Recent updates of JAXA Earth Observation

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Japan Aerospace Exploration Agency (JAXA)

13th AOMSUC-13, Republic of Korea
6th November 2023

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

Current

Greenhouse gases

Water Cycle

Precipitation

Disaster/ Forest

Cloud/ Aerosols/ Vegetation

Greenhouse gases

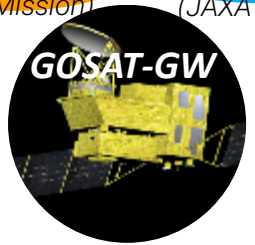
Future

Cloud/Aerosol Radiation Budget

EarthCARE
CPR:
Cloud Profiling Radar

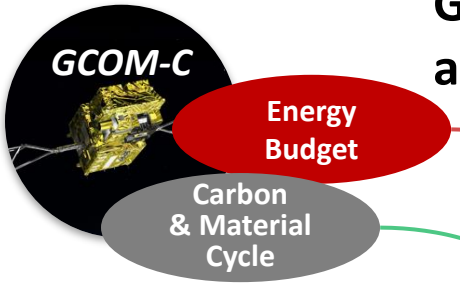
Greenhouse gases
(MOE Mission)

Water Cycle
(JAXA Mission)



Disaster/ Forest

GCOM-C has achieved the 5-year nominal mission phase and been in the post-mission phase since Jan. 2023.

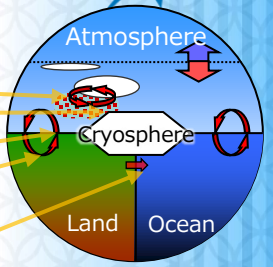


GCOM-C/SGLI characteristics:

- ✓ 250-m spatial resolution with >1150km swath
- ✓ 19 channels from Near-UV to thermal infrared wavelengths
- ✓ Polarimetry

Examples of the current focus:

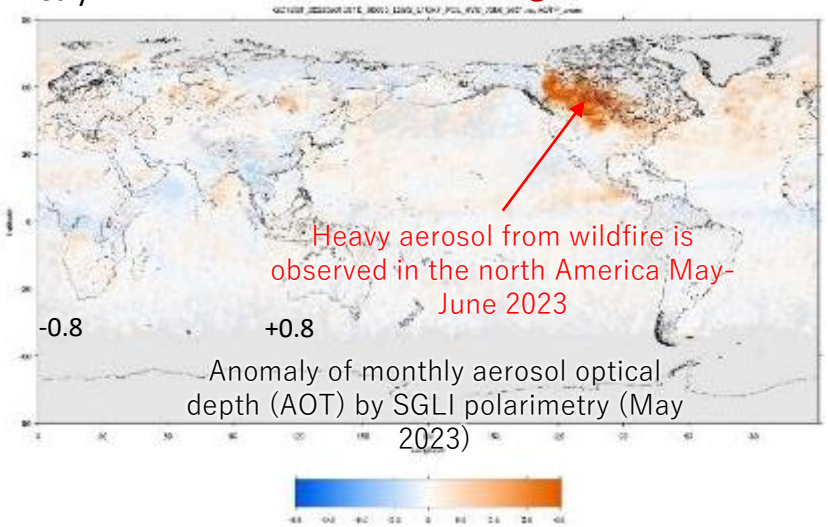
- ✓ Aerosol, cloud, and solar radiation
- ✓ Arctic change including Greenland ice sheet
- ✓ Wildfire processes including land cover change and aerosol emission
- ✓ Seasonal and year-to-year change of the vegetation
- ✓ ocean ecosystem and carbon cycle including land-ocean interface



