



JAXA GPM Application Science

Takuji Kubota

Earth Observation Research Center (EORC)

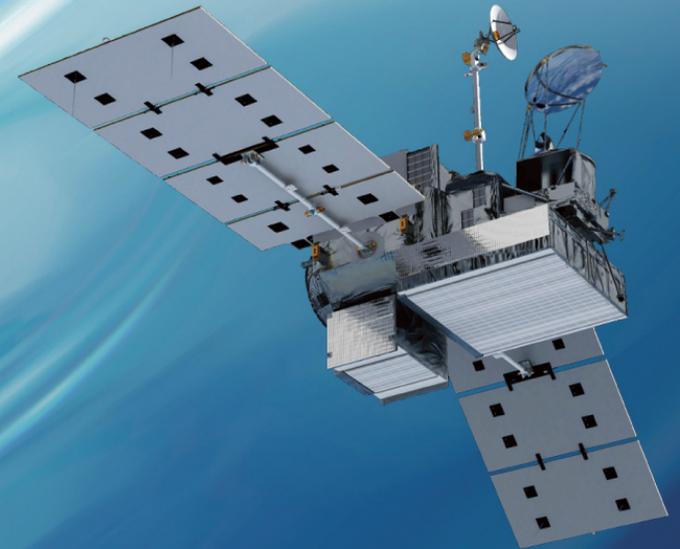
Japan Aerospace Exploration Agency (JAXA)

with

M. Yamaji, K. Furukawa, Y. Kaneko, R. Tanabe, T. Miyoshi,

T. Oki, K. Yoshimura, K. Yamamoto, M. Kachi, K. Oyoshi.

S. Sobue, Y. Saitou, A. Masuda, Y. Suzuki, and R. Oki



2017 PMM Science Team Meeting, October 2017

Contents



- * 6th GPM Asia Workshop report
- * JAXA activity for the GSMaP applications.
 - * Rainfall monitoring
 - * Hydrology
 - * Drought monitoring
 - * Agriculture
 - * Public Health
- * Ground Radar Calibration using GPM/DPR for developing countries

Promotion of GPM data utilization and application in Asia



- * **The 6th GPM Asia Workshop on Satellite Precipitation Data Utilization**
 - * Held in Thai meteorological department (TMD) on 18-19 Jan., 2017
- * **Purpose of the workshop:**
 - * To promote satellite precipitation data utilization in Asia, and move forward research activities related to GPM in each country in working-level.
 - * To share early validation and utilization results of the GPM products in Asian countries.
 - * To proceed future collaborations between Japan and Asian countries.
- * **75 participants including participants from 11 Asian and Oceanian countries.**



Presentation by the BMKG, Indonesia, in the workshop



Utilization GSMaP Data on Madden Julian Oscillation (MJO) Monitoring over Indonesia (Asri Susilawati, BMKG, Indonesia)

Operational flow of the GSMaP data processing in the BMKG

GSMaP Data Processing

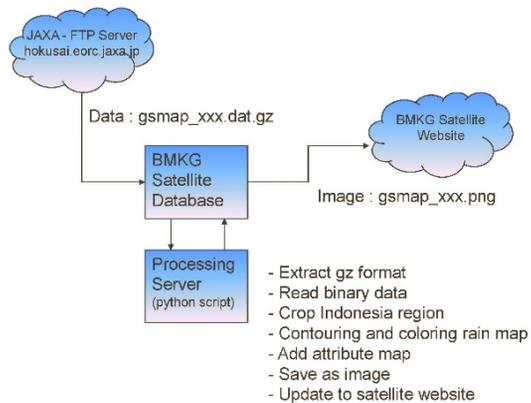
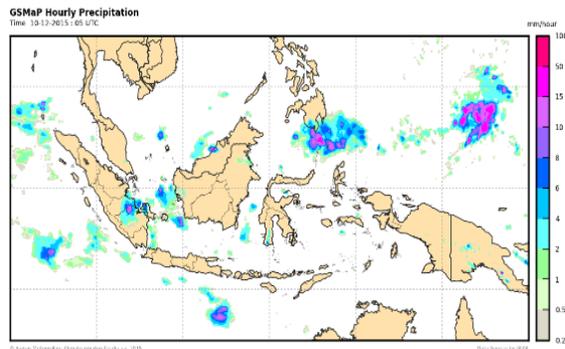
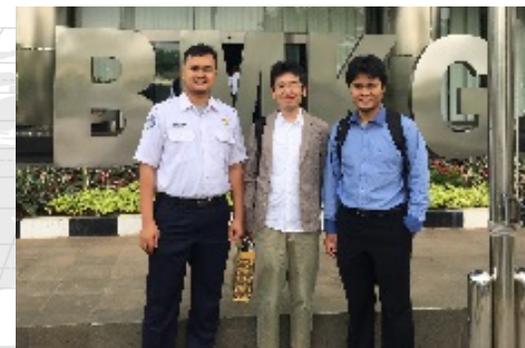


Photo for operational GSMaP utilization in the BMKG, taken by Prof. S. Shige (Kyoto Univ.)



