Global Precipitation Measurement (GPM) mission in Japan and future Japanese Precipitation Measuring Mission (PMM)

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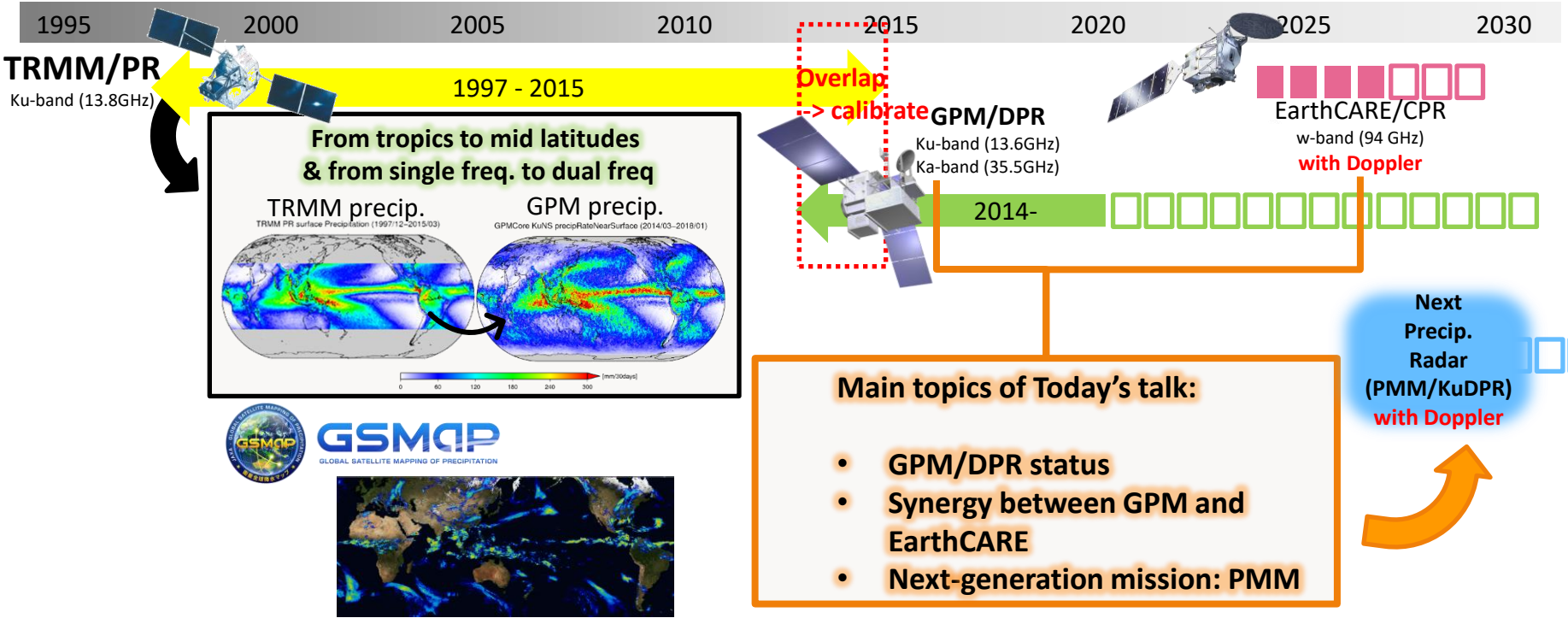
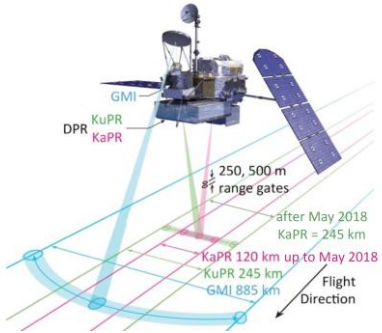


Global Precipitation Measurement (GPM)

