Status of Advanced Microwave Scanning Radiometer 3 (AMSR3)

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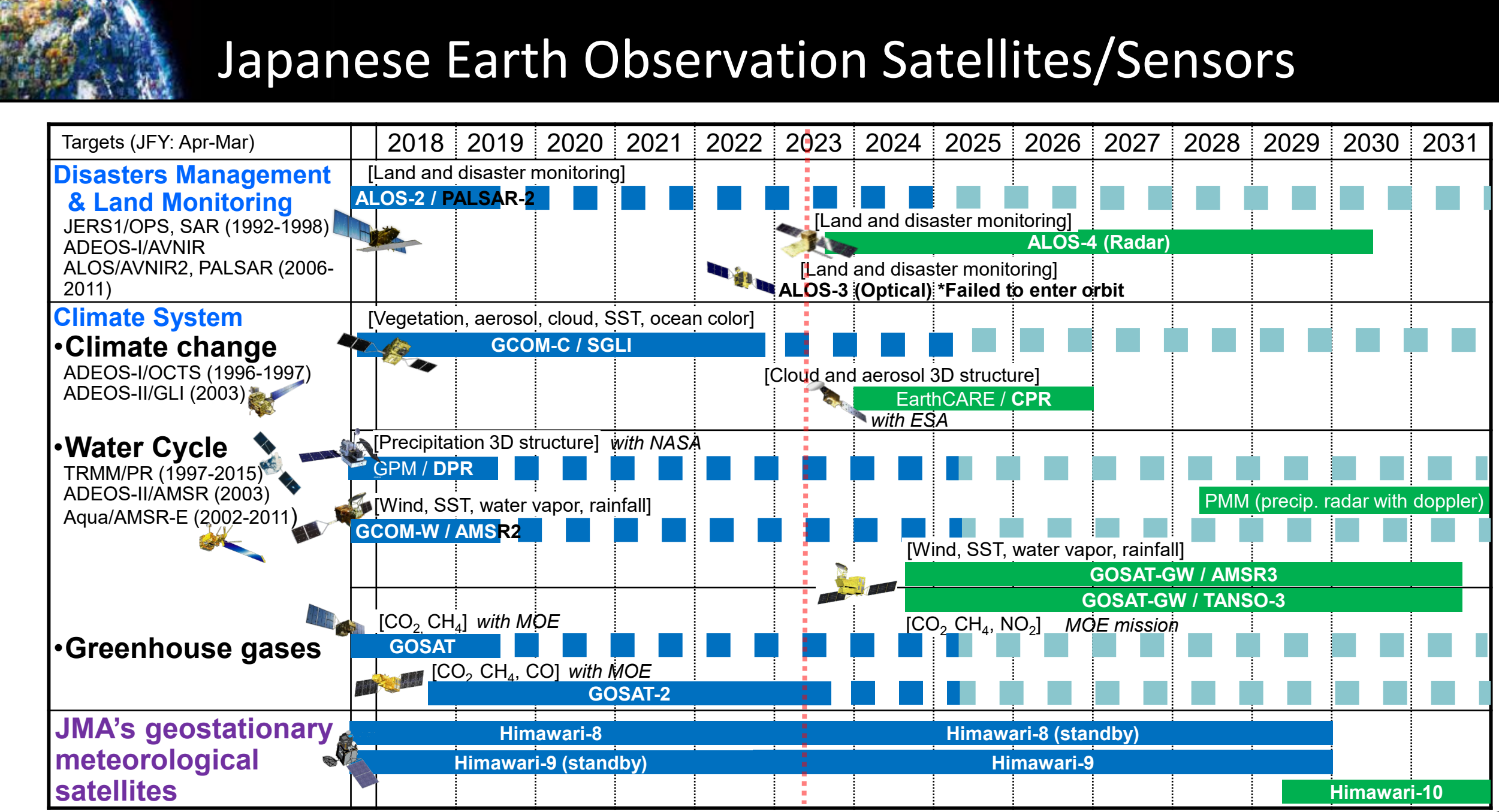
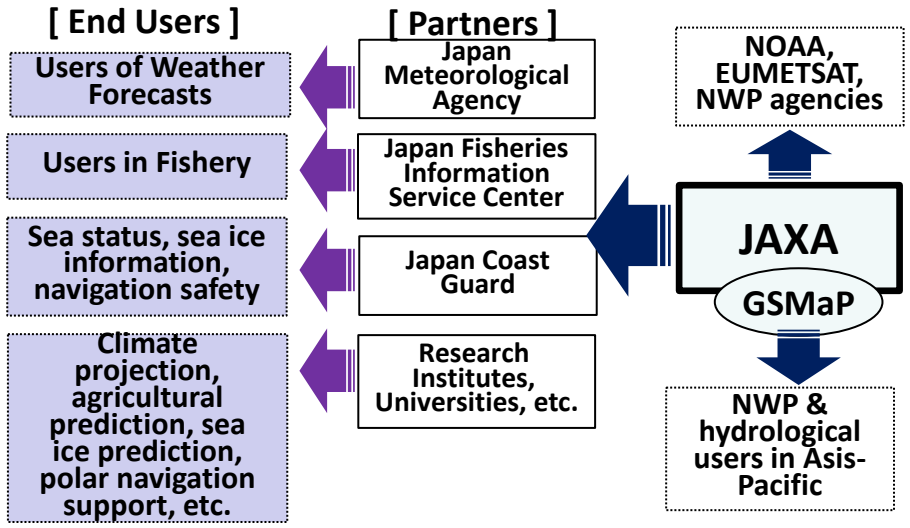
Japanese Earth Observation Satellites/Sensors



