Topographical mapping and generating digital surface model using remote sensing

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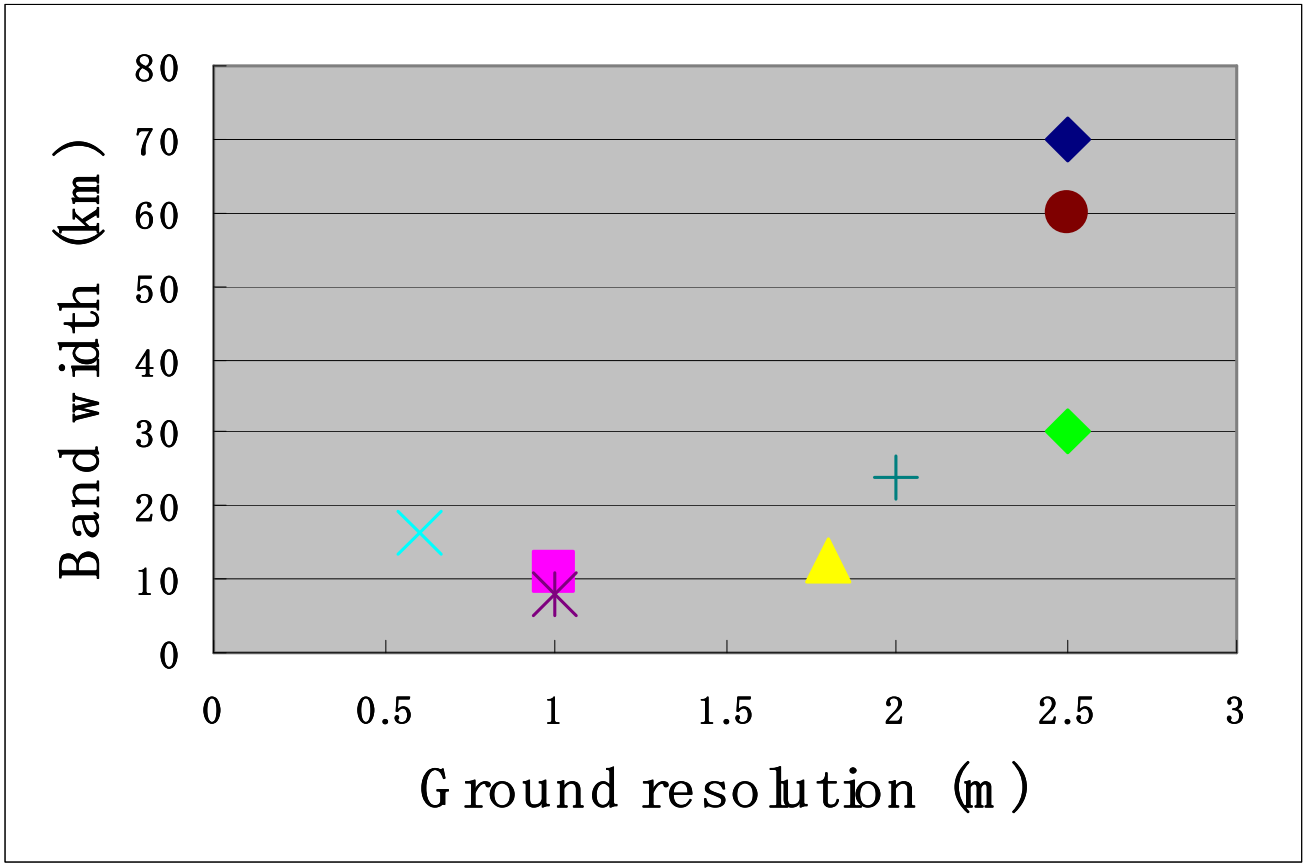
Evaluation of satellite images in the aspect of topographical mapping

IKONOS image （resolution:1m） （Shizuoka Prefecture）

High resolution satellites

Ground resolution (m) / Band width (km) chart of operational satellite image products



Required evaluation of satellite image products for topographic mapping

- **Evaluation of geometric accuracy**
  - Geometric accuracy of 2D/3D measurement using satellite images with/without GCPs
- **Interpretation test from satellite images**
  - Image reading test
  - On-site verification

Permissible accuracy

Permissible accuracy of 1/25,000 scale map

(Maximum permissible errors)