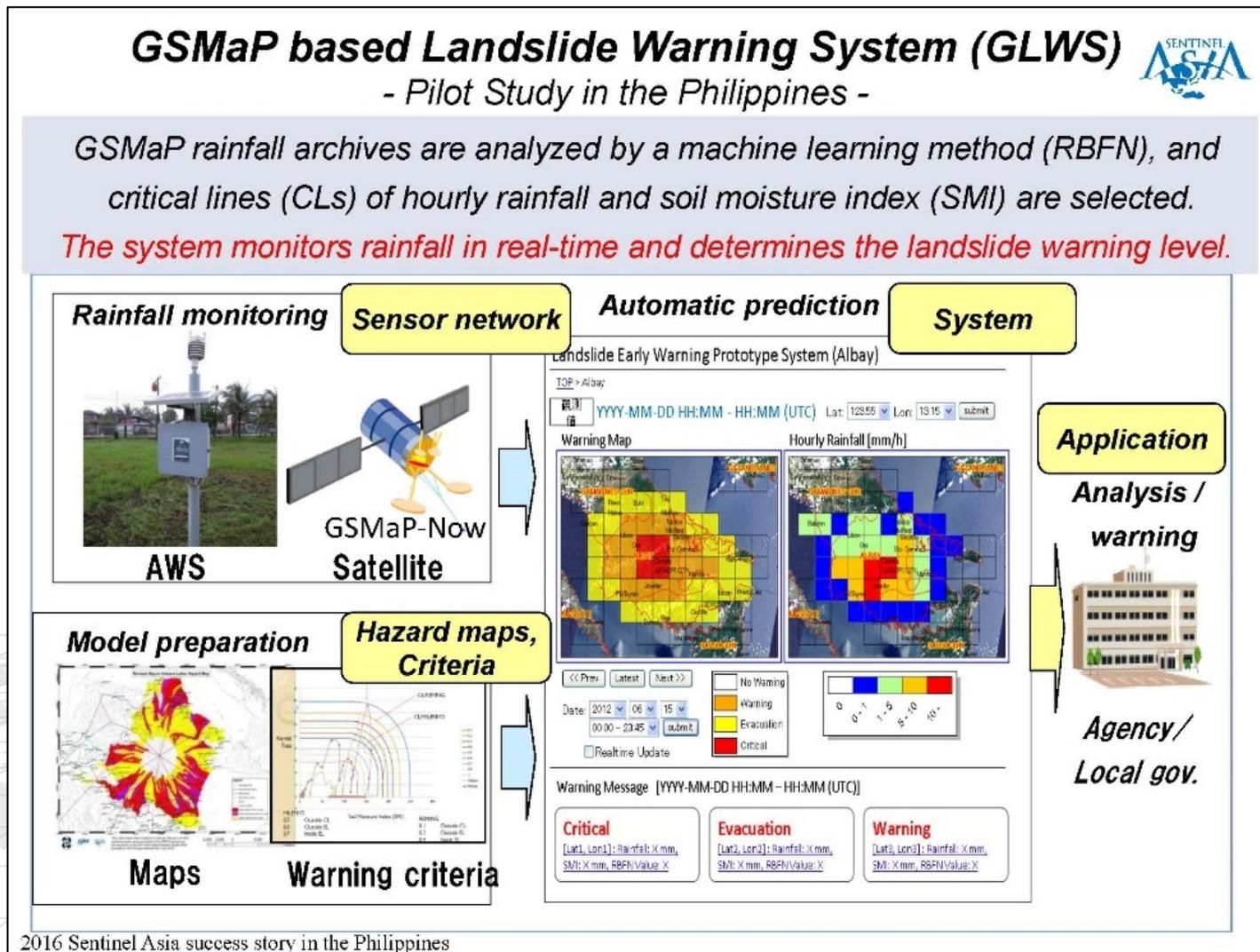
<http://satelit.bmkg.go.id/BMKG/>



Presentation by the PHIVOLCS, Philippine, in the workshop



GSMaP-based Landslide Warning System - A prototype Project in the Philippines under the Sentinel Asia (Arturo S. Daag, PHIVOLCS, Philippine)



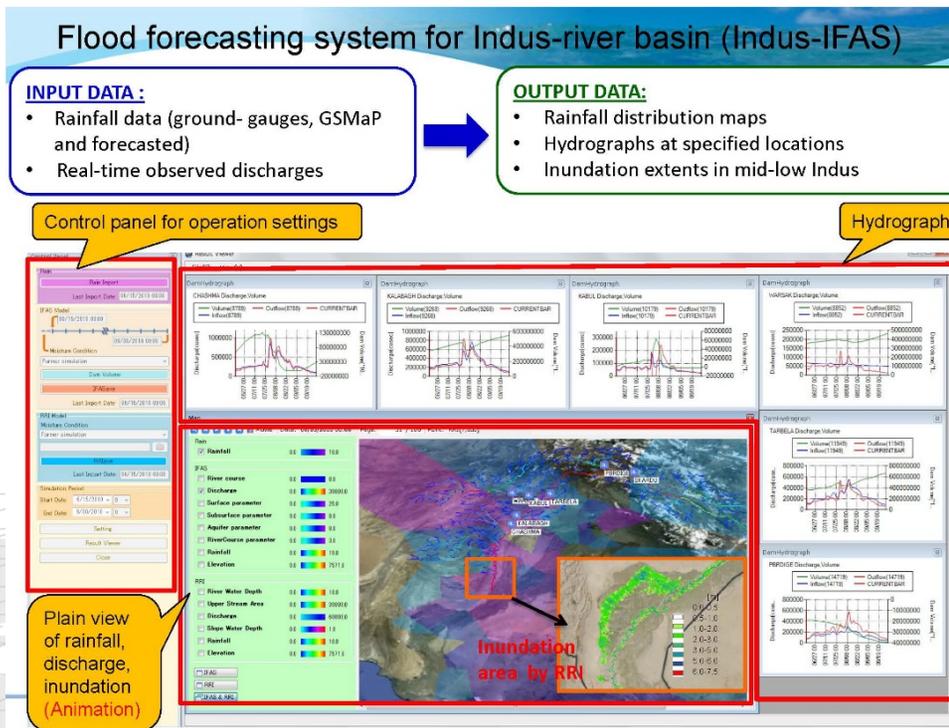
2016 Sentinel Asia success story in the Philippines

Presentation by the flood forecasting in Indus-river basin in the workshop



Application of GSMaP to flood forecasting/analysis in large river basin (Morimasa Tsuda, ICHARM, Japan)

Strategic Strengthening of Flood Warning and Management Capacity and Importance & Applications of JAXA GSMaP_NRT(hourly) in Pakistan (Shahzada Adnan, PMD, Pakistan)

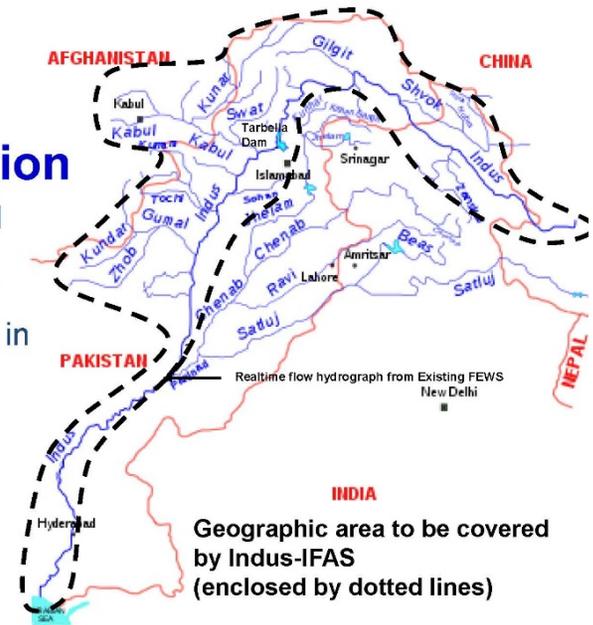


Project Component (1/3)

A1

IFAS Introduction

- Indus-IFAS developed
- Test operation in 2011
- Validation and update in 2012



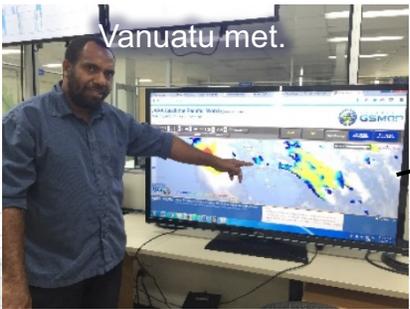
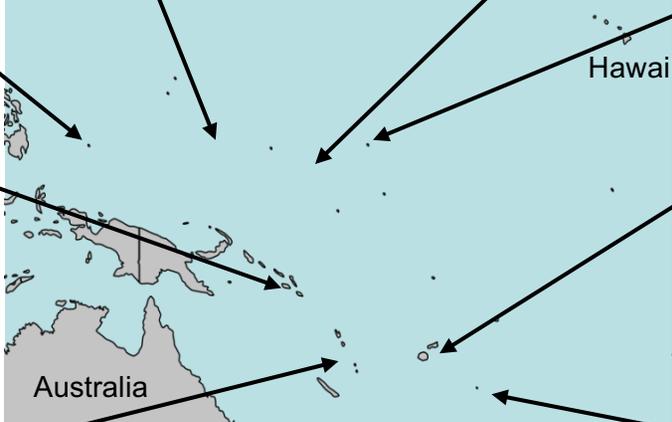
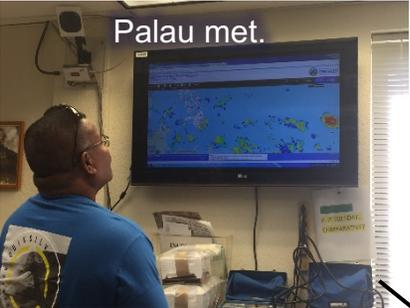
Integrated Flood Analysis System



GSMaP applications for Rainfall monitoring



Broader Utilization in the Pacific islands



- No need to set up any computer specially
- Free to use
- Everyone can view the Website via internet access

With Japan International Cooperation Agency (JICA), local Meteorological Office in the Pacific islands started to use GSMaP NOW to capture the horizontal precipitation distribution around their Islands.

