Session 2.2

GSMaP
- Integrated application with developer and user collaboration -

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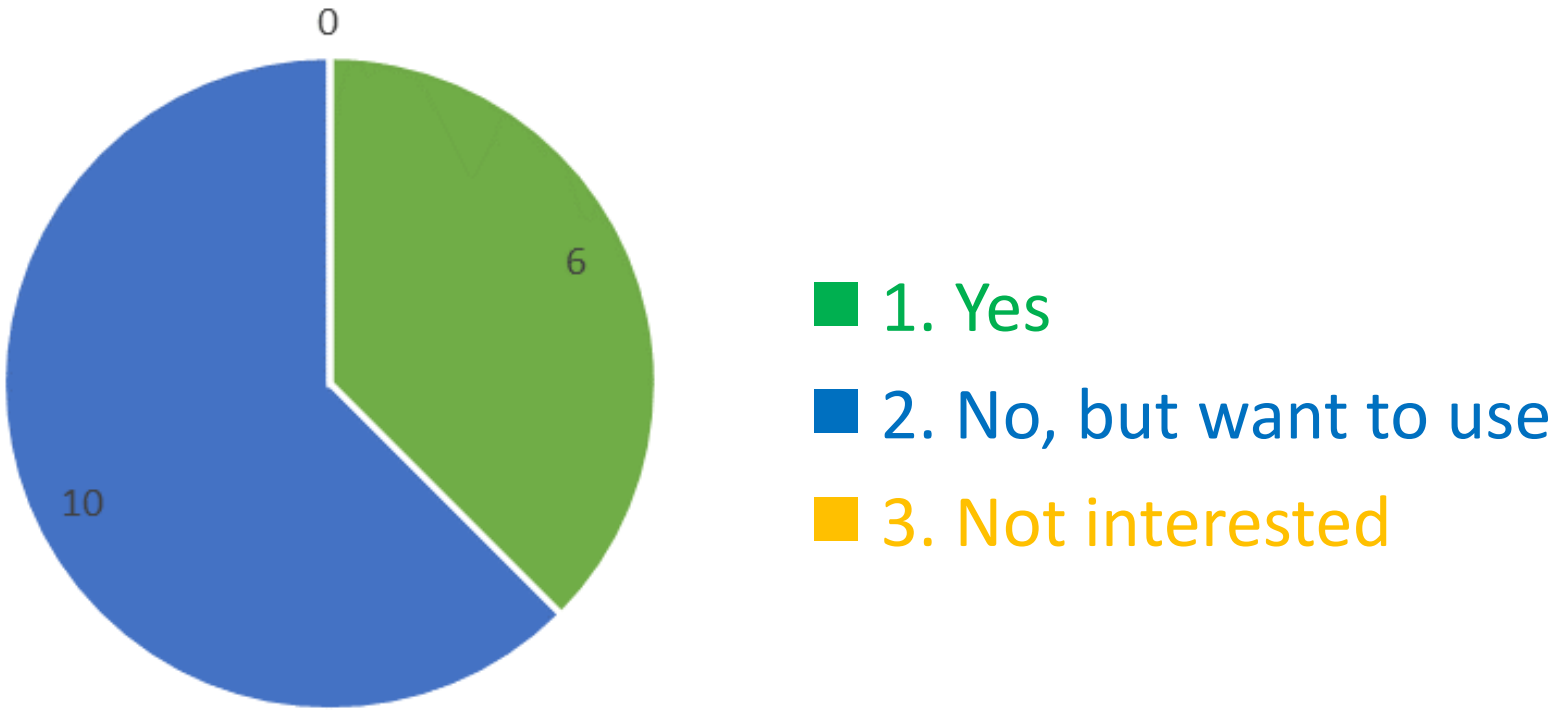
Japan Aerospace Exploration Agency (JAXA)

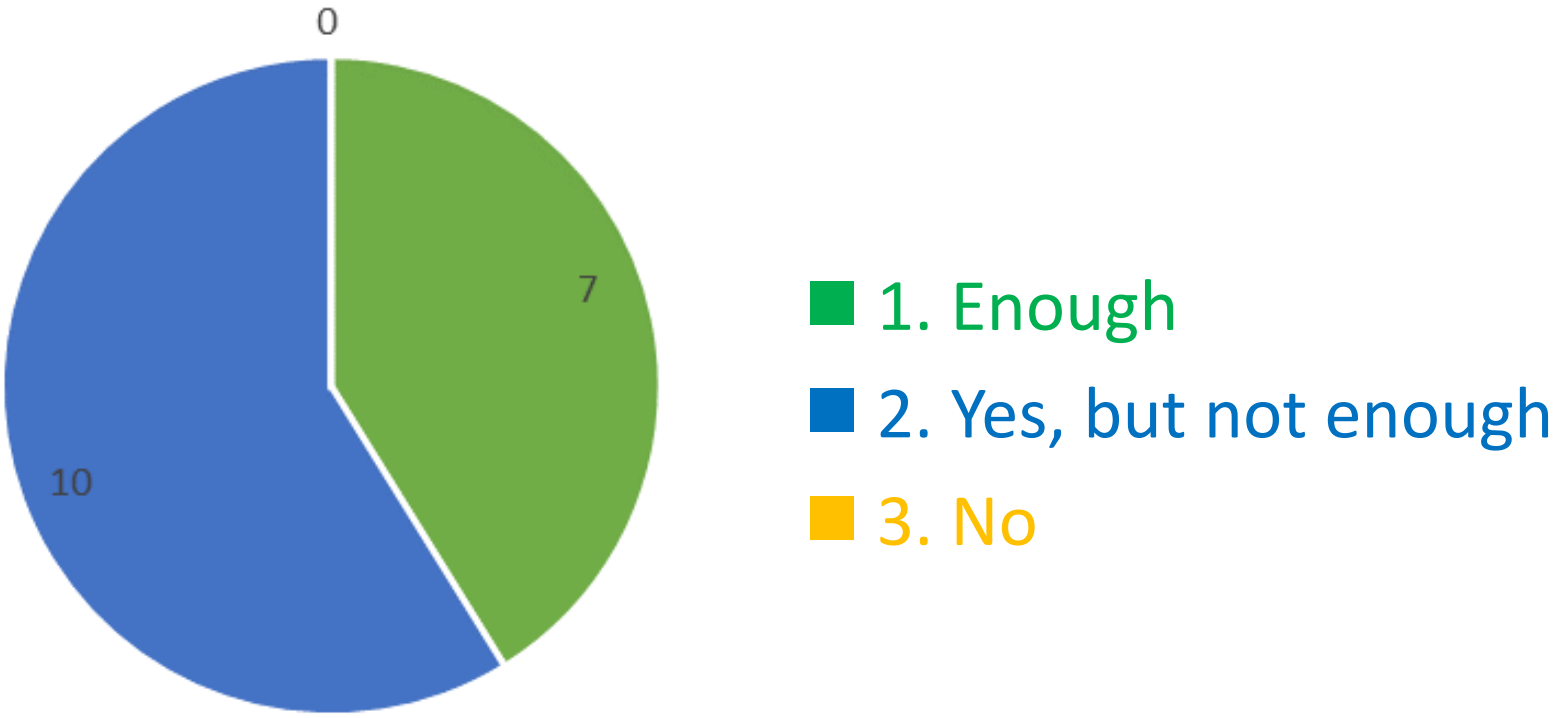
Q2.2-1 Does your organization use GSMaP (https://sharaku.eorc.jaxa.jp/GSMaP_NOW/index.htm)?



Presenter's comments

GSMaP can be a helpful tool to know precipitation over areas where the ground observation network is not sufficient. We're happy to know utilizations of 6 agencies, and positive responses from 10 agencies. This presentation can help you to know what the GSMaP is and the effective way to use the GSMaP data.

Q2.2-2 Do you have resources to use satellite observation data?



