

Satellite-based Global High-resolution Rainfall Data “GSMaP”

13:00-13:30 UTC, November 5, 2021

Session 4: Data Access and Tools (including practical demonstrations),
Seventh WMO International Workshop on Monsoons (IWM-7) ONLINE TRAINING WORKSHOP ON
SUBSEASONAL TO SEASONAL (S2S) PREDICTION OF MONSOONS

Moeka YAMAJI

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Dual-frequency Precipitation Radar

DPR

DPR provides
"reference standard"

GPM
Microwave
Imager

GPM
Core
Observatory

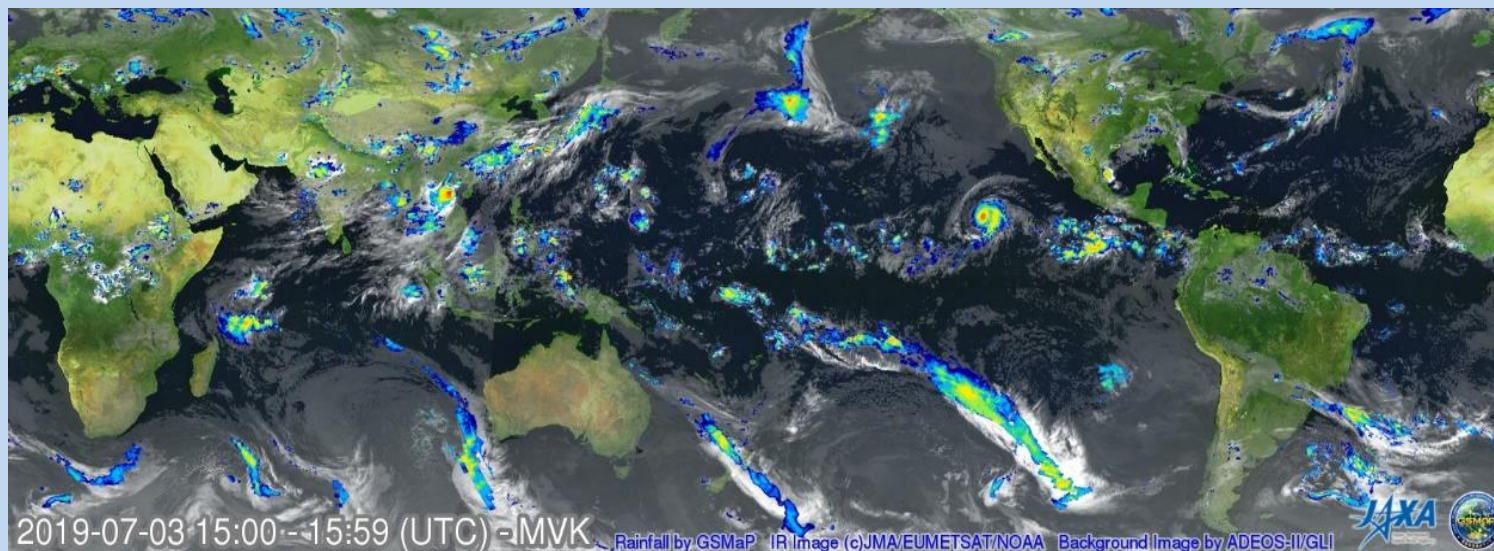
GPM
constellation
satellites

Geostationary
Satellites



©JMA

GPM
Multi
Satellite
Rainfall
Product



衛星全球降水マップ

GSMaP

GLOBAL SATELLITE MAPPING OF PRECIPITATION

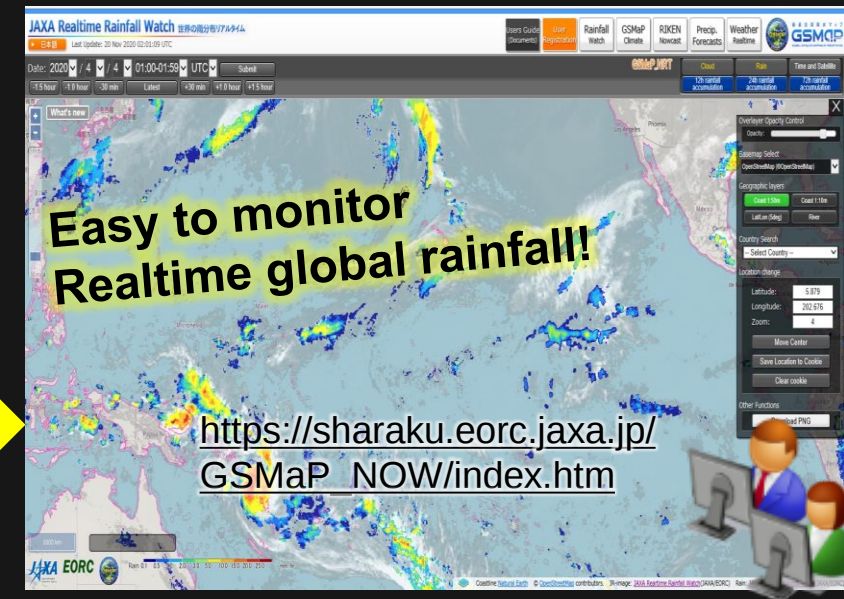
Realtime!
Statistics!
Long-term!





- Hourly global rainfall data
- Spatial resolution: about 11x11km
- Various version such as real-time for monitoring or long-term gauge-adjusted for climatological purposes

8321 registrations
 from **141** countries/regions
 + **website users** (not registered)
 (as of October 2021)



The unique advantage of GSMaP

- Space-based rainfall observations allow us to capture the rainfall **even in the area lack of ground-based observations.**
- Rainfall can be measured **globally, continuous and same interval, and consistent accuracy.**
- **Open and freely available** via web-based GUI, FTP site and data analysis cloud platforms (ex. Tellus, GEE)
- **Long-term archive data** for more than **20 years** (since 2000)

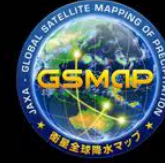


- 1. Web-basis tools and dataset using Global precipitation product “GSMaP”**
- 2. Introduction of algorithm and validation**
- 3. Practical use cases of the rainfall data including WMO project**

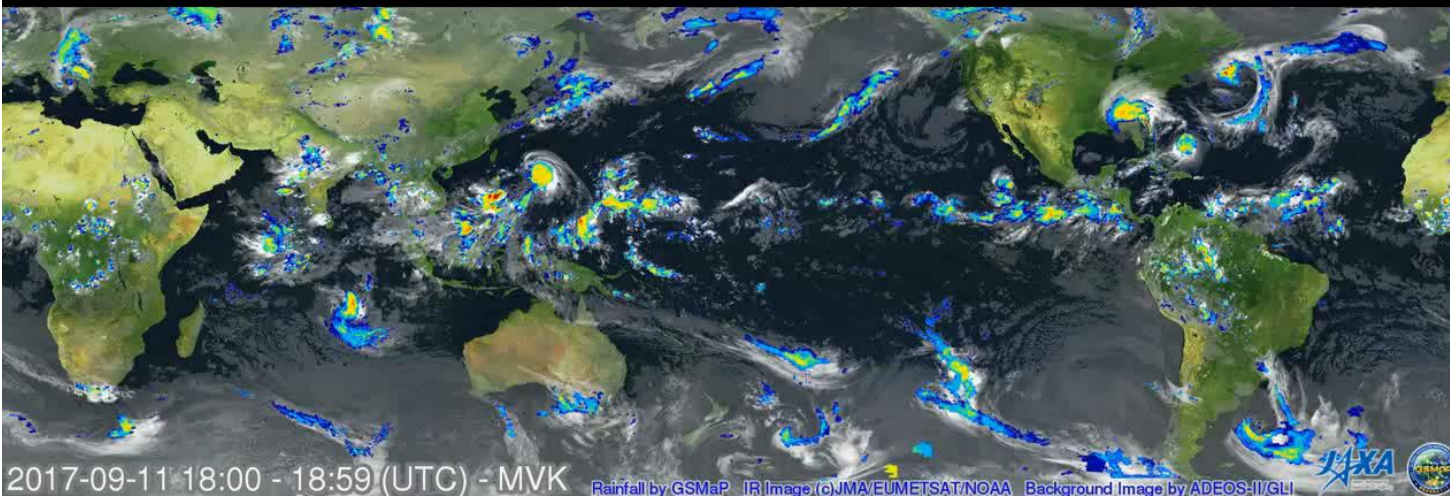


1. Web-basis tools and dataset using Global precipitation product “GSMPaP”

in 1 minute!



How to use GSMaP website



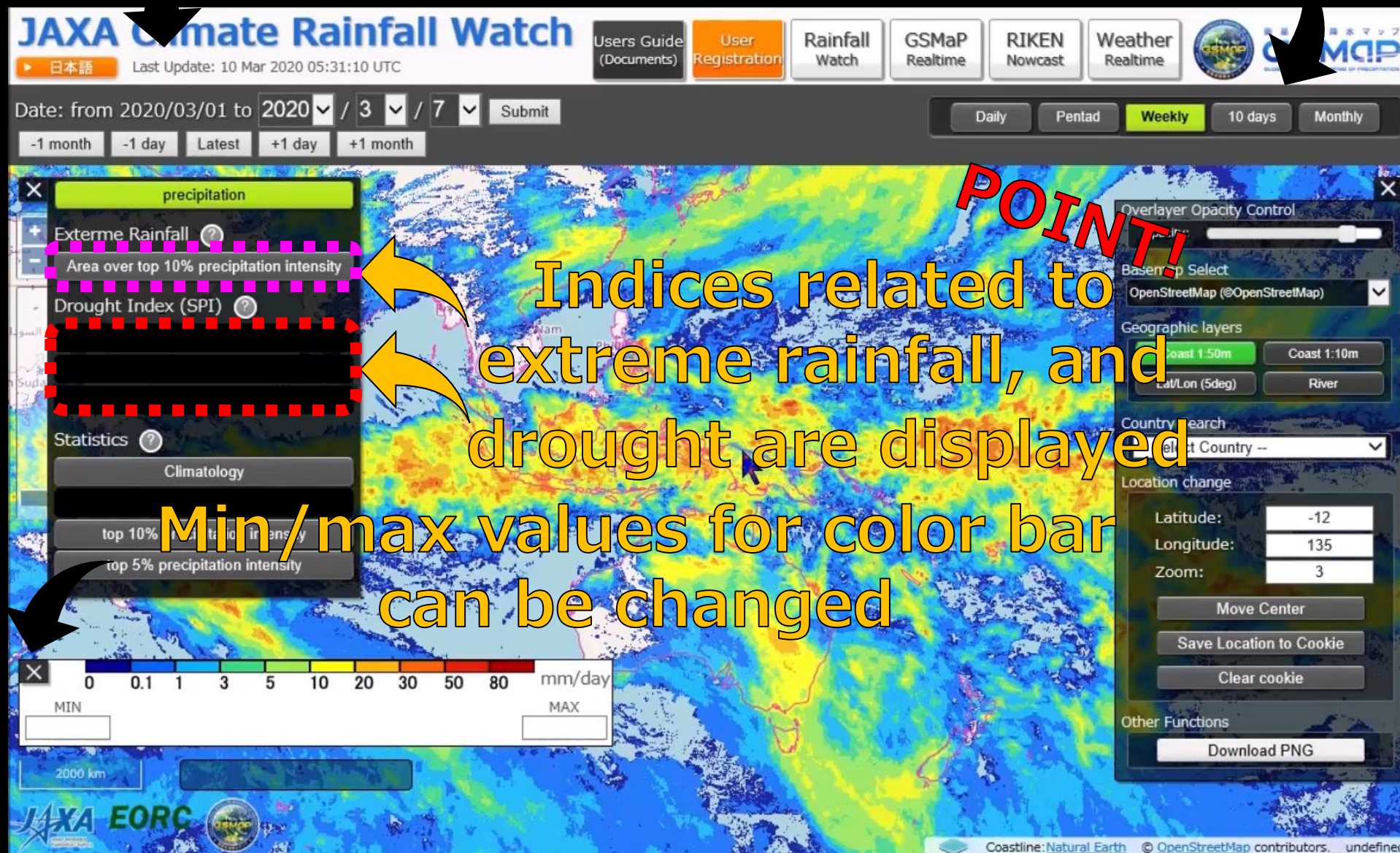
<https://youtu.be/0JanK-fZMt4>

- For users who would like to **monitor precipitation in realtime**
...[JAXA REALTIME RAINFALL WATCH](#)
You can see global precipitation map, updated **every 30 minutes**.
- For users who would like to see **precipitation in the past specific date**
...[JAXA GLOBAL RAINFALL WATCH](#)
You can see hourly global precipitation map **since March 2000**.
- For users who would like to see **daily or monthly precipitation**
...[JAXA CLIMATE RAINFALL WATCH](#)
You can see indices related to **extreme heavy rainfall and drought** as well as accumulated precipitation.

