	1.7	US_CG_2009_03_05_1510674_75
Paraguay, Silvio Pettirossi	1.7	PA_SP_2009_03_17_1512373_75
Oman, Masirah Island	1.7	MU_MI_2009_02_14_1509609_11
United States, El Centro	1.8	US_EC_2009_02_12_1508956_57
Netherlands Antilles, Princess Juliana	1.8	NT_PJ_2009_02_22_1509645_49
United States, Scott	2.2	US_ST_2009_02_12_1508959_60
United States, Camp Guernsey	2.2	US_CG_2009_02_22_1509834_36
United States, Camp Guernsey	2.3	US_CG_2009_03_08_1510936_37
Namibia, Hosea Kutako	2.4	WA_HK_2009_02_26_1509844_45
United States, Vandenberg	2.4	US_VB_2009_02_10_1508706_08
Paraguay, Silvio Pettirossi	2.5	PA_SP_2009_02_12_1509004_06
Peru, Carlos Ciriani Santa Rosa	2.7	PE_CR_2009_02_11_1508818_19
Oman, Thumrait	2.9	MU_TH_2009_02_09_1508621_23
Japan, Misawa	2.9	JA_MS_2009_03_08_1510930_32
Netherlands Antilles, Princess Juliana	3.0	NT_PJ_2009_02_11_1508745_46
United States, Grand Forks	3.3	US_GF_2009_03_02_1510483_84
United States, Grand Forks	4.0	US_GF_2009_02_08_1508591_92
United States, Wheeler Sack	4.2	US_WS_2009_02_08_1508585_87
Japan, Misawa	5.0	JA_MS_2009_02_14_1509613_14

Estimated Stereo CE90 = 4.0 m

GeoEye-1 Basic
Stereo Vertical Accuracy

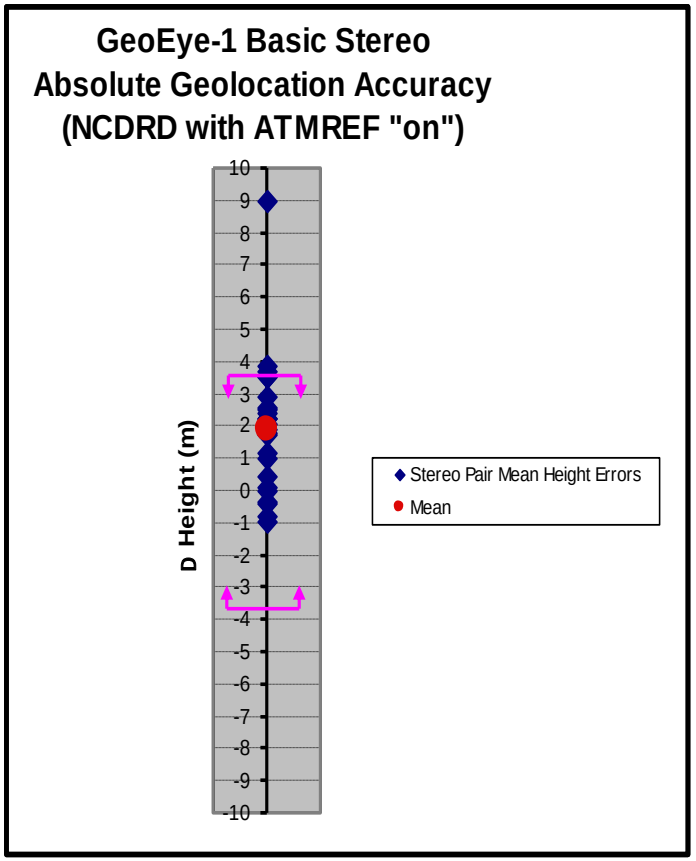
Test Site	CPs	Stereo Pair	Mean Δ Height (m)	Abs. Mean Δ Height (m)
Japan, Misawa	11	JA_MS_2009_02_14_1509613_14	3.9	3.9
Japan, Misawa	11	JA_MS_2009_03_08_1510930_32	2.2	2.2
Namibia, Hosea Kutako	11	WA_HK_2009_02_26_1509844_45	1.9	1.9
Namibia, Hosea Kutako	16	WA_HK_2009_03_17_1512166_68	3.7	3.7
Netherlands Antilles, Princess Juliana	10	NT_PJ_2009_02_11_1508745_46	0.0	0.0
Netherlands Antilles, Princess Juliana	11	NT_PJ_2009_02_22_1509645_49	0.4	0.4
Oman, Masirah Island	31	MU_MI_2009_02_14_1509609_11	2.4	2.4
Oman, Thumrait	18	MU_TH_2009_02_09_1508621_23	9.0	9.0
Paraguay, Silvio Pettirossi	17	PA_SP_2009_02_12_1509004_06	2.1	2.1
Paraguay, Silvio Pettirossi	15	PA_SP_2009_03_17_1512373_75	2.9	2.9
Peru, Carlos Ciriani Santa Rosa	20	PE_CR_2009_02_11_1508818_19	1.7	1.7
Philippines, Puerto Princessa	17	RP_PP_2009_02_21_1509837_39	-0.3	0.3
United States, Beaufort	16	US_BE_2009_02_08_1508588_90	1.0	1.0
United States, Camp Guernsey	19	US_CG_2009_02_22_1509834_36	-1.0	1.0
United States, Camp Guernsey	18	US_CG_2009_03_05_1510674_75	-0.8	0.8
United States, Camp Guernsey	18	US_CG_2009_03_08_1510936_37	-0.4	0.4
United States, El Centro	20	US_EC_2009_02_12_1508956_57	0.1	0.1
United States, Grand Forks	14	US_GF_2009_02_08_1508591_92	2.6	2.6
United States, Grand Forks	16	US_GF_2009_02_19_1509606_07	2.5	2.5
United States, Grand Forks	15	US_GF_2009_03_02_1510483_84	2.3	2.3
United States, Scott	23	US_ST_2009_02_12_1508959_60	3.5	3.5
United States, Vandenberg	10	US_VB_2009_02_10_1508706_08	1.8	1.8
United States, Wheeler Sack	12	US_WS_2009_02_08_1508585_87	1.2	1.2
U.S. Virgin Islands, Cyril E King	8	VQ_CK_2009_02_25_1509840_41	3.6	3.6