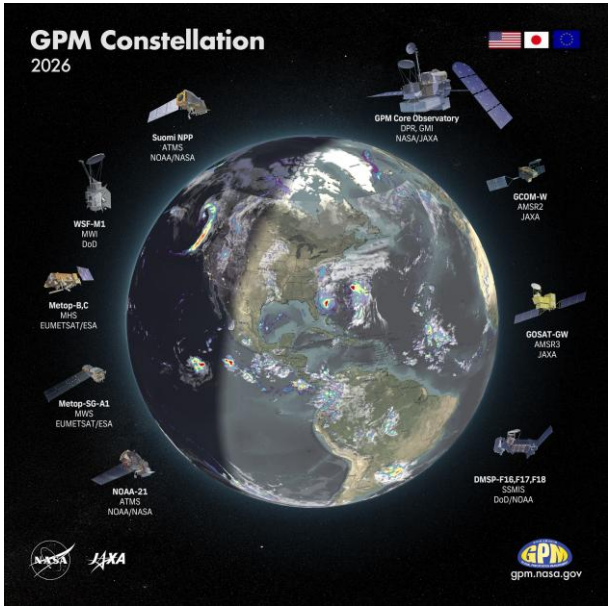
GPM Core Observatory by NASA-JAXA

launched in Feb. 2014, and has been ***in operation for 12 years!***



- The GPM is an international mission consisting of the GPM Core Observatory by NASA-JAXA and constellation satellites by international partners for high-precision and high-frequency global precipitation observation.
- The GPM Core Observatory satellite performed orbit-boost maneuvers in November 2023, increasing its altitude from 407 km to 442 km and extending its expected operational lifetime into the early 2030s.
- We have provided global merged precipitation products, such as JAXA's GSMaP and NASA's IMERG that integrate the GPM Core Observatory and constellation satellites.

Updated GPM Constellation diagram is now available in NASA homepage!
https://gpm.nasa.gov/missions/GPM/constellation



See 3.1 talk for IMERG
See 3.2 talk for GSMaP

Status of Dual-frequency Precipitation Radar (DPR) onboard the GPM Core Observatory

All data collection is nominal and instruments are in good condition.

JAXA and NASA released DPR Version 8 (V08) products in March 2026 (GMI's V08 was also released at the same time).

Major Update points in DPR-L2 precipitation algorithm:

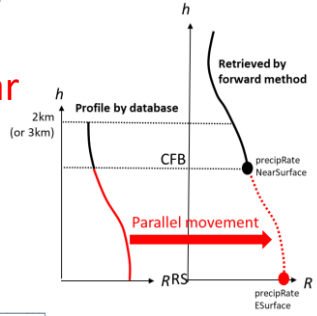
- [PRE] (Kanemaru, Masaki & Kubota)
  - Introduction of adjustment factor for KuPR in Level 1
  - Improvement of ClutterFreeBottom estimation by using dual frequency power method (Shimizu et al., 2023)
- [CSF] (Awaka, Chandra & Le)
  - (new product) Hydrometeor type profile (hydroClass)
- [SRT] (Meneghini, Kim) See 5.8 talk by Dr. Minda Le
  - Improvement of PIAhybrid (piaHY)
- [SLV] (Seto)
  - New surface precipitation estimation (precipRateEsurface) by using the low-level precipitation profile database developed by Hirose et al. (2021, 2026)
  - Improvement of extremely high precipitation over high altitude region

See 4.3 talk by Prof. Seto

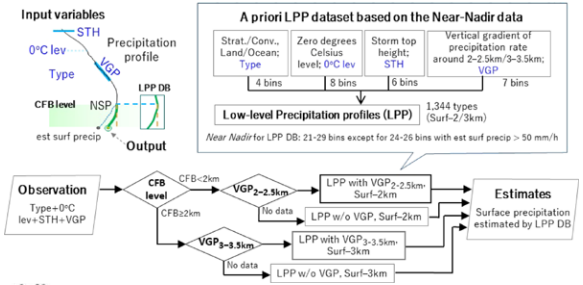
Main features in DPR Version 8 (V08) products

New surface precipitation estimation (precipRateEsurface) by using the low-level precipitation profile database developed by Hirose et al. (2021, 2026)

