

# **Absolute Geolocation Accuracy Evaluation of Cosmo-Skymed Spotlight and Stripmap Imagery – Study Results**

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# Outline

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

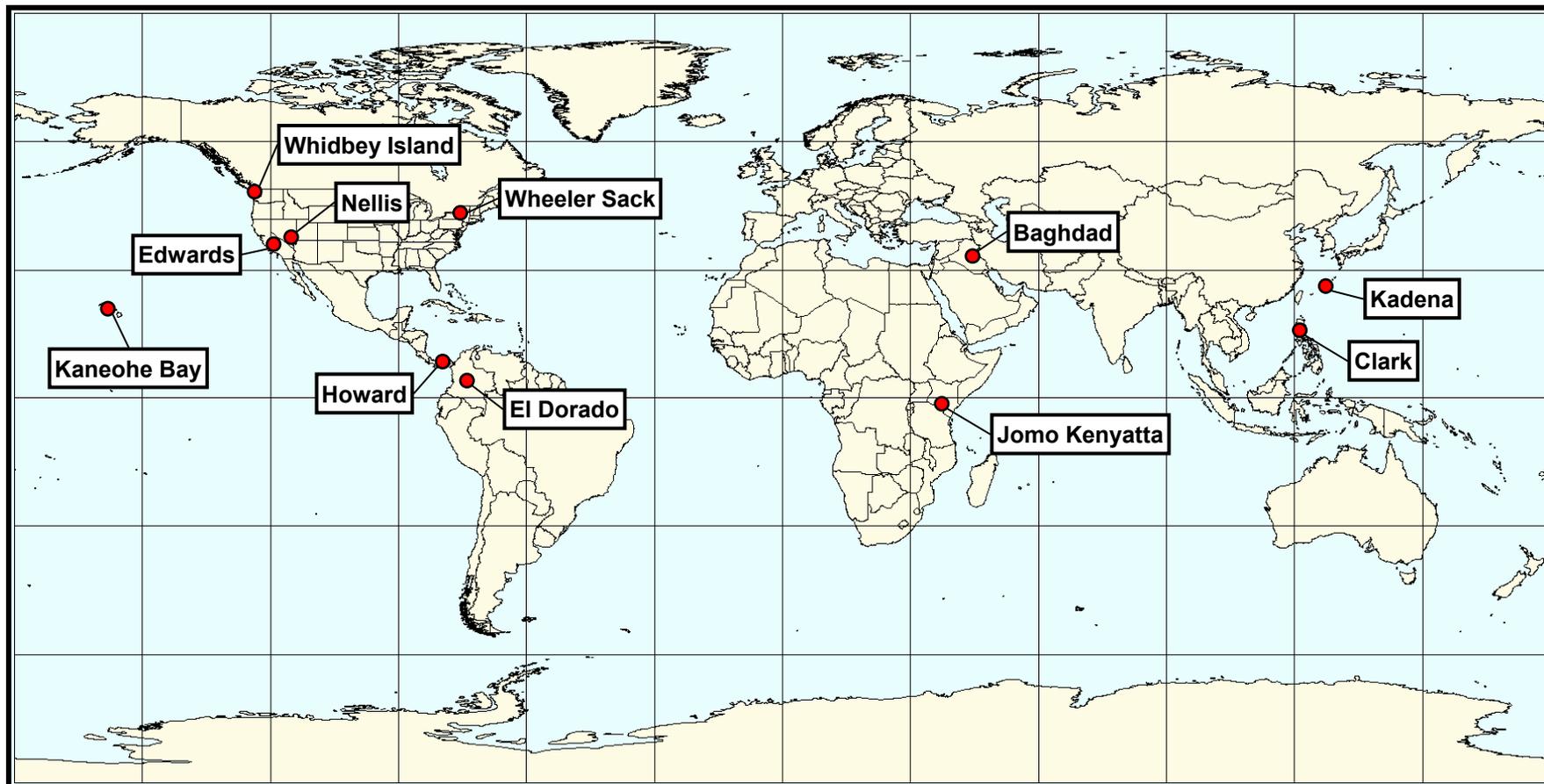


# Objectives

- To estimate the absolute horizontal geolocation accuracy from samples of:
  - 8 spotlight mode images
    - 5 Cosmo-Skymed-1
    - 3 Cosmo-Skymed-2
  - 11 stripmap mode images
    - 4 Cosmo-Skymed-1
    - 7 Cosmo-Skymed-2



