GSMaP

GLOBAL SATELLITE MAPPING OF PRECIPITATION

Rainfall Observation from Space: A overview of GPM and GSMaP

(July 2016 version)

Earth Observation Research Center (EORC)
Japan Aerospace Exploration Agency (JAXA)

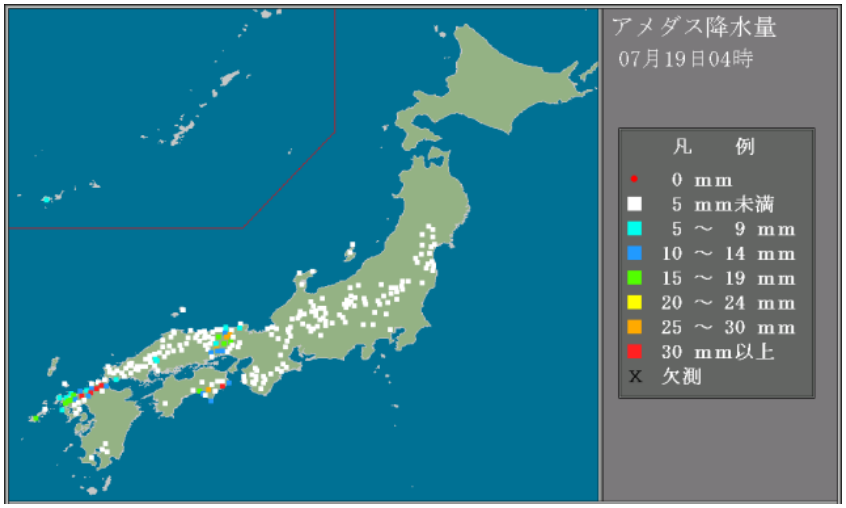
JAXA

Rainfall Measurement and our life

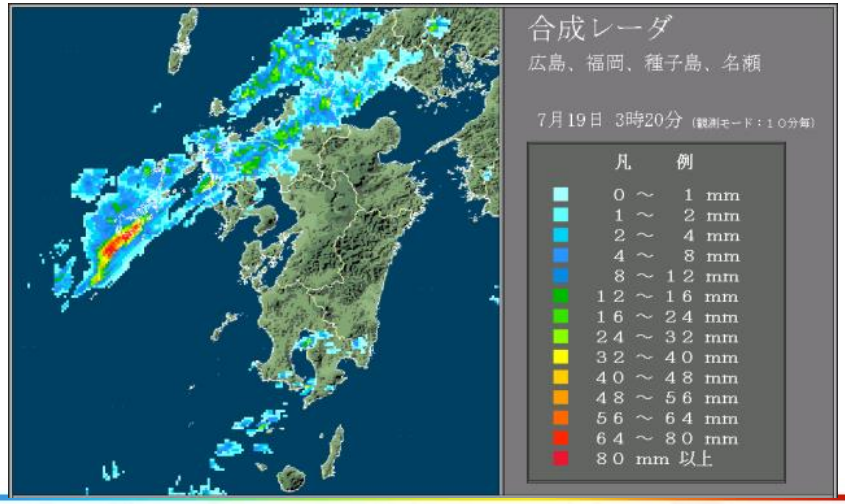
- Rain affects most everyone's life & work;
  - Food production; and
  - Flood and drought.
- Rain is a key variable in;
  - Weather prediction models;
  - Climate models, etc.
- Rain is one of hardest meteorological parameters to measure;
  - because of its spatial and temporal variability; and
  - most of ground observations are performed at urban area, and few observation over the ocean, deserts and mountainous areas

by Ground observation of rainfall?

