GSMaP

GLOBAL SATELLITE MAPPING OF PRECIPITATION

Real-time Global Satellite Mapping of Precipitation (GSMaP) product

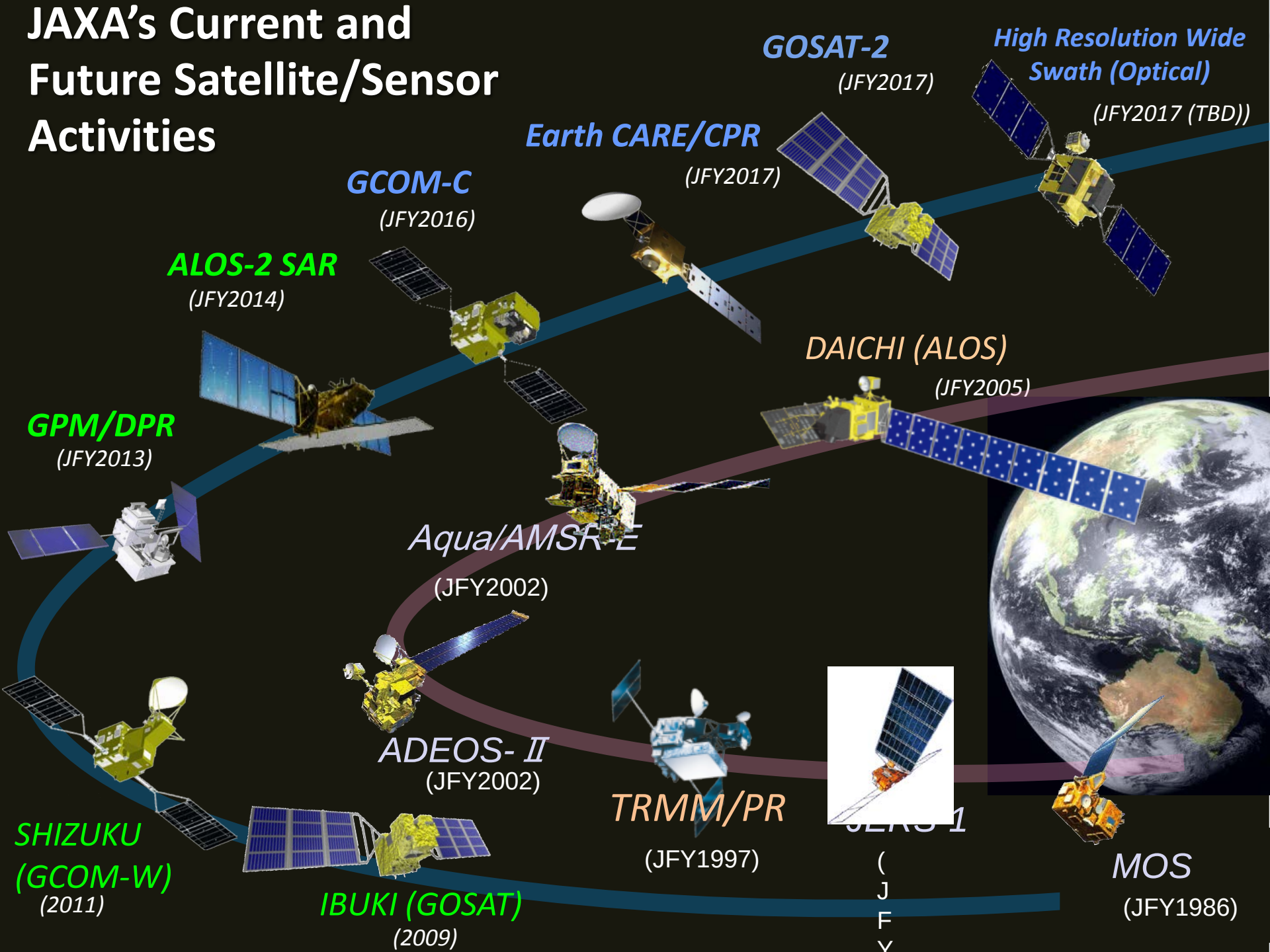
Riko Oki

Earth Observation Research Center (EORC)

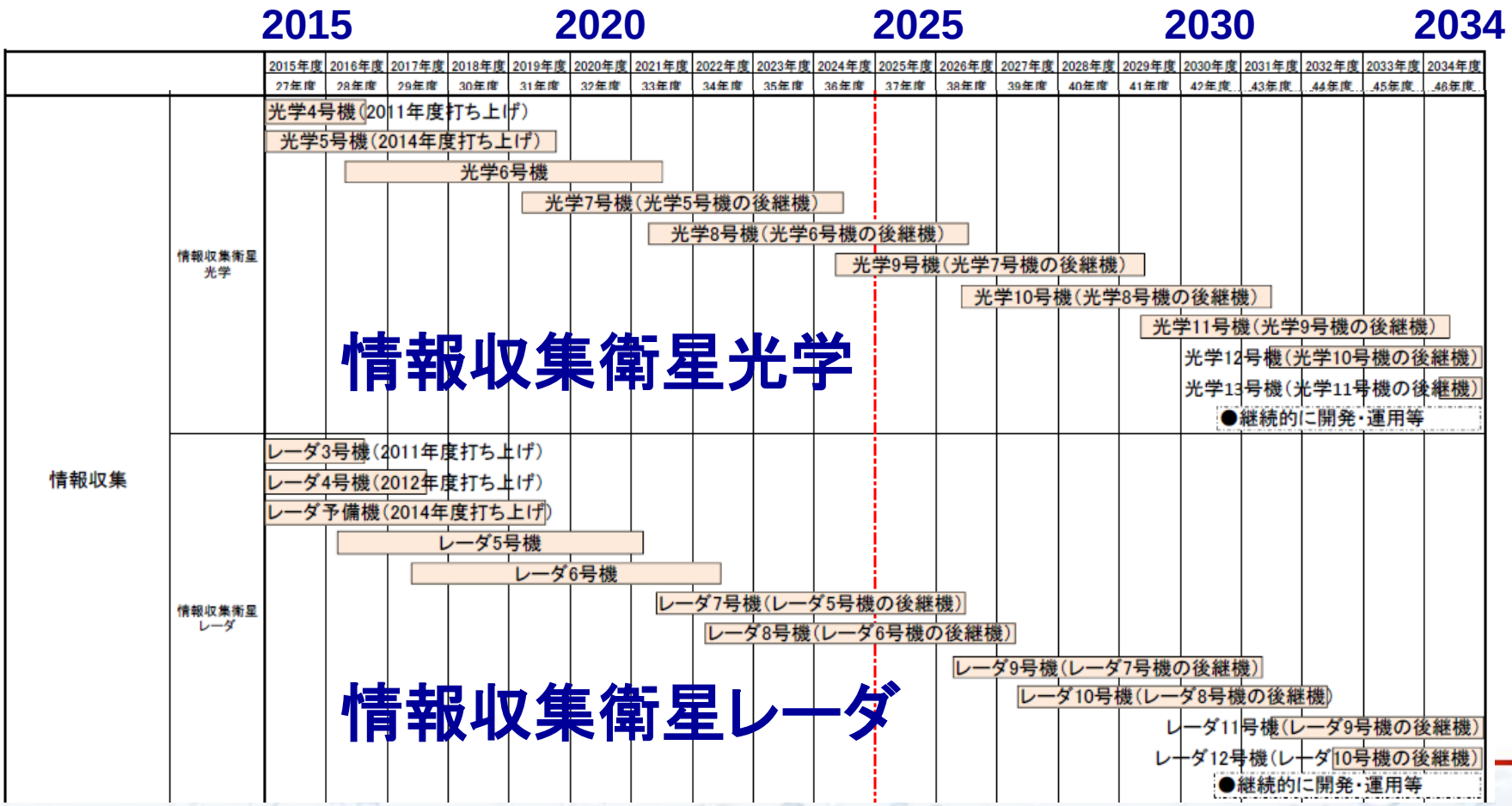
Japan Aerospace Exploration Agency (JAXA)