SUBSEASONAL TO SEASONAL (S2S) time-scale



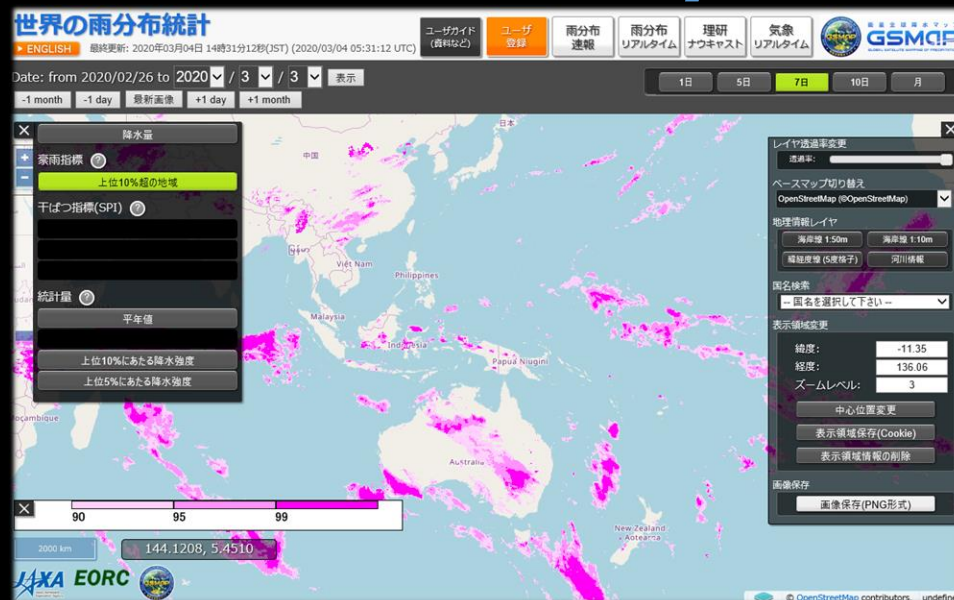
A specified date, weekly, 10 days, and monthly rainfall is available





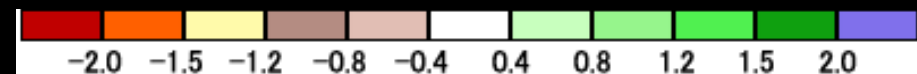
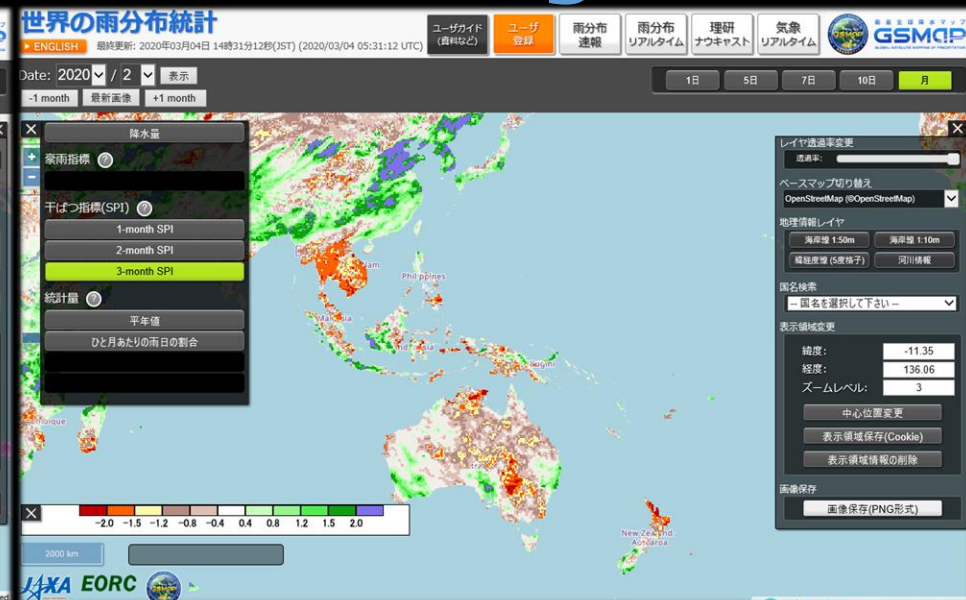
Percentiles for extreme heavy rainfall, and SPI for drought are used as indices.

Extreme heavy rain



Heavy rain area is colored with pink.
Darker pink indicates heavier rain area.

Drought



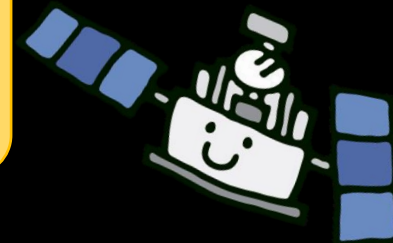
Colors show:
Moderate drought
Severe drought
Extreme drought
Exceptional drought



Variables available on the website

Category	Mean precip.	Extreme rainfall	Drought	Statistics			
				Climatology	% of rainy days in a month	Top 10% precip. intensity	Top 5 % precip. intensity
Daily	○	○		○		○	○
3-day	○	○		○		○	○
Pentad	○	○		○		○	○
Weekly	○	○		○		○	○
10 days	○			○			
Monthly	○		○	○	○		

Index for Extreme heavy rainfall is available in daily~weekly scale while that for drought is in monthly scale.





Please click  for detailed information.

JAXA Climate Rainfall Watch

日本語 Last Update: 10 Mar 2020 05:31:10 UTC

Users Guide (Documents) User Registration Rainfall Watch GSMaP Realtime RIKEN Nowcast Weather Realtime

Date: 2020 / 2 Submit

-1 month Latest month

Daily Pentad Weekly 10 days Monthly

precipitation

+ Externe Rainfall ?

-

Drought Index (SPI) ?

1-month SPI

2-month SPI

3-month SPI

Statistics ?

Climatology

% of rainy days in a month

Overlay Opacity Control

Opacity:

Basemap Select

OpenStreetMap (@OpenStreetMap)

Geographic layers

Coast 1:50m Coast 1:10m

Lat/Lon (5deg) River

Country Search

-- Select Country --

Location change

Latitude: -19

Longitude: 135

Zoom: 3

Move Center

Save Location to Cookie

Clear cookie

Other Functions

Download PNG

0 0.1 0.5 1.0 3 5 10 15 20 35 50 mm/day

MIN MAX

2000 km

JAXA EORC

Coastline: Natural Earth © OpenStreetMap contributors. undefined

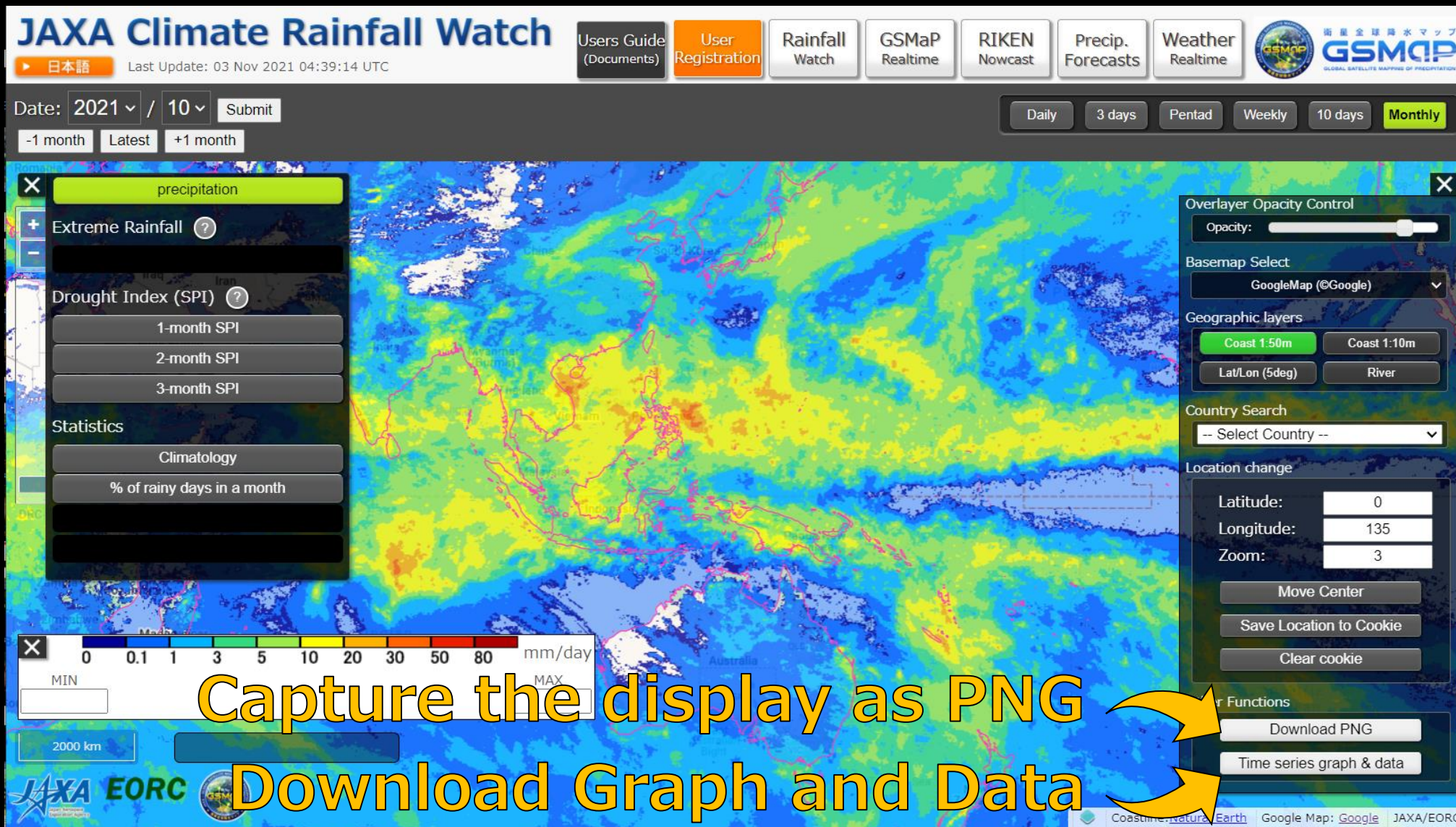
Hover the mouse cursor to the banner to check the explanation about variables.



Available variables depends on time scales (daily, pentad and so on..)



In case of monthly rain for example, Extreme rainfall index and top 10%/5% precipitation intensity banners are masked out.



https://sharaku.eorc.jaxa.jp/GSMaP_CLM/index.htm

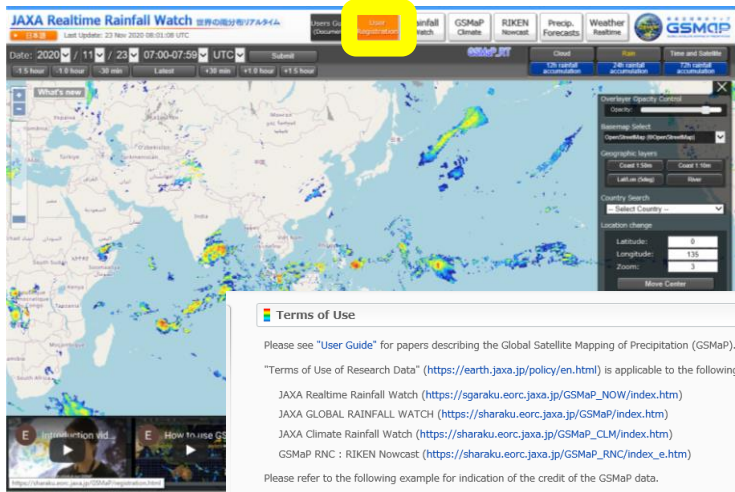
GSMaP data distribution for analysis

Click here

User
Registration

You can download the data after user registration (free of charge).

<https://sharaku.eorc.jaxa.jp/GSMaP/registration.html>



Terms of Use

Please see "User Guide" for papers describing the Global Satellite Mapping of Precipitation (GSMaP).

"Terms of Use of Research Data" (<https://earth.jaxa.jp/policy/en.html>) is applicable to the following services.

JAXA Realtime Rainfall Watch (https://sharaku.eorc.jaxa.jp/GSMaP_NOW/index.htm)

JAXA GLOBAL RAINFALL WATCH (<https://sharaku.eorc.jaxa.jp/GSMaP/index.htm>)

JAXA Climate Rainfall Watch (https://sharaku.eorc.jaxa.jp/GSMaP_CLM/index.htm)

GSMaP RNC : RIKEN Nowcast (https://sharaku.eorc.jaxa.jp/GSMaP_RNC/index_e.htm)

Please refer to the following example for indication of the credit of the GSMaP data.

"GSMaP data by Japan Aerospace Exploration Agency (JAXA)."

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For details, refer to "Consent form for handling personal information based on GDPR" and "JAXA Privacy Policy".

JAXA doesn't use registered personal information except for the following purposes:

- Statistic and analysis of data use
- Questionnaire surveys to users for improvement of the Service
- Response to inquiries from users

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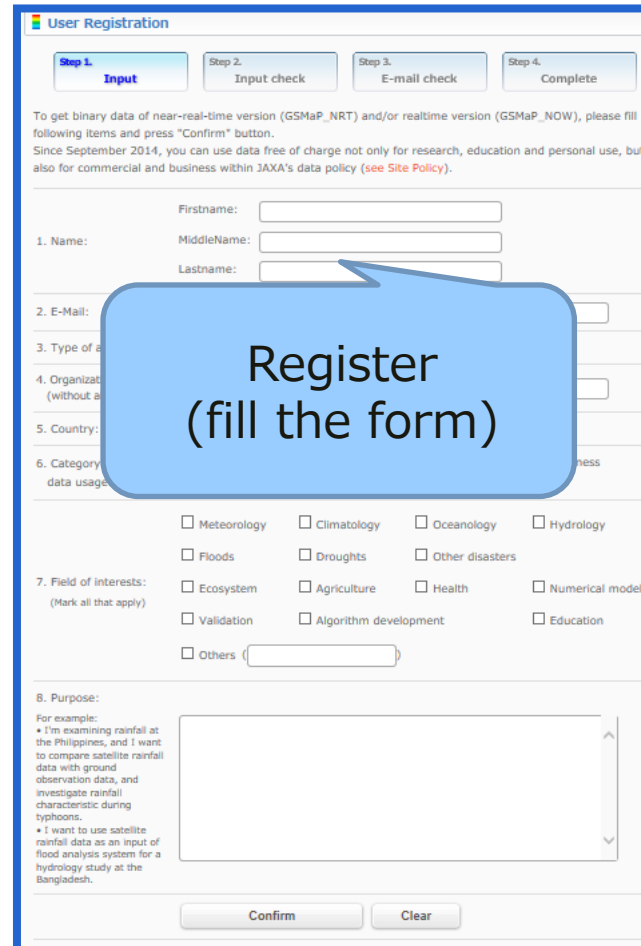
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Terms of Service?

Agree (Next)

Disagree (Back)



User Registration

Step 1. Input Step 2. Input check Step 3. E-mail check Step 4. Complete

To get binary data of near-real-time version (GSMaP_NRT) and/or realtime version (GSMaP_NOW), please fill following items and press "Confirm" button.
Since September 2014, you can use data free of charge not only for research, education and personal use, but also for commercial and business within JAXA's data policy (see Site Policy).

