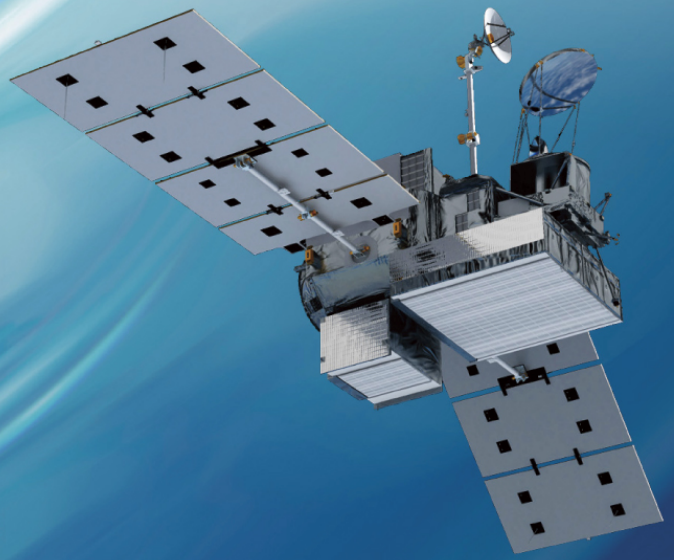
JAXA GPM Application Science



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

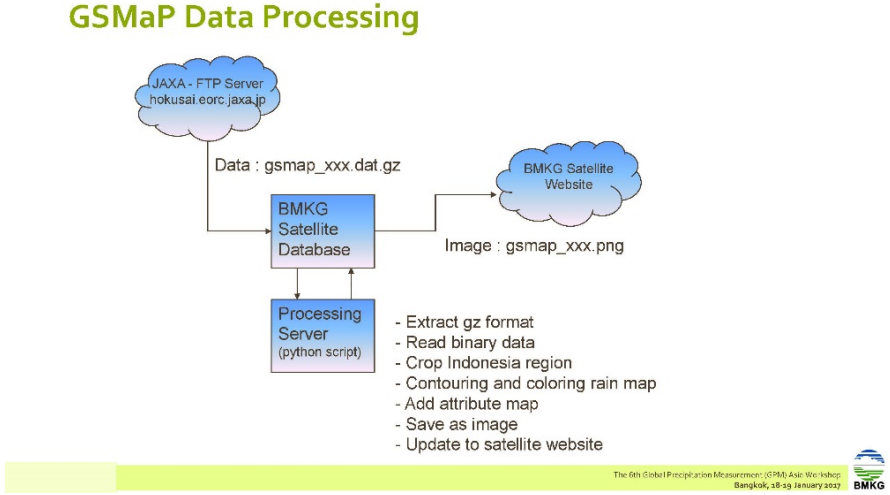
Promotion of GPM data utilization and application in Asia

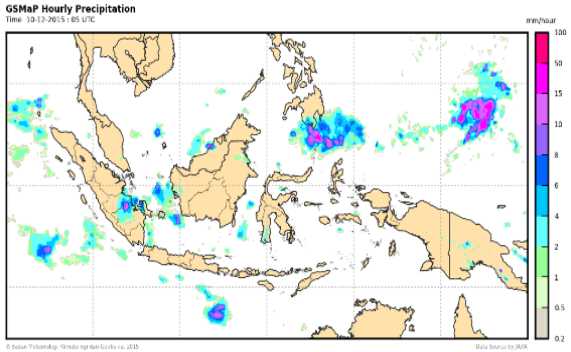
- **The 6th GPM Asia Workshop on Satellite Precipitation Data Utilization**
  - **Held in Thai meteorological department (TMD) on 18-19 Jan., 2017**
- **Purpose of the workshop:**
  - **To promote satellite precipitation data utilization in Asia, and move forward research activities related to GPM in 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 Oscilation (MJO) Monitoring over Indonesia (Asri Susilawati, BMKG, Indonesia)

Operational flow of the GSMaP data processing in the BMKG





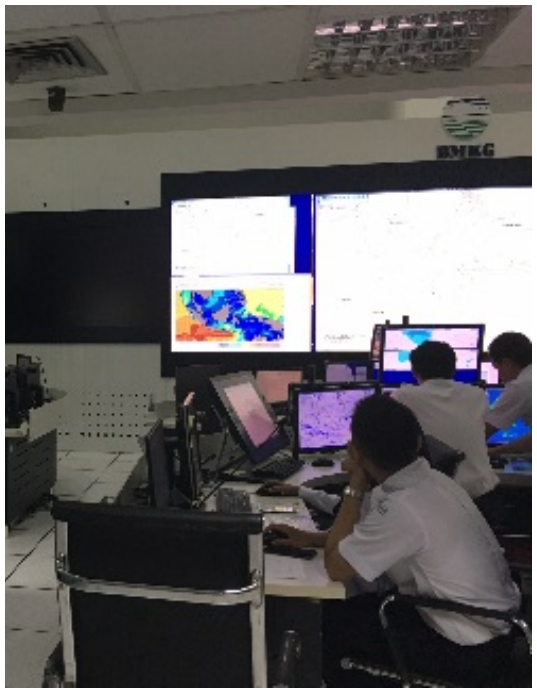
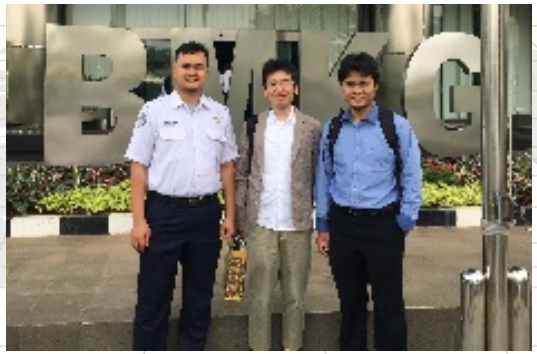