JAXA

JAXA's Current and Future Satellite/Sensor Activities

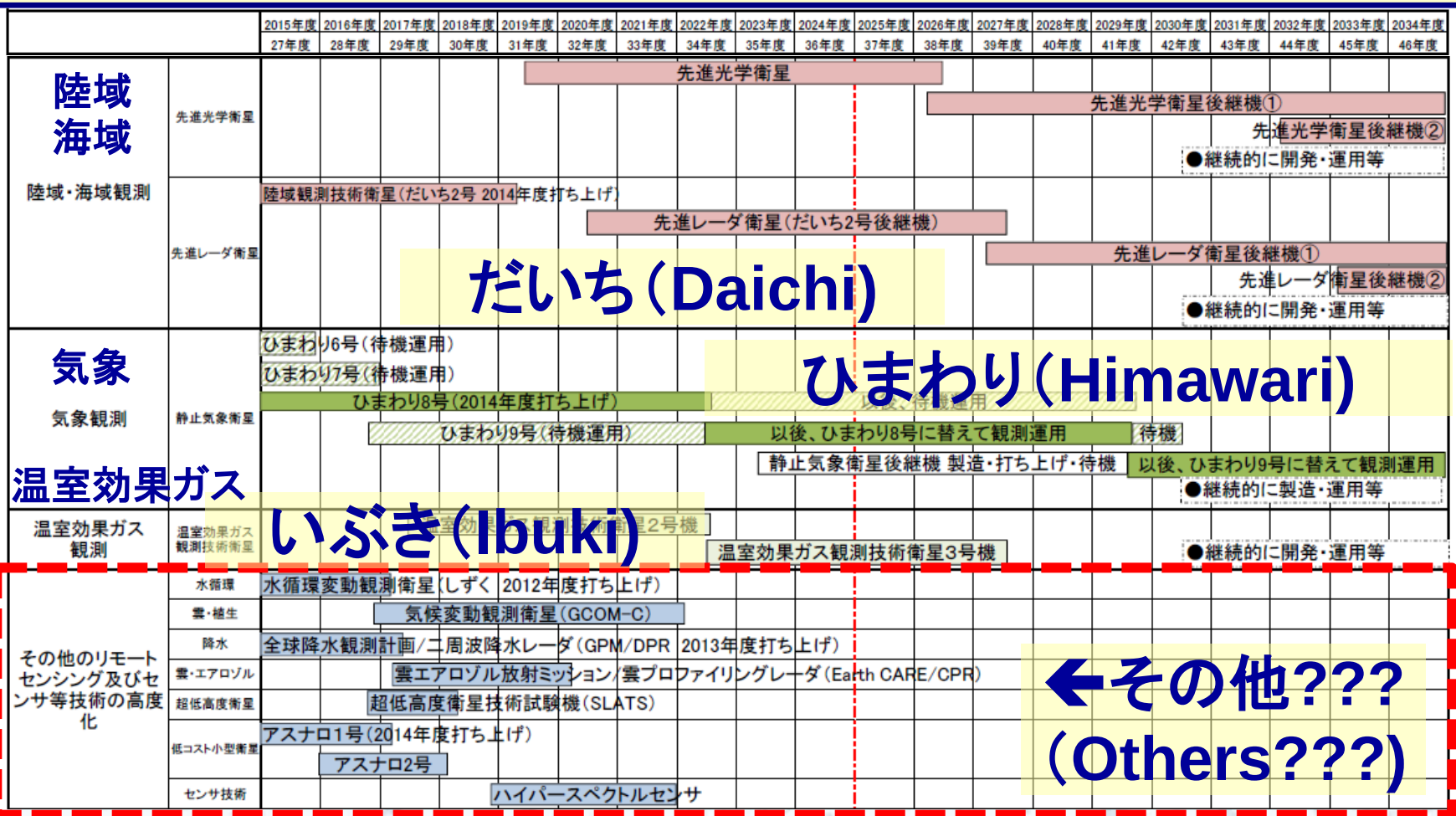


内閣府戦略室宇宙基本計画工程表（情報収集関係）

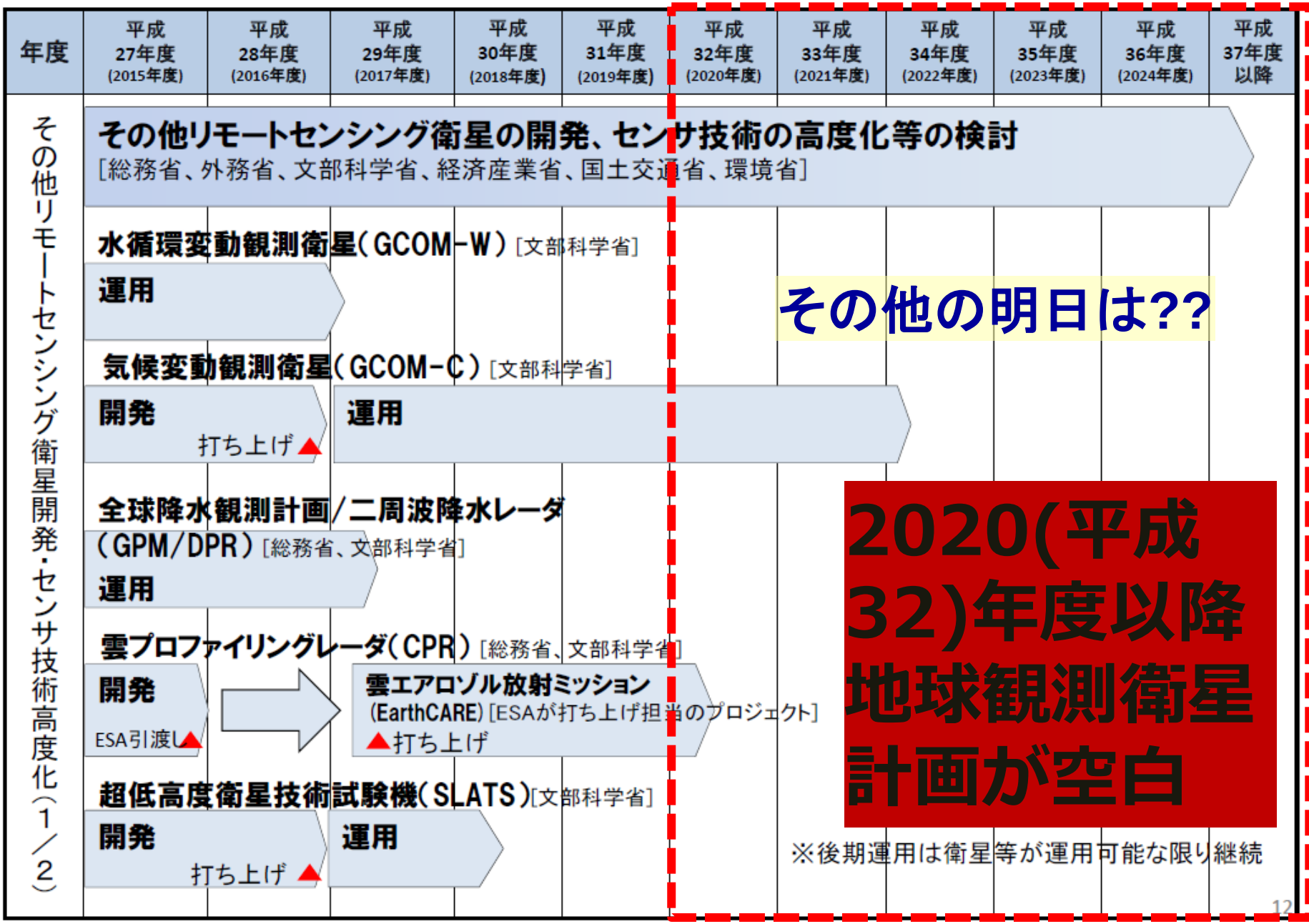


内閣府戦略室宇宙基本計画工程表より抜粋
http://www8.cao.go.jp/space/plan/plan2/plan2_koutei.pdf

内閣府戦略室宇宙基本計画工程表（だいち/ひまわり/いぶき）



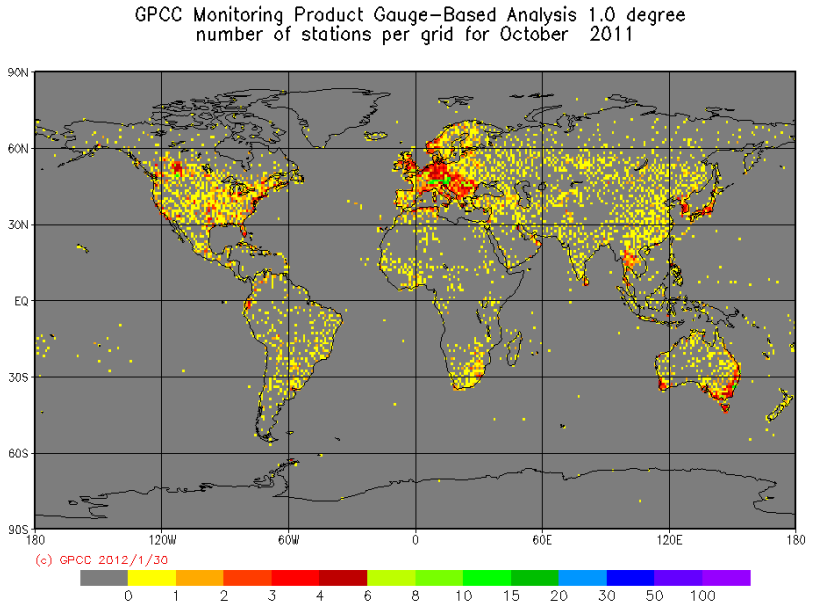
内閣府戦略室宇宙基本計画工程表より抜粋5
http://www8.cao.go.jp/space/plan/plan2/plan2_koutei.pdf

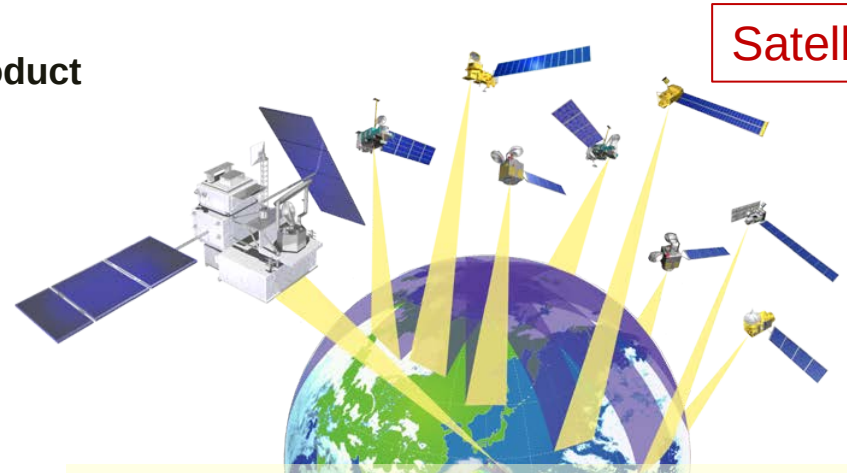


Precipitation observation from Space

- Precipitation affects most everyone's life & work, but is one of hardest meteorological parameters to measure;
