Absolute Geolocation Accuracy Evaluation of RapidEye Level 1B and 3A Imagery

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Civil Commercial Imagery Evaluation Workshop
17 March 2010

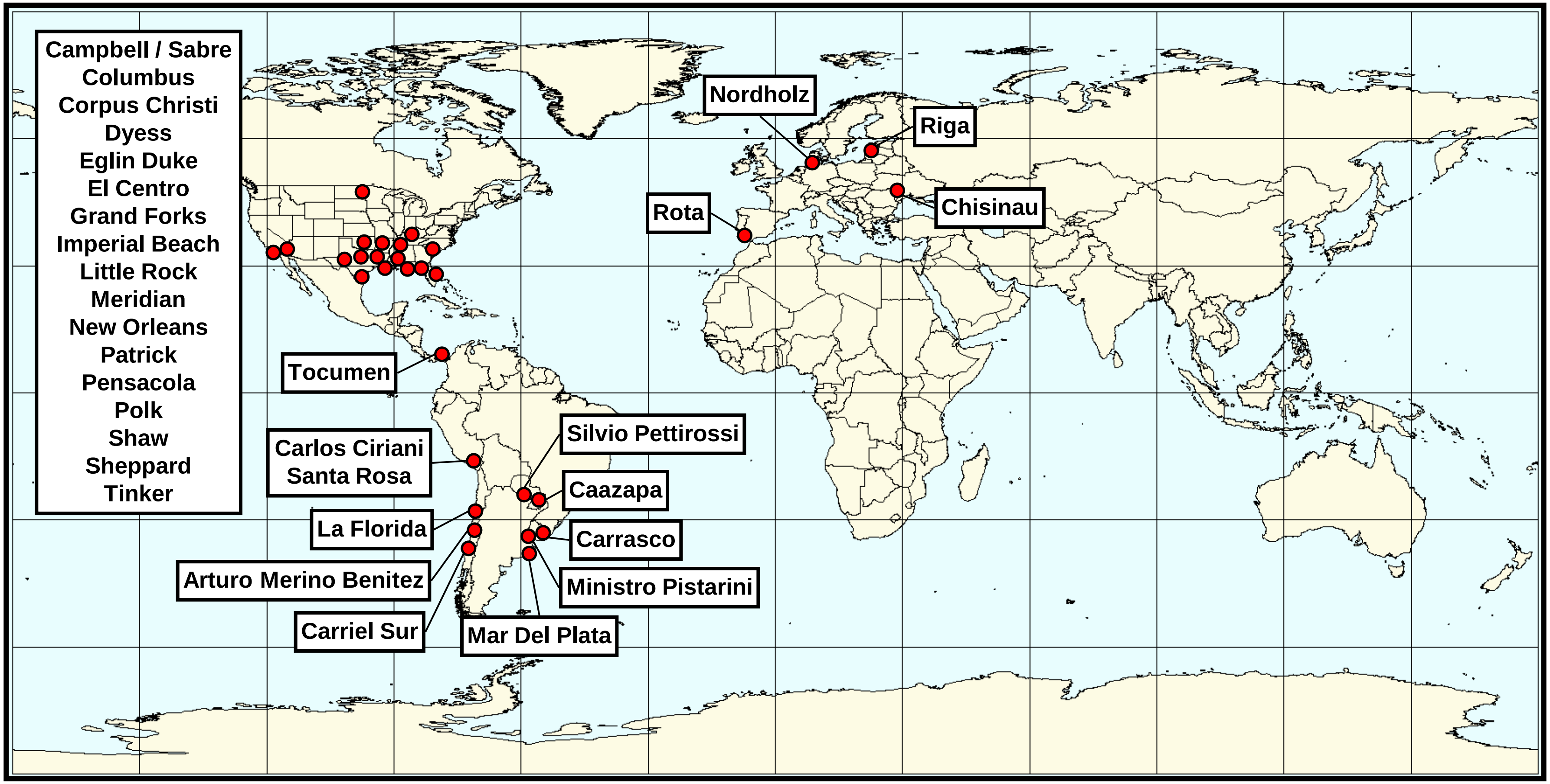
Outline

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

Objective

- To estimate the absolute horizontal geolocation accuracy of RapidEye Level 1B and Level 3A images
  - 31 test sites for Level 1B images
  - 28 test sites for Level 3A images
    - Images over 2 test sites not over check points
    - One test site had two adjacent images of same date
  - Collected from among 5 RapidEye satellites

Test Sites for RapidEye



Collected between February and September 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

RapidEye Level 1B and 3A Products

Processing	Geometry	Ground Sampled Distance (m)	Scene Size (km)	Data Format	Spectral Bands
Level 1B	Basic	6.5 (at nadir)	77 km swath width	NITF 2.0 with RPC	**Blue** (440-510 nm) **Green** (520-590 nm) **Red** (630-685 nm) **Red Edge** (690-730 nm) **NIR** (760-850 nm)
Level 3A	Orthorectified	5	25 x 25	GeoTIFF	

RapidEye Statements		CE90 (m)*
Level 1B	Using Ground Control Points (GCPs) from “Landsat mosaic”	44.9
	Using higher accuracy GCPs (e.g., over US)	23.6
Level 3A	Using GCPs from “Landsat mosaic” and CGIAR** Shuttle Radar Topography Mission (SRTM) 90m Digital Elevation Models (DEMs)	30.3
	Using higher accuracy GCPs and DEMs	14.0

* At nadir over flat (<10   slope) terrain.