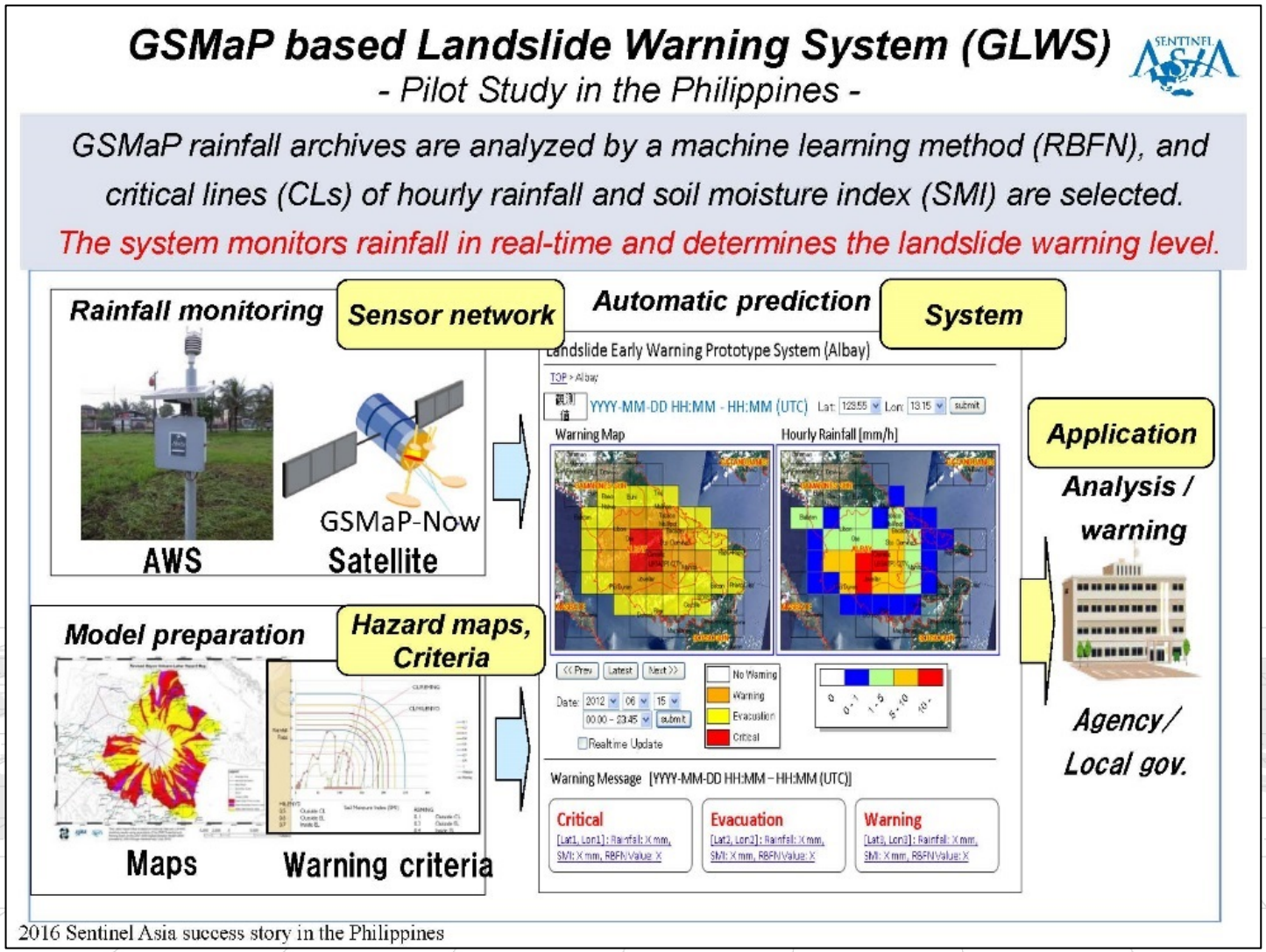
Photo for operational GSMaP utilization in the BMKG, taken by Prof. S. Shige (Kyoto Univ.)



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

Presentation by the PHIVOLCS, Philippine, in the workshop

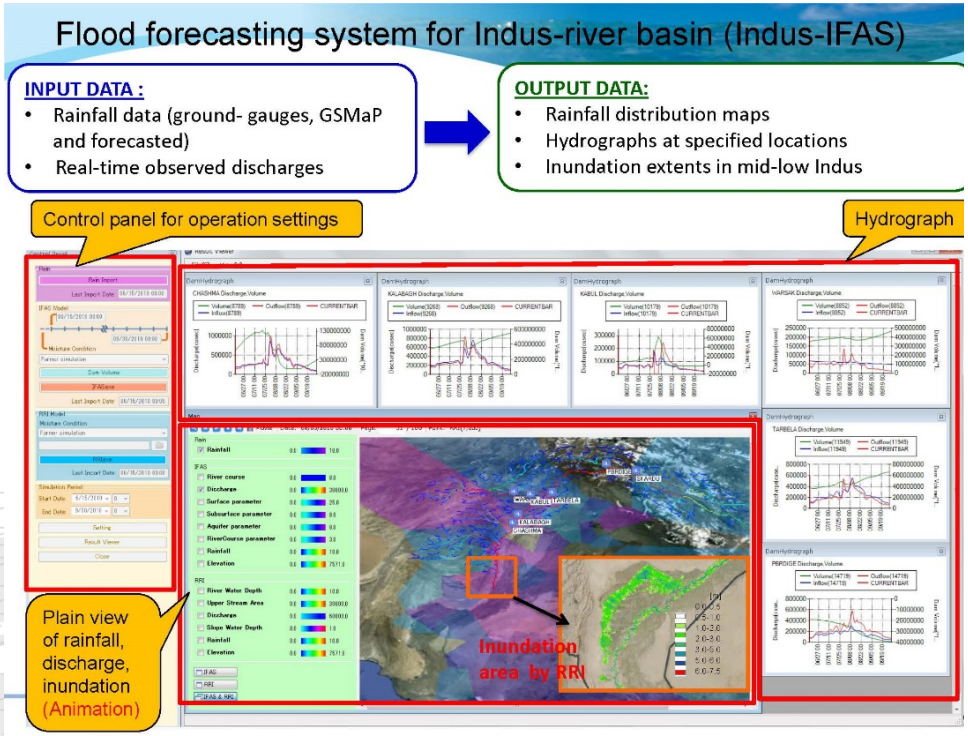
GSMaP-based Landslide Warning System - A prototype Project in the Philippines under the Sentinel Asia (Arturo S. Daag, PHIVOLCS, Philippine)



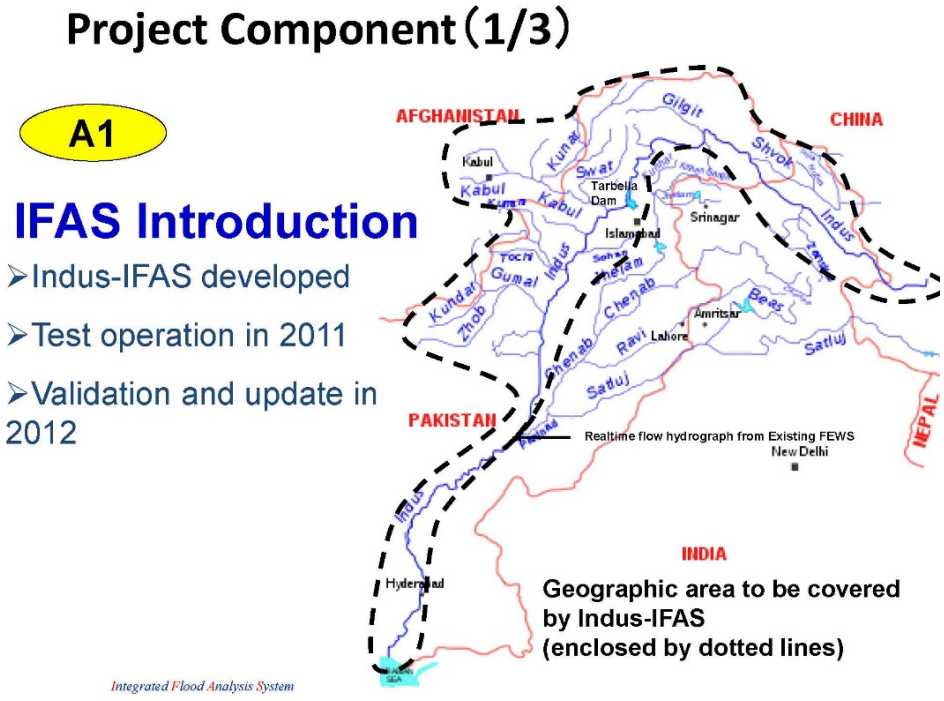
2016 Sentinel Asia success story in the Philippines

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)