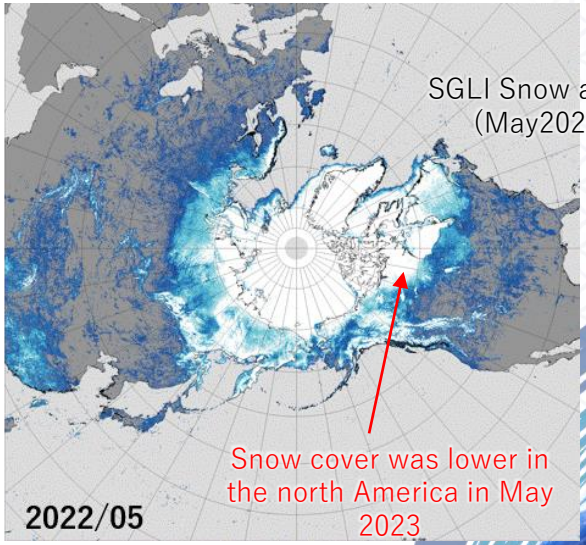
Earth system model

Collaboration with earth system model researches

Aerosol monitoring



Polar area monitoring

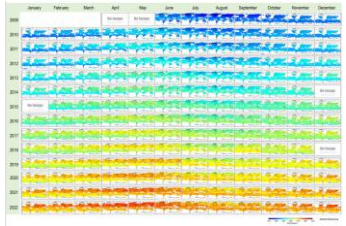


A-decade-long GHG observation by GOSAT series: Greenhouse gases Observing SATellite (GOSAT) & GOSAT-2