Advanced Microwave Scanning Radiometer (AMSR) Series

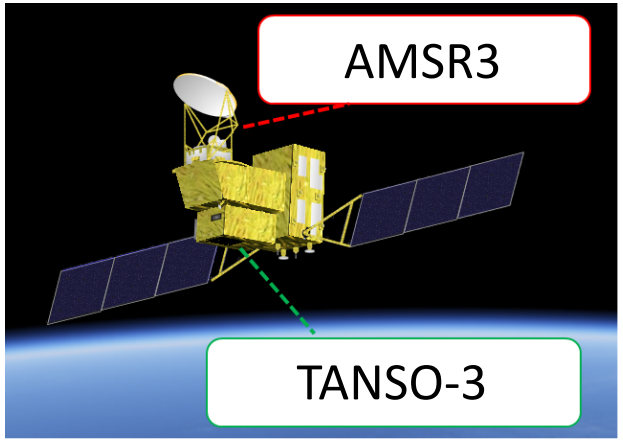
- A series of Japanese passive microwave radiometers with the world best capability with fine spatial resolution by ~2-m diameter antenna
- Same local observation time and similar specification to achieve continuous dataset more than 20 years and will be 30 years by AMSR3
- Widely used in operational applications as well as water cycle & climate studies
- MISSION TARGETS
  - Understanding of water cycle variation that came up with climate change and contributing to prediction of its impacts to civil life and actions
  - Enhancement of operational utilization of near-real time data in the area of weather forecast including hurricane analysis, fishery in coastal area and navigational assistance on arctic shipping route, etc.



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

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

AMSR3: Advanced Microwave Scanning Radiometer 3, conical scanning passive microwave radiometer succeeding GCOM-W/ AMSR2



TANSO-3: Total Anthropogenic and Natural emissions mapping SpectrOmeter-3, grating imaging spectrometer replacing the Fourier transform spectroscopy used in GOSAT-2/TANSO-FTS-2

- 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 JAXA under contract with Japanese Ministry of the Environment (MOE), will improve observation capability of greenhouse gases from GOSAT-2/TANSO-2 by choosing 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
  - Jun. 2023: CDR of GOSAT-GW satellite system
  - Currently, spacecraft integration has been started and AMSR3 flight components are manufacturing and testing

Satellite Specification (Compared with ref. satellites)

Name	GOSAT-GW	GCOM-W (SHIZUKU)	GOSAT-2 (IBUKI-2)
Mission instruments	TANSO-3 AMSR3	AMSR2	TANSO-FTS-2 TANSO-CAI-2
Spacecraft launch Mass	2.6 t	2 t	1.8 t
Power generation (EOL)	5.3 kW	3.9 kW	5.0 kW
Designed lifetime	7 years	5 years	5 years
Orbit type	Synchronous sub-recurrent orbit		
Altitude	666km (Same as GOSAT)	699.6km	613km
Recurrent period	3 days (Same as GOSAT)	16 days	6 days
Local Sun Time	Ascending node: 13:30±15 minutes (Same as GCOM-W)	Ascending node: 13:30±15 minutes	Descending node: 13:00±15 minutes
Launch date	JFY 2024 (Apr.2024-Mar.2025) (planned)	May 18, 2012	October 29, 2018

