High-resolution Precipitation Observation Using Compact X-Band Weather Radar

2 models of Compact X-Band Doppler Weather Radar

January 5th , 2015
95th AMS Annual Meeting, Phoenix, Arizona
By FURUNO ELECTRIC CO.,LTD

Index

- 1. Introduction
- 2. Evaluations at a pin-point observation point
  - Evaluations and comparison of rainfall measurements between a radar and a rain gauge.
- 3. Evaluations on a basin basis
  - Evaluations and comparison of river stages between storm-water runoff simulation model and estimation by radar data.
- 4. Conclusions

Index

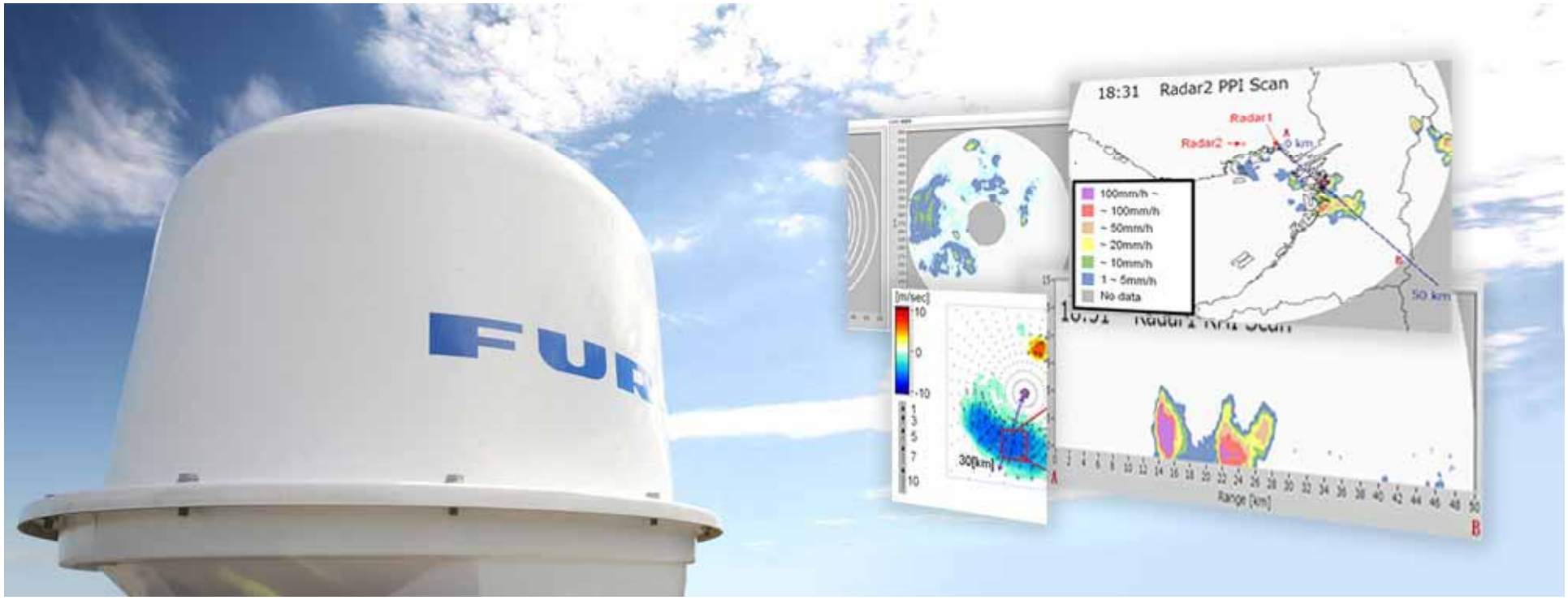
- 1. Introduction
- 2. Evaluations at a pin-point observation point
  - Evaluations and comparison of rainfall measurements between a radar and a rain gauge.
- 3. Evaluations on a basin basis
  - Evaluations and comparison of river stages between storm-water runoff simulation model and estimation by radar data.
- 4. Conclusions

Backgrounds and motivations

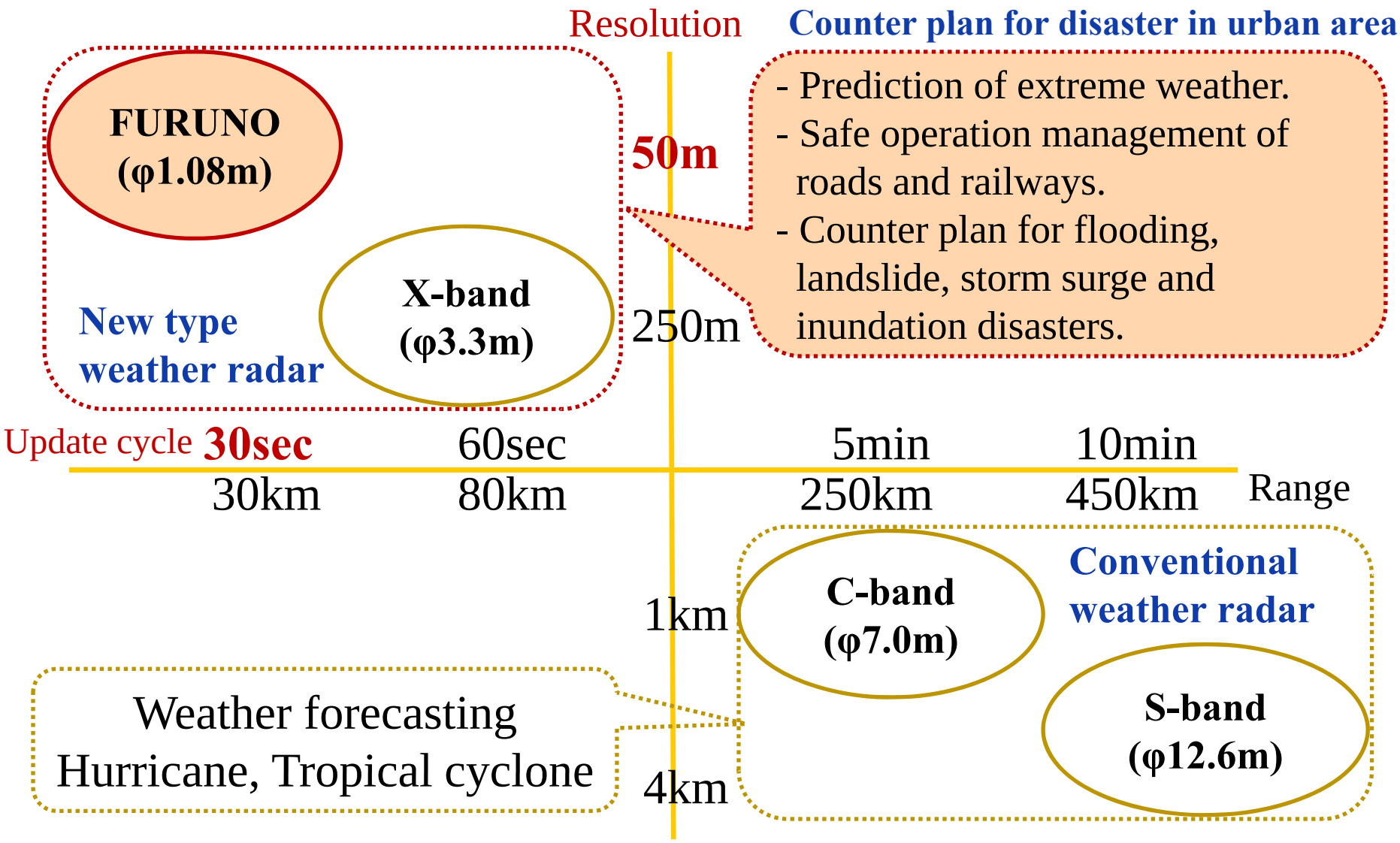
- These days there are soaring numbers of extreme weathers in the world such as torrential rain, tornadoes and so on.
- Needs for observation of precipitation with high spatial and temporal resolutions are growing higher and higher.