Issues of spaceborne radar in blind zones near the surface

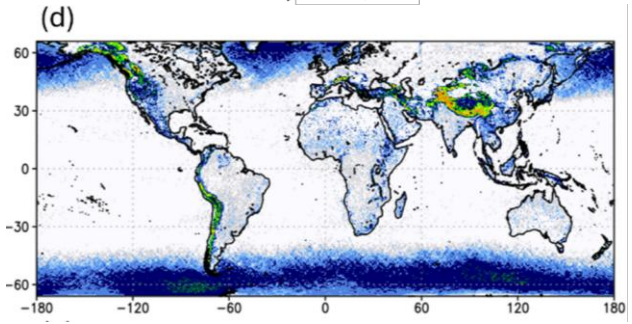


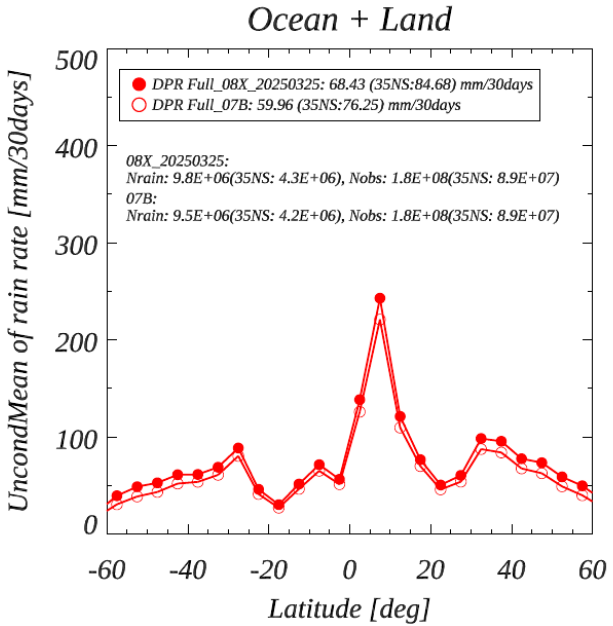
Construction of low-level precipitation profile (LPP) database using the DPR observations (Hirose et al. 2021)
https://doi.org/10.2151/jmsj.2021-060



LPP database was used in the Solver module for estimating surface precipitation

Increase in estimated surface precipitation resulting from the LPP correction at swath-edge (Hirose et al. 2026)
https://doi.org/10.1007/s44394-026-00025-4

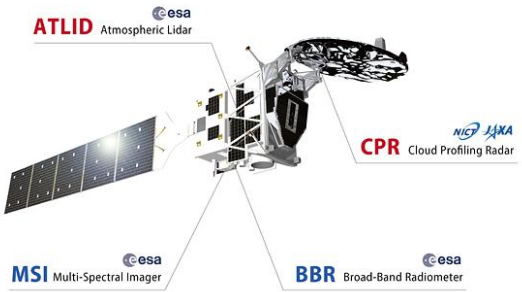


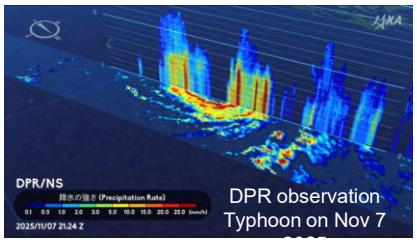


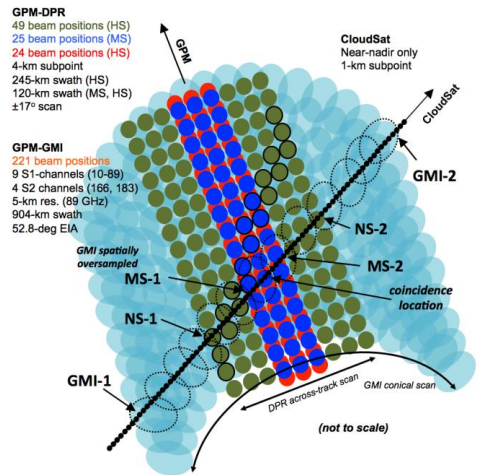
It significantly effected surface precipitation intensity at high latitudes in the new version V08.

