Geolocation Accuracy Performance of the DigitalGlobe Constellation During 2013

David Mulawa, PhD

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Introduction

- This presentation collects together geolocation accuracy performance assessments for the DigitalGlobe satellite constellation from imagery collected during 2013.

- The satellites have been performing well and provided good geolocation accuracy performance for 2013.

- CE90 and LE90 estimation is based on the Percentile Method
  - Recommended by NIQU/CCAP
    - Bresnahan, P., Absolute Geolocation Accuracy Evaluation of Worldview-1 Basic 1B Stereo Pairs, JACIE 2010,
      - http://calval.cr.usgs.gov/JACIE_files/JACIE11/Presentations/WedPM/115_Bresnahan_JACIE_11.005.pdf
    - Bresnahan, P., Absolute Geolocation Accuracy Evaluation of GeoEye-1 Basic Stereo Triplets, JACIE 2010
      - http://calval.cr.usgs.gov/JACIE_files/JACIE10/Presentations/WedPM/Bresnahan_10_005_JACIE2010_CCAP_Geolocation_Accuracy_GeoEye1_R2-Approved.pdf

DigitalGlobe Constellation Mono Geolocation Accuracy for 2013

Satellite	Mono		
	# images	CE90 (m)	*RMSE (radial) (m)*
QuickBird	411	19	*11*
WorldView-1	1251	4.2	*2.8*
WorldView-2	3514	3.2	*2.0*
GeoEye-1	63	3.1	*2.0*

QuickBird Mono Geolocation Accuracy for 2013

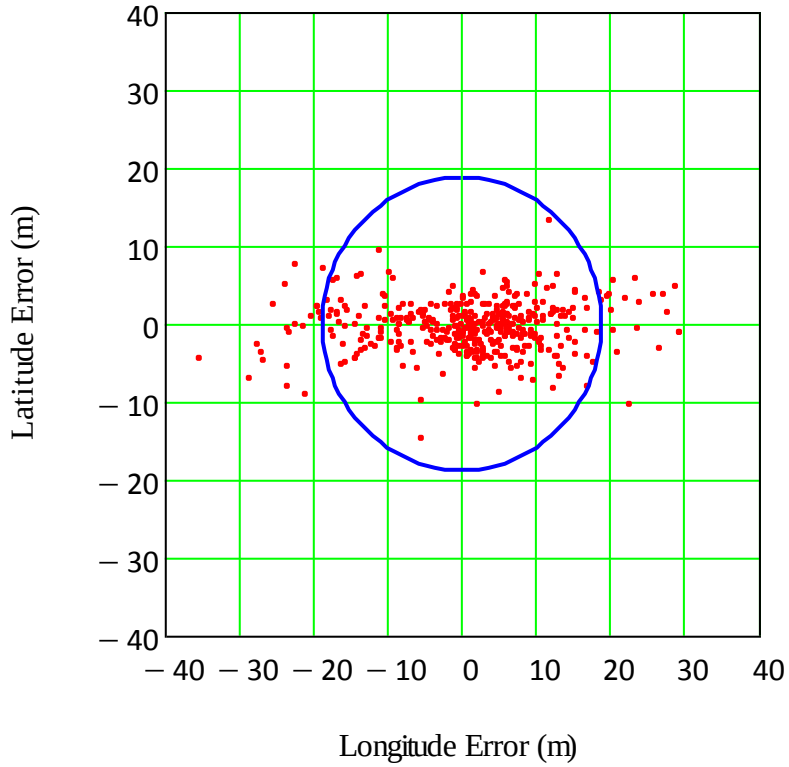
$n = 411$

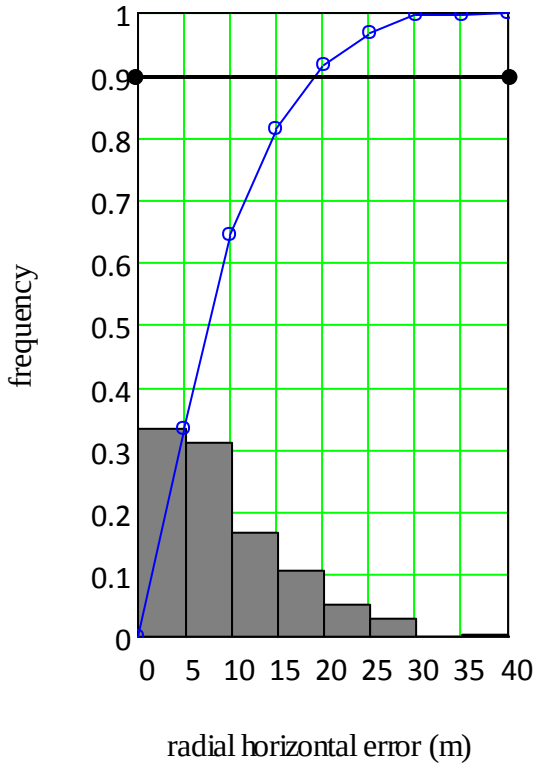
$\text{mean}(\text{lat_err}) = -0.3\,\text{m}$ $\quad$ $\text{mean}(\text{lon_err}) = 1.1\,\text{m}$