Our solutions

- Dual Polarimetric Doppler Weather Radar to contribute to prediction of occurrence of rainstorms.
- High precision 3D meteorological monitoring.
- Classified as one of the smallest and lightest Weather Radar available in market. (as of June 2013)



Dual Polarimetric Radar System



φ : Radome diameter

The main specifications

Items	Specifications
Operating Frequency	9 GHz band
Beam Width	2.7 degrees (both horizontal and vertical beams)
Peak Output Power	100 W (solid-state, both horizontal and vertical beams)
Antenna Rotation Speed	16 rpm max. (adjustable)
Maximum Range	Approx. 30 km
Scan Modes	PPI, CAPPI, RHI
Communication Port	LAN 100Base-TX x 1 port
Power Supply	100-240 VAC, single phase, 50/60 Hz
Power Consumption	650 W max.
Radome Dimensions	Diameter 1,086 mm x height 1,024 mm
Weight	Approx. 65 kg


CSU-CHILL, Colorado


Gent, Belgium


Kagoshima, Japan

Index

- 1. Introduction
- 2. Evaluations at a pin-point observation point
  - Evaluations and comparison of rainfall measurements between a radar and a rain gauge.
- 3. Evaluations on a basin basis
  - Evaluations and comparison of river stages between storm-water runoff simulation model and estimation by radar data.
- 4. Conclusions

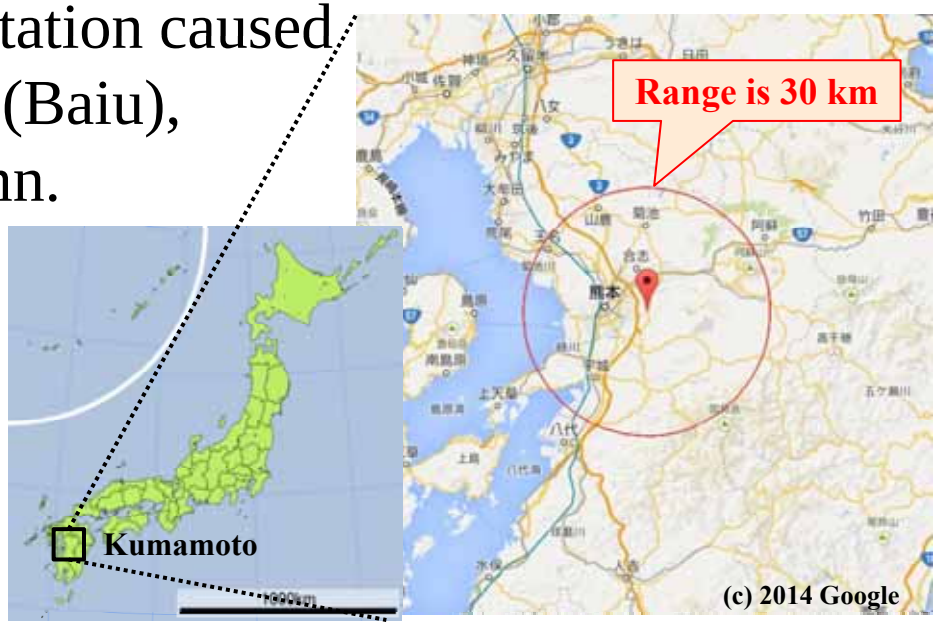
Place and cases to be studied

Place：Kumamoto, Japan

Target：continuously heavy precipitation caused by linear rainbands in rainy season (Baiu), and other cases in spring and autumn.

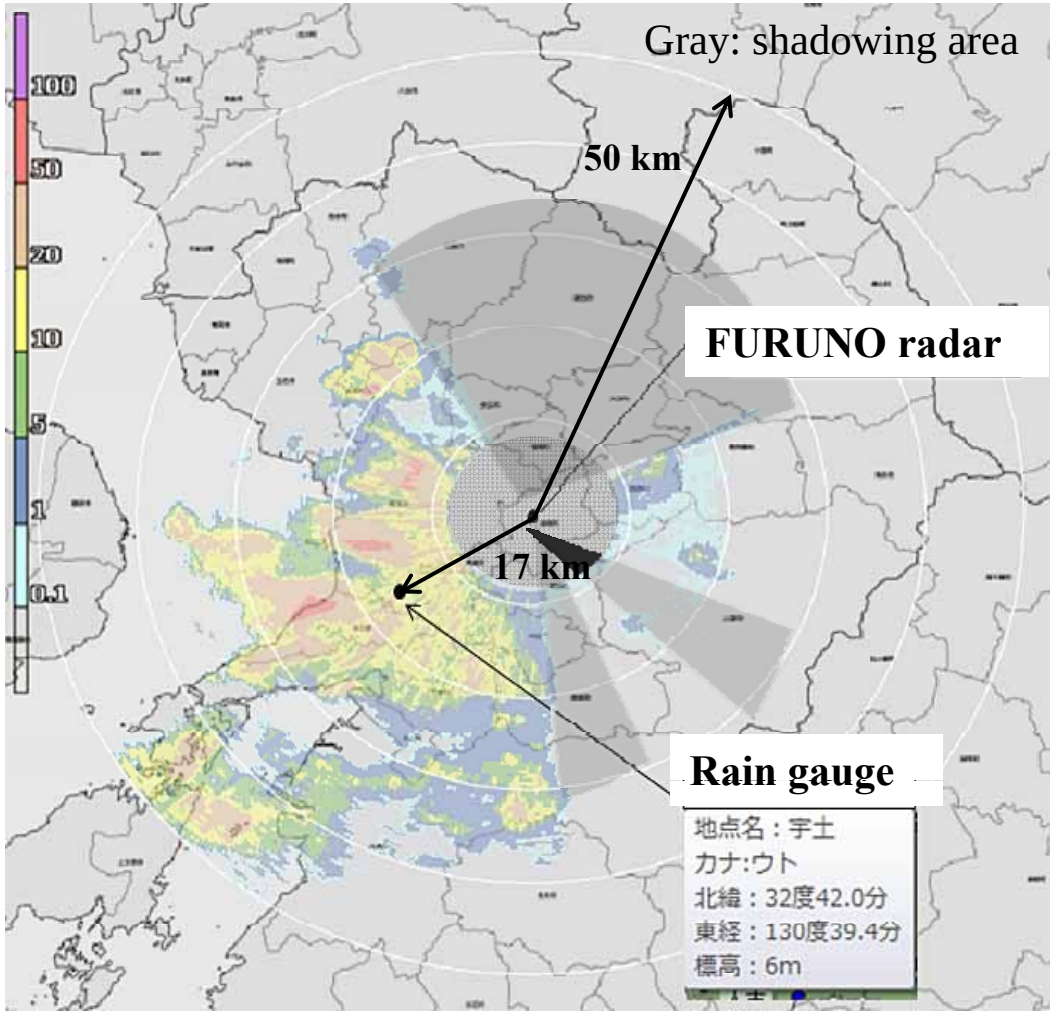
Cases:

(1) 3, 6, 7, July, 2014 ：rainy season
(2) 21, 22, 27, June, 2014 ：rainy season
(3) 29 March, 2014
(4) 24, 25 October, 2013



Radar and rain gauge to be compared

- Comparing observed precipitation by radar with observed precipitation of the rain gauge.