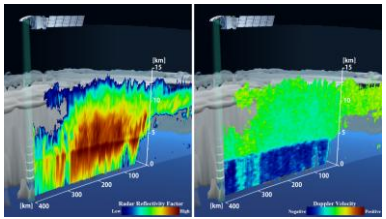
Synergy between Spaceborne Cloud and Precipitation Radar Observations by EarthCARE and GPM

- The **Dual-frequency Precipitation Radar (DPR; Ku-band (13GHz) & Ka-band (35GHz))** onboard the **GPM** Core Observatory have continued observations for more than 12 years.
- EarthCARE/CPR launched in May 2024 observes cloud profiles with the **world's first spaceborne W-band (94GHz) Doppler velocity measurements**.
- JAXA has constructed a coincident observation dataset for the EarthCARE and the GPM as "**EarthCARE–GPM Coincidence Dataset**" and provided it in the JAXA server.
  - **Exploring vertical motions from EarthCARE and GPM coincidence dataset (Aoki et al. 2026, AMT, https://doi.org/10.5194/amt-19-79-2026)**

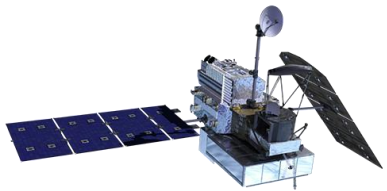




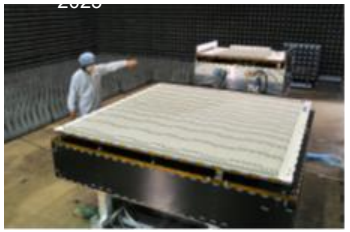




CPR first images (JAXA/NICT)



GPM Core Observatory (NASA/JAXA)



DPR (JAXA/NICT)

EarthCARE Cloud Profiling Radar (CPR) developed by JAXA and NICT

EarthCARE
Earth Cloud Aerosol and Radiation Explorer

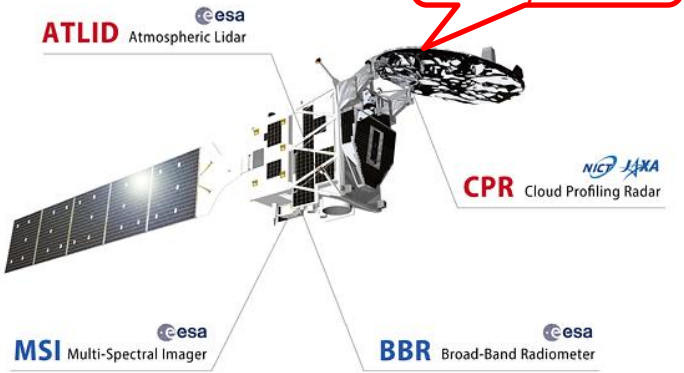
EarthCARE is an ESA Earth Explorer jointly developed and operated by ESA and JAXA to observe cloud, aerosol and radiation (Illingworth et al. 2015, Wehr et al. 2023, Kubota et al. 2026).

Observation Instruments on EarthCARE

CPR	Cloud Profiling Radar	NICT JAXA
ATLID	Atmospheric Lidar	esa
MSI	Multi-Spectral Imager	esa
BBR	Broadband Radiometer	esa

Synergetic Observation by 4 sensors

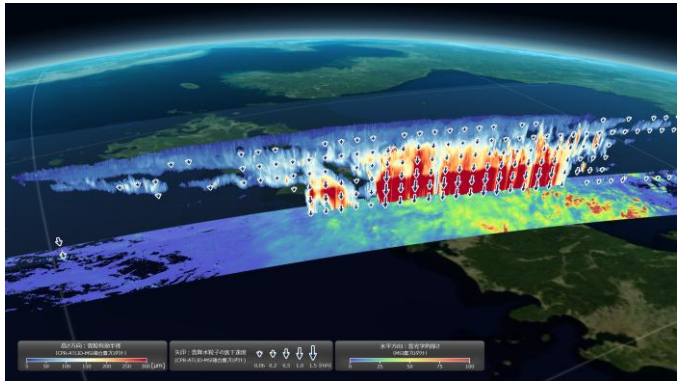
Launched in May 2024



Cloud Profiling Radar CPR
(JAXA/NICT)