# 11 Test Sites for Cosmo-Skymed





# Definition of Statistic

- Circular Error 90% (CE90)
  - In horizontal plane
  - Radial error distance centered at zero within which 90% of the data points fall



# Cosmo-Skymed Imagery Products Evaluated

Imaging Mode	Product Pixel Sampling (m)	Ground Resolution (m)	Scene Size (km)	Specified Geolocation Accuracy CE90 (m)	Geometric Processing	Polarization
Spotlight-2 (S2)	0.5	~1	~10 x ~10	$\leq 17.9$	Level 1B Detected Ground Multi-look (DGM)	HH (3) VV (5)
Stripmap (HIMAGE)	2.5	~5	~40 x ~40	$\leq 17.9$	Level 1B Detected Ground Multi-look (DGM)	HH (4) VV (7)



# CCAP Absolute Geolocation Accuracy Methodology

- General Approach: Monoscopic CE90
  - Intersection with ground-surveyed height
- Images are *\*not\** allowed to adjust during evaluation



# CCAP Absolute Geolocation Accuracy Methodology

- 1) Load imagery onto workstation with SOCET Set<sup>®</sup> photogrammetric software
- 2) Import rigorous sensor model support data accompanying imagery



# 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 (intersection with height)



# CCAP Absolute Geolocation Accuracy Methodology

- 4) For each checkpoint, subtract ground-surveyed coordinates from test-imagery-derived ground coordinates
  - Results in a list of “ $\Delta$  Easting” and “ $\Delta$  Northing” values



# CCAP Absolute Geolocation Accuracy Methodology

## 5) For each image, compute error centroid

- Compute mean “ $\Delta$  Easting” and “ $\Delta$  Northing” values
  - Convert into horizontal “ $\Delta$  Radial” value
  
- Additional statistics:
  - Number of checkpoints
  - Maximums & minimums of  $\Delta$  Easting and  $\Delta$  Northing values
  - Standard deviations of  $\Delta$  Easting and  $\Delta$  Northing values
  
- Each image represented by single data point for CE90 estimation



# CCAP Absolute Geolocation Accuracy Methodology

Each image represented by single data point for CE90 estimation because...

- ...test sites have varying number of checkpoints
  - Challenge for SAR imagery evaluations as many checkpoints are not radar-identifiable
- ...goal of evaluation is to estimate CE90 error statistic for population of images, not individual images



# CCAP Absolute Geolocation Accuracy Methodology

## 6) Estimate CE90

- CCAP uses non-parametric estimator (“Percentile Method”)
- Sort “ $\Delta$  Radial” values in ascending order
- Cut-off at 90<sup>th</sup> 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 centroid values
  - Standard deviations of centroid values



# 90<sup>th</sup> Percentile Estimator for Ordered Statistics

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

where  $x_{(i)} = \Delta r_{(i)}$  for CE90.

Then,

$$CE90 = (1 - f) * x_{(i)} + f * x_{(i+1)}$$

where

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

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



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# Cosmo-Skymed Evaluation Results