Rain gauge



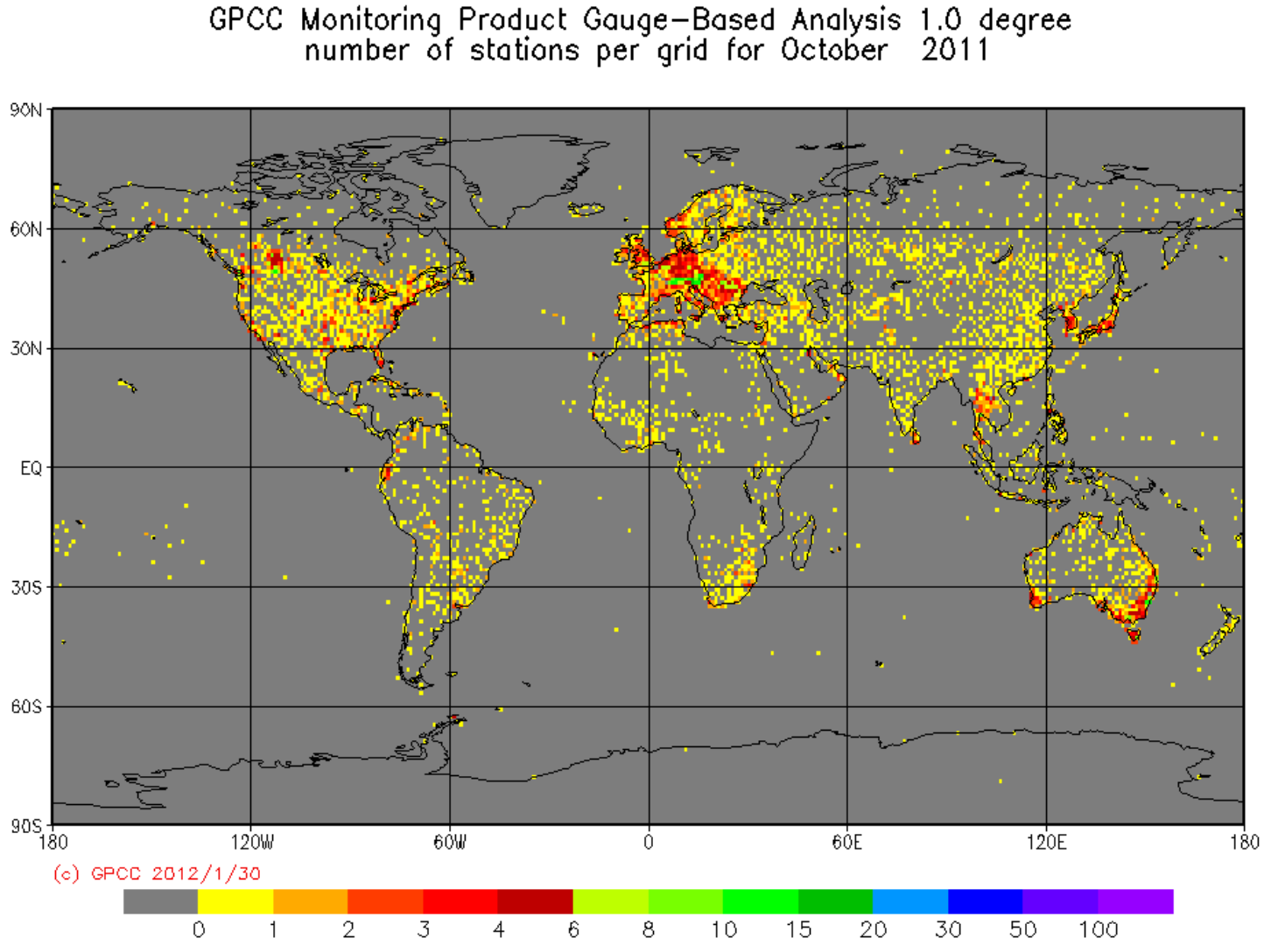
Ground-based radar



Ground rain gauge distribution

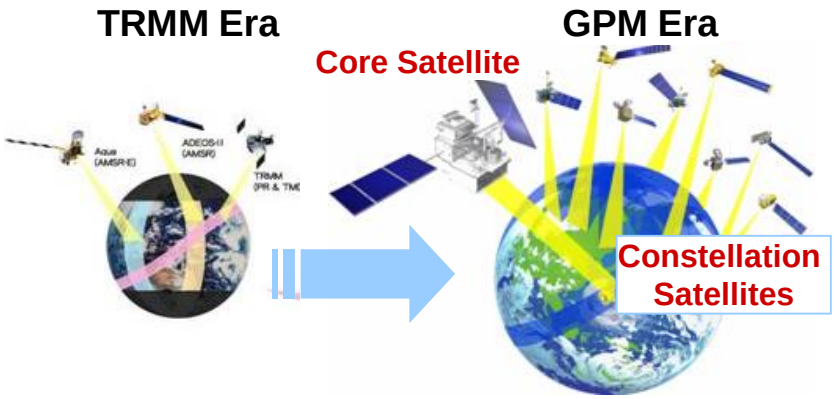
Distribution of rain gauge in GPCC Monitoring Product

Provided by Global Precipitation Climatology Centre (GPCC) http://gpcc.dwd.de



Global Precipitation Measurement (GPM)

- The Global Precipitation Measurement (GPM) is an expanded mission of the Tropical Rainfall Measuring Mission (TRMM)



Core Satellite (JAXA, NASA)

Dual-frequency precipitation radar (DPR)

GPM Microwave Imager (GMI)

- **Precipitation with high precision**
- **Discrimination between rain and snow**
- **Adjustment of data from constellation satellites**

(launch in Feb. 2014)

Constellation Satellites (International Partners)

Microwave radiometers

Microwave sounders

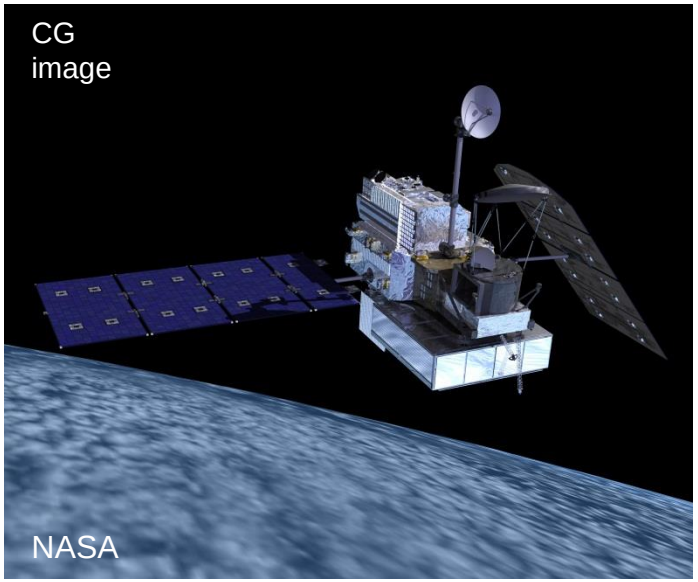
- **Global precipitation every 3 hours**

(launch around 2014)

- **Improve the accuracy of both long-term and short-term weather forecasts**
- **Improve water resource management in river control and irrigation systems for agriculture**

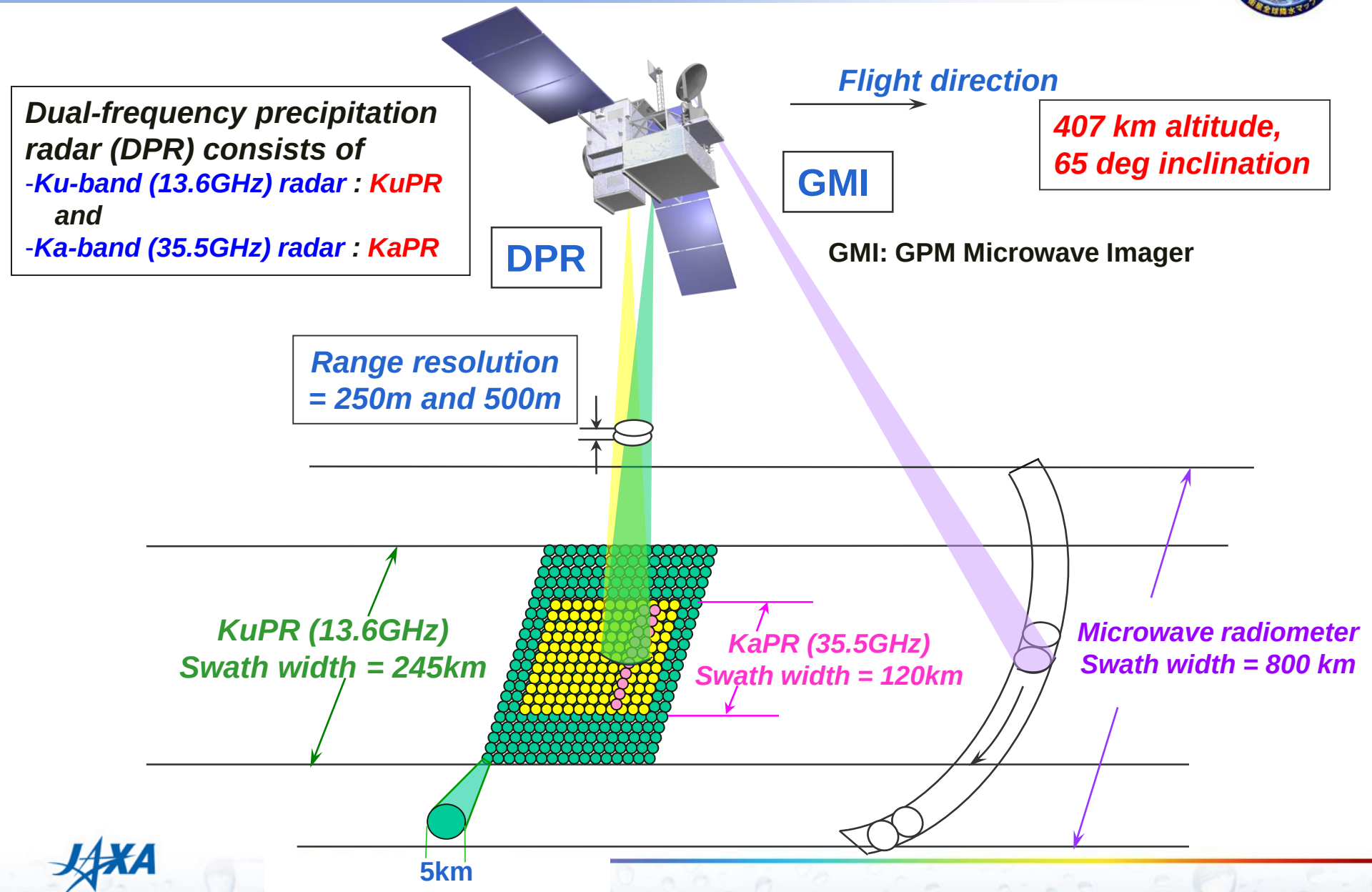
GPM Core Observatory Launch: 3:37 am on 28 Feb. 2014 (JST)

