



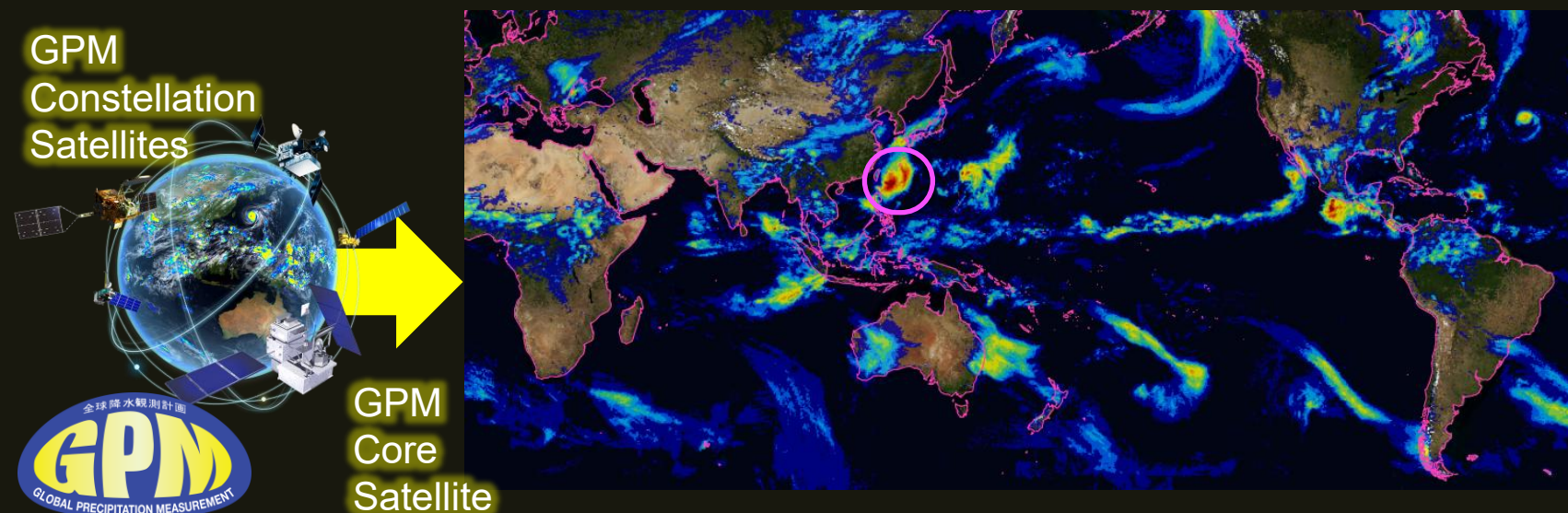
GSMaP
GLOBAL SATELLITE MAPPING OF PRECIPITATION

Recent updates of the Global Satellite Mapping of Precipitation (GSMaP)

T. kubota, M. K. Yamamoto, M. Yamaji, N. Yoshida, and M. Kachi
Earth Observation Research Center (EORC)
Japan Aerospace Exploration Agency (JAXA)

IPWG-12@Kraków, Poland, July 2026

Japanese GPM Product: Global Satellite Mapping of Precipitation



GSMaP is a blended Microwave-IR product and has been developed in Japan for the GPM mission.

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

18,673

registered users

from **163**

countries/regions

(as of the end of June 2026)

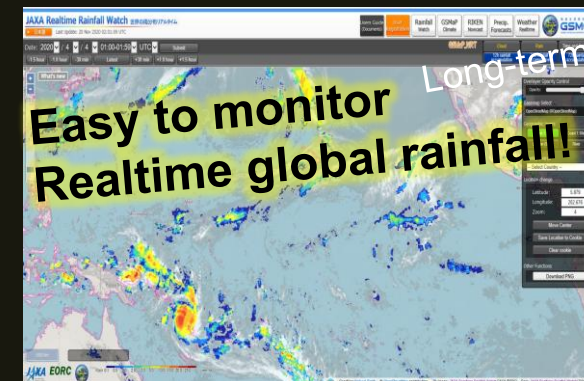
+ website users

(not registered)

Statistics!



Realtime!



<https://sharaku.eorc.jaxa.jp/GSMaP/index.htm>

GSMaP major updates



- History of major updates

Date	Product version	Algorithm version	Reference papers
Sep. 2014	V03	v6	Kubota et al. (2020)
Jan. 2017	V04	v7	https://doi.org/10.1007/978-3-030-24568-9_20
Dec. 2021	V05	v8	Kubota et al. (2026) https://doi.org/10.1007/978-981-95-5409-6_9
Oct. 2026	V06	v9	ATBD in preparation

- Next major version up is scheduled in Oct. 2026. (Product version: V06, algorithm version: v9)**
- This presentation introduces main features of the next major version upgrade (v9) and future plans.

Extended GSMaP area to pole-to-pole

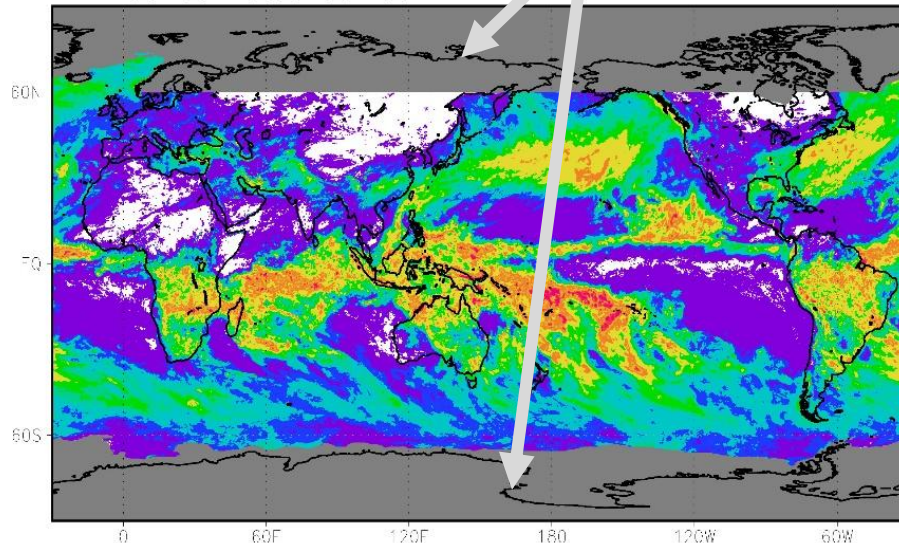
Dr. Yamamoto (JAXA)