** Consultative Group for International Agriculture Research

Source: *RapidEye Standard Image Product Specifications*, version 2.4, RapidEye AG, August 2009.

CCAP Absolute Geolocation Accuracy Methodology

- General Approach:
  - Level 1B: Monoscopic Intersection
    - Ray intersection with ground-surveyed height
  - Level 3A: Geo-referencing from orthorectified image
- Images *not* allowed to adjust during evaluation

CCAP Absolute Geolocation Accuracy Methodology

1) **Load image onto workstation with SOCET Set® photogrammetric software**

2) **Import geometry model or georeferencing support data accompanying imagery**
   – Level 1B: NITF 2.0 with Rapid Positioning Capability (RPC) replacement geometry model metadata
   – Level 3A: GeoTIFF with georeferencing tags

CCAP Absolute Geolocation Accuracy Methodology

3) Compute ground coordinates of checkpoints from test imagery geometry or georeferencing model support data

- Use ground-surveyed control points as checkpoints
- Measure pixel positions (line, sample) of checkpoints
- Hold test imagery fixed (by holding geometry model support data fixed) and allow checkpoint ground coordinates to adjust to pixel measurements using triangulation tool

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
- Then for each point in list, compute "Δ Radial" value

CCAP Absolute Geolocation Accuracy Methodology

5) For each image, compute Root Mean Square (RMS)

- Square each checkpoint "Δ Radial" value, sum them, divide by number of checkpoints, and take square root
- Additional statistics:
  - Number of checkpoints
  - Mean Δ Easting and Δ Northing values (error centroid)
  - Maximums & minimums of Δ Easting and Δ Northing values
  - Standard deviations of Δ Easting and Δ Northing values

CCAP Absolute Geolocation Accuracy Methodology

- Each image represented by single data point for CE90 estimation because…
  - …test sites have varying number of checkpoints
  - …goal of evaluation is to estimate CE90 for population of images, not individual image
- RMS used instead of error centroid because…
  - …accuracy of RapidEye over US test sites approaches GSD

CCAP Absolute Geolocation Accuracy Methodology

6) Estimate CE90

- CCAP uses non-parametric estimator (“Percentile Method”)
- Sort image RMS values in ascending order
- Cut-off at 90^{th} 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
  - Maximums and minimums of RMS values
  - Mean and standard deviations of RMS 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 $0.9*n + 0.5$.

RapidEye Evaluation Results

RapidEye Evaluation Results

- Regional accuracy variations in the GCP and DEM sources introduces significant systematic influence into evaluation
- Grouped images:
  - United States (17 for Level 1B, 15 for Level 3A)
  - South America (9)
  - Europe (4 for Level 1B, 3 for Level 3A)
  - Panama (Tocumen)
- Only enough images in US and South American groups to estimate CE90
- Ranges of errors reported for all groups
- Level 1B and Level 3A results reported separately

RapidEye Level 1B Evaluation Results

Level 1B – United States

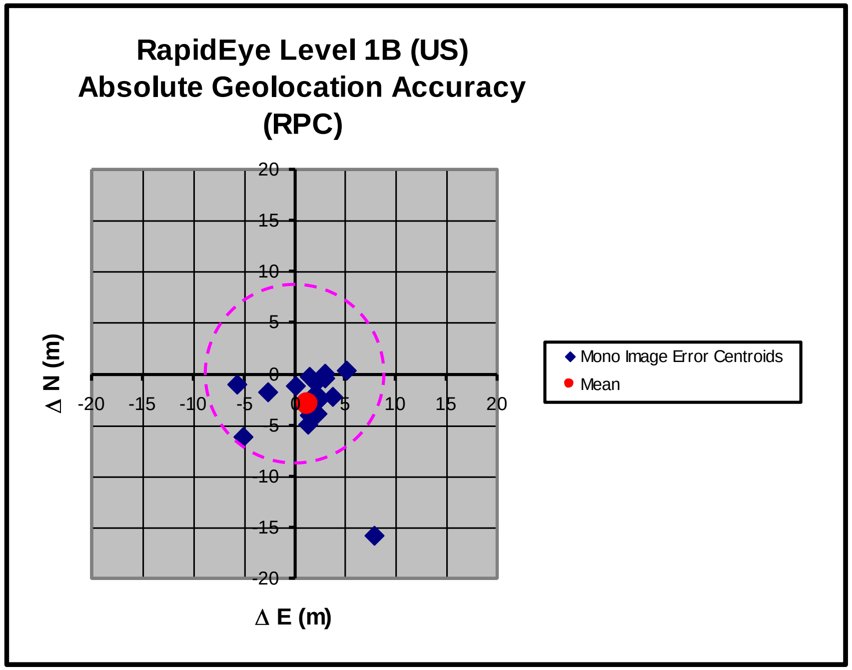
Mono Horizontal Accuracy (n=17)