GOSAT-GW/AMSR3 Sensor Specification

AMSR3 sensor in production.
Photo: AMSR3 Main Reflector at Tsukuba Space Center

AMSR3 Channel Sets

Center frequency [GHz]	Polari-zation	Band width [MHz]	NEDT (1σ)	Beam width (spatial resolution)
6.925 7.3	H/V	350	< 0.34 K	1.8° (34km x 58km)
10.25	**H/V**	**500**	**< 0.34 K**	**1.2° (22km x 39km)**
10.65	H/V	100	< 0.70 K	1.2° (22km x 39km)
18.7	H/V	200	< 0.70 K	0.65° (12km x 21km)
23.8	H/V	400	< 0.60 K	0.75° (14km x 24km)
36.5 **→36.42**	H/V	**1000** **→840**	< 0.70 K	0.35° (7km x 11km)
89.0 A/B	H/V	3000	< 1.20 K	0.15° (3km x 5km)
165.5	**V**	**4000**	**< 1.50 K**	**AZ=0.23° / EL=0.30° (4km x 9km)**
183.31±7	**V**	**2000×2**	**< 1.50 K**	**AZ=0.23° / EL=0.27° (4km x 8km)**
183.31±3	**V**	**2000×2**	**< 1.50 K**	**AZ=0.23° / EL=0.27° (4km x 8km)**

Red: Changes from AMSR2 including additional CHs

Add to improve temperature resolution (NEDT) in high-resolution SST

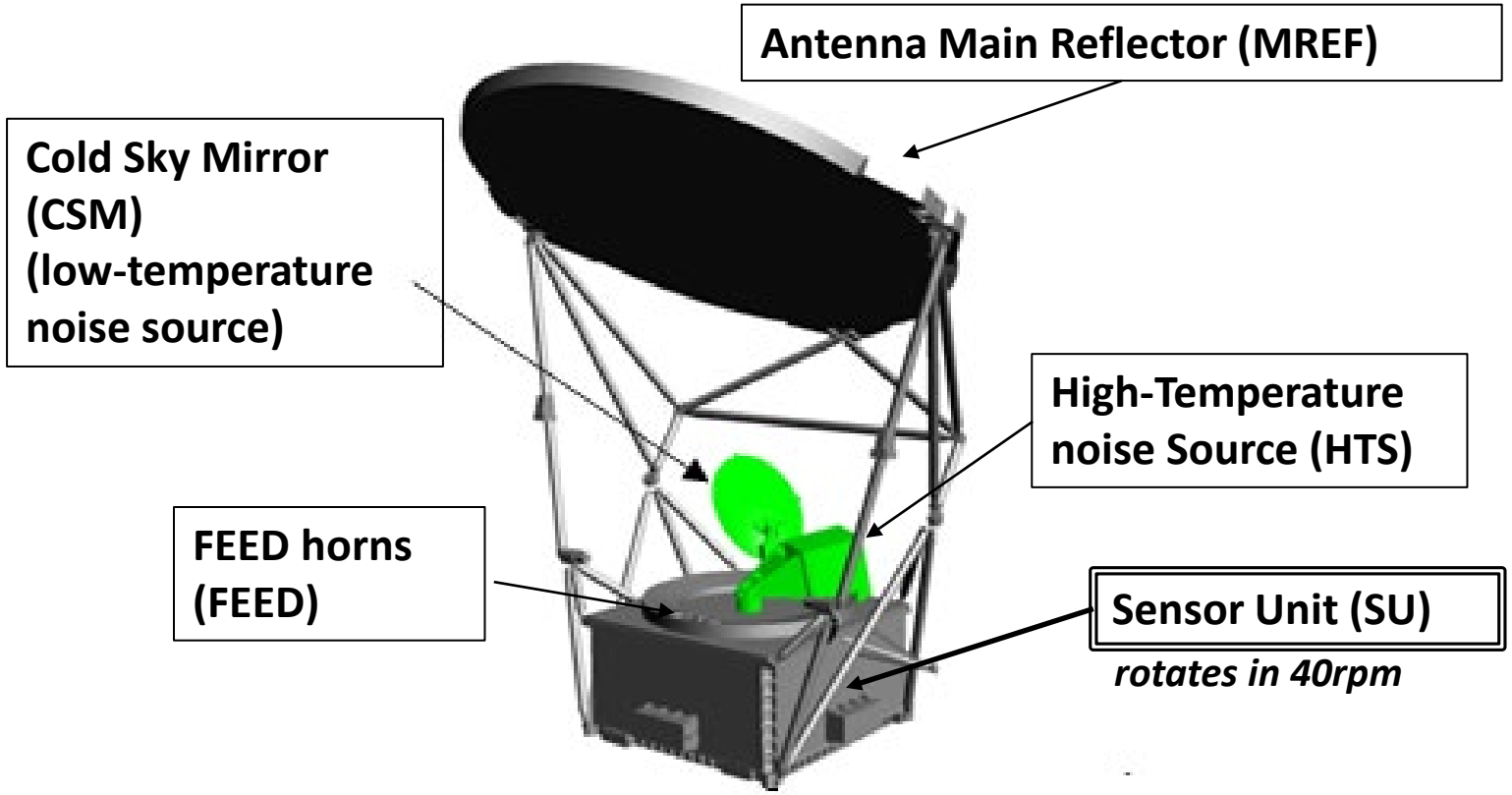
Modify to reduce possible risks of RF interferences from the 5G communication systems