  - because of its high spatial and temporal variability; and
  - most of ground observations are performed at urban area, and few observation over the ocean, deserts and mountainous areas

Distribution of rain gauge in GPCC Monitoring Product
Provided by Global Precipitation Climatology Centre (GPCC)
http://gpcc.dwd.de

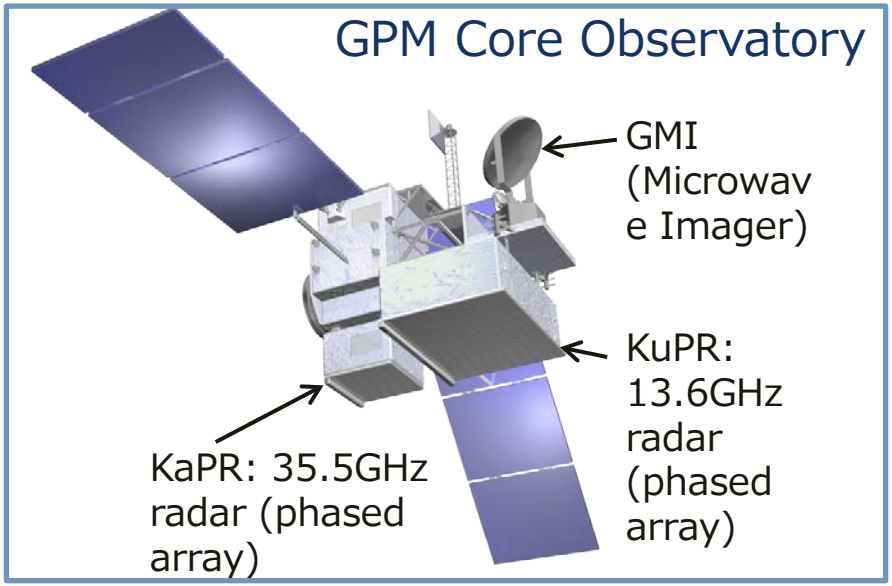


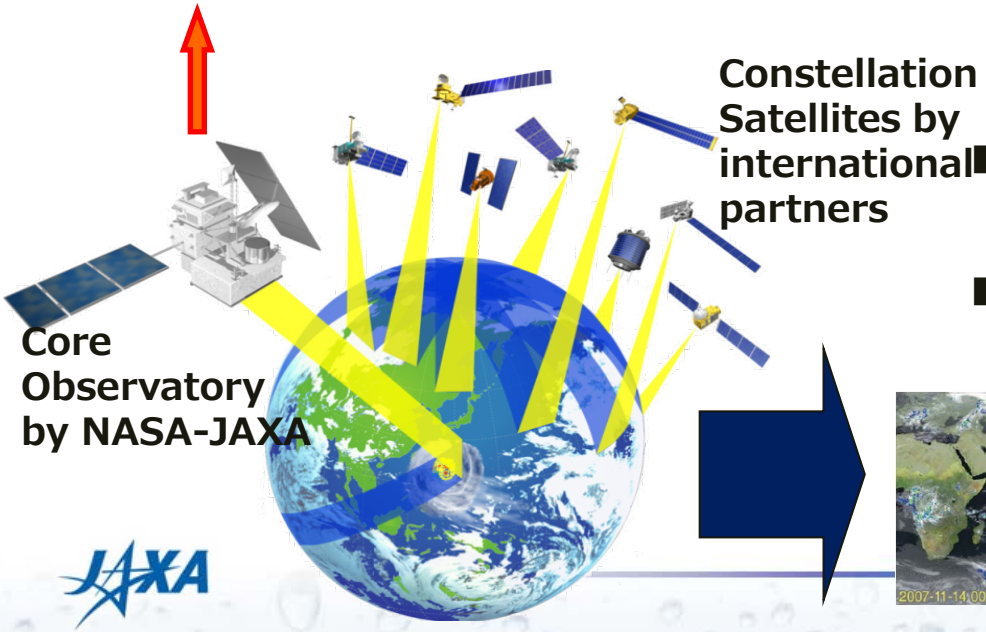


Merits of Satellite

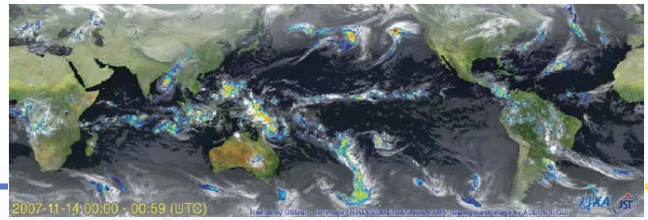
Global observation
with the same time interval
with the same accuracy

