# JAXA Agency Report on Microwave Sensors

Misako KACHI
Japan Aerospace Exploration Agency (JAXA)

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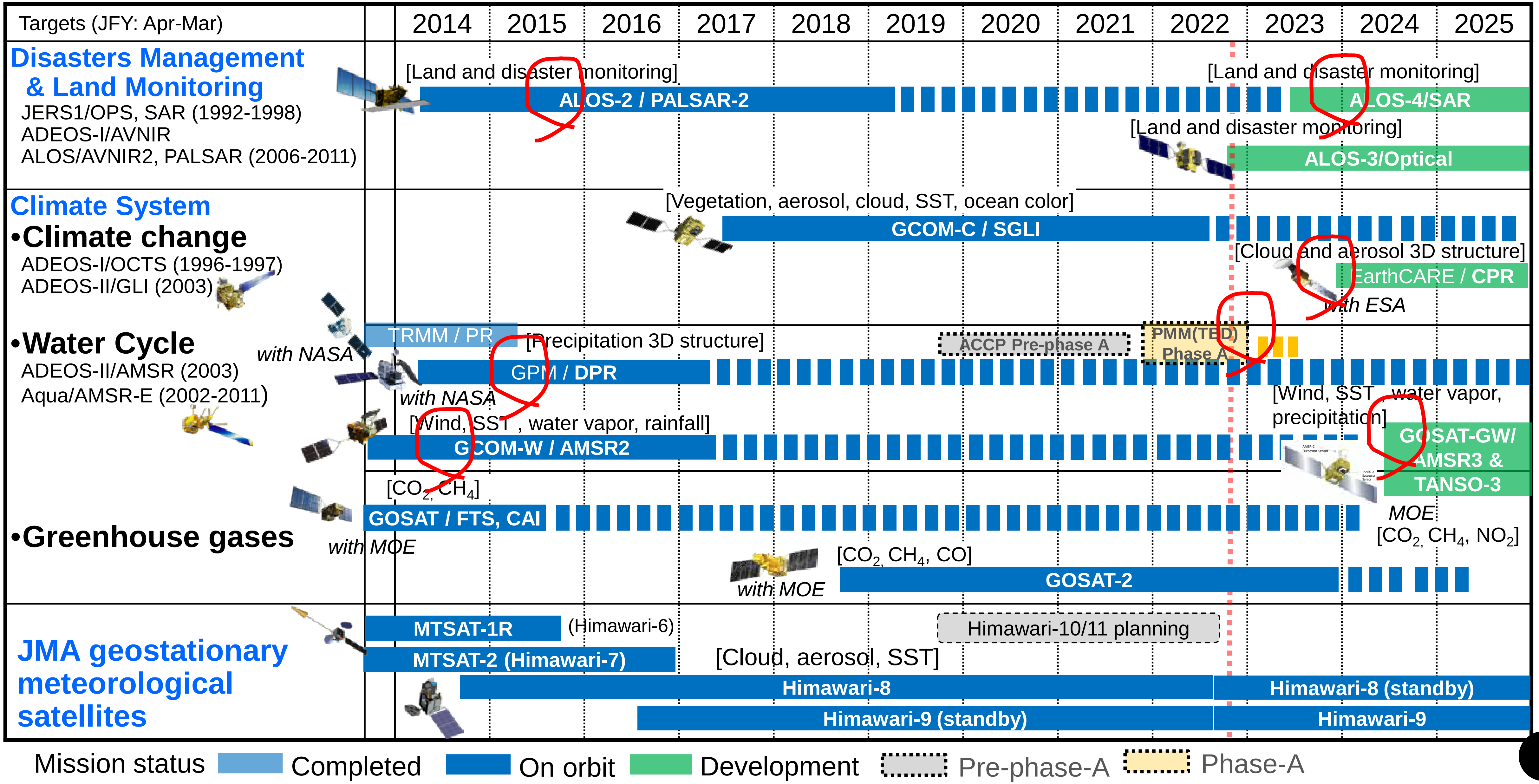
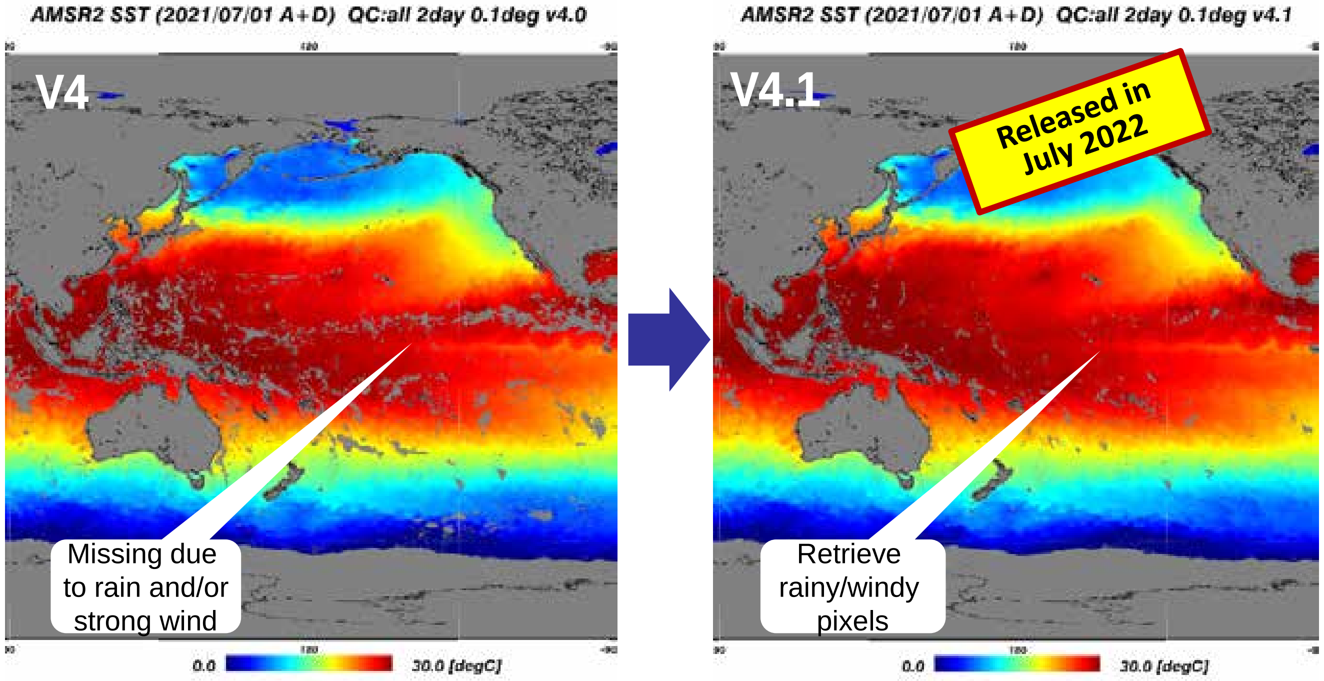
# Japanese Earth Observation Satellites/Sensors