High Power 94GHz Doppler Radar

- *Cloud & Precipitation profiles, particle vertical velocity*

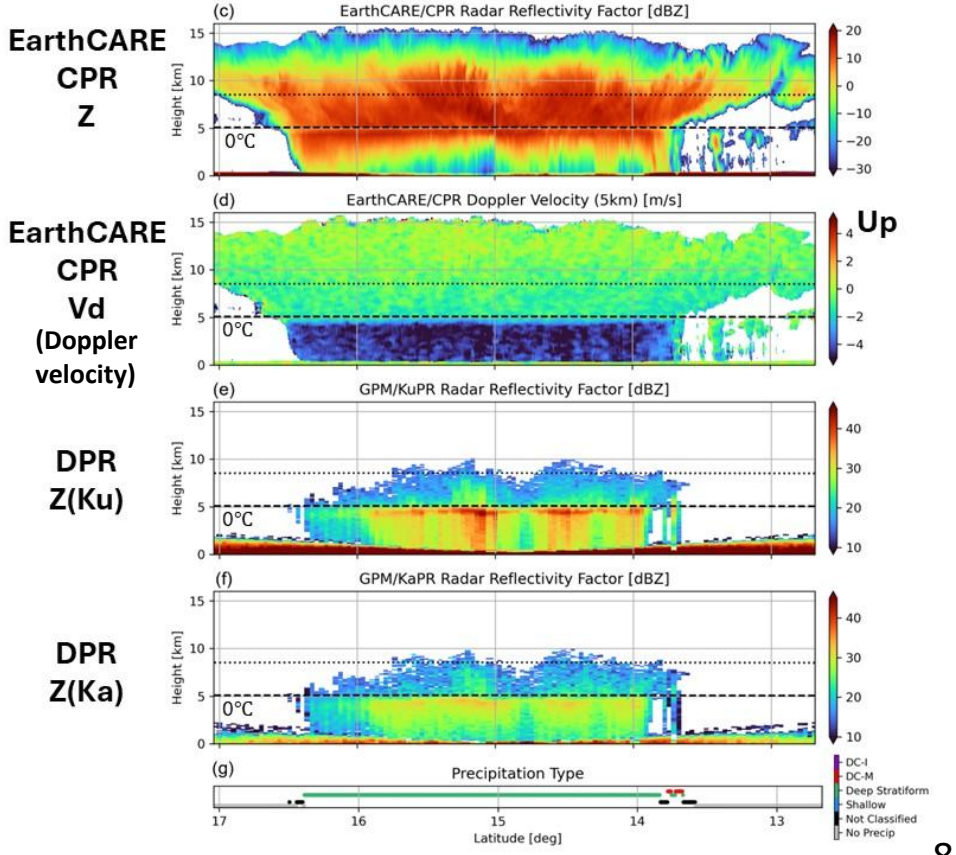


All JAXA and ESA standard products have been since Dec. 2025. (Kubota et al. 2026, JEMS, https://doi.org/10.1016/j.jemets.2026.100037)

EarthCARE–GPM Coincidence Dataset

- Due to the difference in orbits (GPM: inclined, EarthCARE: near-polar), the orbits of **both satellites intersect at the same timing**, and such combined observational data can be utilized.
- Dataset for more than 1-year since Aug 2024 (**>4500 cases**), and more in the future.
- **Now, publicly available with the Data DOI on the JAXA website!**
  - ✓ https://doi.org/10.57746/EO.01ka7xakvwj6pcthxkvgt0vr0y