Launch from the JAXA Tanegashima Space Center by the H-IIA F23 rocket

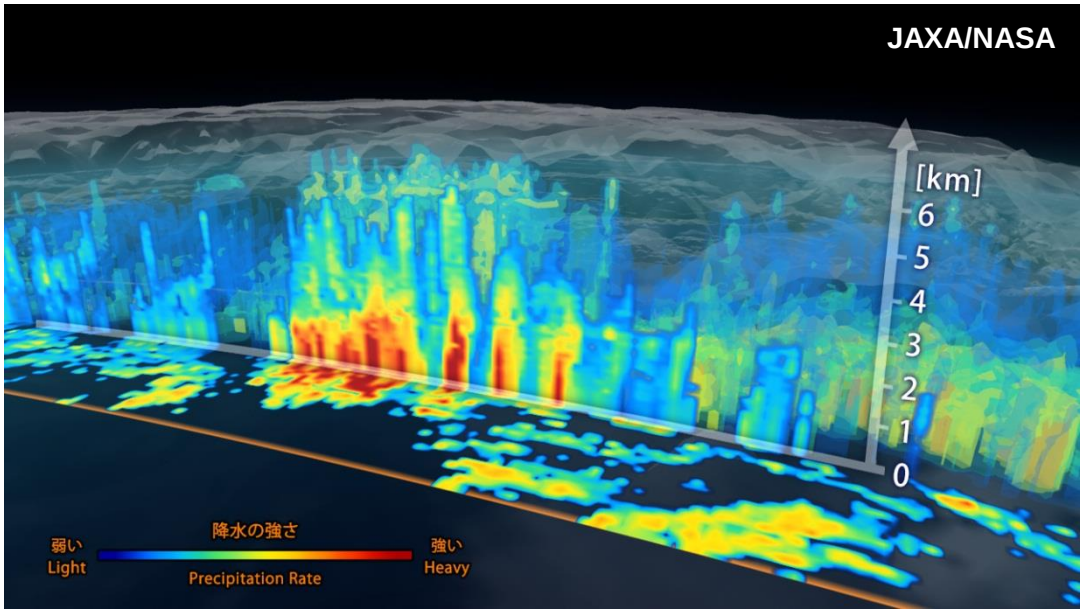


Separation of the spacecraft

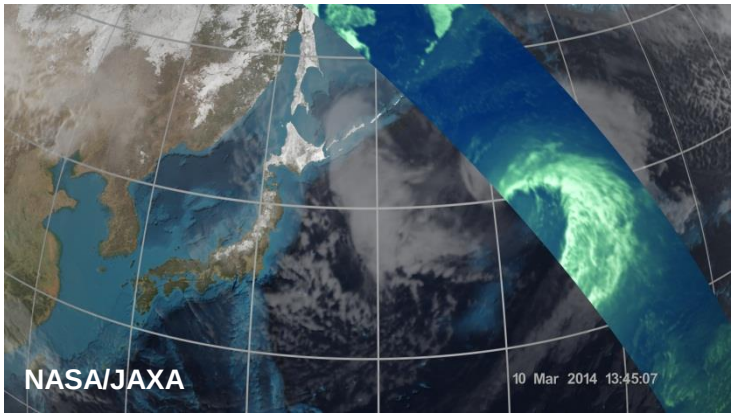
Sensors aboard GPM core satellite



NASA-JAXA Joint First Images from the GPM Core Observatory

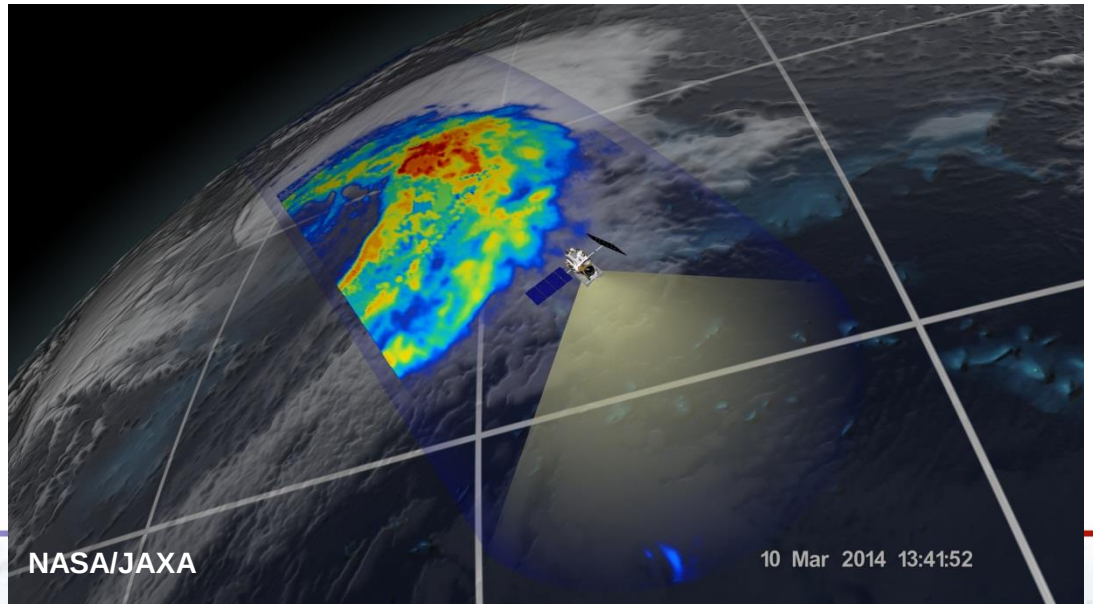


↑ Three dimensional structure of precipitation captured by DPR.