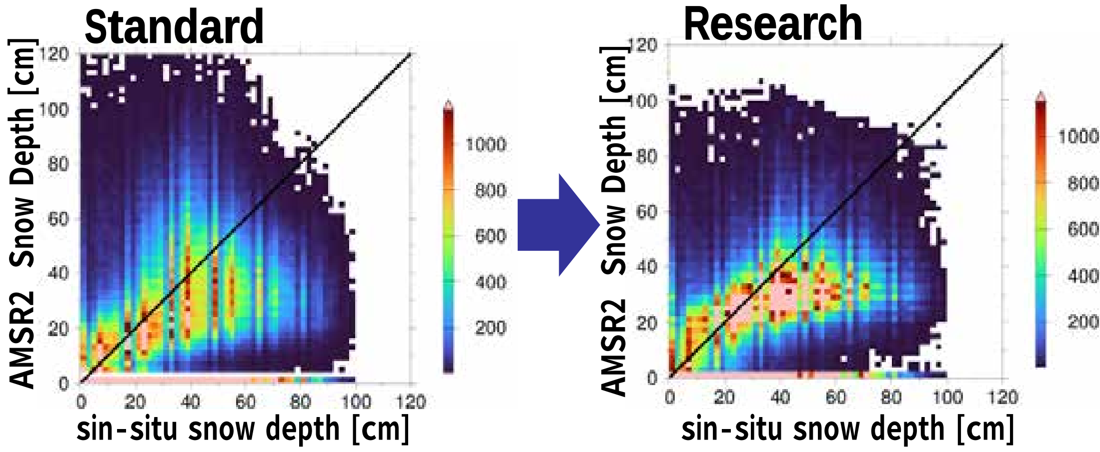

# Status of Advanced Microwave Scanning Radiometer 2 (AMSR2)

- Satellite & instrument are in good condition
- **Sea Ice Motion Vector V1 in Mar. 2022**
- **SST V4.1 in Jul. 2022**
- **Improved Snow depth V3 & Soil Moisture Content as research product in Sep. 2022**
- **Precipitation V3 in Oct. 2022**

## AMSR2 SST Ver.4.1



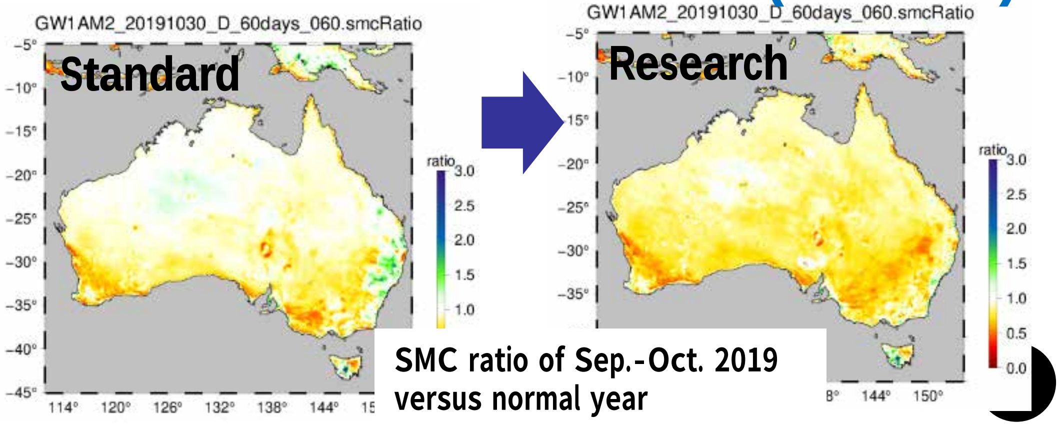

## AMSR2 Snow Depth Ver.3 (Research)




Improved version of Snow Depth (SND) and Soil Moisture Content (SMC) products, which are developed for AMSR3 will be released to public as **research product.**

**Released in September 2022**

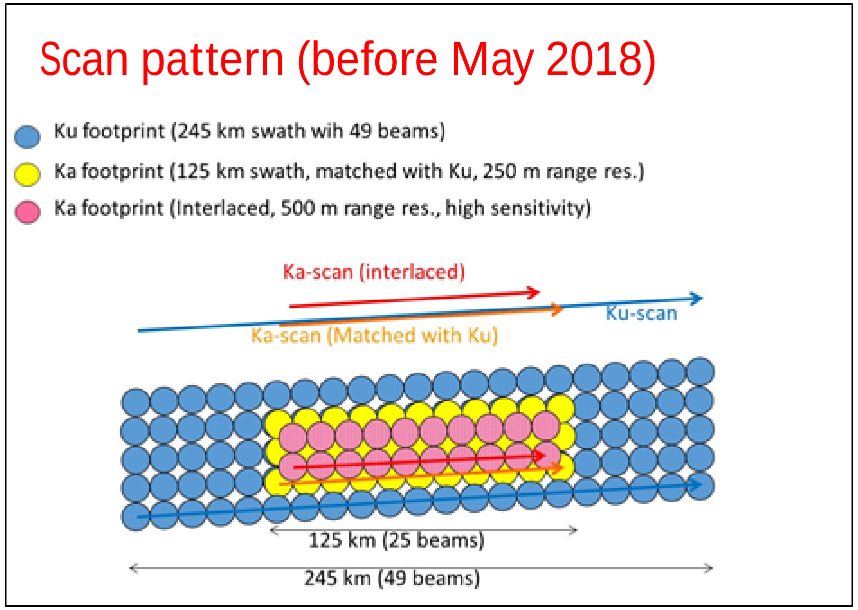
## AMSR2 Soil Moisture Content (Research)