Presenter's comments

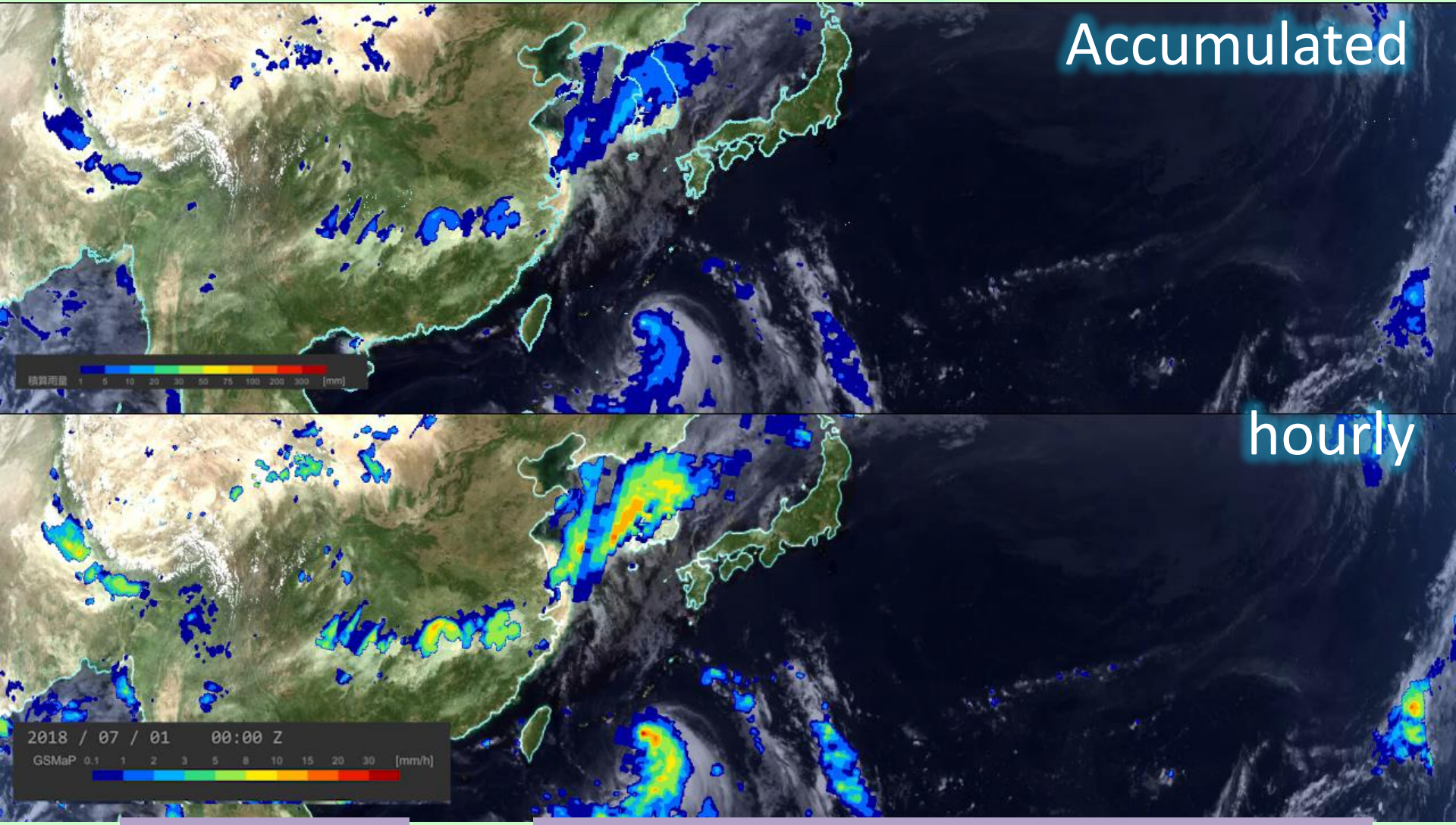
Wider utilizations of the satellite data with smaller resources will be desirable. Communications in the workshop may help you. An introductory book of the GSMaP utilization (https://www.eorc.jaxa.jp/GPM/doc/data_utilization/2016_jireishu_e.pdf) also may help you.

Satellite

Merits of Satellite

Global observation
with the same time interval

Heavy rainfall causing serious damage over western Japan in July 2018



White: Cloud

Color: Rainfall (Blue/weak to Red/Heavy)

Global Satellite Mapping of Precipitation

Dual-Frequency Precipitation Radar

Providing reference standard

GPM Microwave Imager

Gauge-adjusted

Global Precipitation Measurement Core satellite

Constellation satellites

Geostationary satellite

JMA Himawari, and other GEO satellites

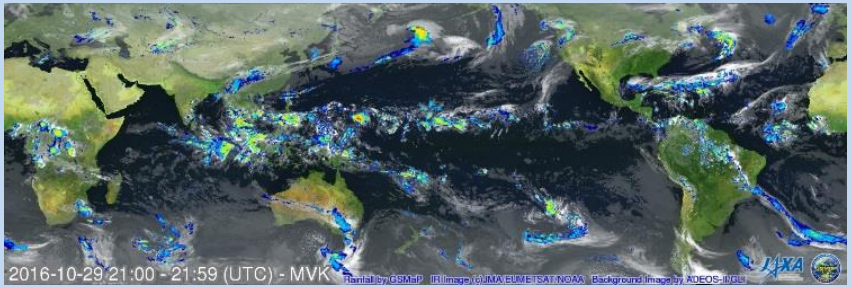
Precipitation Radar

Microwave Radiometer

IR Imager

Multi-satellite Rainfall Product: GSMaP

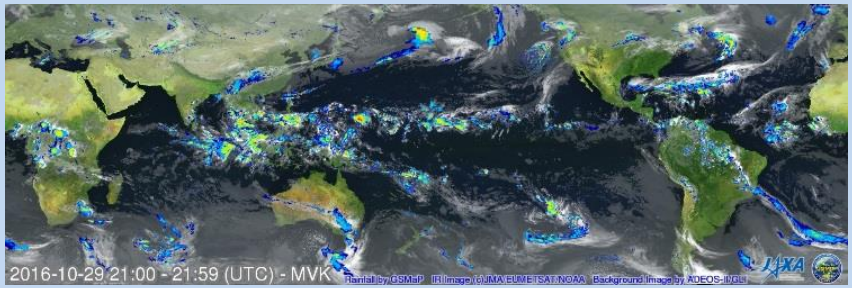
- hourly global rainfall data
- 0.1x0.1deg. lat/lon
- in near real time