$\text{stdev}(\text{lat_err}) = 3.2\,\text{m}$ $\quad$ $\text{stdev}(\text{lon_err}) = 10.8\,\text{m}$

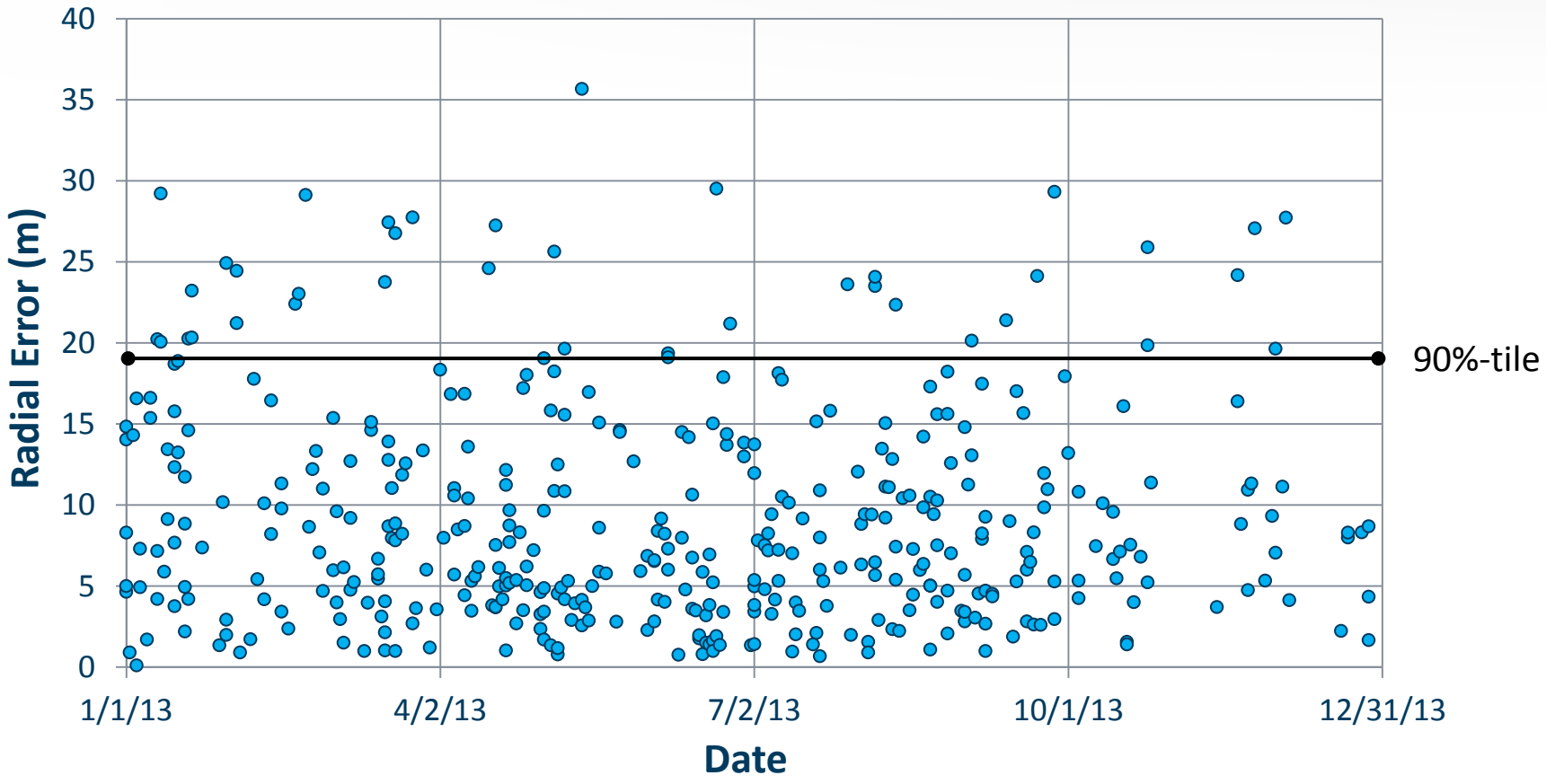
CE90 = 19 meters

RMSE(r) = 11 meters





QuickBird Time Series of Mono Geolocation for 2013



WorldView-1 Mono Geolocation Accuracy for 2013

n = 1251

mean(lat_err) = −0.7 m

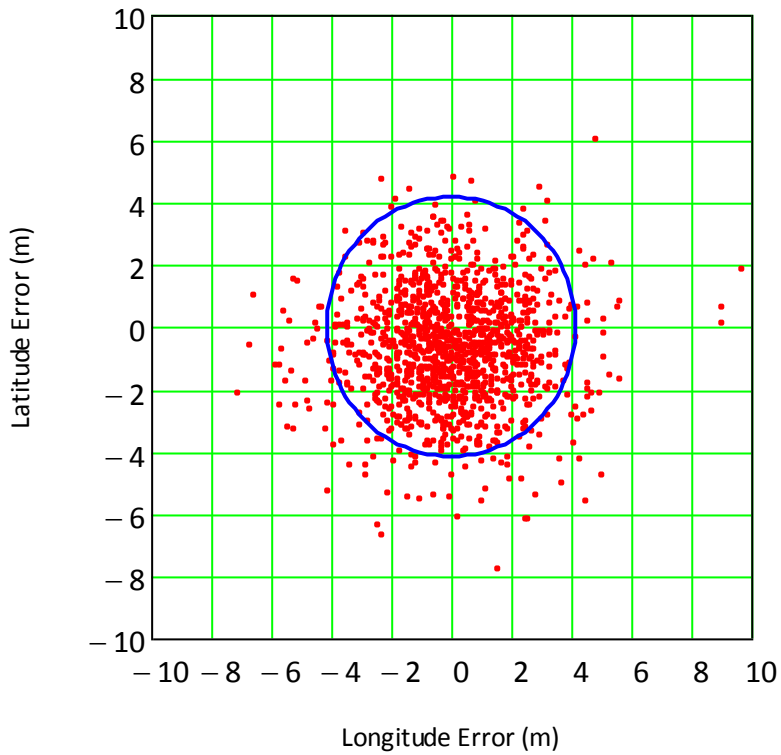
mean(lon_err) = −0.0 m

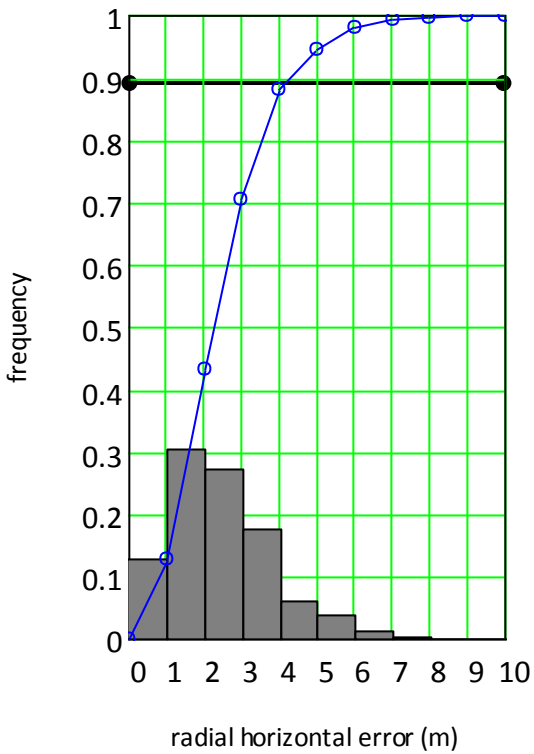
stdev(lat_err) = 1.8 m

stdev(lon_err) = 2.0 m

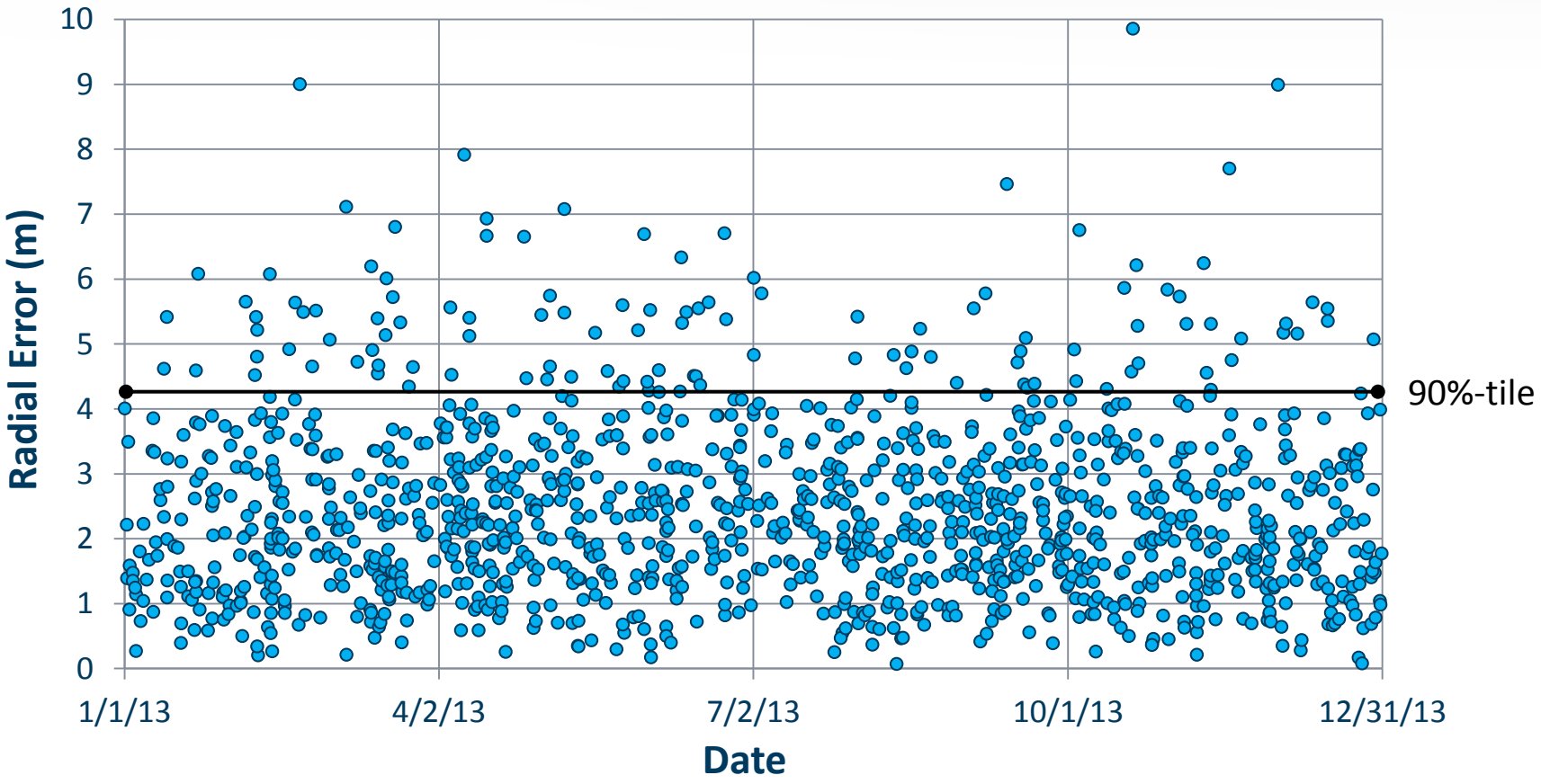
CE90 = 4.2 meters