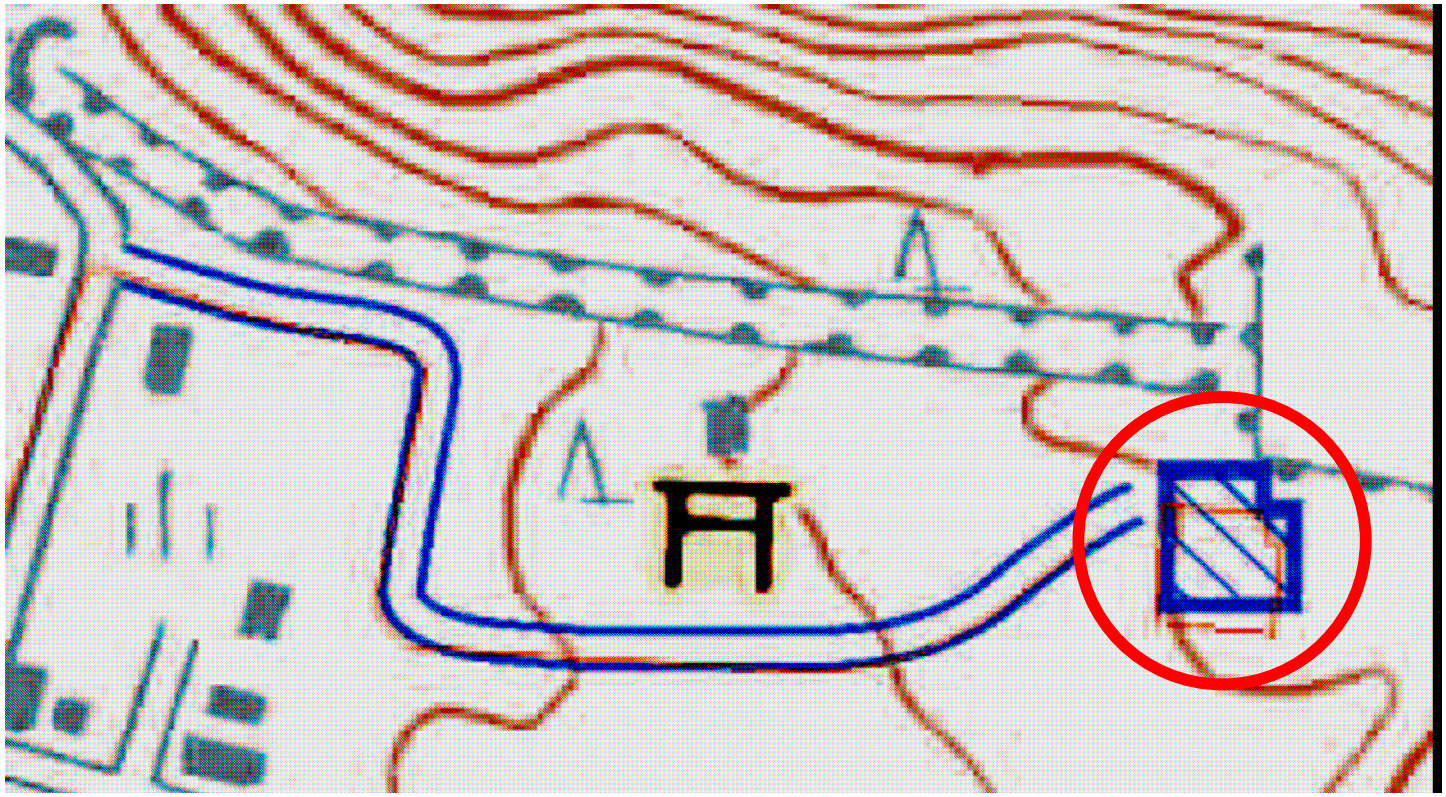
- Horizontal

➢Mapping	: 7.5m
➢Updating	: 12.5m

- Vertical

➢Both mapping and updating	: 2.5m

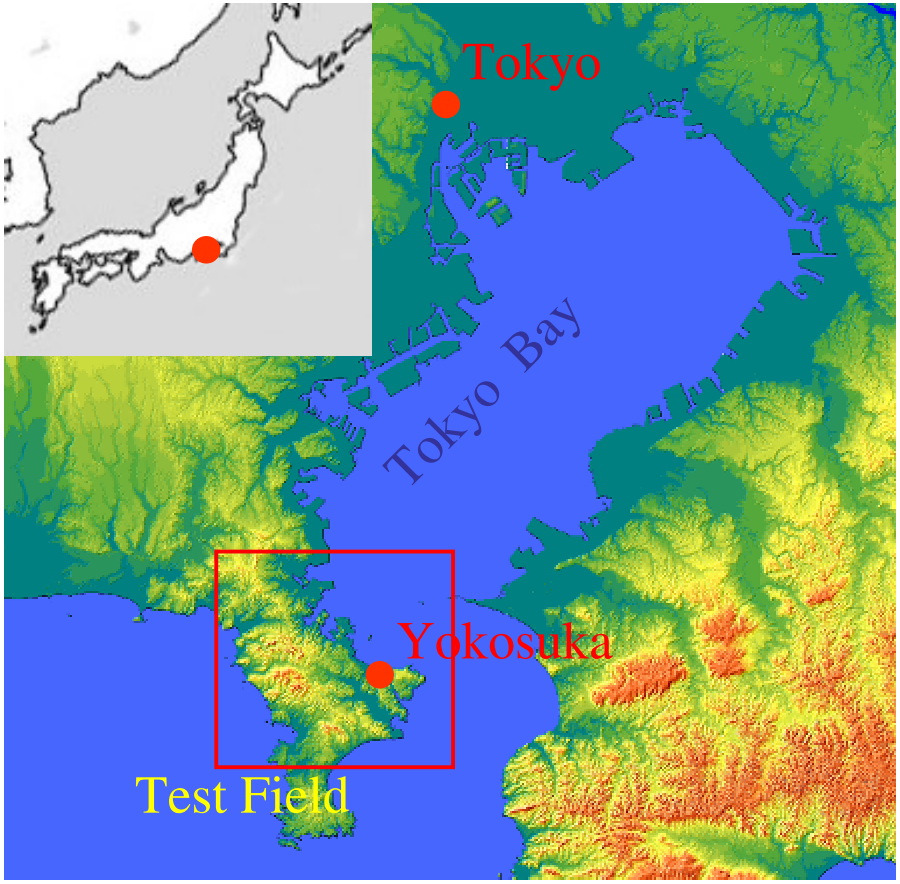
Evaluation of satellite image for topographic mapping



compared the result of drawing with a topographical map

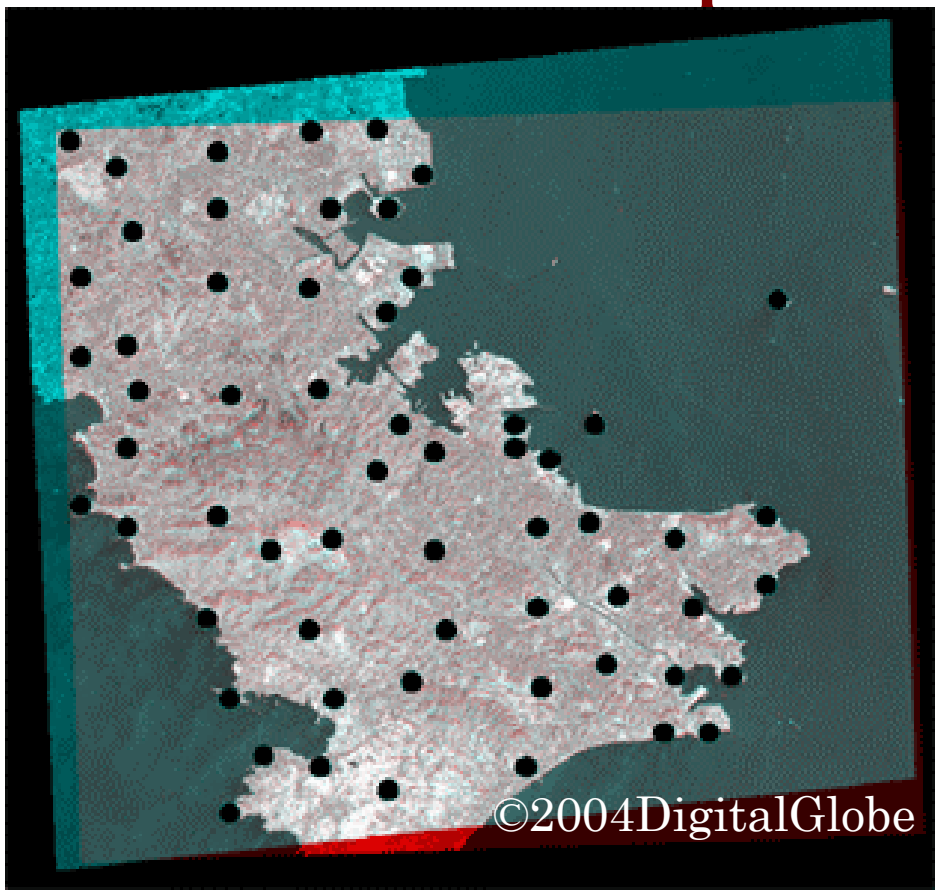
Evaluation of QuickBird stereo image

Location of test field



Yokosuka city and its surroundings nearby Tokyo
Elevation : 0 – 241m

Distribution of checkpoints



Observation Date of images : April 22, 2003
Off-nadir angle : 28.7 degree (forward view)
27.2 degree (backward view)
● : checkpoints (60pts)