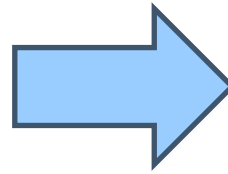
- GSMaP v8: GSMaP estimation is limited from 60S to 60N while it is estimated for pole-to-pole only when PMW observation is available.
- In the lacking high-latitude area (-60S, 60N-), **GSMaP v9 uses numerical weather model (NEXRA) water vapor data.**
 - NEXRA (NICAM-LETKF JAXA Research Analysis): a unique weather data assimilation system.
 - https://www.eorc.jaxa.jp/theme/NEXRA/index_e.htm
- **GSMaP v9 can provide the pole-to-pole precipitation data.**

GSMaP v8

GPMMRG_MAP_2201_M_L3S_MCM_05A monthlyPrecipRate

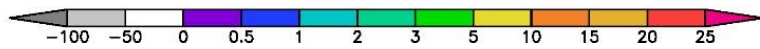
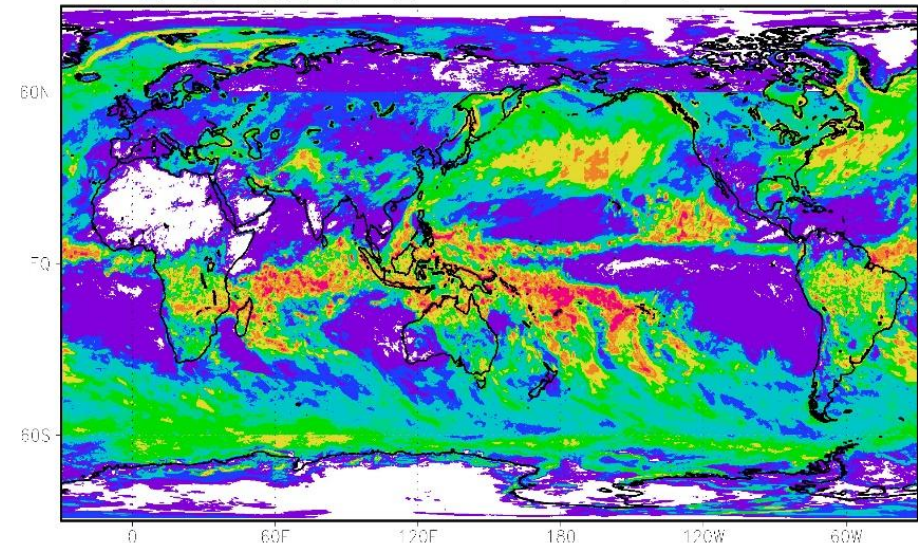