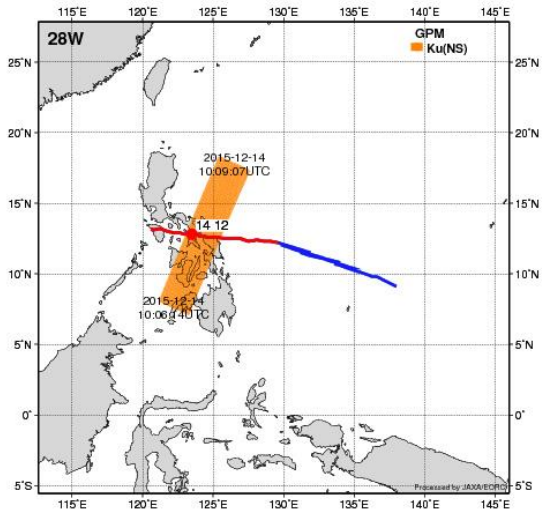
↑ GMI 36-GHz H TB is overlaying to the Geostationary IR provided by JMA and NOAA.

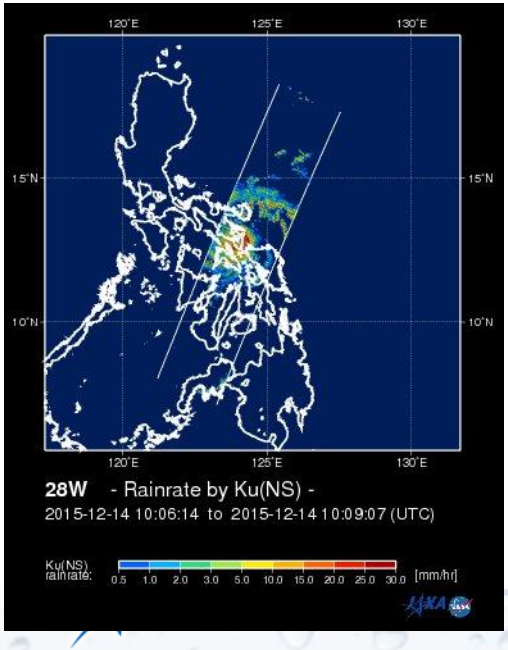
Extratropical Cyclone over the northwest Pacific Ocean (around 40N, 167E) around 1330Z on 10 Mar. 2014.



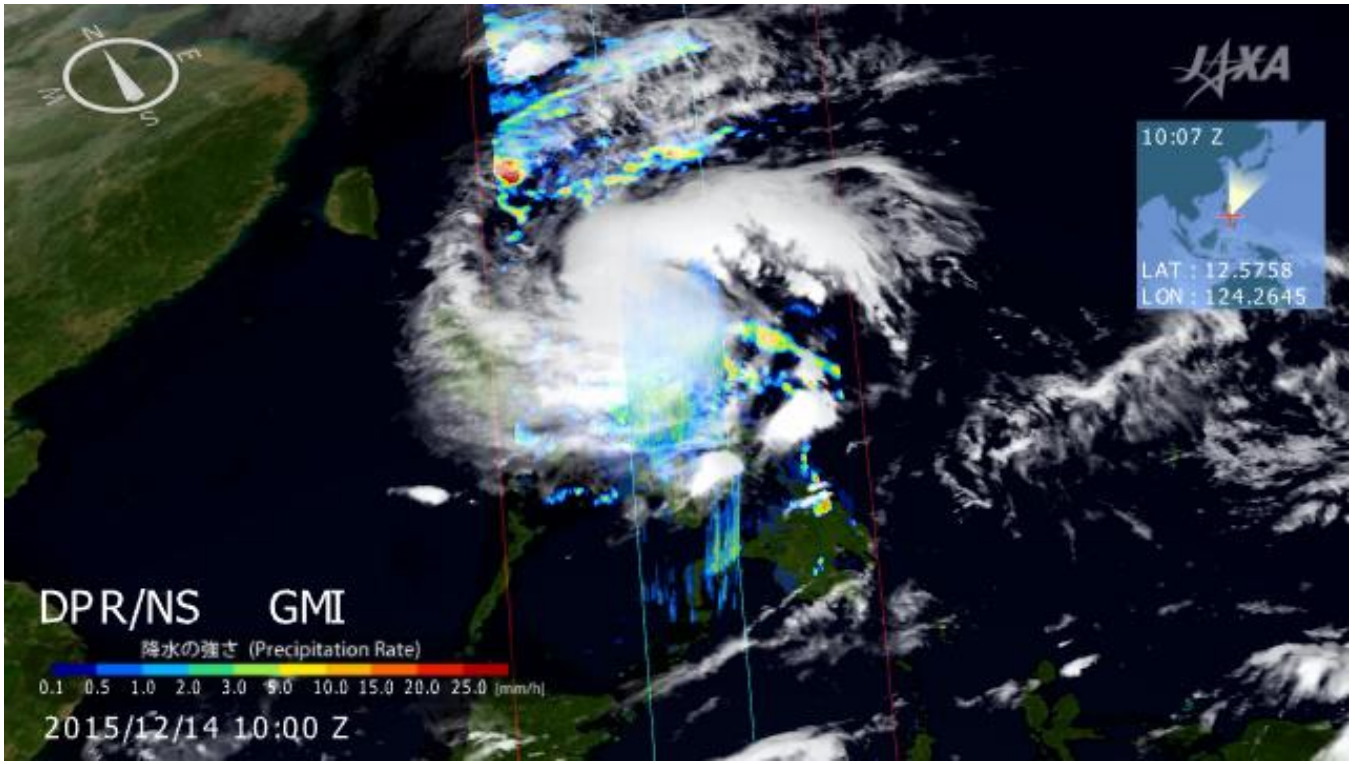
→Surface precipitation captured by GMI.