Global Precipitation Measurement (GPM)





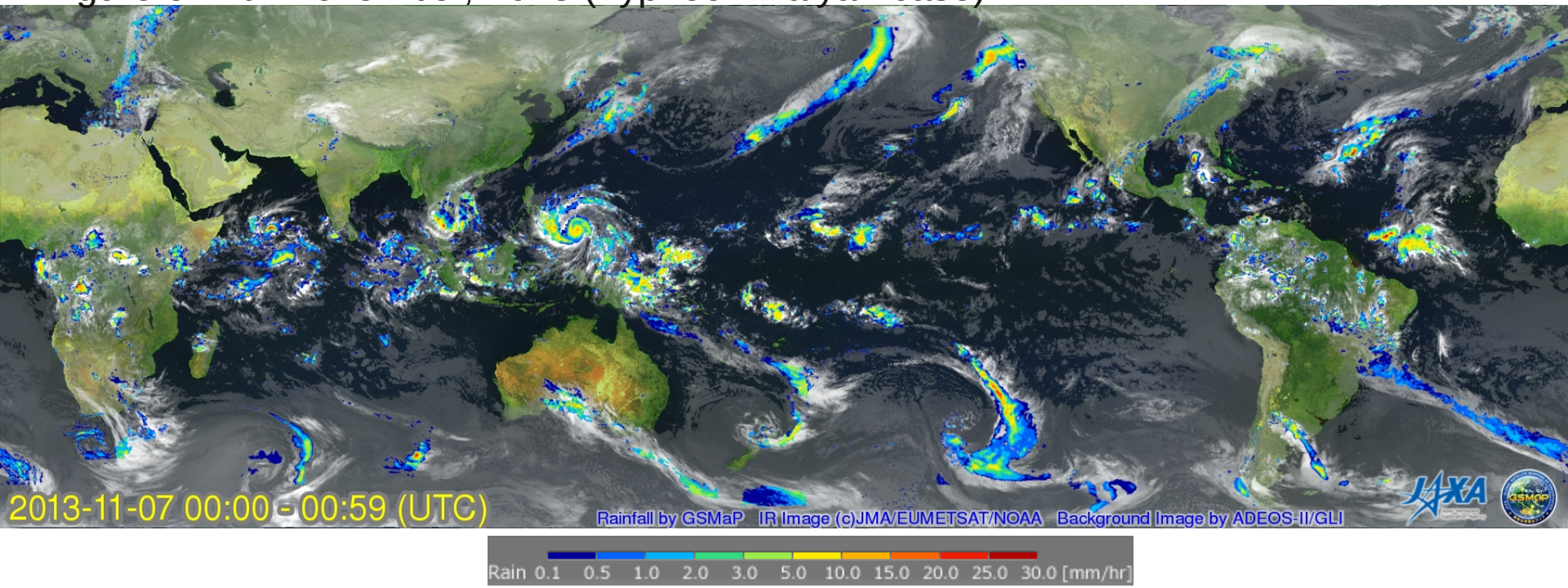
- GPM is an international mission consisting of the GPM Core Observatory and Constellation Satellites for high accurate and frequent global precipitation observation.
  - Core Observatory: developed under NASA and JAXA equal partnership.
  - Constellation satellites: provided by international partners (includes GCOM-W1).
- Dual-frequency Precipitation Radar (DPR)
  - developed by JAXA and NICT
  - DPR is composed of two radars: KuPR & KaPR
- GPM Core Observatory was successfully launched **on 28 Feb. 2014 (JST).**
- All GPM standard products were released on September 2014.



Global Satellite Mapping of Precipitation (GSMaP)

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

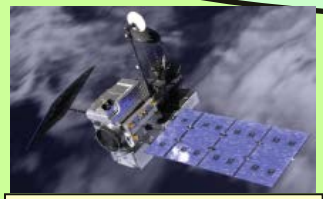
A figure on 7th November, 2013 (Typhoon Haiyan case)



- GSMaP is a blended Microwave-IR product and has been developed in Japan for the GPM mission.
  - Processing and distributing global rainfall data in near real time basis (about 4-hour after observations) by merging multi-satellite data.
  - Hourly product in 0.1x0.1deg. lat/lon grid.
- Proto-type version has been in operation in JAXA since 2007.
  → "GPM-GSMaP" data were released on Sep. 2014.

Overview of GSMaP Algorithm

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

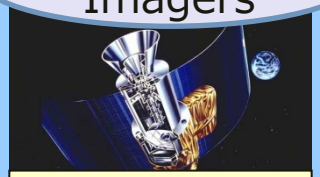
GPM-Core DPR

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)

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

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

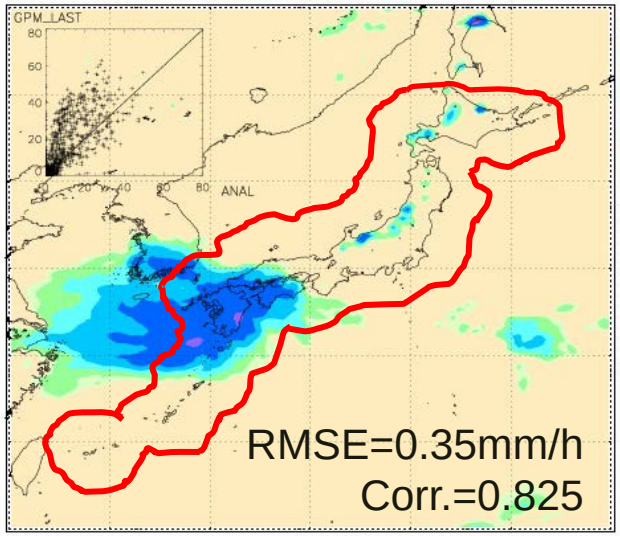
GPM-GSMaP data is now available from JAXA G-portal (https://www.gportal.jaxa.jp) as well as current GSMaP web site (http://sharaku.eorc.jaxa.jp/GSMaP/).

Evaluation of GPM-GSMaP

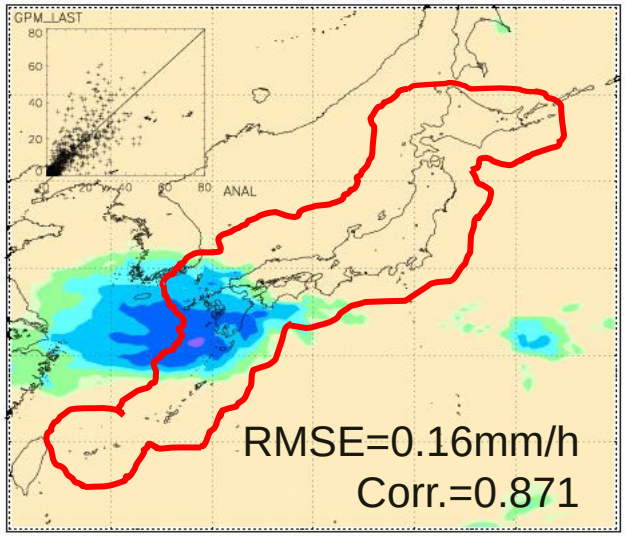
- Daily averaged rainfall around Japan in 0.25 degree grid was compared with JMA's Radar-AMeDAS (gauge-calibrated radar analysis rainfall).