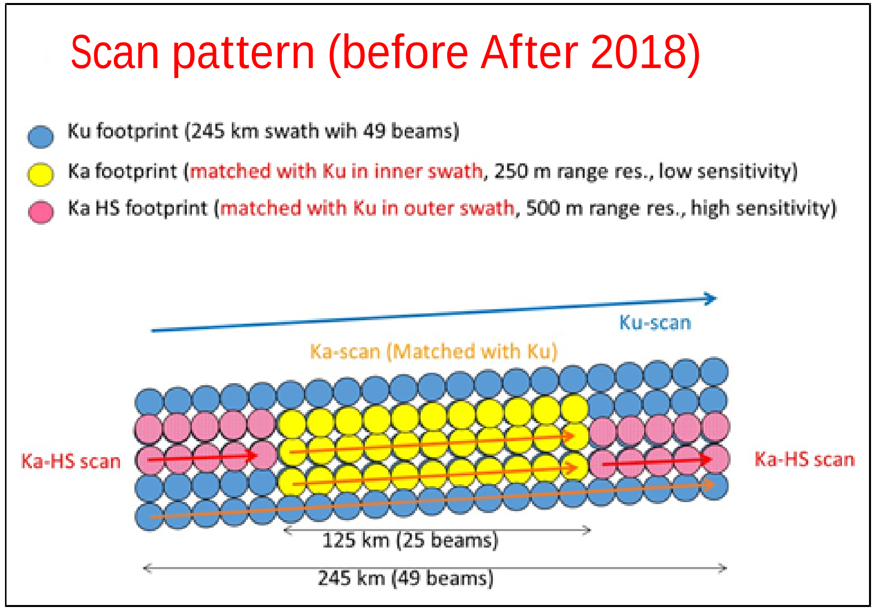


# Dual-frequency Precipitation Radar (DPR) status

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


**In Dec. 2021, JAXA and NASA started to release the DPR V07, corresponding to the KaPR scan pattern change.**

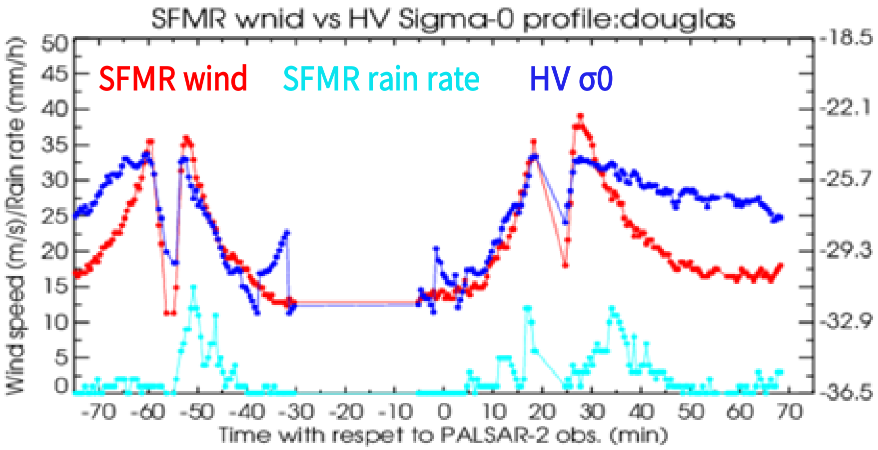


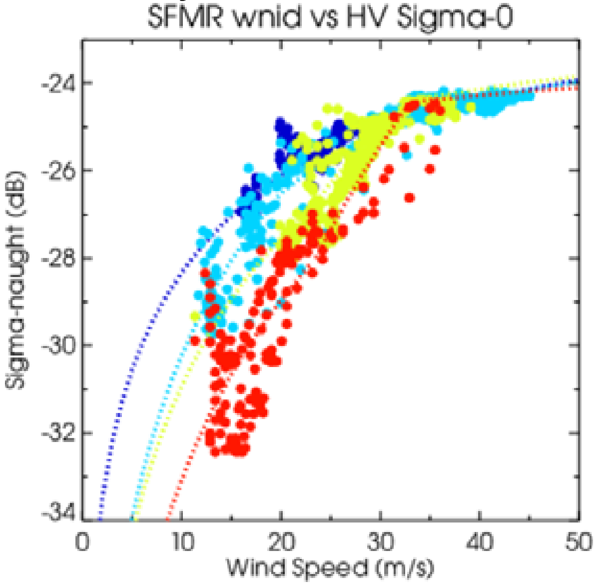

- By the scan pattern change in May 2018, dual-frequency technique can be applied in a full swath, which can enable us more accurate estimates.
- In Dec. 2021, JAXA and NASA started to release the DPR V07 (standard product).
  - V07 is the first standard product, corresponding to the scan pattern change. All GPM/DPR observations were reprocessed in V07.