distribution

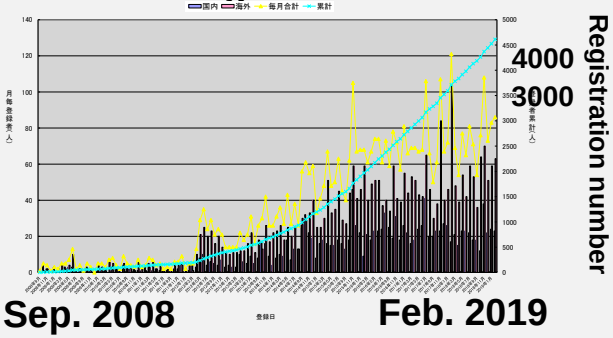
GSMaP Product

- hourly global rainfall data
- 0.1x0.1deg. lat/lon
- in near real time

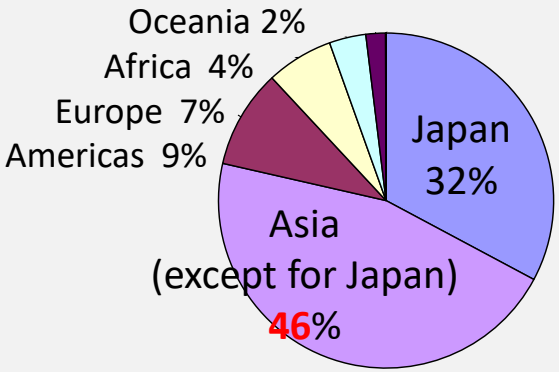


distribution

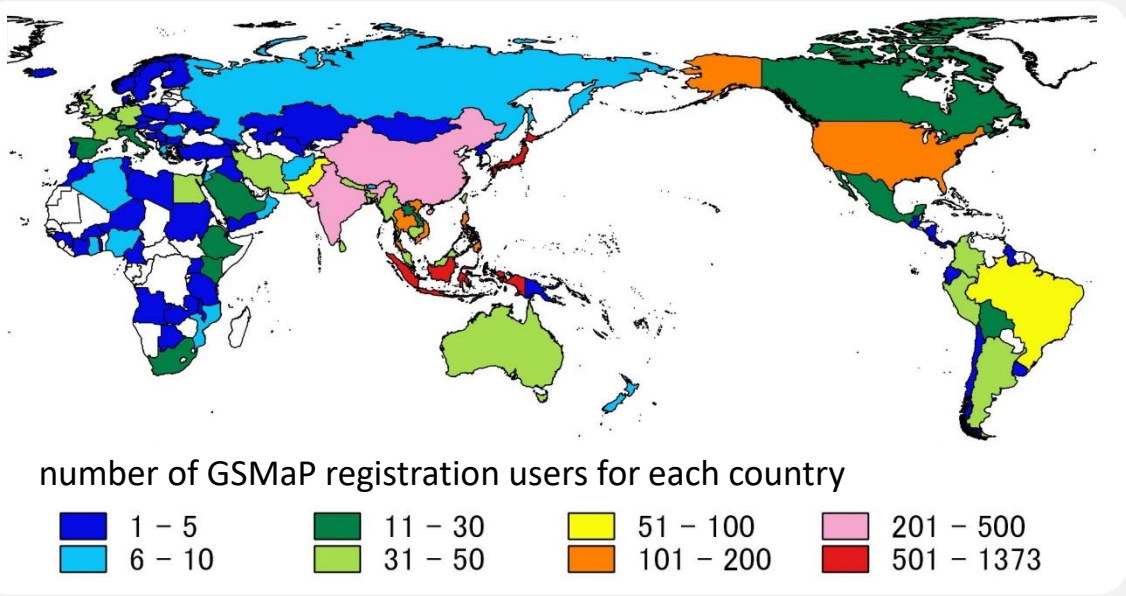
GSMaP registered users



About **4611** registered users from **117** countries at the end of Feb.2019



The number of GSMaP registration users



There are many users from overseas.

78% users are originated from Asian countries.

GSMaP Product list

Product name	Variables	Resolution	Latency	Update interval
Standard product	Hourly Precip Rate (**GSMaP_MVK**)	Horizontal: 0.1 × 0.1 deg.lat/lon Temporal: 1 hour	3 days	1 hour
	Gauge-adjusted Hourly Precip Rate (**GSMaP_Gauge**)			
Near-real-time product	Hourly Precip Rate (**GSMaP_NRT**)		4 hours	
	Gauge-adjusted Hourly Precip Rate (GSMaP_Gauge_NRT)			
Real-time product	Hourly Precip Rate (**GSMaP_NOW**)		0 hours	0.5 hour

GSMaP uses NOAA/CPC unified rain gauge (2-3 day latency, daily)

In addition, there are reanalysis products (GSMaP_RNL, GSMaP_RNL_Gauge), calculated with Japanese 55-year reanalysis (JRA55), and GSMaP Riken NowCast (GSMaP_RNC, Otsuka et al. 2016) by AICS/RIKEN.

Extension of GSMaP_NOW

- JAXA has provided the GSMaP realtime product (GSMaP_NOW) in the domain of JMA GEO-Himawari since Nov. 2015.
  - The rainfall estimates are provided just now (0hr-latency)
- The GSMaP_NOW domain has been extended to the EUMETSAT GEO region (Meteosat/MSG) since 1st Nov 2018.

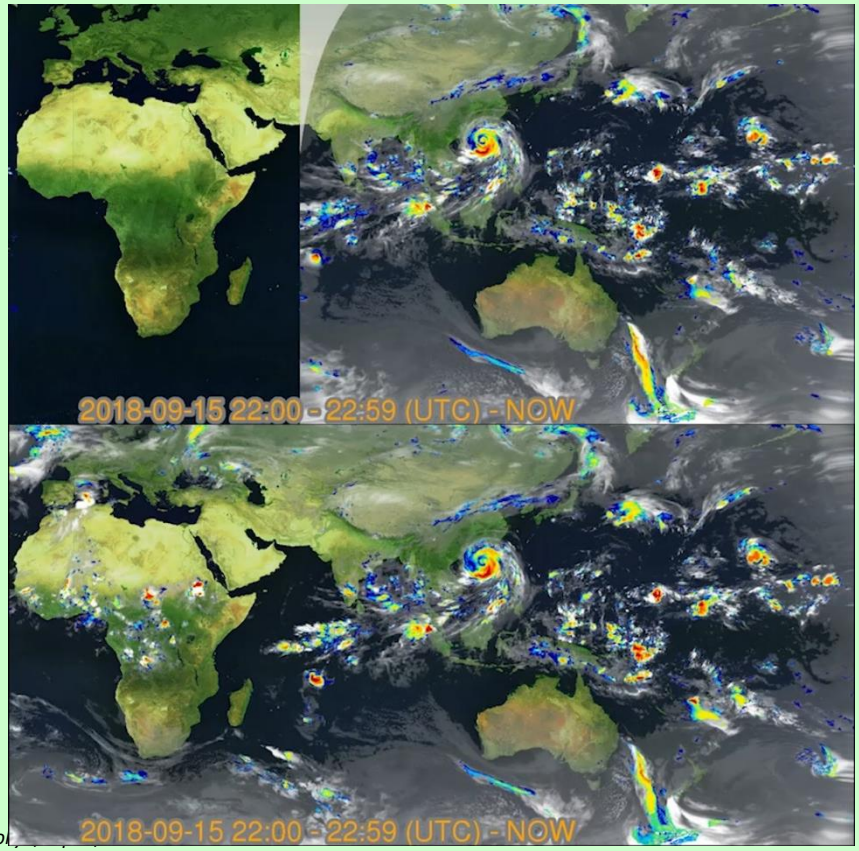
Previous GSMaP_NOW

(JMA GEO-Hiimawari region)

Updated GSMaP_NOW

(JMA GEO-Hiimawari region + EUMETSAT Meteosat/MSG)

Extension of the NOAA GOES regions is on-going.