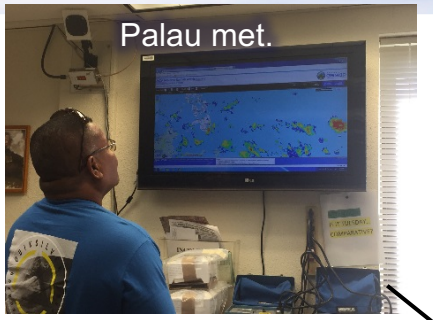


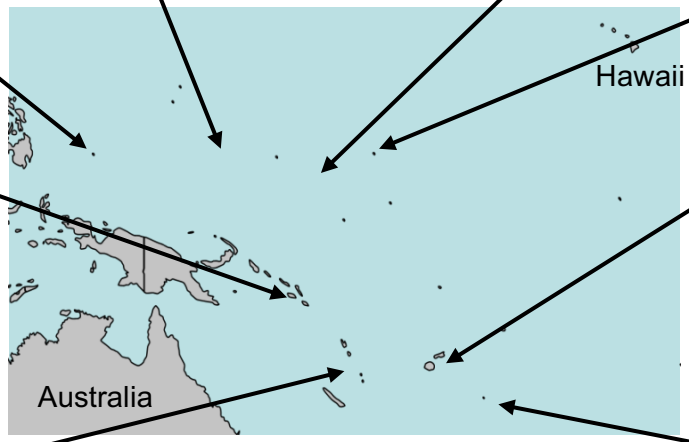
Strategic Strengthening of Flood Warning and Management Capacity and Importance & Applications of JAXA GSMaP_NRT(hourly) in Pakistan (Shahzada Adnan, PMD, Pakistan)

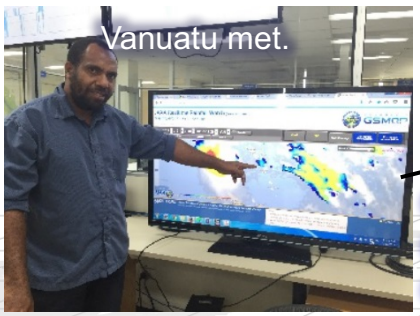


GSMaP applications for Rainfall monitoring

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

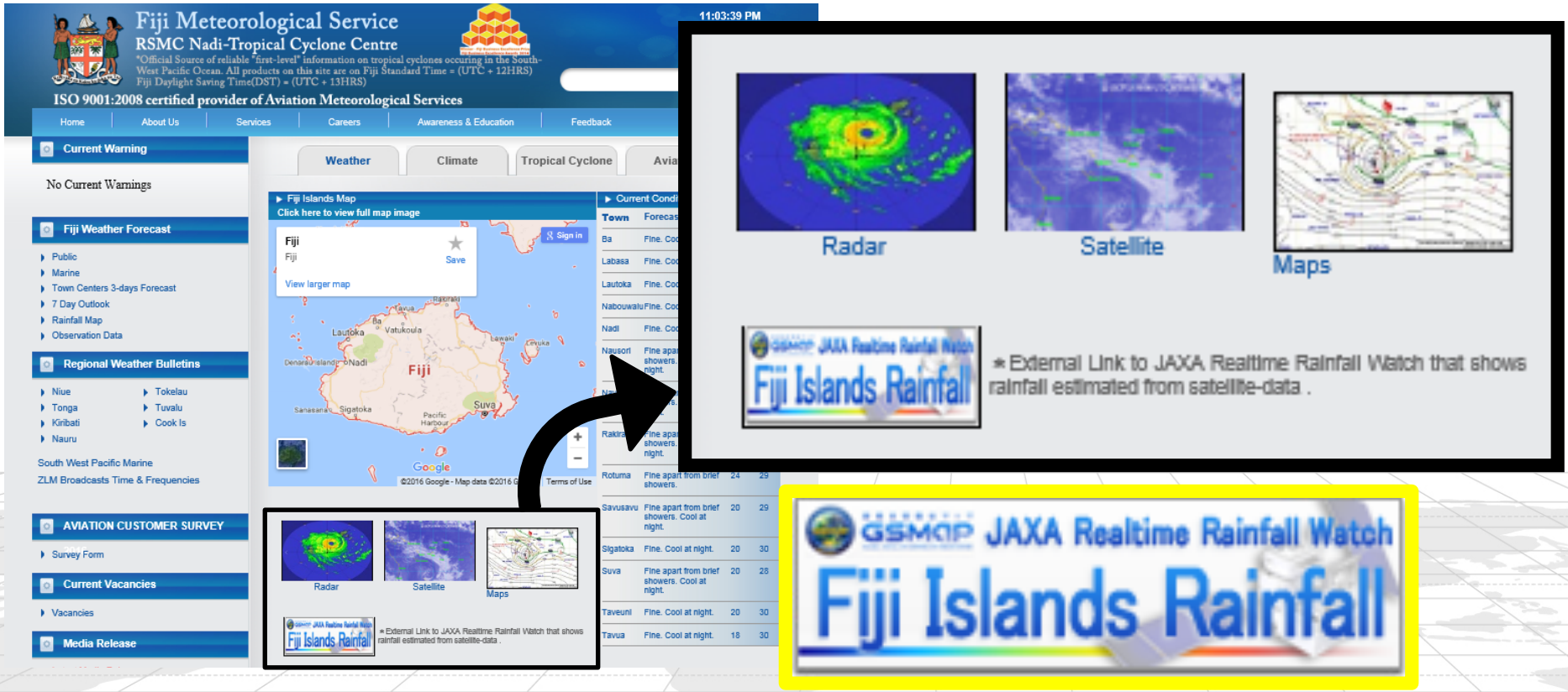
With Japan International Cooperation Agency (JICA), local Meteorological Office in the Pacific islands started to use GSMaP NOW to capture the horizontal precipitation distribution around their Islands.

Utilization of GSMaP in Fiji

20th Sep. 2016

Started to Link to GSMaP website from FMS HP

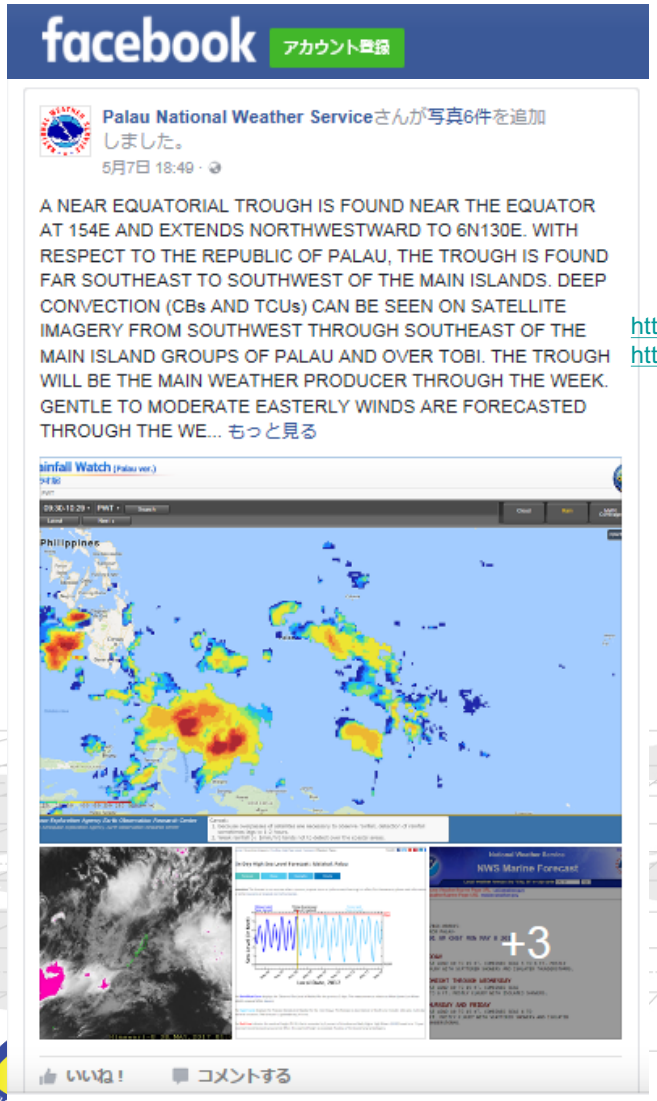
http://www.met.gov.fj/

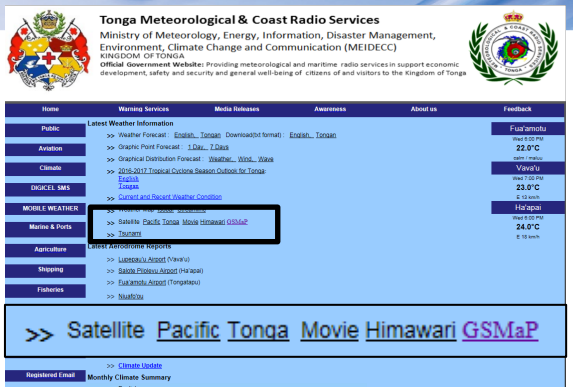


* External Link to JAXA Realtime Rainfall Watch that show rainfall estimated from satellite-data .