FURUNO radar :
Elevation : 4.0 deg

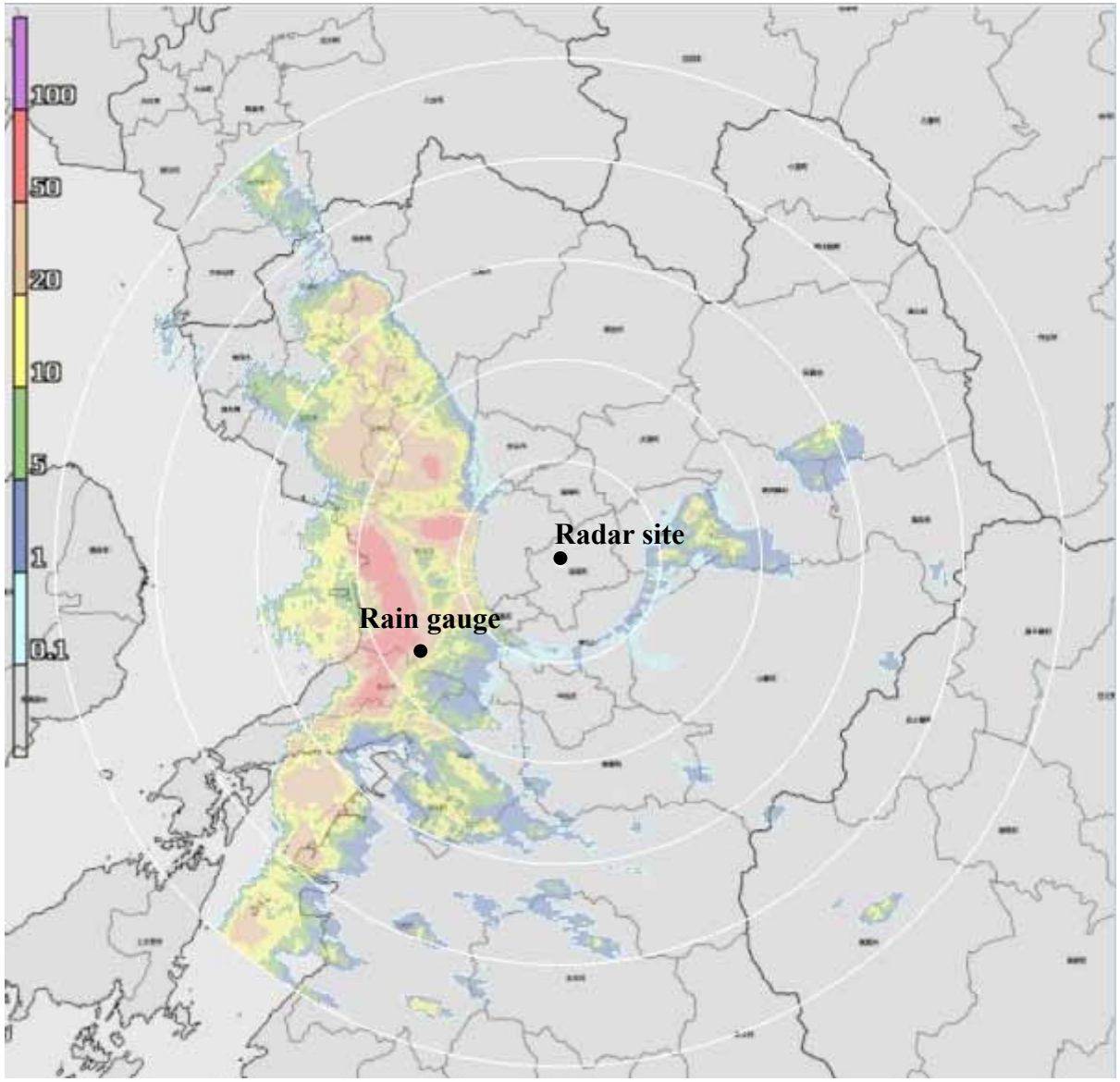
Radar precipitation observed by every 1 min is accumulated during 10 min and compared with observed precipitation of the rain gauge.

Rain gauge :
Uto, Kumamoto,

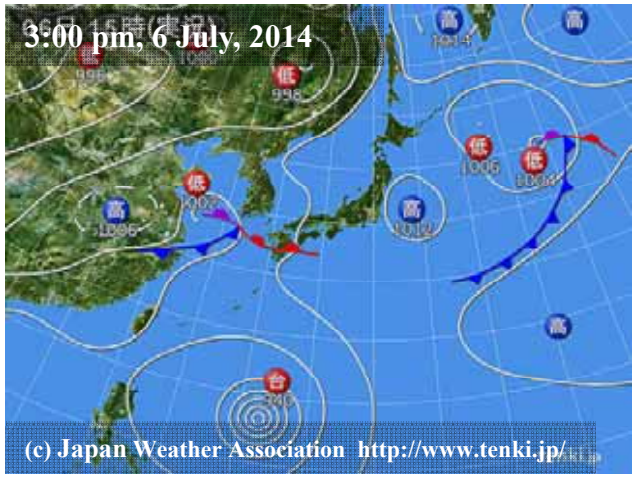
Lat: 32 deg 42.0 min
Lon: 130 deg 39.4 min
17 km away from the radar

Used the map of The Geospatial Information Authority of Japan Digital Japan Portal Web Site.

PPI display image of radar : case 1

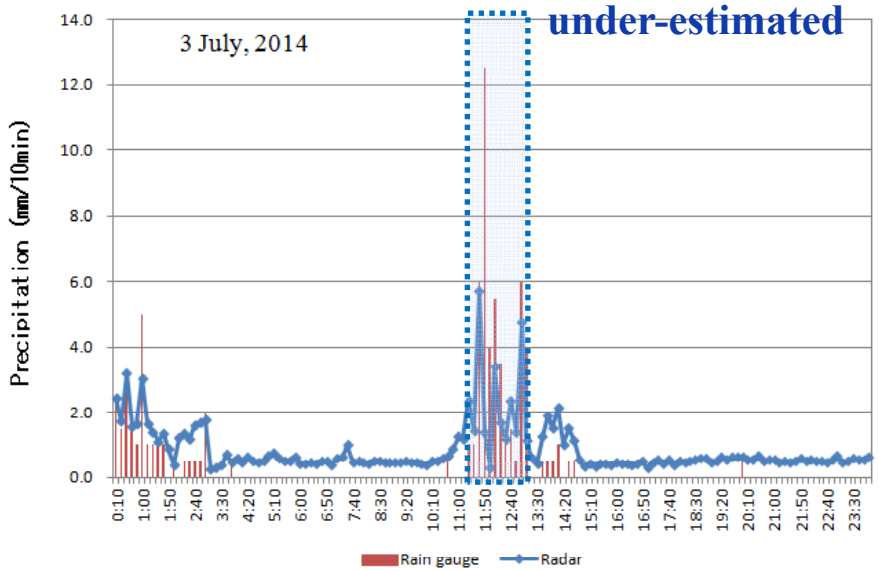


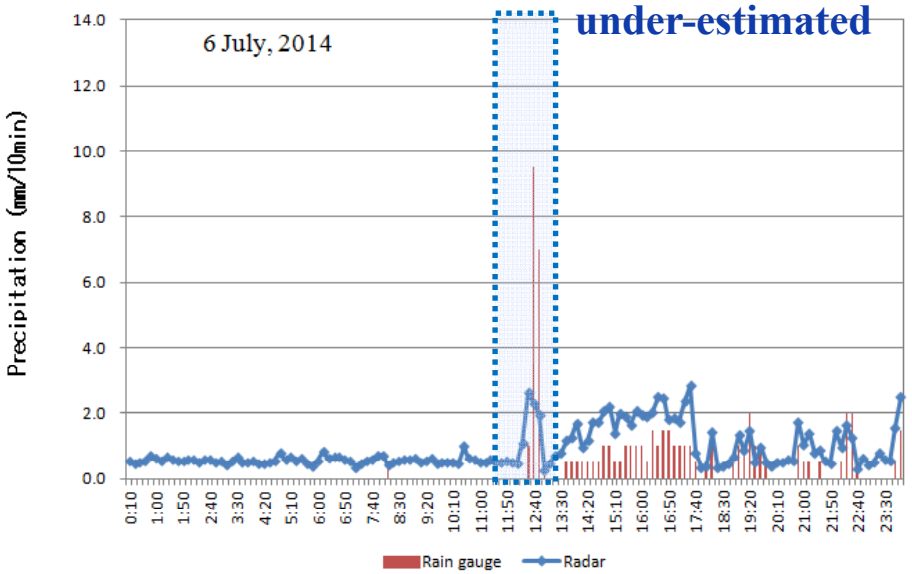
Case 1:
12:30 pm, 6 July, 2014
Case of rainy season

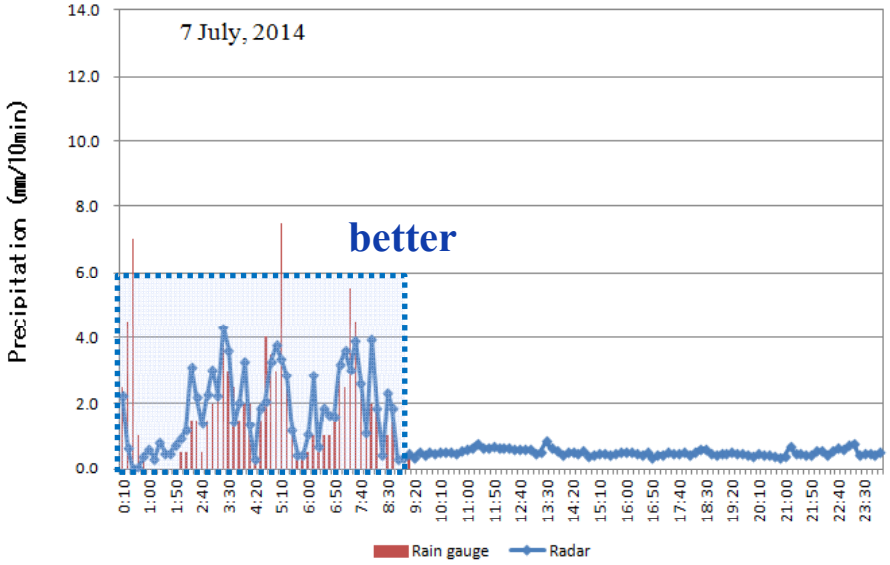


Used the map of The Geospatial Information Authority of Japan
Digital Japan Portal Web Site.