Utilization of GSMaP in Fiji



20th Sep. 2016

Started to Link to GSMaP website from FMS HP

<http://www.met.gov.fj/>

The screenshot shows the Fiji Meteorological Service website. The header includes the service name, RSMC Nadi-Tropical Cyclone Centre, and ISO 9001:2008 certification. Navigation menus include Home, About Us, Services, Careers, Awareness & Education, and Feedback. A 'Current Warning' section shows 'No Current Warnings'. A 'Fiji Weather Forecast' section lists various forecast options like Public, Marine, and Town Centers. A 'Regional Weather Bulletins' section lists countries like Niue, Tonga, Kiribati, Nauru, Tokelau, Tuvalu, and Cook Is. An 'AVIATION CUSTOMER SURVEY' section is also visible. A map of Fiji is displayed in the center, with a black arrow pointing from it to a larger inset image on the right.

This inset image displays three panels: 'Radar' showing a weather radar scan, 'Satellite' showing a satellite image of a cloud system, and 'Maps' showing a map with various data points. Below these panels is a banner for 'GSMaP JAXA Realtime Rainfall Watch Fiji Islands Rainfall' with a star icon. To the right of the banner is the text: '* External Link to JAXA Realtime Rainfall Watch that shows rainfall estimated from satellite-data .'

A yellow-bordered banner with the text: 'GSMaP JAXA Realtime Rainfall Watch Fiji Islands Rainfall'. The banner features a globe icon and a star icon.

* External Link to JAXA Realtime Rainfall Watch that show rainfall estimated from satellite-data .



Utilization in other Pacific islands



In Palau, image of GSMaP is used in FB post.

facebook アカウント登録

Palau National Weather Serviceさんが写真6件を追加しました。
5月7日 18:49

A NEAR EQUATORIAL TROUGH IS FOUND NEAR THE EQUATOR AT 154E AND EXTENDS NORTHWESTWARD TO 6N130E. WITH RESPECT TO THE REPUBLIC OF PALAU, THE TROUGH IS FOUND FAR SOUTHEAST TO TCWEST OF THE MAIN ISLANDS. DEEP CONVECTION (CBs AND TCUs) CAN BE SEEN ON SATELLITE IMAGERY FROM SOUTHWEST THROUGH SOUTHEAST OF THE MAIN ISLAND GROUPS OF PALAU AND OVER TOBI. THE TROUGH WILL BE THE MAIN WEATHER PRODUCER THROUGH THE WEEK. GENTLE TO MODERATE EASTERLY WINDS ARE FORECASTED THROUGH THE WE... もっと見る

rainfall Watch (Palau ver.)
94 30

Philippines

NWS Marine Forecast
+3

いいね! コメントする

Tonga Meteorological & Coast Radio Services
Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communication (MEIDECC)
KINGDOM OF TONGA
Official Government Website: Providing meteorological and maritime radio services in support economic development, safety and security and general well-being of citizens of and visitors to the Kingdom of Tonga

Home Warning Services Media Releases Awareness About us Feedback

Public Latest Weather Information
 >> Weather Forecast: English, Tongan, Download format: English, Tongan
 >> Graphic Point Forecast: 1 Day, 3 Days
 >> Graphic Distribution Forecast: 3Day, Wind, Wave
 >> 2016-2017 Tropical Cyclone Season Outlook for Tonga
 English
 >> Current and Recent Weather Condition

MOBILE WEATHER
 >> Satellite Data: Tonga Mobile (GSMaP) OISAE
 >> Tongan

Marine & Ports
 >> LAKELAKA Atoll (Pikini)
 >> SAKON, ELISABETH Atoll (Pikini)
 >> FUAFAUFA Atoll (Tongareva)
 >> Nukunono

Agriculture
 >> LAKELAKA Atoll (Pikini)
 >> SAKON, ELISABETH Atoll (Pikini)
 >> FUAFAUFA Atoll (Tongareva)
 >> Nukunono

Shipping
 >> LAKELAKA Atoll (Pikini)
 >> SAKON, ELISABETH Atoll (Pikini)
 >> FUAFAUFA Atoll (Tongareva)
 >> Nukunono

Fisheries
 >> LAKELAKA Atoll (Pikini)
 >> SAKON, ELISABETH Atoll (Pikini)
 >> FUAFAUFA Atoll (Tongareva)
 >> Nukunono

>> Satellite Pacific Tonga Movie Himawari GSMaP

Registered Email >> Climate Update
Monthly Climate Summary

Tonga met service

<http://www.met.gov.to/>
http://sharaku.eorc.jaxa.jp/GSMaP_NOW/tonga.htm

Kosrae's Coast
Responding to coastal change in Kosrae

Home About Shoreline change Coastal Inundation Damaging events Climate change Lessons learned What Kosrae can do

Kosrae's weather
JAXA Realtime Rainfall Watch
Kosrae Island Rainfall

Today, 14
30°
11:15 AM EST
Mostly cloudy

Kosrae Coastal Waters
There are no active watches, watches or advisories right now.

The tide tables for June, July and August can be downloaded from the links below:

Kosrae (Micronesia) resource management office

<http://kosraecoast.com/>
http://sharaku.eorc.jaxa.jp/GSMaP_NOW/kosrae.htm

SOLOMON ISLANDS GOVERNMENT
METEOROLOGICAL SERVICES DIVISION
MINISTRY OF ENVIRONMENT CLIMATE CHANGE DISASTER MANAGEMENT AND METEOROLOGY

Home Home Weather Forecasting Marine Weather Forecasting Tropical Cyclone Forecasting Thunder Storm Forecasting Trough Forecasting

Current Observation

Station	Time	Wind dir	Temperature (C)	Sea Swell (cm)	Current direction	Cloudcover
Male	14:00	10	27.0°C	1.0	None	Partly Cloudy
Malakal	14:00	10	28.0°C	1.0	None	Partly Cloudy
Taka	14:00	10	28.0°C	2.0	obscure precipitation but not falling at station	Cloudy
Wasa	14:00	10	28.0°C	0.1	None	Cloudy
Wakabunan	14:00	10	28.0°C	1.0	None	Partly Cloudy

Weather Forecasting Services
 Weather Forecasts
 Marine Weather Forecasting
 Tropical Cyclone Forecasting
 Thunder Storm Forecasting
 Trough Forecasting

Weather Maps

Satellite Products
 Satellite Animation
 JAXA Realtime Rainfall Watch for Solomon Islands

Solomon met service

<http://www.met.gov.sb/>
http://sharaku.eorc.jaxa.jp/GSMaP_NOW/solomon.htm

Tonga met service, Solomon met service, and Kosrae (Micronesia) resource management office also put the link to GSMaP in their own website. The publics in the islands can use this system via internet access.