An example on Apr. 12, 2014

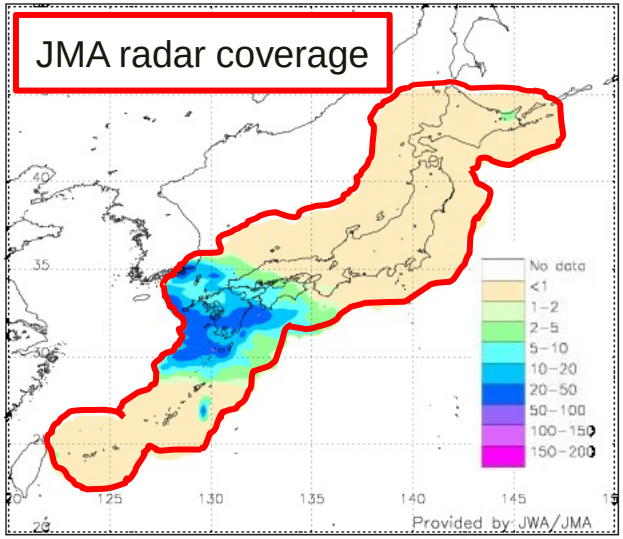
GSMaP_MVK



GSMaP_Gauge



Gauge-Radar Analysis

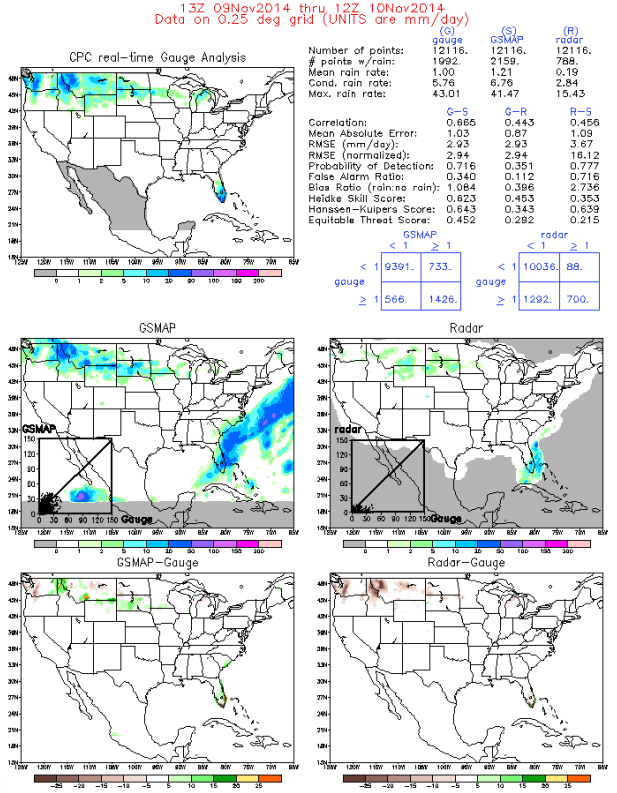


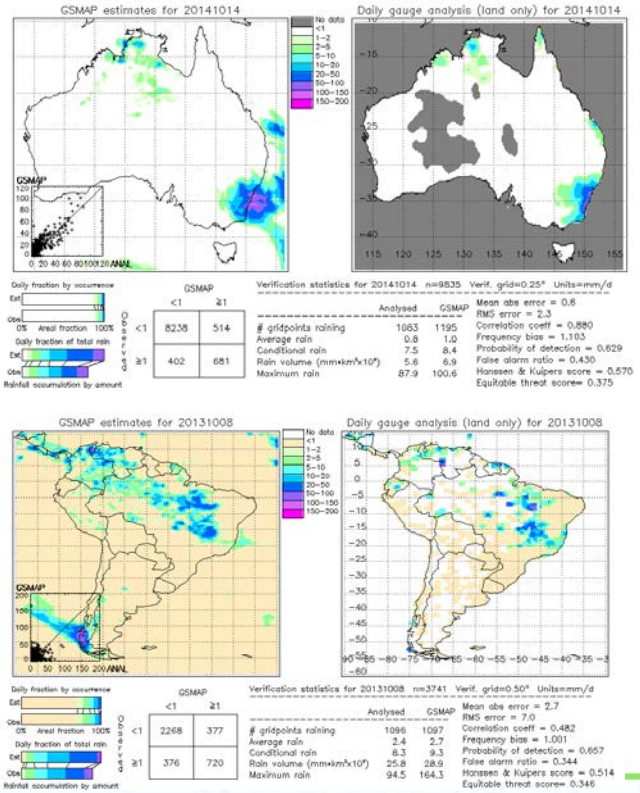
→ **GSMaP_Gauge** shows better correlation with less Root Mean Square Error (RMSE) on Apr. 12, 2014.

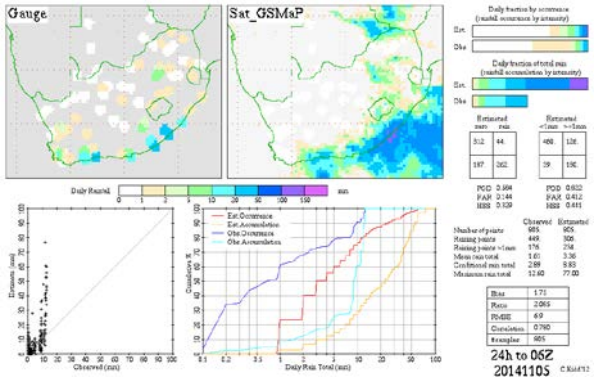
IPWG Validation collaboration

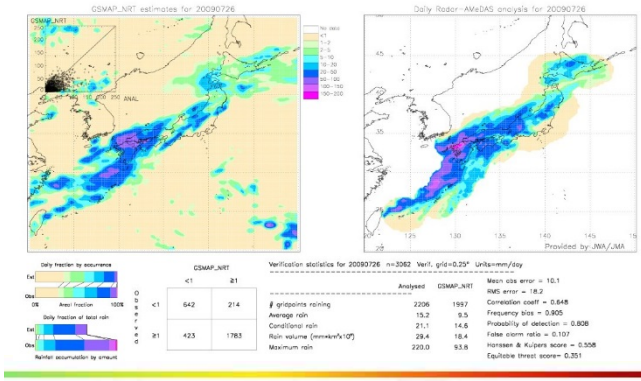
- The GSMaP joins the International Precipitation Working Group (IPWG) validation activities.
- Within IPWG Validation collaboration framework, our GSMaP products are validated also in U.S.(J.-J.Wang/J. Janowiak), Australia (E. Ebert), South America (D. Vila), Europe (C. Kidd), and South Africa (E. Becker).