Utilization in other Pacific islands

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

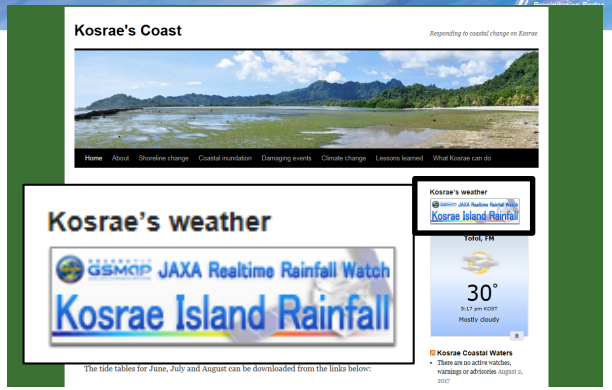




Tonga met service

http://www.met.gov.to/

http://sharaku.eorc.jaxa.jp/GSMaP_NOW/tonga.htm



Kosrae (Micronesia) resource management office

http://kosraecoast.com/

http://sharaku.eorc.jaxa.jp/GSMaP_NOW/kosrae.htm

Solomon met service

http://www.met.gov.sb/

http://sharaku.eorc.jaxa.jp/GSMaP_NOW/solomon.htm

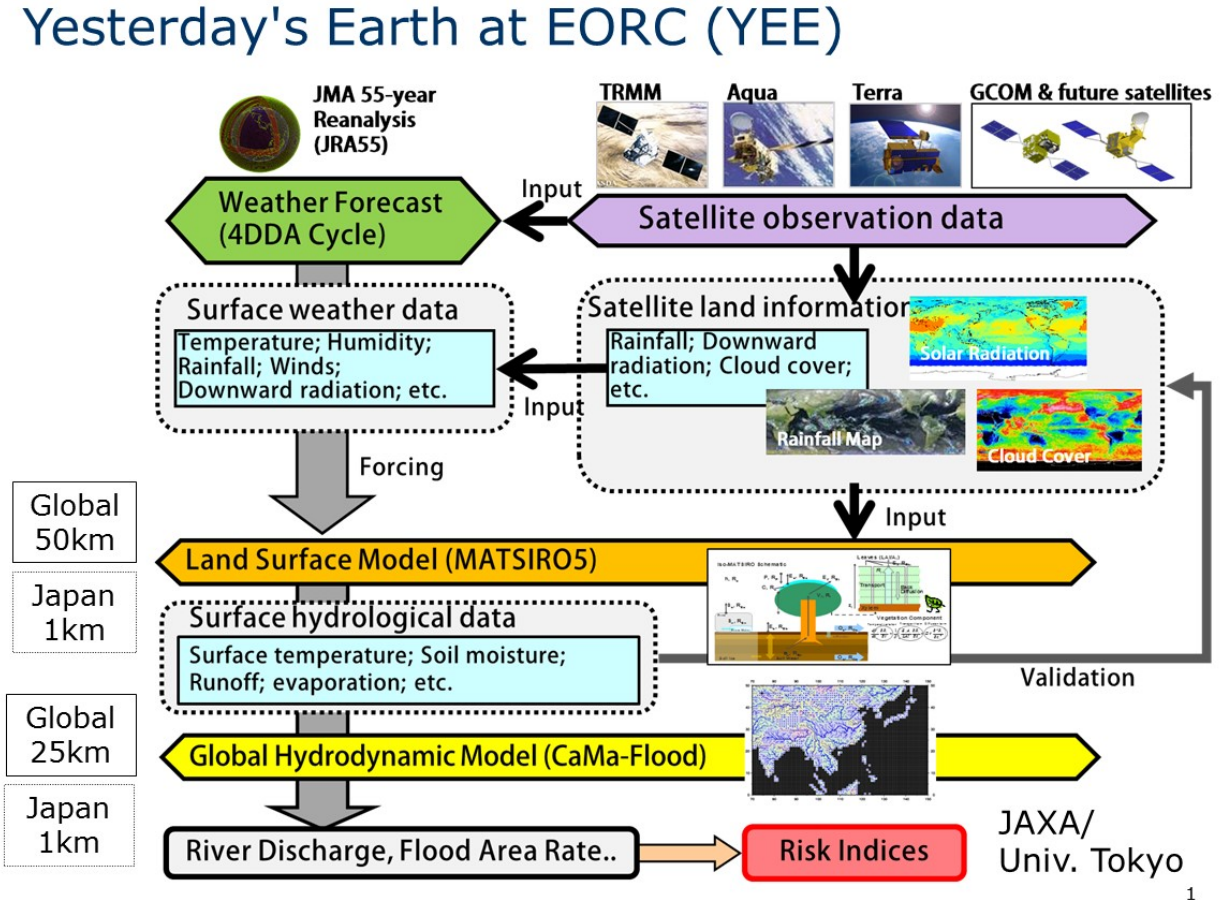
Tonga met service, Solomon met service, and Kosrae (Micronesia) resource management office also put the link to GSMaP in their own website. The publics in the islands can use this system via internet access.