# ALOS-2's SAR Derived Surface Wind Speed of Cyclone "DOUGLAS" in July 2020

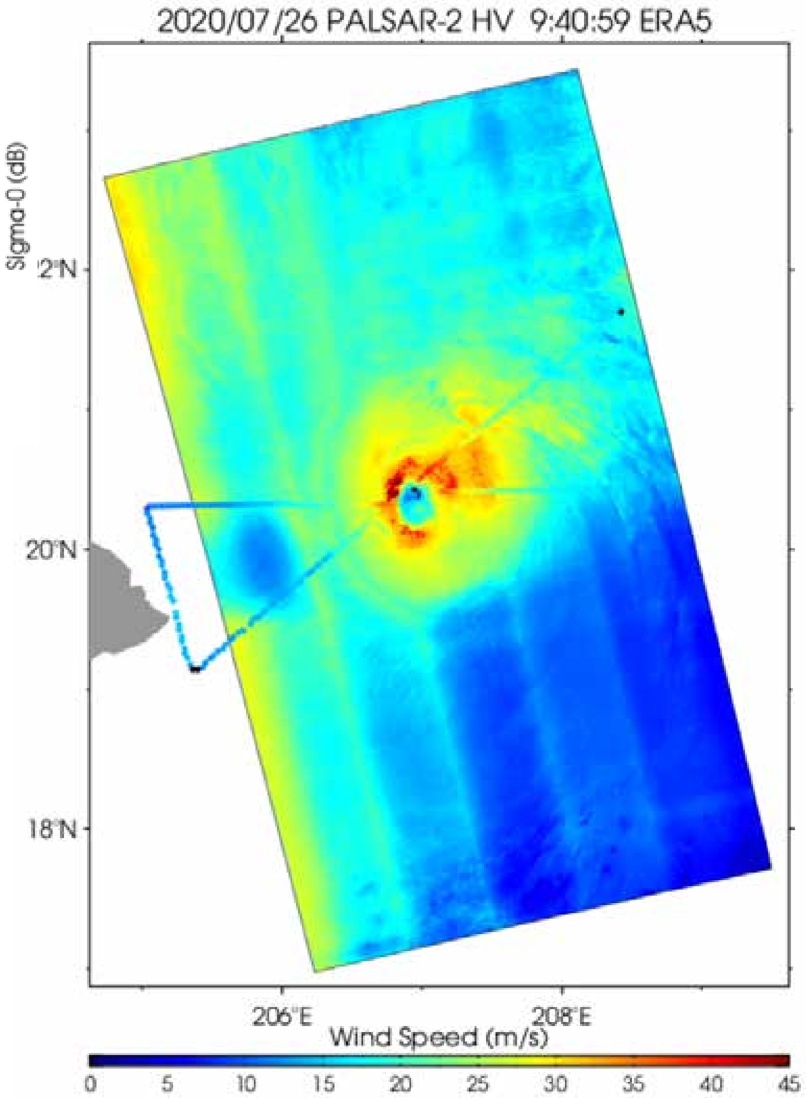

- The Sea Surface Wind (SSW) estimation under typhoon / tropical cyclone is essential to improve the forecasting.
- The emergency observations conducted several times in 2020.
- SFMR, the Airborne Passive Microwave Radiometer observations were used to develop model function collaboration with JMA-MRI.




Comparison between wind speed and rain rate derived by SFMR and PALSAR-2 $\sigma^0$.




Updates of the model function (GMF).
DORIAN(2019/9/5), DOUGLAS(2020/7/26)