Evaluation of QuickBird stereo image

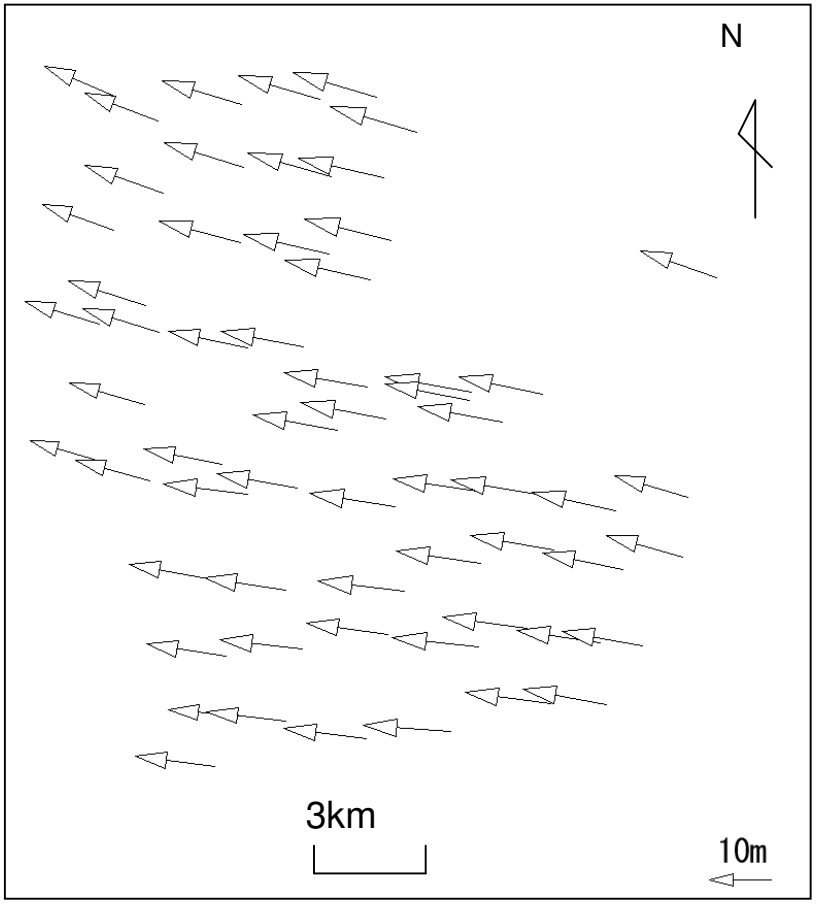
Measurement of check points

Coordinates measurement from imagery （RPC-model）

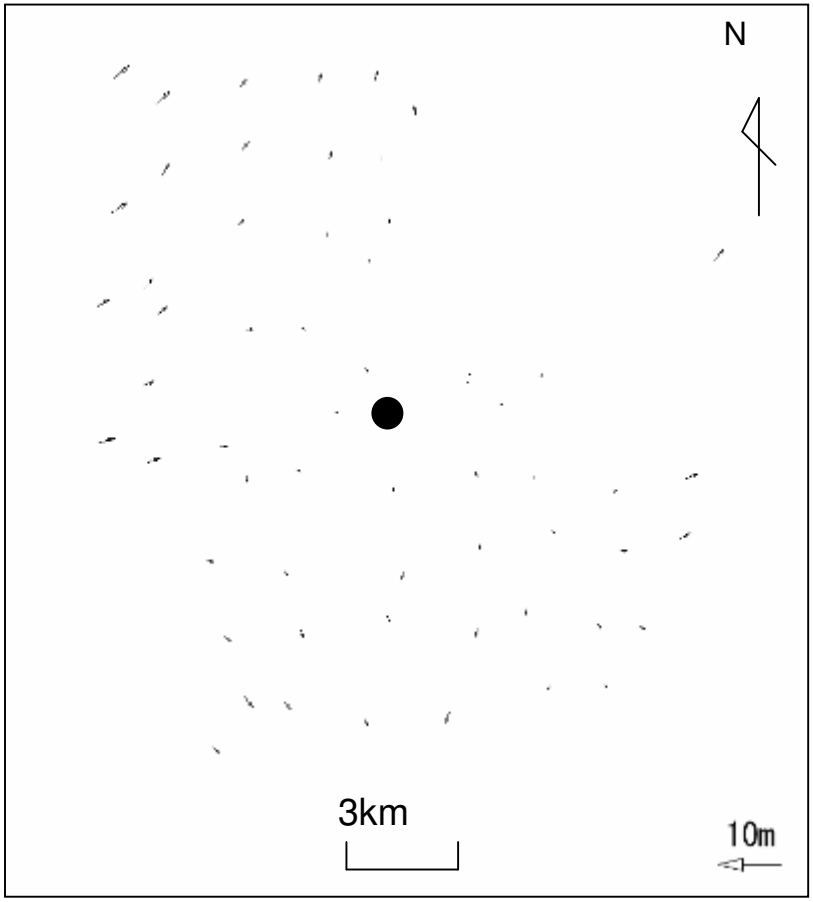
Measurement by GPS
(Fast-static GPS)

Evaluation of QuickBird stereo image

Comparison of coordinates
(Horizontal component of error vectors)



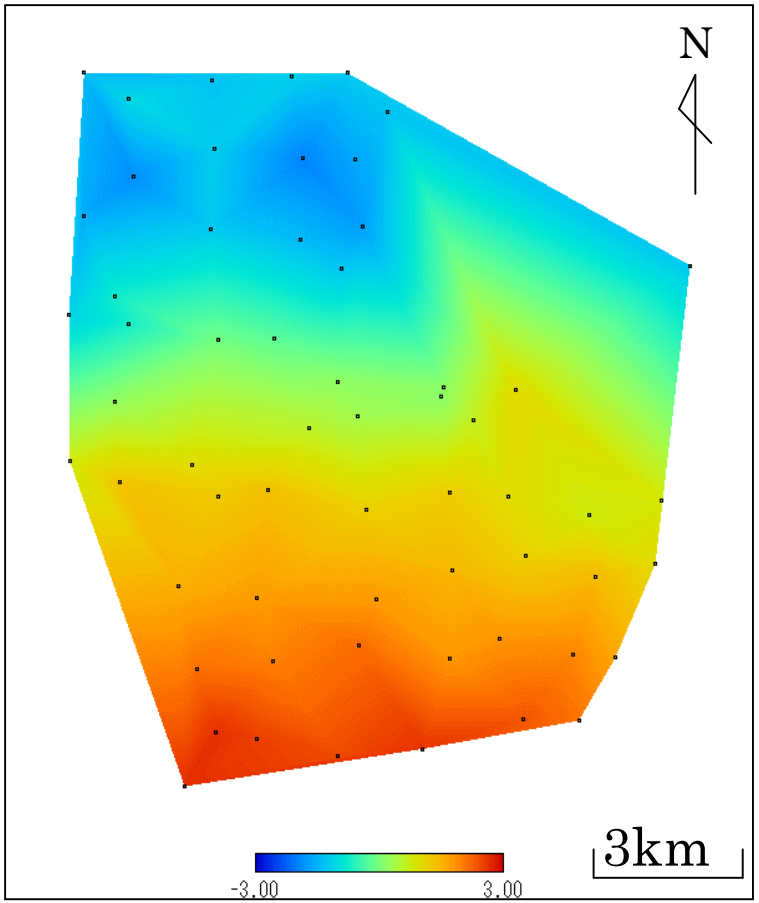
Before correction
RMSE:13.47m



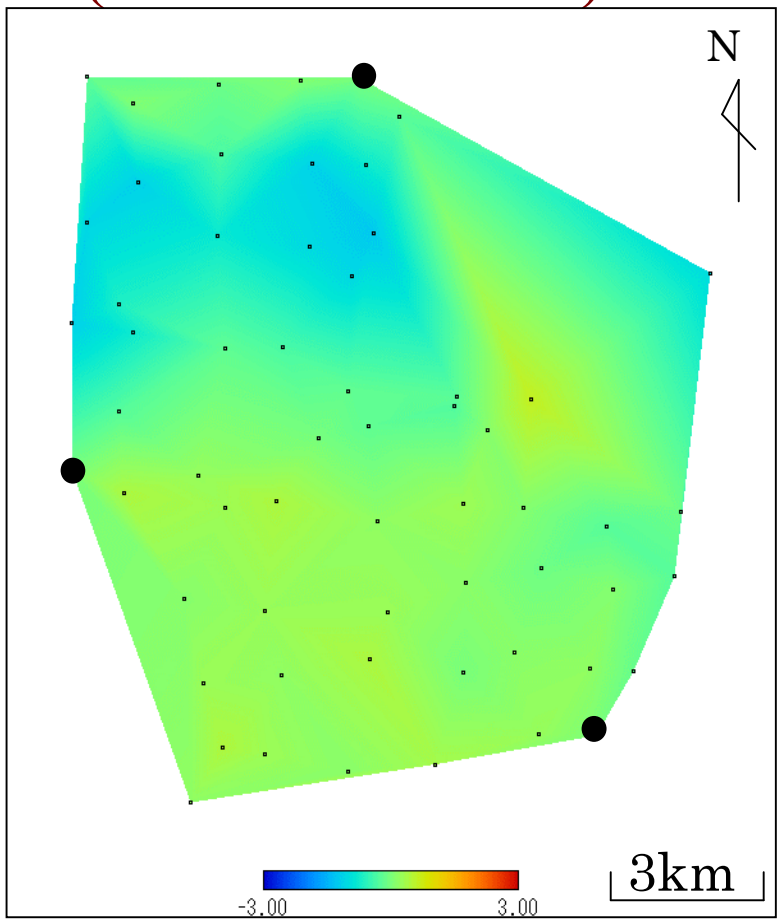
After correction with one GCP
RMSE:1.37m

Evaluation of QuickBird stereo image

Comparison of coordinates (Vertical errors)