Results : case 1

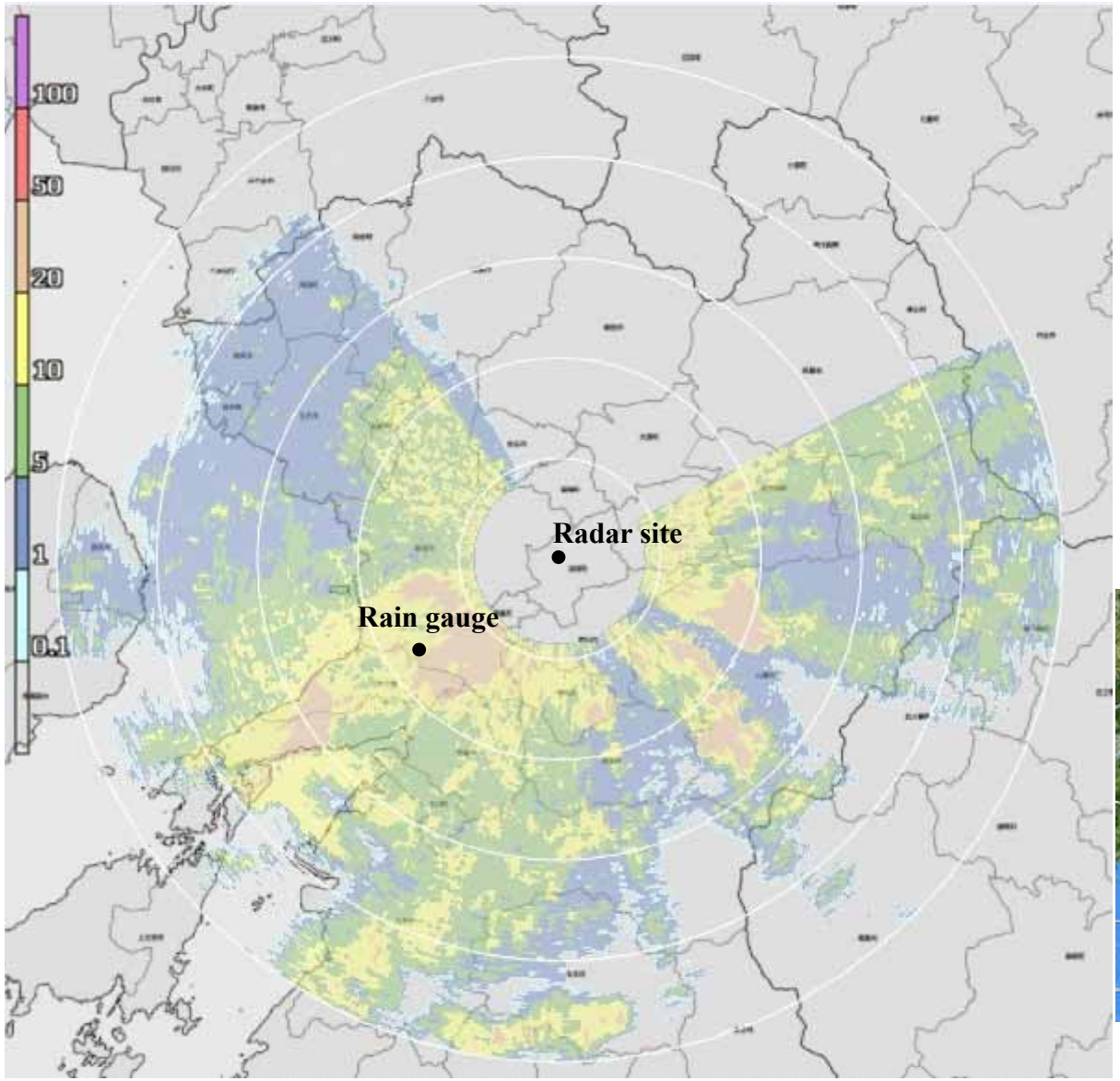




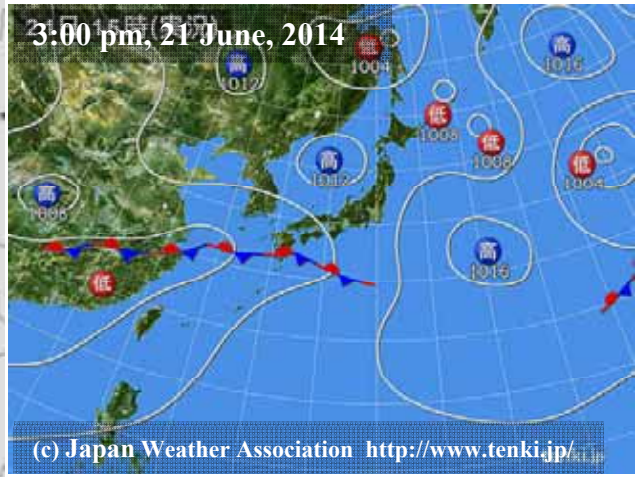


Case 1:
> 4 mm/10min : under-estimated
2-4 mm/10min : better

PPI display image of radar : case 2

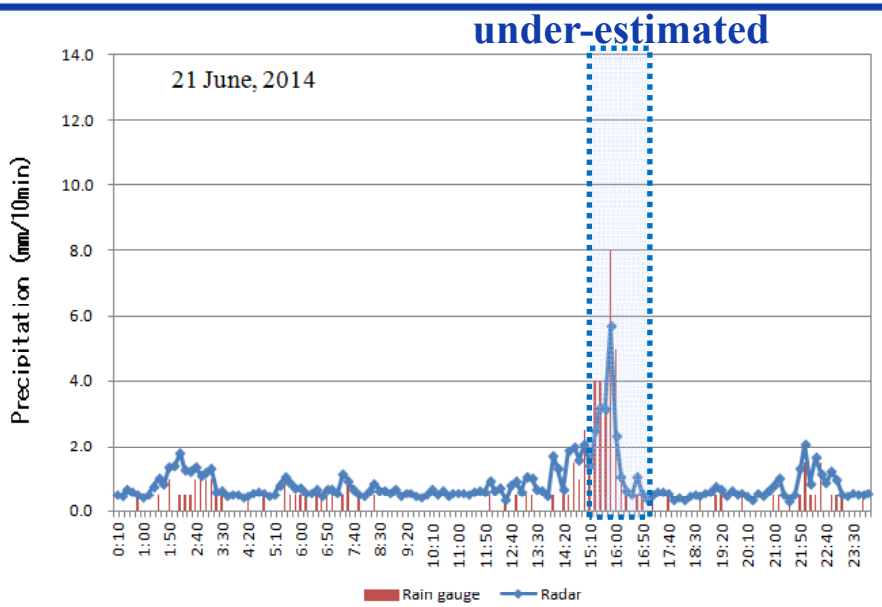


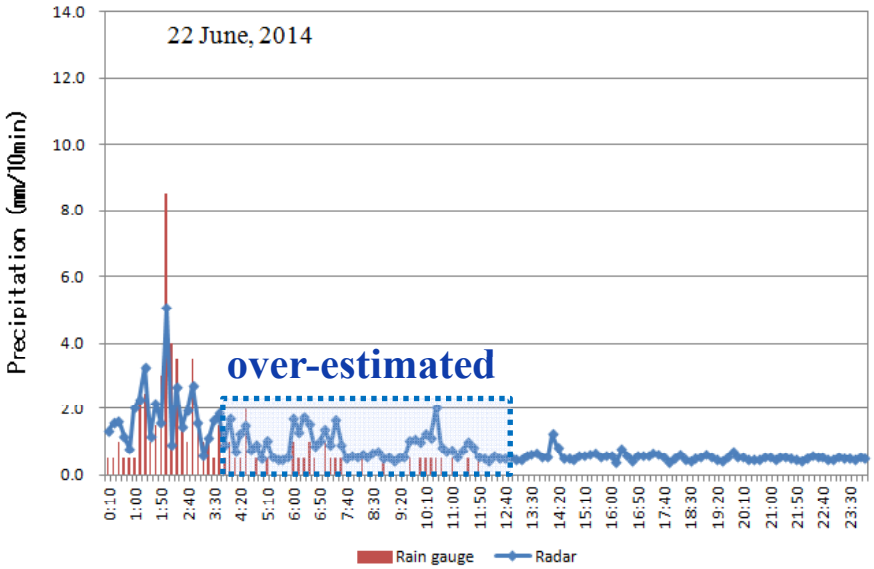
Case 2:
3:30 pm, 21 June, 2014
Case of rainy season

