



JAXA updates since CGMS-51 and report on the medium to long-term future plans

Presented to CGMS-52 Plenary, agenda item 2

Executive summary of the WP

- JAXA operates various kind of satellite sensors and opens the products to the public. We keep developing and improving the products to address the climate issues.
- The major updates since CGMS-51 is that the reprocessing during about 26 years for the new version of the Global Satellite Mapping of Precipitation (GSMaP) was completed with the latest GSMaP algorithm released in December 2021 (algorithm version 8). GCOM-C has achieved the 6-year in Dec. 2023 and been in the post-mission phase. GCOM-W has achieved 12-year in May 2024 and several new research products are available.
- The joint Japanese-European EarthCARE mission with cloud profiling doppler radar was successfully launched on May 29, 2024. JAXA will launch two more missions in JFY2024; the ALOS-4 satellite with L-band SAR in June 2024; and the GOSAT-GW satellite with GHG sensor and microwave imager in JFY2024.
- In terms of the WMO project for monitoring extremes, JAXA contributes to the WMO Space-based Weather and Climate Extremes Monitoring (SWCEM) Project by providing more than 25-yr GSMaP rainfall product with climate normal.
- JAXA also contributes to the Global Greenhouse Gas Watch (G3W) by defining the role of satellite products. Since May 2023, JAXA is continuously providing JAXA/GHG products in public.
- Moreover, JAXA will host the 11th Workshop of the International Precipitation Working Group (IPWG) at Tokyo Institute of Technology from July 15th to 18th, 2024, in collaboration with the IPWG, which is co-sponsored by the CGMS and WMO.

Current and future JAXA Earth Observation Missions contributing to Science and Societal Benefits

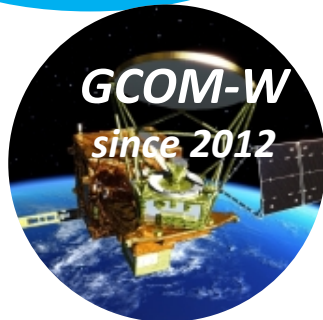
Current

Greenhouse gases



GOSAT
since 2009

Water Cycle



GCOM-W
since 2012

Precipitation



GPM-Core
since 2014
NASA-JAXA
joint mission

Disaster/
Forest



**ALOS-2
(Radar)**
since 2014

Cloud/
Aerosols/
Vegetation



GCOM-C
since 2017

Greenhouse gases



GOSAT-2
since 2018

Future

Cloud/Aerosol
Radiation Budget



EarthCARE

Disaster/
Forest



**ALOS-4
(Radar)**

Greenhouse gases
(MOE Mission)

(MOE Mission)



GOSAT-GW

Water Cycle
(JAXA Mission)

(JAXA Mission)

EarthCARE
CPR:
Cloud Profiling Radar

EarthCARE (with ESA)

launched
on 29th May
2024



EarthCARE

Cloud/
Aerosol
Radiation
Budget



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

Group photo in front of EarthCARE satellite in the cleanroom at Airbus' facilities in Friedrichshafen, Germany (February 2024).



(c) ESA/Airbus

Group photo in front of EarthCARE satellite in Vandenberg Space Center in California, USA (April 2024).



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



EarthCARE (with ESA)

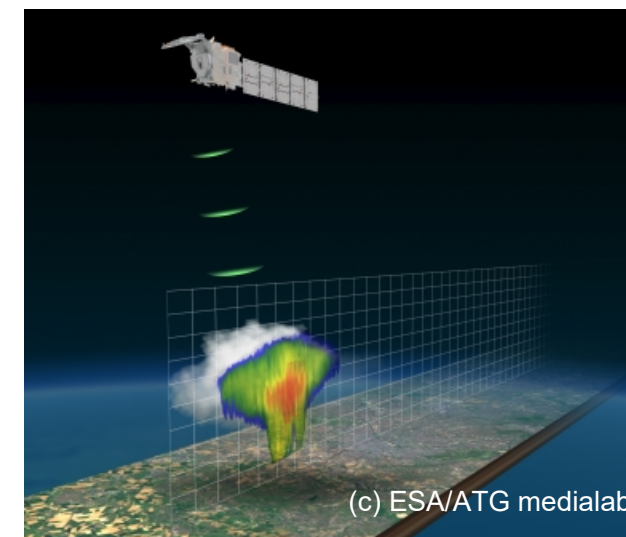
launched
on 29th May 2024



The EarthCARE satellite was launched on 29 May at 00:20 CEST aboard a Falcon 9 rocket from the Vandenberg Space Force Base in California, US.