Lack of IR observation



GSMaP v9

GPMMRG_MAP_2201_M_L3S_MCM_05A-Liu2022 monthlyPrecipRate





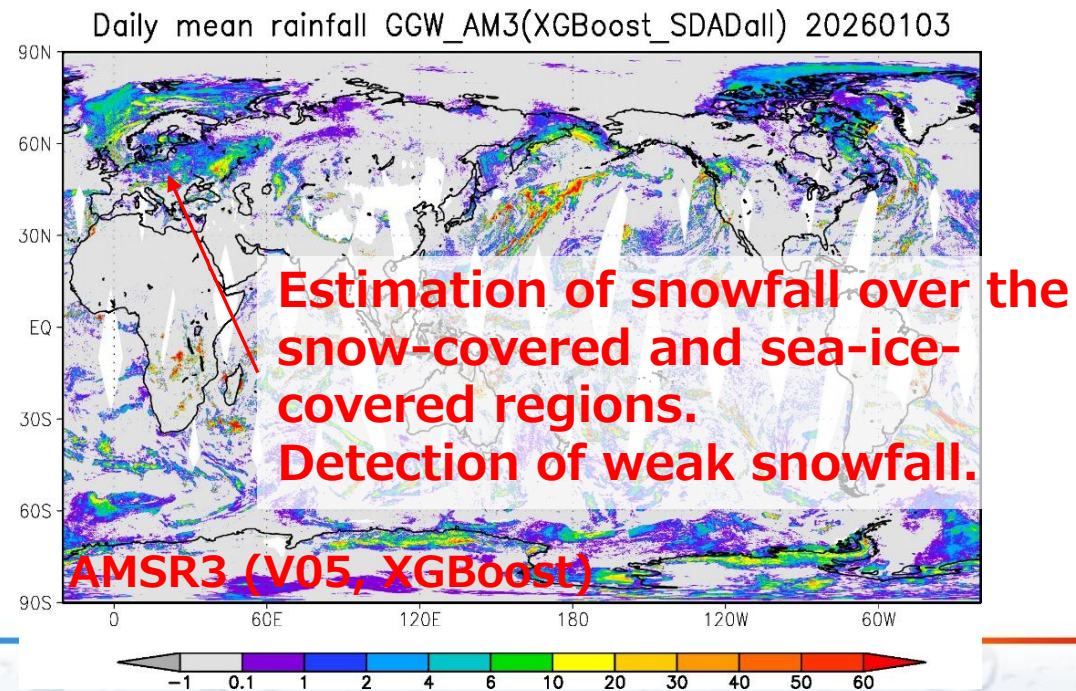
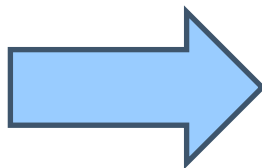
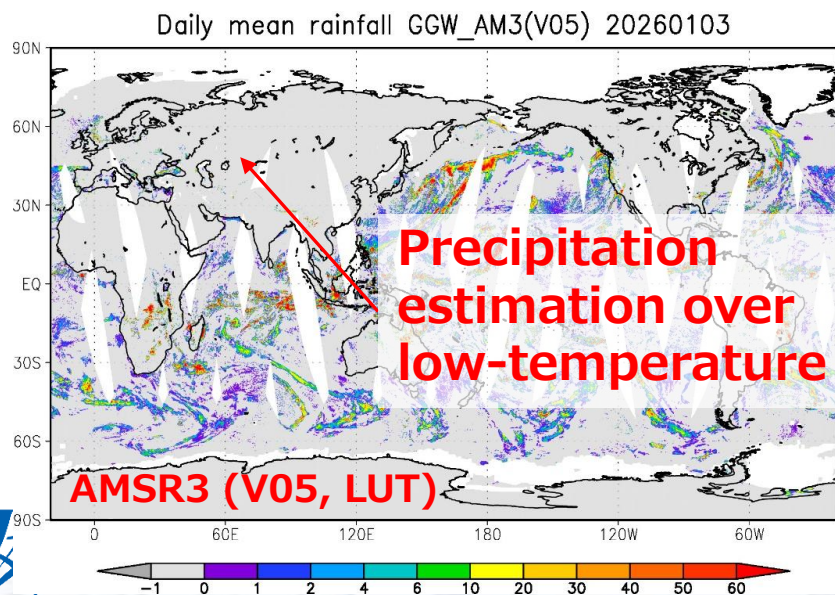
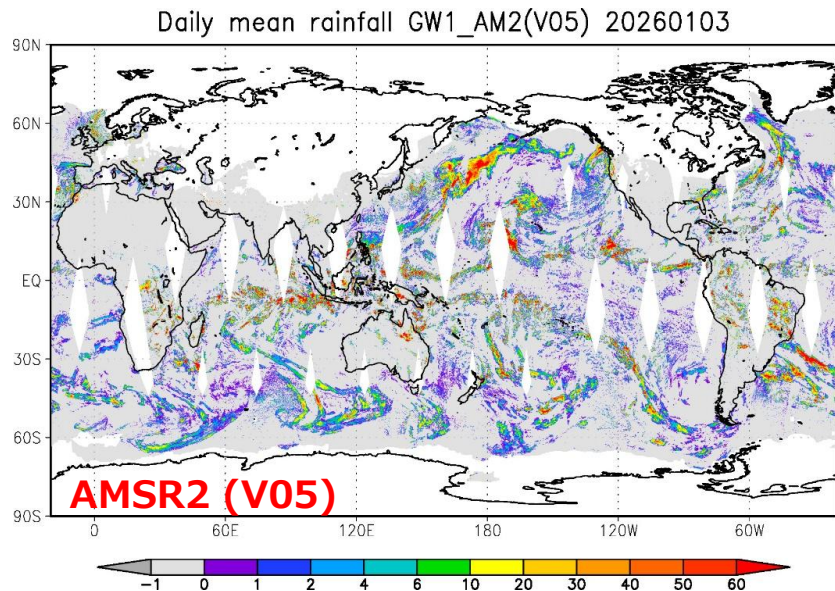
- ML techniques introduced to improve precipitation detection and estimation for passive microwave algorithm.
- Linear Regression & Random Forest reduce missed rainfall events
- ➡ **Improving the detection of rainfall over the coastal and orographic regions**
- Support vector machines (SVM) based correction using DPR rainfall as training data
- ➡ **Enabling more accurate retrievals.**

Improvements of snowfall estimation

Dr. Yamamoto (JAXA) and
Prof. G. Liu (FSU)



- **New snowfall estimation by the ML (XGBoost).**
 - **Snowfall over the entire region including snow-covered and sea-ice-covered regions can be estimated**
- The common snowfall algorithm among GMI, AMSR3, and SSMIS, carrying high frequency channels, has been applied in the GSMaP.
- This XGBoost method will be applied for GSMaP v9.



Updated microwave normalized method

Dr. Yoshida (JAXA)
See 6.9 poster on Wednesday



- Corrections using the average and standard deviation will be applied [Bouwer et al., 2004].

Bouwer et al. (2004)

$$SRE_{cor} = (SRE_0 - \mu_{SRE})\tau_f + \mu_{OBS}$$

$$\left(\mu_f = \frac{\mu_{OBS}}{\mu_{SRE}} \quad \tau_f = \frac{\tau_{OBS}}{\tau_{SRE}} \right)$$

The square root of precipitation was applied to calculate the average and standard deviation.

(μ : average, τ : standard deviation, OBS: Reference (GMI), SRE: Other sensors.)

RMSE has been improved.

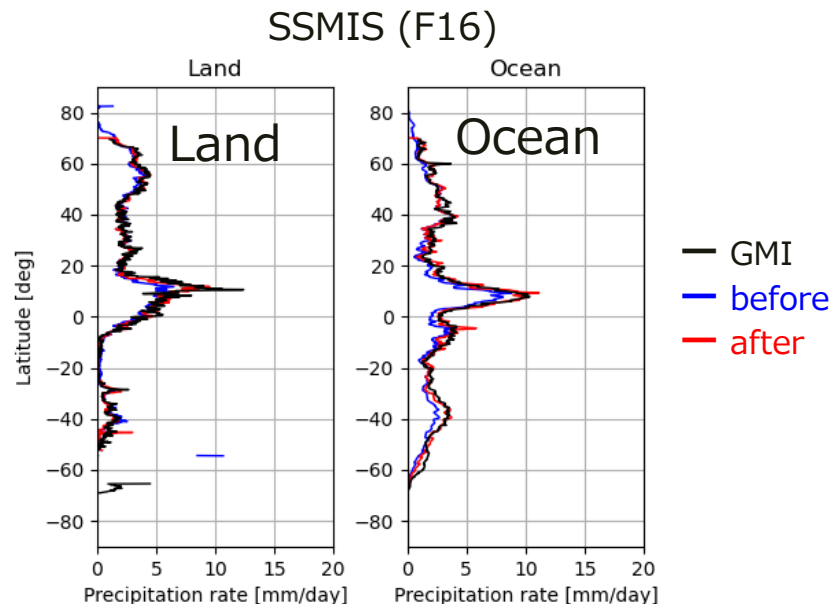


Fig. Zonal mean rainfall amount between GMI and F16. GMI (black), before (blue) and after (red) MMN correction.