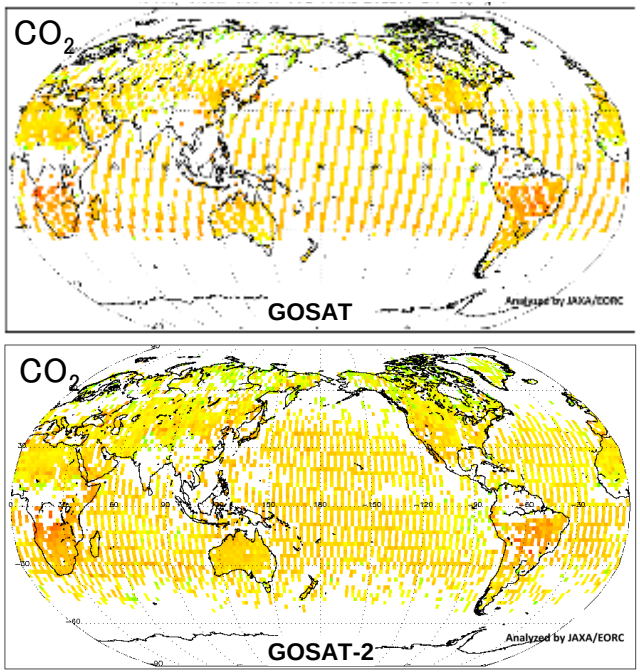
Carbon & Material Cycle

2009-Now

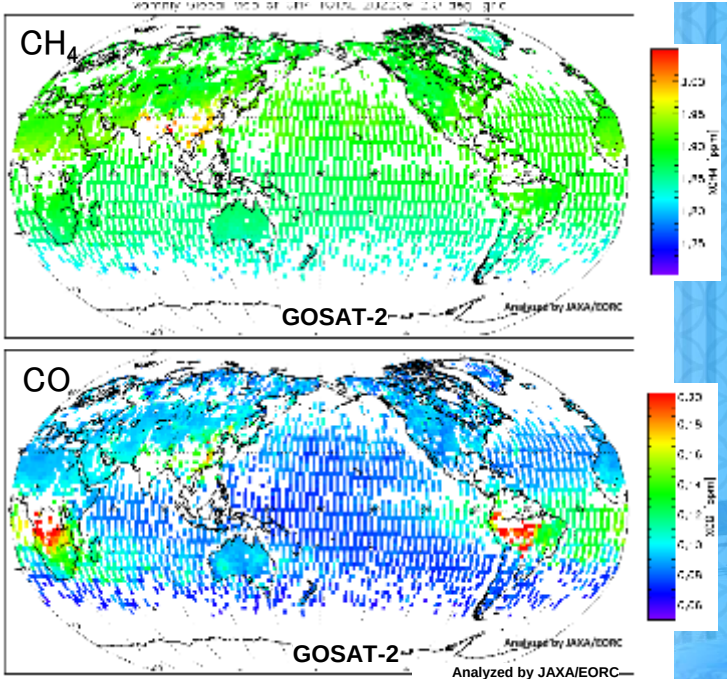
2018-Now



CO_2 Observation



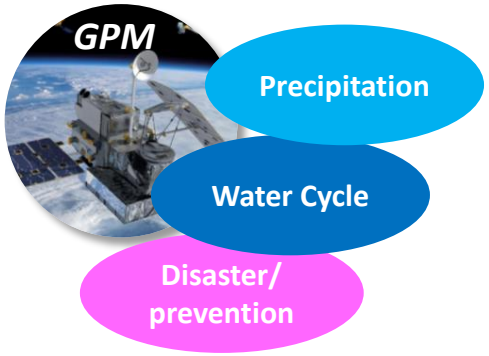
CH_4 (upper) & CO (lower) Observation



Global CO_2 concentrations observed by GOSAT and GOSAT-2, CH_4 and CO (September 2022)

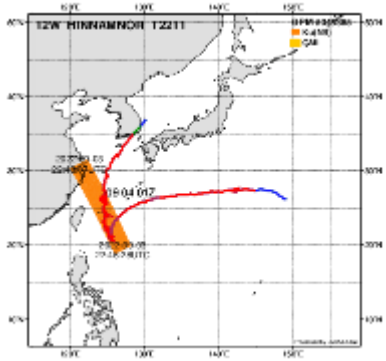
2009-2022 seasonal variation and year-to-year increase of global CO_2 observed by GOSAT.

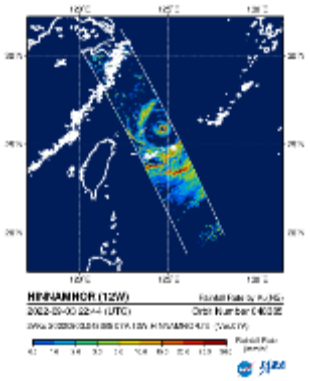
Utilization of Precipitation Radar in NWP: Assimilation of 3D information derived by GPM/DPR in JMA

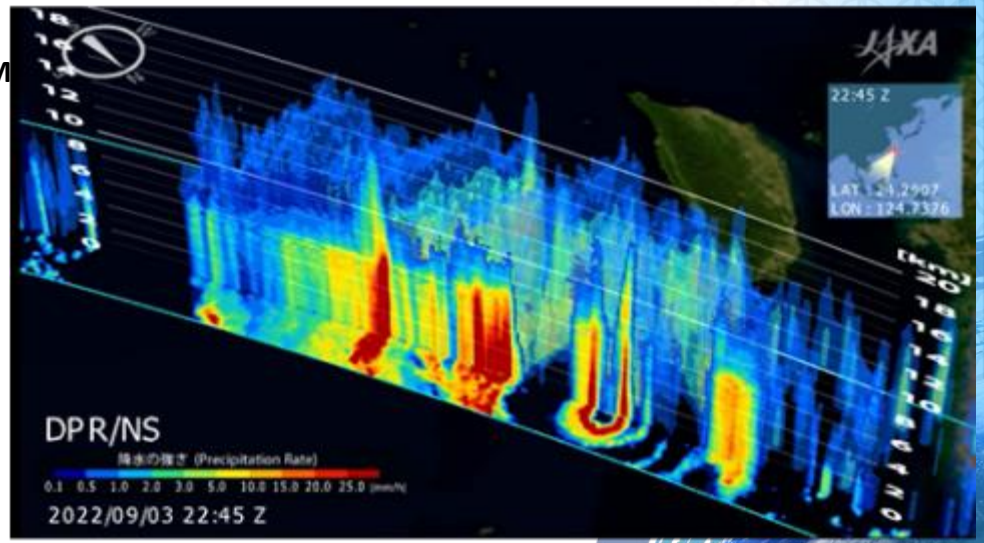


- The Japan Meteorological Agency (JMA) started the Global Precipitation Measurement Mission (GPM) / Dual-frequency Precipitation Radar (DPR) assimilation in the meso-NWP system on March 24, 2016 (https://doi.org/10.1002/qj.3950).
- The assimilation technique for the DPR by the JMA was improved on 30th June 2022. This included an improvement related to the scan pattern change of the DPR in May 2018.

3-D precipitation of the typhoon (Super Typhoon HINNAMNOR) by GPM in 3rd Sep.2022







GPM Core Observatory Orbit Boost

The GPM Core Observatory orbit boost on 7-8th November 2023 will extend mission lifetime.