GSMaP applications for Hydrology

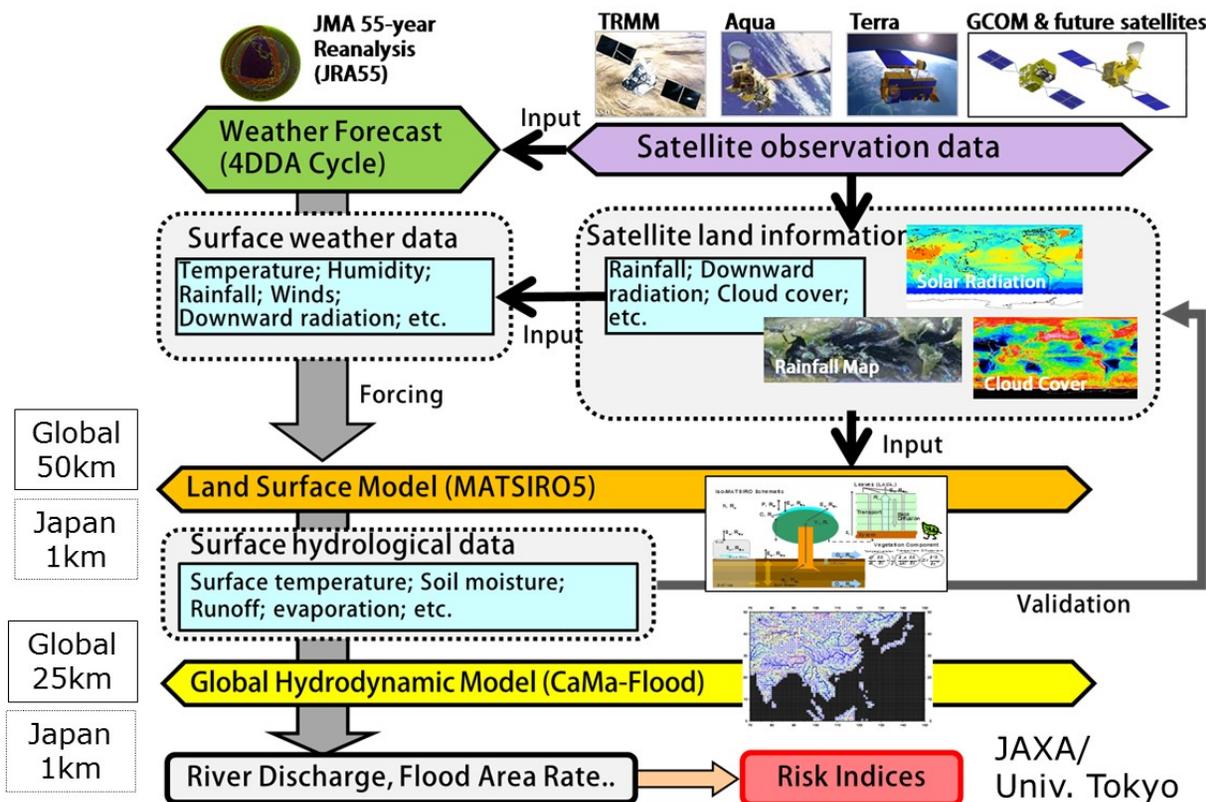


Yesterday's Earth at EORC (YEE)

- * JAXA/EORC now operates the Global Land Data Assimilation System using the GSMaP data, named as Yesterday's Earth at EORC (YEE). The data from the YEE will be open to the public by the end of JFY2017.

Yesterday's Earth at EORC (YEE)

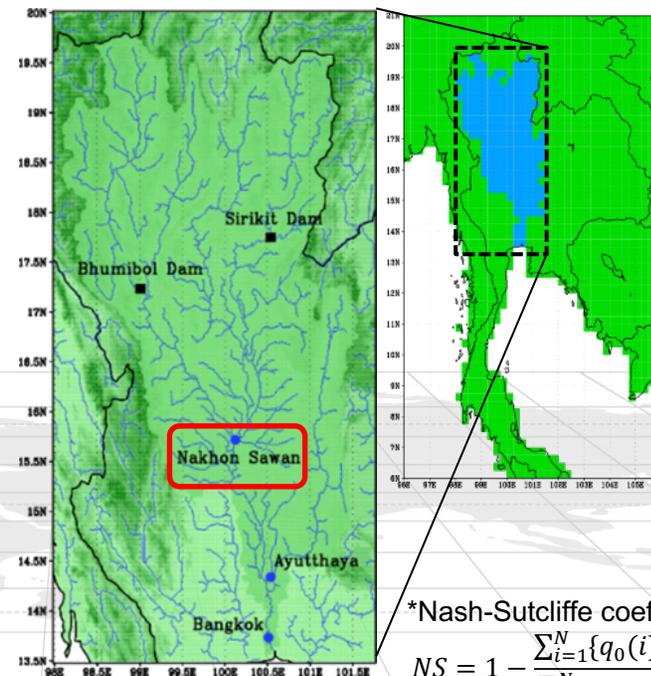
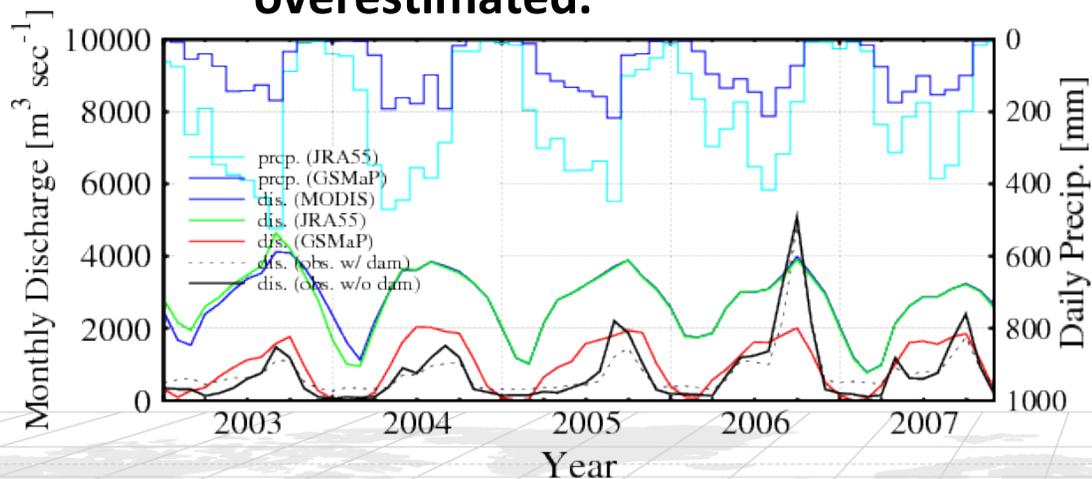
The YEE system has been developed by collaboration with Profs. T. Oki and K. Yoshimura (Univ. Tokyo)



GSMaP effects in YEE system

1. Evaluation of River Discharge

- * Duration : 2003-2007
- * Location : Nakhon Sawan (Chao Phraya river basin, Thailand)
- * Input data : 1. JRA55
 2. JRA55 (SW radiation data for MODIS) → MODIS
 3. JRA55 (precipitation data for GSMaP) → GSMaP
- Result using GSMaP showed better agreement with observed data whereas results by JRA55 and MODIS are significantly overestimated.



	Correlation	RMSE	Nash coef.*
GSMaP	0.700	671.20	0.424
JRA55	0.563	2141.5	-4.87
MODIS	0.576	2131.5	-4.81

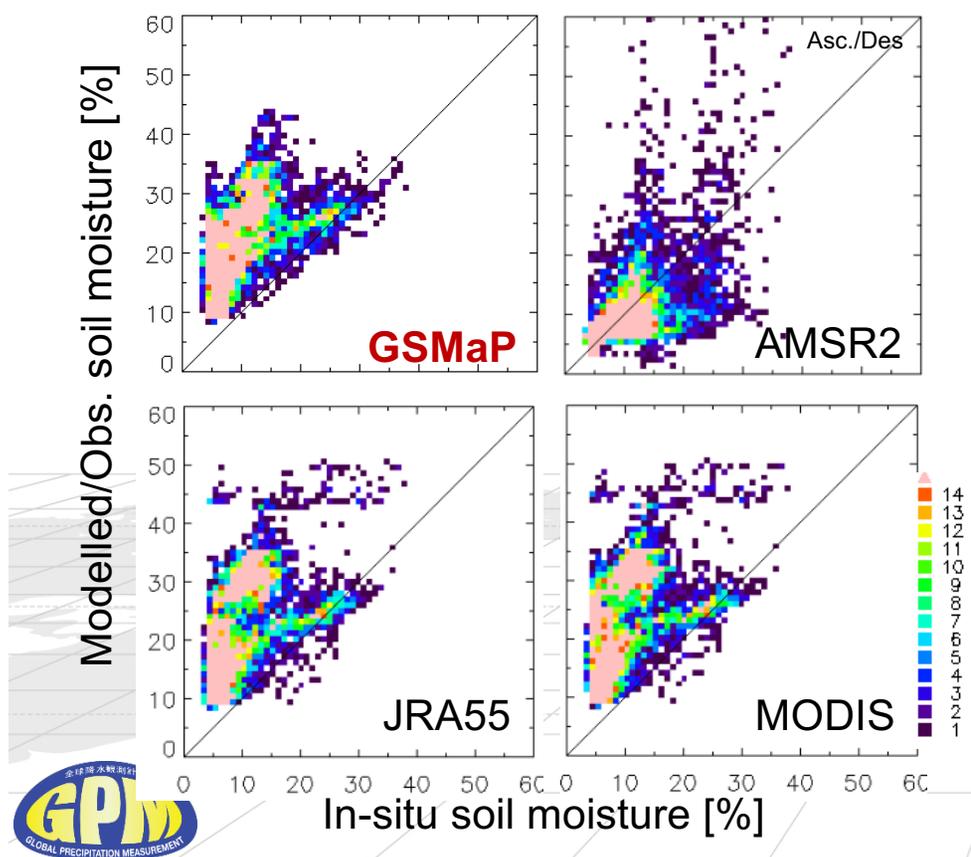
*Nash-Sutcliffe coef.