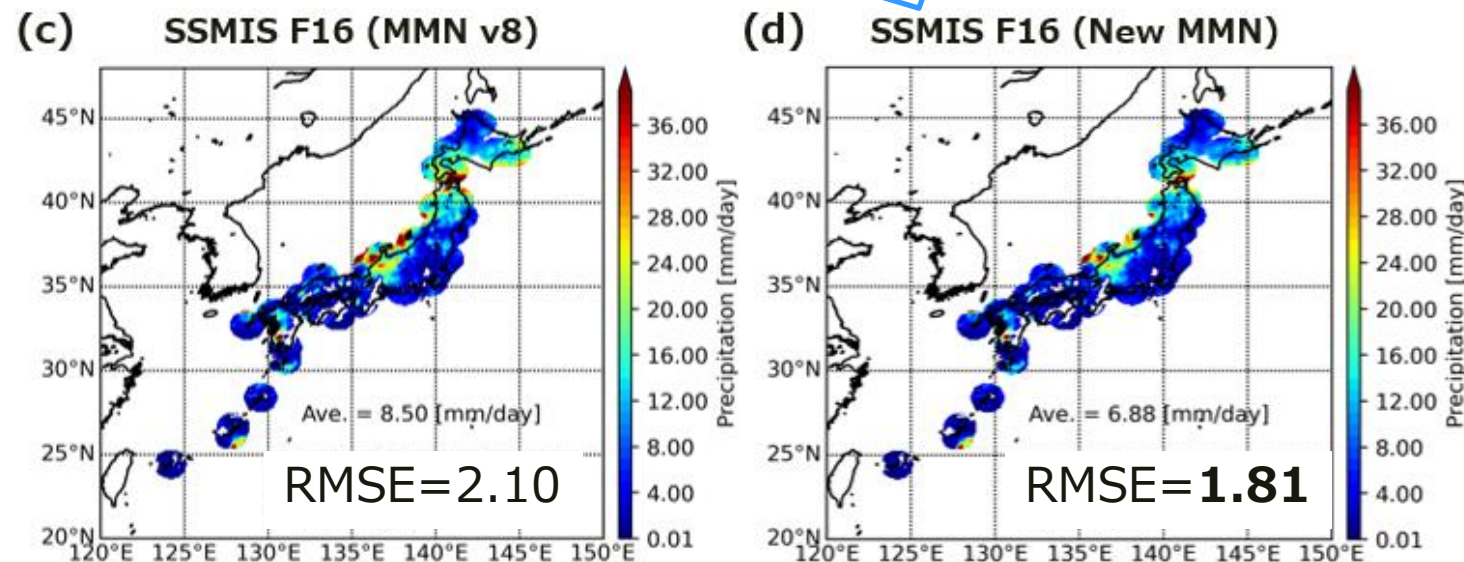


Fig. Monthly precipitation rate of SSMIS F16 around Japan. RMSE has been calculated between GSMaP and ground observation data.

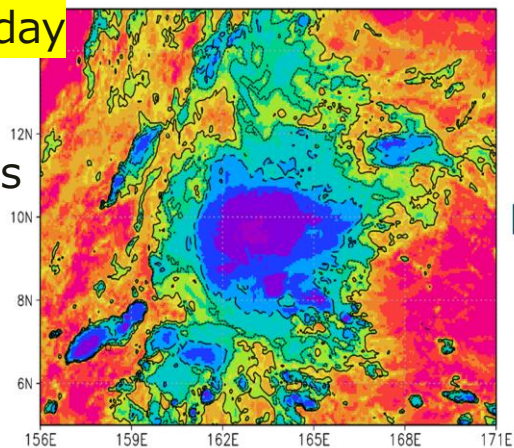


A precipitation correction method by using SOM

Dr. Hirose (Univ. of Osaka)
See 6.4 poster on Wednesday

By correcting rain rate for each of the 400 cloud types classified using the [Self Organization Map \(SOM\)](#), the underestimation of orographic precipitation is improved.