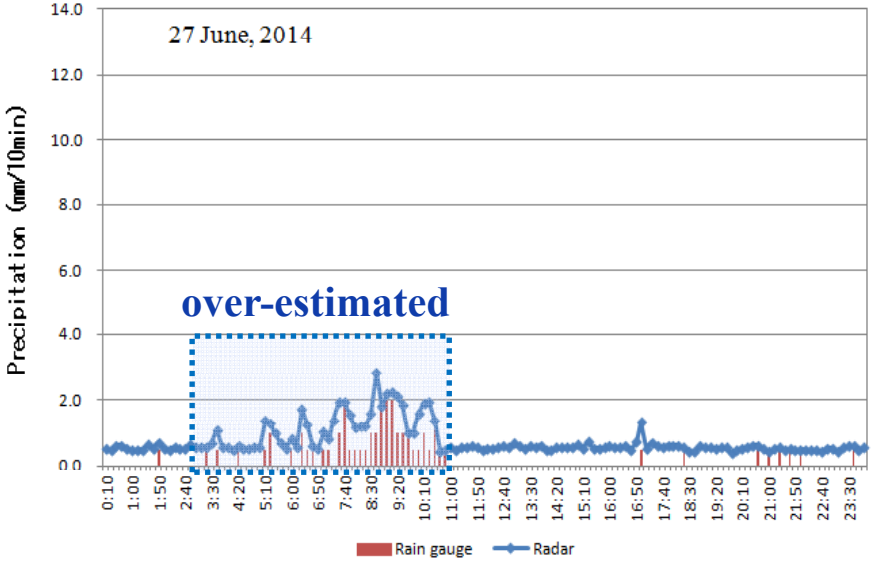


Used the map of The Geospatial Information Authority of Japan
Digital Japan Portal Web Site.

Results : case 2





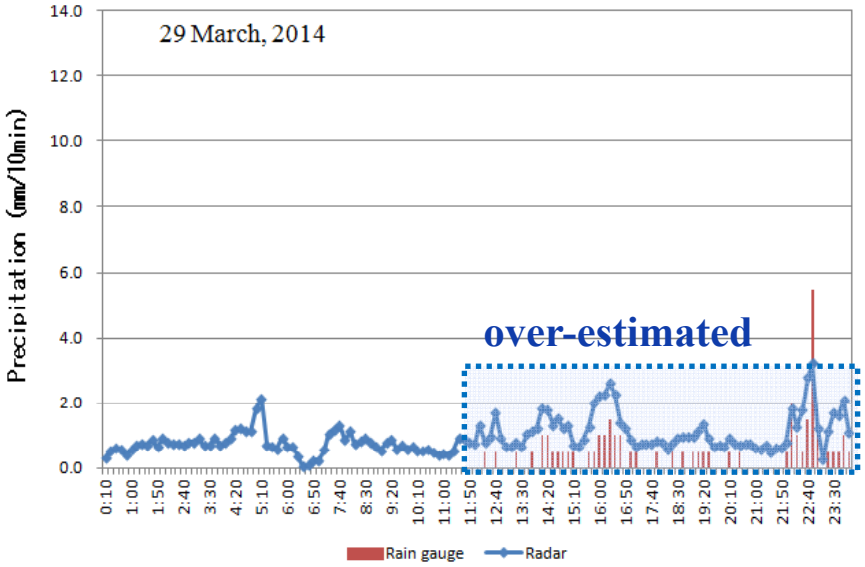


Case 2:

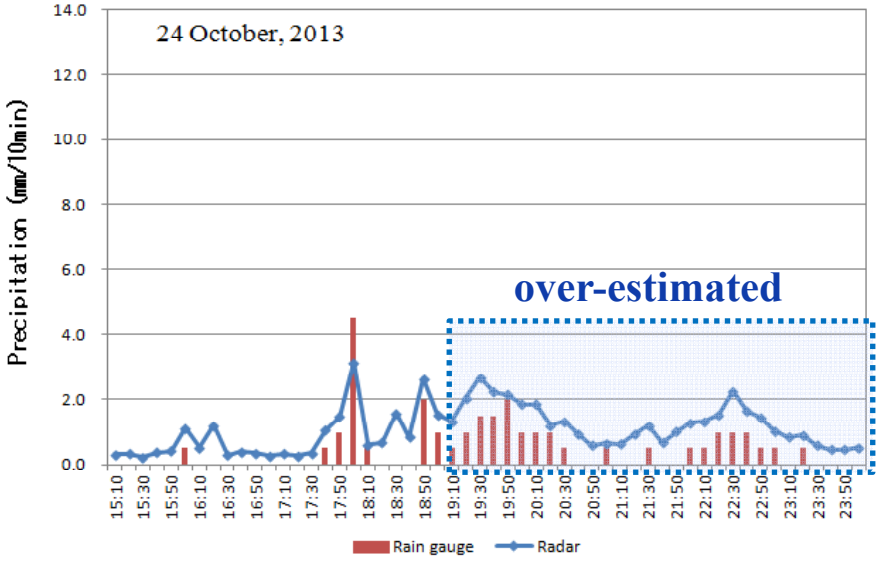
> 4 mm/10min : under-estimated

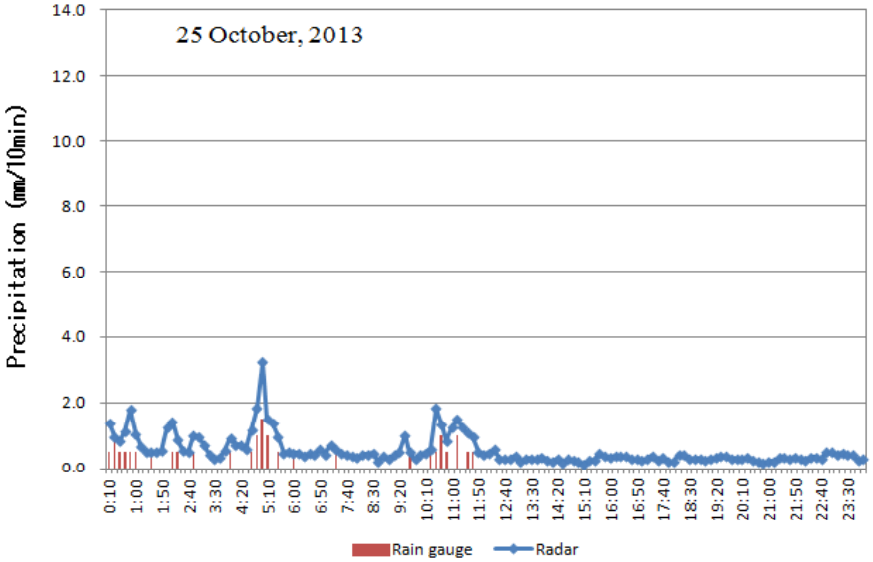
< 2 mm/10min : over-estimated

Results : case 3, 4



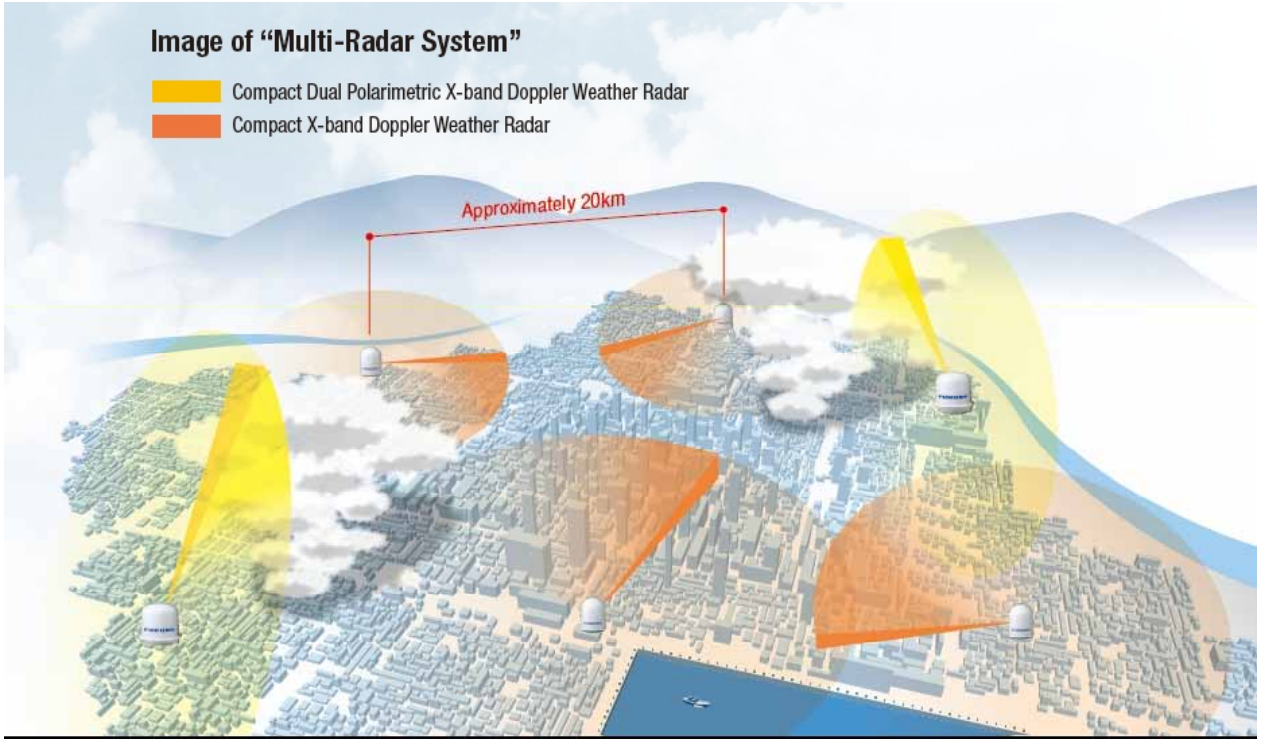
Case 3, 4:
< 2 mm/10min : over-estimated





Evaluations at a pin-point observation point

- Amount of precipitation is more than 4 mm/10min : under-estimated
  - Because of signal attenuation due to heavy rain.
  - Multi-radar System could cover the signal attenuation effectively by arranging each radar system in optimal positions.
- Amount of precipitation is less than 2 mm/10min : over-estimated
  - Additional fine tuning for QPE parameters might be necessary.
  - Possibly due to error of the rain gauge.

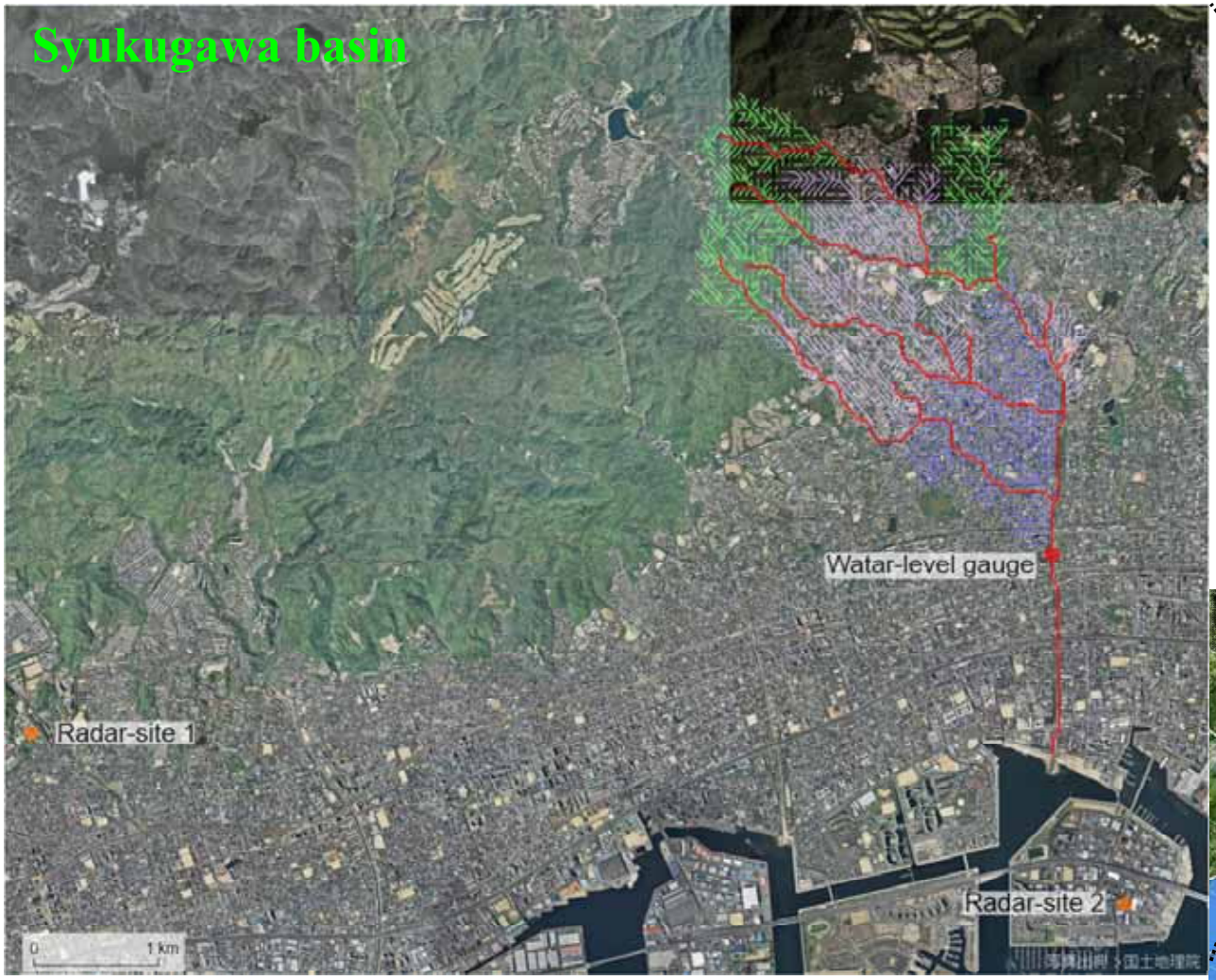


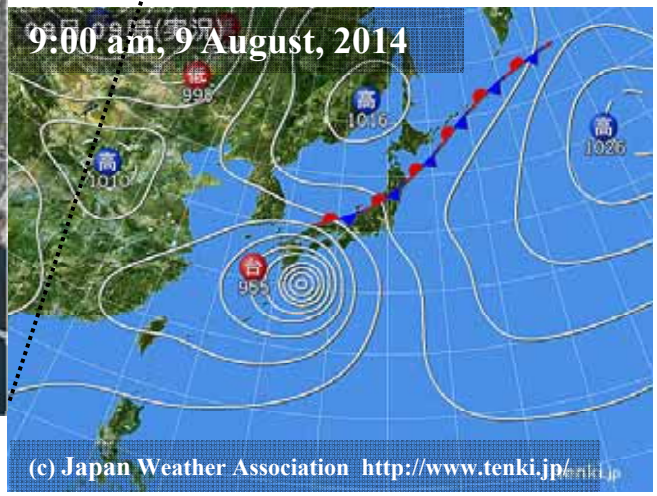
Index

- 1. Introduction
- 2. Evaluations at a pin-point observation point
  - Evaluations and comparison of rainfall measurements between a radar and a rain gauge.
- 3. Evaluations on a basin basis
  - Evaluations and comparison of river stages between storm-water runoff simulation model and estimation by radar data.
- 4. Conclusions

Syukugawa basin and a weather condition

Time is local time (JST).