EarthCARE deploys solar wing and Cloud Profiling Radar (CPR)

Measuring cloud by the CPR



(c) ESA/ATG medialab

(c) ESA/ATG medialab

The full deployment of the EarthCARE/CPR was confirmed by on May 30, 2024.

EarthCARE/CPR's contribution to the CGMS community:

- GEO/LEO satellite product evaluation and development, including cloud and snowfall algorithms, with EarthCARE/CPR data
- Utilization of EarthCARE/CPR data in weather/climate models



(c) ESA - S. Corvaja



Spacecraft deployment
(SpaceX/ESA)

Climate Monitoring by GCOM-C

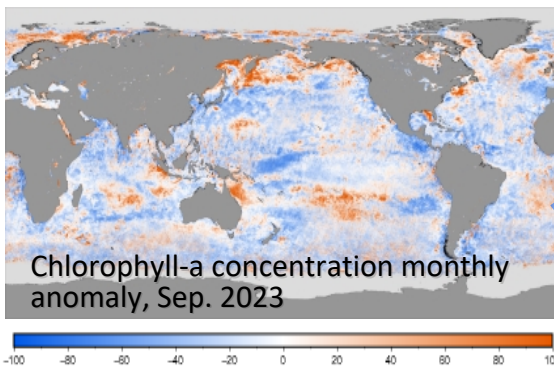
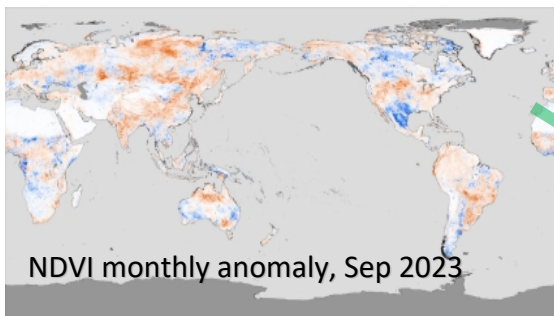
Global Change Observation Mission - Climate (GCOM-C)

GCOM-C

Energy Budget

Carbon & Material Cycle

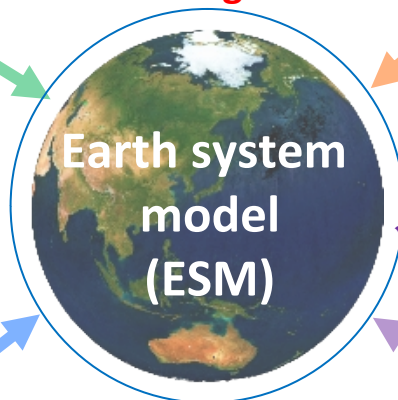
✓ Global ecosystem change



JAXA/GCOM-C observation:

- Observation: since 1 Jan 2018
- The extension phase: since Jan 2023
- Second-generation Global Imager, SGLI
 - ✓ 250-m spatial resolution
 - ✓ Near-UV wavelength
 - ✓ Polarimetry

GCOM-C targets:



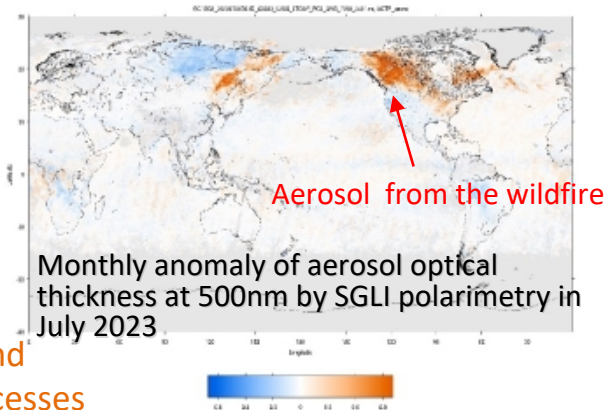
Collaboration with JAMSTEC, the Univ. of Tokyo

Model-Observation comparison:

- ✓ Spatial/temporal changes
- ✓ Correlation among the observed variables

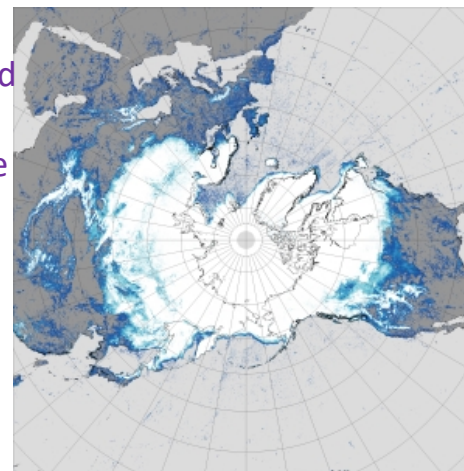
- Improvement of the ESM
- Improvement of prediction of the future global environment

✓ Radiative forcing



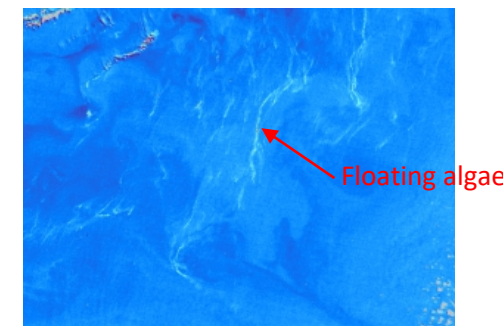
✓ Aerosol and cloud processes and radiative forcing

✓ Distribution and properties of snow and ice

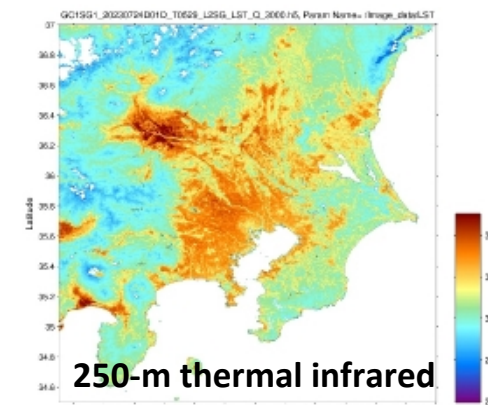


Monthly snow and sea ice distribution in Mar. 2024

✓ Environmental monitoring by 250m spatial resolution



SGLI Floating algae index in the south of East China Sea n 20 Mar. 2024



High land surface temperature observed by 250-m SGLI thermal infrared around Kanto area Japan at local time AM 10:21 on 24 July 2023