Recent observation: Super Typhoon Melor



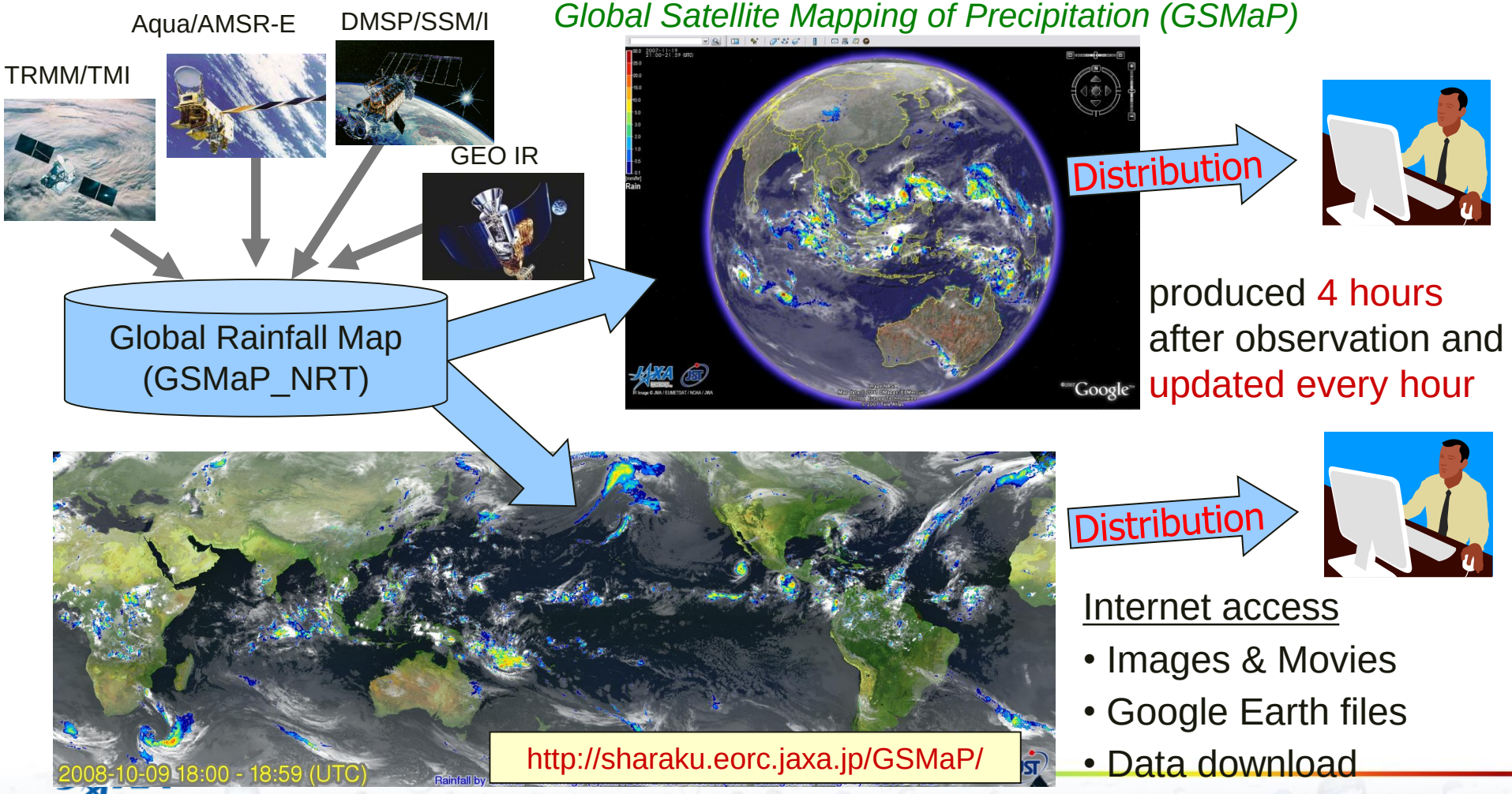


Typhoon Melor, hitting The Philippines
(10Z 14th December 2015)