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.**

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

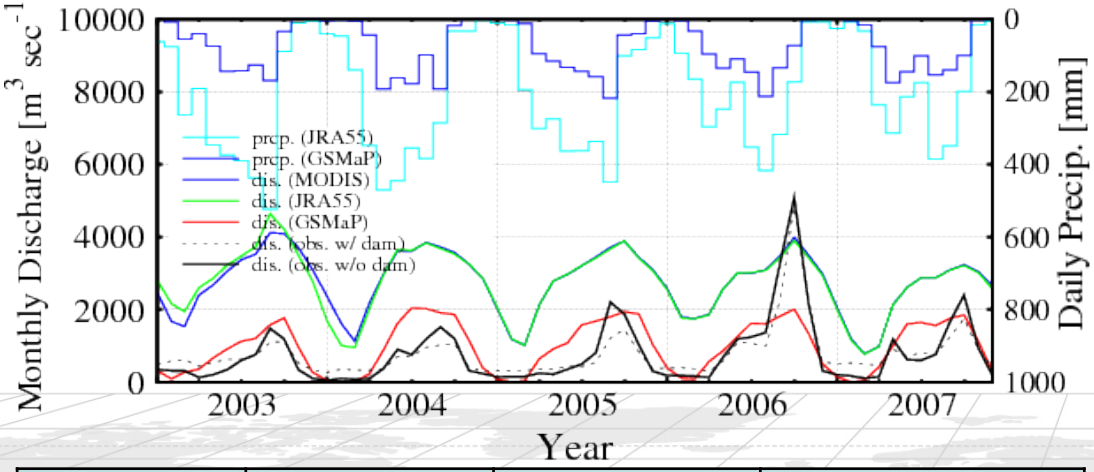


GSMaP effects in YEE system

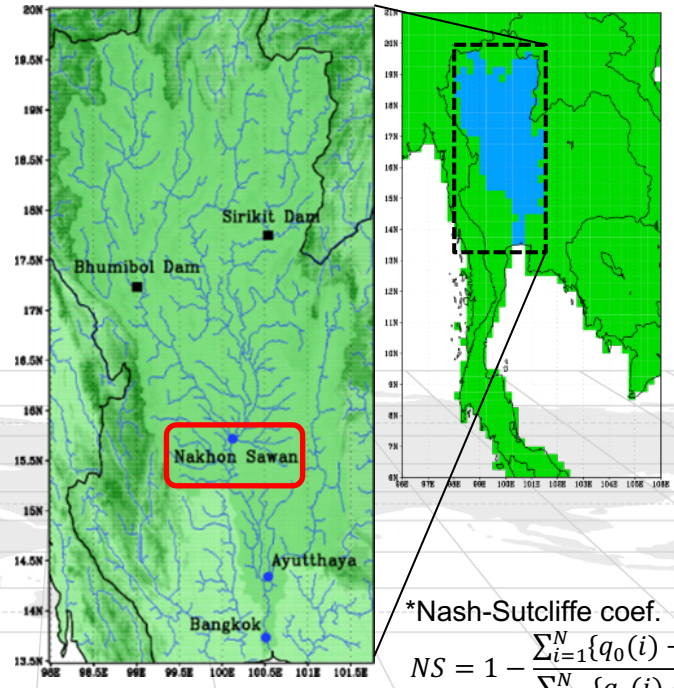
1. Evaluation of River Discharge

- 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 (preciptaiton 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



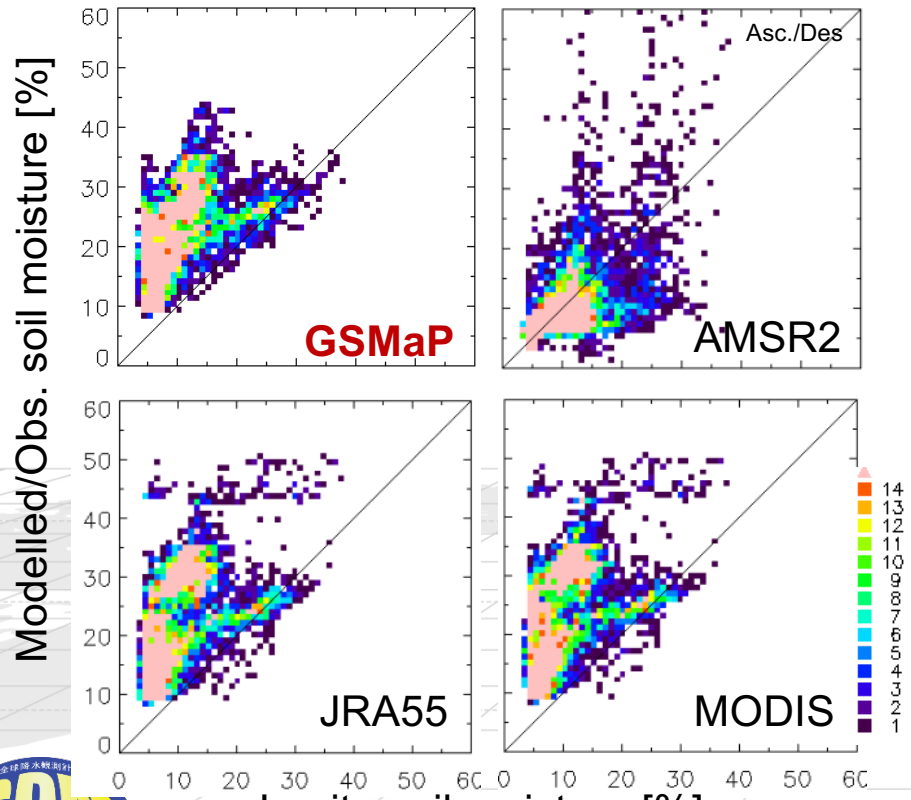
*Nash-Sutcliffe coef.

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

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 (preciptaiton 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

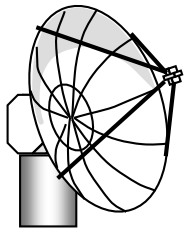
Radar Calibration using GPM/DPR for developing countries

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)

Z_{sat} ⟷ Comparison ⟷ Z_{grd} → Z'_{grd}

Calibration

Rainfall (R)