RMSE(r) = 2.8 meters





WorldView-1 Time Series of Mono Geolocation for 2013



WorldView-2 Mono Geolocation Accuracy for 2013

n = 3514

mean(lat_err) = −0.3 m

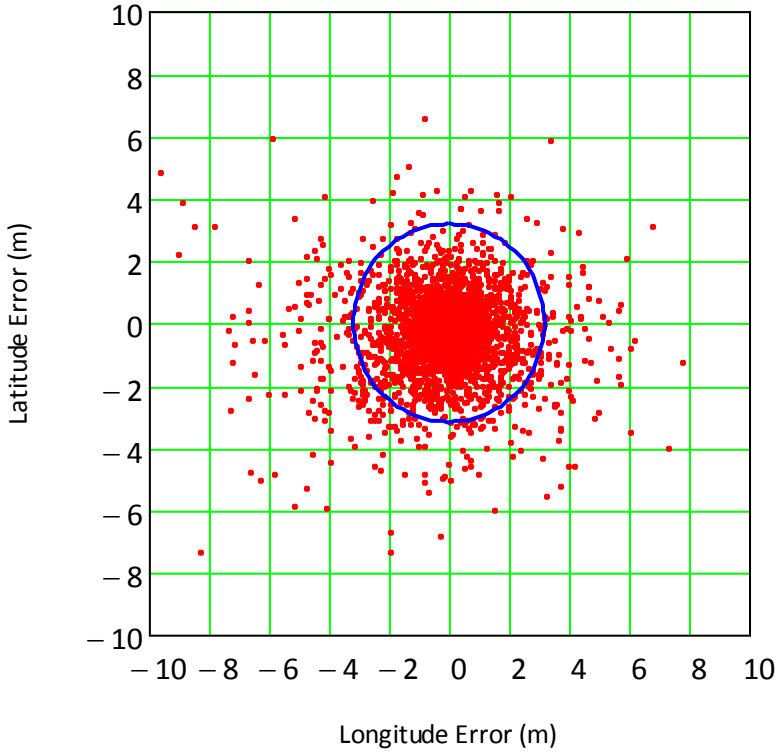
mean(lon_err) = −0.1 m

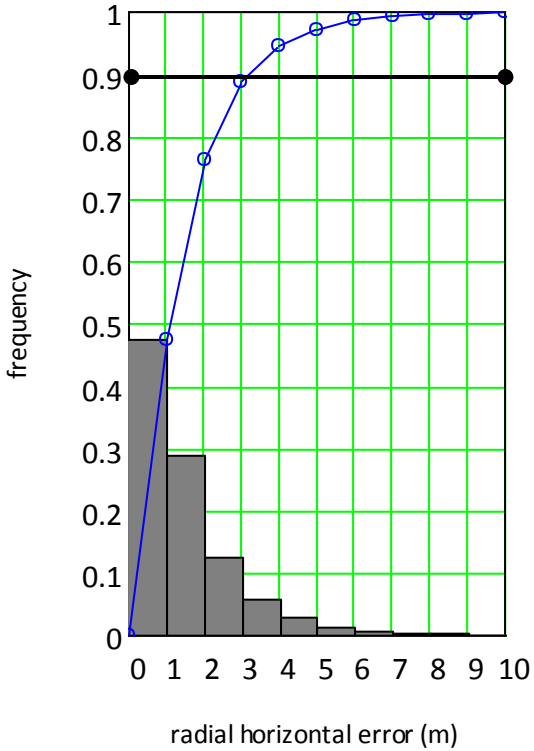
stdev(lat_err) = 1.2 m

stdev(lon_err) = 1.6 m

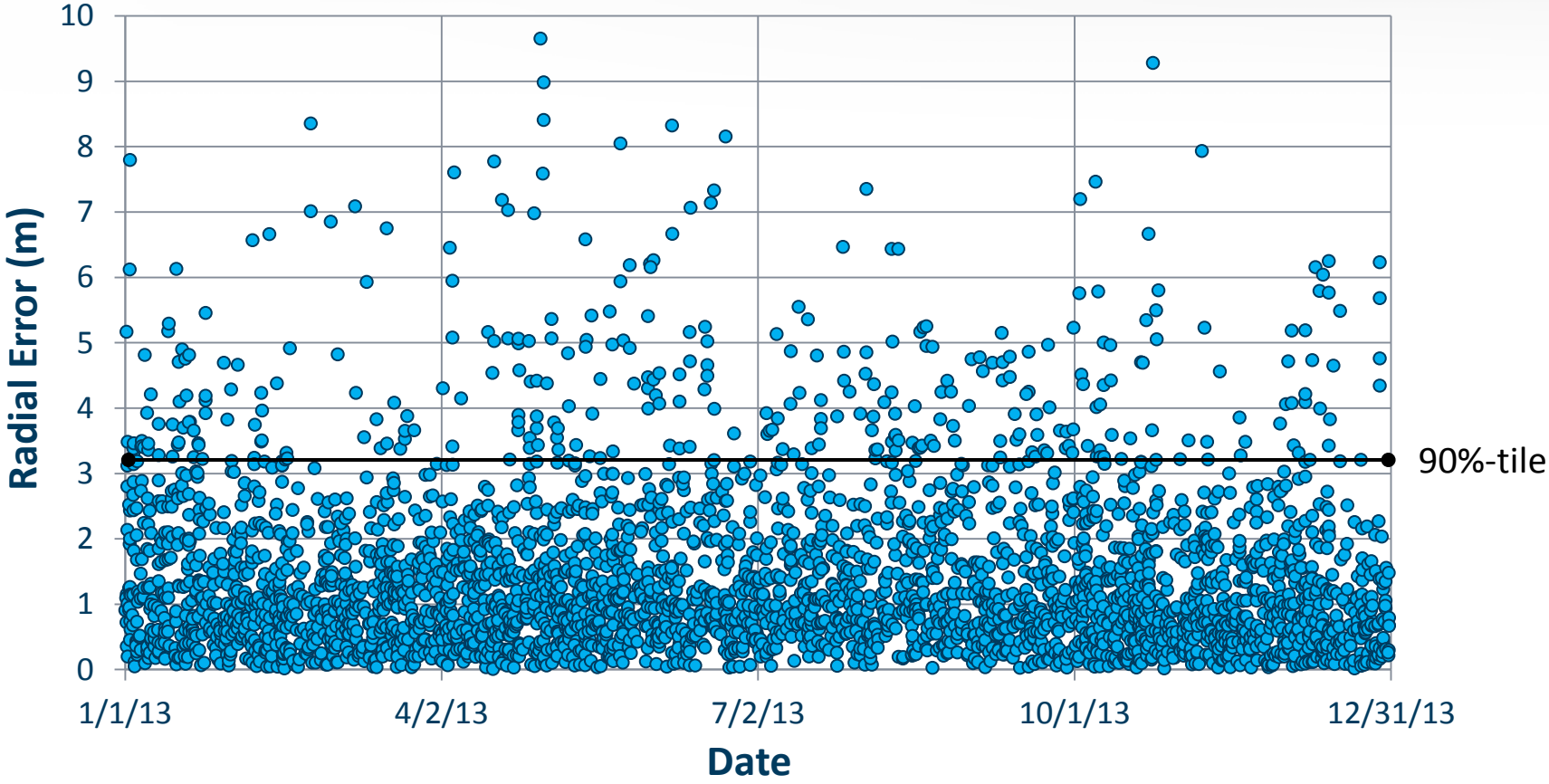
CE90 = 3.2 meters

RMSE(r) = 2.0 meters





WorldView-2 Time Series of Mono Geolocation for 2013



GeoEye-1 Mono Geolocation Accuracy for 2013

n = 63

mean(lat_err) = 0.2 m

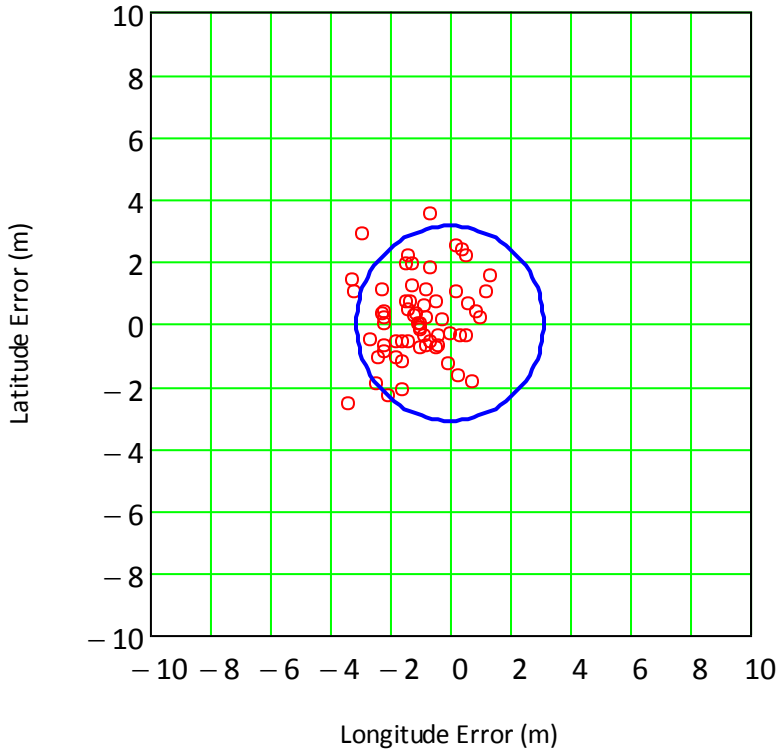