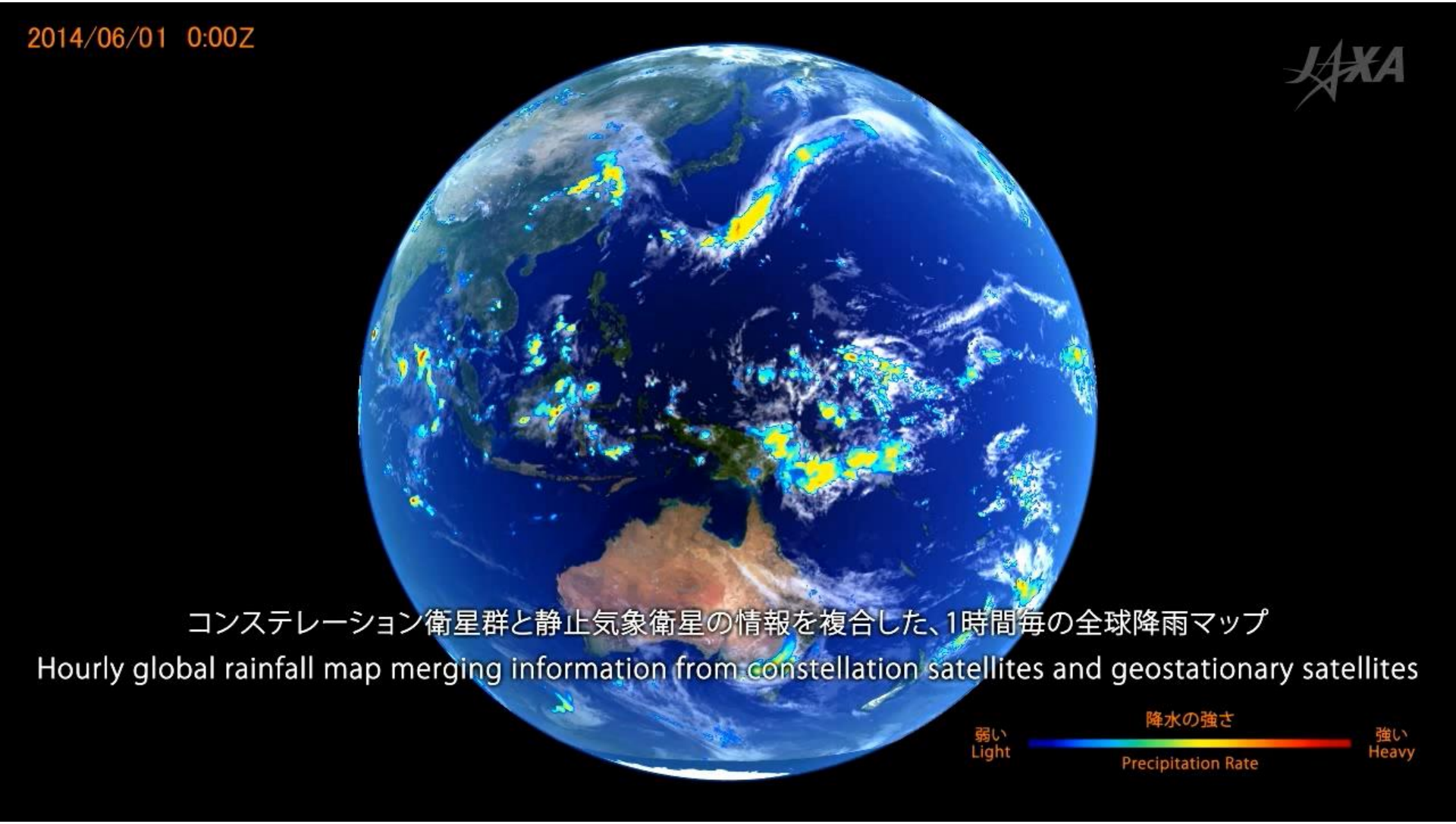


Multi-satellite rainfall product by JAXA (GSMaP)

We have started to release hourly global rainfall data (0.1x0.1deg. lat/lon) in near real time (about four hours after observations) and visualize the latest data quickly.



GPM-GSMaP movie in June 2014



GPM-GSMaP Product list

Standard product (Latency: 3 days)

Product name	Variables	Horizontal resolution	Temporal resolution	Latency	Correction
L3 GSMaP Hourly	Hourly Precip Rate (**GSMaP_MVK**)	0.1×0.1 deg.lat/lon	1 hour	3 days	None
	Gauge-corrected Hourly Precip Rate corrected by gauge (**GSMaP_Gauge**)				Corrected by daily rain gauges (NOAA CPC Gauge-Based Analysis, Chen et al. 2008)

Near-real-time product (Latency: 4 hours)

Product name	Variables	Horizontal resolution	Temporal resolution	Latency	Correction
L3R GSMaP Hourly	Hourly Precip Rate (**GSMaP_NRT**)	0.1×0.1 deg.lat/lon	1 hour	4 hours	None
	Gauge-corrected Hourly Precip Rate corrected by gauge (GSMaP_Gauge_NRT)				Correction by empirical coefficients

GPM-GSMaP data is now available from JAXA G-portal (https://www.gportal.jaxa.jp) as well as current GSMaP web site (http://sharaku.eorc.jaxa.jp/GSMaP/).

Production of GSMaP by multi-satellite

Microwave Imagers & Sounders

GPM-Core GMI

GCOM-W AMSR2

DMSP SSM/I, SSMIS

NOAA/MetOp AMSU

Good: high-frequent (wide swath, multi-satellites)
Bad: cannot measure vertical structure (need info. from radar)

GSMaP Microwave Radiometer Retrieval Algorithm

Precipitation Radars

TRMM PR

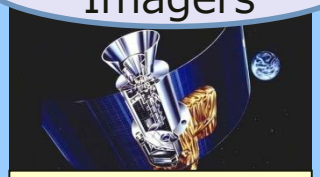
GPM-Core DPR

Data Base

Rainfall Data from each Microwave Radiometer

Merged Microwave Rainfall Data

IR Imagers



Geostationary Satellites

Microwave-IR Merged Algorithm (CMV, K/F)

Global Rainfall Map
+ Gauge-calibrated Rainfall Map
(0.1 degree grid, Hourly)

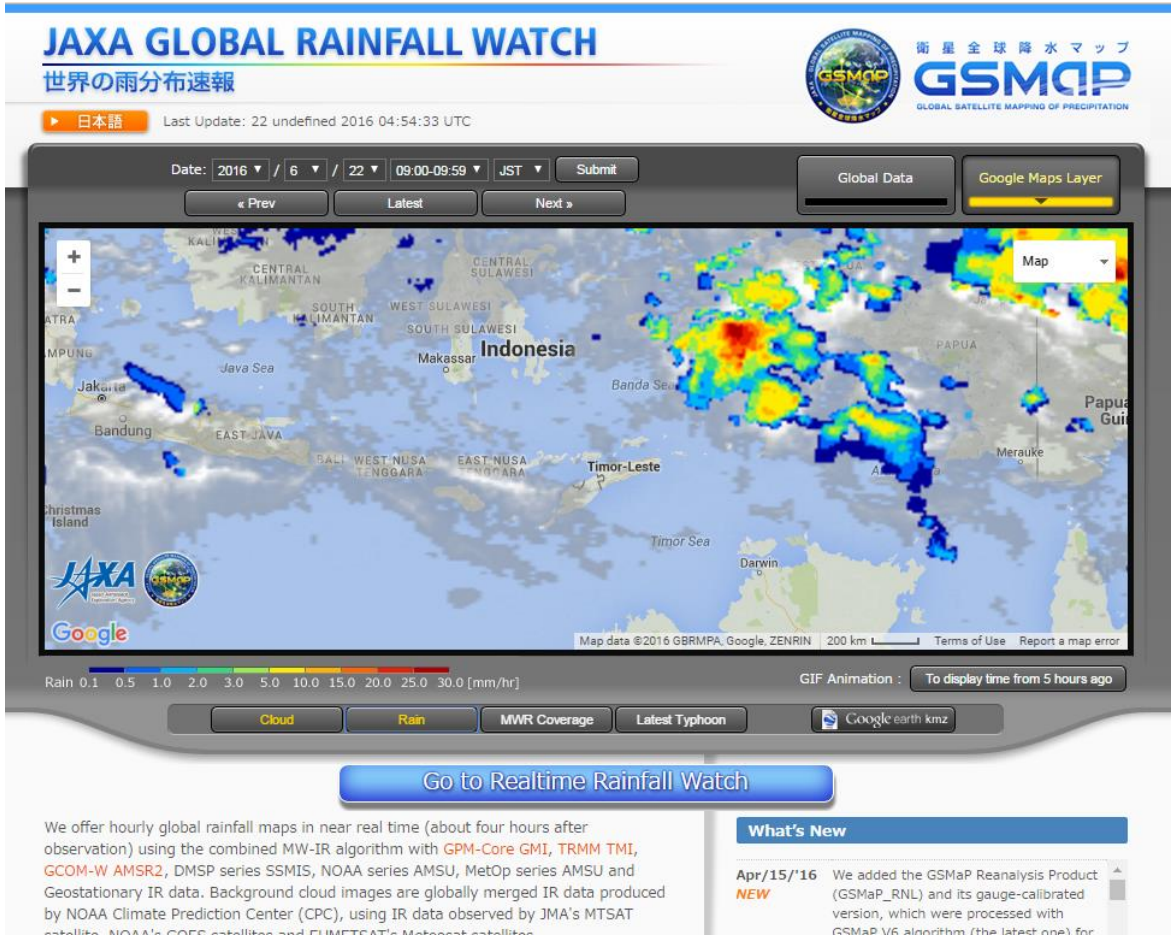
(Okamoto et al. 2005, Kubota et al, 2007, Aonashi et al. 2009, Ushio et al. 2009, Shige et al. 2009, Kachi et al. 2011)