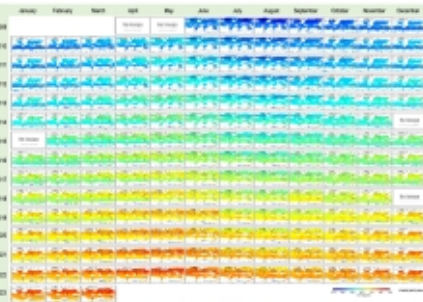
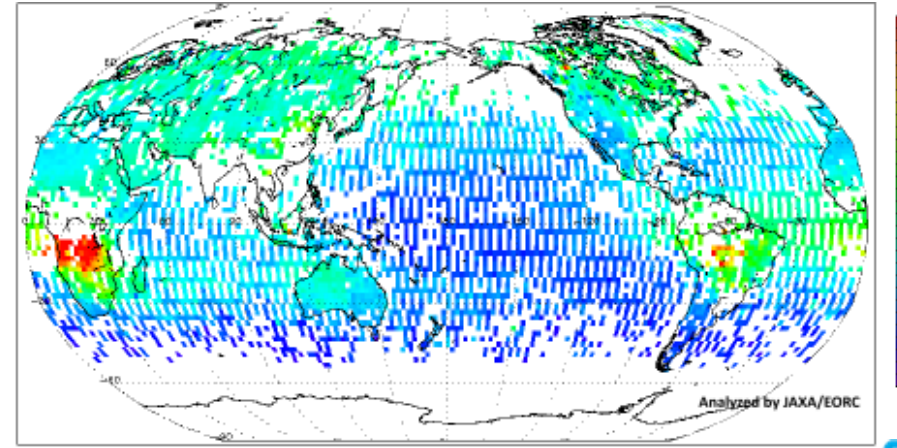
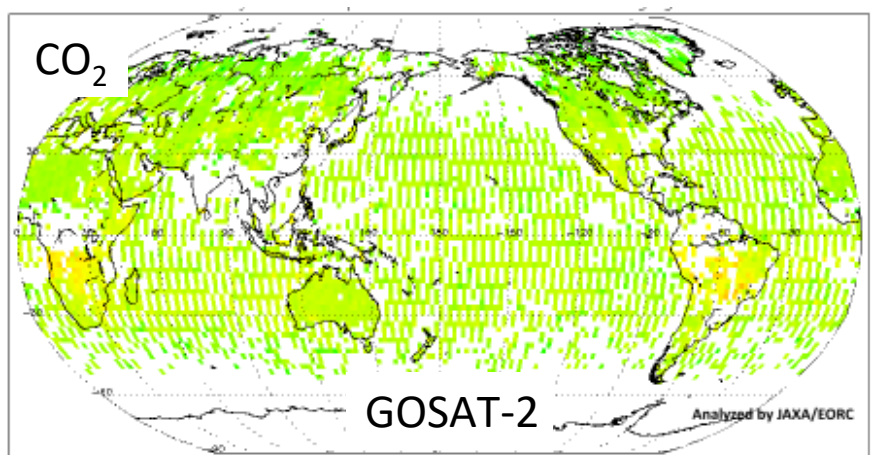
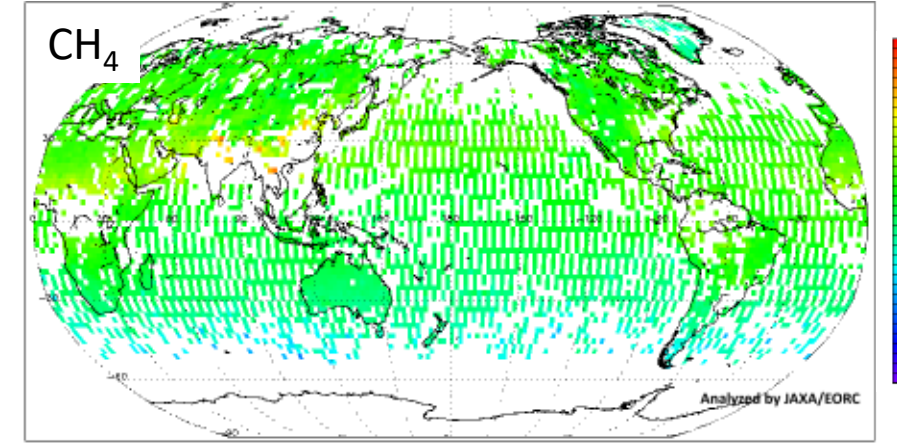
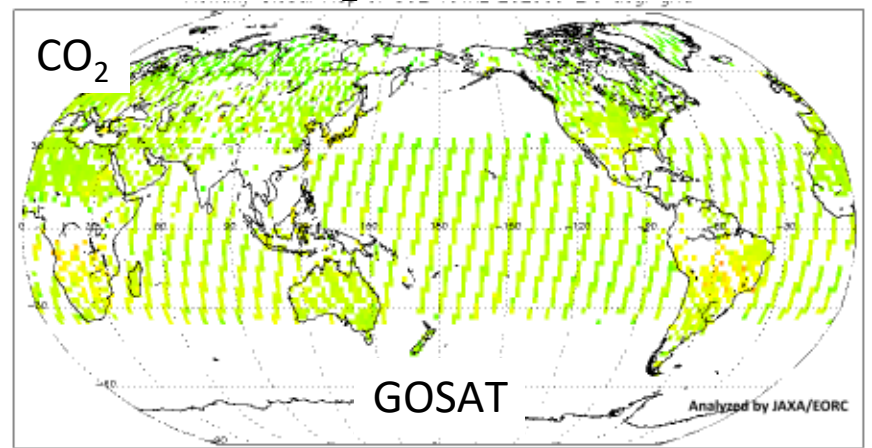
A-decade-long GHG observation by GOSAT series