$$NS = 1 - \frac{\sum_{i=1}^N \{q_0(i) - q_c(i)\}^2}{\sum_{i=1}^N \{q_0(i) - q_{ave}\}^2}$$

GSMaP effects in YEE system

2. Evaluation of Soil Moisture

- * Duration : 2012/7/2 – 2016/10/31
- * Area : Thailand, Mongolia, Australia, Little River(U.S.)
- * Input data : 1. JRA55
 2. JRA55 (SW radiation data for MODIS) → MODIS
 3. JRA55 (precipitation data for GSMaP) → GSMaP
- * Comparative data : AMSR2



- Using GSMaP for input data improved soil moisture simulation as well.
- All modelled soil moisture showed lower accuracy compared to AMSR2, which indicates the model itself has room for improvement.

	Correlation	RMSE	Bias
GSMaP	0.494	13.167	12.007
JRA55	0.471	14.905	12.862
MODIS	0.426	15.911	13.842
AMSR2	0.586	5.768	-0.115

Radar Calibration using GPM/DPR for developing countries

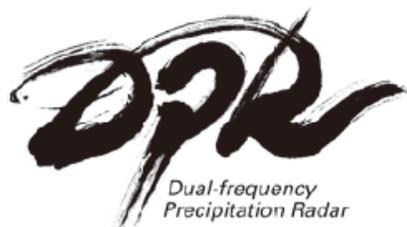


Ground Radar Calibration using GPM/DPR + Ground radar coverage extension using GSMaP

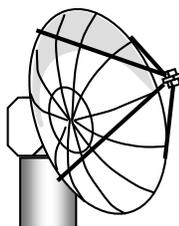


- * Ground radar calibration using spaceborne radar has been studied in previous works (e.g., Anagnostou et al. 2001).
- * Recently, ground radars have been introduced in many developing countries, but, their maintenance is a serious issue for many of them.
 - * The ground radar calibration using spaceborne radar can be more effective in the developing countries than in the advanced countries.
- * Here, JAXA and Japan Weather Association (JWA) studied this using ground radar data in the **Philippines** and the **Fiji**.
- * In addition, the ground radar coverage extension using satellite data (**GSMaP**) was also tested.

Flowchart of this study



Satellite radar

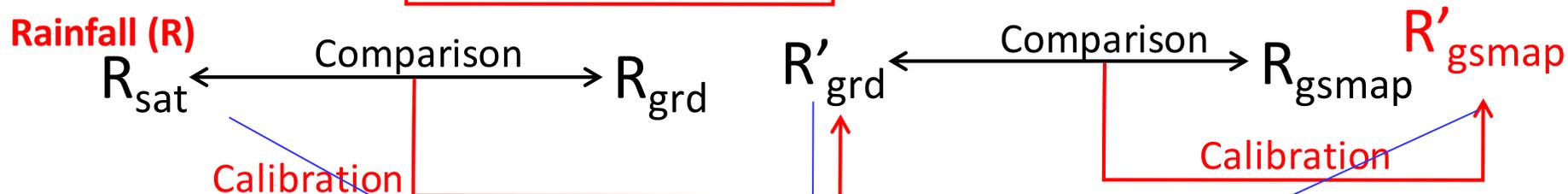
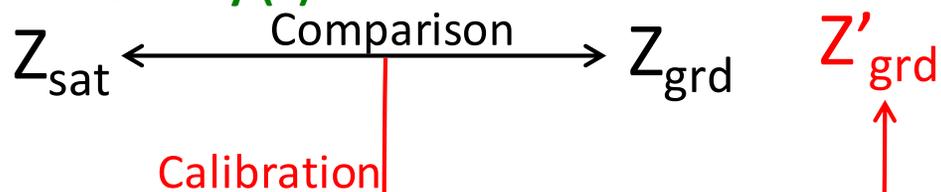


Ground-based radar



GSMaP_NRT

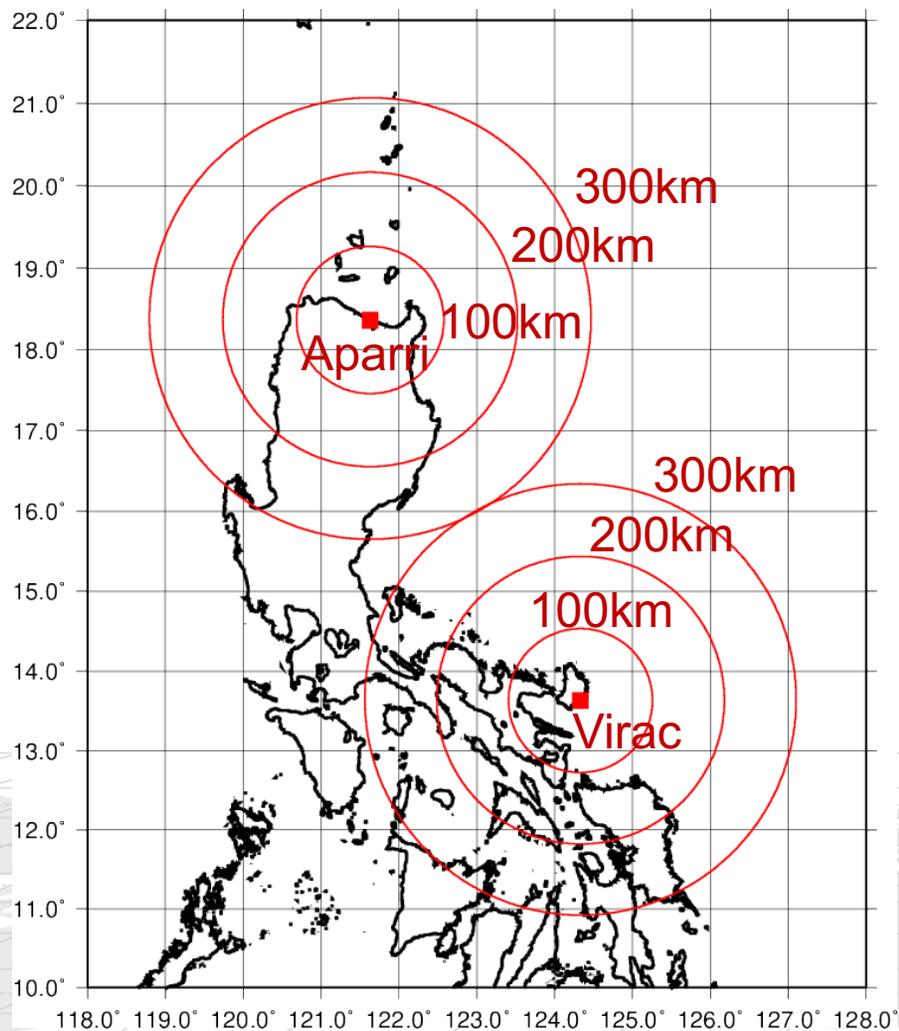
Radar reflectivity (Z)