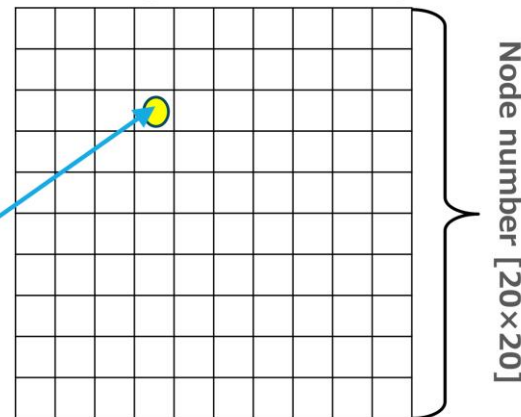
IR based Cloud Clusters



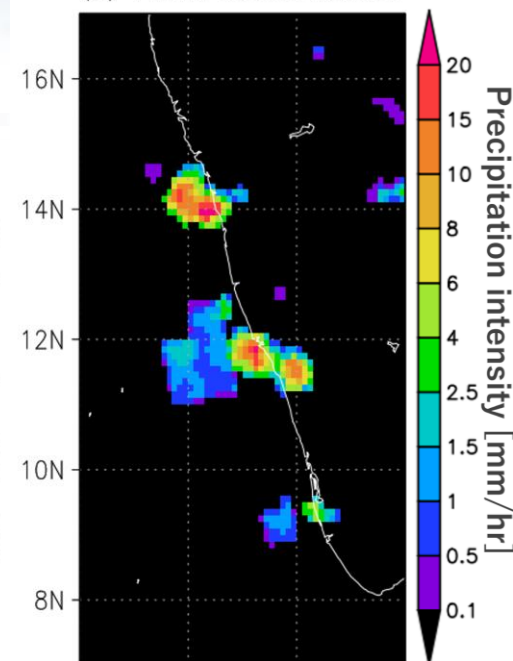
Feature Vectors

Tmin
Split-window
 $\Delta T_{WV1-WV2}$
⋮
Tmean
Cluster size
STD
Shape Index

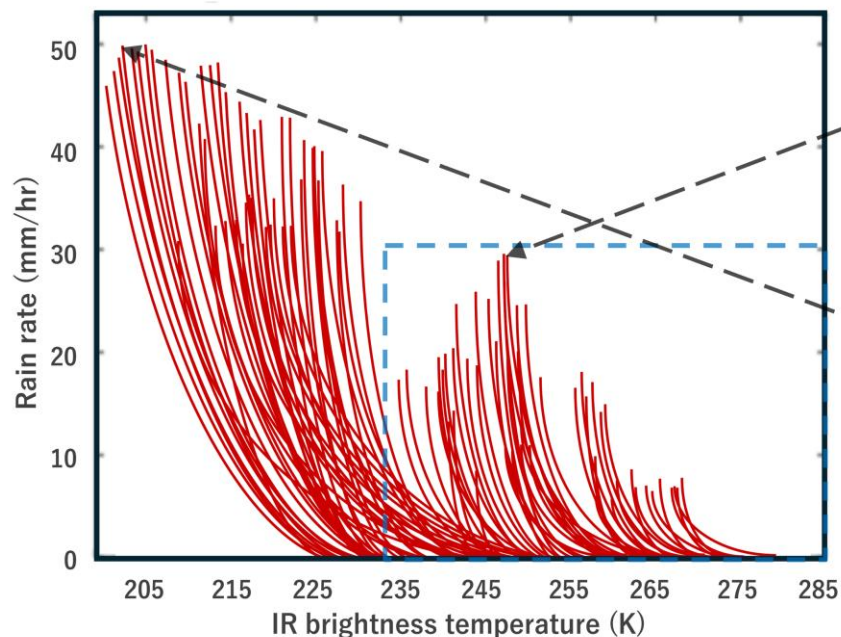
Self Organization Map



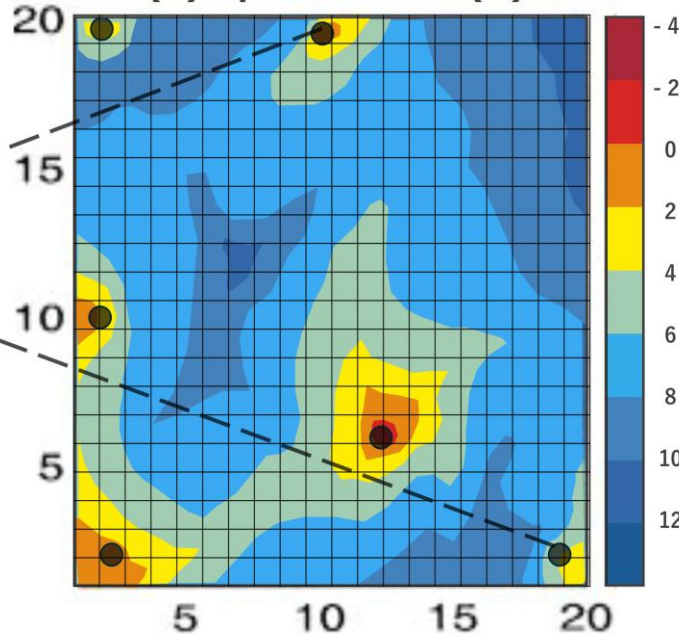
(a) PMW observation



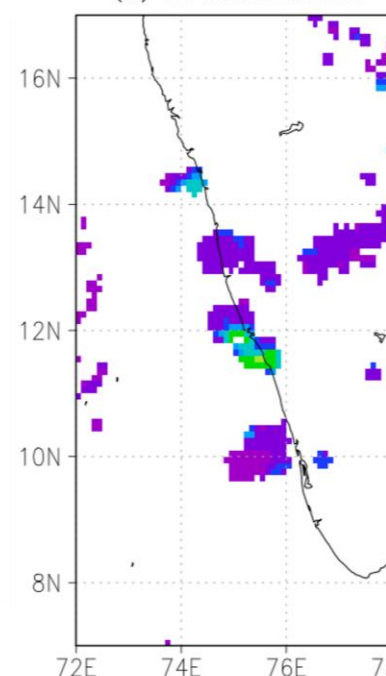
(a) Tb-RR Curves by each cloud type



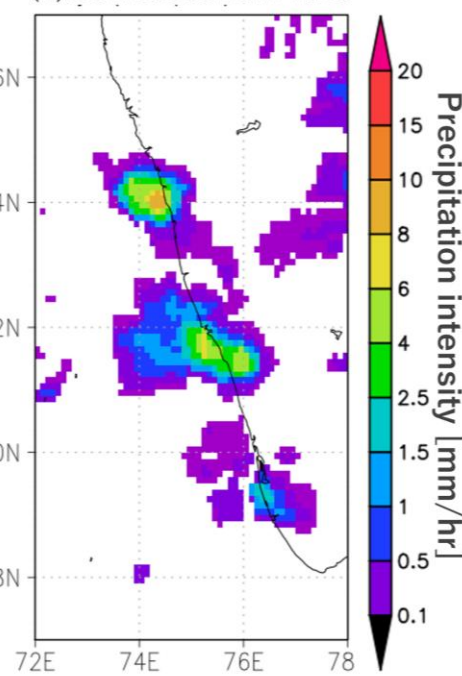
(b) Split-window (K)



(b) IR estimation



(c) Corrected rain rate

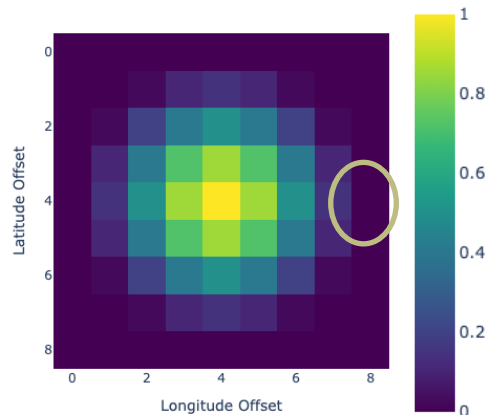


Improvement of gauge algorithm

Dr. Konduru (JAXA)