# Cosmo-Skymed Spotlight Mode Horizontal Accuracy (n=8)

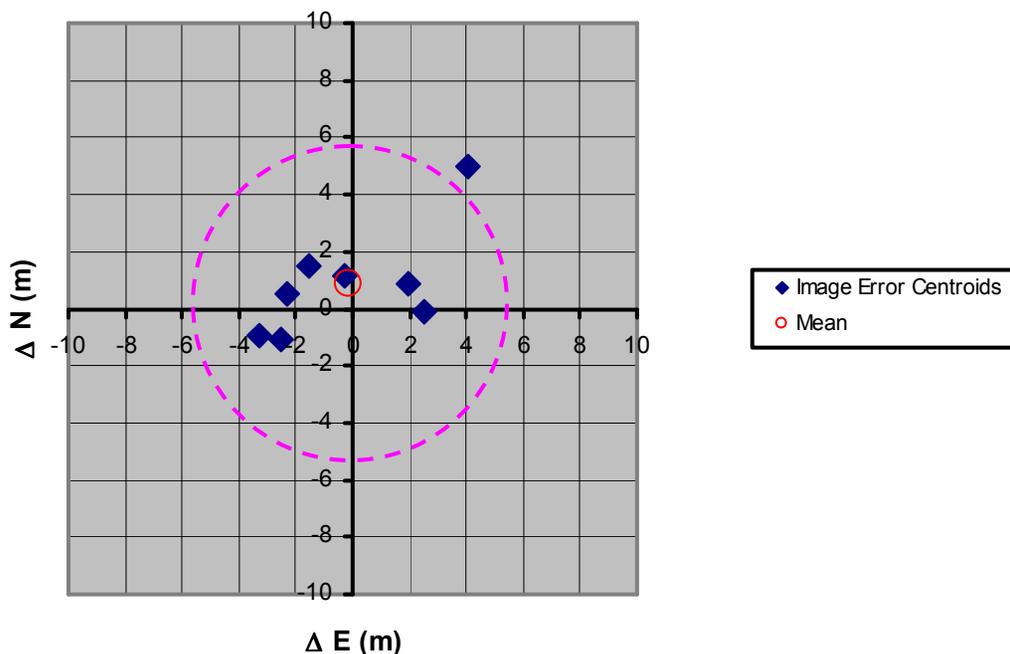
Test Site	CPs	Imagery Date	Mean $\Delta$ E (m)	Mean $\Delta$ N (m)	$\Delta$ r (m)
Japan, Kadena	6	20-Aug-2008	-2.5	-1.1	2.7
Kenya, Jomo Kenyatta	6	26-Sep-2008	2.0	0.9	2.2
Panama, Howard	10	22-Aug-2008	-3.3	-1.0	3.4
Philippines, Clark	10	20-Aug-2008	2.5	-0.1	2.5
United States, Edwards	10	20-Aug-2008	-0.3	1.2	1.2
United States, Kaneohe Bay	9	22-Aug-2008	-1.5	1.5	2.1
United States, Nellis	8	21-Aug-2008	-2.3	0.6	2.4
United States, Wheeler Sack	6	6-Sep-2008	4.0	5.0	6.4

	Mean $\Delta$ E (m)	Mean $\Delta$ N (m)	$\Delta$ r (m)
Mean (m)	-0.2	0.9	2.9
Standard Deviation (m)	2.7	1.9	1.6
Maximum (m)	4.0	5.0	6.4
Minimum (m)	-3.3	-1.1	1.2



# Cosmo-Skymed Spotlight Mode Horizontal Accuracy (n=8)

Cosmo-Skymed Spotlight Monoscopic  
Absolute Geolocation Accuracy  
(Rigorous Sensor Model Data)



Test Site	Sorted $\Delta r$ (m)
United States, Edwards	1.2
United States, Kaneohe Bay	2.1
Kenya, Jomo Kenyatta	2.2
United States, Nellis	2.4
Philippines, Clark	2.5
Japan, Kadena	2.7
Panama, Howard	3.4
United States, Wheeler Sack	6.4