1. Name: Firstname: MiddleName: Lastname:

2. E-Mail: E-mail address:

3. Type of use: (Select one)

4. Organization (without a company): (Select one)

5. Country: (Select one)

6. Category of data usage: (Select one)

7. Field of interests: (Mark all that apply)

☐ Meteorology	☐ Climatology	☐ Oceanology	☐ Hydrology
☐ Floods	☐ Droughts	☐ Other disasters	
☐ Ecosystem	☐ Agriculture	☐ Health	☐ Numerical model
☐ Validation	☐ Algorithm development	☐ Education	
☐ Others ()			

8. Purpose: (Text area for purpose)

Confirm Clear

Ftp server
information will be
sent via email

riken_nowcast
climate
now
standard
realtime_ver
realtime

Data specifications are
explained in the documents.

https://sharaku.eorc.jaxa.jp/GSMaP/faq/GSMaP_faq18.html



2. Introduction of algorithm and validation

Algorithm

- How to generate GSMaP? -



GSMoP Global Satellite Mapping of Precipitation

Dual-frequency Precipitation Radar

DPR  **DPR provides
“reference standard”**

**GPM
Microwave
Imager**

**GPM
Core
Observatory**

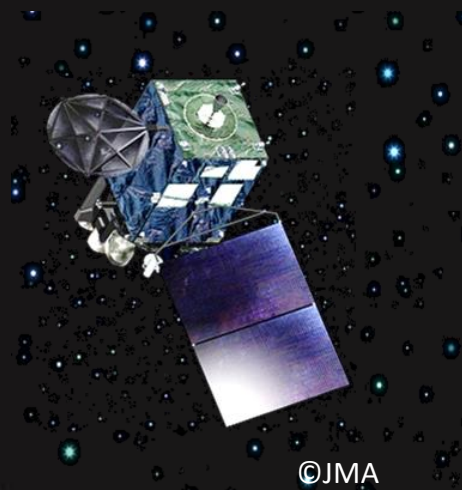
**GPM
constellation
satellites**

**Geostationary
Satellites**

**Precipitation
Radar**

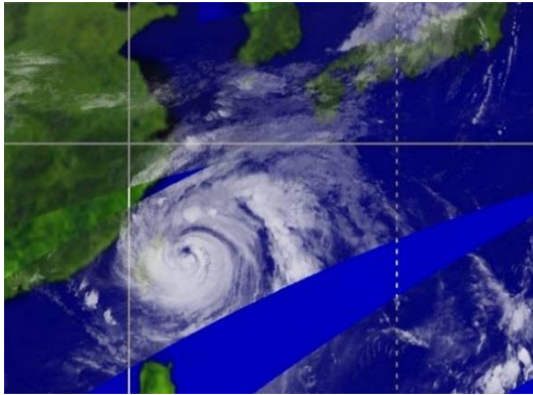
**Microwave
Radiometer**

**Infrared
Imager**

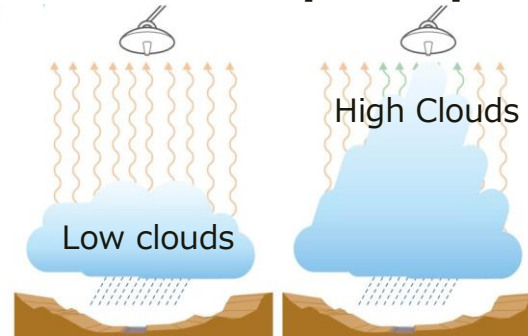


How can these different sensors be used in the algorithm?

Features of sensors



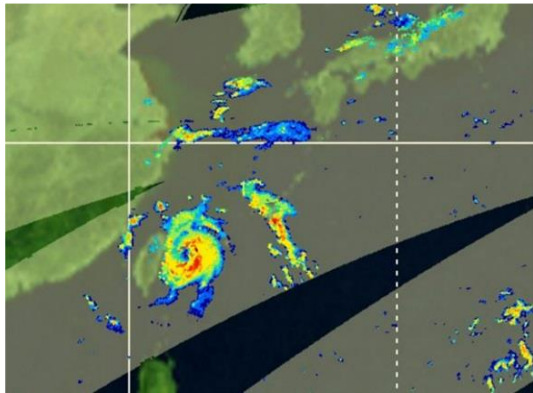
Measure cloud top temperature



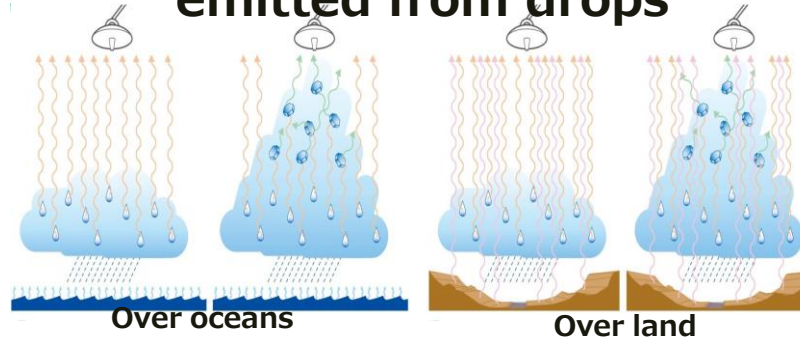
Infrared Imager

e.g., Himawari/AHI

- Measure cloud top temperature.
- **Cannot directly observe precipitation.**



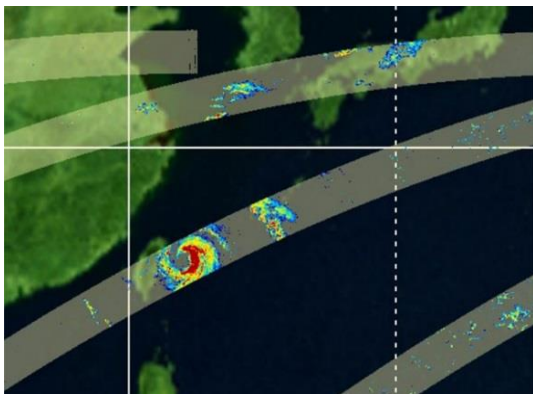
Measure microwave radiation emitted from drops



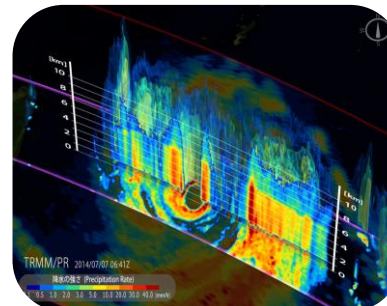
Microwave Radiometer (Imager/Sounder)

e.g., GPM/GMI

- Measure **intensity of microwave radiation** that is constantly emitted from raindrops.
- Can estimate **spatial distributions of precipitation with wider swath**
- There are many microwave radiometers in operation.



Directly observe vertical structure of precipitation



Precipitation Radar

e.g., GPM/DPR

- Actively emit pulse and measure the echoes reflected back from drops.
- Can detect vertical distributions of precipitation but narrow swath.
- There is only one precipitation radar in operation over the world, developed by Japan.

NASA-JAXA Joint Mission

“Global Precipitation Measurement (GPM) Mission”