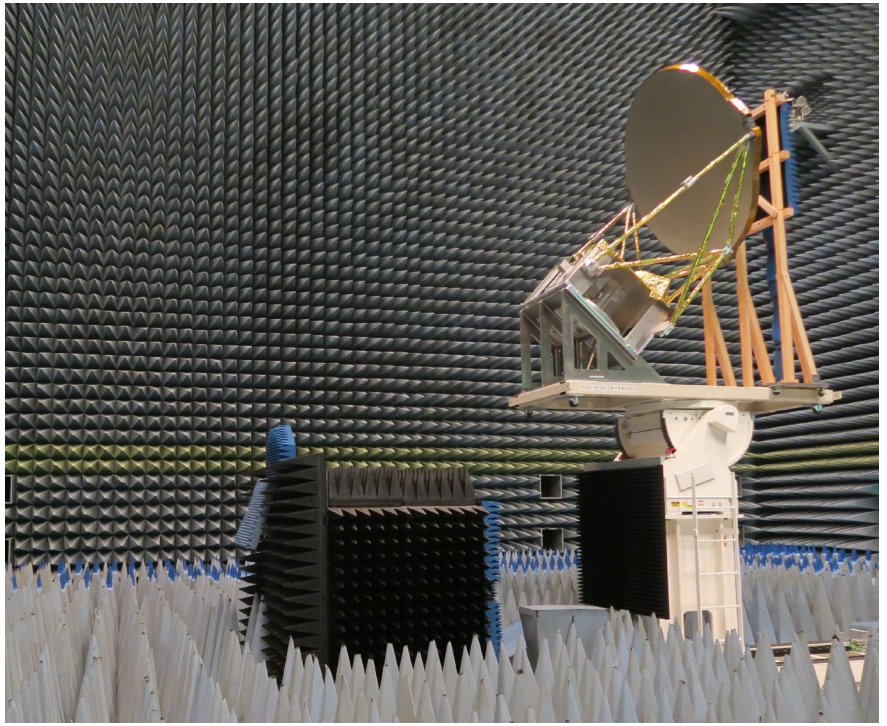
Add to get snowfall and water vapor in higher levels

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

AMSR3 hardware and Tests





Antenna pattern measurement with MREF and Feed. Radiation characteristics for channels below 89 GHz were verified.