R_{sat} ⟷ Comparison ⟷ R_{grd} → R'_{grd} ⟷ Comparison ⟷ R_{gsmap} → R'_{gsmap}

Calibration

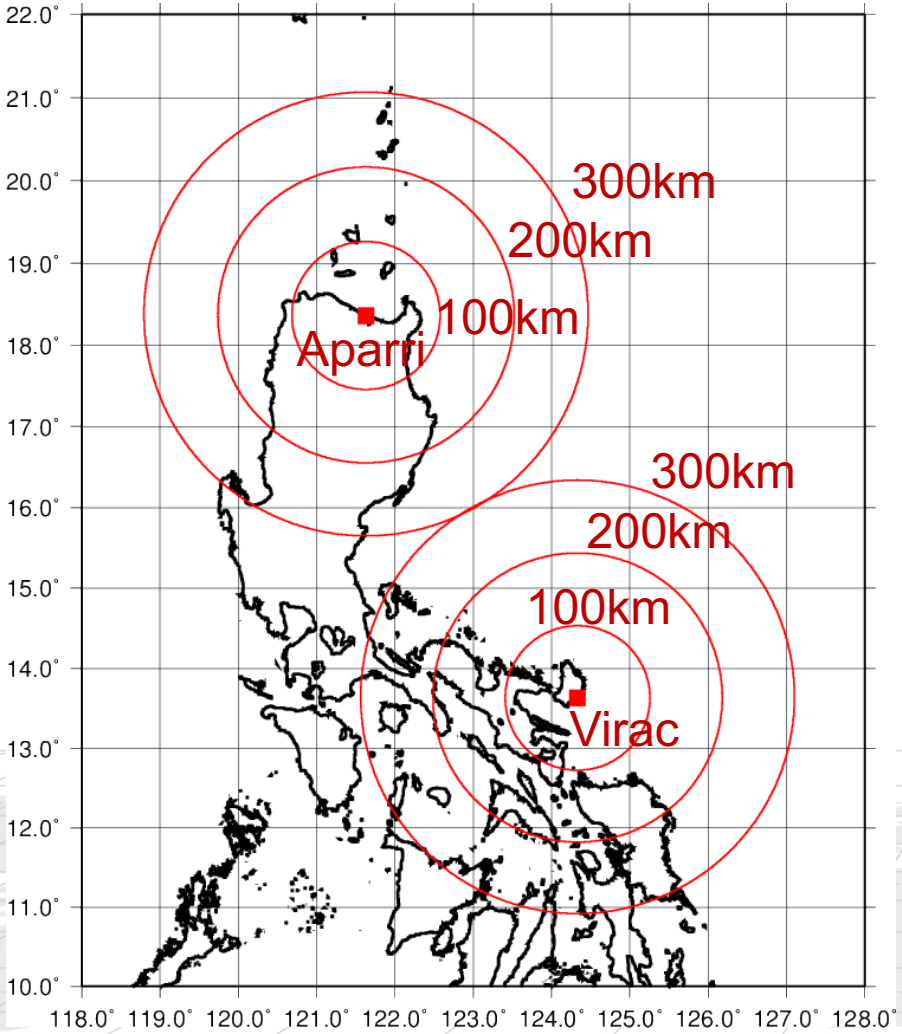
Calibration

Rainfall composite

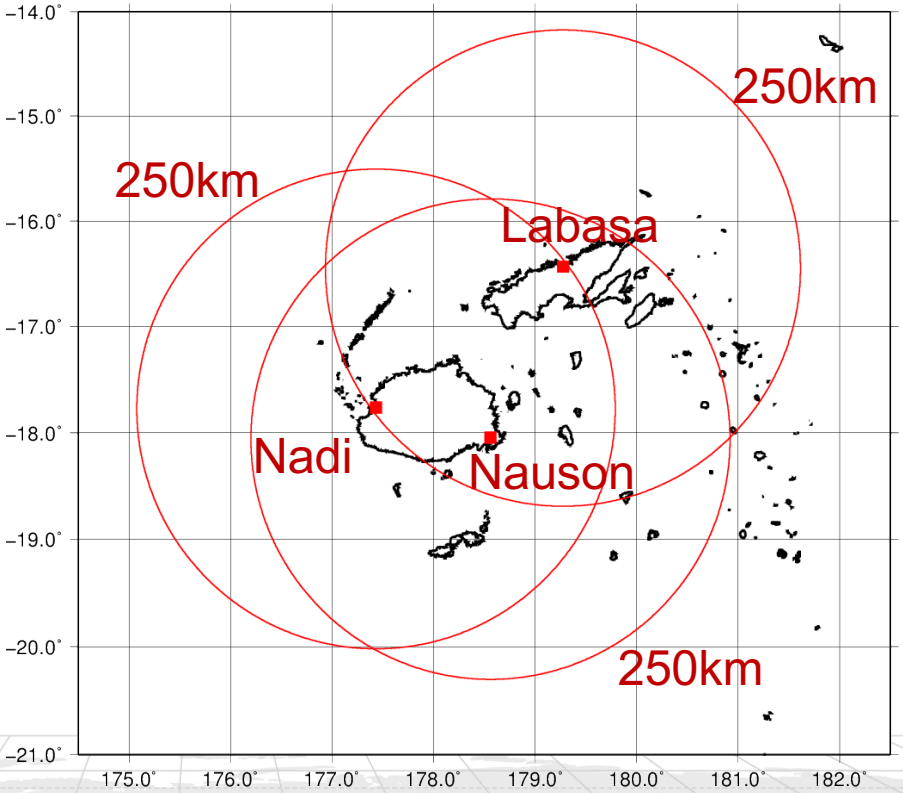
(DPR + Ground radar + GSMaP)

Ground radar coverage

Philippines : 2 radars (Aparri, Virac)



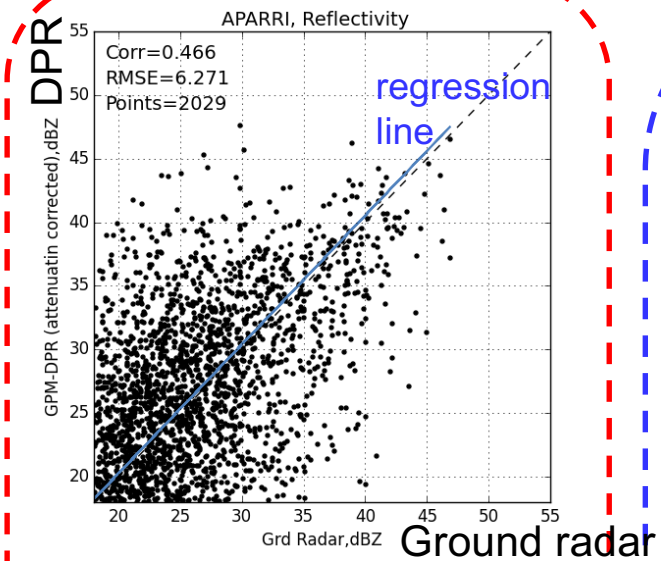
Fiji : 3 radars (Nadi, Nauson, Labasa)

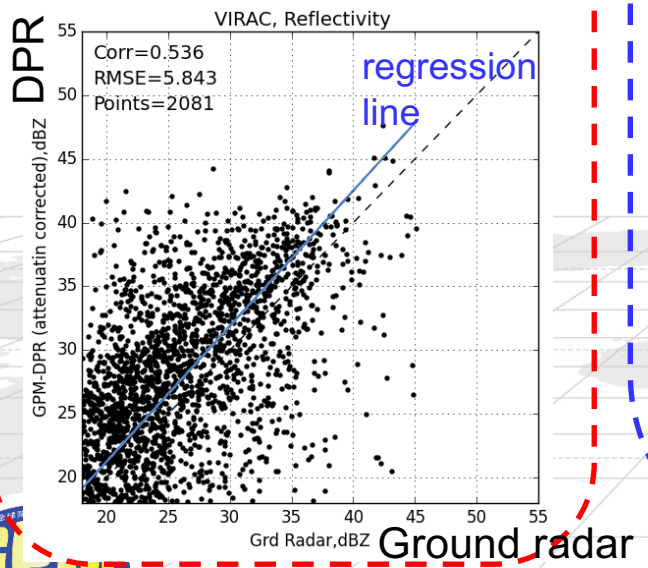


There are wider oceanic areas in Fiji radar coverages, while mountainous areas are included in the Philippines radar coverages.

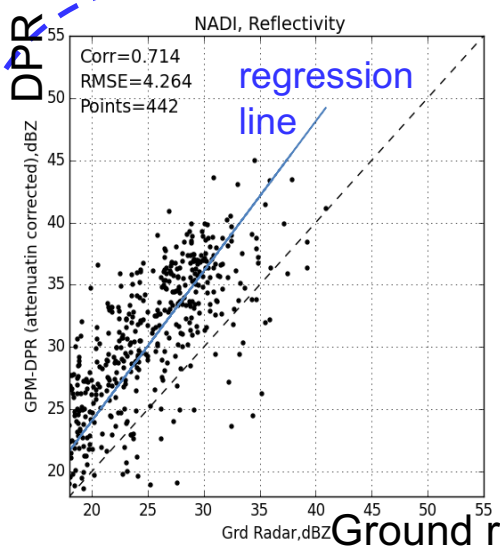
Scatter plots: Ground radar Z vs DPR Z

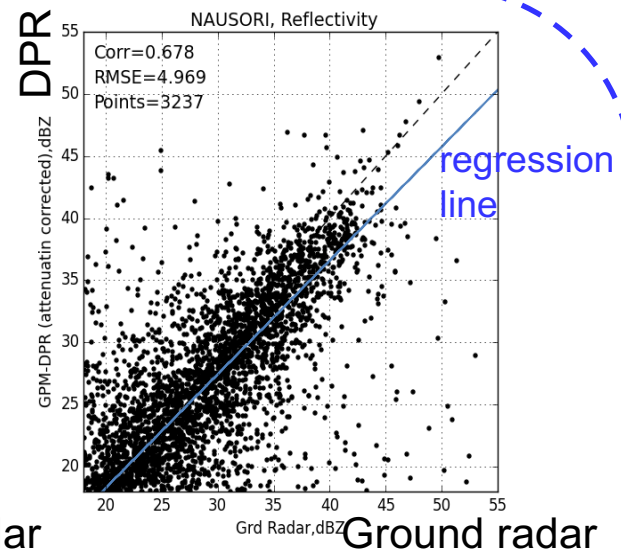
Philippines

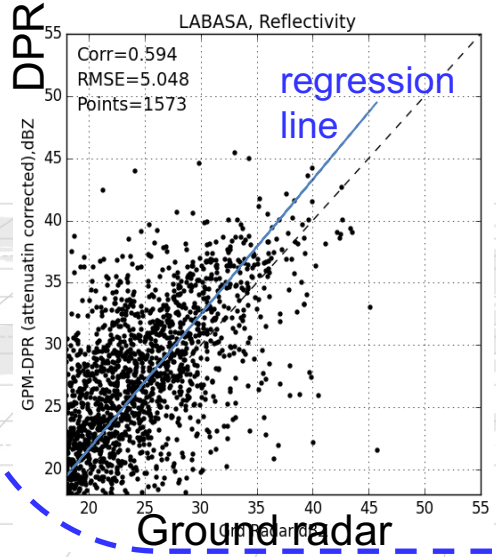




Fiji







- 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)