Estimated SSW by PALSAR-2/HV for DOUGLAS. Overlaid SFMR SSW

# Future Missions: ALOS-4 L-band SAR (JFY2023)

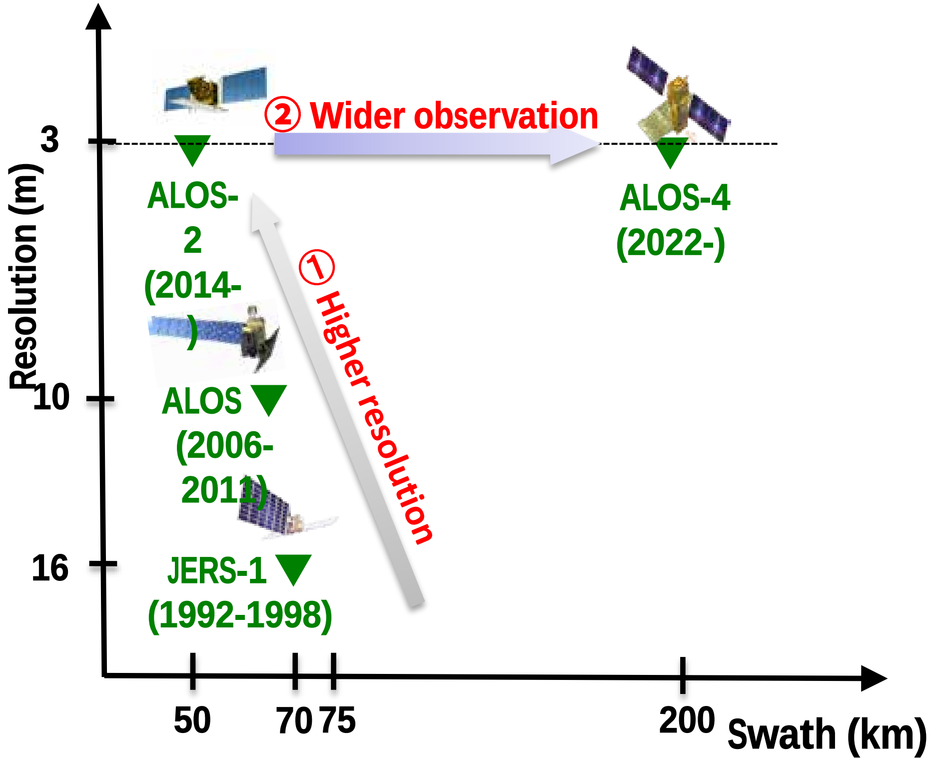

**To be launched in JFY2023**

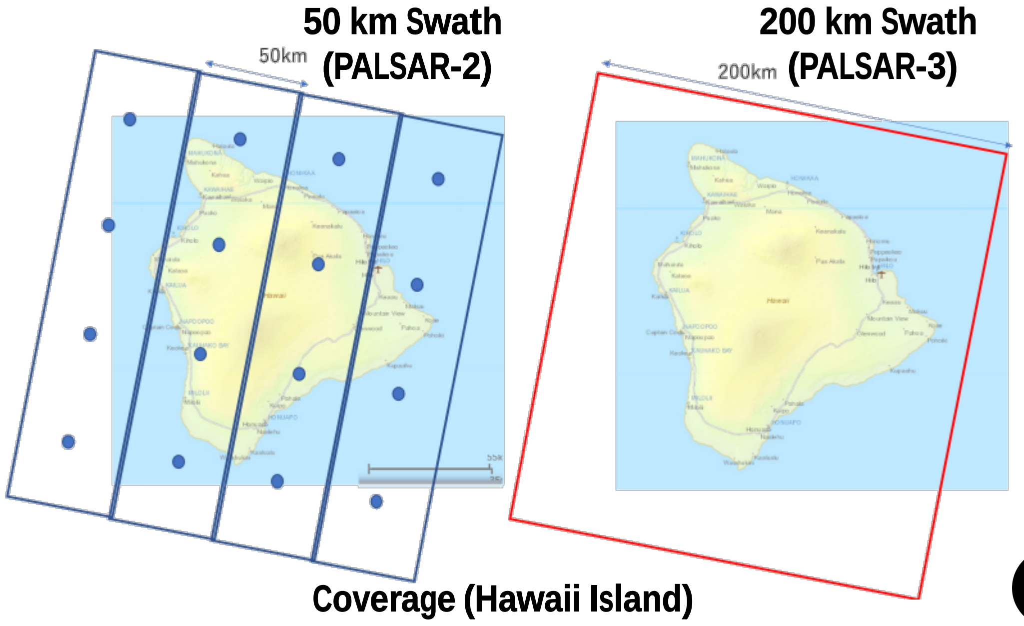
| | |
|---|---|
| **Orbit** | **Same orbit as ALOS-2**<br>Altitude: 628 km at the equator<br>Inclination angle: 97.9 °<br>Local sun time at Desc.: 12:00 +/- 15 min<br>Revisit time: 14 day (15-3/14 rev/day) |
| **Instruments** | - **PALSAR-3** (Phased Array type L-band Synthetic Aperture Radar-3)<br>- **SPAISE3** (SPace based AIS Experiment 3) |
| **Satellite Mass** | Approx. 3 tons at launch |
| **Designed lifetime** | **7 years** |

## Swath Width of PALSAR-2/3

| Modes | PALSAR-2 | PALSAR-3 |
|---|---|---|
| Stripmap (res. 3/6/10 m) | 30-70 km | **100-200 km** |
| ScanSAR (res. 25 m*) | 350-490 km | **700 km** |
| Spotlight (res. 1x3 m) | 25 x 25 km | **35 x 35 km** |

*single look

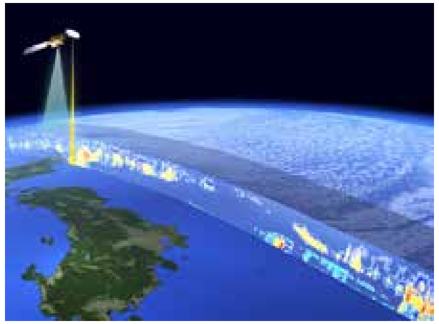


# Future Missions for Climate & Water: EarthCARE (JFY2023)


**To be launched in JFY2023**

- Europe-Japan joint mission
- 3 dimensional global distributions of cloud and aerosol to contribute to precise understanding of climate change
- JAXA and NICT provides <u>world's first satellite-based cloud vertical motion</u> by the Clod Profiling Radar (CPR) with 94 GHz with Doppler Capability at 0.8 km spatial resolution.

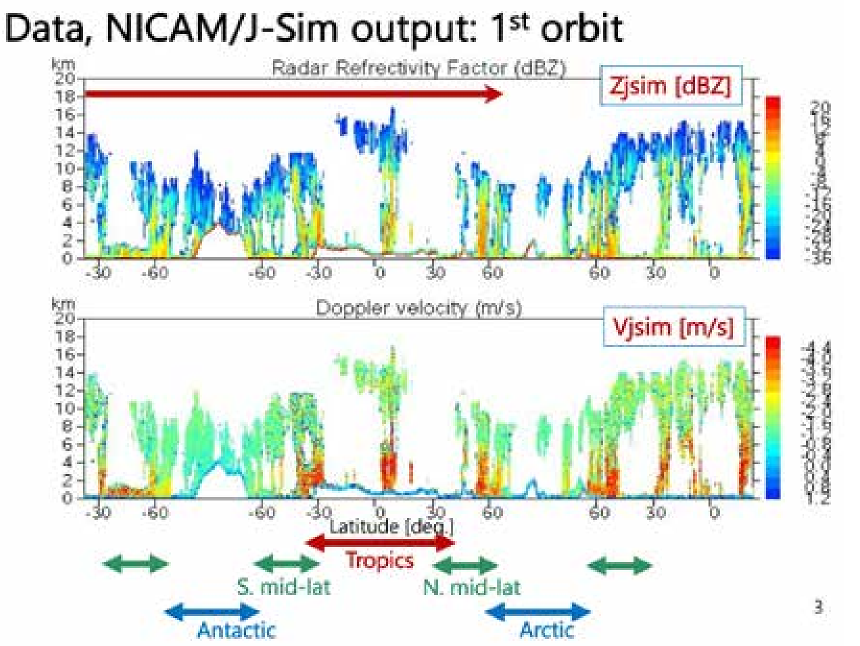


| | |
|---|---|
| **Orbit** | Sun-synchronous sub-recurrent orbit<br>Altitude: approx. 400km<br>Inclination angle: 97.05 °<br>Local Sun Time at Desc.: 14:00<br>Revisit time: 25 days |
| **Instruments** | - **Cloud Profiling Radar (CPR)** by NICT & JAXA<br>- Atmospheric Lidar (ATLID) by ESA<br>- Multi-Spectral Imager (MSI) by ESA)<br>- Broad-Band Radiometer (BBR) by ESA |
| **Mass** | Approx. 2.2 tons at launch |
| **Designed lifetime** | 3 years |

- Clouds continue to contribute the largest sources of uncertainty in current climate predictions.
- Measuring Doppler velocities from space is very challenging (Illingworth et al. 2015), but it is expected to advance climate modeling.