JAXA

http://sharaku.eorc.jaxa.jp/GSMaP/

JAXA Global Rainfall Watch (GSMaP_NRT/GSMaP_MVK)

http://sharaku.eorc.jaxa.jp/GSMaP/

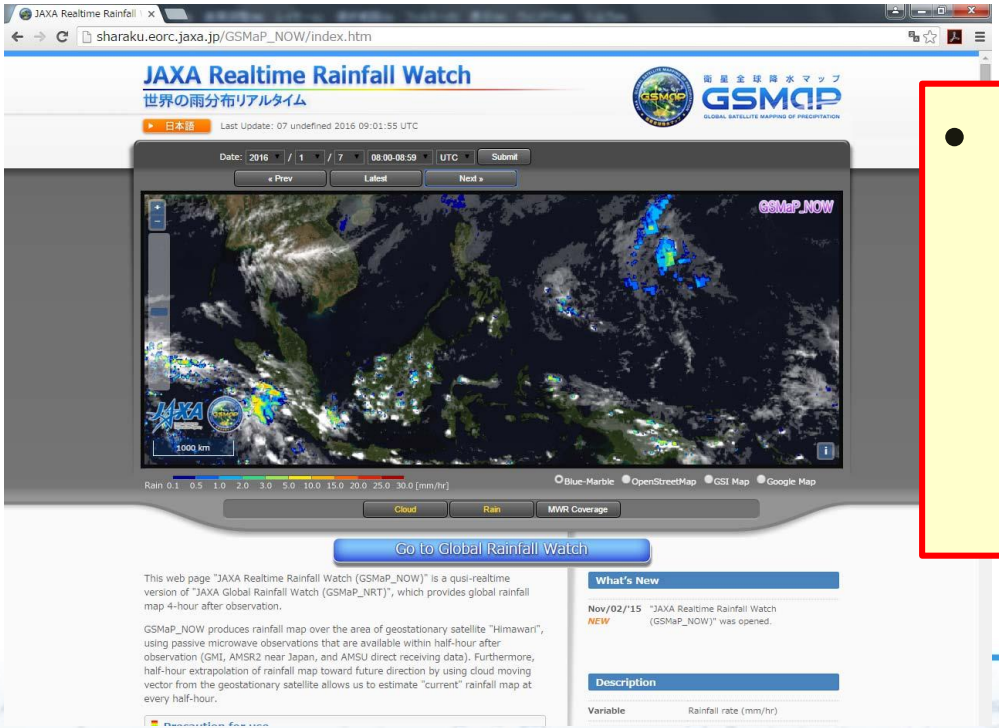


The GSMaP data are freely available all users with simple registration.

Same data in HDF5 format (GPM standard) is also available from **JAXA G-portal (https://www.gportal.jaxa.jp)**

GSMaP real-time version (GSMaP_NOW)

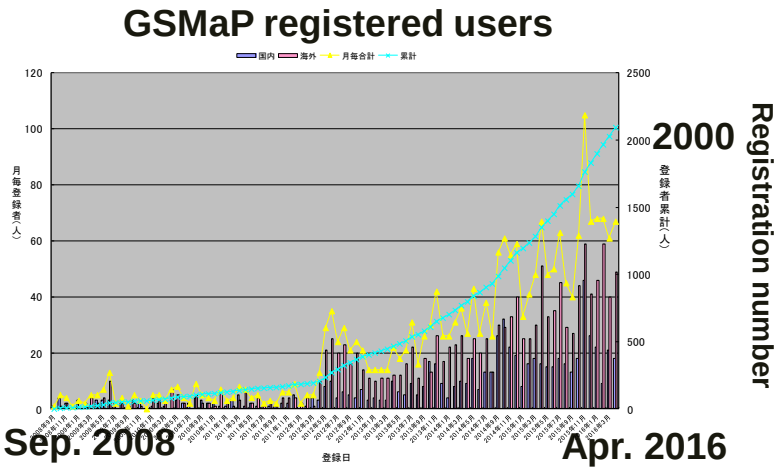
- To reduce latency from 4-hr to “quasi-realtime”
  - Using data that is available within 0.5-hour (GMI, AMSR2 direct receiving data, AMSU direct receiving data and Himawari-IR) to produce GSMaP at 0.5-hr before (observation).
  - Applying 0.5-hour forward extrapolation (future direction) by cloud motion vector to produce GSMaP at current hour (just now).



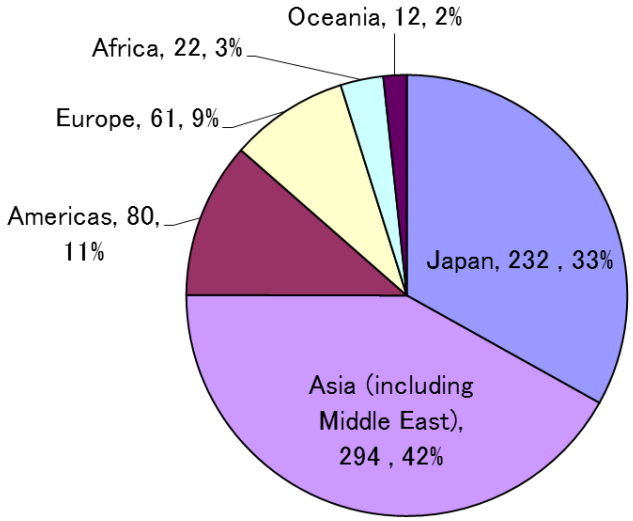
- Web site and data (GEO-Himawari region) are now open to the public from http://sharaku.eorc.jaxa.jp/GSMaP_NOW/

GSMaP Applications

GSMaP Application



About 2100 registered users as of 30 Apr. 2016



About 67% users are originated from foreign countries.