NASA

GPM

Passive

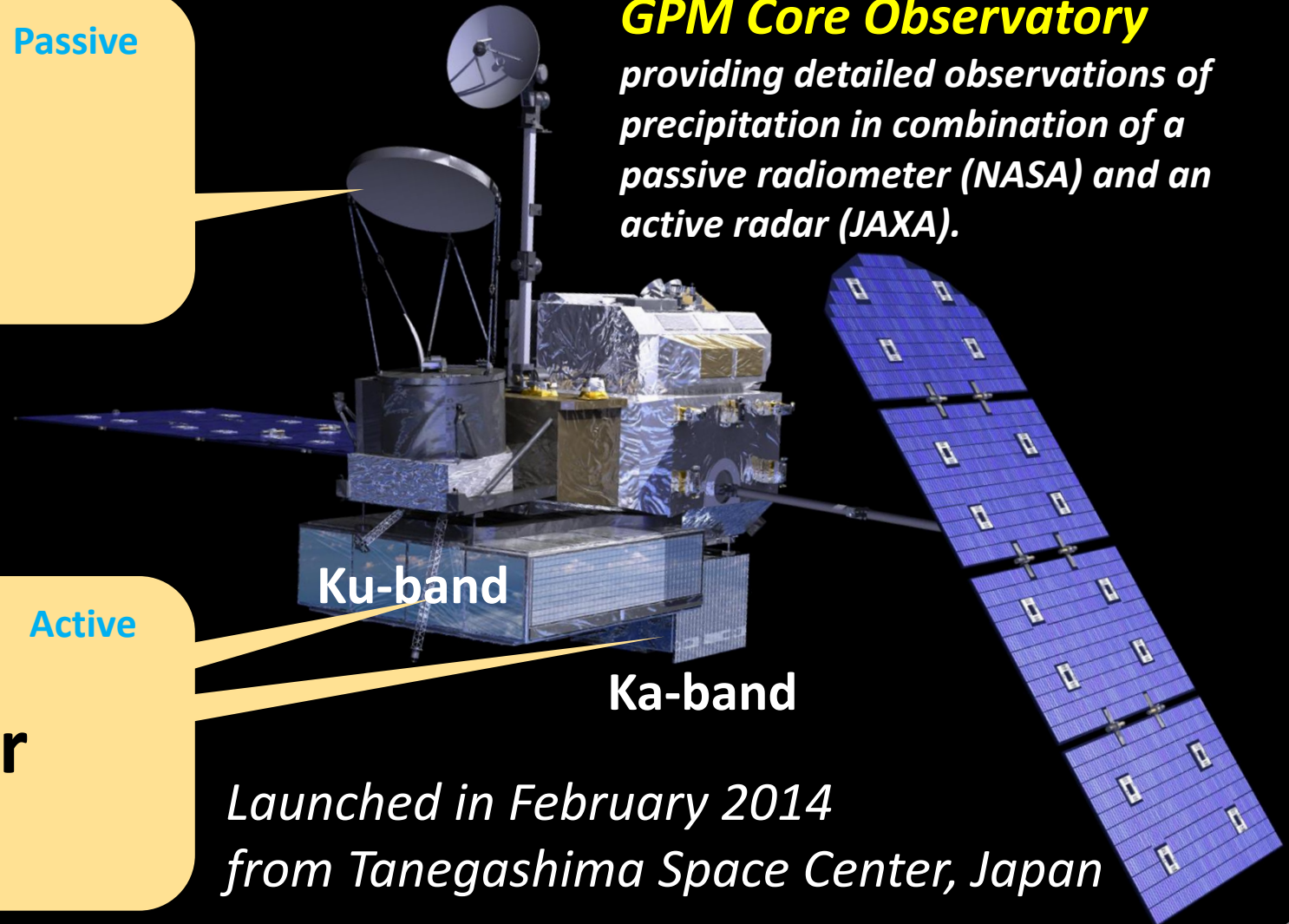
**Microwave Imager
(GMI)**



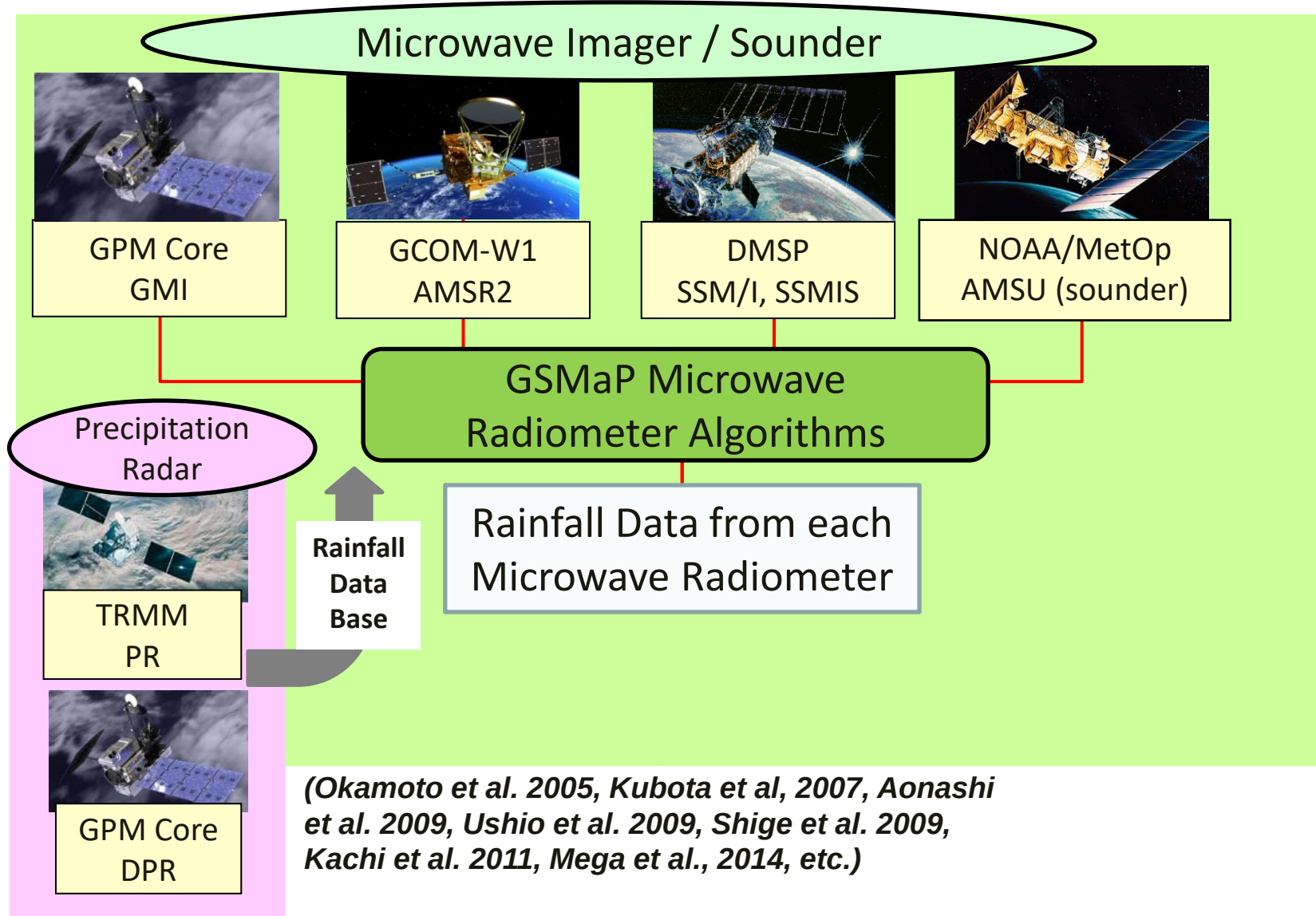
JAXA
NICT

**Dual-frequency
Precipitation Radar
(DPR)**

Active

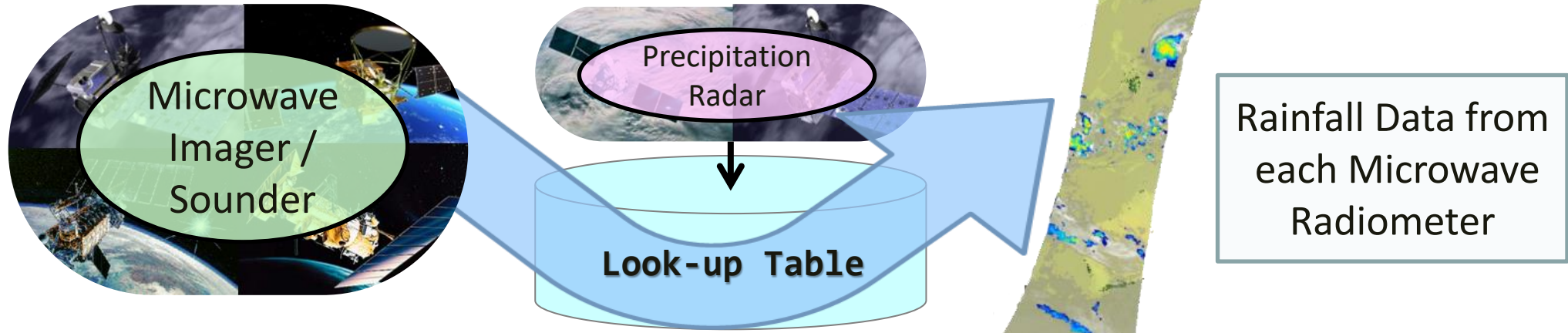


Overview of GSMaP Algorithm

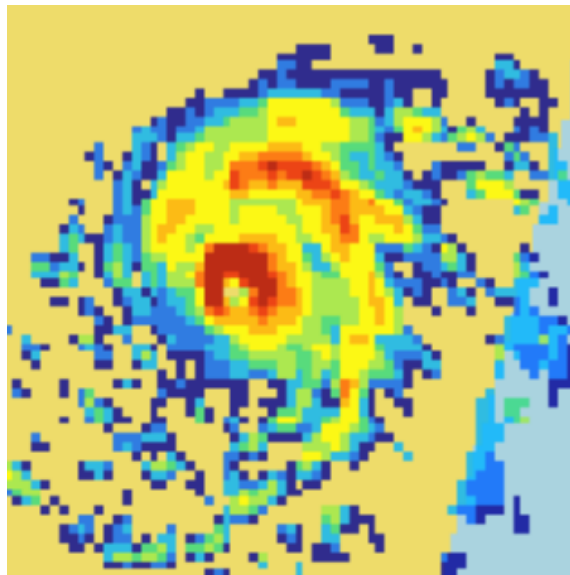


Rainfall Data from each Microwave Radiometer

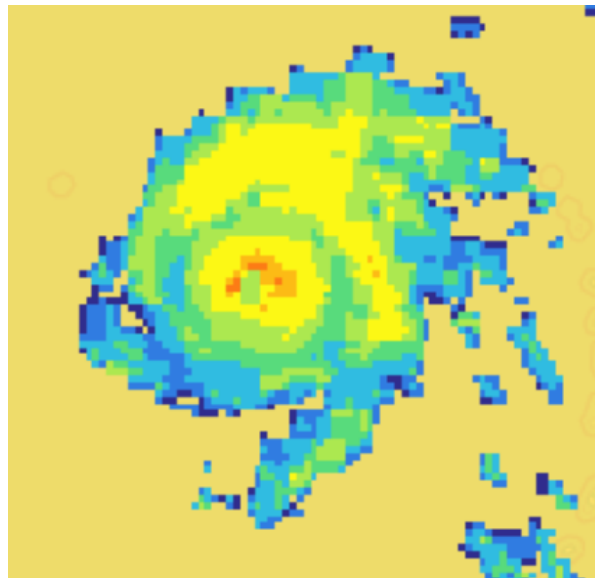
(Aonashi and Liu 2000, Kubota et al. 2007, Aonashi et al. 2009)



(Microwave Imager)
GCOM-W/AMSR-2

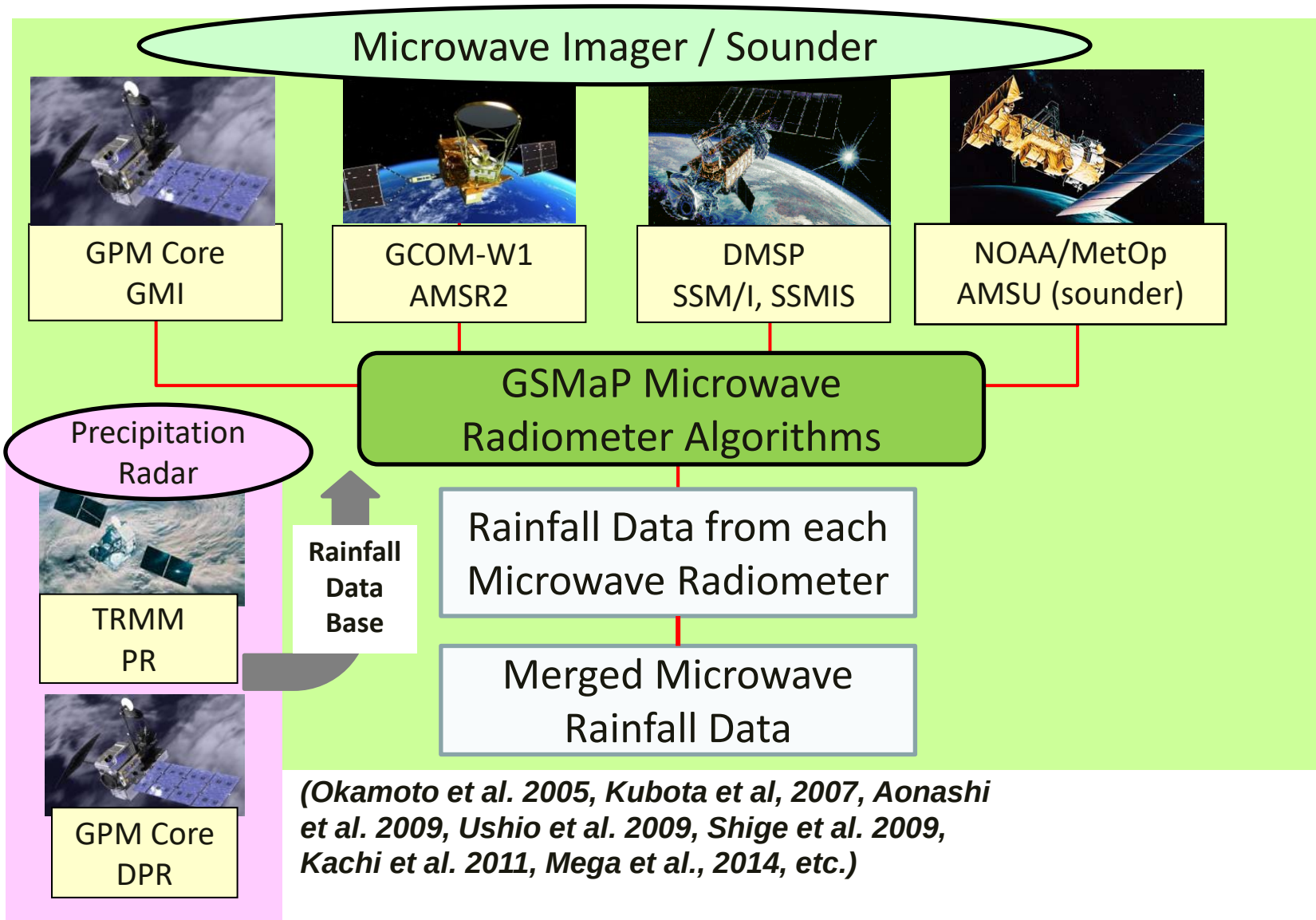


(Microwave Sounder)
NOAA-19/AMSU-A/MHS



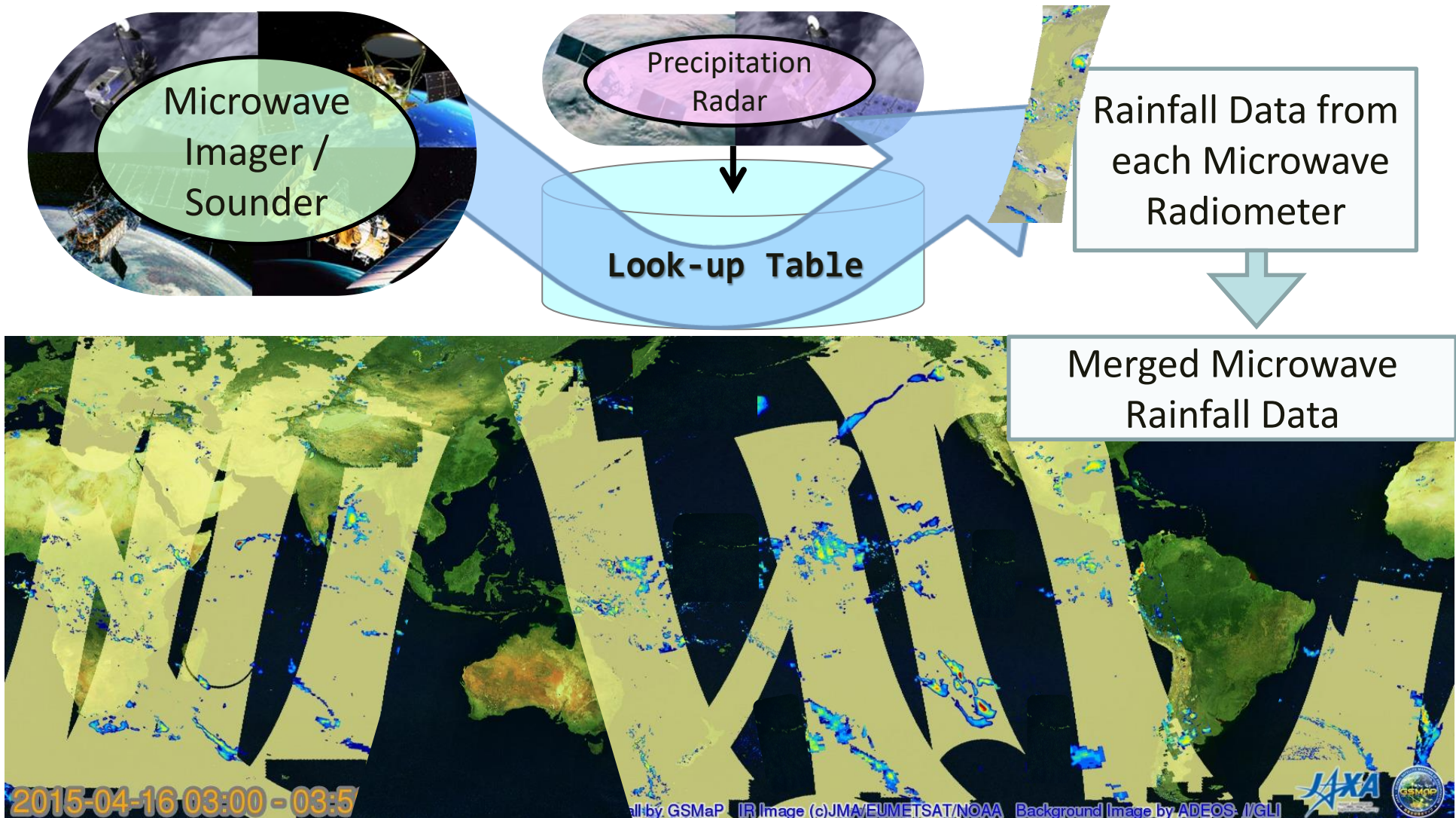
Depending on the type of Microwave Radiometer, precipitation intensity and resolution slightly differ.

Overview of GSMaP Algorithm



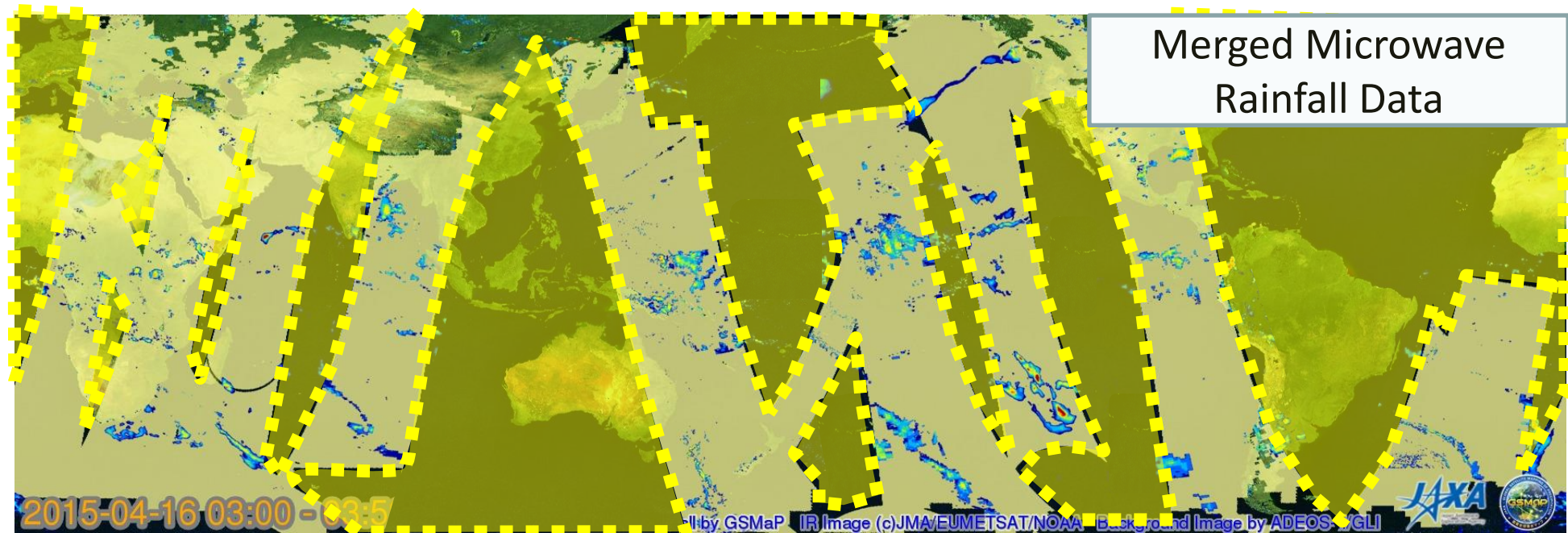
Simplified explanation of Algorithm

(Aonashi and Liu 2000, Kubota et al. 2007, Aonashi et al. 2009)