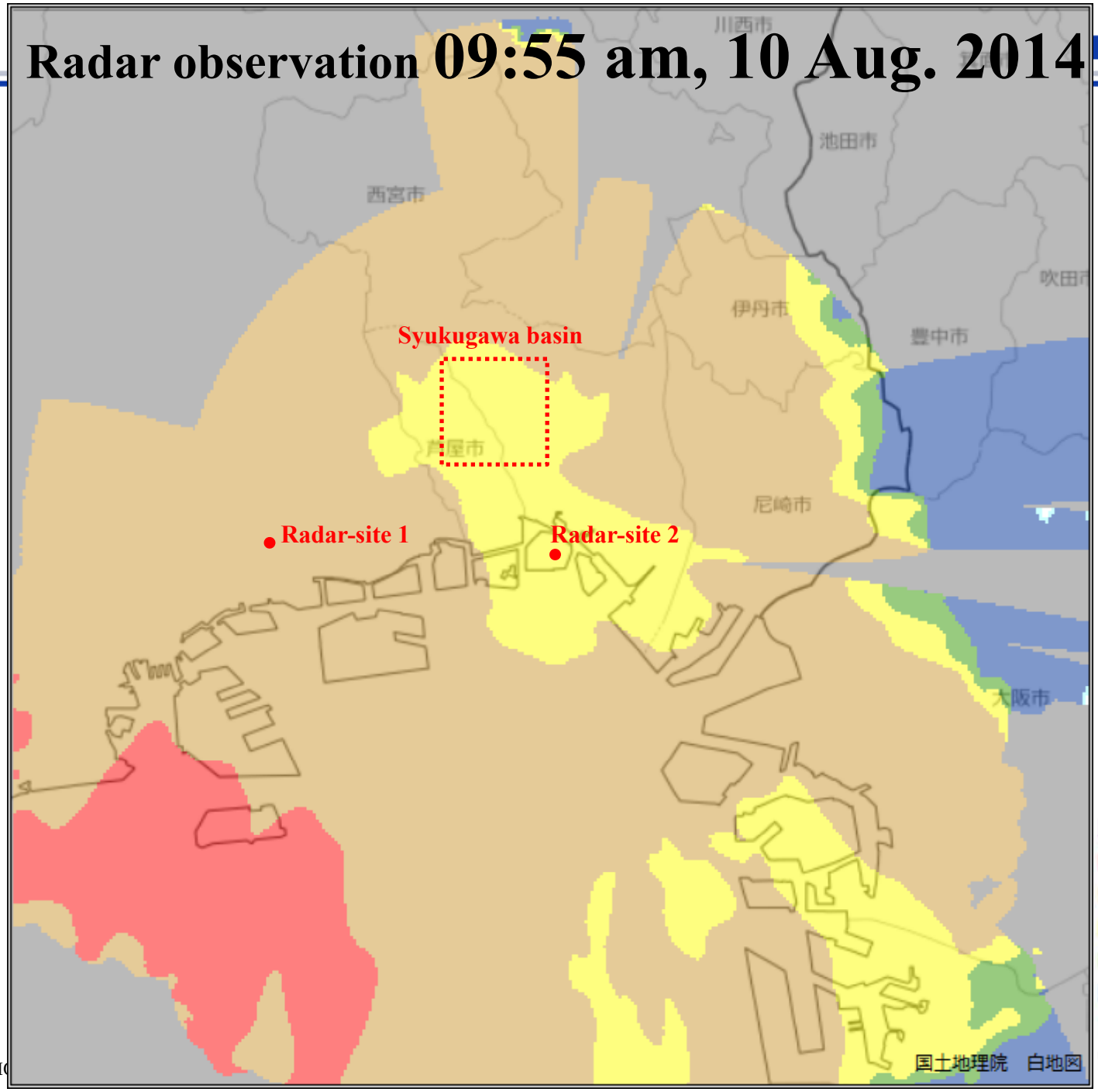


Used the map of The Geospatial Information Authority of Japan Digital Japan Portal Web Site.

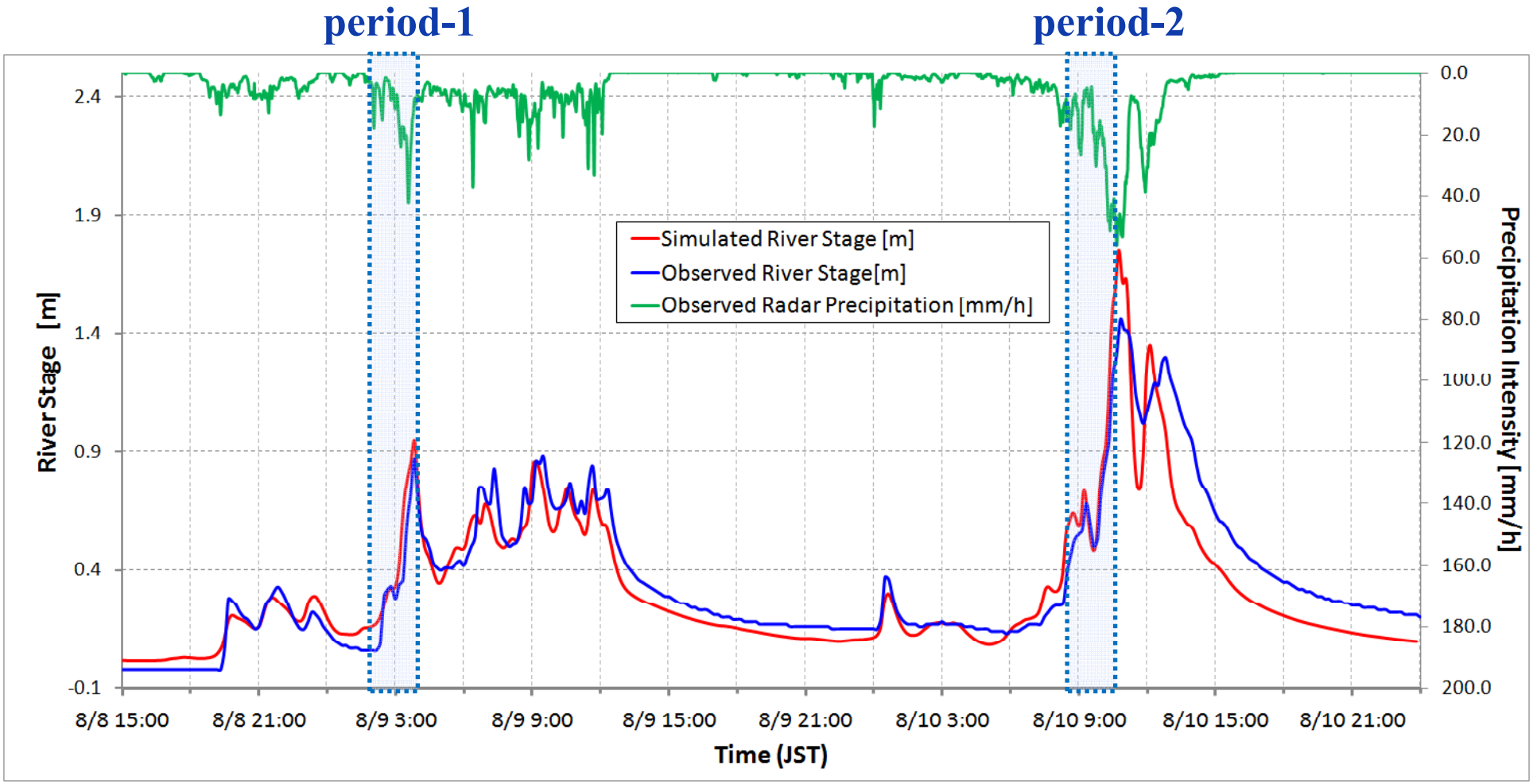
Used storm-water runoff simulation model, GeoHyMoS
http://hywr.kuciv.kyoto-u.ac.jp/index-e.html

Case: 8-10 August, 2014
The Typhoon No.11 is approaching to the west part of Japan.