Test Site	CPs	Image	Mean Δ E (m)	Mean Δ N (m)	Δ r (m)	RMS (m)
US, Campbell/Sabre	13	US_CS_RE1_2009_04_08_838189_37404	-5.7	-1.0	5.8	6.6
US, Columbus	14	US_CU_RE2_2009_03_02_838196_37404	-2.6	-1.7	3.1	5.2
US, Corpus Christi	30	US_CR_RE2_2009_02_22_838257_37404	5.0	0.4	5.1	6.9
US, Dyess	15	US_DY_RE4_2009_02_15_838217_37405	0.9	-3.1	3.2	4.1
US, Eglin Duke	10	US_EG_RE1_2009_02_19_838247_37405	2.2	-2.7	3.4	6.1
US, El Centro	22	US_EC_RE5_2009_03_15_838241_37379	1.4	-0.2	1.4	3.1
US, Grand Forks	14	US_GF_RE4_2009_04_09_838243_37404	1.2	-4.8	5.0	6.5
US, Imperial Beach	18	US_IB_RE4_2009_02_18_838232_37405	7.8	-15.8	17.6	17.7
US, Little Rock	17	US_LR_RE1_2009_02_20_838202_37405	3.8	-2.2	4.3	6.3
US, Meridian	13	US_MN_RE2_2009_03_02_838194_37405	2.9	0.1	2.9	5.3
US, New Orleans	15	US_NO_RE4_2009_02_08_838252_37404	1.5	-4.0	4.3	4.7
US, Patrick	15	US_PA_RE3_2009_02_20_838253_37406	2.2	-3.8	4.4	6.3
US, Pensacola	18	US_PE_RE4_2009_02_03_838203_37406	-5.0	-6.2	8.0	8.5
US, Polk	15	US_PK_RE4_2009_02_04_838230_37406	0.1	-1.1	1.1	4.4
US, Shaw	16	US_SH_RE4_2009_03_21_838233_37404	2.1	-0.8	2.2	4.4
US, Sheppard	28	US_SP_RE5_2009_03_26_838207_37406	2.1	-1.8	2.8	4.0
US, Tinker	17	US_TK_RE4_2009_02_05_838220_37406	3.0	-0.4	3.0	4.4

Mean (m)	1.3	-2.9	4.6	6.1
Standard Deviation (m)	3.3	3.8	3.7	3.3
Maximum (m)	7.8	0.4	17.6	17.7
Minimum (m)	-5.7	-15.8	1.1	3.1

Level 1B – United States

Mono Horizontal Accuracy (n=17)



RMS Method		
Test Site	Sorted RMS (m)	Test Image
US, El Centro	3.1	US_EC_RE5_2009_03_15_838241_37379
US, Sheppard	4.0	US_SP_RE5_2009_03_26_838207_37406
US, Dyess	4.1	US_DY_RE4_2009_02_15_838217_37405
US, Tinker	4.4	US_TK_RE4_2009_02_05_838220_37406
US, Polk	4.4	US_PK_RE4_2009_02_04_838230_37406
US, Shaw	4.4	US_SH_RE4_2009_03_21_838233_37404
US, New Orleans	4.7	US_NO_RE4_2009_02_08_838252_37404
US, Columbus	5.2	US_CU_RE2_2009_03_02_838196_37404
US, Meridian	5.3	US_MN_RE2_2009_03_02_838194_37405
US, Eglin Duke	6.1	US_EG_RE1_2009_02_19_838247_37405
US, Patrick	6.3	US_PA_RE3_2009_02_20_838253_37406
US, Little Rock	6.3	US_LR_RE1_2009_02_20_838202_37405
US, Grand Forks	6.5	US_GF_RE4_2009_04_09_838243_37404
US, Campbell/Sabre	6.6	US_CS_RE1_2009_04_08_838189_37404
US, Corpus Christi	6.9	US_CR_RE2_2009_02_22_838257_37404
US, Pensacola	8.5	US_PE_RE4_2009_02_03_838203_37406
US, Imperial Beach	17.7	US_IB_RE4_2009_02_18_838232_37405