http://cawcr.gov.au/projects/SatRainVal/validation-intercomparison.html



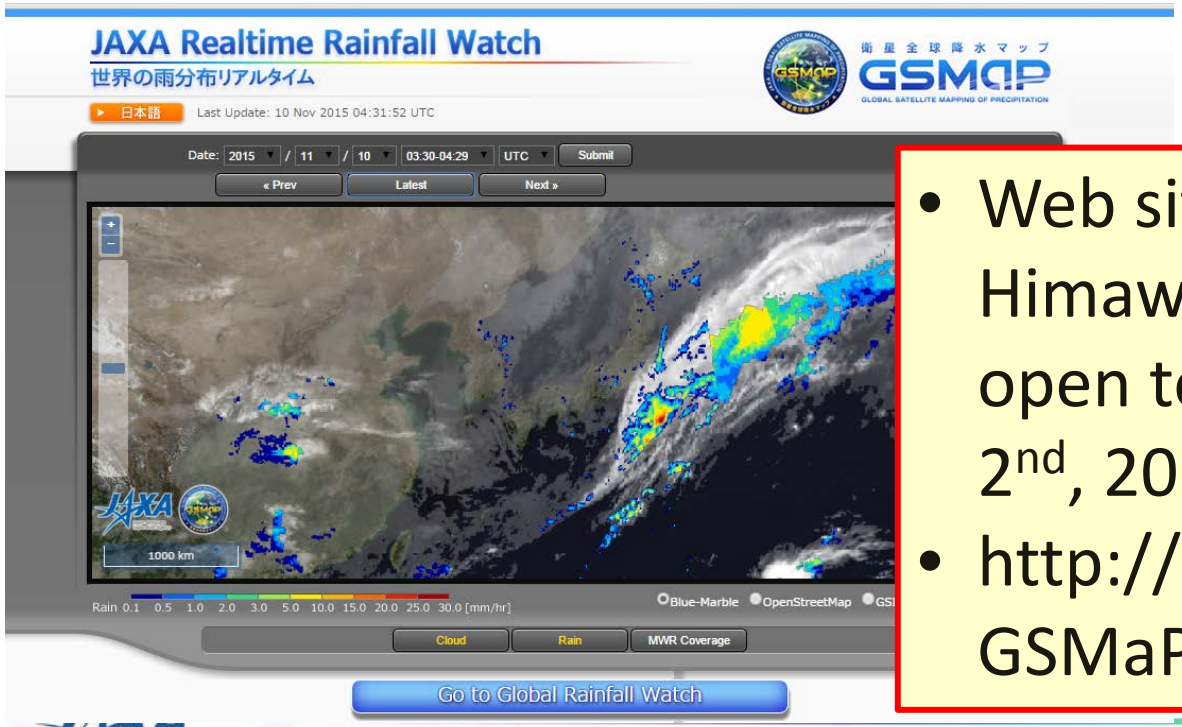






Development of GSMaP just now version (GSMaP_NOW)

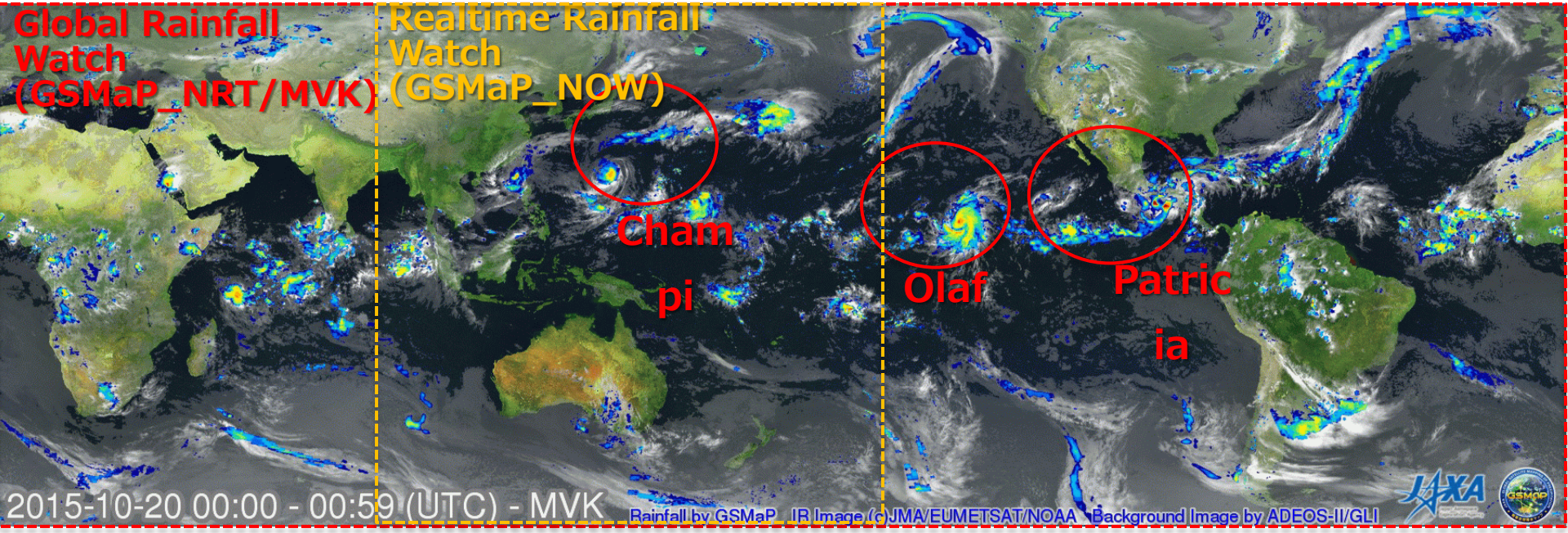
- To reduce latency from 4-hr to “now”
  - Using data that is available within 0.5-hour (GMI, AMSR2 direct receiving data, AMSU direct receiving data and Himawari-IR) to produce GSMaP at 1-hr before (observation).
  - Applying 0.5-hour forward extrapolation (future direction) by cloud motion vector to produce GSMaP at current hour (just now).



- Web site and data (GEO-Himawari region) are now open to the public on Nov. 2nd, 2015.
- http://sharaku.eorc.jaxa.jp/GSMaP_NOW/index_j.htm

“GSMaP_NOW” over “Himawari-8” area started!

Global Satellite Mapping of Precipitation (GSMaP)



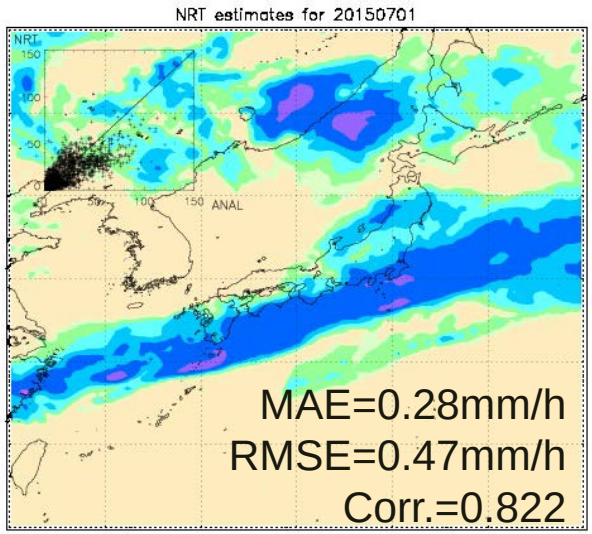
GSMaP (Global) observed Hurricane Patricia and Olaf, and Typhoon Champi: 20-24 Oct. 2015, hourly animation

- **Rapidly changing precipitation phenomena need frequent observations.**

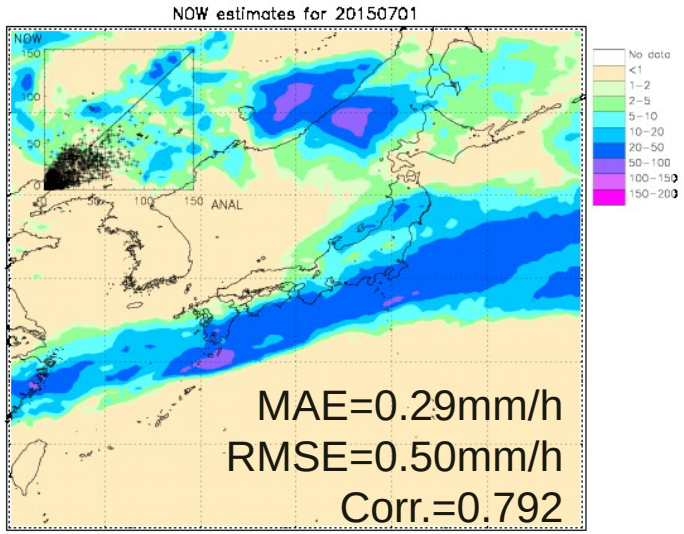
JAXA Global Rainfall Watch (4-hr delay) : http://sharaku.eorc.jaxa.jp/GSMaP
JAXA Realtime Rainfall Watch (Himawari-area):
http://sharaku.eorc.jaxa.jp/GSMaP_NOW