See 9.14 poster by Dr. Joe Turk

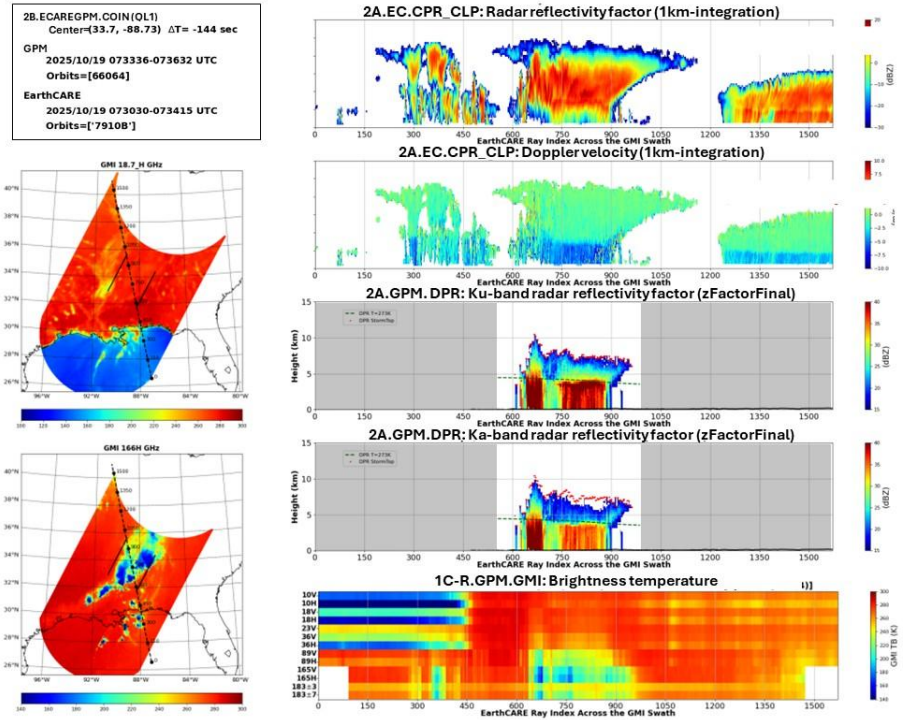


Aoki et al. 2026, *AMT*

GSMaP snowfall estimation by the ML trained by the EarthCARE–GPM Coincidence Dataset

EarthCARE and GPM coincidence dataset

(https://doi.org/10.57746/EO.01ka7xakvwj6pcthxkvgt0vr0y)



2-Step Retrieval developed by Prof. G. Liu (FSU)
XGBoost Classification for yes/no precipitation
XGBoost Regression for TB to snowfall rate conversion

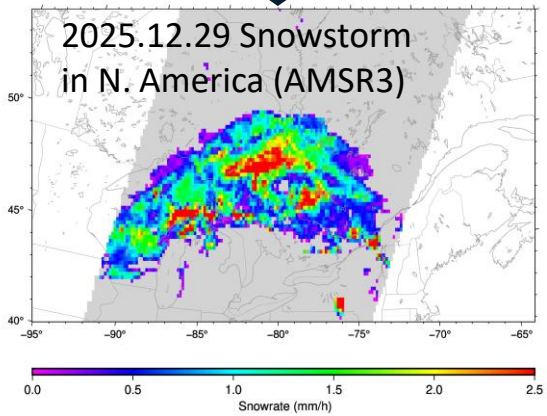


Figure by Prof. G. Liu (FSU)

This ML (XGBoost) method is applied for AMSR3 snowfall product and GSMaP v9.