Estimated CE90 = 8.2 m

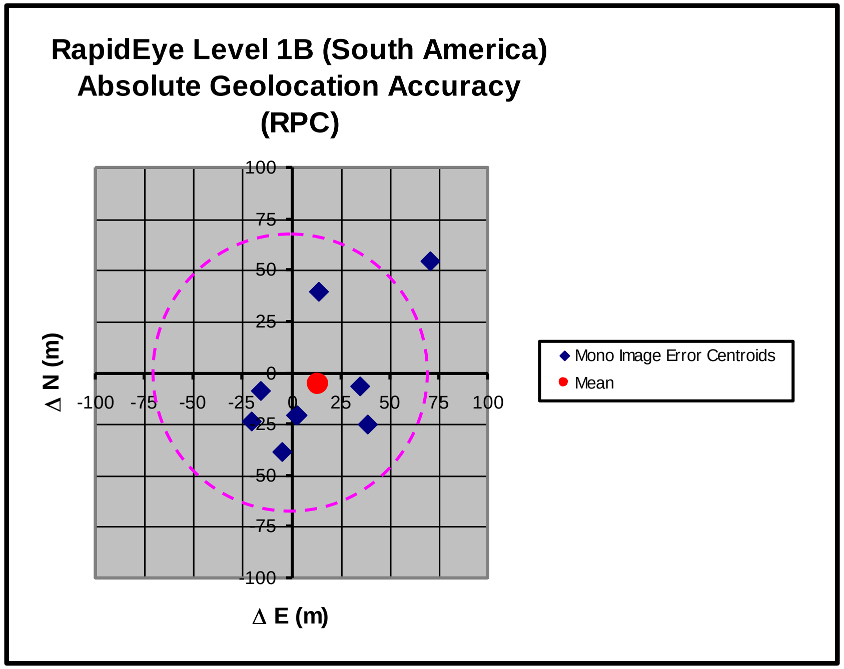
Level 1B – South America
Mono Horizontal Accuracy (n=9)

Test Site	CPs	Image	Mean Δ E (m)	Mean Δ N (m)	Δ r (m)	RMS (m)
Argentina, Mar Del Plata	9	AR_MD_RE4_2009_05_05_1628411_46971	70.1	54.6	88.8	89.0
Argentina, Ministro Pistarini	9	AR_MP_RE3_2009_04_25_1628414_46981	13.3	39.7	41.9	42.0
Chile, Arturo Merino Benitez	10	CI_AB_RE3_2009_07_13_1652013_47470	38.3	-24.6	45.6	45.9
Chile, Carriel Sur	9	CI_CS_RE5_2009_07_25_1629052_46976	-20.5	-23.1	30.9	31.1
Chile, La Florida	9	CI_LF_RE3_2009_07_18_1629051_46978	1.9	-20.3	20.4	21.1
Paraguay, Caazapa	10	PA_CA_RE5_2009_07_03_1638142_47464	-15.8	-8.7	18.0	18.1
Paraguay, Silvio Pettirossi	12	PA_SP_RE2_2009_08_12_1628879_46974	2.8	-20.3	20.5	20.9
Peru, Carlos Ciriani Santa Rosa	9	PE_CR_RE5_2009_09_01_1628413_46980	-4.8	-37.9	38.2	38.3
Uruguay, Carrasco	10	UY_CA_RE1_2009_08_06_1628408_46970	34.9	-6.2	35.5	35.6

Mean (m)	13.4	-5.2	37.8	38.0
Standard Deviation (m)	29.3	31.3	21.6	21.5
Maximum (m)	70.1	54.6	88.8	89.0
Minimum (m)	-20.5	-37.9	18.0	18.1

Level 1B – South America

Mono Horizontal Accuracy (n=9)



RMS Method		
Test Site	**Sorted RMS (m)**	**Test Image**
Paraguay, Caazapa	18.1	PA_CA_RE5_2009_07_03_1638142_47464
Paraguay, Silvio Pettirossi	20.9	PA_SP_RE2_2009_08_12_1628879_46974
Chile, La Florida	21.1	CI_LF_RE3_2009_07_18_1629051_46978
Chile, Carriel Sur	31.1	CI_CS_RE5_2009_07_25_1629052_46976
Uruguay, Carrasco	35.6	UY_CA_RE1_2009_08_06_1628408_46970
Peru, Carlos Ciriani Santa Rosa	38.3	PE_CR_RE5_2009_09_01_1628413_46980
Argentina, Ministro Pistarini	42.0	AR_MP_RE3_2009_04_25_1628414_46981
Chile, Arturo Merino Benitez	45.9	CI_AB_RE3_2009_07_13_1652013_47470
Argentina, Mar Del Plata	89.0	AR_MD_RE4_2009_05_05_1628411_46971

Estimated CE90 = 71.7 m

Level 1B – Europe and Panama

Mono Horizontal Accuracy

RMS Method			
Test Site	CPs	Sorted RMS (m)	Test Image
Germany, Nordholz	22	22.7	GM_NH_RE1_2009_04_19_838190_37405
Spain, Rota	15	22.7	SP_RO_RE2_2009_08_05_1629050_46972
Moldova, Chisinau	19	25.6	MD_CH_RE5_2009_07_18_1629033_46977
Latvia, Riga	10	56.2	LG_RG_RE2_2009_06_28_1612243_46975

Test Site	CPs	RMS (m)	Test Image
Panama, Tocumen	11	146.2	PM_TO_RE3_2009_07_26_1628871_46973

RapidEye Level 1B
Mono Horizontal Accuracy Summary

Product Level	Group / Image	Number of Test Sites	Minimum Image RMS Error (m)	Maximum Image RMS Error (m)	Monoscopic CE90 (m)
Level 1B	United States	17	3.1	17.7	8.2
	South America	9	18.1	89.0	71.7
	Europe	4	22.7	56.2	
	Panama (Tocumen)	1	146.2		