	Test items
Component proto-flight test / acceptance test	electrical function test / vibration test / thermal vacuum test (or thermal cycle test) / electromagnetic compatibility test / mechanical inspection
Combinational test	antenna pattern with MREF and CSM / antenna pattern with MREF and Feed
AMSR3 proto-flight test	electrical function test (including RF characteristics) / alignment test / mass properties test / antenna deployment test/ thermal balance and thermal vacuum test / sinusoidal vibration test / modal survey test / acoustic test / shock test / antenna rotation test /mechanical inspection

List of AMSR3 Standard Products (as of Jul. 2023)

Product	Area	Status in AMSR2
Brightness Temperature (L1B)	Global	Released (V2.2)
Resampled Brightness Temperature (L1R)	Global	Released (V2.2)
Integrated Water Vapor Content (ocean & land)	Global Ocean & Land (except vegetation/ice area)	Ocean: Released (V2.2) by H. Murata & M. Kazumori Land: Released (V1) as research product by H. Murata & M. Kazumori
Integrated Cloud Liquid Water Content	Global Ocean	Released (V2.2) by H. Murata
Precipitation (rainfall & snowfall) * to be consistent to GSMaP	Global	Rainfall: Released (V3.1) by K. Aonashi Snowfall: Under development for AMSR3 by G. Liu
Sea Surface Temperature (6GHz, 10GHz, multi-band)	Global Ocean	6GHz: Released (V4.1) by A. Shibata 10GHz & multi-band: Released (V4.1) as research product
Sea Surface Wind Speed	Global Ocean	Released (V4) by A. Shibata
All-weather Sea Surface Wind Speed	Global Ocean	Released (V3) as research product by A. Shibata
Sea Ice Concentration	High-lat. Ocean	Released (V3) by K. Cho & J. Comiso
High-resolution Sea Ice Concentration	High-lat. Ocean	Released (V1) as research product by G. Spreen
Snow Depth	Global Land	Released (V2) by R. Kelly * New version for AMSR3 was released as research product
Soil Moisture Content	Global Land	Released (V3) by H. Fujii * New version for AMSR3 was released as research product

* Sea Ice Motion Vector by K. Shimada is being considered to upgrade from research to standard product.

Mission Targets (1): Atmosphere & Ocean

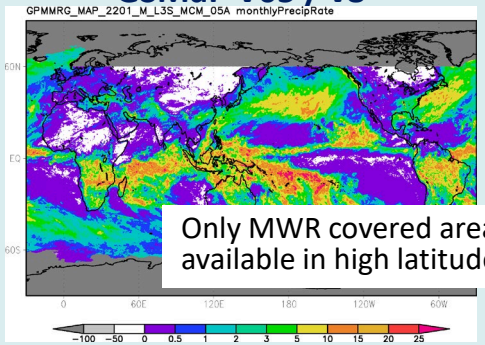
ATMOSPHERE TARGETS

- Highly-developed observation of **cloud-precipitation microphysics and prediction of extreme events** related to cloud and precipitation, advancement of GSMaP (refinement of rain/snow observation)
- Improvement of **cloud-precipitation process** in numerical model, impacts of global warming to typhoons

Precipitation algorithm is being developed under close collaboration with GPM/GSMaP, global precipitation map.
Snowfall algorithm developed for AMSR3 will be also applied to future GSMaP.
See TPW comparison results at **Poster 5.18** (by K. Ohara).

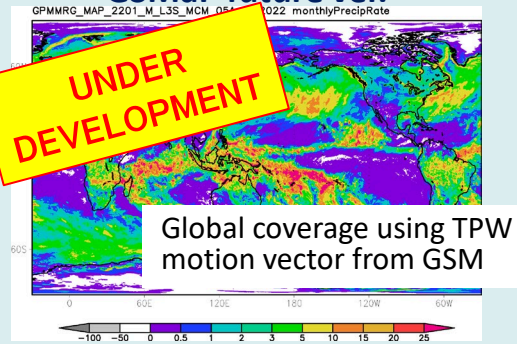
Currently developing new GSMaP algorithm to extent global coverage including polar region by using model TPW motion vector for outside of GEO-IR coverage. Estimate of precipitation over ice surface will be also possible.

GSMaP V05 / v8



Only MWR covered area is available in high latitudes

GSMaP future ver.