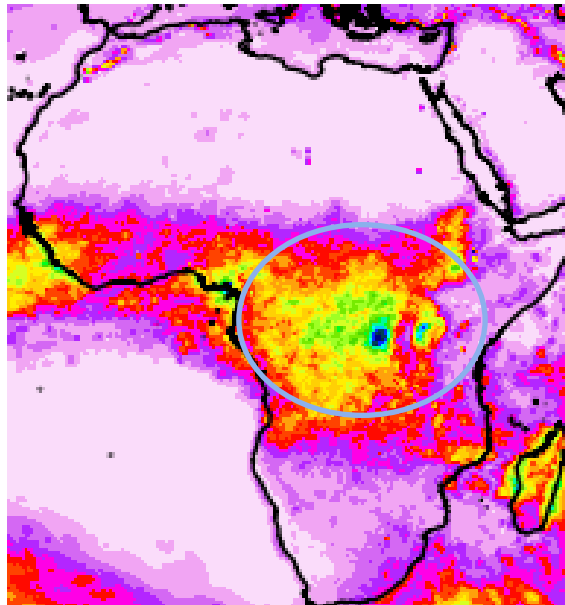


- Artificial linear patterns have appeared regionally over land.
- Improved gauge algorithm can correct artificial patterns.**

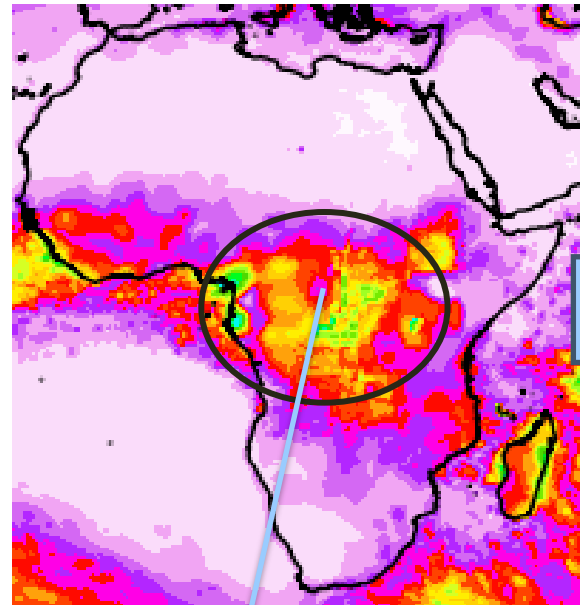


✓ Revised weight distribution

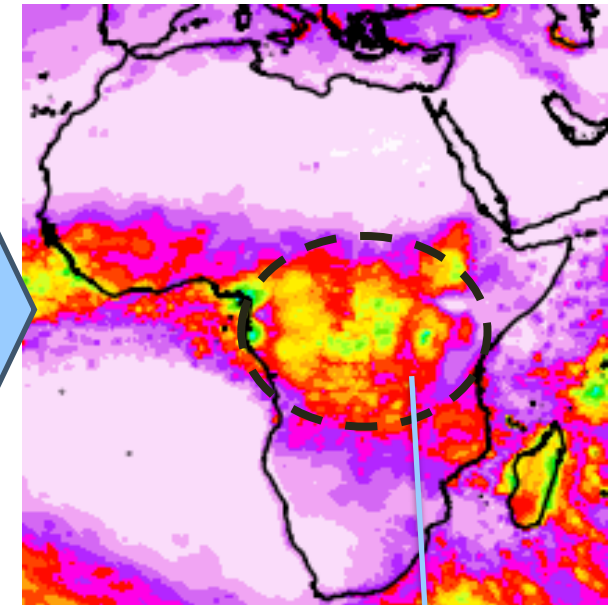
a) GSMP MVK



b) GSMP Gauge

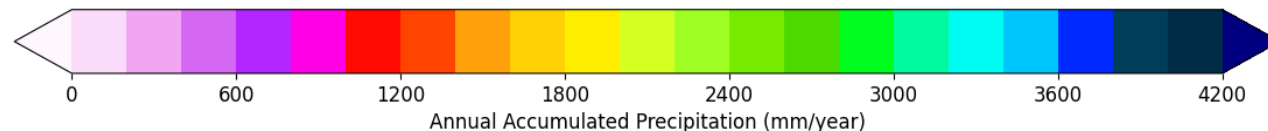


c) Modified version



Artificial patterns

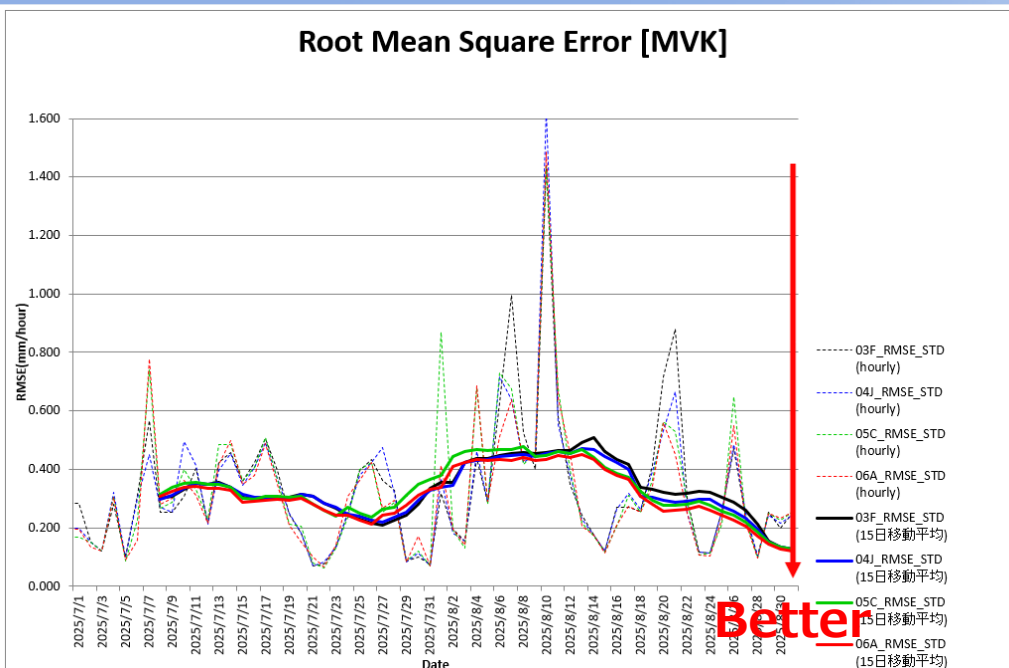
No artificial patterns



Preliminary evaluations around the Japan using the gauge-calibrated radar network dataset