Radar observation 09:55 am, 10 Aug. 2014

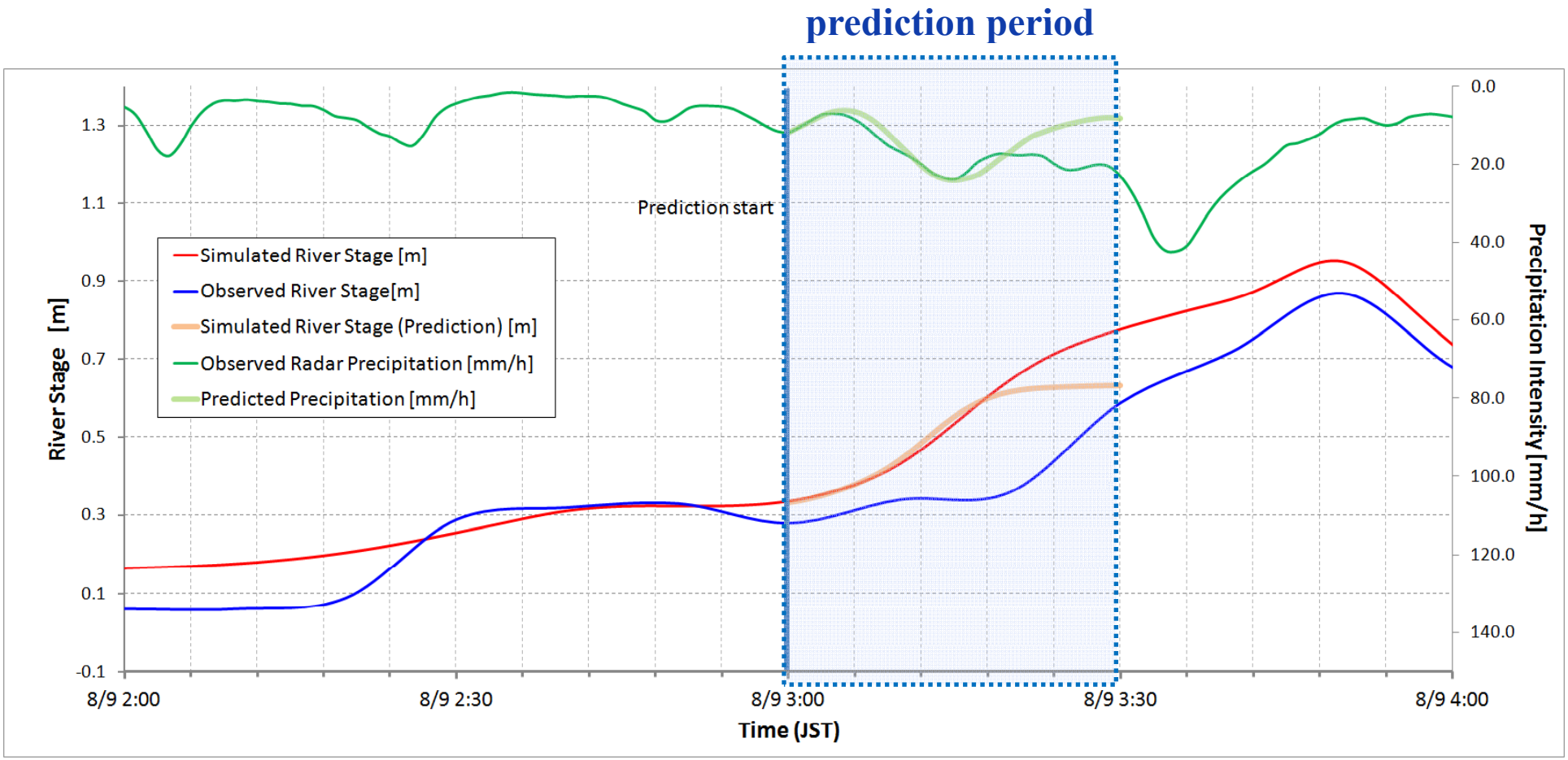


Comparison between simulation and observation (1/3)



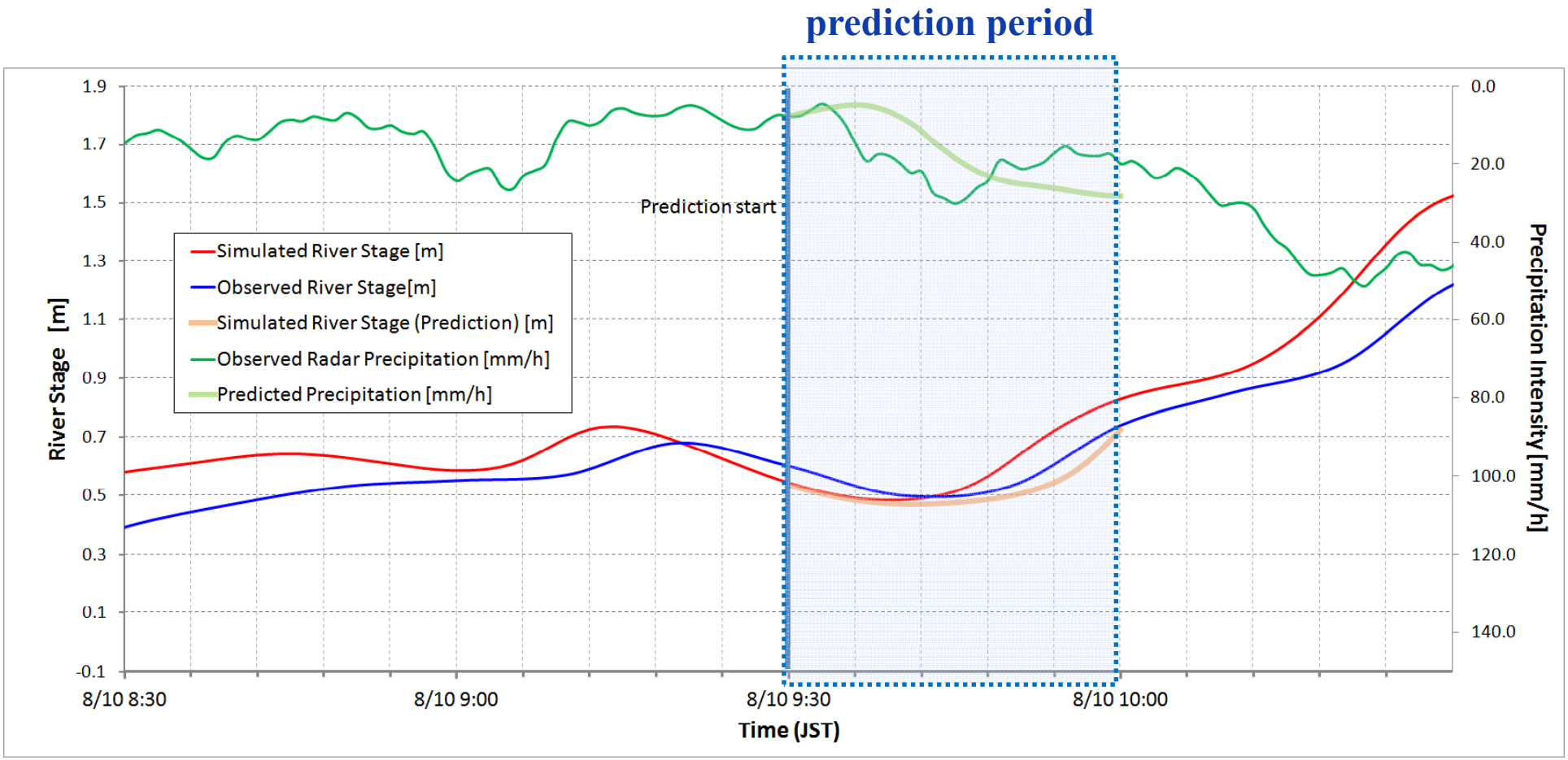
A comparison of river stage between simulation and observation at Syukugawa River.
The observation period starts from 3:00 pm, 8 Aug. and continues till 12:00 am, 11 Aug., 2014.

Comparison between simulation and observation (2/3)



Prediction of precipitation is started from 3:00 am 9 Aug. and calculated till 30 min forward. Precipitation predicted by advection model is input into the model and river stage is calculated in the same way as observed one.

Comparison between simulation and observation (3/3)



Prediction of precipitation is started from 9:30 am 10 Aug. and calculated till 30 min forward.

Index

- 1. Introduction
- 2. Evaluations at a pin-point observation point
  - Evaluations and comparison of rainfall measurements between a radar and a rain gauge.
- 3. Evaluations on a basin basis
  - Evaluations and comparison of river stages between storm-water runoff simulation model and estimation by radar data.
- 4. Conclusions

Conclusions (1/2)

- High spatial and temporal resolutions of Furuno's radar, 50 m and 30 sec respectively lead to these good results.
  - This topnotch feature is first developed in this industry.
- Evaluations at a pin-point observation point
  - Rainfall observed by FURUNO radar is compared with rainfall measured by a rain gauge at a pin-point observation point.
  - In case amount of precipitation is more than 4 mm/10min, radar observation tends to under-estimate the precipitation because of signal attenuation.
  - Multi-radar System should be installed to avoid problems of shadowing areas due to buildings or strong signal attenuation due to heavy rain.

Conclusions (2/2)

- Evaluations on a basin basis
  - The storm-water runoff simulation model, GeoHyMoS is applied to the calculation of river stage of Syukugawa River.
  - Sudden increase of river stage is reproduced successfully from the observed precipitation as well as predicted one.
  - In order to issue the early-warning of urban flood, combining the storm-water runoff simulation model and prediction data is one of the most effective methods.

Acknowledgement

- The research project is supervised by Professor Eiichi Nakakita of Kyoto University and Professor Satoru Oishi of Kobe University.
- Radar data of Kumamoto are provided by Japan Weather Association (JWA).

Thank you for your attention ! ☺

http://www.furuno.com