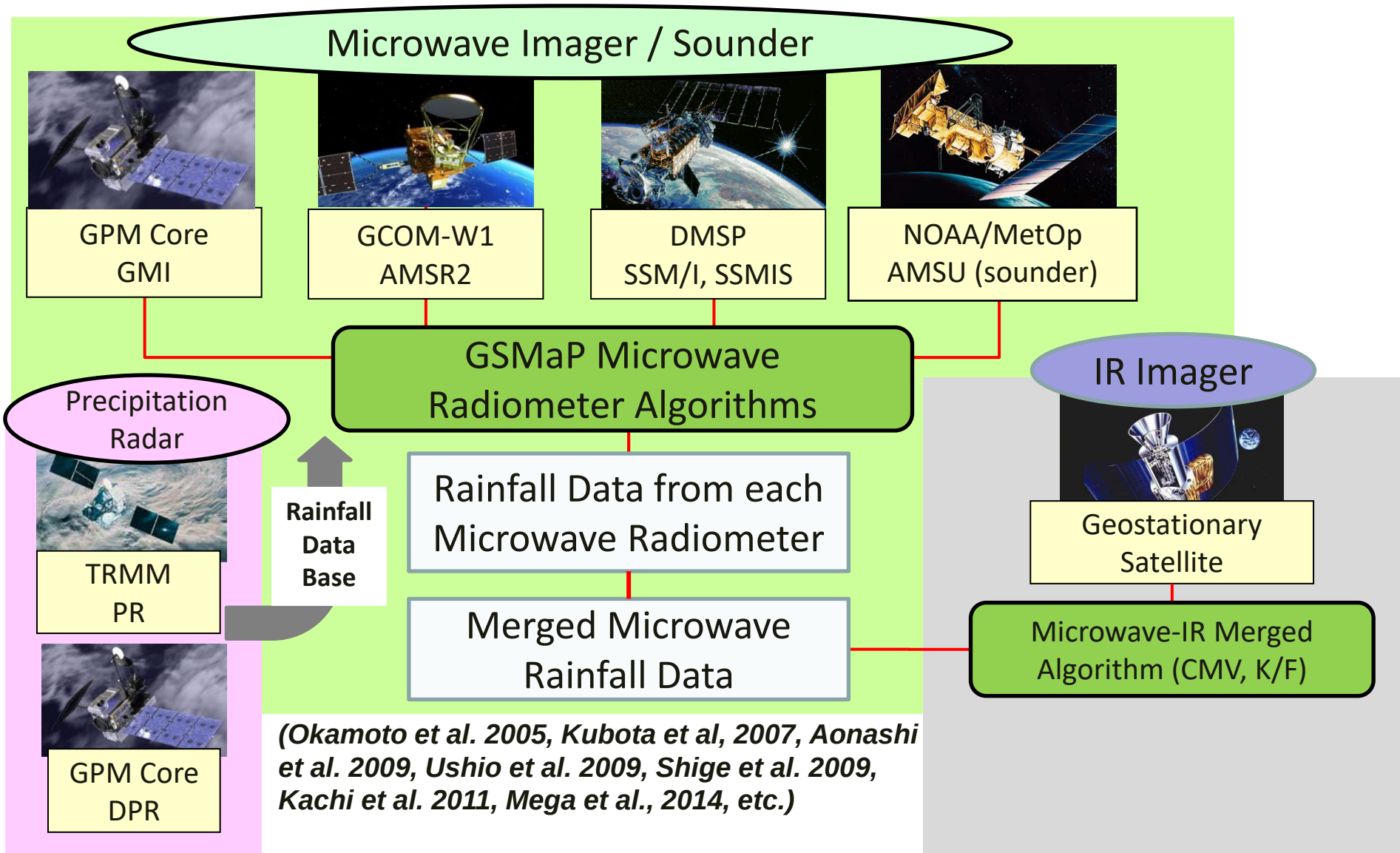
Simplified explanation of Algorithm

Some area cannot be covered with merged microwave rainfall data in one hour...



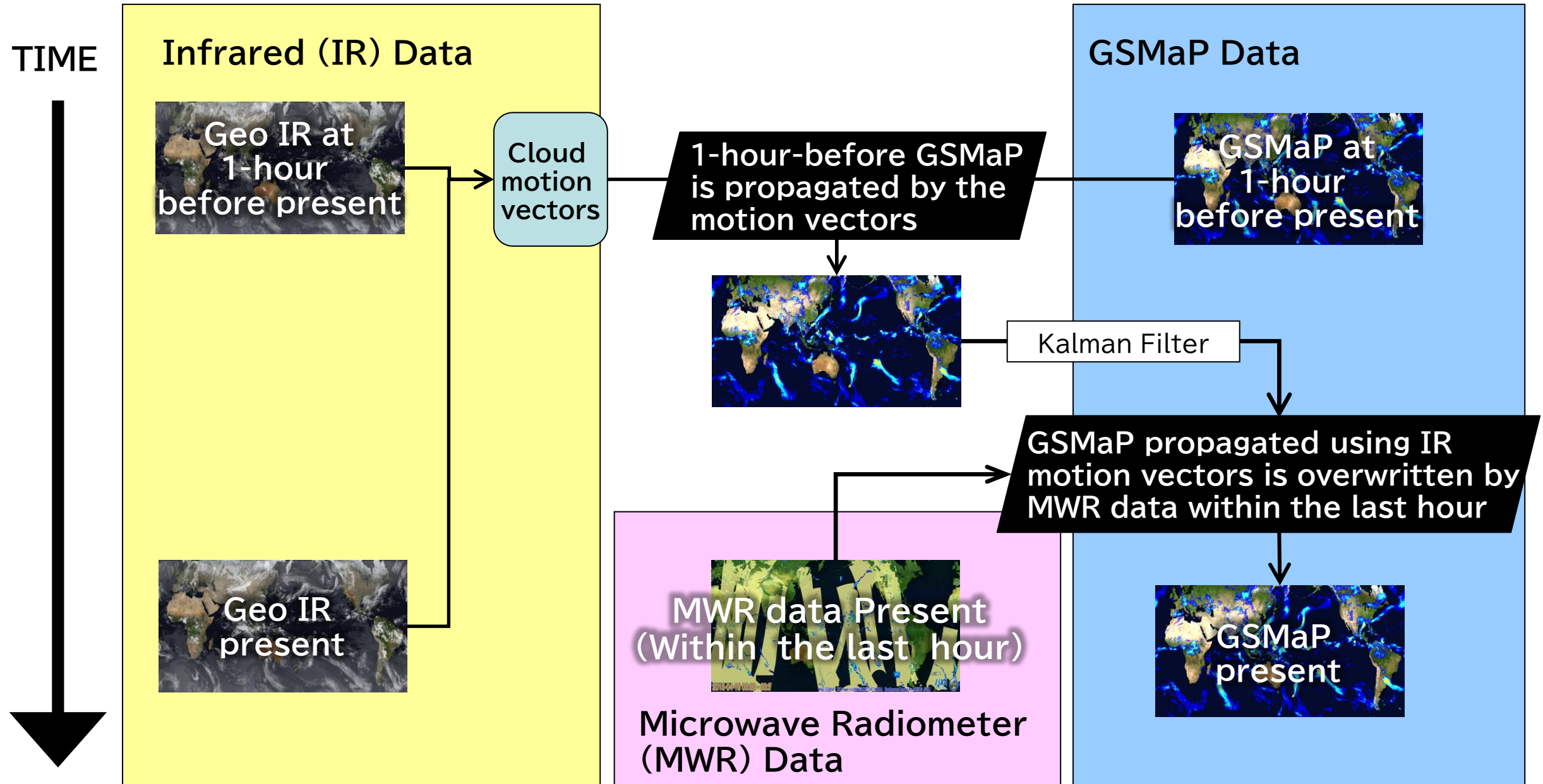
Yellow color indicates an area observed by microwave imager and sounder.

Overview of GSMaP Algorithm

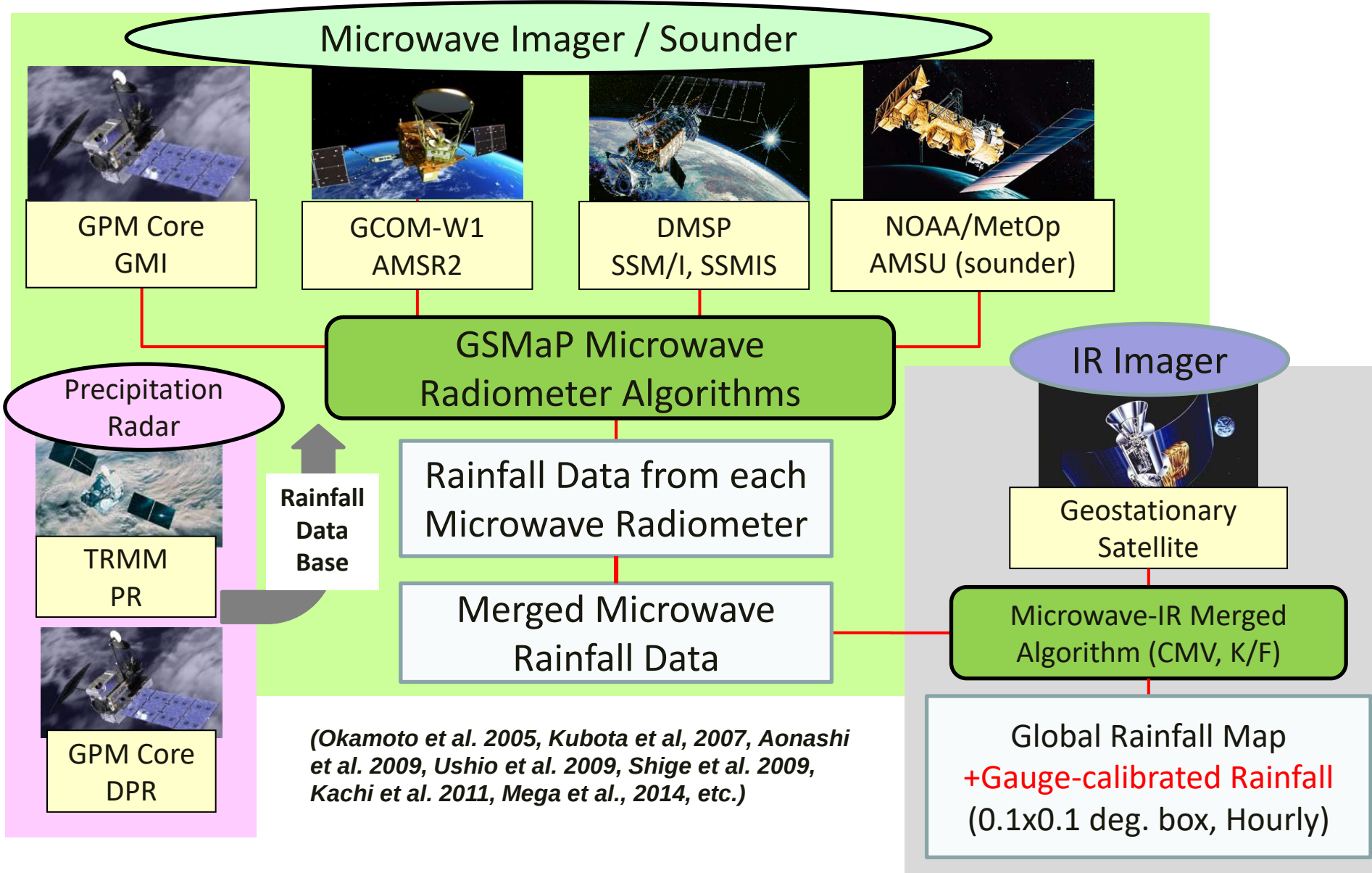


Flowchart of MWR-IR Merged algorithm

(Ushio et al. 2009)



Overview of GSMaP Algorithm





2. Introduction of algorithm and validation

Validation Results

- What is the accuracy of GSMaP? -

We provide various kind of GSMaP for various utilization purposes

GSMaP MVK (standard)

- * 3-day latency
- * past duration available since ~~Mar2000~~-will be Jan1998

GSMaP NRT (near-realtime)

- * 4-hour latency
- * past duration available since ~~Mar2000~~-will be Jan1998

GSMaP NOW (realtime)

- * On quasi-realtime (a few minutes latency)

Each products has gauge-adjusted version using NOAA/CPC daily precipitation (Chen et al. 2008)