## Doppler simulation of global clouds

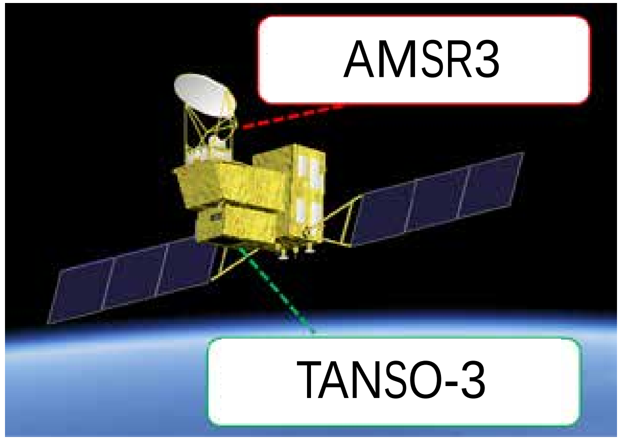
ü **estimated the satellite-observed Doppler velocity by using a combined approach of global cloud resolving model "NICAM" and a satellite data simulator "Joint-Simulator" (Hagihara et al. 2022).**



# Future Missions: GOSAT-GW (Global Observation SATellite for Greenhouse gases and Water cycle)

GOSAT-GW

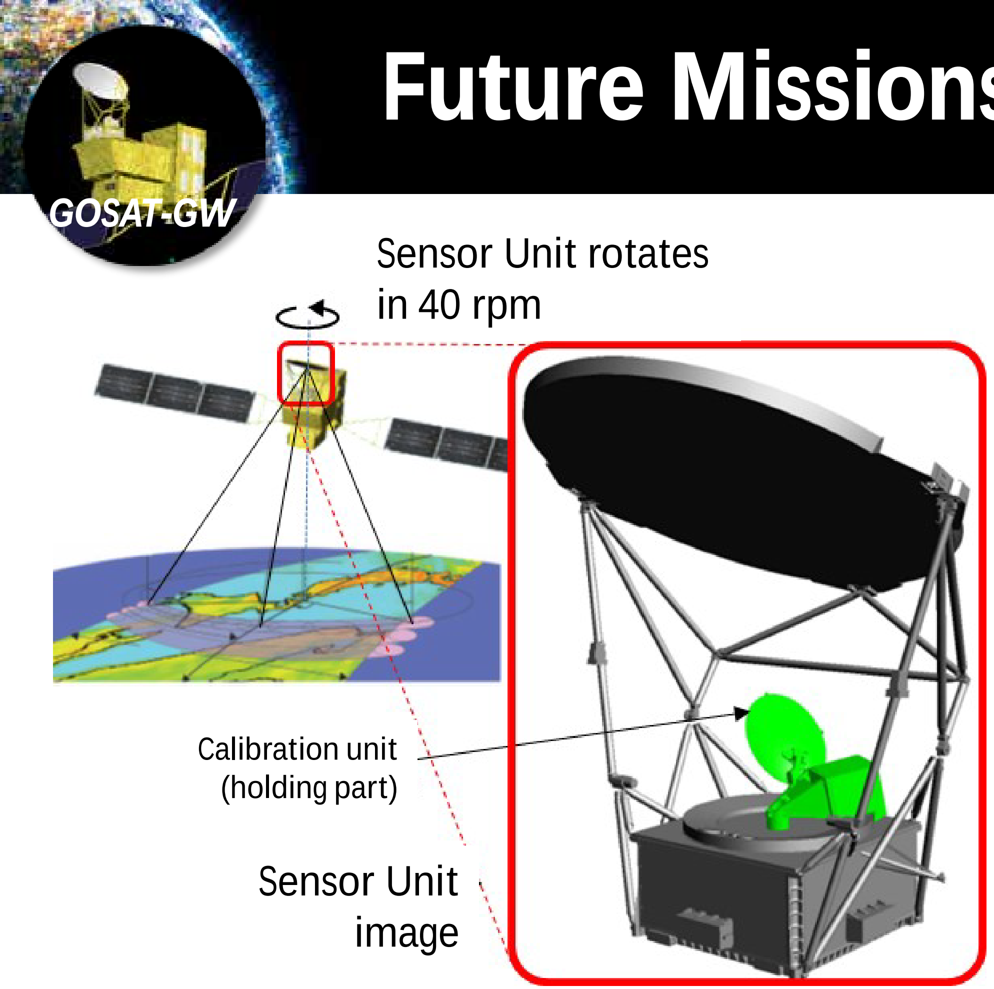
- GOSAT-GW will carry two instruments, AMSR3 & TANSO-3.
  - **AMSR3**, developed by JAXA, will succeed AMSR series observations adding new high-frequency channels for solid precipitation retrievals and water vapor analysis in NWP.
  - **TANSO-3**, developed by Japanese Ministry of the Environment (MOE), will improve observation capability of greenhouse gases from GOSAT-2/TANSO-2. (Choose grating spectrometer to enable spatially detailed observation)
  - Target launch is **JFY2024** (Apr. 2024 - Mar. 2025)
- Status of development
  - Jun. 2018： Mission Definition Review (MDR)
  - Jul. 2018: Project Preparation Review
  - Nov. 2019: Project Readiness Review
  - Dec. 2019： Established GOSAT-GW Project
  - Aug. 2020： Preliminary Design Review (PDR) of AMSR3 system
  - Dec. 2020： PDR of TANSO-3 system
  - Mar. 2021: PDR of GOSAT-GW satellite system
  - Oct. 2021: Critical Design Review (CDR) of AMSR3 system
    - Currently, AMSR3 flight components are manufacturing and testing
  - Spring 2023: CDR of GOSAT-GW satellite system