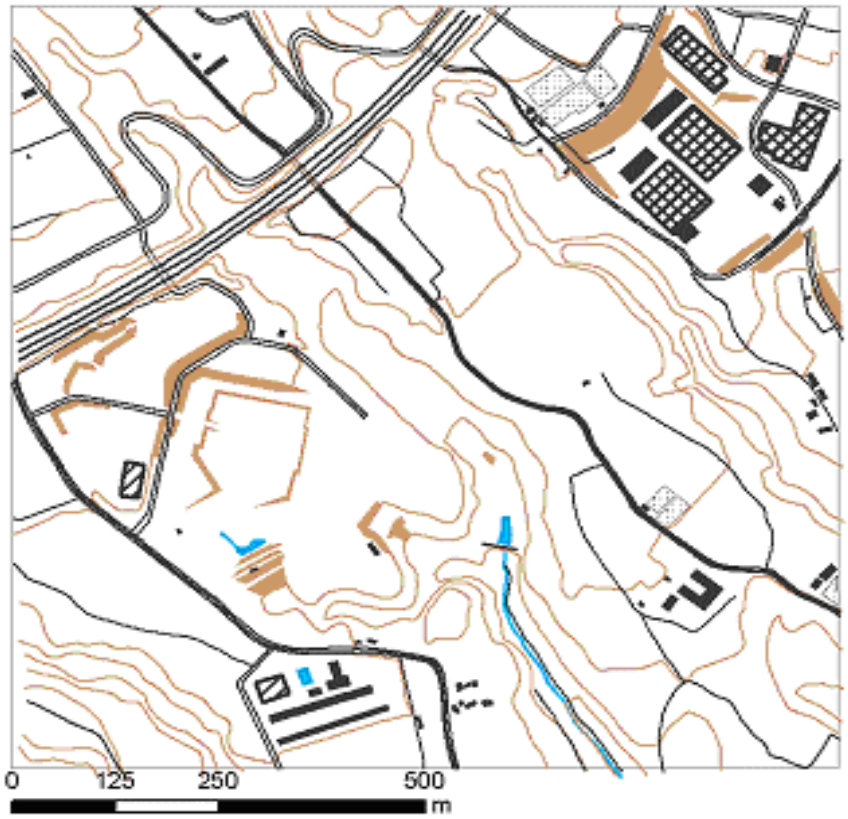
Before correction
RMSE:1.42m



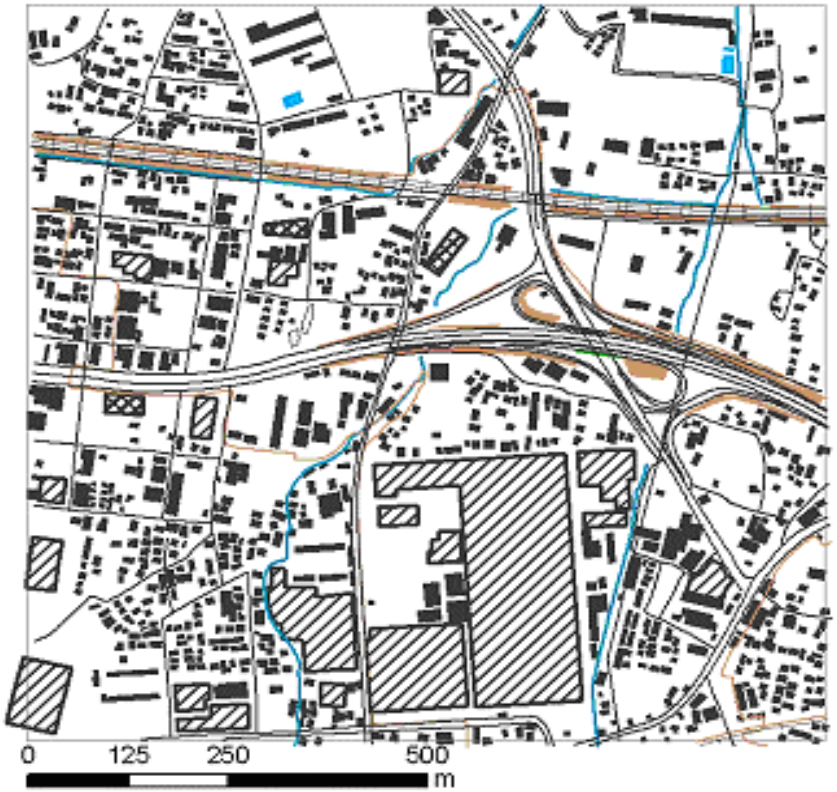
After correction with 3 GCPs
taken from coastline
RMSE:0.44m

Validation of geometric accuracy and Interpretation test of IKONOS image

Extraction of features using Digital Photogrammetry Workstation



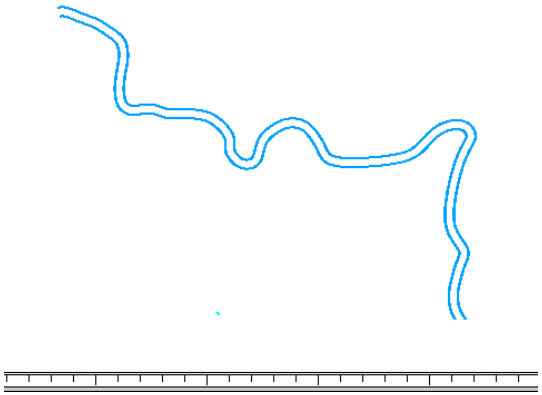
＜hilly area＞



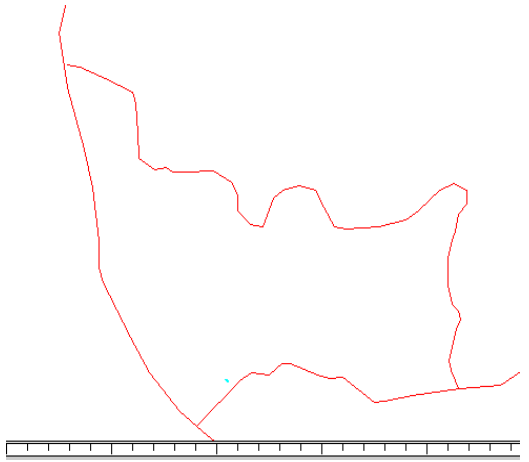
＜urban area＞

※Susono city in Shizuoka Prefecture

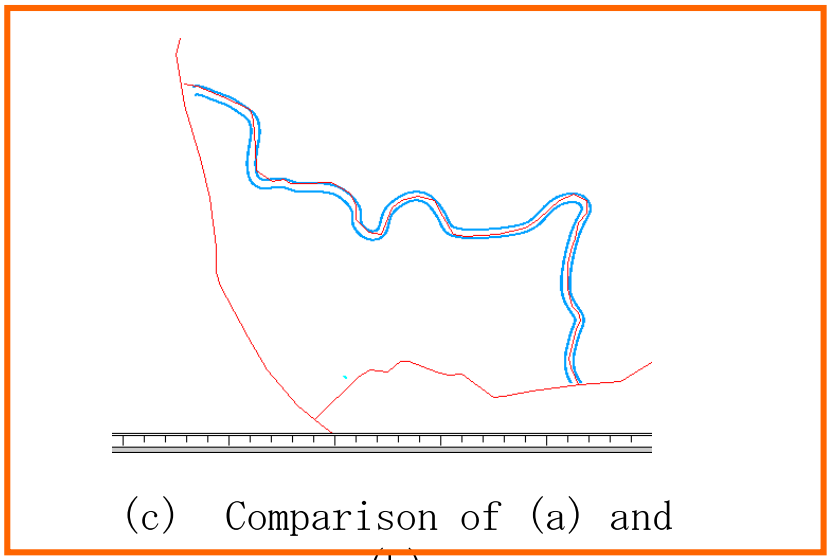
Validation of geometric accuracy of satellite image



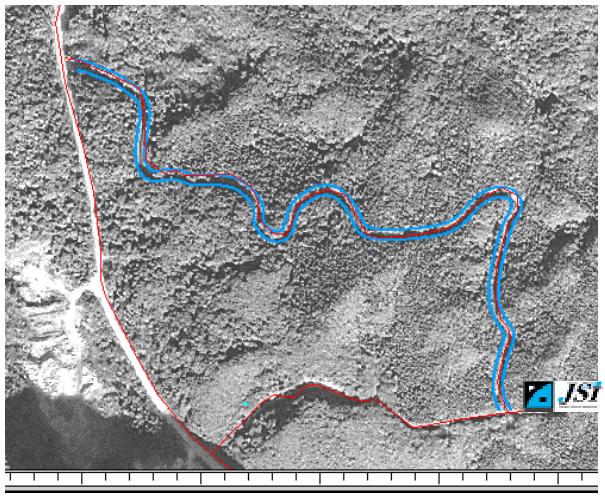
(a) Data extracted from IKONOS image



(b) Data extracted from aerial photograph



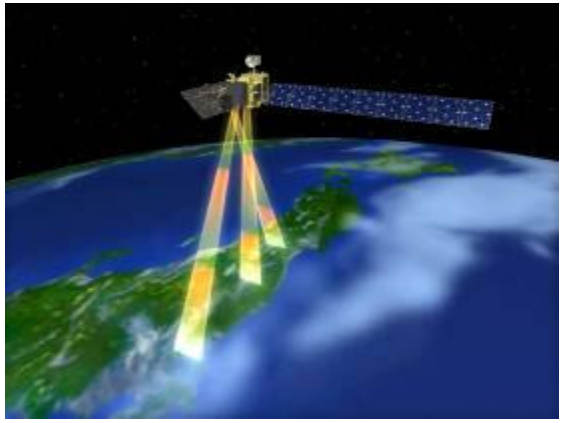
(c) Comparison of (a) and (b)