By the orbit boost, following Impacts on the GPM/DPR are expected.

- Instrument footprints and swath widths will increase proportionately with the altitude change.
- Radar sensitivity will be reduced slightly.

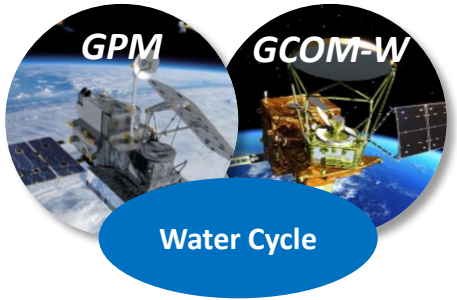
By NEC

Satellite altitude	Spatial resolution		Swath width
	Nadir (Angle-bin No. 25)	Scan edge (Angle-bin No. 1, 49)	
407km	5.04km×5.04km	5.04km×5.57km	255.8km
442km	5.48km×5.48km	5.48km×6.05km	277.9km

By Dr. Kanemaru (NICT)

Satellite alititude	FOV size	S/N change (total)
407 km	~5.0 km	
430 km	~5.3 km	- 0.64 dB
450 km	~5.6 km	- 1.11 dB

WMO Space- based Weather and Climate Extremes Monitoring (SWCEM) .



- **JAXA attends 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.**

- **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.

- In June 2022, JAXA started to distribute the GSMaP real time data (GSMaP_NOW) to the SWCEM members, corresponding to the recommendation in the Steering Group meeting (SG-SWCEM-EAWP-4) held on March 2022.
- JAXA is preparing the release of the reprocessing GSMaP data and will re-calculate the climate normal again for the WMO project using 25yr-GSMaP.

Future Missions for Climate & Water: EarthCARE (2024) & GOSAT-GW (2024)

To be launched in 2024

Cloud/ Aerosol Radiation Budget

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

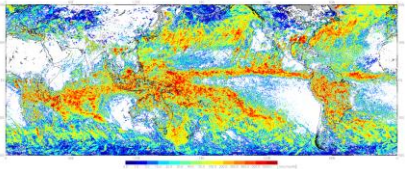
Orbit	Sun-synchronous sub-recurrent orbit Altitude: approx. 400km Inclination angle: 97.05° Local Sun Time at Desc.: 14:00 Revisit time: 25 days
Instruments	**- Cloud Profiling Radar (CPR)** by NICT & JAXA - Atmospheric Lidar (ATLID) by ESA - Multi-Spectral Imager (MSI) by ESA - Broad-Band Radiometer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

To be launched in JFY2024

Water Cycle

Green-house gases

AMSR3 for both snow & rain



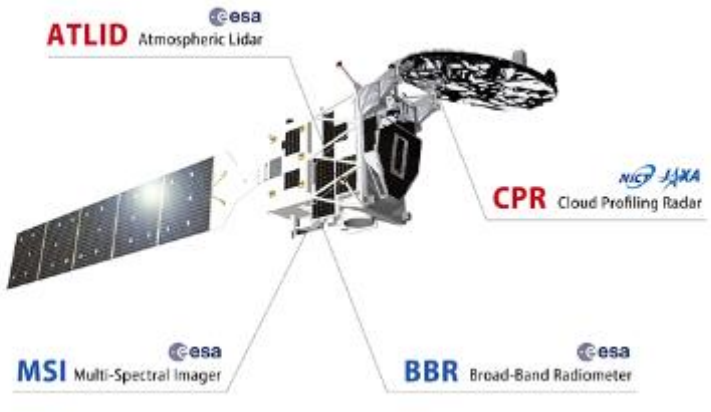
- Carrying two instruments, AMSR3 and TANSO-3.
  - AMSR3 (JAXA) will succeed AMSR series observations with adding new high frequency channels (166 & 183 GHz) for snow fall retrievals and water vapor analysis for numerical weather prediction.
  - TANSO-3 (led by Ministry of Environment in Japan) uses imaging spectrometer technology to measure CO2, CH4 and NO2 globally with medium and locally with high spatial resolution.