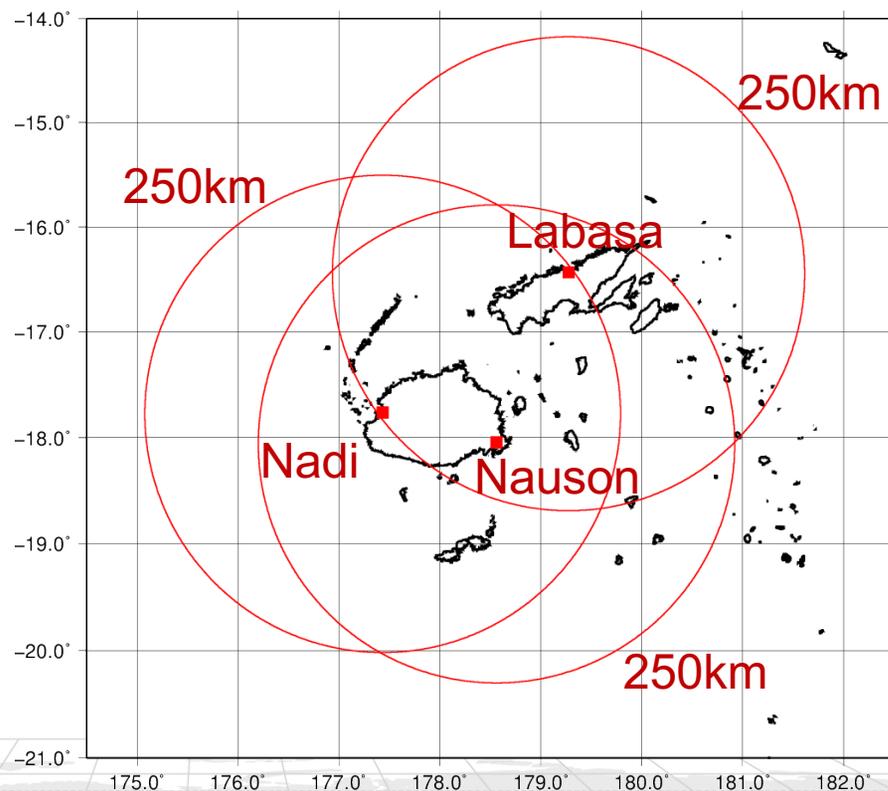
Rainfall composite
 (DPR + Ground radar + GSMaP)

Ground radar coverage

Philippines : 2 radars (Aparri, Virac)



Fiji : 3 radars (Nadi, Nauson, Labasa)

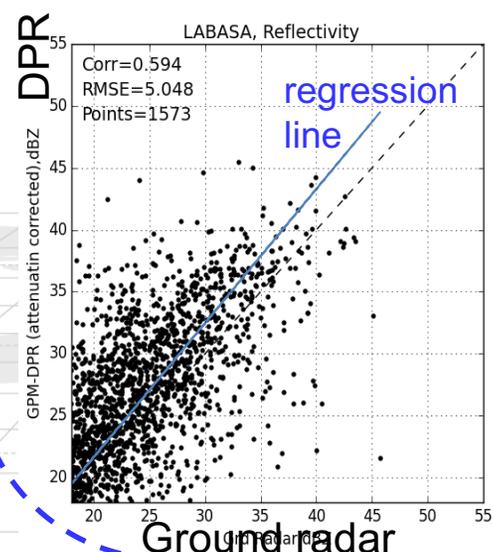
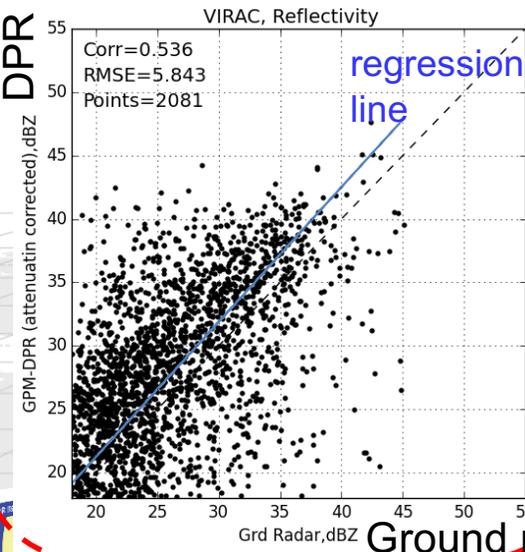
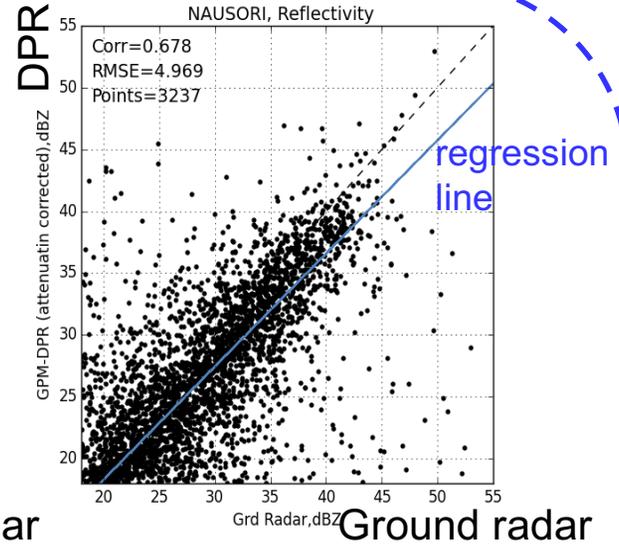
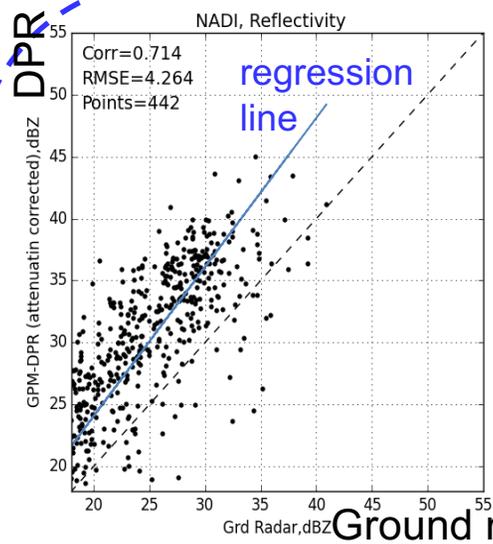
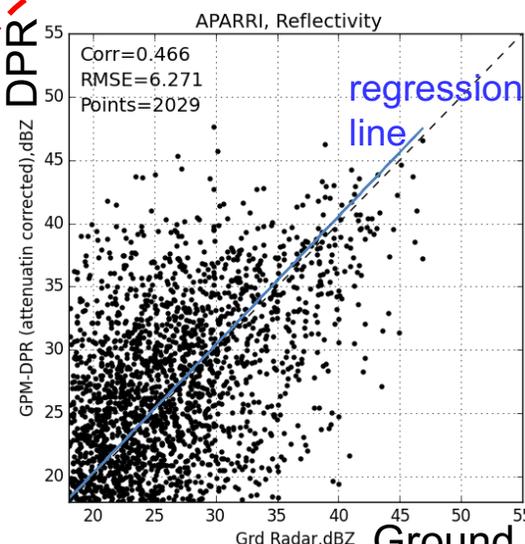


There are wider oceanic areas in Fiji radar coverages, while mountainous areas are included in the Philippines radar coverages.