- 24 stereo triplet pairs
- NCDRD support data
- ATMREF correction “on”

Mean (m)	1.9	2.1
Standard Deviation (m)	2.1	1.9
Maximum (m)	9.0	9.0
Minimum (m)	-1.0	0.0

GeoEye-1 Basic

Stereo Vertical Accuracy (n=24)



Test Site	Sorted Abs. Δ Height (m)	Test Stereo Pair
Netherlands Antilles, Princess Juliana	0.0	NT_PJ_2009_02_11_1508745_46
United States, El Centro	0.1	US_EC_2009_02_12_1508956_57
Philippines, Puerto Princessa	0.3	RP_PP_2009_02_21_1509837_39
United States, Camp Guernsey	0.4	US_CG_2009_03_08_1510936_37
Netherlands Antilles, Princess Juliana	0.4	NT_PJ_2009_02_22_1509645_49
United States, Camp Guernsey	0.8	US_CG_2009_03_05_1510674_75
United States, Camp Guernsey	1.0	US_CG_2009_02_22_1509834_36
United States, Beaufort	1.0	US_BE_2009_02_08_1508588_90
United States, Wheeler Sack	1.2	US_WS_2009_02_08_1508585_87
Peru, Carlos Ciriani Santa Rosa	1.7	PE_CR_2009_02_11_1508818_19
United States, Vandenberg	1.8	US_VB_2009_02_10_1508706_08
Namibia, Hosea Kutako	1.9	WA_HK_2009_02_26_1509844_45
Paraguay, Silvio Pettirossi	2.1	PA_SP_2009_02_12_1509004_06
Japan, Misawa	2.2	JA_MS_2009_03_08_1510930_32
United States, Grand Forks	2.3	US_GF_2009_03_02_1510483_84
Oman, Masirah Island	2.4	MU_MI_2009_02_14_1509609_11
United States, Grand Forks	2.5	US_GF_2009_02_19_1509606_07
United States, Grand Forks	2.6	US_GF_2009_02_08_1508591_92
Paraguay, Silvio Pettirossi	2.9	PA_SP_2009_03_17_1512373_75
United States, Scott	3.5	US_ST_2009_02_12_1508959_60
U.S. Virgin Islands, Cyril E King	3.6	VQ_CK_2009_02_25_1509840_41
Namibia, Hosea Kutako	3.7	WA_HK_2009_03_17_1512166_68
Japan, Misawa	3.9	JA_MS_2009_02_14_1509613_14
Oman, Thumrait	9.0	MU_TH_2009_02_09_1508621_23