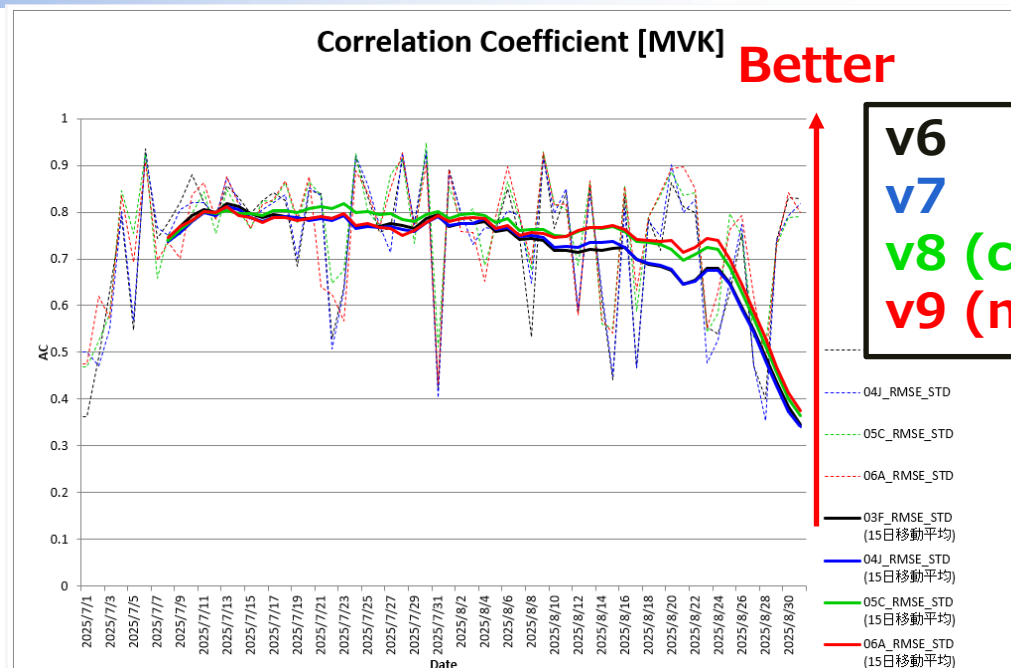


MVK



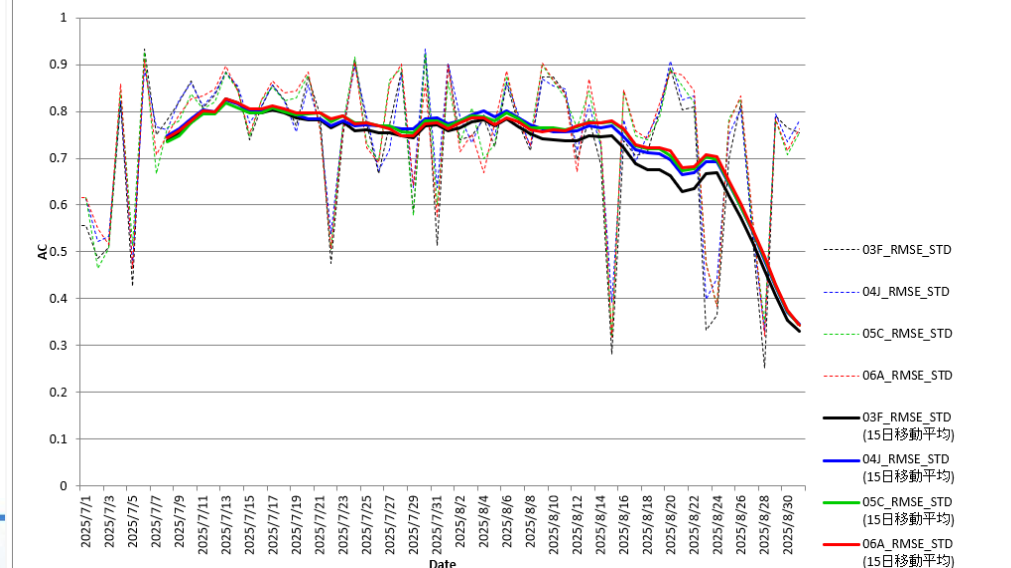
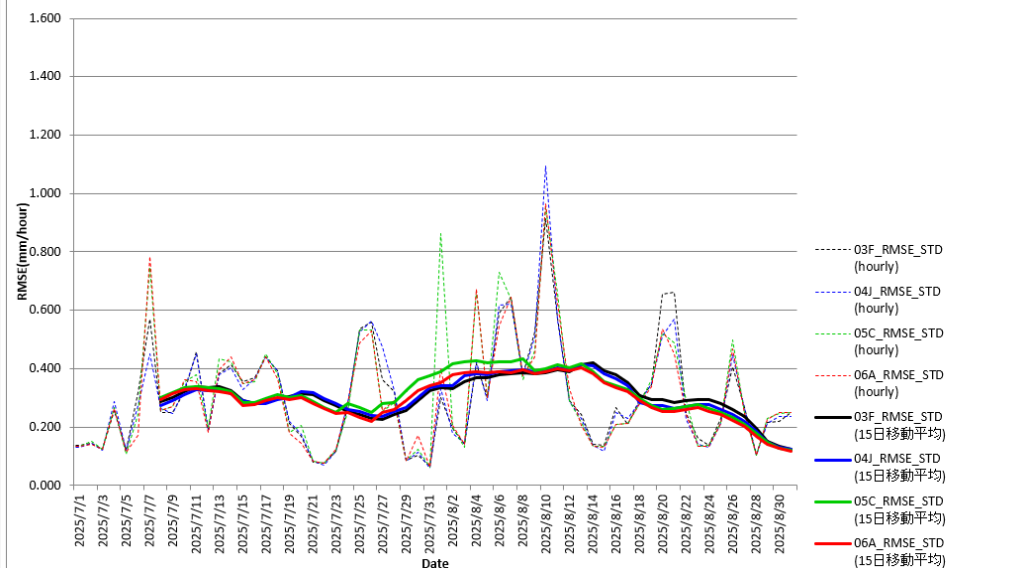
Correlation Coefficient [MVK]