Scatter plots: Ground radar Z vs DPR Z

Philippines

Fiji



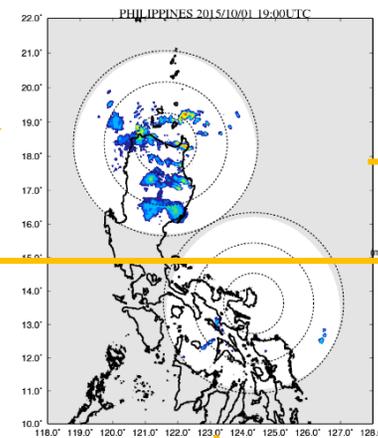
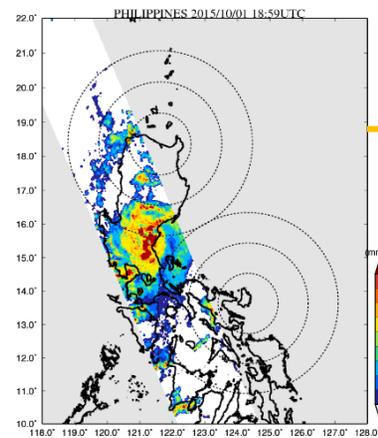
- Fiji radars have more apparent biases with the reference to the DPR than the Philippines radar
- Correlation coefficients are higher in the Fiji than in the Philippines, probably due to issues such as radar shadow in mountainous regions, radar quality, and etc.

Radar + GSMaP composite (Philippines)

DPR

Ground radar

$$G_j = \frac{1}{H_j} \left\{ \frac{1}{H_{rad,j}} \frac{\sum_{i=1}^N D_i W_i}{\sum_{i=1}^N W_i} + \frac{1}{H_{sat}} D_{sat,j} + \frac{1}{H_{gsmap}} D_{gsmap,j} \right\}$$



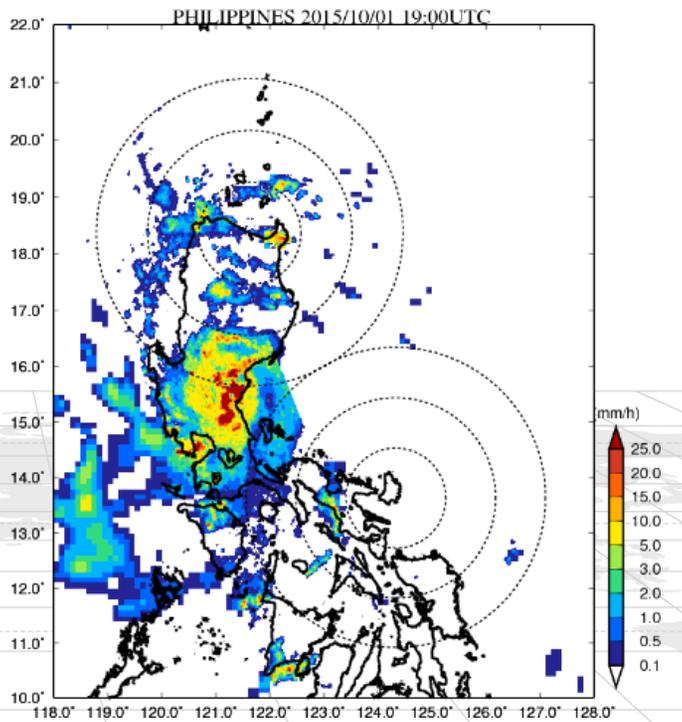
Weighting function

Ground Radar DPR GSMaP

Rainfall composite (Radar + GSMaP)

GSMaP (not calibrated)

Calibrated GSMaP



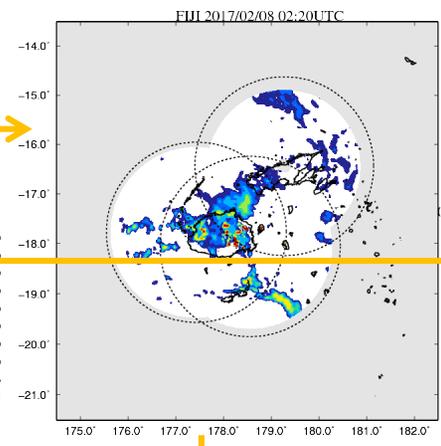
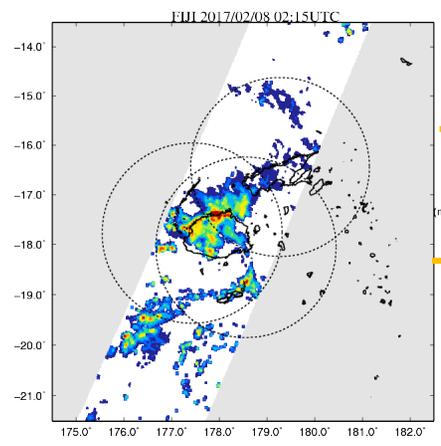
Radar + GSMap composite (Fiji)

DPR

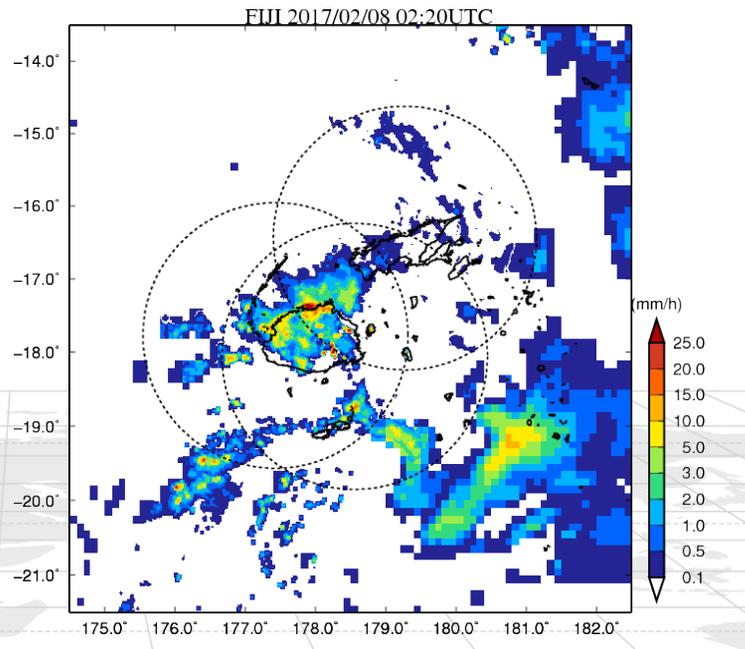
Ground radar

$$G_j = \frac{1}{H_j} \left\{ \frac{1}{H_{rad,j}} \frac{\sum_{i=1}^N D_i W_i}{\sum_{i=1}^N W_i} + \frac{1}{H_{sat}} D_{sat,j} + \frac{1}{H_{gsmap}} D_{gsmap,j} \right\}$$

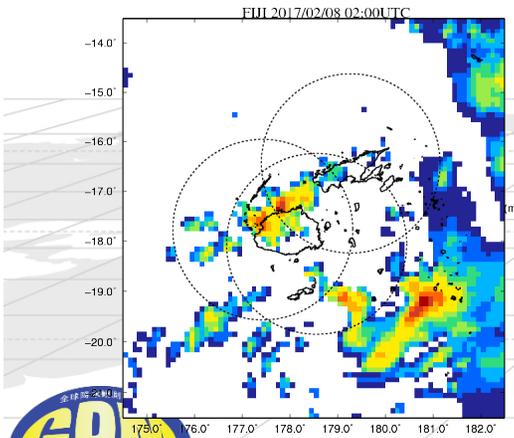
Weighting function Ground Radar DPR GSMap



Rainfall composite (Radar + GSMap)



GSMap (not calibrated)