Estimated Stereo LE90 = 3.7 m

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GeoEye-1 Basic

NCDRD Rigorous vs. RPC Comparison

Test Site	Monoscopic Image	Stereo Pair	Monoscopic Image (RPC-NCDRD1)			Stereo Pair (RPC-NCDRD1)			
			ΔΔ E (m)	ΔΔ N (m)	r (m)	ΔΔ E (m)	ΔΔ N (m)	r (m)	ΔΔ Height (m)
Japan, Misawa	JA_MS_2009_02_14_1509612	JA_MS_2009_02_14_1509613_14	0.01	-0.29	0.29	1.71	0.63	1.82	-0.58
Japan, Misawa	JA_MS_2009_03_08_1510931	JA_MS_2009_03_08_1510930_32	-0.11	-0.34	0.36	1.71	0.59	1.81	-0.57
Namibia, Hosea Kutako	WA_HK_2009_02_26_1509846	WA_HK_2009_02_26_1509844_45	0.35	-0.25	0.43	1.85	0.72	1.98	-0.31
Namibia, Hosea Kutako	WA_HK_2009_03_17_1512167	WA_HK_2009_03_17_1512166_68	0.56	-0.22	0.60	1.83	0.64	1.94	-0.42
Netherlands Antilles, Princess Juliana	NT_PJ_2009_02_11_1508747	NT_PJ_2009_02_11_1508745_46	1.89	0.58	1.98	0.56	-0.20	0.60	-0.38
Netherlands Antilles, Princess Juliana	NT_PJ_2009_02_22_1509646	NT_PJ_2009_02_22_1509645_49	1.83	0.56	1.92	0.45	-0.24	0.51	-0.27
Oman, Masirah Island	MU_MI_2009_02_14_1509610	MU_MI_2009_02_14_1509609_11	0.55	-0.23	0.60	1.77	0.65	1.89	-0.58
Oman, Thumrait	MU_TH_2009_02_09_1508622	MU_TH_2009_02_09_1508621_23	0.46	-0.27	0.53	1.76	0.72	1.90	-0.28
Paraguay, Silvio Pettirossi	PA_SP_2009_02_12_1509005	PA_SP_2009_02_12_1509004_06	0.56	-0.15	0.58	1.84	0.69	1.97	-0.52
Paraguay, Silvio Pettirossi	PA_SP_2009_03_17_1512374	PA_SP_2009_03_17_1512373_75	0.43	-0.32	0.53	1.85	0.60	1.95	-0.40
Peru, Carlos Ciriani Santa Rosa	PE_CR_2009_02_11_1508820	PE_CR_2009_02_11_1508818_19	0.56	-0.21	0.60	1.79	0.67	1.91	-0.48
Philippines, Puerto Princessa	RP_PP_2009_02_21_1509838	RP_PP_2009_02_21_1509837_39	0.40	-0.18	0.44	1.75	0.68	1.88	-0.26
United States, Camp Guernsey	US_CG_2009_02_22_1509835	US_CG_2009_02_22_1509834_36	0.16	-0.28	0.32	1.56	0.70	1.71	-0.63
United States, Camp Guernsey	US_CG_2009_03_05_1510676	US_CG_2009_03_05_1510674_75	0.31	-0.16	0.34	1.62	0.68	1.75	-0.83
United States, Camp Guernsey	US_CG_2009_03_08_1510935	US_CG_2009_03_08_1510936_37	0.07	-0.20	0.21	1.61	0.61	1.72	-0.38
United States, El Centro	US_EC_2009_02_12_1508955	US_EC_2009_02_12_1508956_57	0.35	-0.21	0.41	1.71	0.61	1.82	-0.38
United States, Grand Forks	US_GF_2009_02_08_1508593	US_GF_2009_02_08_1508591_92	-0.04	-0.29	0.29	1.54	0.61	1.66	-0.69
United States, Grand Forks	US_GF_2009_02_19_1509608	US_GF_2009_02_19_1509606_07	1.28	-0.57	1.40	0.49	0.87	1.00	-0.85
United States, Grand Forks	US_GF_2009_03_02_1510482	US_GF_2009_03_02_1510483_84	1.45	0.63	1.58	0.30	-0.29	0.42	-1.07
United States, Scott	US_ST_2009_02_12_1508958	US_ST_2009_02_12_1508959_60	0.27	-0.29	0.40	1.58	0.62	1.69	-0.38
United States, Vandenberg	US_VB_2009_02_10_1509010	US_VB_2009_02_10_1508706_08	0.21	-0.22	0.31	1.69	0.64	1.81	-0.49
United States, Wheeler Sack	US_WS_2009_02_08_1508586	US_WS_2009_02_08_1508585_87	-0.03	-0.32	0.33	1.46	0.57	1.57	-0.14
U.S. Virgin Islands, Cyril E King	VQ_CK_2009_02_25_1509842	VQ_CK_2009_02_25_1509840_41	1.74	0.63	1.85	0.43	-0.33	0.54	-0.23