See 2.4 (AMSR3) & 3.2 (GSMaP) talks

PMM (Precipitation Measuring Mission)

Ku-band Doppler Precipitation Radar (KuDPR) will focus on advanced observation of precipitation:
Doppler velocity observation &
High sensitivity observation

PMM specifications

Instrument	Ku-band Doppler Precipitation Radar Microwave radiometer (CNES)
Weight	2900kg (Max)
Mission life	5 years after launch
Power	4000W (Max)
Launcher	TBC (NASA)
Orbit	Altitude is similar to GPM, 55° inclined

KuDPR major characteristics

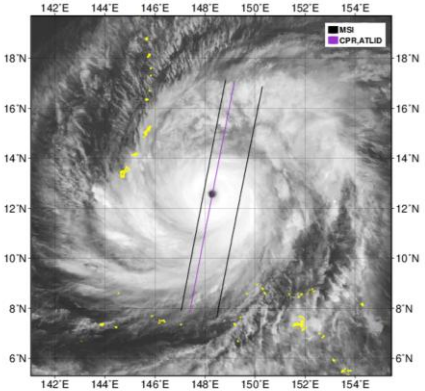
Frequency	13.6 GHz
Observation modes	・Doppler obs. mode ・Dense sampling obs. mode ・Normal scan obs. mode

The KuDPR will be two-antenna system that adopts Displaced Phase Center Antenna (DPCA) approach (Durden et al. 2007, Tanelli et al. 2016).

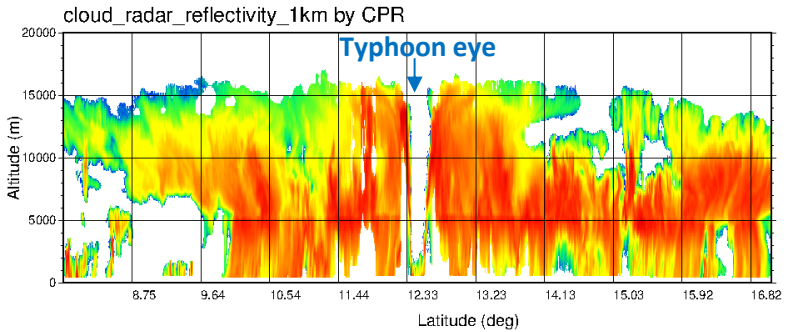
→ The DPCA approach can lead to **more accurate Doppler measurement**.

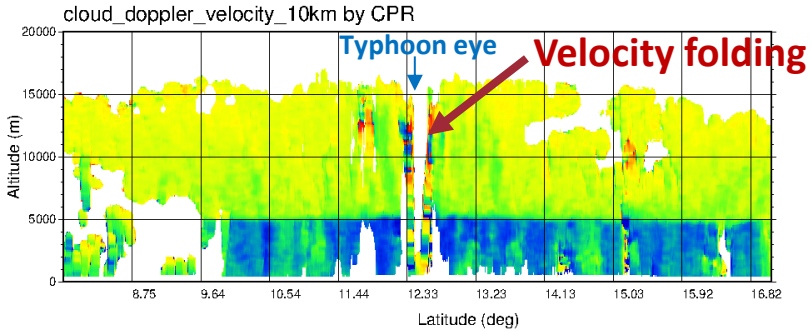
Importance of Ku-band Dopper velocity measurement

Velocity folding or aliasing is inherent to Doppler radar.



An example of the Doppler velocity folding in the **EarthCARE/CPR observations (Typhoon Sinlaku case)**

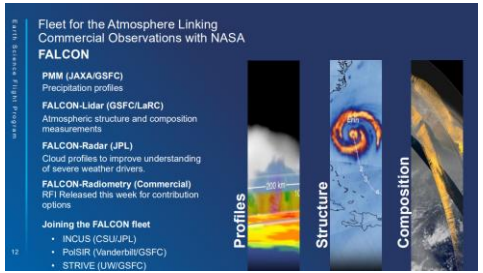




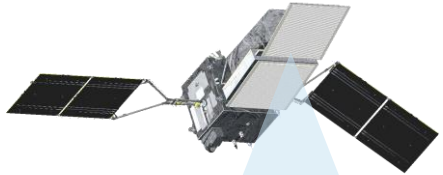
- For the EarthCARE/CPR (W-band radar), velocity folding occurs at around **5–6 m/s** (e.g., Hagihara et al. 2023).
- In contrast, the folding for the KuDPR (Ku-band radar) occurs at approximately **28 m/s**, allowing more reliable observations under strong vertical motion conditions such as typhoons and intense convective rainfall.