Carbon & Material Cycle

Greenhouse gases Observing SATellite (GOSAT) & GOSAT-2

CO₂ Observation

CH₄ (upper) & CO (lower) Observation



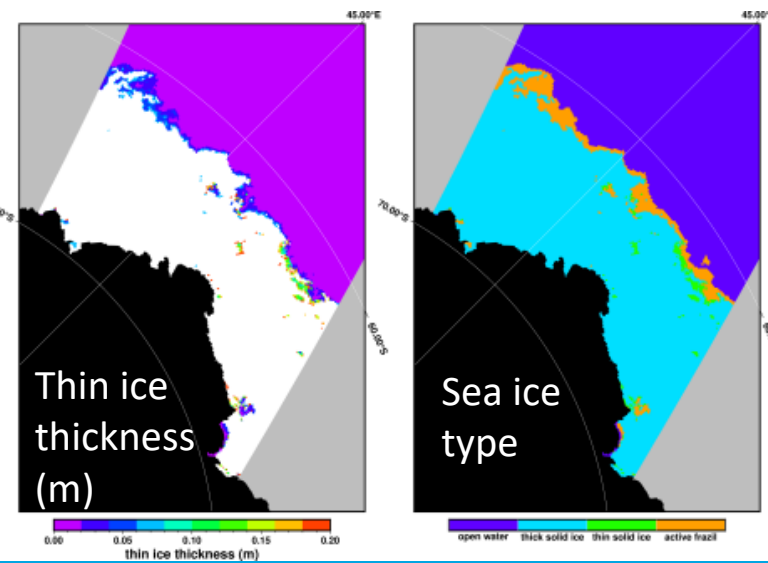
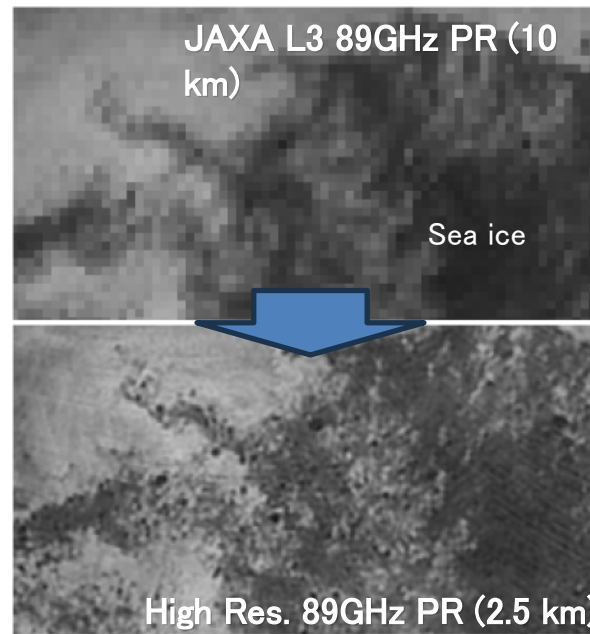
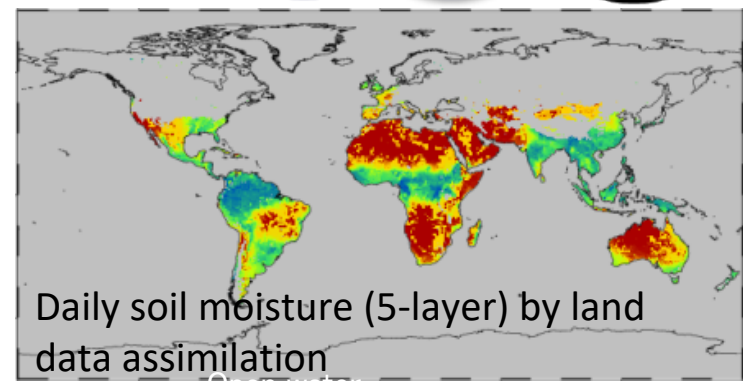
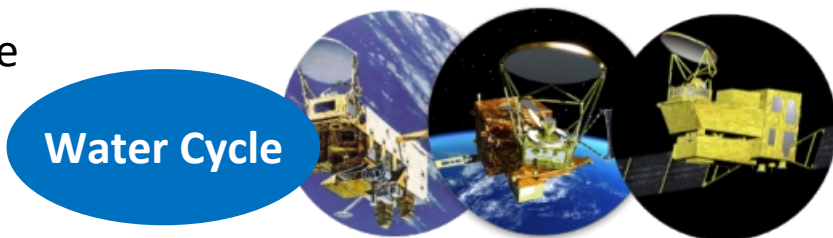
Global CO₂ concentrations observed by GOSAT and GOSAT-2, CH₄ and CO (September 2023)

2009-2023 seasonal variation and year-to-year increase of global CO₂ observed by GOSAT.