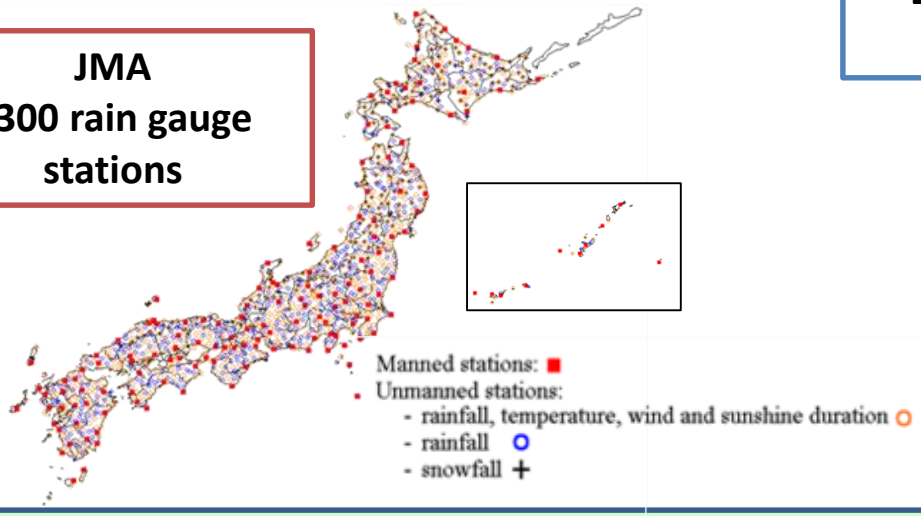


Validation results of the GSMaP

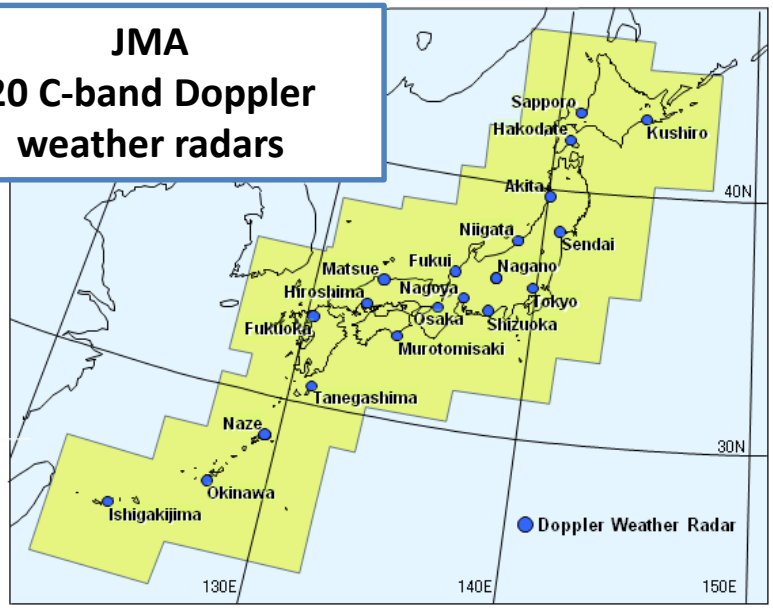
Japan

- **Radar/Raingauge-Analyzed Precipitation data**
  - provided by JMA
  - Resolution: 1km/30-min

JMA
1300 rain gauge stations

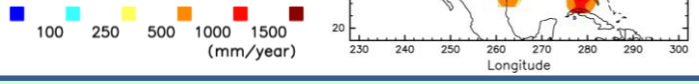


JMA
20 C-band Doppler weather radars



U.S.

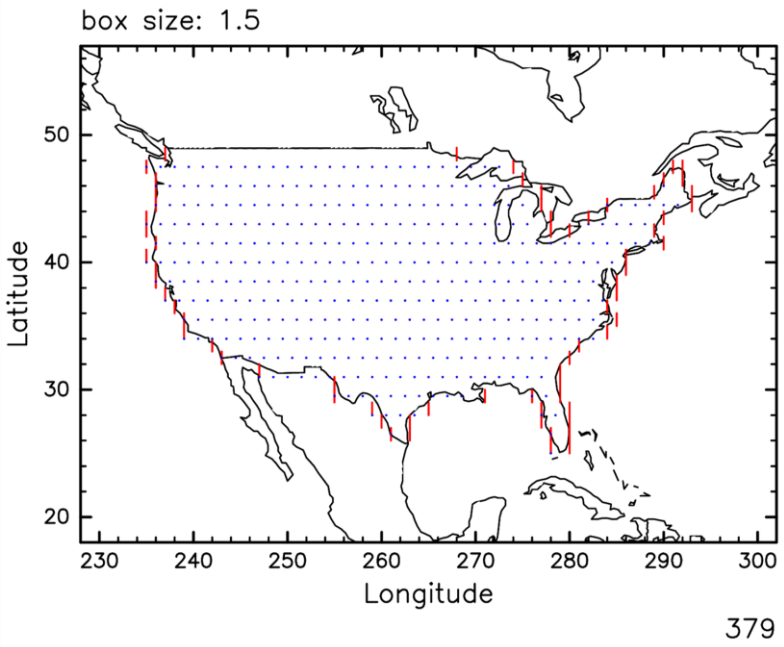
- **Multi-Radar Multi-Sensor (MRMS) Dataset**
  - provided by NASA GV team
  - Resolution: 0.01°/ 2-min

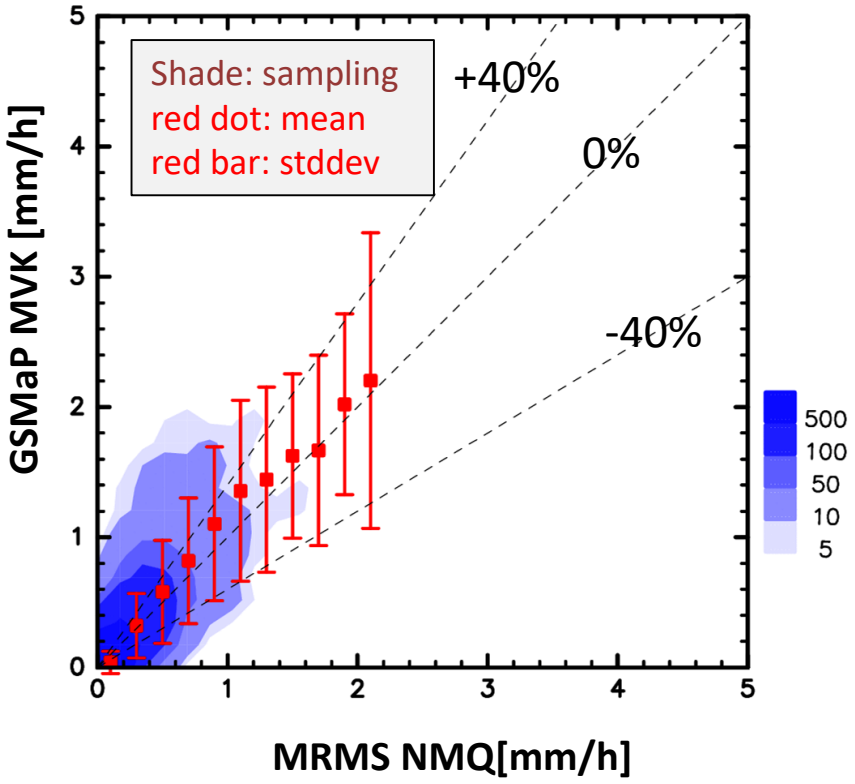


Validation in the U.S.