Early Evaluation of GSMaP_NOW

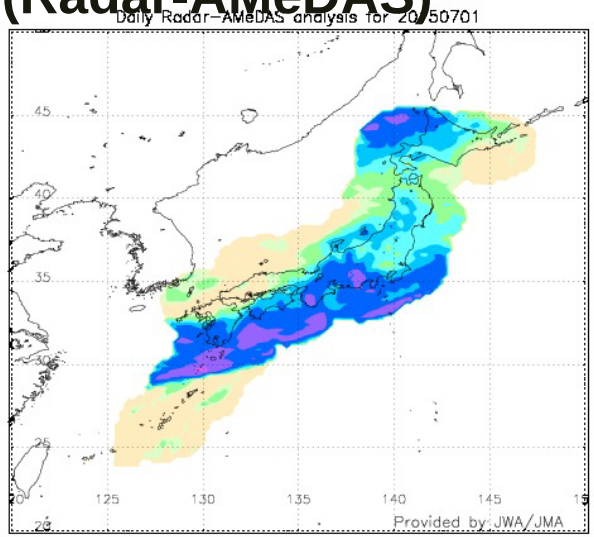
GSMaP_NRT



GSMaP_NOW



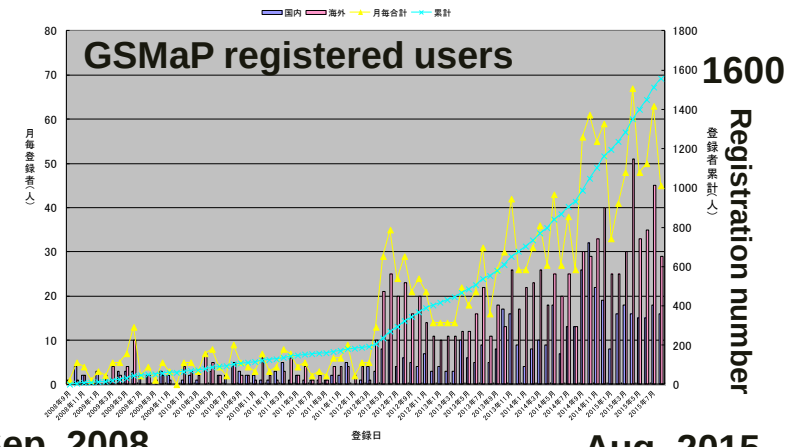
Gauge-Radar Analysis (Radar-AMeDAS)



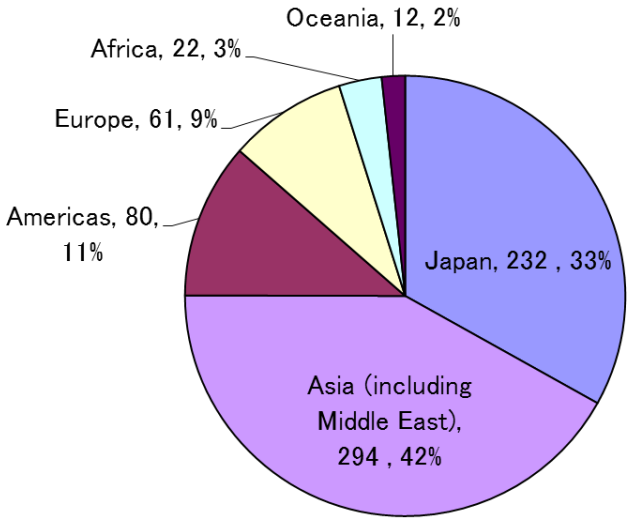
Daily averaged rainfall on Jul. 1, 2015

Period	Mean ABS Error (mm/h)		RMS Error (mm/h)		Correlation Coefficient	
	NRT	NOW	NRT	NOW	NRT	NOW
Jun. 11 – Jul. 3, 2015	0.22	0.24	0.52	0.56	0.786	0.756

GSMaP Applications



About 1600 registered users as of 31 Aug. 2015



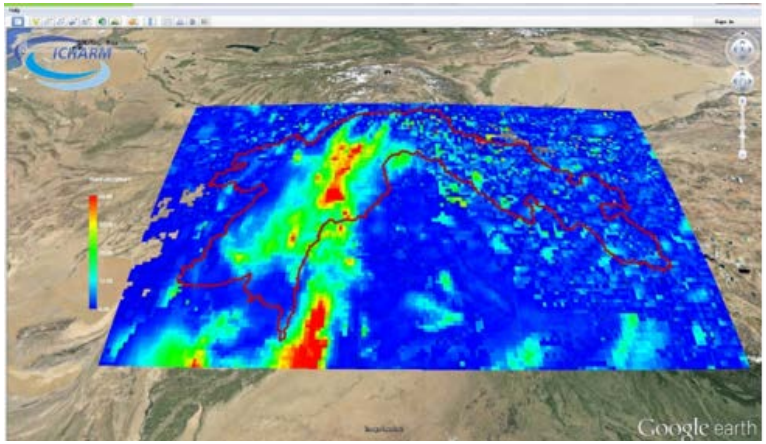
About 67% users are originated from foreign countries.

- Weather forecast/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

GSMaP in Flood Analysis with ICHARM

- Under UNESCO-IHP project, JAXA and ICHARM is developing with 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 will be in operation in 2015 by PMD, and plan to extend the system to larger regions is underway.
- Similar system is in operation in Bangladesh and Philippines under ADB project.

Rainfall by GSMaP

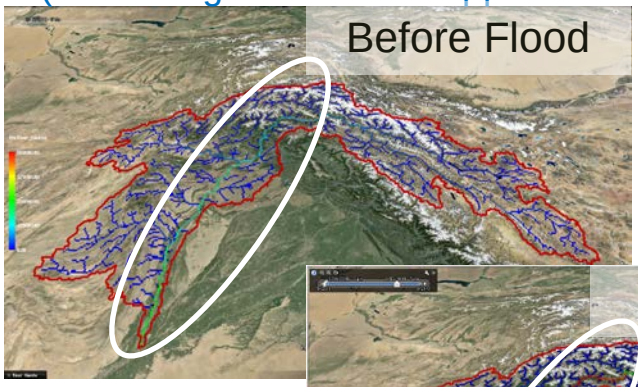


(Area within red line is Indus river basin)

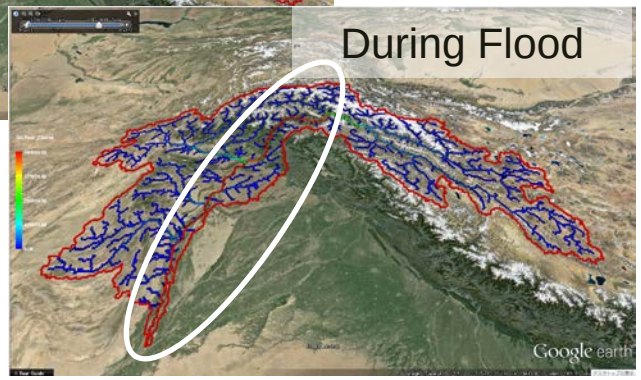
INPUT

River discharge output using GSMaP

(increasing as rainfall in upper stream increased)