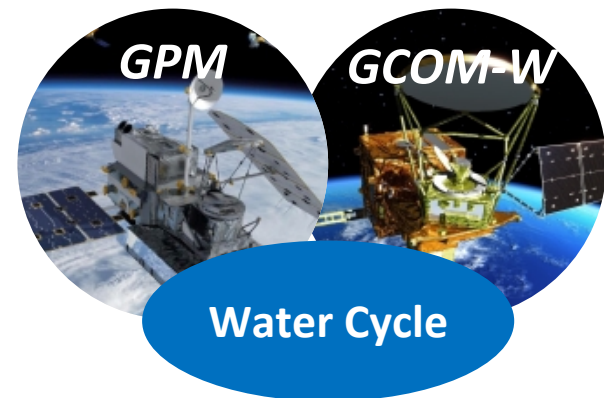


The Advanced Microwave Scanning Radiometer (AMSR) series

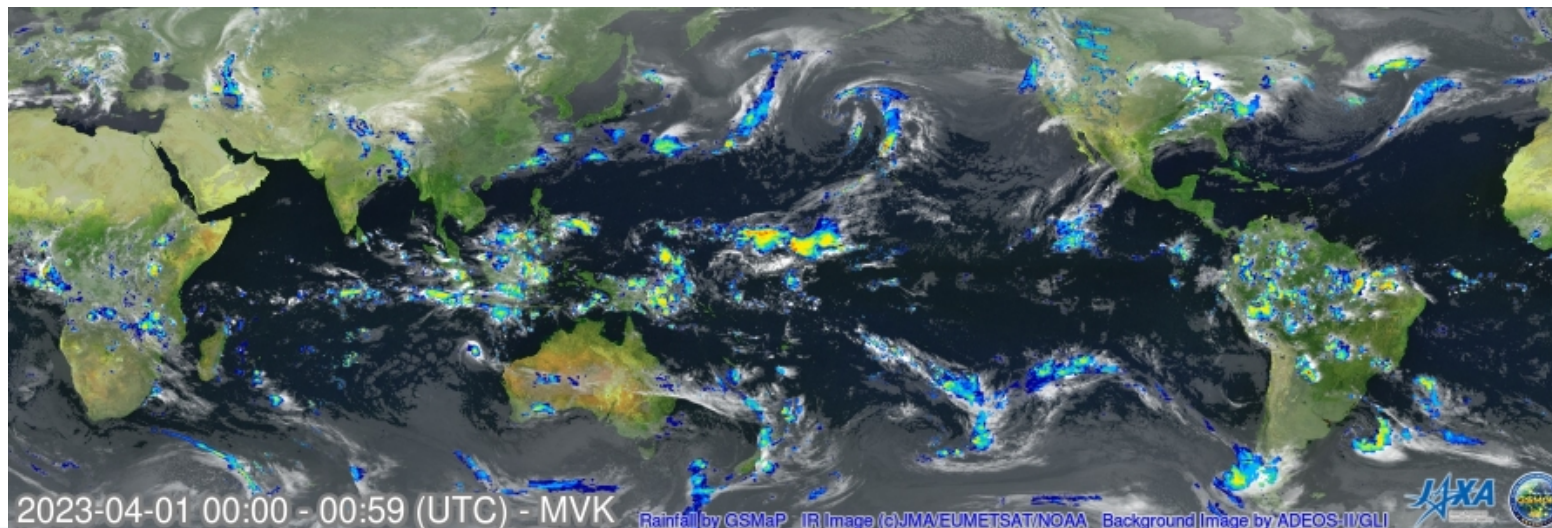
- The Advanced Microwave Scanning Radiometer series (AMSR-E, AMSR2, and future AMSR3)
 - Microwave channels of **6.9-89GHz** enable to observe “water-related” geophysical parameters in **all-weather without sun-light**
 - Observing **SST and soil moisture in 30-50km spatial resolution** by large (~2-m) diameter antenna
 - Same local observation time and similar specification to achieve **continuous observation +22 years**
- New research products has been released in Mar. 2024
 - **Thin ice thickness (thermal ice thickness)** -- Nakata et al. (2019)
 - **Soil moisture & vegetation water content using land data assimilation technique** – Sawada (2020), etc.
- Development of **enhanced-resolution brightness temperature for Cryosphere studies**
 - Work in progress with Cryosphere community
 - To be expanded to global area