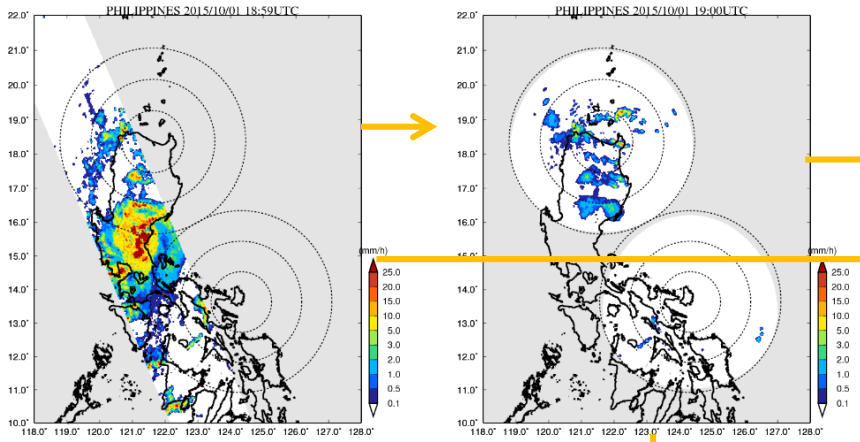
DPR

Ground radar

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

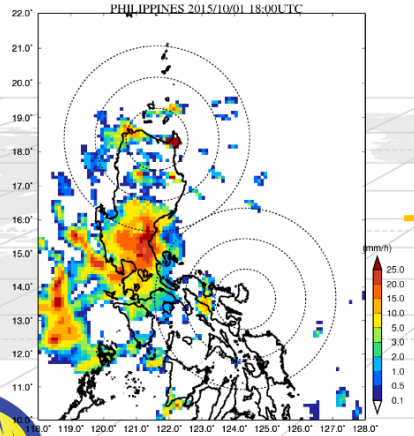
Weighting function

Ground Radar DPR GSMaP

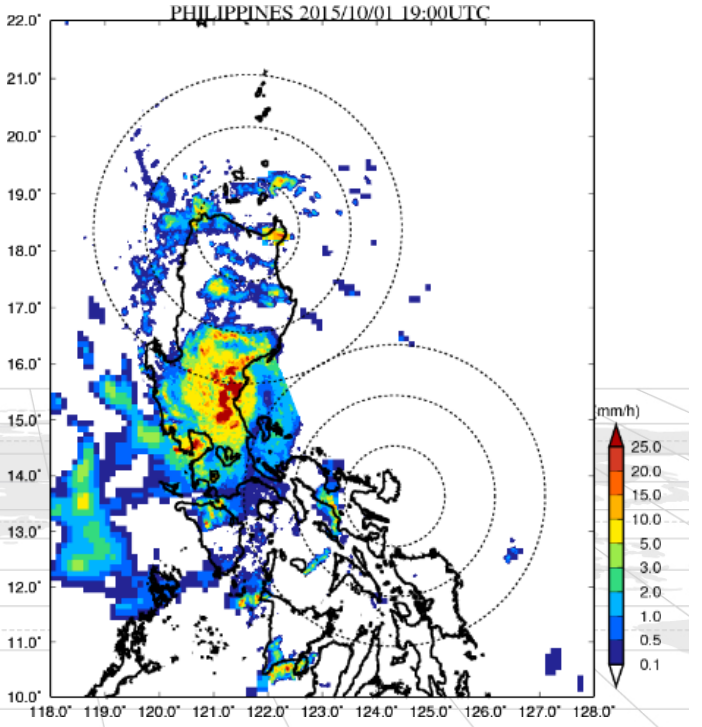


Rainfall composite (Radar + GSMaP)

GSMaP (not calibrated)



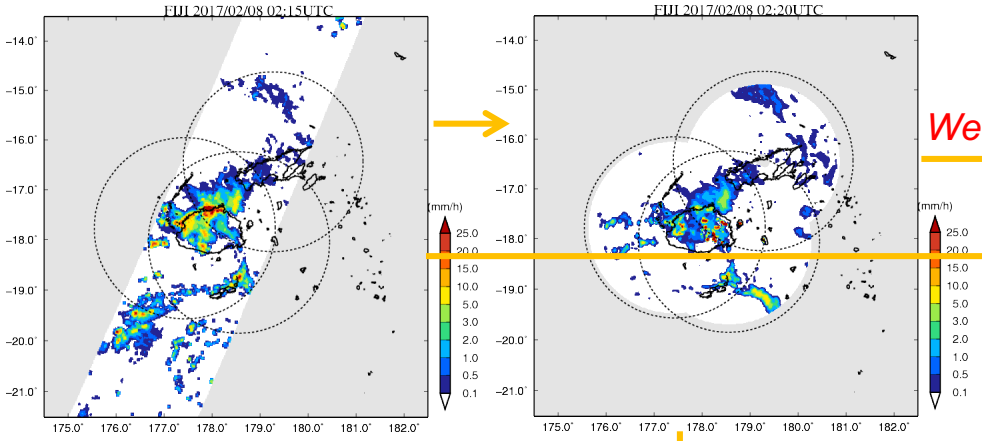
Calibrated GSMaP



Radar + GSMaP composite (Fiji)

DPR

Ground radar



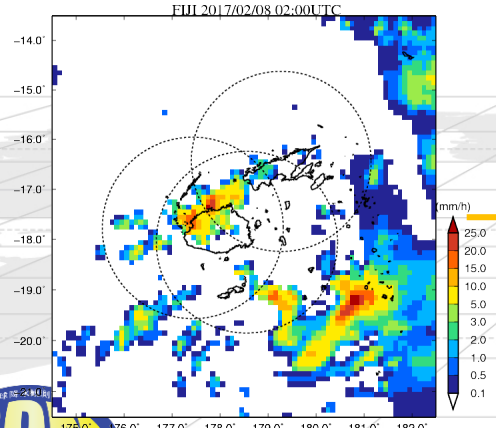
$$G_j = \frac{1}{H_j}\left\{\frac{1}{H_{rad,j}}\frac{\sum_{i=1}^{N} D_i W_i}{\sum_{i=1}^{N} W_i} + \frac{1}{H_{sat}} D_{sat,j} + \frac{1}{H_{gsmap}} D_{gsmap,j}\right\}$$

Weighting function

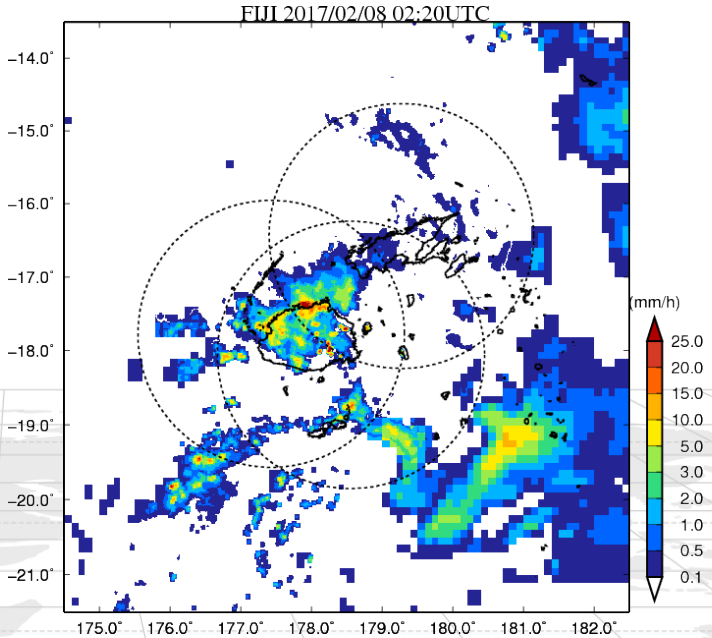
Ground Radar DPR GSMaP

Rainfall composite (Radar + GSMaP)