- **The GSMaP_MVK v6 product well-corresponded to the MRMS data over the US.**

US MRMS data



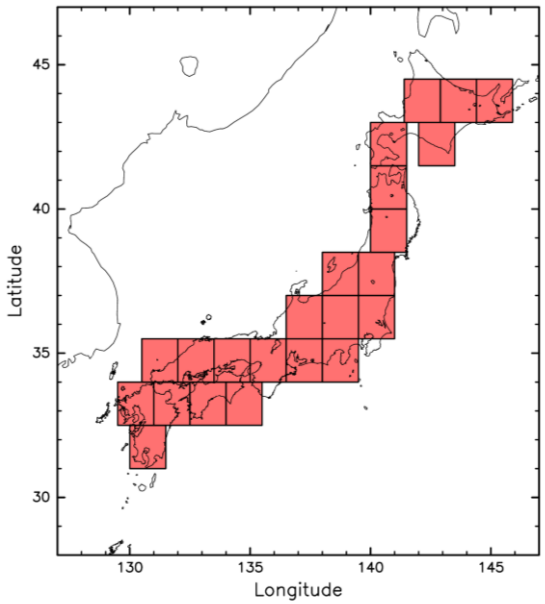


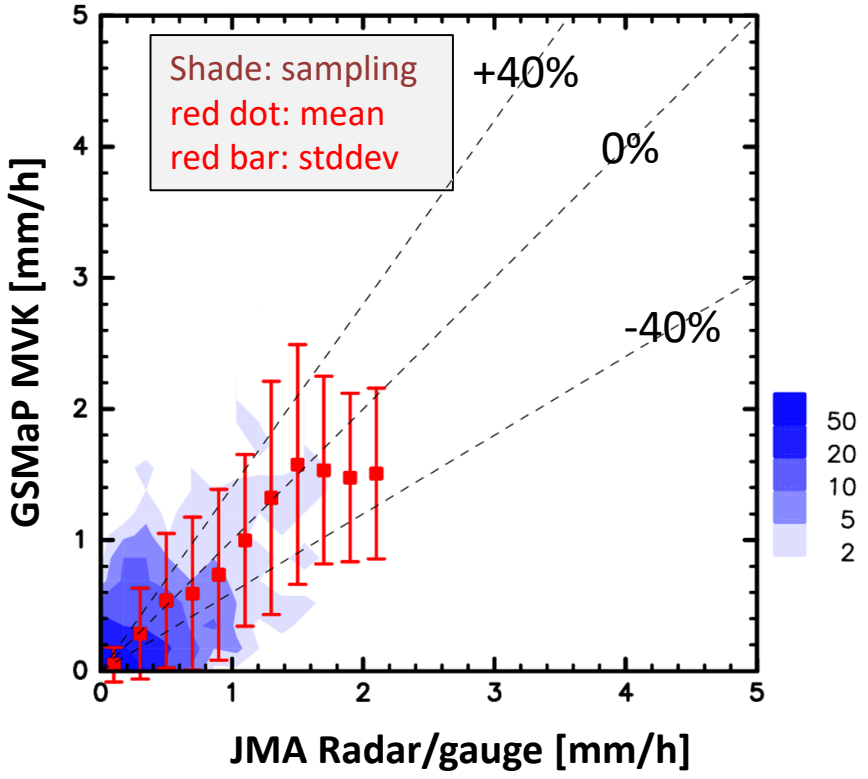
- June-July-August 2015
- daily mean precipitation in 1.5 x 1.5 degrees was calculated.

Validation in the Japan

- **The GSMaP_MVK v6 product well-corresponded to the JMA Radar/gauge data over the Japan, except for higher rain rates over the Japan (probably due to the orographic heavy rainfall).**

Japan JMA Radar/gauge data





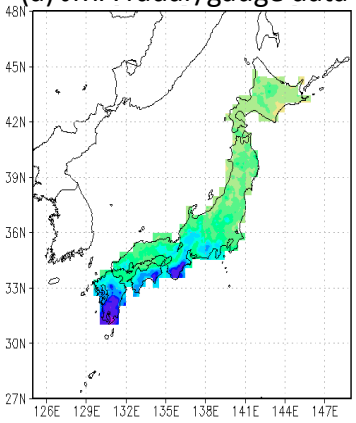
- June-July-August 2015
- daily mean precipitation in 1.5 x 1.5 degrees was calculated.

GSMaP validation for various spatial/temporal resolutions

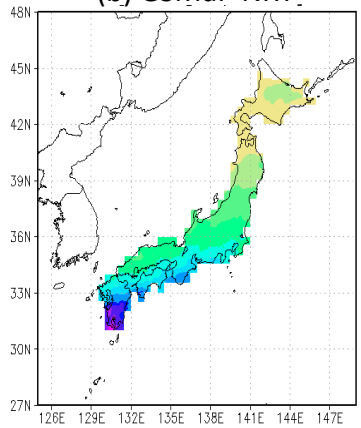
- Validation analyses in Japan using JMA radar/gauge analyzed data and GSMaP_NRT were conducted in various resolutions.
- The accuracy got better as the spatial/temporal resolution became coarser.

3-month accumulated precip(JJA 2015)

(a) JMA radar/gauge data



(b) GSMaP NRT



RMSE

Spatial res.[deg] \ temporal res. [hour]	1	3	6	12	24
0.1	1.20	0.93	0.78	0.63	0.51
0.3	1.00	0.82	0.70	0.58	0.47
0.5	0.86	0.72	0.63	0.52	0.42
0.8	0.70	0.61	0.54	0.45	0.37
1.0	0.66	0.58	0.51	0.43	0.35

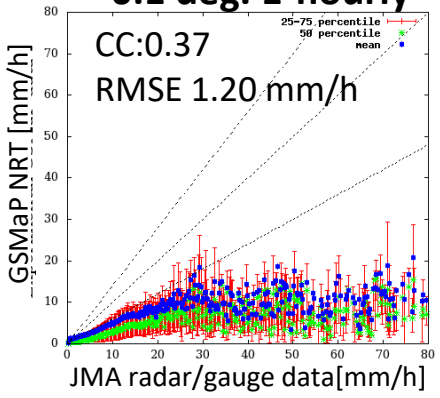
※The unit for RMSE is unified to mm/h.

Correlation Coefficient

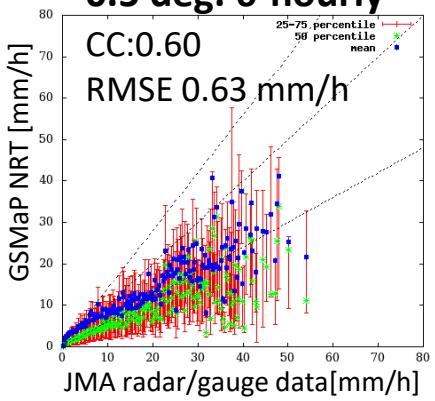
Spatial res.[deg] \ temporal res. [hour]	1	3	6	12	24
0.1	0.37	0.45	0.49	0.53	0.58
0.3	0.45	0.52	0.55	0.59	0.63
0.5	0.51	0.56	0.60	0.62	0.67
0.8	0.57	0.61	0.64	0.67	0.71
1.0	0.61	0.65	0.68	0.70	0.73

High res. ⟷ Low res.

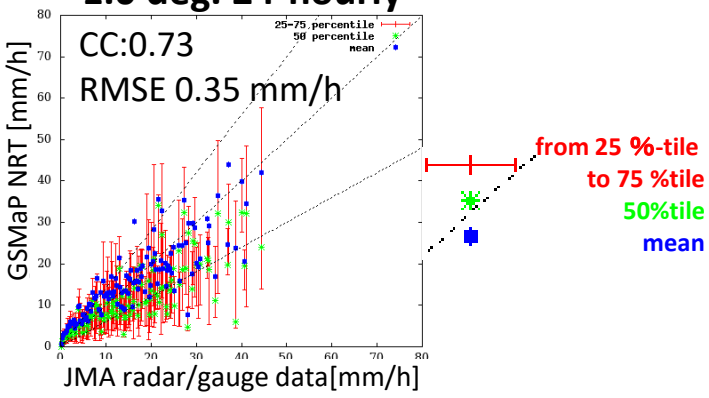
0.1 deg. 1-hourly



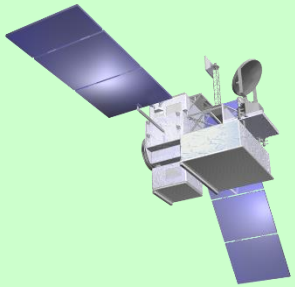
0.5 deg. 6-hourly



1.0 deg. 24-hourly



Integration of Satellite data and Ground Radar data



Algorithm development

GSMaP
(MW-IR merged product)

Good
- World coverage in hourly time-scale

Bad
- Less accurate (due to passive sensors)