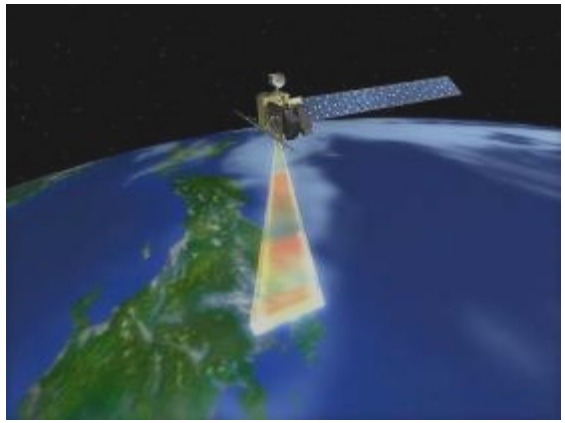
(d) Superimposing of IKONOS image

Advanced Land Observing Satellite (ALOS"Daichi")

Launched : 2006.1.24

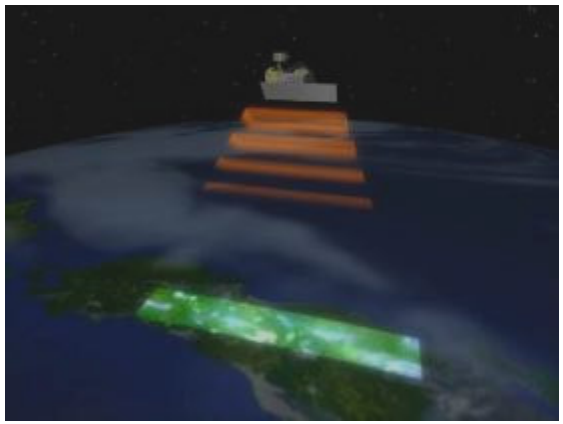


PRISM
2.5m-spatial resolution
three optical system
Panchromatic sensor



AVNIR-2
10m-spatial resolution
Multi-band(BGRNIR)
sensor

Mission
- **cartography**
- regional observation
- disaster monitoring
- resource surveying

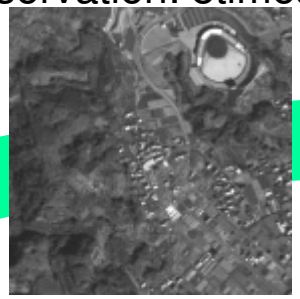


PALSAR
10m-spatial resolution
L-band SAR

From JAXA HP

Topographical Mapping using "Daichi" Images

Observation: 8times/year



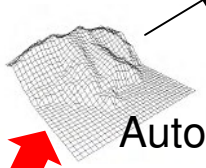
2.5m Ground Resolution nadir images

Collect changed features

Efficient revision of topographic maps

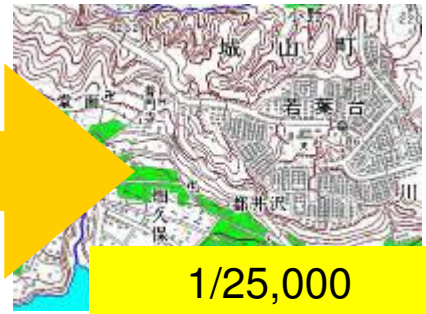
"Daichi"/PRISM triple line sensor

Generate Ortho satellite images



Automatic DSM generation

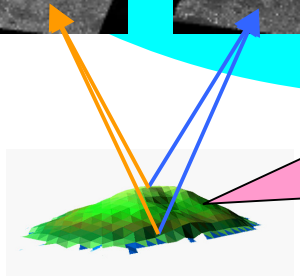
Revision of maps overlaying ortho images



1/25,000 Topographic mapping

forward

backward



Generate a 3D model by a stereo pair

Precise mapping and measurement by a Digital Photogrammetry Workstation

Evaluation of "Daichi"/PRISM image quality

- **Evaluation of geometric accuracy**
  - Geometric accuracy of generic pushbroom sensor model applied to PRISM images using GCPs
- **Interpretation of PRISM image**
  - Image reading test
  - On-site verification
- **Evaluation of DSM generation**
  - Accuracy of DSM generated by "Daichi"/PRISM stereo pairs

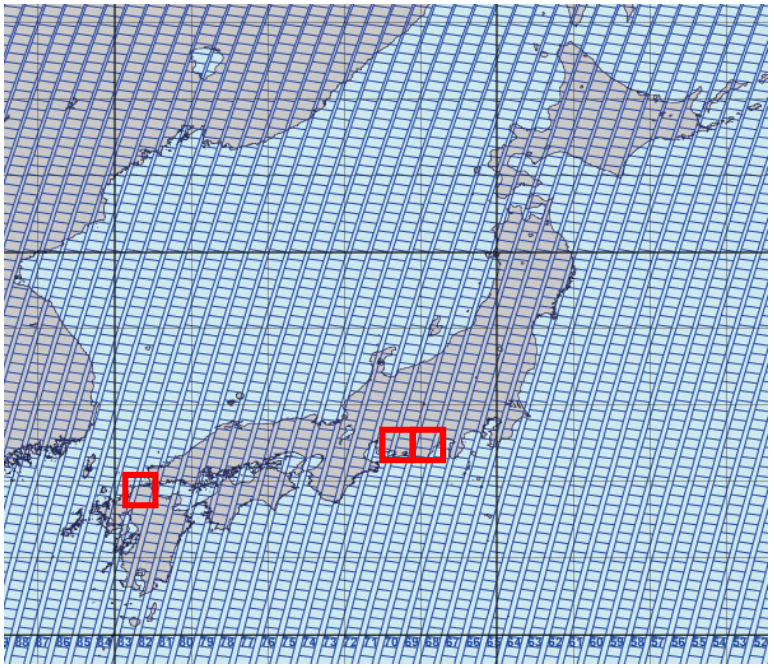
Evaluation of geometric accuracy

- Used geometric models
  - ➢ Generic Pushbroom sensor model
  - ➢ Orientation parameters were calculated by conventional triangulation method using some GCPs