Higher Accuracy
Lower Latency



Lower Accuracy
Better Latency



Expected Purposes

Long-term Analysis for climate,
Agricultural monitor

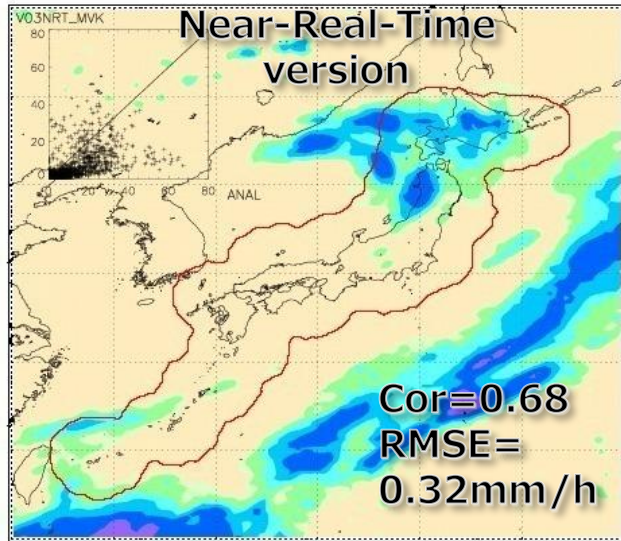
Flood Analysis
and/or prediction

Weather Realtime
Monitoring

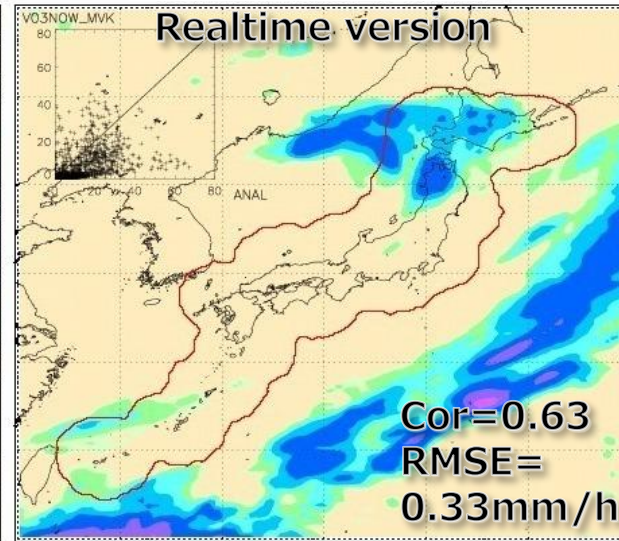
Snapshots of Daily Validation

May. 27, 2017, in 0.25 degree grid and daily accumulation

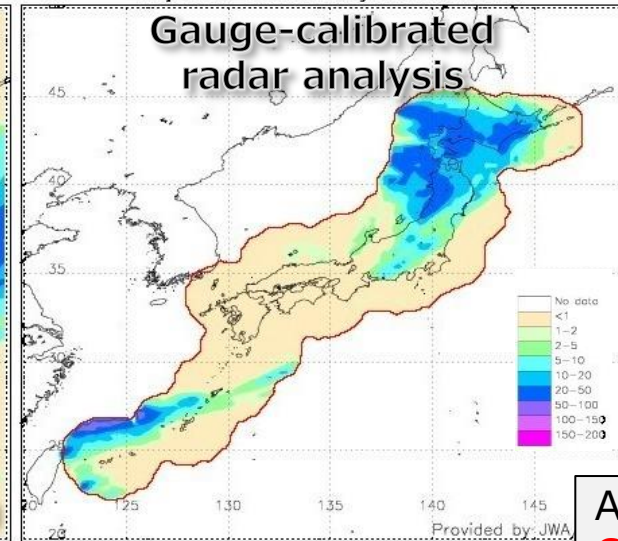
GSMaP_NRT



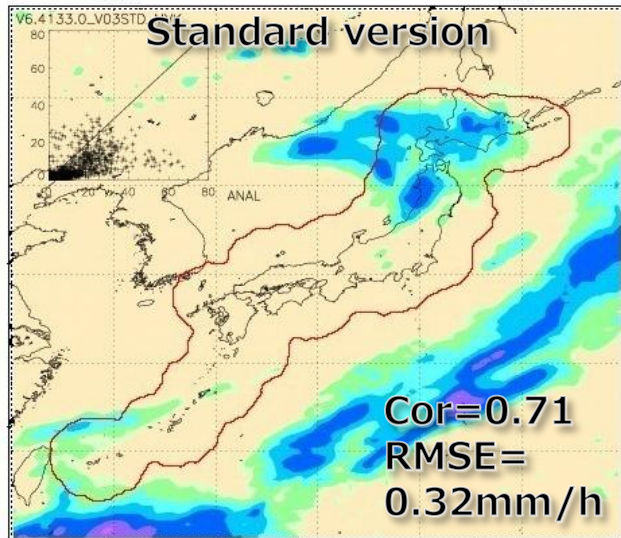
GSMaP_NOW



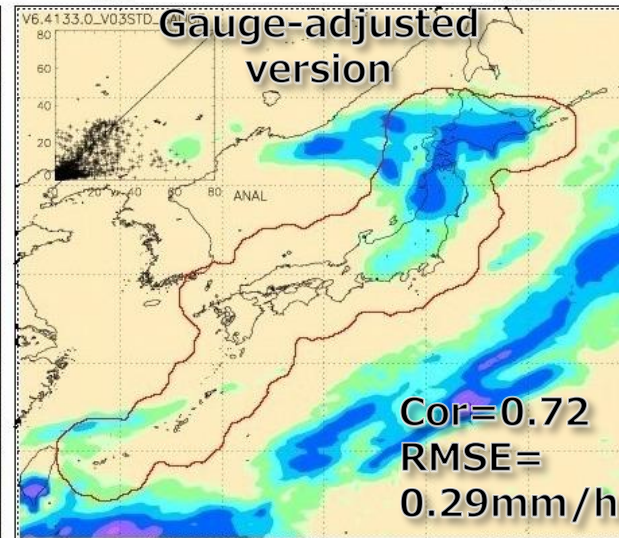
JMA's Radar-AMeDAS



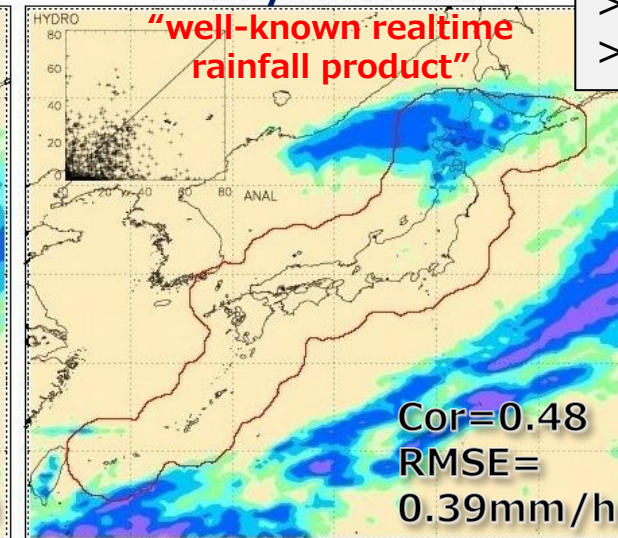
GSMaP_MVK



GSMaP_Gauge



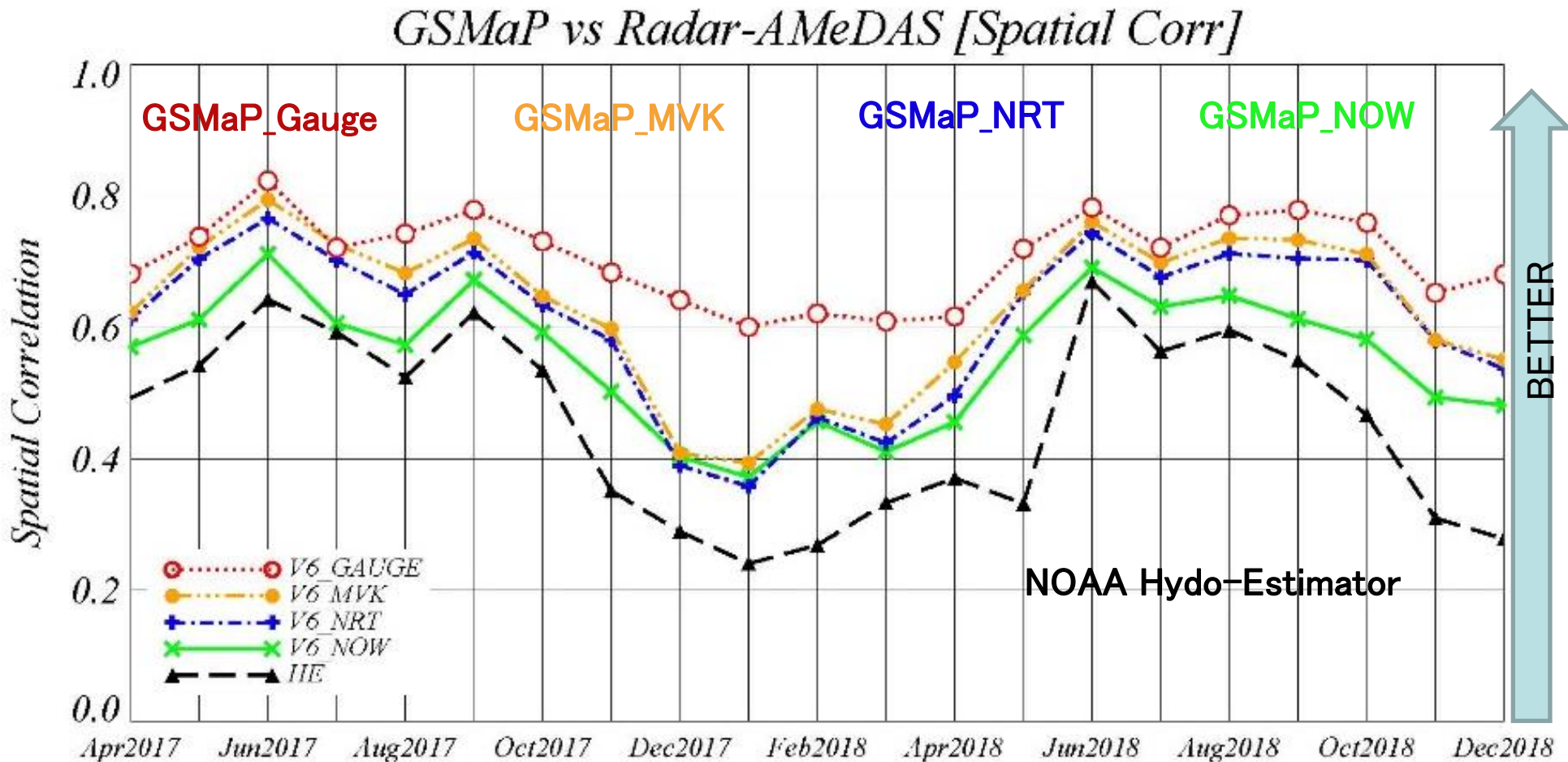
NOAA Hydro-Estimator



Accuracy over Japan is ...

GSMaP_Gauge > GSMaP_MVK
> GSMaP_NRT > GSMaP_NOW
> NOAA H-E

Snapshots of Daily Validation



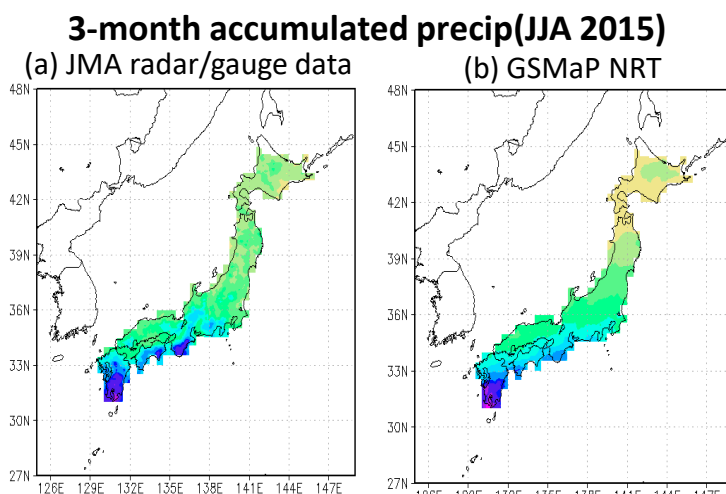
Accuracy over Japan is ...

GSMaP_Gauge > GSMaP_MVK
> GSMaP_NRT > GSMaP_NOW
> NOAA H-E

Accuracy varied seasonally around Japan, which suggested that the accuracy depends on some factors like precipitation amount and characteristics.

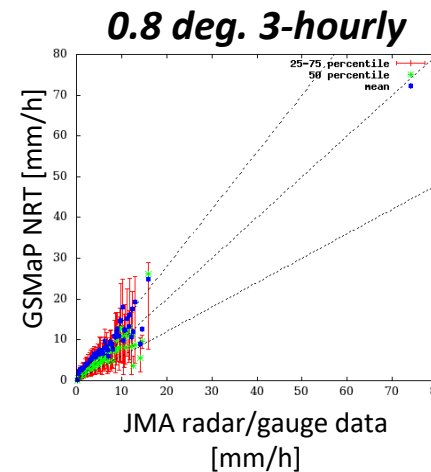
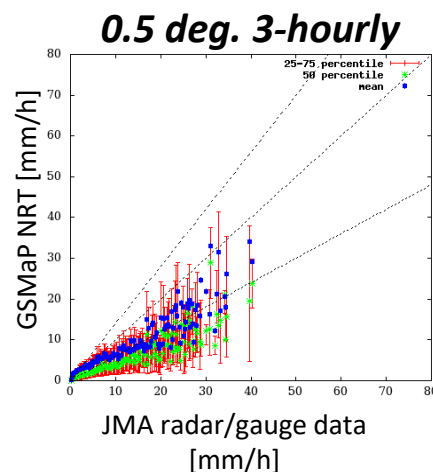
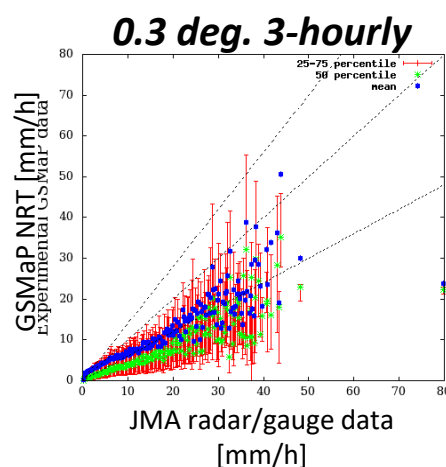
GSMaP validation for some spatial/temporal resolutions

- Same kind of validation analysis in Japan using JMA radar/gauge analyzed data and GSMaP_NRT was conducted in some resolutions.
- The accuracy got better as the spatial/temporal resolution became coarser, which is because shift of location and time is canceled.



RMSE							Correlation Coefficient						
		temporal res.							temporal res.				
		1	3	6	12	24			1	3	6	12	24
Spatial res.	0.1	1.20	0.93	0.78	0.63	0.51	Spatial res.	0.1	0.37	0.45	0.49	0.53	0.58
	0.3	1.00	0.82	0.70	0.58	0.47		0.3	0.45	0.52	0.55	0.59	0.63
	0.5	0.86	0.72	0.63	0.52	0.42		0.5	0.51	0.56	0.60	0.62	0.67
	0.8	0.70	0.61	0.54	0.45	0.37		0.8	0.57	0.61	0.64	0.67	0.71
	1.0	0.66	0.58	0.51	0.43	0.35		1.0	0.61	0.65	0.68	0.70	0.73

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



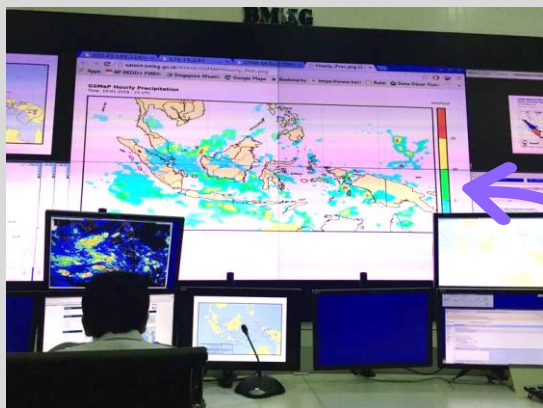
from 25 %-tile
to 75 %-tile
50%tile
mean



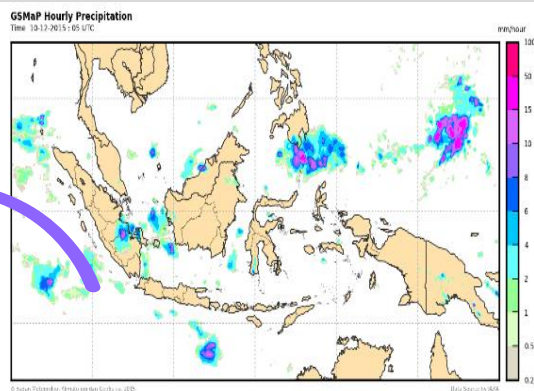
3. Practical use cases of the rainfall data including WMO project

Utilization in Asian Countries

GSMaP can be used for operational weather monitoring, rainfall analysis, validation of prediction etc.



(Left; taken in BMKG, right quoted from BMKG website)



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

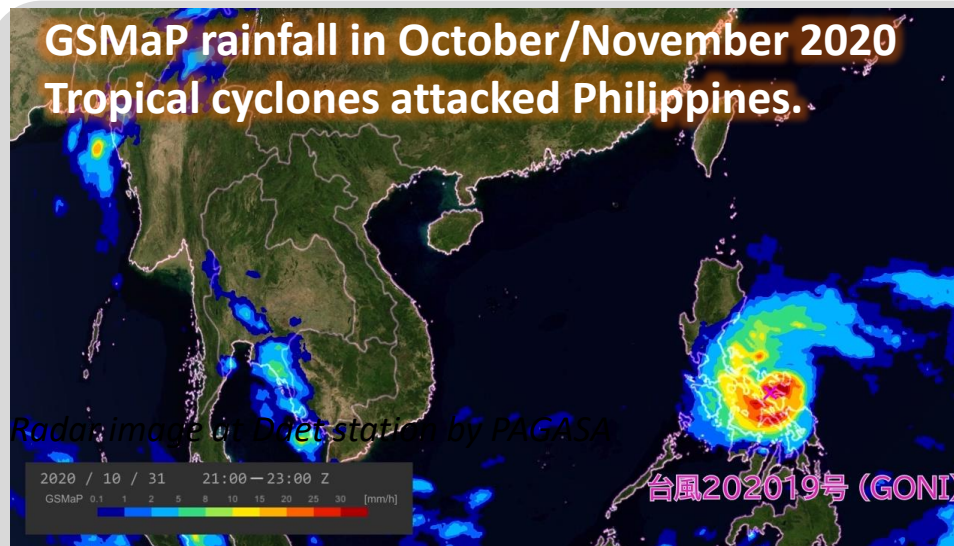
BMKG, Indonesia operationally processes and displays the GSMaP data for monitoring realtime rainfall, validating the prediction with GSMaP, analysis, researches for the improvement of warning.