RapidEye Level 3A Evaluation Results

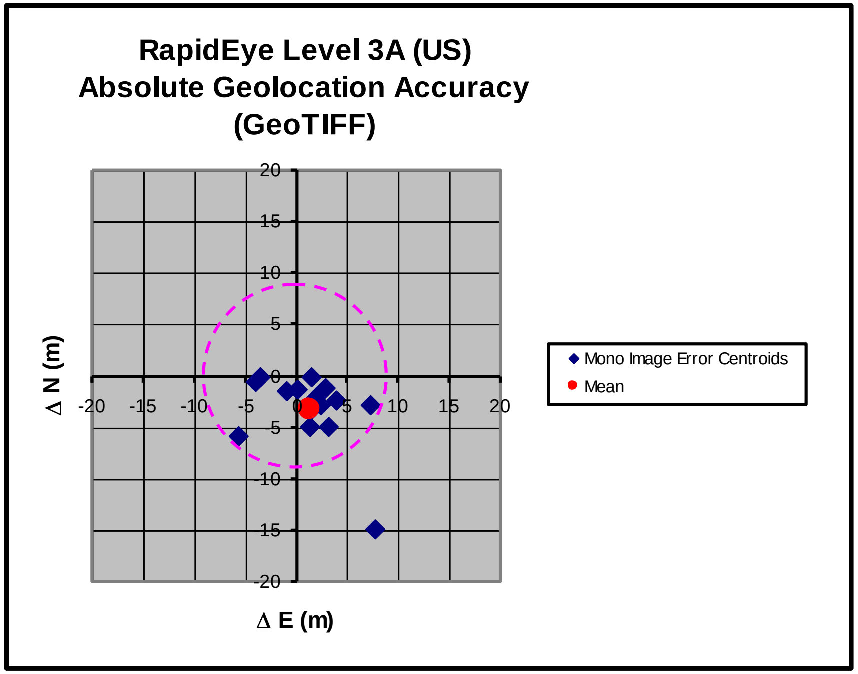
Level 3A – United States
Mono Horizontal Accuracy (n=15)

Test Site	CPs	Image	Mean Δ E (m)	Mean Δ N (m)	Δ r (m)	RMS (m)
US, Campbell/Sabre	7	US_CS_RE1_2009_04_08_828335_37248	-4.0	-0.5	4.1	5.4
US, Columbus	14	US_CU_RE2_2009_02_06_828337_37248	-3.6	-0.1	3.6	5.4
US, Corpus Christi	6	US_CR_RE2_2009_02_22_828344_37248	7.2	-2.9	7.8	8.4
US, Dyess	15	US_DY_RE4_2009_02_15_828438_37248	1.5	-3.2	3.5	4.4
US, Eglin Duke	10	US_EG_RE1_2009_02_19_828339_37248	2.3	-2.8	3.6	6.1
US, El Centro	22	US_EC_RE5_2009_03_15_828434_37248	1.5	-0.1	1.5	3.4
US, Grand Forks	14	US_GF_RE4_2009_04_09_828432_37248	1.2	-4.8	5.0	6.5
US, Imperial Beach	17	US_IB_RE4_2009_02_18_828475_37248	7.6	-14.8	16.7	16.9
US, Little Rock	7	US_LR_RE1_2009_02_20_828679_37248	2.8	-1.2	3.0	5.2
US, Patrick	12	US_PA_RE3_2009_02_20_828435_37248	3.1	-4.8	5.7	6.8
US, Pensacola	13	US_PE_RE4_2009_02_03_828439_37248	-5.7	-5.9	8.2	8.7
US, Polk	15	US_PK_RE4_2009_02_04_828343_37248	-1.0	-1.4	1.8	4.5
US, Shaw	12	US_SH_RE4_2009_03_21_828436_37248	0.1	-1.3	1.3	4.0
US, Sheppard	25	US_SP_RE5_2009_03_26_828336_37248	2.0	-2.1	2.9	4.0
US, Tinker	2	US_TK_RE4_2009_02_05_828338_37248	3.9	-2.3	4.6	4.6

Mean (m)	1.2	-3.2	4.9	6.3
Standard Deviation (m)	3.8	3.7	3.8	3.3
Maximum (m)	7.6	-0.1	16.7	16.9
Minimum (m)	-5.7	-14.8	1.3	3.4

Level 3A – United States

Mono Horizontal Accuracy (n=15)