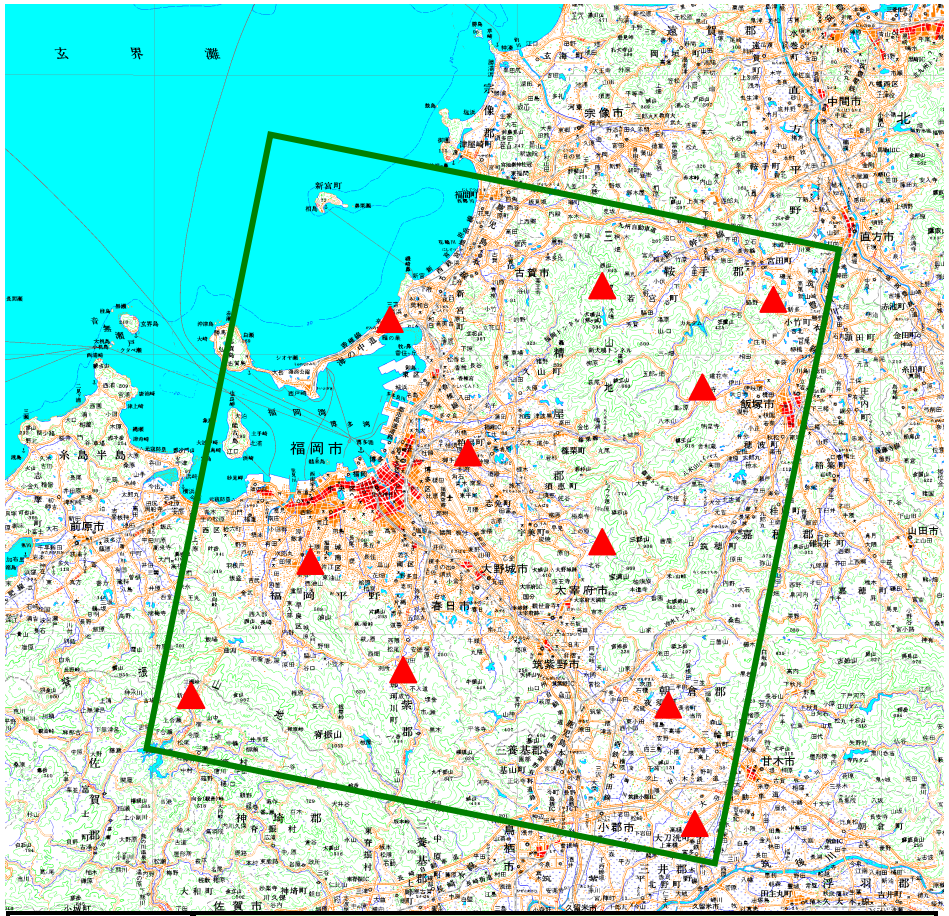
- Method
  - ➢ Comparison using 30～50 GCPs as check points

- Test areas and data

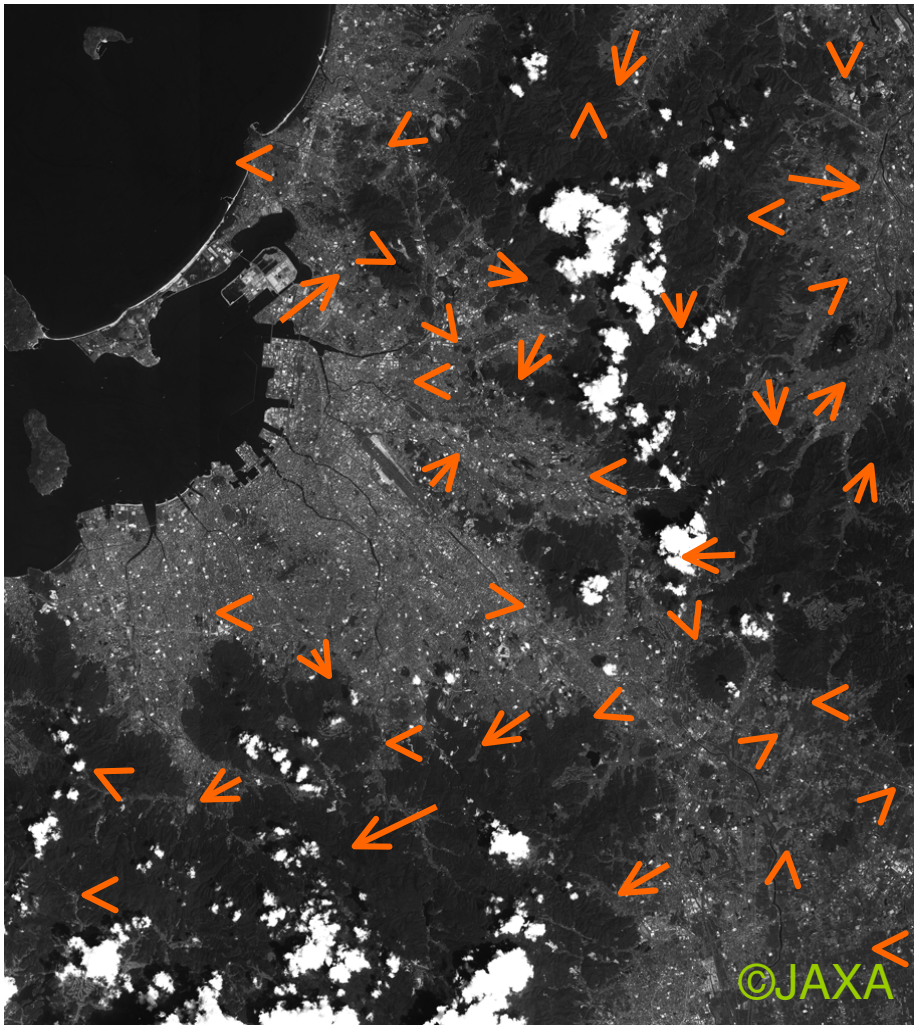
Area	Data		
	Sensor	Level	DATE
Okazaki	PRISM	1B1	2006/6/20
Hamanako	PRISM	1B1	2006/8/5
Fukuoka	PRISM	1B1	2006/8/25



Fukuoka



	Error(m)			
	X	Y	Z	horizontal
Maximum	5.164	3.545	12.932	5.799
Average	1.188	1.068	3.698	1.742
Standard deviation	1.314	1.058	3.794	1.532



Horizontal error vector

10 m

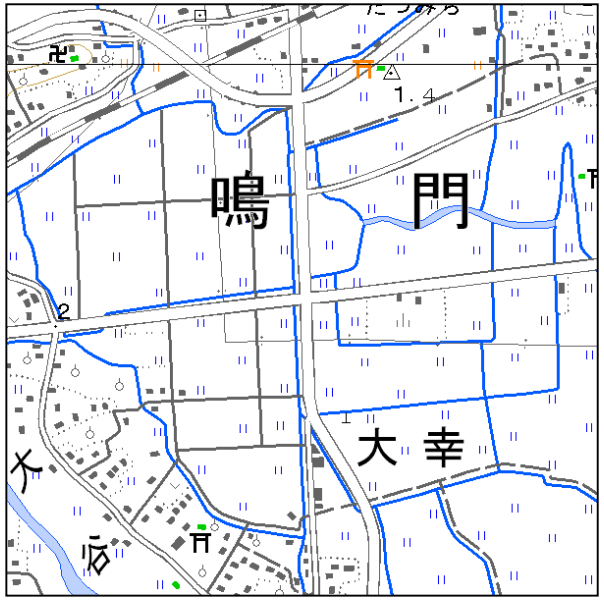
Image interpretation

- Image reading test
  - Identification of features included in 1/25,000 scale map
- On-site verification
  - An experiment of feature change extraction
  - Comparison of extracted changes with ground truth data

Reading test : Road(5.5～13m width)