GSMaP (not calibrated)



Calibrated GSMaP



Summary

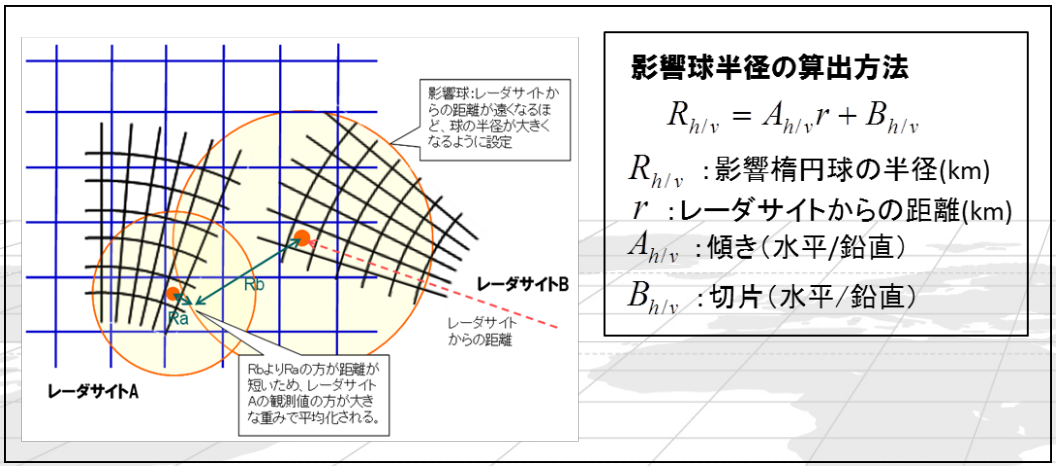
- 6th GPM Asia Workshop report
- JAXA activity for the GSMaP applications.
  - Here, recent progress in the rainfall monitoring over the Pacific islands and in hydrological system by the JAXA/EORC (YEE) were introduced.
- Ground Radar Calibration using GPM/DPR for developing countries
  - Preliminary 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

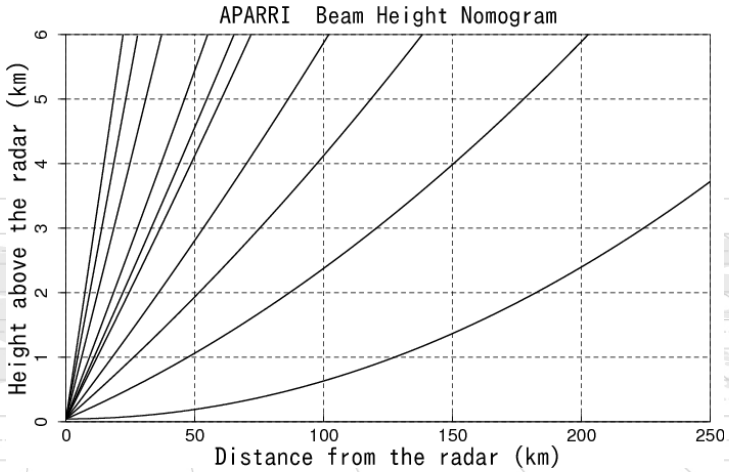


影響球半径の算出方法

$$R_{h/v} = A_{h/v} r + B_{h/v}$$

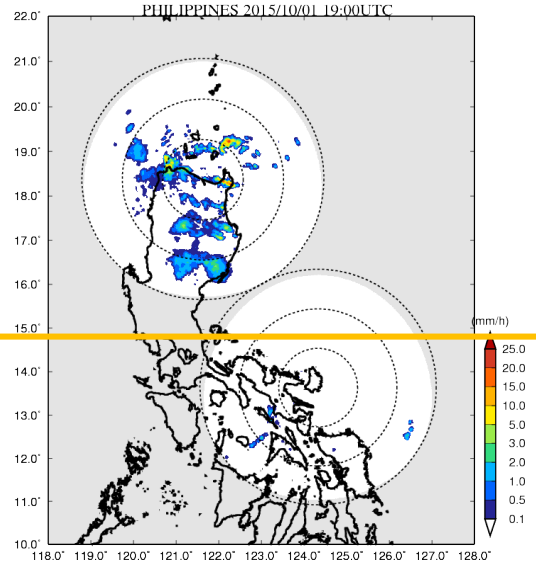
$R_{h/v}$:影響楕円球の半径(km)
r :レーダサイトからの距離(km)
$A_{h/v}$:傾き(水平/鉛直)
$B_{h/v}$:切片(水平/鉛直)

Radar beam height nomogram (e.g. Appari)

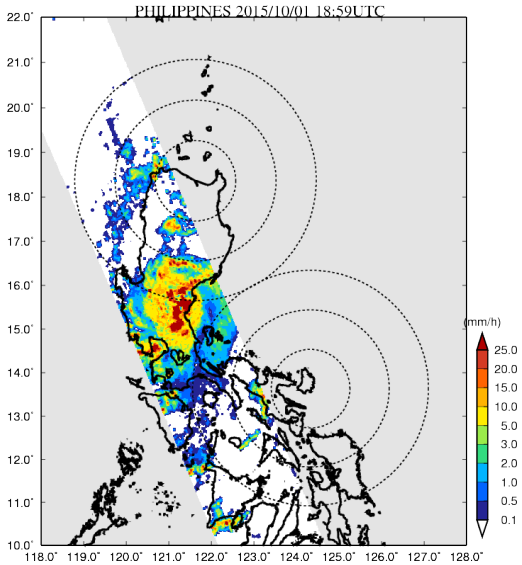


Radar composite

Ground radar

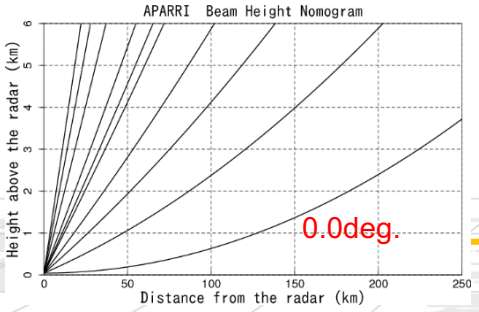


DPR



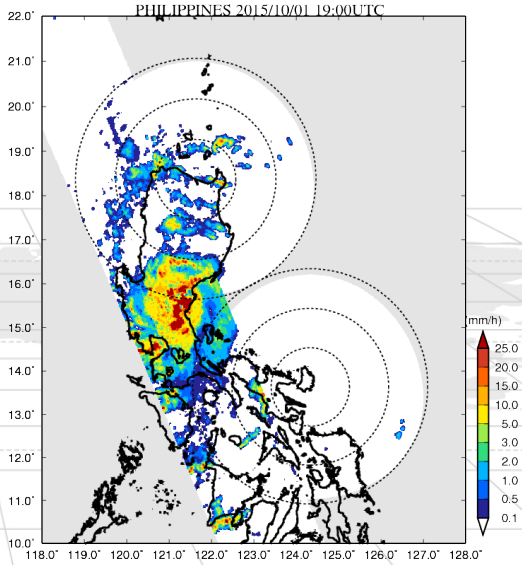
Ground radar calibrated by the DPR

Ground radar beam height



Weighting function

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.