RMS Method		
Test Site	Sorted RMS (m)	Test Image
US, El Centro	3.4	US_EC_RE5_2009_03_15_828434_37248
US, Sheppard	4.0	US_SP_RE5_2009_03_26_828336_37248
US, Shaw	4.0	US_SH_RE4_2009_03_21_828436_37248
US, Dyess	4.4	US_DY_RE4_2009_02_15_828438_37248
US, Polk	4.5	US_PK_RE4_2009_02_04_828343_37248
US, Tinker	4.6	US_TK_RE4_2009_02_05_828338_37248
US, Little Rock	5.2	US_LR_RE1_2009_02_20_828679_37248
US, Columbus	5.4	US_CU_RE2_2009_02_06_828337_37248
US, Campbell/Sabre	5.4	US_CS_RE1_2009_04_08_828335_37248
US, Eglin Duke	6.1	US_EG_RE1_2009_02_19_828339_37248
US, Grand Forks	6.5	US_GF_RE4_2009_04_09_828432_37248
US, Patrick	6.8	US_PA_RE3_2009_02_20_828435_37248
US, Corpus Christi	8.4	US_CR_RE2_2009_02_22_828344_37248
US, Pensacola	8.7	US_PE_RE4_2009_02_03_828439_37248
US, Imperial Beach	16.9	US_IB_RE4_2009_02_18_828475_37248

Estimated CE90 = 8.7 m

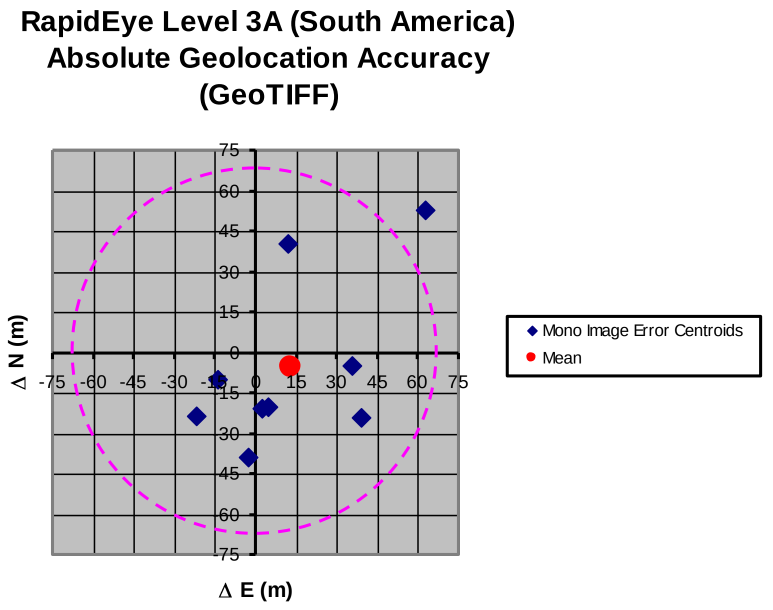
Level 3A – South America

Mono Horizontal Accuracy (n=9)

Test Site	CPs	Image	Mean Δ E (m)	Mean Δ N (m)	Δ r (m)	RMS (m)
Argentina, Mar Del Plata	7	AR_MD_RE4_2009_05_05_1625427_47370	62.5	53.0	82.0	82.2
Argentina, Ministro Pistarini	6	AR_MP_RE3_2009_04_25_1611847_47370	12.1	40.5	42.3	42.5
Chile, Arturo Merino Benitez	11	CI_AB_RE3_2009_07_13_1611846_1611834_47370	39.2	-24.2	46.0	46.3
Chile, Carriel Sur	9	CI_CS_RE5_2009_07_25_1611829_47370	-21.8	-23.2	31.9	32.1
Chile, La Florida	8	CI_LF_RE3_2009_07_18_1611838_47370	2.2	-20.9	21.1	21.4
Paraguay, Caazapa	10	PA_CA_RE5_2009_07_03_1634050_47493	-14.3	-10.0	17.4	17.6
Paraguay, Silvio Pettirossi	10	PA_SP_RE2_2009_08_12_1611835_47370	4.5	-20.3	20.8	21.1
Peru, Carlos Ciriani Santa Rosa	9	PE_CR_RE5_2009_09_01_1611687_47370	-3.0	-38.7	38.8	38.9
Uruguay, Carrasco	7	UY_CA_RE1_2009_08_06_1611849_47370	35.4	-4.9	35.8	35.9

Mean (m)	13.0	-5.4	37.3	37.5
Standard Deviation (m)	27.5	31.2	19.6	19.6
Maximum (m)	62.5	53.0	82.0	82.2
Minimum (m)	-21.8	-38.7	17.4	17.6

Level 3A – South America
Mono Horizontal Accuracy (n=9)



RMS Method		
Test Site	Sorted RMS (m)	Test Image
Paraguay, Caazapa	17.6	PA_CA_RE5_2009_07_03_1634050_47493
Paraguay, Silvio Pettirossi	21.1	PA_SP_RE2_2009_08_12_1611835_47370
Chile, La Florida	21.4	CI_LF_RE3_2009_07_18_1611838_47370
Chile, Carriel Sur	32.1	CI_CS_RE5_2009_07_25_1611829_47370
Uruguay, Carrasco	35.9	UY_CA_RE1_2009_08_06_1611849_47370
Peru, Carlos Ciriani Santa Rosa	38.9	PE_CR_RE5_2009_09_01_1611687_47370
Argentina, Ministro Pistarini	42.5	AR_MP_RE3_2009_04_25_1611847_47370
Chile, Arturo Merino Benitez	46.3	CI_AB_RE3_2009_07_13_1611846_1611834_47370
Argentina, Mar Del Plata	82.2	AR_MD_RE4_2009_05_05_1625427_47370