PRISM
（Panchromatic）

PRISM-AVNIR2
（Pan sharpen）



Evaluation

Panchromatic	Pan sharpen	Stereoscopic images
○	○	

Evaluation of DSM generation

Test Aria

Fukuoka City

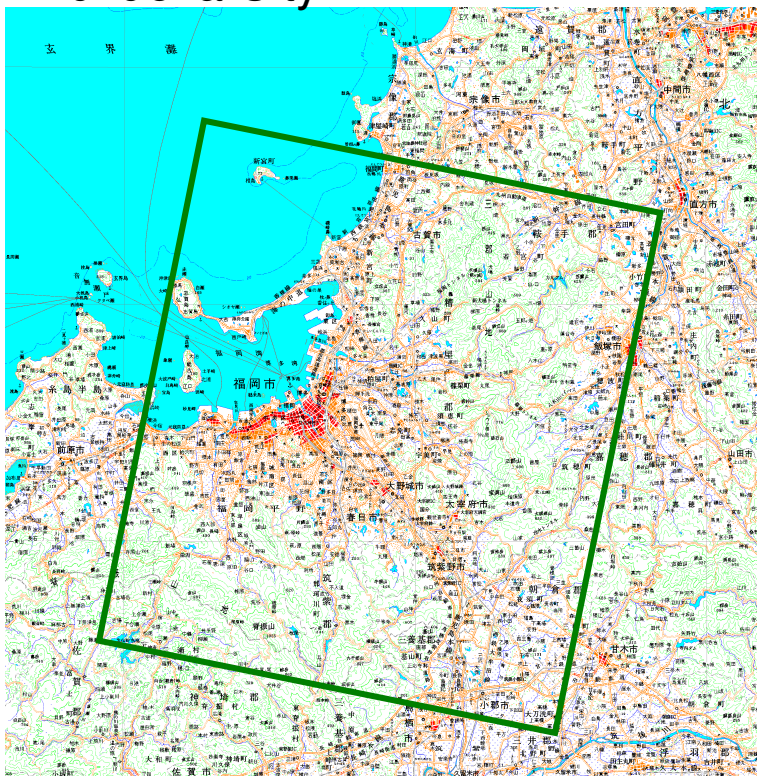
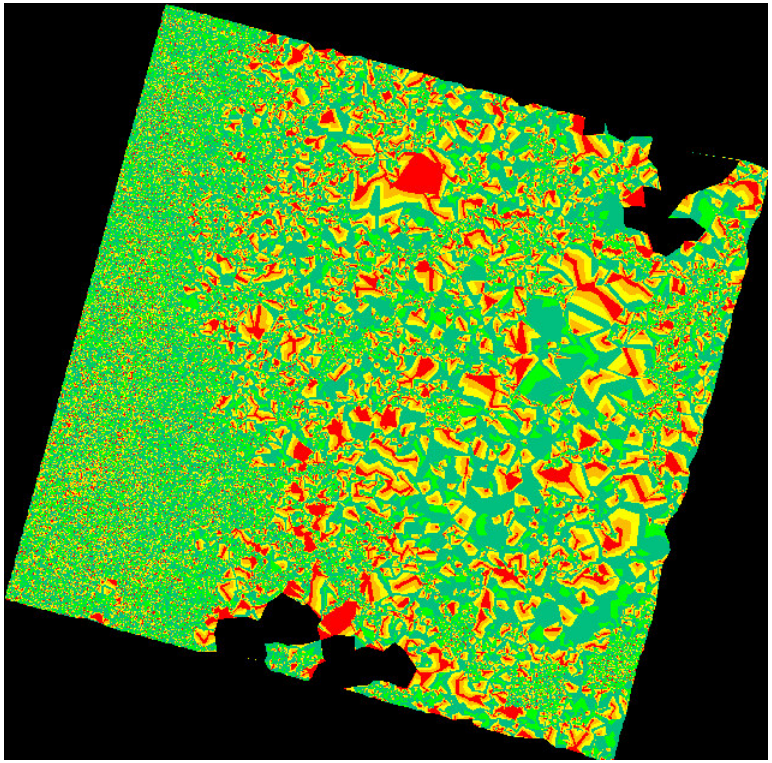


Image Specification

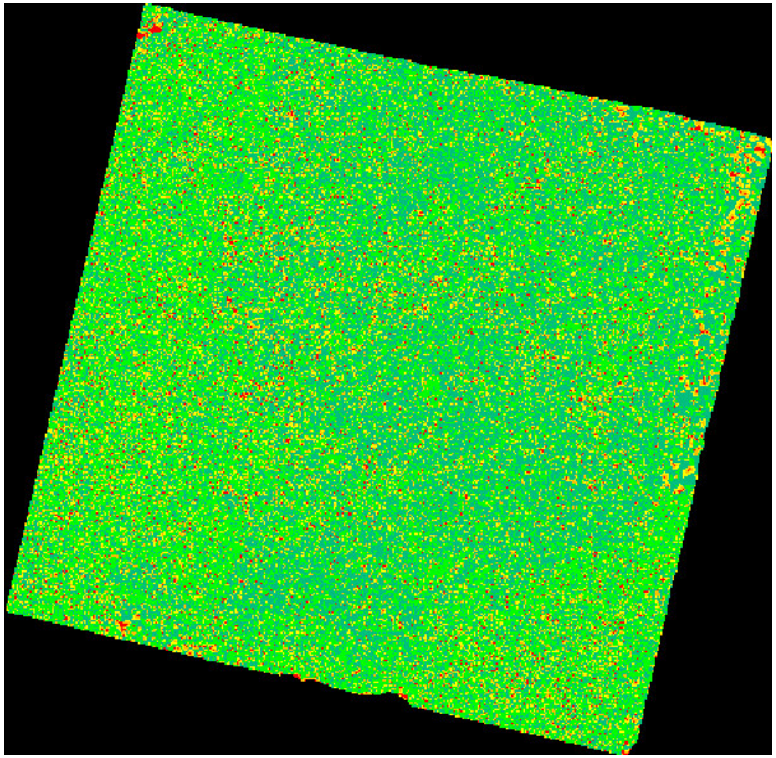
Sensor	PRISM
Processing le	1B1
Pointing angle (range)	-1.2°
Scenes used:	Forward,Nadir,Backward
Observation	2006.6.20
Scene size	35km × 35km

Effect of filtering

Before filtering

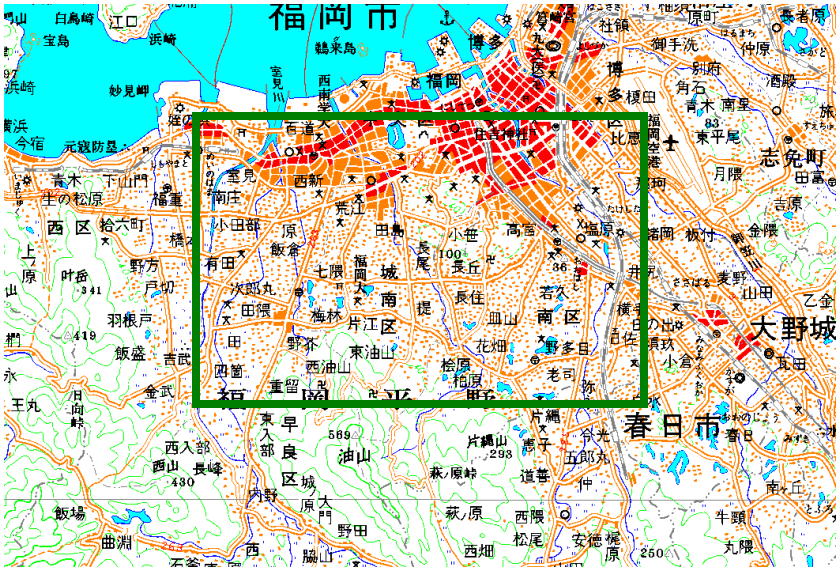


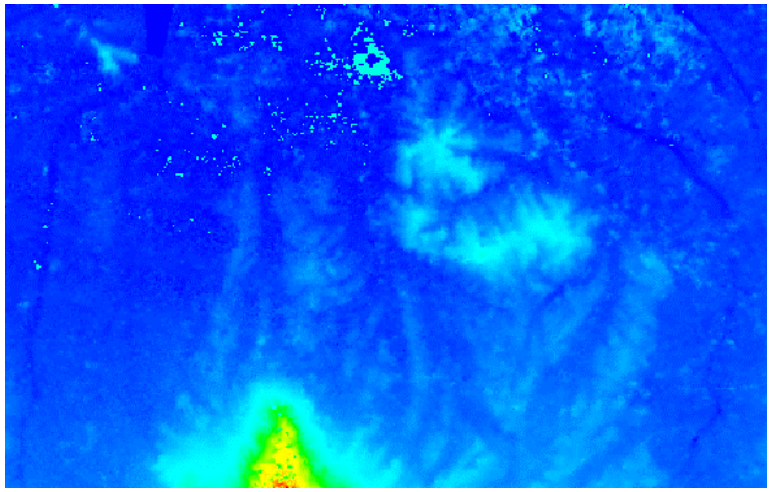
After filtering



Correlation factor	index	no filtering (%)	filtering (%)
1.00～0.85		17.4	39.6
0.85～0.70		40.5	40.5
0.70～0.50		17.8	10.4
0.50～		14.4	6.8
		9.9	2.7