Calibrated GSMap



Summary



- * **6th GPM Asia Workshop report**
- * **JAXA activity for the GSMaP applications.**
 - * **Here, recent progress in the rainfall monitoring over the Pacific islands and in hydrological system by the JAXA/EORC (YEE) were introduced.**
- * **Ground Radar Calibration using GPM/DPR for developing countries**
 - * **Preliminary results in the in the Philippines and the Fiji suggests that the ground radar calibration using spaceborne radar can be more effective in the developing countries.**
 - * **Ground radar coverage extension using GSMaP was also tested, which will enhance monitoring capability in the developing countries.**

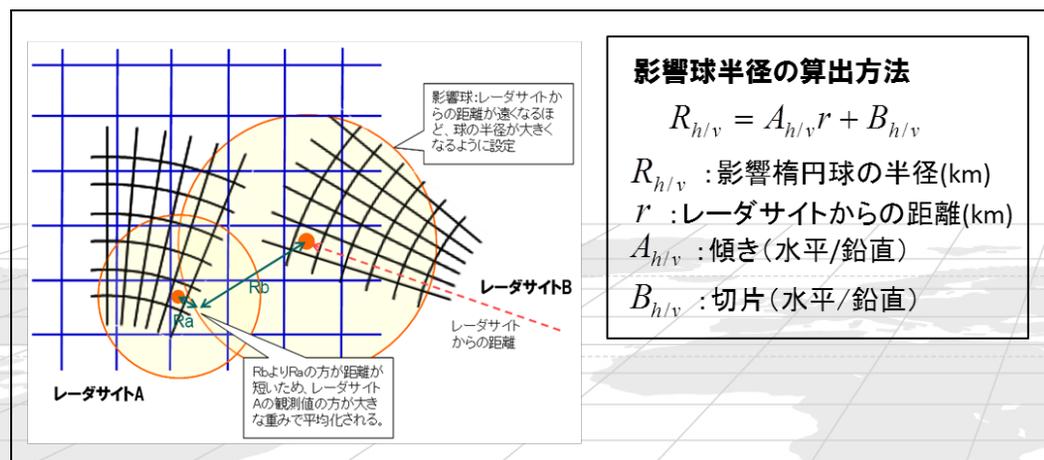
* Backup



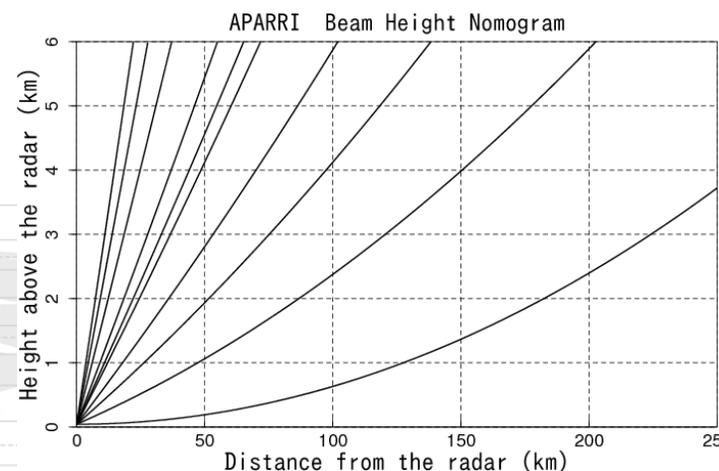
Data and Method

- * We collected 10 DPR overpasses for Philippines and 15 DPR overpasses for Fiji.
- * PPI data by the Ground Radar was converted to the CAPPI data using the Cressman (1959) method.

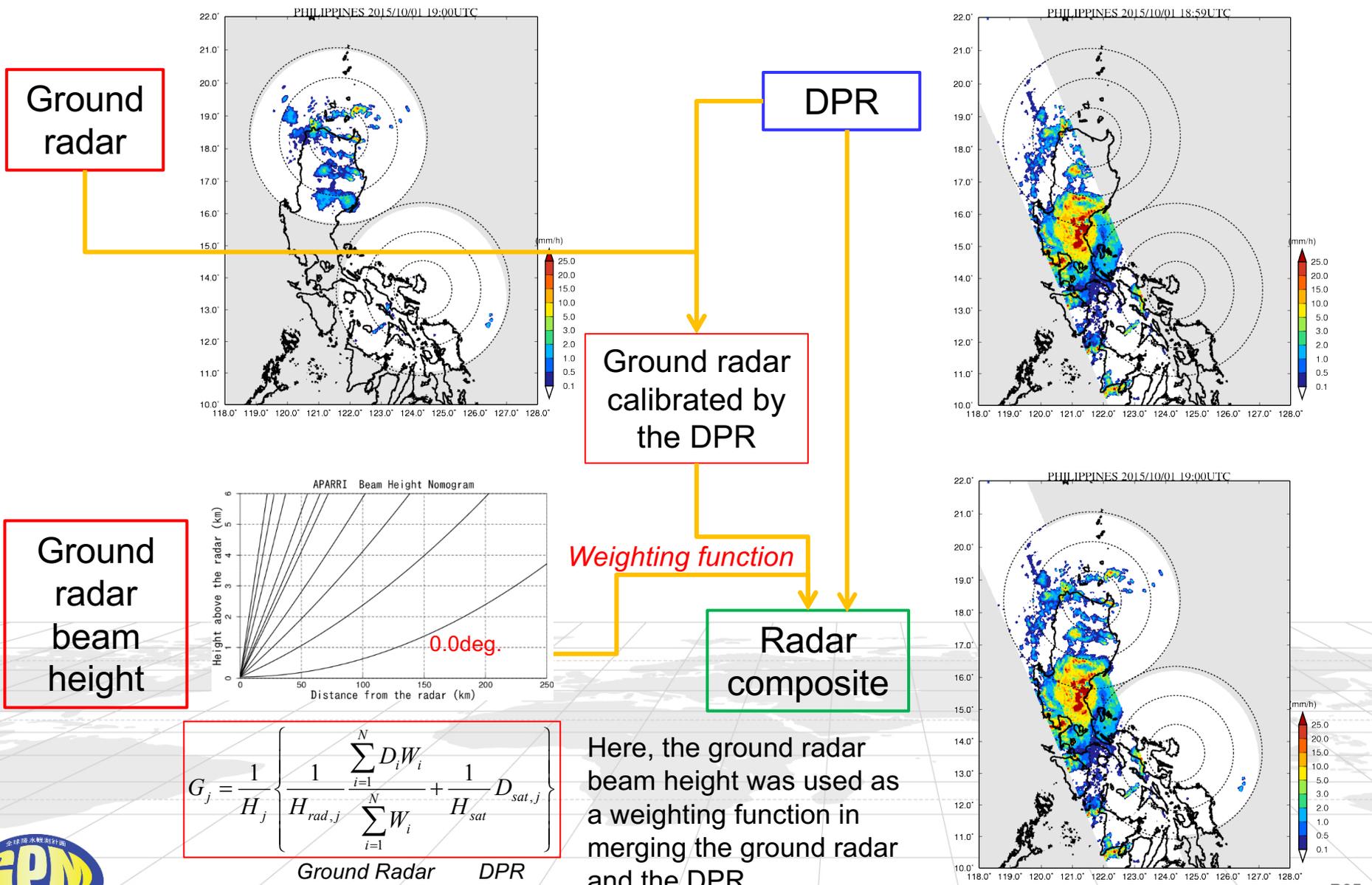
Concept of Cressman (1959) method



Radar beam height nomogram (e.g. Appari)



Radar composite



$$G_j = \frac{1}{H_j} \left\{ \frac{1}{H_{rad,j}} \frac{\sum_{i=1}^N D_i W_i}{\sum_{i=1}^N W_i} + \frac{1}{H_{sat}} D_{sat,j} \right\}$$

Ground Radar DPR

Here, the ground radar beam height was used as a weighting function in merging the ground radar and the DPR.