stdev(lat_err) = 1.3 m

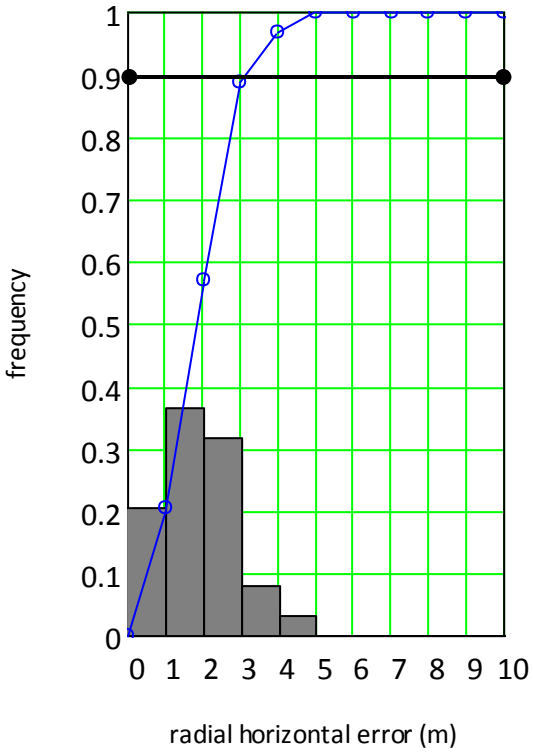
mean(lon_err) = −1.0 m

stdev(lon_err) = 1.1 m

CE90 = 3.1 meters

RMSE(r) = 2.0 meters





GeoEye-1 Stereo Geolocation Accuracy for 2013

n = 17

mean(lat_err) = −0.0 m

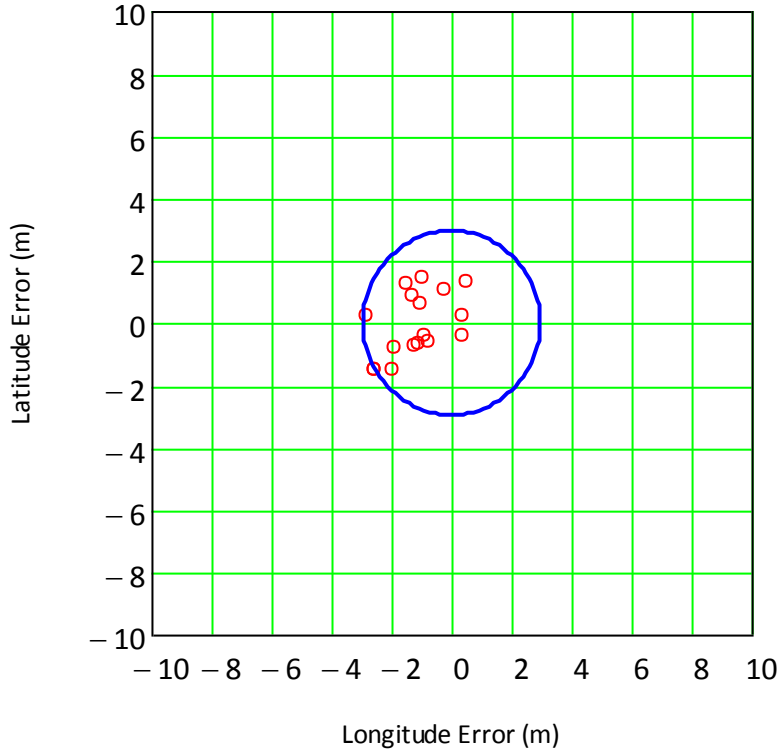
mean(lon_err) = −1.2 m

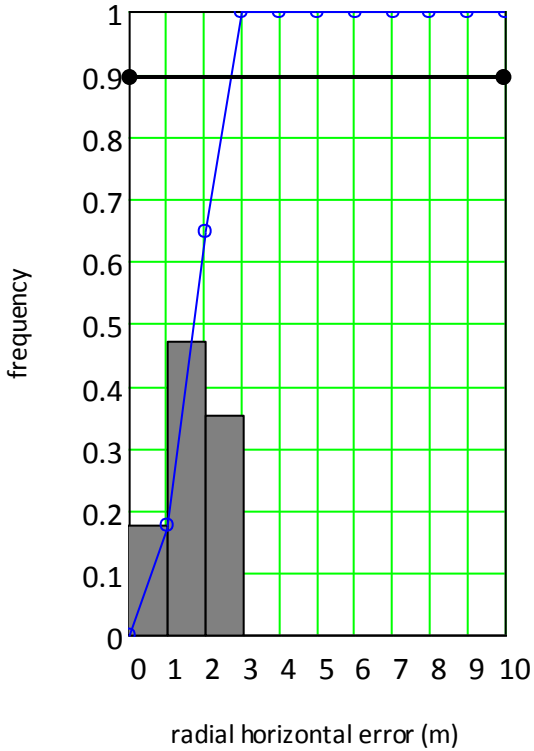
stdev(lat_err) = 1.0 m

stdev(lon_err) = 1.0 m

CE90 = 2.9 meters

RMSE(r) = 1.8 meters



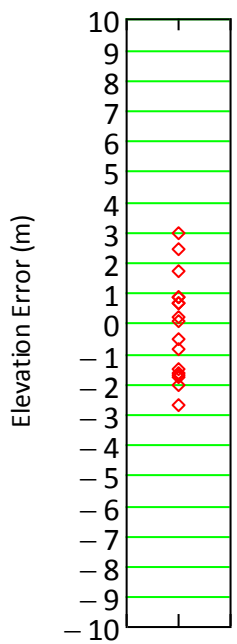


GeoEye-1 Stereo Geolocation Accuracy for 2012

$n = 17$