Evaluation of DSM generation





"Daichi"/PRISM DSM

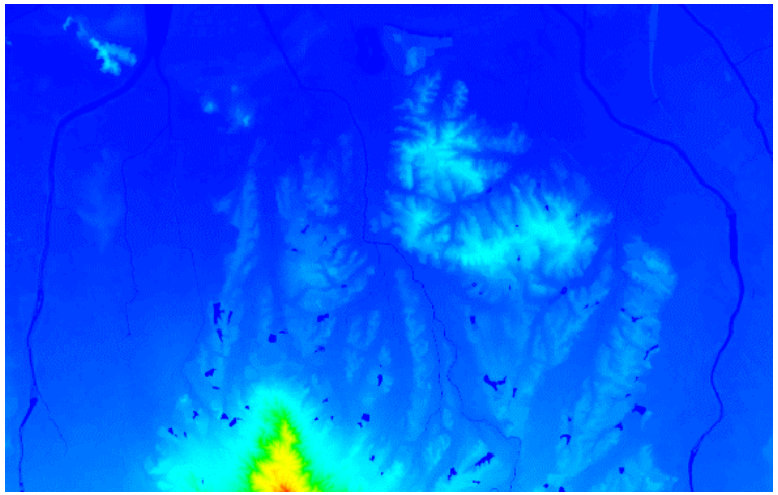
Errors (height) on reference points (98 pts.)

max	min	average	SD
13.6m	-8.7m	1.9m	4.9m

Discrepancies between "Daichi" DSM and Lidar DEM

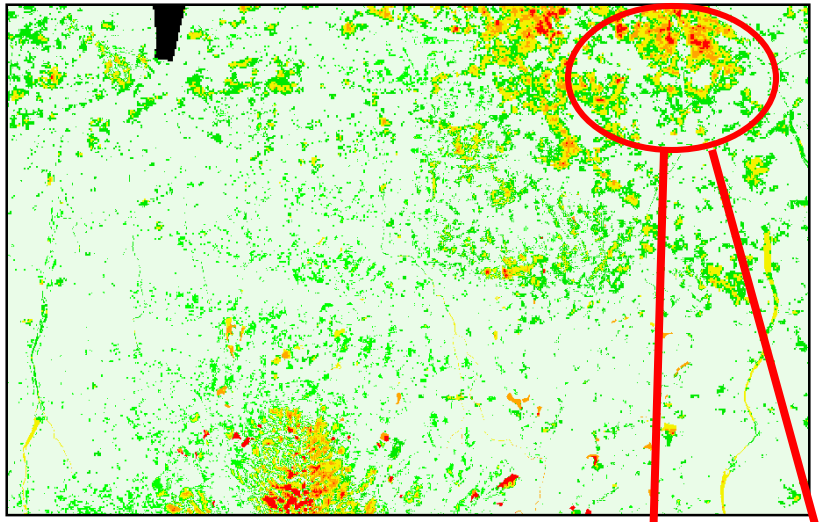
Height range : 0～359m Total grids : 3149304

max	min	average	SD
161.6m	-63.7m	-1.2m	6.1m

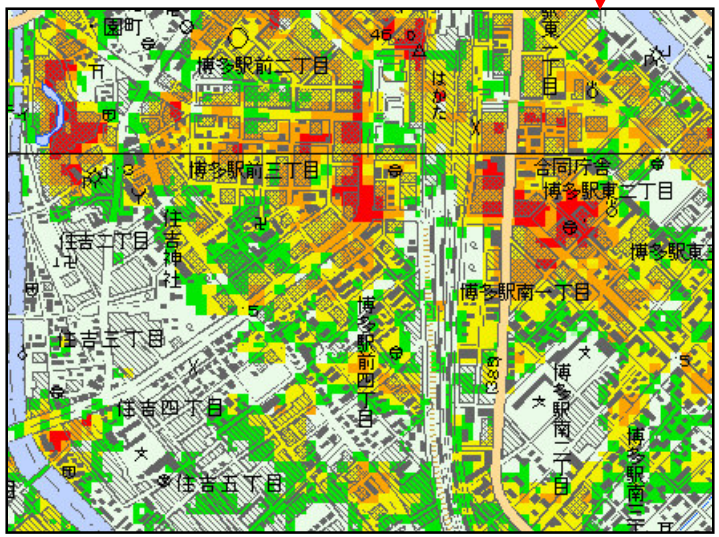


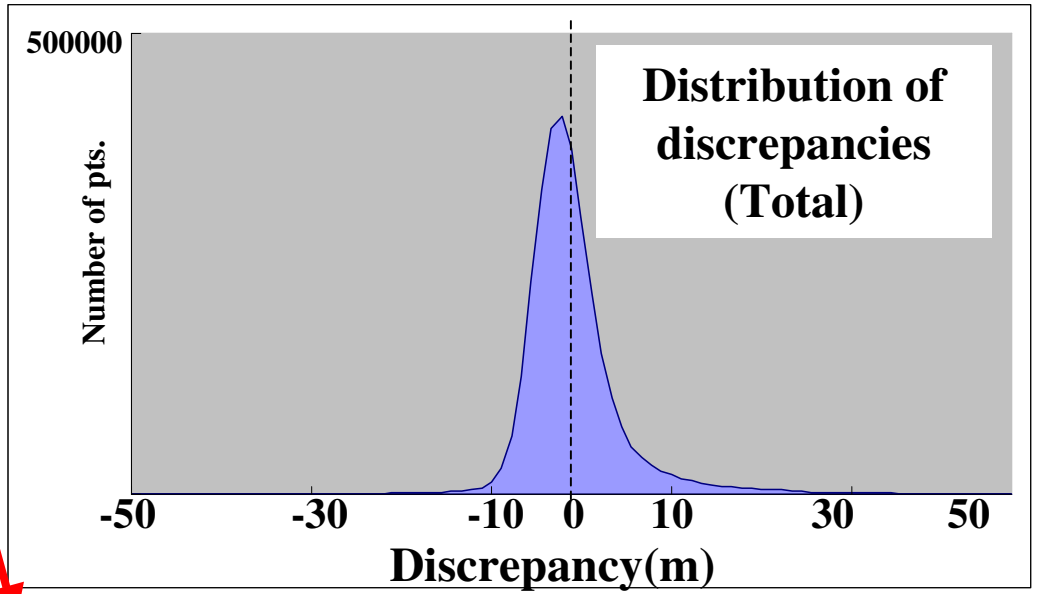
Lidar DEM

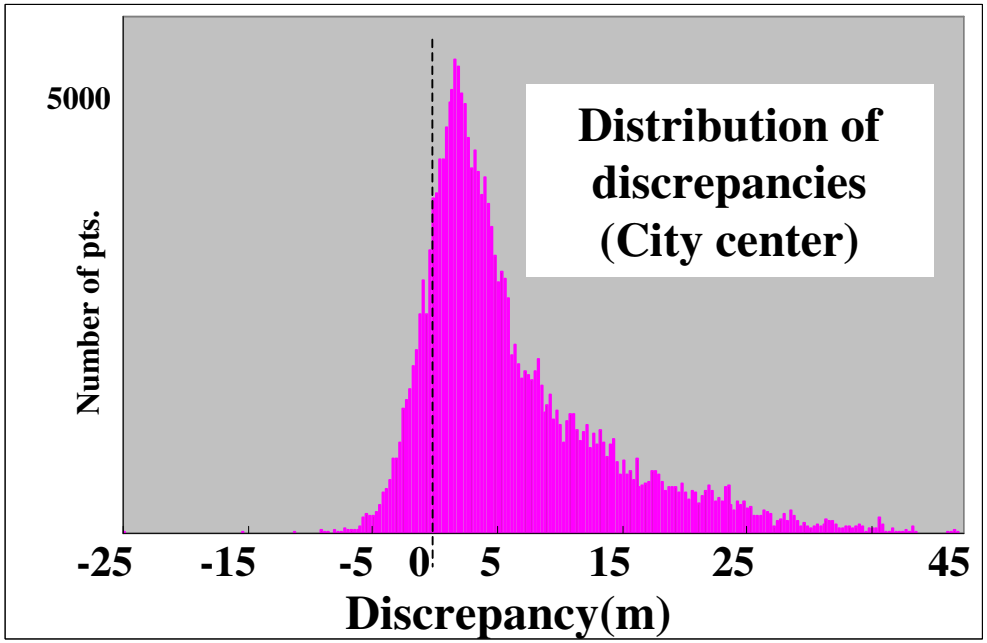
Evaluation of DSM generation



"Daichi" DSM-Lidar DEM







Conclusion

- High resolution satellite image with several GCPs has enough accuracy to make 25000 topographical map
- It is possible Daichi/PRISM image generate DSM automatically and constantly.