Department of Disaster Management in Myanmar uses GSMaP for monitoring spatially distributed rainfall in real time.



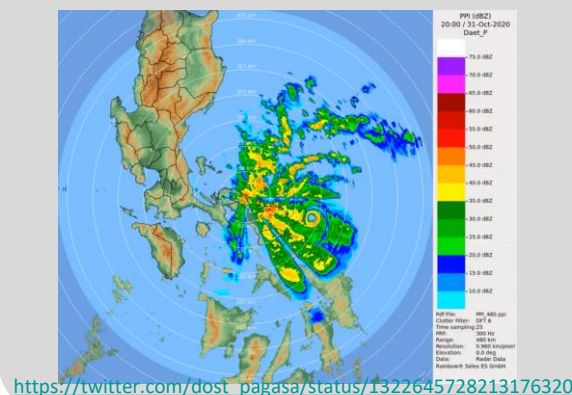
2017年9月訪問時のRRD/EOCにて撮影

GSMaP rainfall in October/November 2020
Tropical cyclones attacked Philippines.



Radar image in Doet station by PAGASA

Space-based information is useful to know rainfall over the oceans far from the radar site.



https://twitter.com/dost_pagasa/status/1322645728213176320

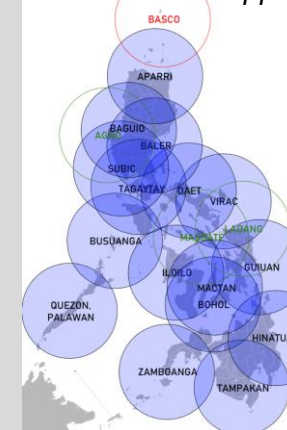
Weather radar at Virac was destroyed by Typhoon Rolly/GONI



Photo from PAGASA / MANILA BULLETIN

<https://mb.com.ph/2020/11/03/pagasa-weather-radar-among-rolly-casualties-in-catanduanes/>
<https://www.rappler.com/nation/new-doppler-radar-in-catanduanes-promises-more-accurate-forecasts>

Doppler radar stations installed in the Philippines

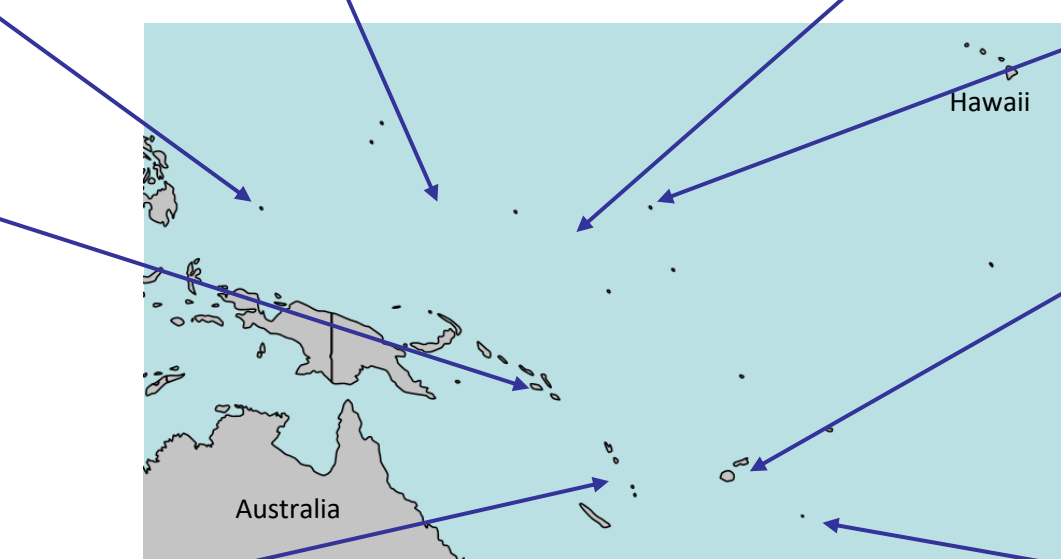
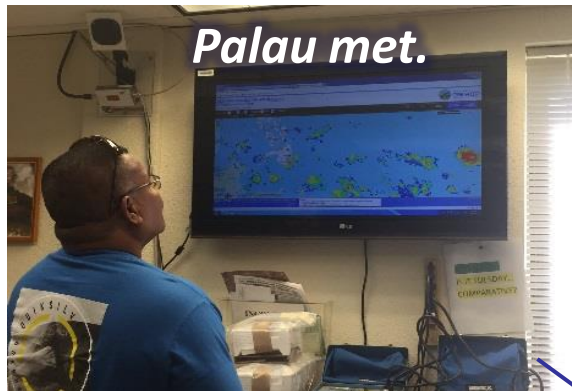


Typhoons are usually approaching from the eastern ocean.
-> Virac radar can play an important role for rainfall monitoring.

https://commons.wikimedia.org/wiki/File:PAGASA_Doppler_Radar_Network.png



Utilization in Pacific Islands



GSMaP has been used for rainfall monitoring by meteorological services in Pacific Islands.

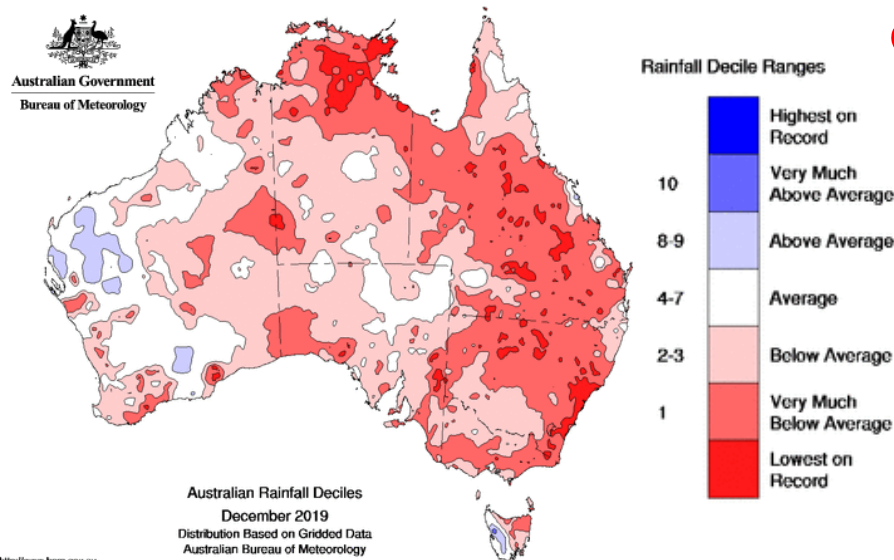
GSMaP Application for Climate Extremes

- JAXA has participated in the WMO Space-based weather and climate extremes monitoring (SWCEM) project with GSMaP for monitoring extremes.

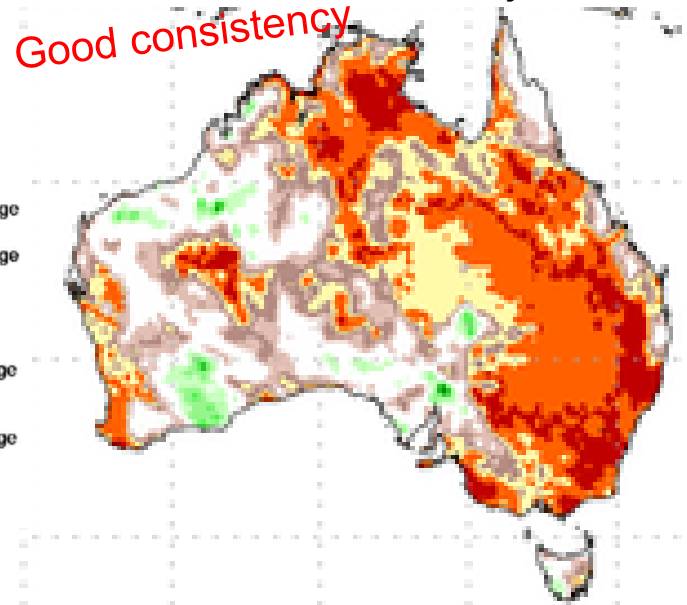
Spatial distribution of the anomaly from climate normal by approximately 20-year GSMaP data can help their decision making.

Case study for severe drought in Australia (Dec. 2019)

Reported by local Agency (BoM)



1-month SPI detected by GSMaP



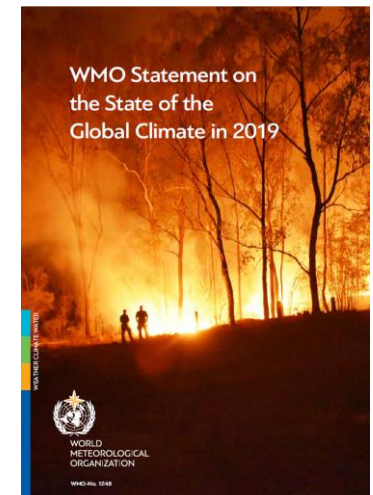
The results were used in

- WMO Statement on the State of the Global Climate in 2019] issued in March 2020

<https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate>

- WMO Bulletin issued in March 2020.

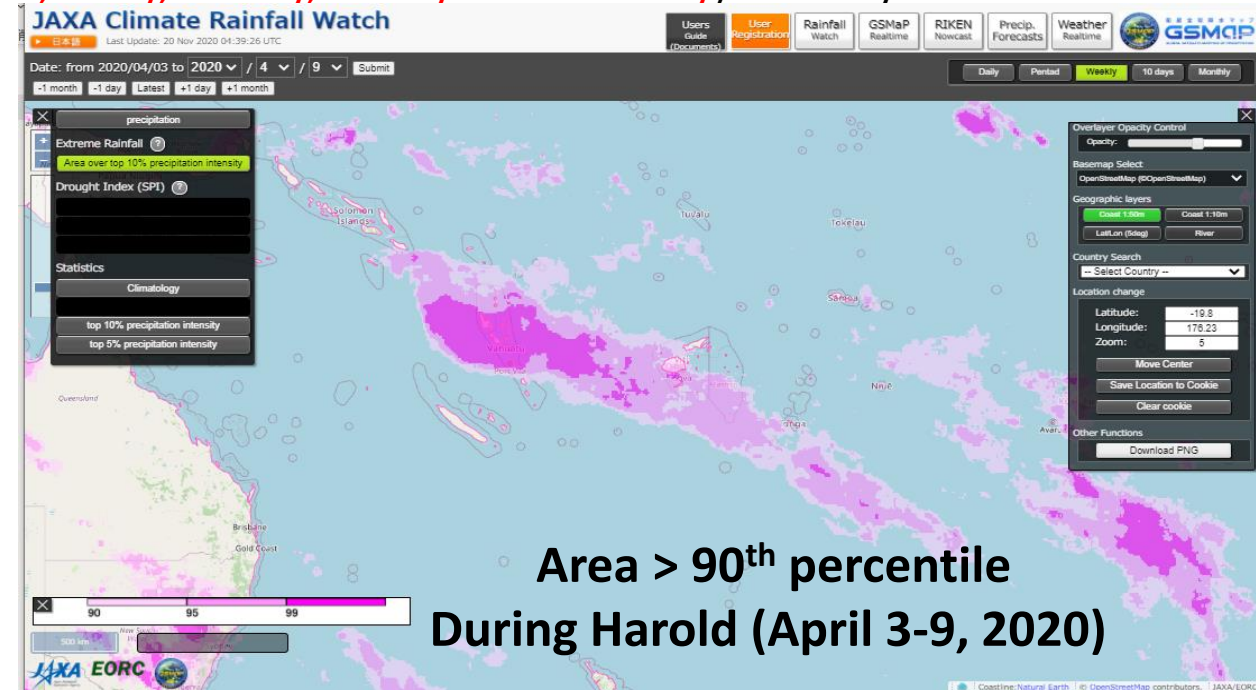
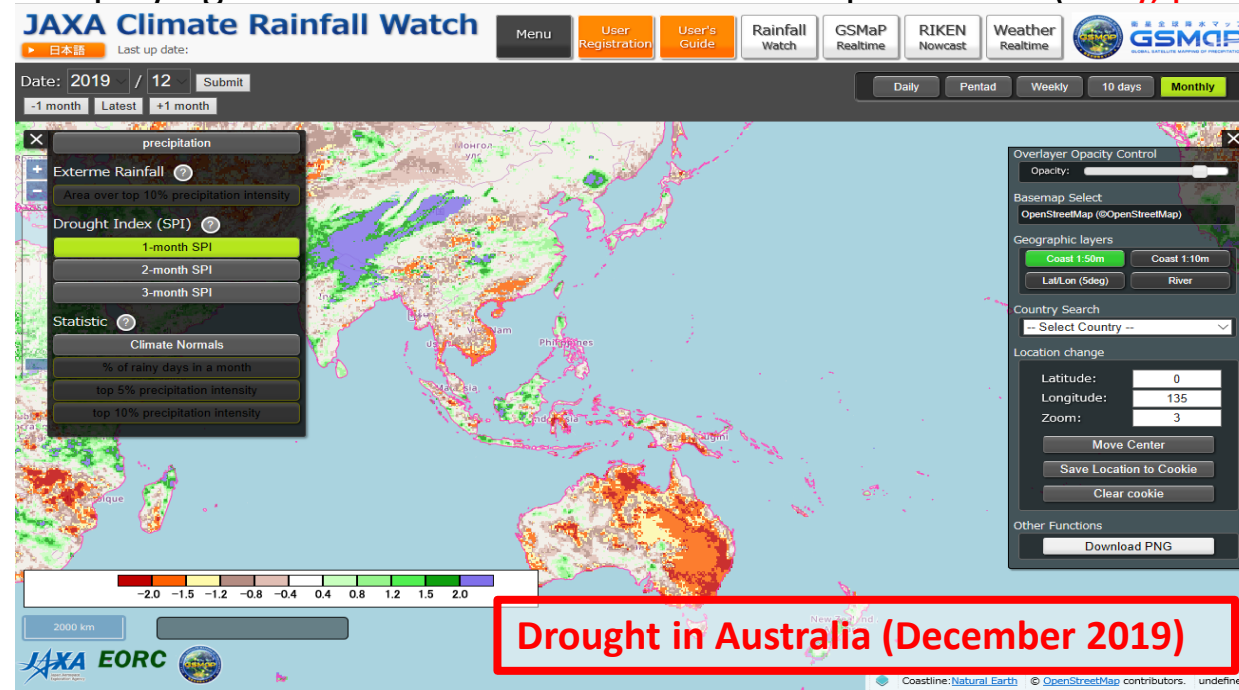
<https://public.wmo.int/en/resources/bulletin/wmo-space-based-weather-and-climate-extremes-monitoring-demonstration-project>



GSMaP Application for Climate Extremes

- JAXA has participated in the WMO Space-based weather and climate extremes monitoring (SWCEM) project with GSMaP for monitoring extremes.
- We started to operate a website “**JAXA Climate Rainfall Watch**”, which provides information about extreme heavy rainfall and drought over the world based on the GSMaP statistics.