Orbit	Sun-synchronous sub-recurrent orbit Altitude: approx. 666km Inclination angle: 98.06° Local Sun Time at Desc.: 1:30 +/- 15 min Revisit time: 3 days
Instruments	**- Advanced Microwave Scanning Radiometer 3 (AMSR3)** **- Total Anthropogenic and Natural emissions mapping SpectrOmeter-3 (TANSO-3)** (for Ministry of Environment in Japan (MOE))
Mass	Approx. 2.6 tons at launch
Designed lifetime	**7 years**

Future Missions related to precipitation: EarthCARE (2024)
Cloud Profiling Radar with Doppler capability in EarthCARE mission

- The Earth Cloud, Aerosol and Radiation Explorer (EarthCARE) jointly with ESA and JAXA observes clouds, aerosols, and radiation on a global scale to improve the accuracy of climate change predictions.
- JAXA and NICT are developing Cloud Profiling Radar (CPR) with doppler capability.
  - It will be the world's first spaceborne W-band (94GHz) radar with doppler capability.

ESA will provide 3 sensors such as ATLID, MSI, and BBR.



Launcher: SpaceX/Falcon 9

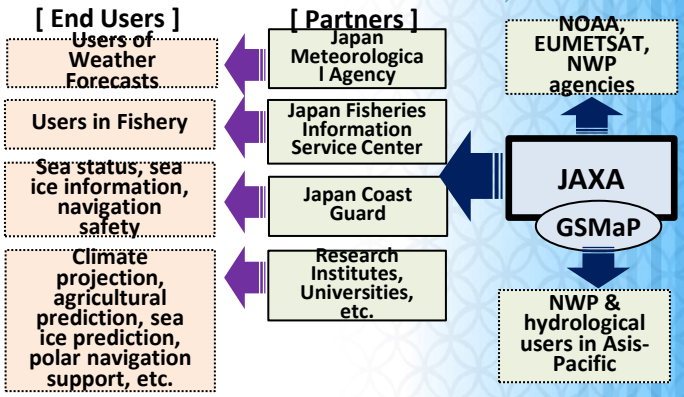
EarthCARE@Airbus（April.2021）
©Airbus

Recently, ESA/JAXA/NICT EarthCARE overview paper was published.

The EarthCARE mission – science and system overview
Tobias Wehr, Takuji Kubota, et al., *Atmos. Meas. Tech.*, 16, 3581–3608, https://doi.org/10.5194/amt-16-3581-2023, 2023

Future Missions related to precipitation: GOSAT-GW (2024)
Advanced Microwave Scanning Radiometer (AMSR) Series

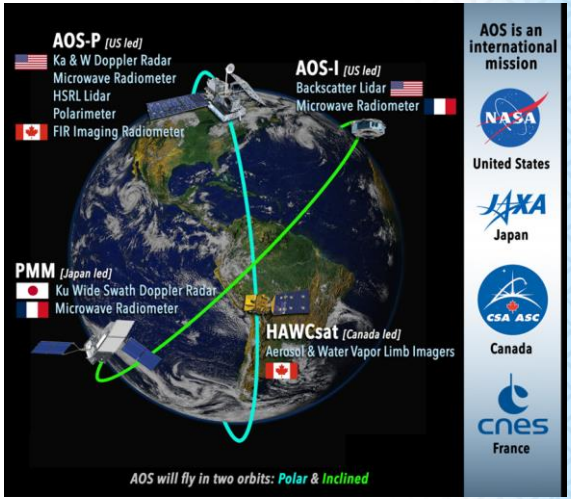
- A series of Japanese passive microwave radiometers with the world best capability with fine spatial resolution by ~2-m diameter antenna.
- Same local observation time and similar specification to achieve continuous dataset more than 20 years and will be 30 years by AMSR3.
- Widely used in operational applications as well as water cycle & climate studies.