Estimated CE90 = 67.8 m

Level 3A – Europe and Panama

Mono Horizontal Accuracy

RMS Method			
Test Site	CPs	Sorted RMS (m)	Test Image
Spain, Rota	14	21.7	SP_RO_RE2_2009_08_05_1611848_47370
Moldova, Chisinau	18	25.5	MD_CH_RE5_2009_07_18_1611641_47370
Latvia, Riga	8	55.8	LG_RG_RE2_2009_06_28_1611830_47370

Test Site	CPs	RMS (m)	Test Image
Panama, Tocumen	11	147.0	PM_TO_RE3_2009_07_26_1611827_47370

RapidEye Level 3A
Mono Horizontal Accuracy Summary

Product Level	Group / Image	Number of Test Sites	Minimum Image RMS Error (m)	Maximum Image RMS Error (m)	Monoscopic CE90 (m)
Level 3A	United States	15	3.4	16.9	8.7
	South America	9	17.6	82.2	67.8
	Europe	3	21.7	55.8	
	Panama (Tocumen)	1	147.0		

Why do some RapidEye images have large errors?

Why do some RapidEye images have large errors?

- Considered 1B images with larger errors
  - Riga, Latvia (56.2 m)
  - Mar Del Plata, Argentina (89.0 m)
  - Tocumen, Panama (146.2 m)

- Which “Landsat layer” was used by RapidEye to control RapidEye images?

Background on Landsat Layers

- Original GeoCover Landsat Layer
  - 1990-era Thematic Mapper (TM) base
  - 2000-era Enhanced TM Plus (ETM+) and 1975-era Multi-Spectal Scanner (MSS) tied to base

- Global Land Survey (GLS) Landsat Layer
  - 2000-era ETM+ with better control and denser DEMs as new base
  - 2005, 1990, and 1975 eras tied to base

Which “Landsat layer” was used by RapidEye to control RapidEye images?

- Gathered all Original GeoCover and GLS TM and ETM+ images over the 3 sites and tested them against checkpoints
  - Images downloaded from Global Land Cover Facility (GLCF) – (www.landcover.org)
- Typically only 4 - 6 check points per image because of difficulty in identifying points
  - Ends of runways most commonly used

Landsat Layer Test Results

- **Riga**
  - Both layer eras are quite good and similar
  - Some mis-registration of RapidEye image (56.2m error)
- **Mar Del Plata**
  - p223r086 from Original GeoCover era most consistent with observed 89m RapidEye error
- **Tocumen**
  - Original GeoCover era clearly more consistent with observed 146.2m RapidEye error