Displaying accumulated rainfall in some temporal scale (**daily, pentad, 3-day, weekly, 10-days and monthly**) and 21-year climate normal.



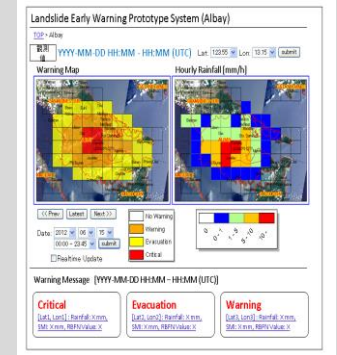
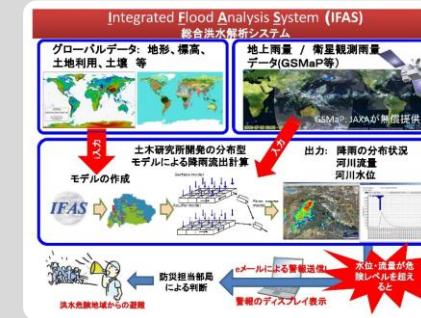
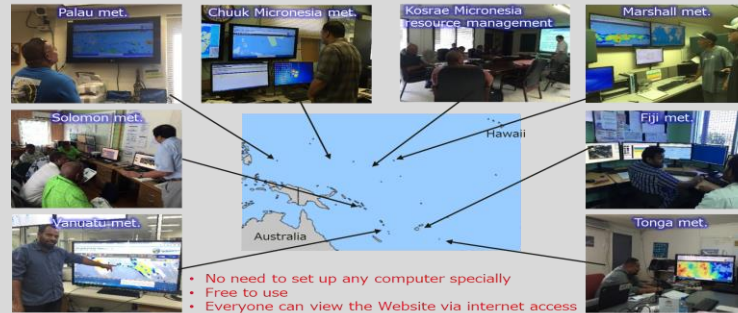
Graphical User Interface of the "JAXA Climate Rainfall Watch" website
(https://sharaku.eorc.jaxa.jp/GSMaP_CLM/)

Various Utilizations of GSMaP rainfall product



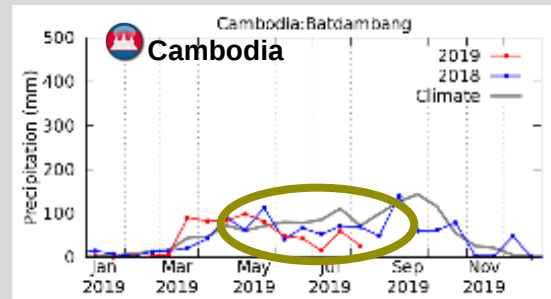
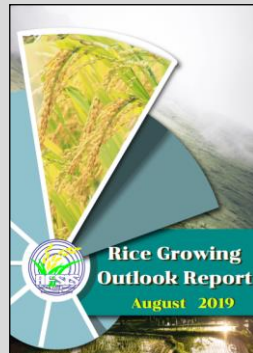
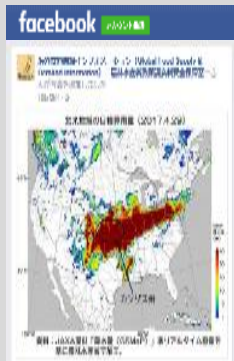
Disaster Risk Reduction and Management (DRRM)

- Cyclone/Heavy rainfall monitoring
- Flood forecasting (with ground rain gauge) for areas with limited/lack of ground-based observations system
- Real time landslide warning with spatial risk information



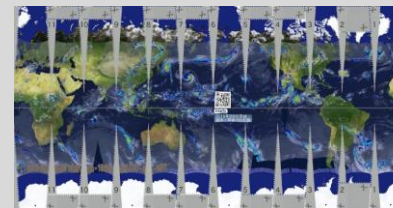
Agriculture and Food Security

- Global and near real time drought and heavy rain monitoring for national/regional food security
- Weather index based insurance for agriculture



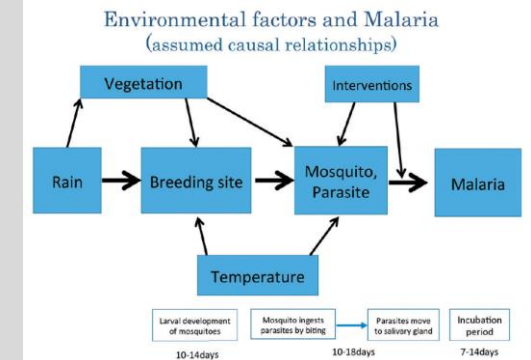
<http://www.aptfss.org/publication>

Educations



Dagick Team
<https://www.dagick.net/>

Public Health



https://www.eorc.jaxa.jp/GPM/doc/data_utilization/2019_jireishu_j.pdf

Others
Climate monitoring etc.

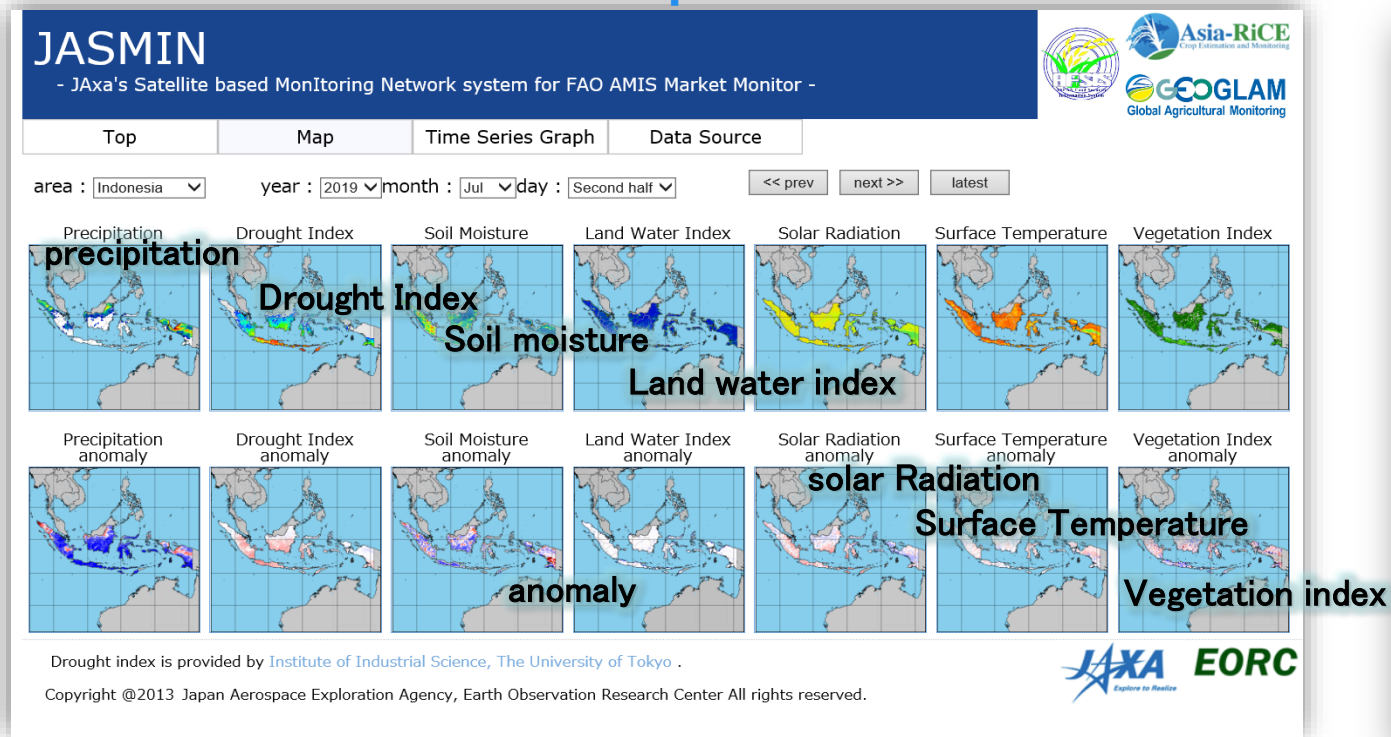
- As one of the Japanese **GPM** products, **GSMaP** has been developed and widely used in various purposes.
- GSMaP is the **multi-satellite product** by using passive microwave radiometers, IR imagers, and precipitation radars.
- GSMaP is used in Pacific Islands for **monitoring realtime rainfall distributions** in large scale viewpoint.
- The data can be quickly checked using websites, and also be downloaded via ftp site.

GSMaP Application for Agriculture in Asian countries

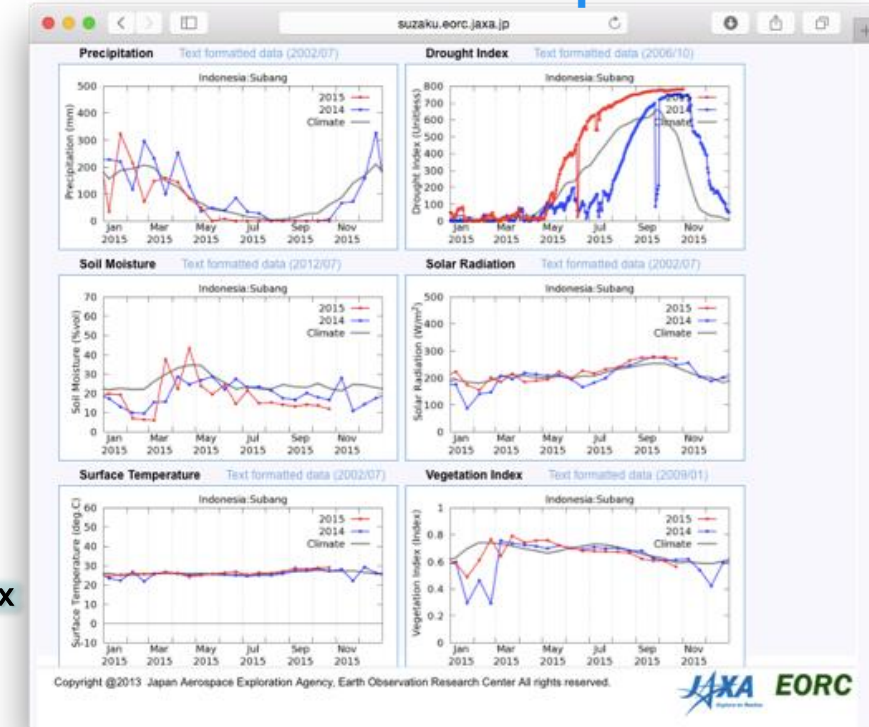


- **JASMIN** developed by JAXA provides **satellite-based various agromet data** for monitor.
 - **GEOGLAM** was endorsed by the G20 Summit, aims to enhance regional and global agricultural production estimates through the use of Earth observations [Meeting of G20 Agriculture Ministers, G20 France 2011 Summit final declaration, 2011]
 - Asian agencies are implementing **Asia-RiCE (Asia Rice Crop Estimation & Monitoring)** to strengthen **rice crop** monitoring ability **by using remote sensing**, which is a component for GEOGLAM.

Map



Time-series plot



<http://suzaku.eorc.jaxa.jp/JASMIN/index.html>

Satellite derived agro-met information can support to judge rice growth.

DPR data distribution

G-Portal

Globe Portal System

First of all, search the data you seek (no registration required)

* [Registration](#) required for download.

Search by:

-  **Physical quantities**
precipitation, ocean color, etc.
-  **Spacecraft**
spacecraft, sensor, level, etc.
-  **Direct download**
How to download via FTP, etc.

 Login

User registration

For first-time users

Product information / operation

Tools / documents

Support / inquiry / FAQ

Announcement

Search this site:

ENHANCED BY 

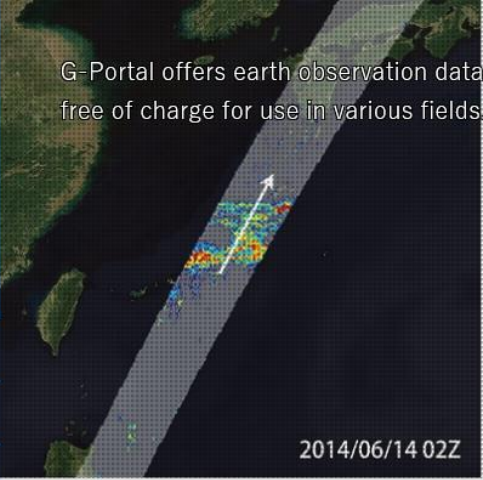
日本語

ENGLISH

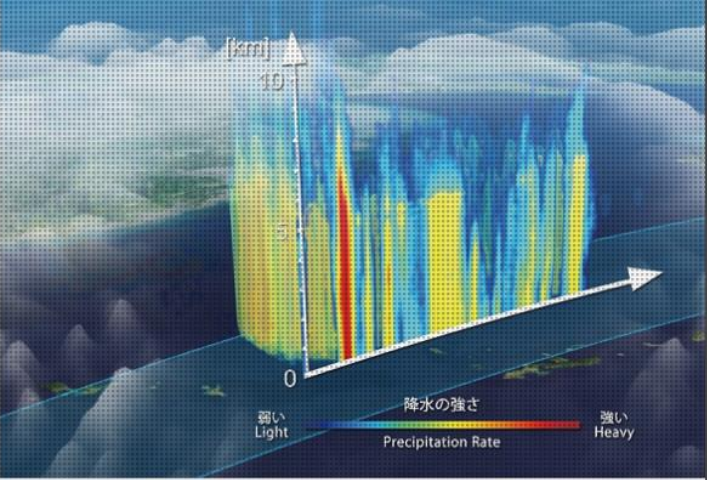


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G-Portal offers earth observation data free of charge for use in various fields.



2014/06/14 02Z



降水の強さ
Precipitation Rate
弱い Light Heavy

INFO [2020/11/04] Maintenance information (2020/11/05)

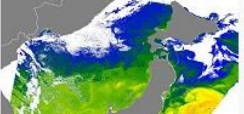
Due to system maintenance, new product registration will be temporarily suspended during the following period.

Use cases



Release started for GCOM-C/SGLI Products (Version 2)

 GCOM-C/SGLI



Imaging procedure for GCOM-C (SHIKISAI) products using QGIS

<https://gportal.jaxa.jp/gpr/?lang=en>

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