Satellite/Sensor	ADEOS-II/AMSR	Aqua/AMSR-E	GCOM-W/AMSR2	GOSAT-GW/AMSR3
Mission Period	2002.12 - 2003.9	2002.5 - 2011.10	2012.5 - present	JFY2024 (TBD)
Altitude	803 km	705 km	700 km	666 km
Swath Width	1600 km	1450 km	1617 km	> 1530 km
Frequency (GHz)	6.9,10.65, 18,23,36,**50,52**,89	6.9,10.65, 18,23,36,89	6.9/**7.3**,10.65, 18,23,36,89	6.9/**7.3**,**10.25**/10.65, 18,23,36,89,**166**,**183**
Antenna Size	2.0 m	1.6 m	2.0 m	2.0 m
Spatial Resolution	40x70 km@6.9 GHz 8x14 km@36 GHz	43x75 km@6.9 GHz 8x14 km@36 GHz	35x62 km@6.9 GHz 7x12 km@36 GHz	34x58 km@6.9 GHz 7x11 km@36 GHz
Local Time at Asc.Node	10:30	13:30	13:30	13:30

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

JAXA PMM spacecraft
with Ku-band Doppler Precipitation Radar (KuDPR)



JAXA PMM is one of the AOS architecture

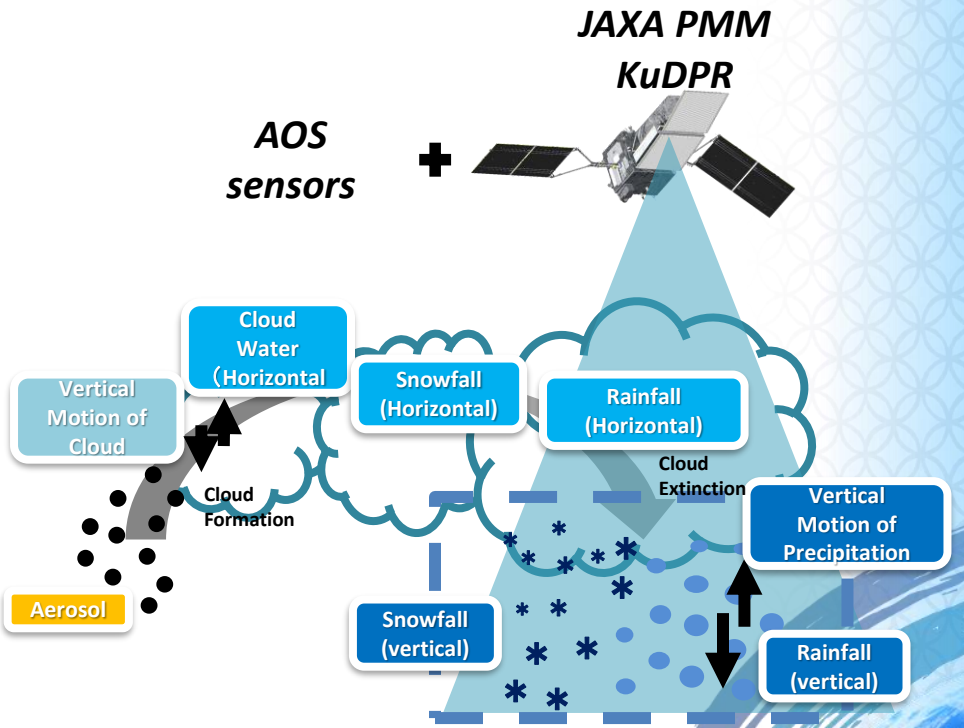
- **In June 2023, JAXA's Precipitation Measuring Mission (PMM) Project Team was established on for the Spacecraft carrying the Ku-band Doppler Precipitation Radar (KuDPR), with participation in NASA Atmosphere Observing System (AOS) mission.**
- **Implementation Plan of the "Basic Plan on Space Policy"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

Precipitation Radar in Synergy with Aerosols and Cloud Science

- JAXA's KuDPR will focus on advanced observation of precipitation.
  - Doppler velocity obs.
  - High sensitivity obs.

- International collaboration with NASA AOS mission will bring us integrated understanding of Aerosol, Cloud and Precipitation processes.

- It also enhances the mission value for improving weather/climate models in the context of international collaboration.



CGMS/IPWG-11 + GPM 10th Anniversary symposium

- **CGMS/ International Precipitation Working Group (IPWG) 11th Workshop (IPWG-11)**
  - The IPWG-11 will be held in 15(Mon)-18(Thu) July 2024 at Tokyo Institute of Technology (Tokyo Tech).
  - IPWG-11 will be hosted by JAXA.
- In addition, the GPM 10th anniversary symposium will be held on 19 (Fri) July 2024. The venue of symposium will be near the Tokyo station.