**Satellite specification**

| | | |
|---|---|---|
| **Orbit** | **Type** | Sun-synchronous, Sub-recurrent orbit |
| | **Altitude** | **666km, recurrent cycle 3days**<br>(same as GOSAT) |
| | **MLTAN** | 13:30±15min (same as GCOM-W) |
| **Mass** | | 2.6 ton (Including propellant) |
| **Power** | | > 5.3 kW |
| **Design life** | | **> 7 years** |
| **Launch vehicle** | | H-IIA rocket |
| **Mission data downlink rate** | | Direct transmission with X-band: 400 Mbps<br>Direct transmission with S-band:<br>1 Mbps (Only for AMSR3) |
| **Instrument** | | TANSO-3 (for GHG)<br>AMSR3 (for Water Cycle) |

# Future Missions: AMSR3 Sensor Specification




| Center frequency [GHz] | Polarization | Band width [MHz] | NEDT (1σ) | Beam width (spatial resolution) |
|---|---|---|---|---|
| 6.925<br>7.3 | H/V | 350 | < 0.34 K | 1.8 °<br>(34km x 58km) |
| **10.25** | **H/V** | **500** | **< 0.34 K** | **1.2 °<br>(22km x 39km)** |
| 10.65 | H/V | 100 | < 0.70 K | 1.2 °<br>(22km x 39km) |
| 18.7 | H/V | 200 | < 0.70 K | 0.65 °<br>(12km x 21km) |
| 23.8 | H/V | 400 | < 0.60 K | 0.75 °<br>(14km x 24km) |
| **36.42** | H/V | **840*** | < 0.70 K | 0.35 °<br>(7km x 11km) |
| 89.0 A/B | H/V | 3000 | < 1.20 K | 0.15 °<br>(3km x 5km) |
| **165.5** | **V** | **4000** | **< 1.50 K** | **AZ=0.23 ° / EL=0.30 °<br>(4km x 9km)** |
| **183.31±7** | **V** | **2000×2** | **< 1.50 K** | **AZ=0.23 ° / EL=0.27 °<br>(4km x 8km)** |
| **183.31±3** | **V** | **2000×2** | **< 1.50 K** | **AZ=0.23 ° / EL=0.27 °<br>(4km x 8km)** |

Red: Changes from AMSR2 including additional CHs

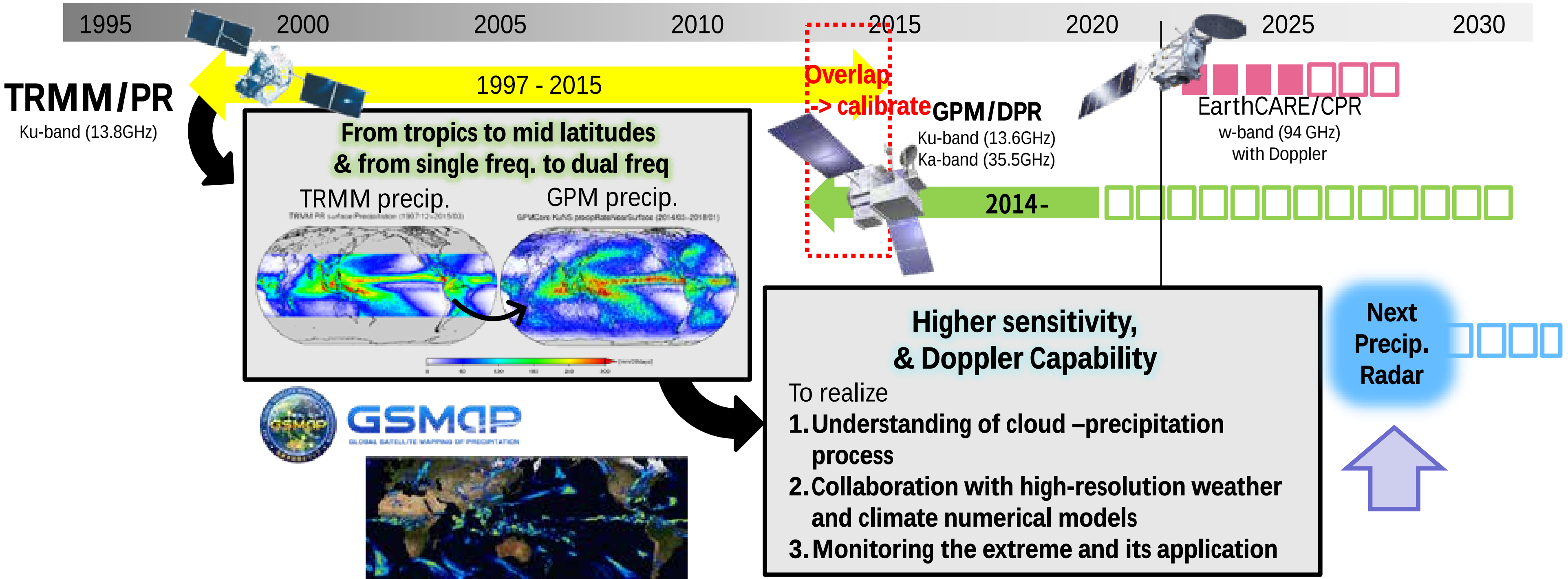
* Changed the specification of Ka-band passband to reduce the future risk of RF interference from 5-G mobile communication system

① Additional 166 & 183 GHz channels to enable monitoring of global precipitation (rain & snow) and contribute to water vapor analysis in NWP

② Additional 10 GHz channels with improved NEDT to enable robust SST retrievals in higher spatial resolution

# Future Missions: JAXA's Next-generation Precipitation Radar Project (PMM)

- The JAXA has studied a feasibility of a **next generation precipitation radar** with Japanese science team and user community.
  - Ø The EarthCARE will have the first Cloud Profiling Radar (CPR) with a **Doppler capability in space**. The CPR has been developed by the JAXA and the NICT.
- Our targets for the next generation precipitation radar in the **Precipitation Measuring Mission (PMM)** will be **Doppler Observations**, **Higher sensitivity measurements with scanning capability.**
  - ü JAXA has participated **in NASA's Atmosphere Observing System (AOS)** Pre-Phase A activities.