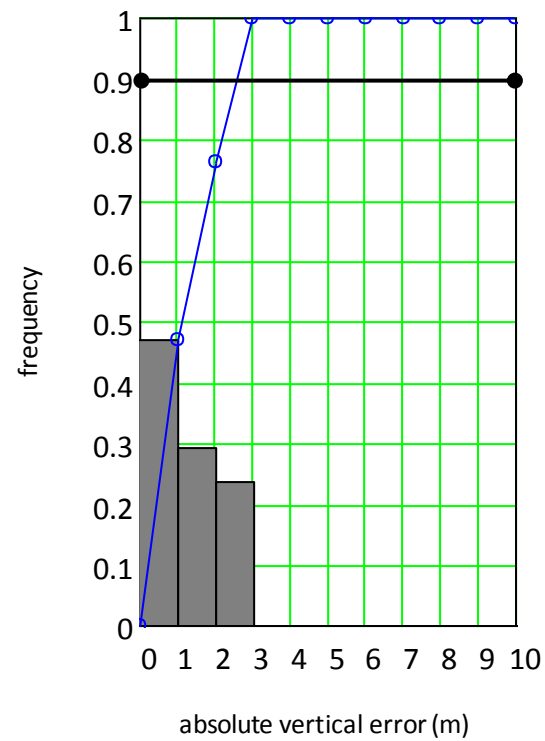
$\text{mean}(\Delta h) = -0.1\,\text{m}$

$\text{stdev}(\Delta h) = 1.6\,\text{m}$



LE90 = 2.6 meters

RMSE(H) = 1.6 meters



GeoEye-1 Geolocation Accuracy Test Results

Period	Mono			Stereo				
	# images	CE90 (m)	*RMSE radial (m)*	# pairs	CE90 (m)	*RMSE radial (m)*	LE90 (m)	*RMSE H (m)*
2009 Q2-Q4	530	3.6	*2.3*	222	3.4	*2.2*	3.2	*2.0*
2010	136	3.8	*2.4*	65	3.5	*2.2*	3.5	*2.3*
2011	193	2.8	*1.9*	43	2.8	*1.9*	2.9	*1.8*
2012	120	3.0	*2.0*	28	2.6	*1.8*	2.7	*2.0*
2013	63	3.1	*2.0*	17	2.9	*1.8*	2.6	*1.6*