Satellite radar

Good
- Accurate
- Stable calibration
- World coverage

Bad
- Not frequent observation in a specific region

Calibrator

Ground radar

Calibrator

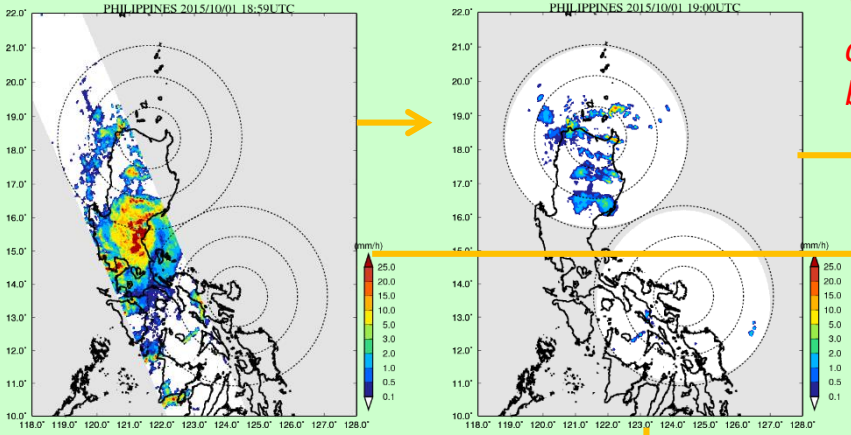
Good
- Accurate
- Frequent observation in a specific region

Bad
- Unreliable calibration
- Limited coverage

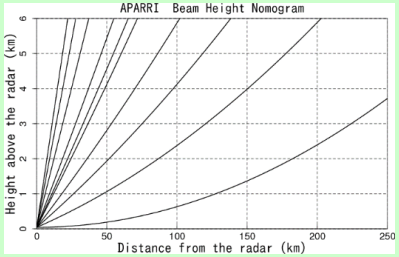
Integration of Radar + GSMaP (Philippines)

DPR

Ground radar



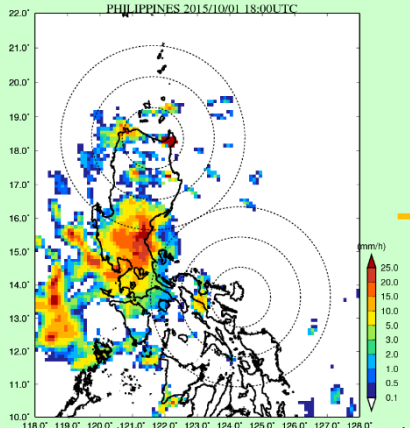
Weighting function, considering ground radar beam height



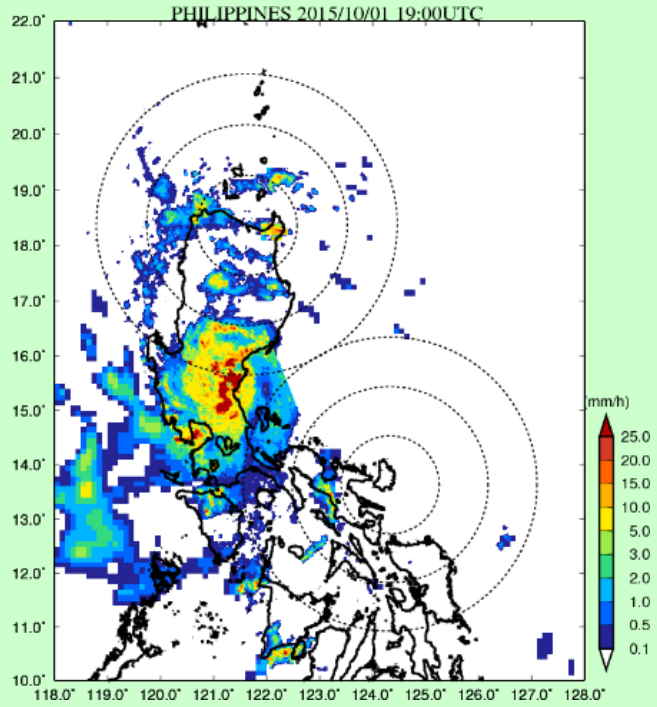
Ground radar beam height

Integrated Rainfall (Radar + GSMaP)

GSMaP (not calibrated)



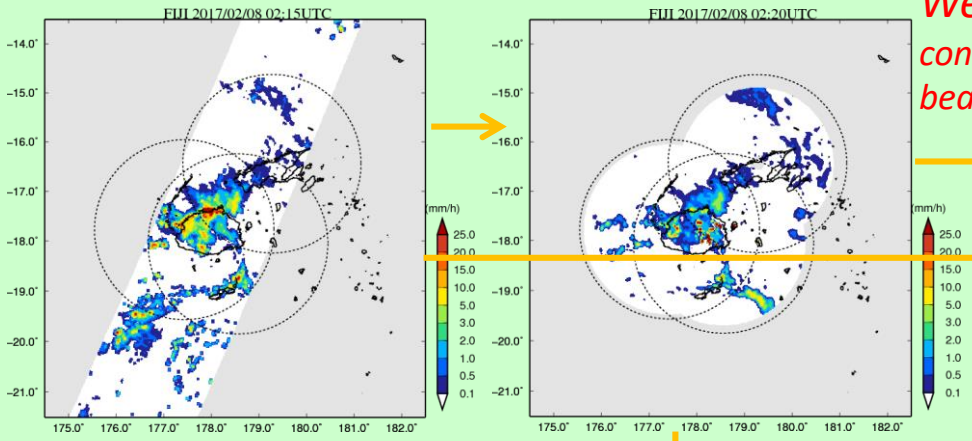
Calibrated GSMaP



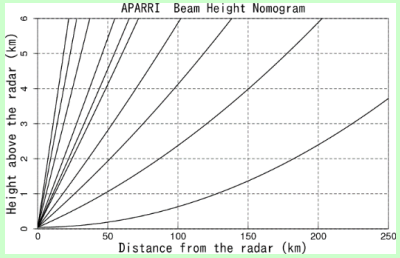
Integration of Radar + GSMaP (Fiji)

DPR

Ground radar

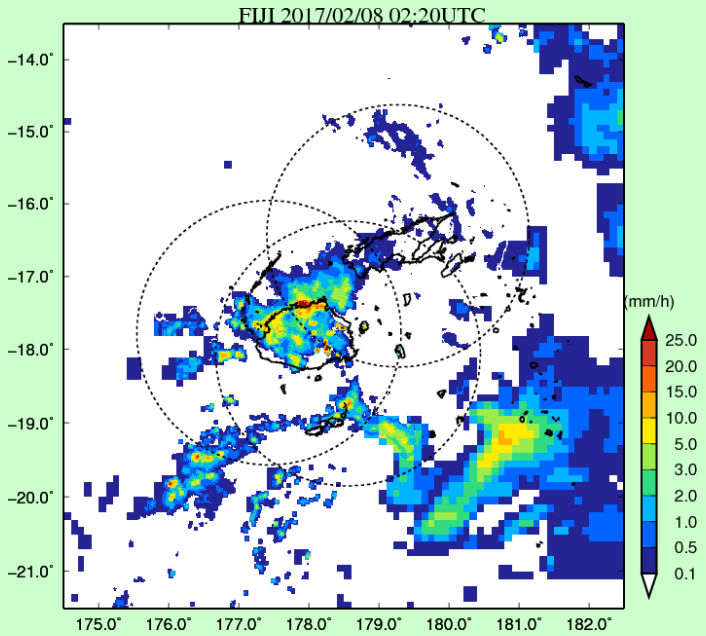


Weighting function, considering ground radar beam height

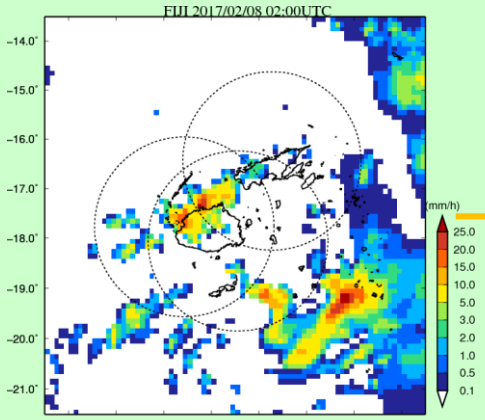


Ground radar beam height

Integrated Rainfall (Radar + GSMaP)