Global Satellite Mapping of Precipitation (GSMaP)



- **Global Satellite Mapping of Precipitation (GSMaP)** is the Japanese precipitation product, and Graphical User Interface of the "JAXA Global Rainfall Watch" website (<https://sharaku.eorc.jaxa.jp/GSMaP/index.htm>) is available based upon the GSMaP product.
 - GSMaP is a blended Microwave-IR product and has been developed in Japan for the GPM mission (Kubota et al. 2020).
- JAXA improved the GSMaP algorithm in December 2021 (algorithm version 8) (Kubota et al. 2022, <https://doi.org/10.5194/egusphere-egu22-332R8>).
- Reprocessing since Jan. 1998 was completed in September 2023, and now JAXA has distributed more than 26-yr data records of the GSMaP precipitation dataset.



JAXA's contributions to activities in SWCEM and IPWG

- JAXA participates the **WMO** Space-based Weather and Climate Extremes Monitoring (**SWCEM**) project and provide the **GSMaP product** with about 22yr-climate data to National Meteorological and Hydrological Service in **Asia and Pacific regions**.



- In June 2022, JAXA started to distribute the GSMaP real time data (GSMaP_NOW) to the SWCEM members, corresponding to the recommendation in the SG-SWCEM-EAWP-4 held on March 2022.
- JAXA prepared the release of the 26yr-GSMaP data, as noted the previous page, and **re-calculate the climate normal again for the WMO SWCEM project**.

International Precipitation Working Group (IPWG)

- JAXA has hosted the CGMS **IPWG web site** since Aug. 2023 (<https://www.eorc.jaxa.jp/IPWG/>)
- JAXA will host the 11th Workshop of IPWG (**IPWG-11**) held in 15-18 Jul. 2024 in Tokyo, Japan

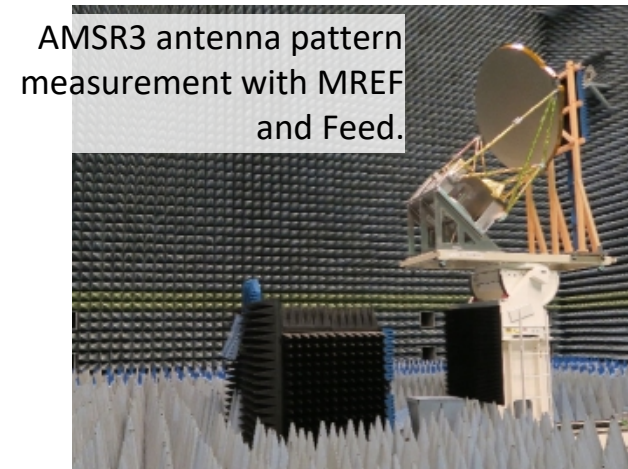
<https://www.eorc.jaxa.jp/IPWG/meetings/tokyo-2024/Tokyo2024.html>



GOSAT-GW (Global Observation SATellite for Greenhouse gases and Water cycle)



- GOSAT-GW will carry two instruments, AMSR3 & TANSO-3
 - **AMSR3**, developed by JAXA, will succeed AMSR series observations adding new channels to improve its capability.
 - **TANSO-3**, led 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)



Satellite specification

Orbit	Type	Sun-synchronous, Sub-recurrent orbit
	Altitude	666km, recurrent cycle 3days (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 Direct transmission with S-band: 1 Mbps (Only for AMSR3)	
Instrument	TANSO-3 (GHGs), AMSR3 (water cycle variables)	

Status of development

- Jun. 2018: Mission Definition Review (MDR)
- Dec. 2019: Established GOSAT-GW Project
- Oct. 2021: Critical Design Review (CDR) of AMSR3 system
- Jun. 2023: CDR of GOSAT-GW satellite system
- Spacecraft and AMSR3 flight model are in manufacturing and testing phase

AMSR3 Major Improvements

- ① Additional **166 & 183 GHz** channels to enable monitoring of global precipitation (rain & snow) and contribute to water vapor analysis in NWP
- ② Additional **10.25 GHz channels with improved NEDT** to enable robust SST retrievals in higher spatial resolution