Better



v6
v7
v8 (current)
v9 (next)

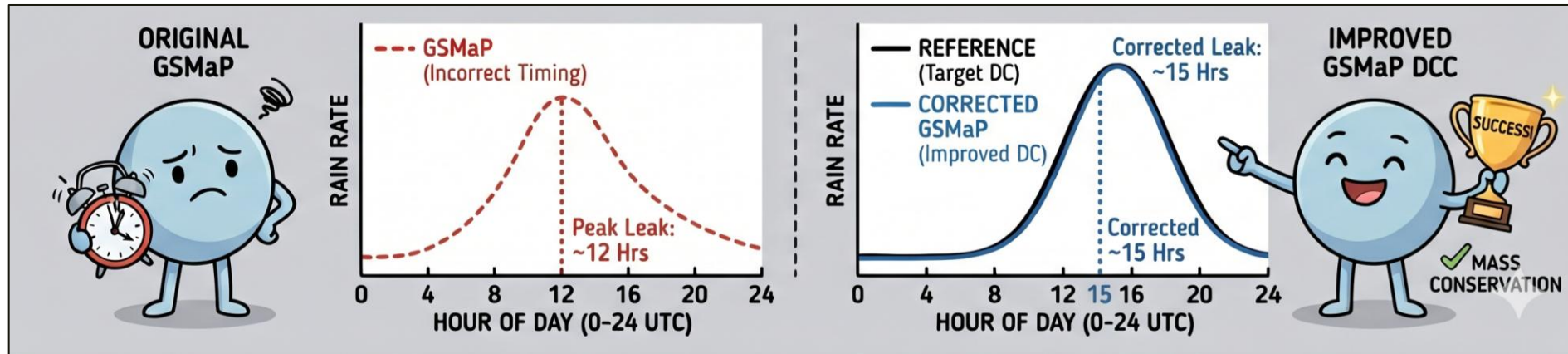
MVK_Gauge



FUTURE GSMAP DEVELOPMENT BEYOND 2026

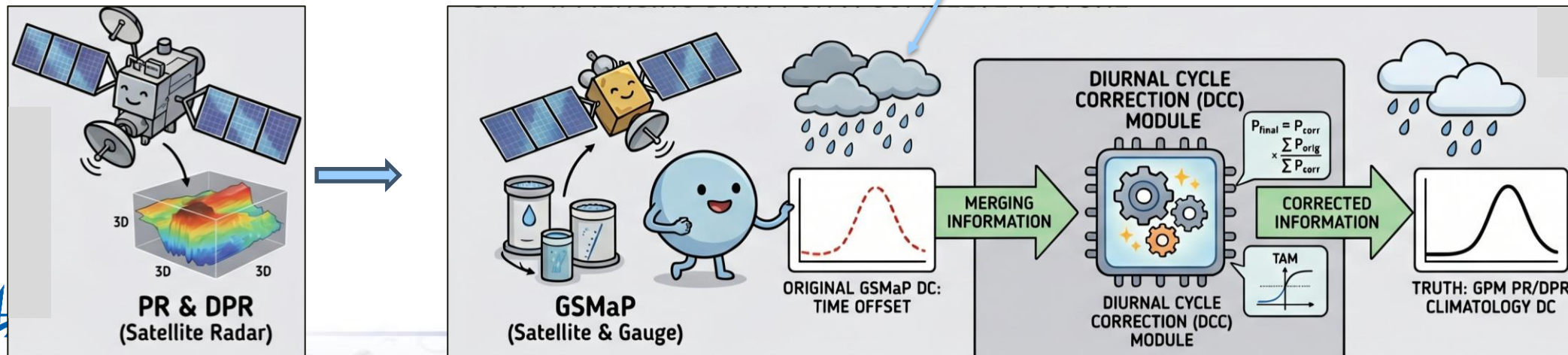
Development for refining the Diurnal Cycle

Studies refining **Diurnal Cycle patterns** in GSMaP precipitation data through satellite data fusion are on-going (EGU26 presentation: <https://doi.org/10.5194/egusphere-egu26-18166>, manuscript in preparation). We plan to release the data as an **experimental product**.



❑ There is need for climatological diurnal cycle correction in GSMaP Gauge.

❑ Objective is to improve the Diurnal cycle within the GSMaP



Illustrations by
Dr. Konduru
Rakesh Teja
(JAXA)

Future development plan



Japanese FY	2025	2026	2027	2028	2029	2030	2031-
GSMaP	GSMaP V06 (v9) - Spatial resolution : 0.1 deg. - Updated every 1 hour.			High resolution		Next period GSMaP (PMM era) Target of next period GSMaP - Spatial resolution : 0.1 deg. - Updated every 30 min. → challenging with more finer resolutions. Experimental products will be included in the standard product.	
		▲October Major updates of GSMaP	GSMaP_EXP (experimental products) - Products corrected in viewpoints of the Diurnal Cycles. - A climate product with 2 to 3-month latency that incorporates the GPCC rain-gauge dataset and related data. - And so on...		 Precipitation Measuring Mission (PMM) Observatory		

- Major update of GSMP (v9) is scheduled in **October 2026**.
- Further **utilization of numerical weather model information** (NEXRA) enables pole-to-pole precipitation coverage.
- **Utilization of AI/ML techniques** improves passive microwave precipitation detection, snowfall retrievals, and IR precipitation rate.
- ***Future GSMP development beyond 2026***
 - JAXA has started the discussions of **next-generation GSMP products towards the PMM era** including **high-resolution GSMP** and a climate product including the **diurnal cycle correction** for further improving data consistency and quality.