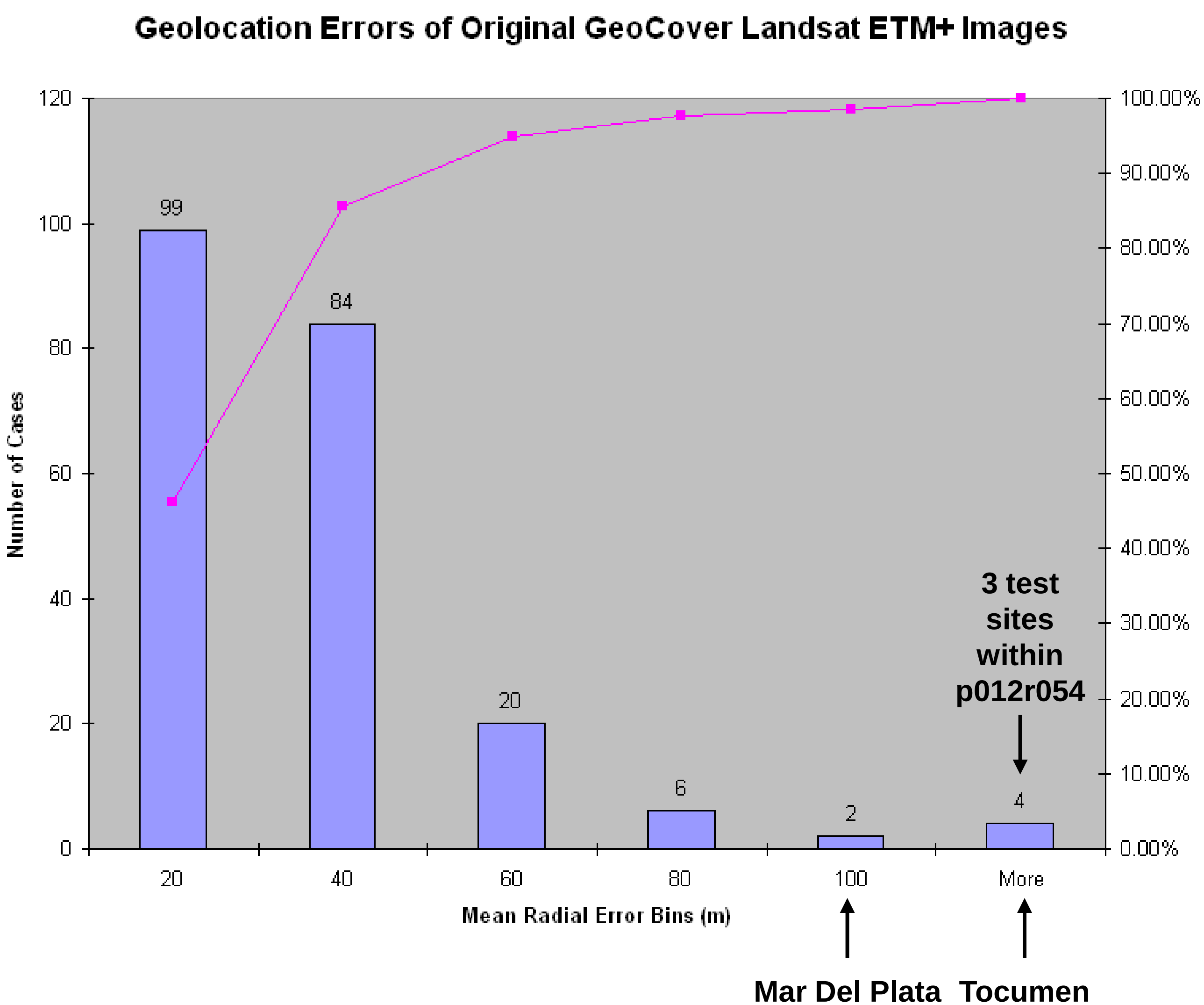
Test Site	Path/Row	Image Date	Layer	Mean Radial Error (m)	Mean Azimuth (°)	# of Points
Riga, Latvia	p187r020	13-May-1990	**TM-Original GeoCover**	**26**	207	6
		8-May-1994	**TM-Original GeoCover**	**30**	232	6
		2-Aug-1999	ETM-Original GeoCover	21	252	6
		2-Aug-1999	**ETM-GLS2000**	**20**	211	6
		5-Jun-2007	ETM-GLS2005	19	197	6
		13-May-1990	TM-GLS1990	20	163	6
		8-May-1994	TM-GLS1990	16	237	6
	p188r020	26-Jun-1986	**TM-Original GeoCover**	**18**	269	6
		29-Jul-2001	ETM-Original GeoCover	22	282	6
		29-Jul-2001	**ETM-GLS2000**	**24**	236	6
		21-May-2005	ETM-GLS2005	22	234	6
		26-Jun-1986	TM-GLS1990	19	228	6
Mar Del Plata, Argentina	p223r086	19-Mar-1989	**TM-Original GeoCover**	**90**	82	4
		6-Dec-2000	ETM-Original GeoCover	87	73	4
		6-Dec-2000	**ETM-GLS2000**	**34**	319	4
		19-Mar-1989	TM-GLS1990	18	349	4
	p224r086	15-Dec-1986	**TM-Original GeoCover**	**46**	49	4
		14-Jan-2001	ETM-Original GeoCover	66	53	4
		14-Jan-2001	**ETM-GLS2000**	**28**	312	4
		20-Nov-2006	TM-GLS2005	24	260	4
		15-Dec-1986	TM-GLS1990	44	239	4
Tocumen, Panama	p012r054	31-Oct-1986	**TM-Original GeoCover**	**140**	173	4
		28-May-2002	ETM-Original GeoCover	147	174	4
		28-May-2002	**ETM-GLS2000**	**12**	180	4
		30-Dec-2005	ETM-GLS2005	17	126	3
		16-Feb-2006	ETM-GLS2005	17	117	1
		31-Oct-1986	TM-GLS1990	17	145	4

RapidEye has confirmed use of Original ETM+ GeoCover outside U.S., Canada, and Germany

How prevalent are Original GeoCover Landsat layer errors?

Original Landsat Layer Testing

- Downloaded and tested Original GeoCover Landsat ETM+ images from GLCF
  - Over "Ron Brown" airfield test sites
  - Represents a sample
    - Certainly many more images available
  - Checkpoints cover only a very small portion of each Landsat image
- 215 total cases (180 path/rows, 196 test sites)
  - For some, multiple airfields fall on one path/row image
  - For some, multiple path/row images fall over an airfield



Path/Rows with >60m errors

Panama	p012r054
Paraguay	p228r075
Argentina	p231r077
Argentina	p223r086
US (California)	p041r037
Guatemala	p019r049
Argentina	p224r086
Oman	p157r046
Peru	p008r064
Ecuador	p018r060

2 of 14 RapidEye images outside U.S. (14%) were over 1st and 4th worst path/rows out of 180 (2%)

Only 32 of 215 cases (15%) worse than 40m

Conclusions

- Geolocation accuracy of RapidEye strongly correlates with the accuracy of the ground control source used
- Large errors for RapidEye outside U.S. not as probable as happened in this test
- Limited comparison of Original GeoCover to GLS era indicates reasonable chance that better accuracy may be achieved using GLS layer
  - Further testing of GLS layer recommended

Questions?

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