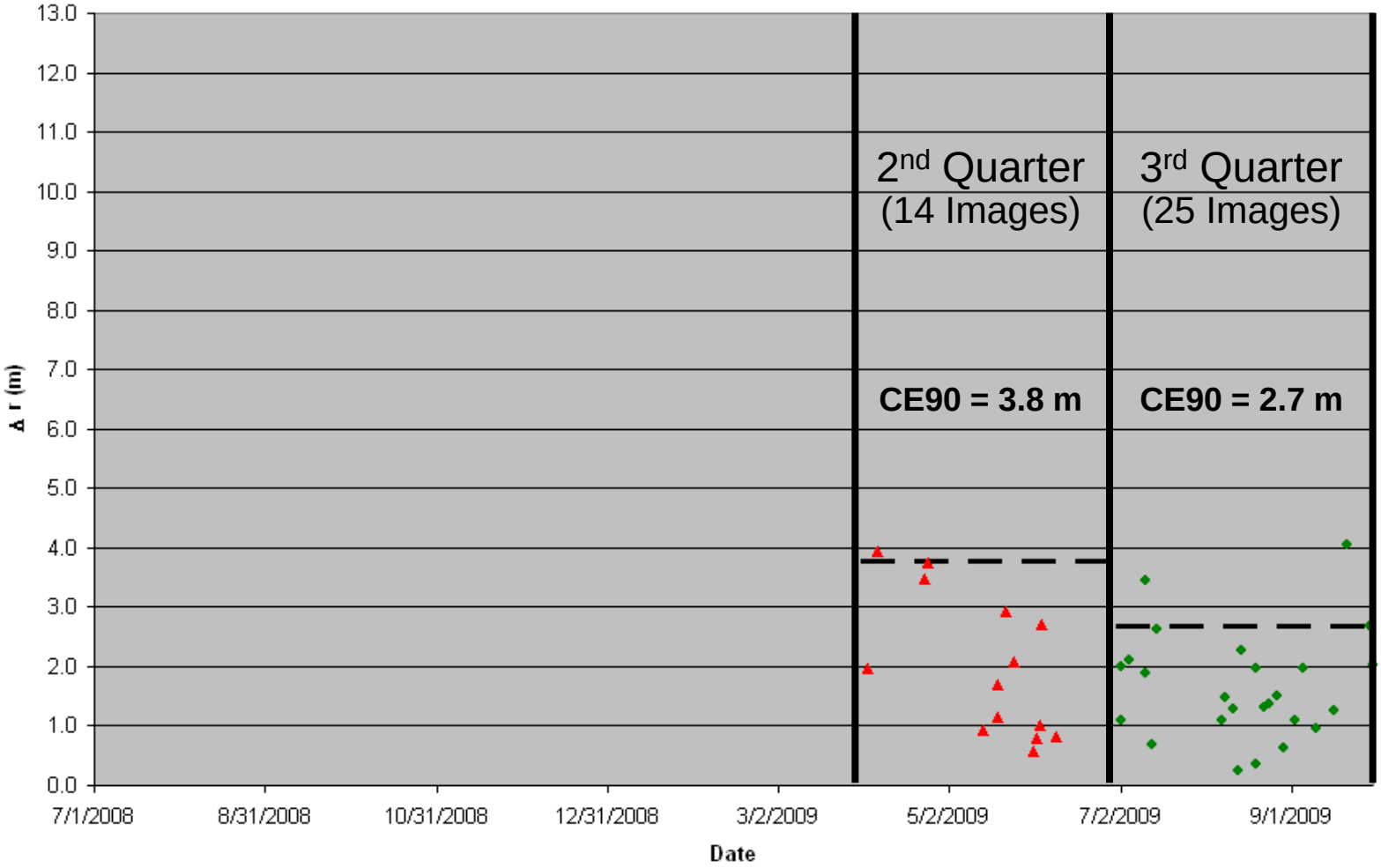
- 23 stereo triplets
- RPC - NCDRD Rigorous

Mean (m)	0.58	-0.11	0.71	1.43	0.50	1.56	-0.48
Standard Deviation (m)	0.62	0.35	0.58	0.54	0.36	0.53	0.22
Maximum (m)	1.89	0.63	1.98	1.85	0.87	1.98	-0.14
Minimum (m)	-0.11	-0.57	0.21	0.30	-0.33	0.42	-1.07

Monitoring Results

GeoEye-1 CE90 Performance

Additional Monoscopic Images



Questions?

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