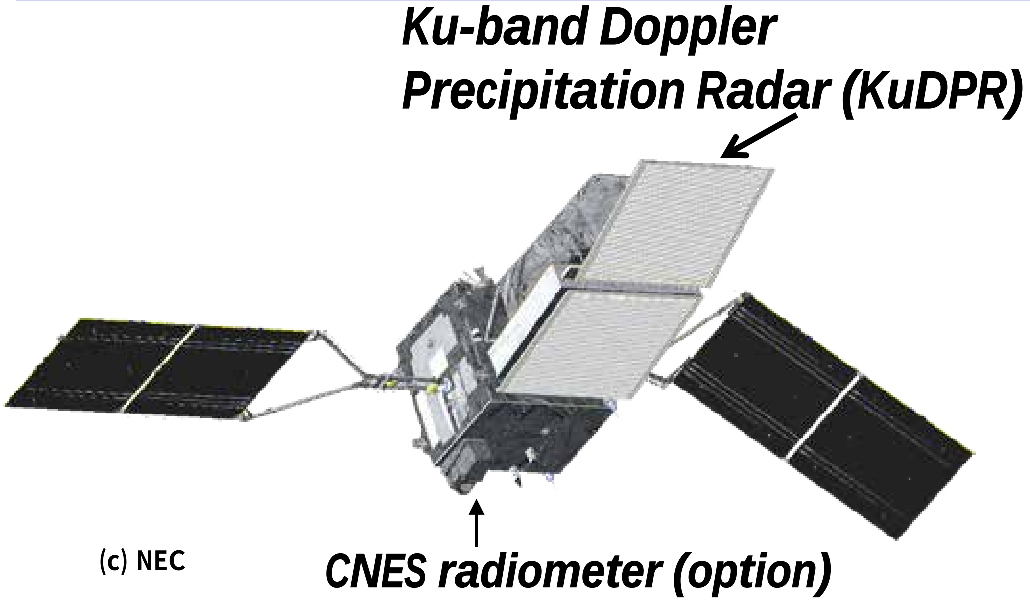


# Future Missions: JAXA's Next-generation Precipitation Radar Project (PMM)

- In January 2022, JAXA's Precipitation Measuring Mission (PMM) Pre-Project Team (Project Manager: Kinji Furukawa) was established on for the Spacecraft carrying the Ku-band Doppler Precipitation Radar. Target launch: JFY2028.

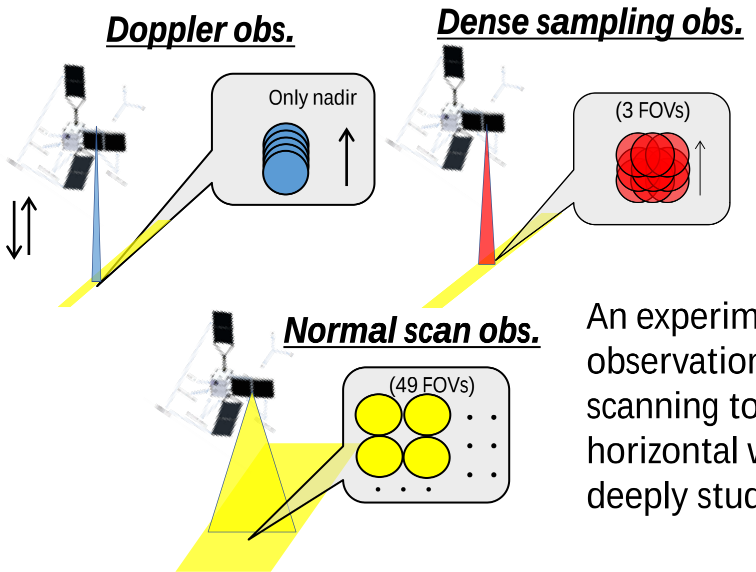
The Ku-band Doppler Precipitation Radar (KuDPR) will be two-antenna system that adopts Displaced Phase Center Antenna (DPCA) approach (Durden et al. 2007, Tanelli et al. 2016).

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




### *Major characteristics*

| | |
|---|---|
| Frequency | 13.6 GHz |
| Observation modes | • Doppler obs. mode<br>• Dense sampling obs. mode<br>• Normal scan obs. mode |




An experimental observation of doppler beam scanning to measure horizontal winds has been deeply studied in the Japan.

# Summary

- Currently Operating Microwave Sensors
  - Microwave Radiometer: GCOM-W/AMSR2, GOSAT-GW/AMSR3 (JFY2024)
  - Precipitation Radar: GPM/DPR
  - Cloud Profiling Radar: EarthCARE/CPR (JFY2023)
  - SAR: ALOS-2/PALSAR-2, ALOS-4 (JFY2023)
- Future Plans
  - Microwave Radiometer: GOSAT-GW/AMSR3 with high-freq. channels (JFY2024)
  - Precipitation Radar: PMM/KuDPR (with doppler capability) (JFY2028)
  - Cloud Profiling Radar: EarthCARE/CPR with doppler capability (JFY2023)
  - SAR: ALOS-4/PALSAR-3 with wider swath (JFY2023)