Estimated Mono CE90 = 5.5 m



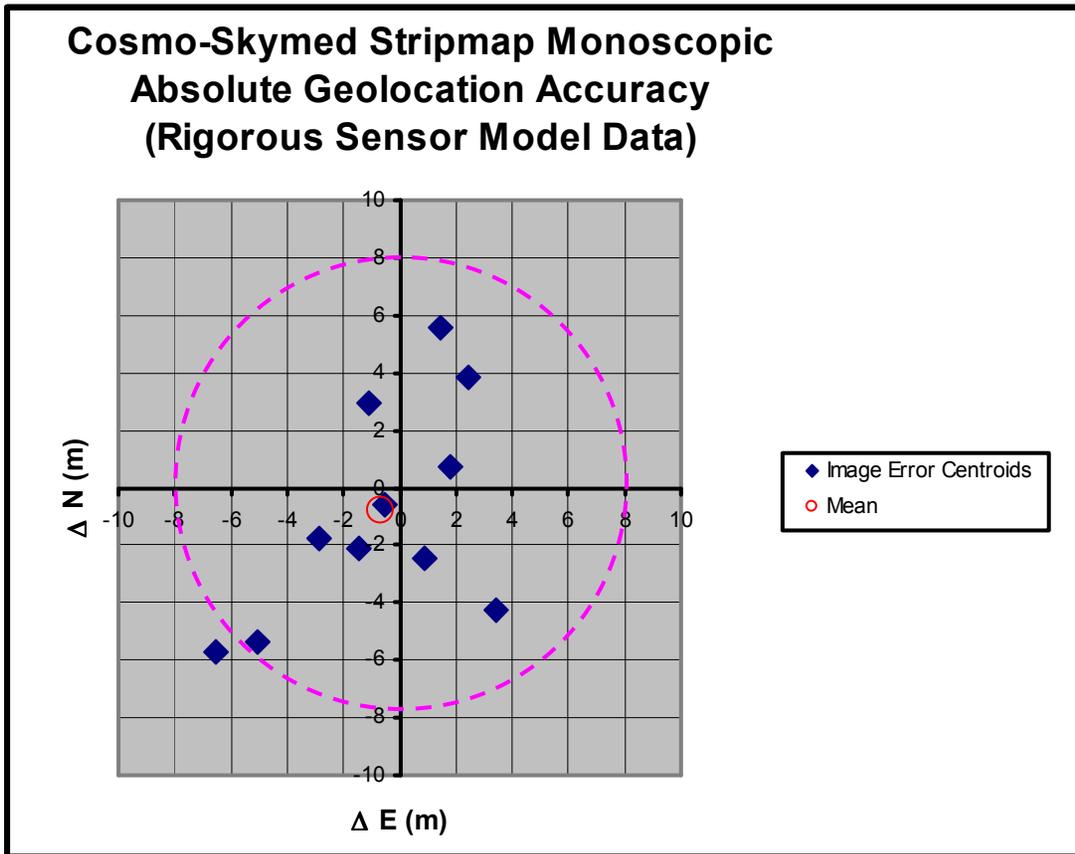
# Cosmo-Skymed Stripmap Mode Horizontal Accuracy (n=11)

Test Site	CPs	Imagery Date	Mean $\Delta$ E (m)	Mean $\Delta$ N (m)	$\Delta$ r (m)
Colombia, El Dorado	4	26-Sep-2008	-1.4	-2.1	2.5
Iraq, Baghdad	3	2-Sep-2008	1.8	0.8	2.0
Japan, Kadena	8	12-Sep-2008	-6.5	-5.7	8.7
Kenya, Jomo Kenyatta	5	25-Aug-2008	2.4	3.8	4.5
Panama, Howard	13	25-Sep-2008	-0.5	-0.6	0.8
Philippines, Clark	8	6-Sep-2008	-1.1	2.9	3.1
United States, Edwards	12	26-Sep-2008	1.5	5.6	5.8
United States, Kaneohe Bay	4	22-Aug-2008	-2.9	-1.8	3.4
United States, Nellis	6	18-Sep-2008	3.4	-4.2	5.4
United States, Wheeler Sack	4	19-Sep-2008	-5.0	-5.4	7.4
United States, Whidbey Island	11	20-Sep-2008	0.9	-2.4	2.6

	Mean $\Delta$ E (m)	Mean $\Delta$ N (m)	$\Delta$ r (m)
Mean (m)	-0.7	-0.8	4.2
Standard Deviation (m)	3.1	3.7	2.4
Maximum (m)	3.4	5.6	8.7
Minimum (m)	-6.5	-5.7	0.8



# Cosmo-Skymed Stripmap Mode Horizontal Accuracy (n=11)



Test Site	Sorted $\Delta r$ (m)
Panama, Howard	0.8
Iraq, Baghdad	2.0
Colombia, El Dorado	2.5
United States, Whidbey Island	2.6
Philippines, Clark	3.1
United States, Kaneohe Bay	3.4
Kenya, Jomo Kenyatta	4.5
United States, Nellis	5.4
United States, Edwards	5.8
United States, Wheeler Sack	7.4
Japan, Kadana	8.7

**Estimated Mono CE90 = 7.9 m**



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# Questions?



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