JAXA IPWG International Precipitation Working Group

First Circular – August 2023

IPWG-11 in Tokyo

The 11th workshop is organized in Tokyo following previous workshops in Madrid (2002), Monterey (2004), Melbourne (2006), Beijing (2008), Hamburg (2010), São José dos Campos (2012), Tsukuba (2014), Bologna (2016), Seoul (2018), and Fort Collins (2022).

Workshop Format

- Plenary and poster sessions will be organized by the IPWG committees based on the submitted contributions.
- These sessions will be followed ad-hoc meetings of **four Working Groups (WGs) and five Focus Groups (FGs)**.
- In parallel to the workshop, a **satellite data training event** is planned. The separate training activity will focus on new and emerging satellite technologies, sensors, and precipitation datasets.

Local logistics

- The conference will take place at **Tokyo Institute of Technology (Tokyo Tech).**
- More information at **https://www.eorc.jaxa.jp/IPWG/**

11th Workshop of International Precipitation Working Group (IPWG-11)

15-18 July 2024
Tokyo, Japan

Objectives of the Workshop

- Review the state of the art of operational and research satellite rainfall and snowfall technique and discuss remaining challenges.
- Promote topical discussions to foster improved mutual understanding.
- Recommend future directions to CGMS, WMO, GEWEX, and CEOS.

Abstract Submission

- Abstracts that deal with current operational and research precipitation estimation techniques, applications to climate and weather, data assimilation, validation, sensor calibration, and future satellite missions are encouraged. **In the IPWG-11, abstracts are encouraged that address topics in the WG/FG areas listed in "About the IPWG".**
- The abstract should be in English, approximately one half of an A4 page (details provided on the IPWG web page).
- No abstract fee is requested.

The deadline for the receipt of abstracts and registrations is 29th February 2024.

About the IPWG

The International Precipitation Working Group (IPWG) was established as a permanent Working Group of the Coordination Group for Meteorological Satellites (CGMS) in 2001.
The IPWG is co-sponsored by CGMS and the World Meteorological Organization (WMO) and focuses the scientific community on operational and research satellite based quantitative precipitation measurement issues and challenges.

In order to be more responsive to the discussions and sentiments expressed at IPWG-10, the IPWG formed **four Working Groups (WGs) and five Focus Groups (FGs).**

WG 1: Baseline Surface Precipitation Network
WG 2: Merged Satellite Precipitation Products
WG 3: Machine Learning
WG 4: CubeSat/SmallSat WG
FG 1: Orographic Precipitation
FG 2: Snowfall
FG 3: Particle Scattering
FG 4: Data Assimilation
FG 5: Land Surface

Scientific Committee

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Tomoo Ushio, Osaka Univ.
Nobuyuki Utsumi, Tokyo Tech

Please check the IPWG website.
https://www.eorc.jaxa.jp/IPWG/index.html

Summary

- JAXA operates various kind of satellite sensors and opens the products to the public.
- The recent major updates is is that the project team of Precipitation Measuring Mission (PMM), targeting the launch of JFY2028 (April 2028 to March 2029), was organized in JAXA on June 2023. JAXA would appreciate the supports by CGMS and IPWG.
- In the WMO project for monitoring extremes, JAXA contributes to the SWCEM Project by providing GSMaP rainfall product. In June 2022, JAXA started to distribute the GSMaP_NOW to the SWCEM members, corresponding to the recommendation from the Steering Group.
- JAXA also contributes to the Global Greenhouse Gas Watch (G3W) by defining the role of satellite products. In May 2023, JAXA started to distribute the latest version of JAXA/GHG products.
- The medium to long-term future plans of JAXA
  - GCOM-C has achieved the 5-year nominal mission phase and been in the post-mission phase
  - EarthCARE (a joint Japanese-European mission) will be launched in 2024, which observes clouds, aerosols, and radiation on a global scale to improve the accuracy of climate change predictions.
  - GOSAT-GW, joint mission of GOSAT-2 follow-on (TANSO-3) and GCOM-W/AMSR2 follow-on (AMSR3), is scheduled to be launched in JFY2024.