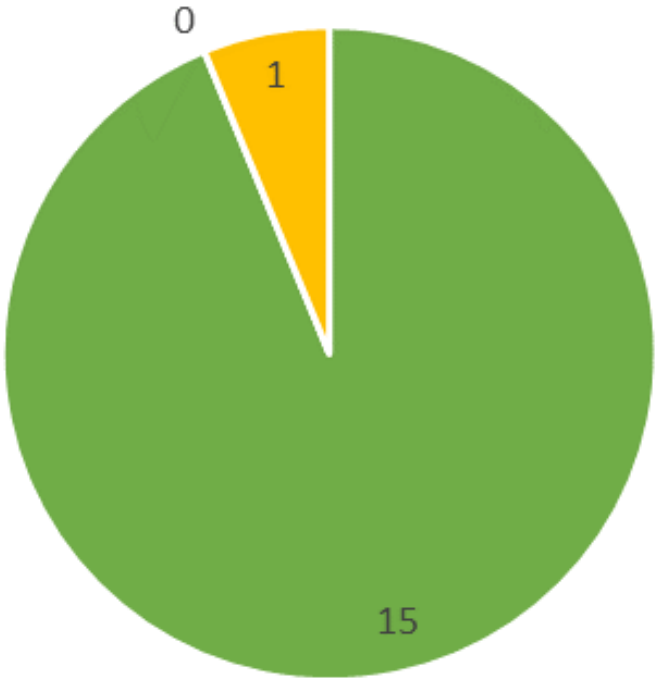


GSMaP (not calibrated)



Calibrated GSMaP

Q2.2-3 How do you think about collaboration between research and development organizations and National Meteorological and Hydrological Service (NMHS)?



- 1. They should collaborate actively
- 2. Wonder about the effect of collaboration
- 3. Don’t know

Presenter’s comments

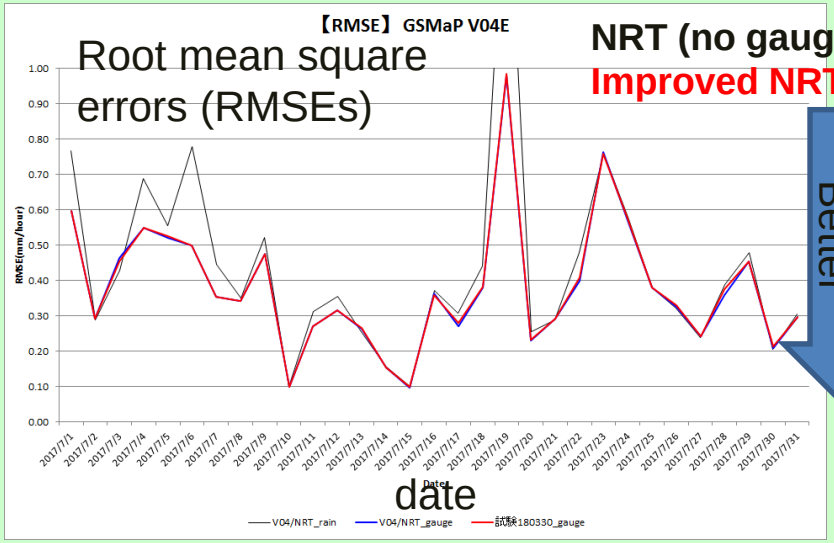
We’d like to promote collaboration with the JMA more strongly than ever, together with Asian users. We believe this opportunity can be the first step to move the integrated applications forward!

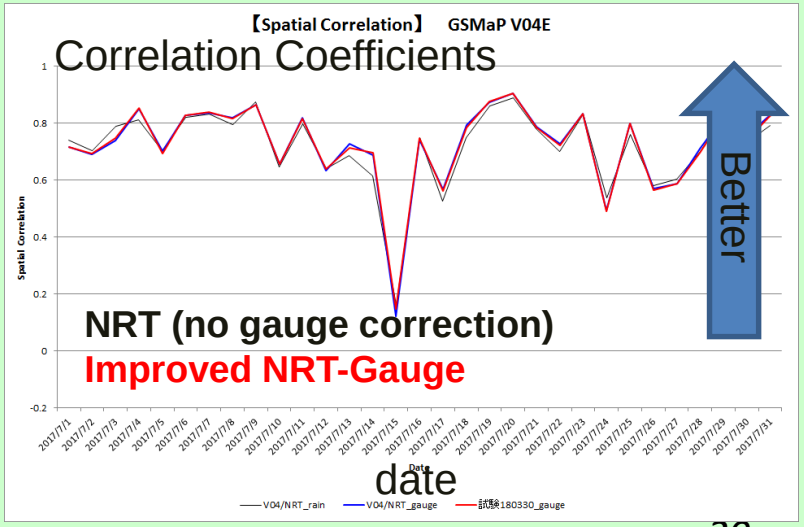
Summary and future tasks

- **Multi-satellite Precipitation Product, GSMaP**
  - Global Satellite Mapping of Precipitation (GSMaP)
  - Real-time version : GSMaP_NOW
- **Validation using ground instruments**
  - Gauge-corrected radar data: Japan, US, (Gauge: CLIMAT)
- **Integration of Satellite data and Ground Radar data**
  - Demonstrations in the Philippines and Fiji
- **Integrated application with developer and user collaboration**
  - We’re happy to know your positive responses to the GSMaP. We wish this opportunity can help you to use the data with your available resources.
  - We’d like to promote collaboration between the JAXA and the JMA with Asian users.

Improved NRT-basis Gauge-adjusted GSMaP

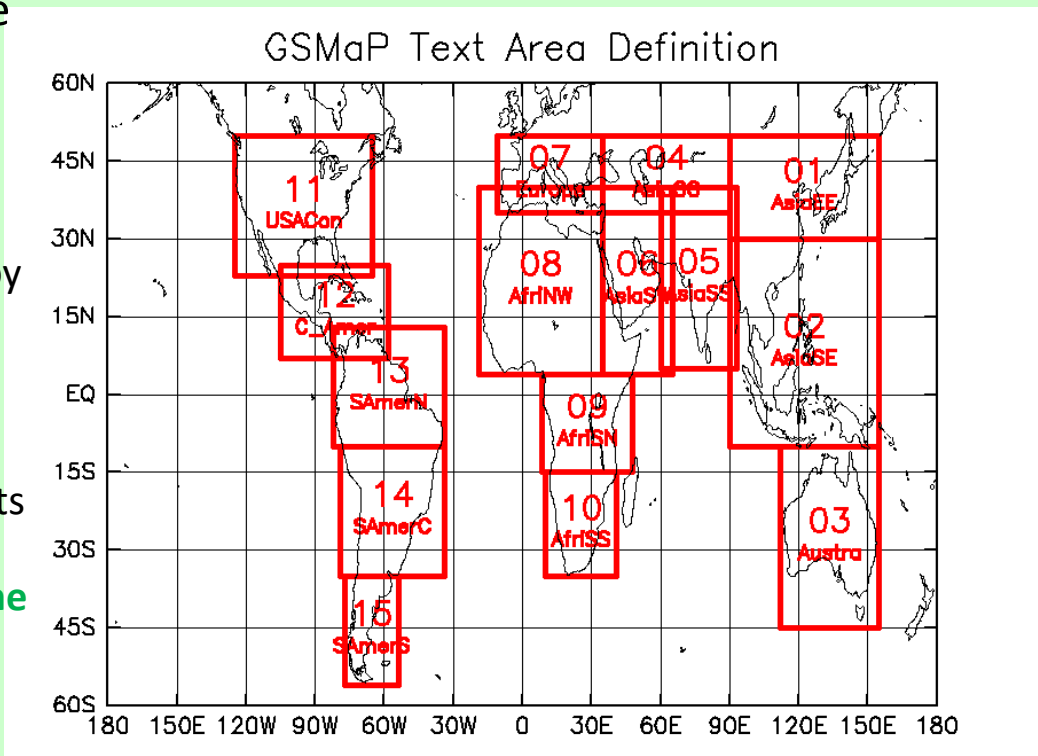
- Improved NRT-basis Gauge-adjusted GSMaP product (v6) was open to the public in December 2018.
  - Correction coefficients were calculated using past 30 days.
  - We reprocessed past 18yr data record (since Mar. 2000)
- Validations with reference to the JMA radar around Japan show smaller RMSEs in this new product than the current NRT (no gauge-correction).
- Similar technique will be applied also to the GSMaP_NOW soon.