Discharge of main river is normal (green) before flood

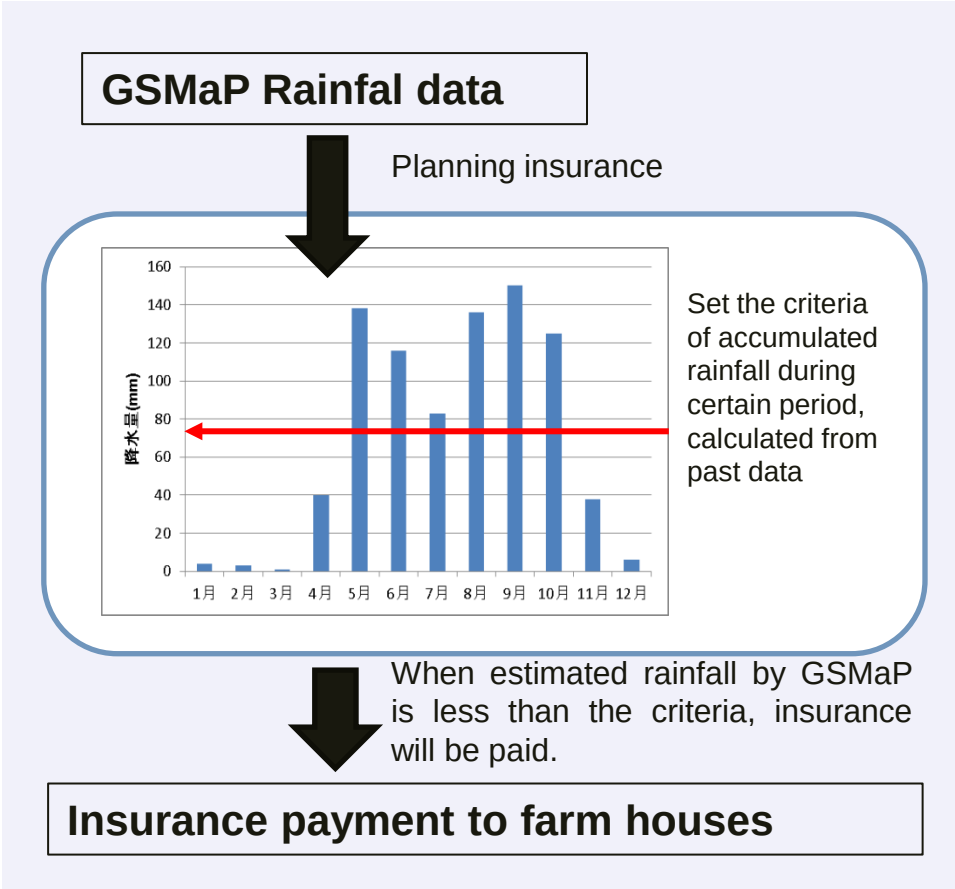


Discharge of main river is largely increased (red) during flood

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

GSMaP in Agricultural Insurance

- Japanese insurance company has developed Weather Index Insurance in Myanmar using GSMaP rainfall data, and plans to sell it in 2015
- In Myanmar, agriculture makes up 40% of GDP, but natural disasters such as droughts happens often recently.
- Overview of the insurance
  - Assured persons: farm houses in the assured regions
  - Assured crops: rice, sesame
  - Assured regions: Arid regions in the central Myanmar
  - Assured risks: drought (risk of less rainfall in rainy season)
- Plan to expand the insurance to other disaster risks (cyclone, heavy rainfall) in Myanmar, and to other countries in South-East Asia



(from press release from Sompo Japan Nipponkoa & RESTEC in Dec. 2014)

A "Food Security Package" research using GSMaP by a fund of the MEXT

By Higuchi
(Chiba Univ.)

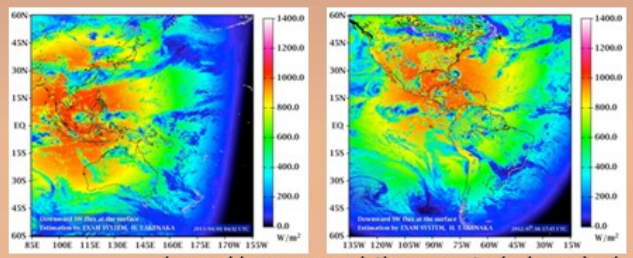
Food Security Package: Utilizing High Frequency Satellite Products with Integrated Land Process Models (SiBUC & SIMRIW) & Short-time Prediction with Cloud Resolving Model (CReSS)

High Time Frequency Forcing Data by RS

Precipitation: GSMaP

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

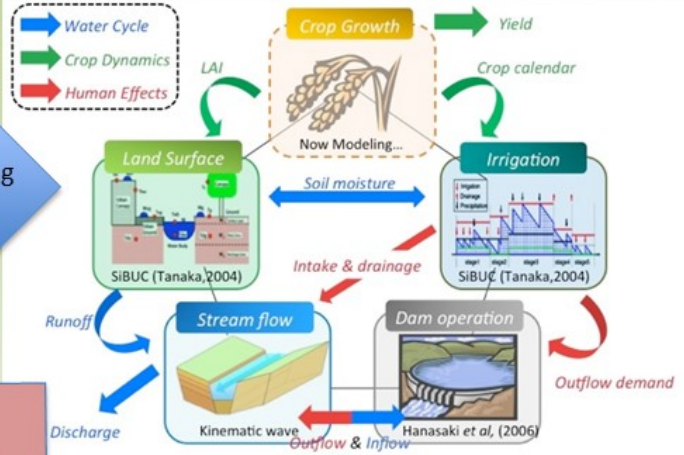
Solar Radiation: EXAM



http://atmos.cr.chiba-u.ac.jp/takenaka/

"Real" Forcing to Model

Integrated Land Process Modeling
Hydrology [SiBUC]+ Crop Growth [SIMRIW]

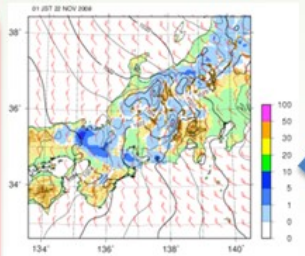


More realistic initial condition estimation

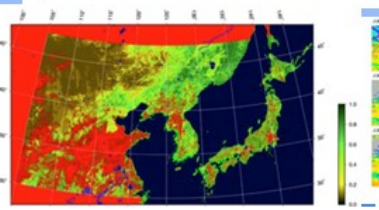
Model Validation
Initial Condition check

Short-term Prediction by CReSS+SiBUC (CReSiBUC) (1-5 days forecast)

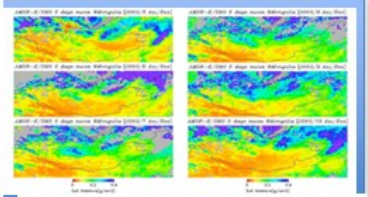
- Integrated Research Demonstration: Satellite Observation & Numerical Modeling
- Test Short-term Alert system for crop yield
- Real-time system operation as a test of "infra-structure" for *food security.*



RS Products for Model Input and/or Validation



Biomass by Optical Sensor



Soil Moisture by AMSR2

Summary

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  - Japanese product of the GPM mission
  - Processing and distributing global rainfall data in near real time basis (about 4-hour after observations) by merging multi-satellite data.
  - Hourly product in 0.1x0.1deg. lat/lon grid.
  - 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/).
  - GSMaP_NOW is now available at http://sharaku.eorc.jaxa.jp/GSMaP_NOW/index_j.htm
- GSMaP application
  - About 1600 registered users as of 31 Aug. 2015
    - About 67% users are originated from foreign countries.
  - Flood Analysis with ICHARM
  - “Food Security Package” research under a fund of the MEXT.