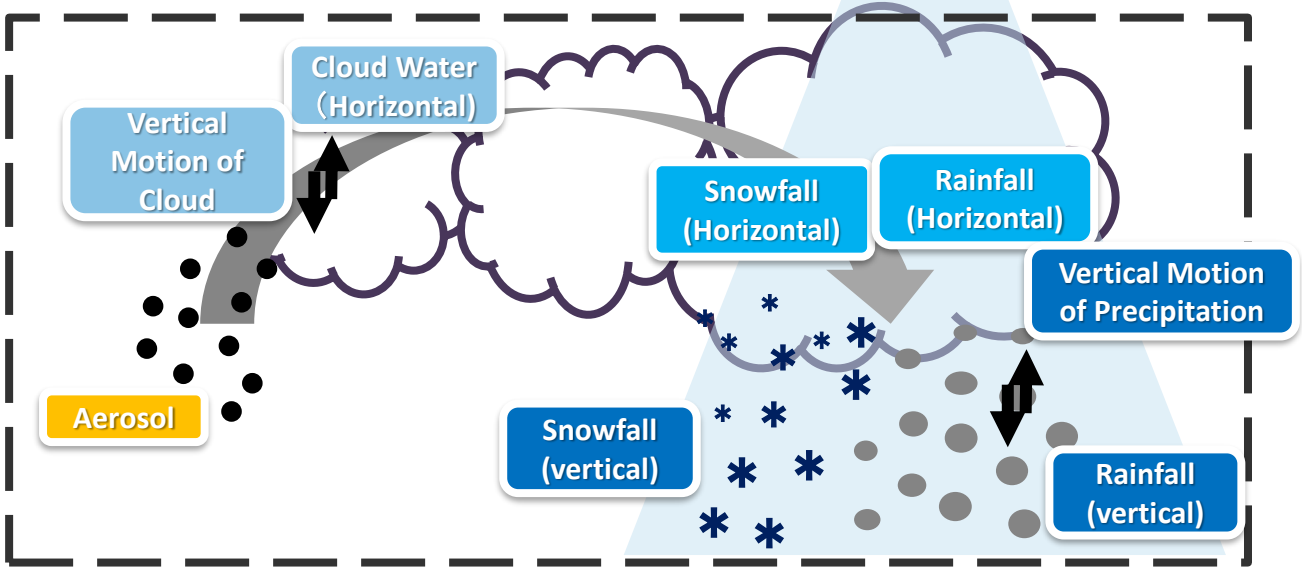
Next-generation Precipitation Radar mission in Synergy with Aerosols and Cloud Science

NASA FALCON



JAXA PMM KuDPR





- Ku-band Doppler Precipitation Radar (KuDPR)
  - Doppler velocity obs.
  - High sensitivity
- Collaboration with NASA FALCON for understanding of Aerosol~Cloud~Precipitation processes
- Improving weather/climate models

Summary

- Global Precipitation Measurement (GPM) mission status
  - JAXA and NASA released DPR Version 8 (V08) products in March 2026.
  - New surface precipitation estimation (precipRateEsurface) by using the low-level precipitation profile database developed by Hirose et al. (2021, 2026) in GPM/DPR precipitation algorithms
- Recent Spaceborne “Doppler” Cloud radar (EarthCARE/CPR) : Synergy between GPM and EarthCARE/CPR
  - The EarthCARE-GPM coincidence dataset has been released Nov 2025 in the JAXA server (https://doi.org/10.57746/EO.01ka7xakvwj6pcthxkvgt0vr0y).
  - Snowfall estimation in the GSMaP trained by the EarthCARE–GPM Coincidence Dataset
- Future Mission: Precipitation Measuring Mission (PMM)
  - Ku-band Doppler Precipitation Radar (KuDPR): Doppler velocity obs.& High sensitivity
  - Collaboration with NASA FALCON for understanding of Aerosol~Cloud~Precipitation processes
  - Improving weather/climate models