- Based on rigorous (physical) model
- Direct positioning
  - No adjustment of imagery
- Typical collection geometry was up to 35 degrees off nadir angle and stereo convergence angle of 45 degrees

Preparing for WorldView-3

- Camera Field Angle Map (FAM) self-calibration software used in the GE-1 program has been adapted to include WorldView-1, 2 and 3 geometric models, data formats and geometric calibration tables for the product processor.

- Exercise and rehearsals are going on using WV-1 and WV-2 data sets.
  - Looking at ways to shorten the calibration period and verification process and improve the quality of the calibration results.
  - Attitude determination team is performing a cold start exercise using early WV-2 data.
  - WV-1 and WV-2 FAM will be updated in 2014Q2.

Preparing for WorldView-3

- As-built data is used to create pre-launch calibration tables.

- Ground truth
  - GeoCal Ranges: FAM calibration and relative geolocation accuracy accessment
    - Uses aerial imagery with geodetic control survey
    - Automatic matching between aerial control and satellite imagery
    - Phoenix GeoCal Range has updated aerial images in the urban area
    - Building a new type of GeoCal Range based on satellite imagery and geodetic control survey
  - Test and Evaluation Sites (T&E): Camera to body alignment (interlock)
    - Existing worldwide set of T&E sites

Concluding Remarks

- The satellites continue to meet their geolocation accuracy product specifications.

- WV01, WV02, and GE-1 provide very good CE90 geolocation accuracy performance in the 3-4 meter range.

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