Next Generation Precipitation Radar planned in JAXA: Precipitation Measuring Mission (PMM)

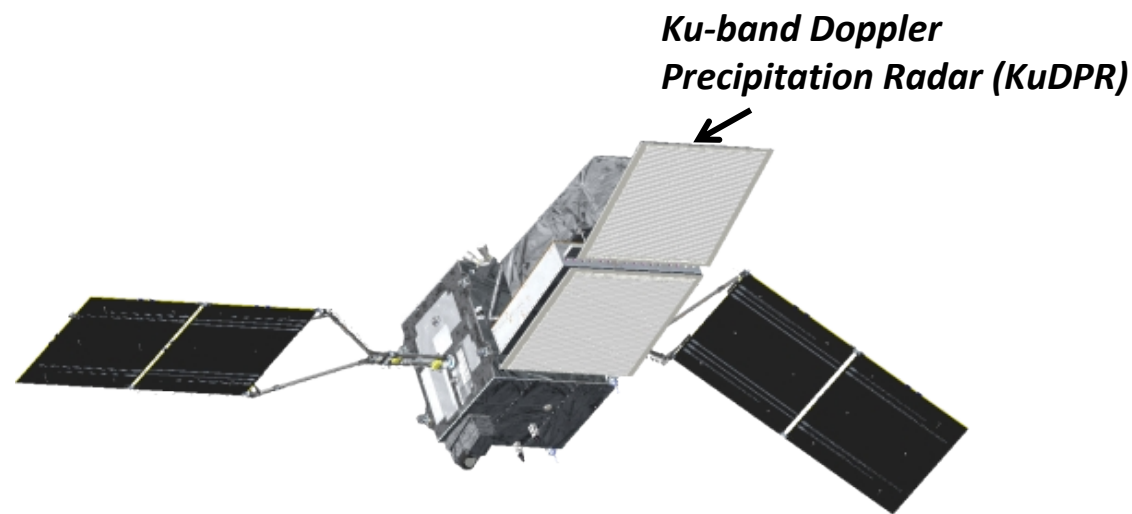
- In June 2023, **JAXA's Precipitation Measuring Mission (PMM) Project Team** was established on for the Spacecraft carrying the Ku-band Doppler Precipitation Radar, with participation in NASA Atmosphere Observing System (AOS) mission.
- In December 2022, the Cabinet Office of the Japanese government released Implementation Plan of the “Basic Plan on Space Policy” noting the Precipitation Radar Satellite Phase B activity targeting the launch of **JFY2028 (April 2028 to March 2029)**.

Major characteristics

Frequency	13.6 GHz
Observation modes	<ul style="list-style-type: none"> ▪ Doppler obs. mode ▪ Dense sampling obs. mode ▪ Normal scan obs. mode

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).

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



(a design life of 5 years)

Key issues of relevance to CGMS:

- The major updates since CGMS-51 is that the launch of the EarthCARE satellite carrying the CPR, and the reprocessing during about 26 years for the new version of the GSMaP.
- In terms of the WMO project for monitoring extremes, JAXA contributes to the WMO SWCEM Project by providing more than 25-yr GSMaP rainfall product with climate normal. In contribution to IPWG activities, JAXA has hosted the CGMS IPWG web site since Aug. 2023 (<https://www.eorc.jaxa.jp/IPWG/>), JAXA will host The 11th Workshop of IPWG (IPWG-11) held in 15-18 Jul. 2024 in Tokyo, Japan
- JAXA also contributes to the Global Greenhouse Gas Watch (G3W) by defining the role of satellite products, and continuously provides JAXA/GHG products in public
- The medium to long-term future plans of JAXA
 - GCOM-C has achieved the 6-year in Dec. 2023 and been in the post-mission phase.
 - GCOM-W has achieved the 12-year in May 2024 and continues observation in healthy condition.
 - EarthCARE (a joint Japanese-European mission) was launched in May 2024, which observes clouds, aerosols, and radiation on a global scale to improve the accuracy of climate change predictions.
 - ALOS-4, L-band SAR mission to succeed the current ALOS-2, is scheduled to be launched in Jun. 2024.
 - GOSAT-GW, joint mission of GOSAT-2 follow-on (TANSO-3) and GCOM-W/AMSR2 follow-on (AMSR3), is scheduled to be launched in latter half of JFY2024.