- **Weather monitoring**
  - Japan Weather Association (JWA) : Mobile phone, weather information
  - Meteorological agencies in Asian country: Rainfall monitoring, typhoon monitoring, flood prediction
- **Flood warning/prediction**
  - International Flood Network (IFNet), Infrastructure Development Institute (IDI) : Global Flood Alert System (GFAS)
  - International Centre for Water Hazard and Risk Management (ICHARM) : Integrated Flood Analysis System (IFAS)
  - Japan Water Association : flood potential monitoring
  - UNESCO-IHP: flood warning system using IFAS
  - Asia Development Bank (ADB): River management including flood risk
  - Japan International Cooperation Agency (JICA): Water resource management in river-basin, flood monitoring
- **Agriculture/Industry/Education**
  - Crop forecast, food security, weather index insurance
  - Providing precipitation and flood information to factories abroad
  - Using global rainfall map in educational materials

Utilization of GSMaP in Asia

- Indonesia
  - BMKG: Operational rainfall monitoring
  - LAPAN: Research in diurnal, annual, and climate variations
  - BPPT: Research in thunderstorm variations
- Viet Nam
  - NHMS: Operational rainfall monitoring
  - Hanoi University: Bias correction of GSMaP with Neural Network (ANN) for hydrological applications
- Thailand
  - TMD: Production of GSMaP graphic and subset for domestic stake folders
  - HAII: Operational flood forecasting with bias correction of GSMaP
- Philippines
  - PAGASA: Operational typhoon and rainfall monitoring, flood forecasts in Cagayan River basin by ADB project
- Pakistan
  - PMD: Operational flood forecasts using Indus-IFAS with gauge-corrected GSMaP by UNESCO project

Drought monitoring in Indonesia

JAXA

Satellite data preparation
- GSMaP: Rainfall
- HIMAWARI: Land surface temperature

ICALRD, LAPAN, Univ. Tokyo

Satellite data processing
- Produce KBDI
- Mapping drought index
- Estimate drought impact on rice production

LAPAN, IAARD, BPS, BMKG, PUSDATIN

Information system management
- Area affected by drought
- Recommendation; planting time, crop, etc

Web-GIS based information system

- This web-GIS system is sustainably operated by MOAI.
- The system is used by MOA for food security management.
- The developed index was utilized in ADB project in Lower Mekong Region.

MOA: Ministry of Agriculture
ICALRD: Indonesian Center for Agricultural Land Resources Research and Development

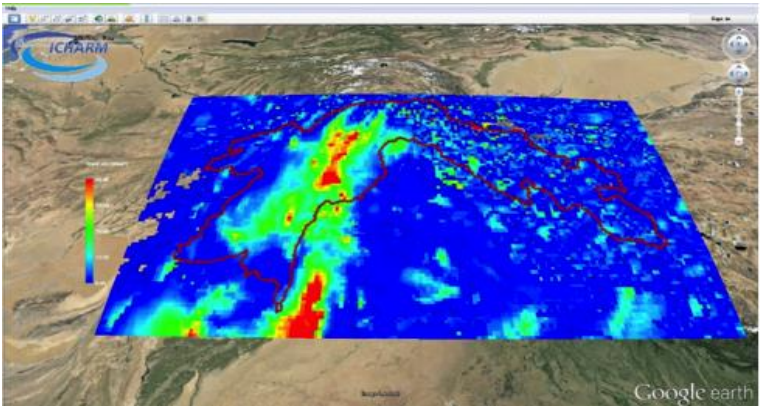
Data utilization in flood warning

- Collaboration with International Flood Network (IFNet) since 2003.
  - Utilization of TRMM and GPM satellite-based rainfall data as input to their Global Flood Alert System (GFAS).
  - Current system uses GSMAP near-real-time product.
- Collaboration with International Centre for Water Hazard and Risk Management (ICHARM) since 2005.
  - Utilization of hourly GSMaP near-real-time data in their flood forecasting system, Integrated Flood Analysis System (IFAS).
  - Development of self-collection method for GSMaP as input to IFAS.

UNESCO Pakistan Project for Predicting Floods

- **Under UNESCO-IHP** project, **JAXA**, **ICHARM** and **Pakistan Meteorological Department (PMD)** to develop operational flood analysis system.
- After calibration of **GSMaP product** with **ground-based stations** in Pakistan, correlation coefficients are increased from 0.5 to 0.7, and can be used in the Indus Integrated Flood Analysis System (Indus-IFAS) developed by ICHARM.
- The system is now in operation by PMD, and a plan to extend the system to eastern river area is now underway.

Rainfall by GSMaP

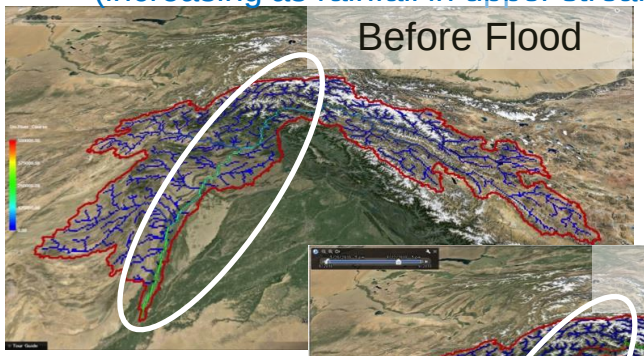


(Area within red line is Indus river basin)

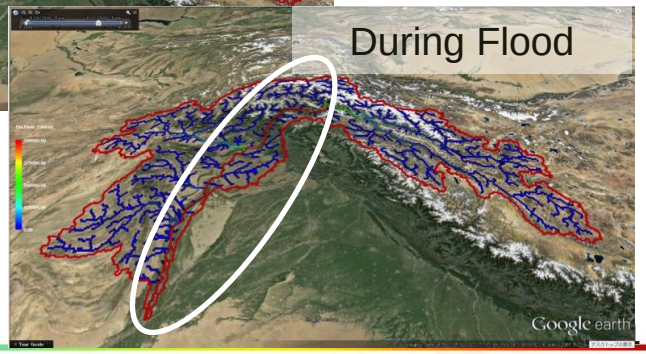
INPUT

Indus_IFAS:River discharge output using GSMaP

(increasing as rainfall in upper stream increased)



Discharge of main river is normal (green) before flood



Discharge of main river is largely increased (red) during flood

Example of Indus-IFAS in Pakistan
(Image provided by ICHARM)

Summary

- Global Precipitation Measurement (GPM)
  - Dual-frequency Precipitation Radar (DPR)
- Multi-satellite Precipitation Products
  - Global Satellite Mapping of Precipitation (GSMaP)
    - GPM-GSMaP
      - Data are available from GSMaP web site (http://sharaku.eorc.jaxa.jp/GSMaP/).
    - GSMaP_NOW
      - GSMaP realtime product (GSMaP_NOW) was open on Nov. 2016(http://sharaku.eorc.jaxa.jp/GSMaP_NOW/), but the GEO-Himawari area. Other areas will be developed in the near future.
- GSMaP data applications
  - Weather monitoring, Flood warning/prediction, etc.