Validation of the GSMaP by CLIMAT data (1/3)

- Here, we examined performances of the GSMaP products with reference to the CLIMAT data (monthly gauge data) provided by the JMA during 17years (Mar-2000 - Feb-2017)
- Data
  - Rain Gauge: CLIMAT data (provided by the JMA under the JAXA-JMA agreement)
  - Satellite: GSMaP product version 3 (algorithm version 6)
  - ➢ Here, following three GSMaP products were compared.
  - ✓ **GSMaP_NRT: GSMaP Near-Real-Time** version (latency: 4 hour)
    - →**GNRT**
  - ✓ **GSMaP_MVK: GSMaP Standard** version (latency: 3 days)
    - →**GMVK**
  - ✓ **GSMaP_Gauge: Gauge-adjusted** version (latency: 3 days)
    - →**GGauge**

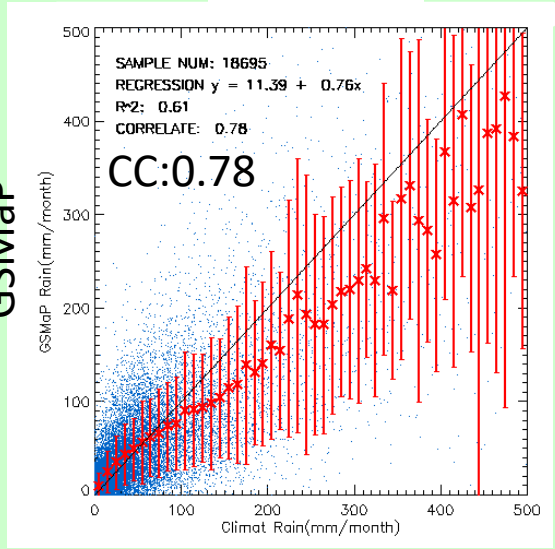


Validation of the GSMaP by CLIMAT data (2/3)

- Scatter Diagram of Monthly Rainfall in Australia

Australia

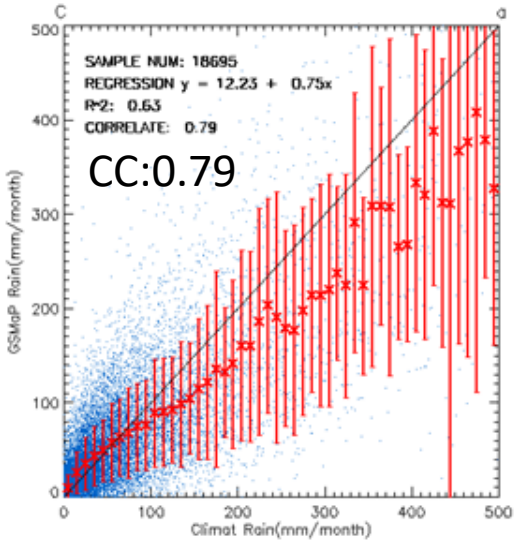
GNRT



GSMaP

CLIMAT

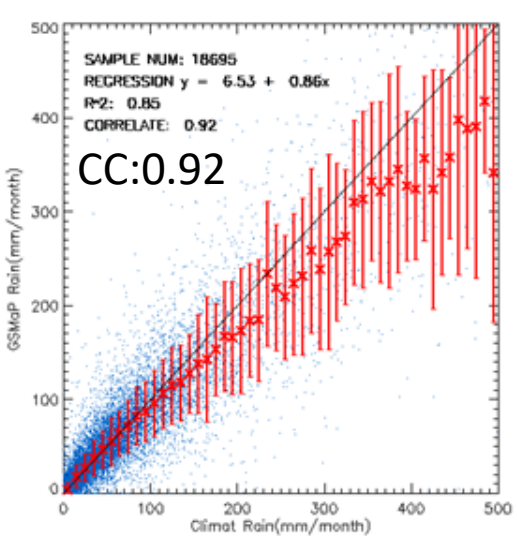
GMVK



GSMaP

CLIMAT

GGAUGE



GSMaP

CLIMAT

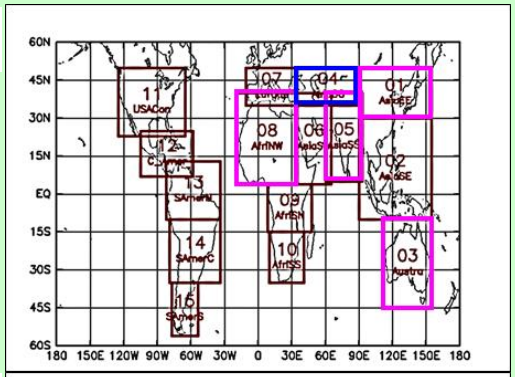
- Slightly overestimated until ～100mm/month, after that underestimated.
- The correlation of GGauge is the best, and the error bar of GGauge is the smallest.
- In terms of the correlation, GNRT is 0.78, GMVK is 0.79 and GGauge is 0.92. These are the highest in 15 areas examined.

Validation of the GSMaP by CLIMAT data (3/3)

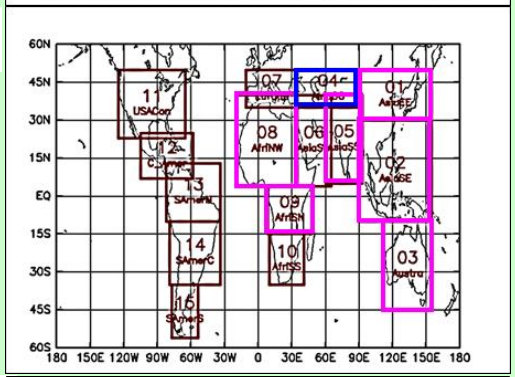
➢ Correlation of Monthly Rainfall in 15 areas during 17 years

	Area	GNRT	GMVK	GGauge
1	AsiaEE	0.74	0.75	**0.92**
2	AsiaSE	0.68	0.70	0.84
3	Austra	**0.78**	**0.79**	**0.92**
4	AsiaCC	0.31	0.32	0.68
5	AsiaSS	0.70	0.71	0.80
6	AsiaSW	0.51	0.53	0.67
7	Europe	0.52	0.55	0.83
8	AfriNW	0.74	0.77	0.88
9	AfriSN	0.68	0.70	0.74
10	AfriSS	0.67	0.67	0.82
11	USACon	0.64	0.65	0.89
12	C_Amer	0.58	0.58	0.69
13	SAmerN	0.62	0.64	0.83
14	SAmerC	0.65	0.67	0.87
15	SAmerS	0.61	0.63	0.78

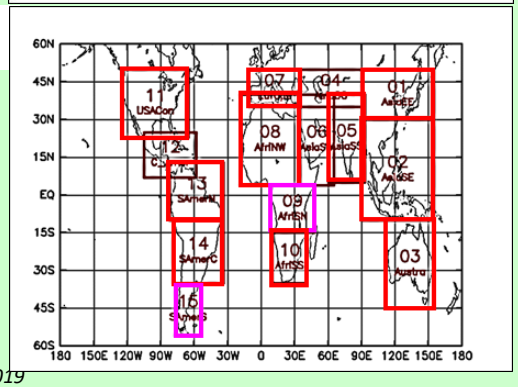
GNRT



GMVK



GGauge



□ : R≧0.80
□ : 0.70≦R＜0.80
□ : R≦0.50