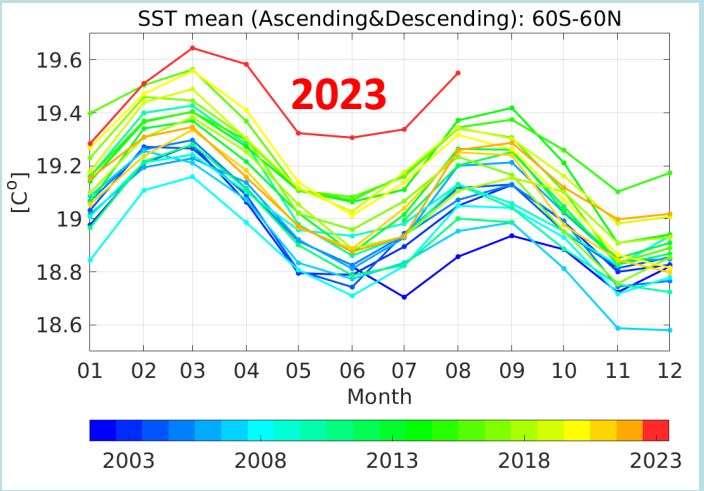
Global coverage using TPW motion vector from GSM

OCEAN TARGETS

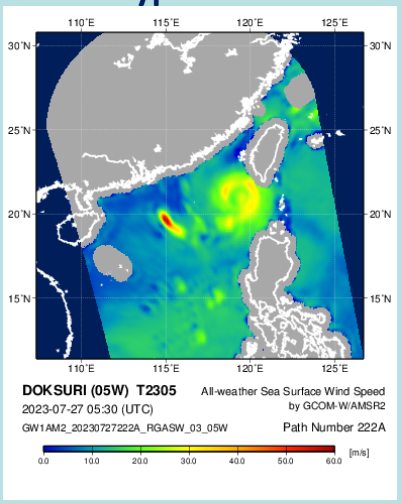
- Quantitative understanding of **atmosphere-ocean fluxes**, impacts of air-sea interactions to local scale

Cloud-free and fine-resolution SST and sea surface wind speed data are unique and critical for NWP, typhoon analysis and ocean state monitoring.
Recent anomalous warming of SST can be clearly seen by AMSR's +20 years dataset.

AMSR-E/2 global (60N-60S) monthly SST variation for 2002-2023



AMSR2 all-weather sea surface wind speed under Typhoon#5 in 2023



Mission Targets (2): Land & Cryosphere

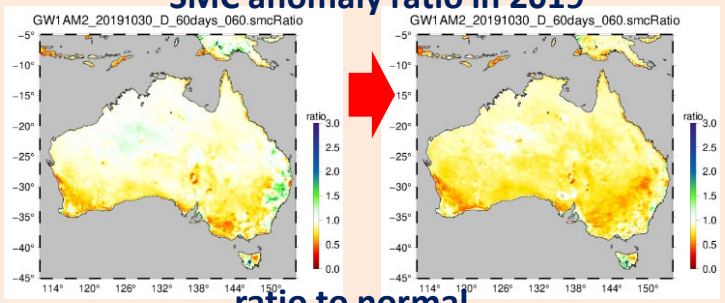
LAND TARGETS

- Highly-developed **land model and land surface microwave radiative transfer computation**, improvement of prediction of water cycle over land by refined rain/snow observation
- Clarification and modeling of **ecosystem-water cycle process over land**

Cloud-free and fine-resolution land surface information is important for land surface simulation.
Soil moisture content (SMC) and land surface temp. (LST) are used to make outlook and prediction of essential grain yield as food security.

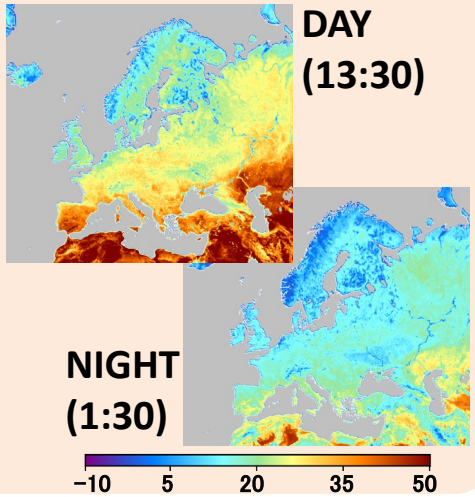
AMSR2 research SMC (developed for AMSR3) uses dynamic vegetation coverage as reference while standard SMC uses monthly climatology.

AMSR2 standard (left) and research (right) SMC anomaly ratio in 2019



ratio to normal

AMSR2 LST in July 2023

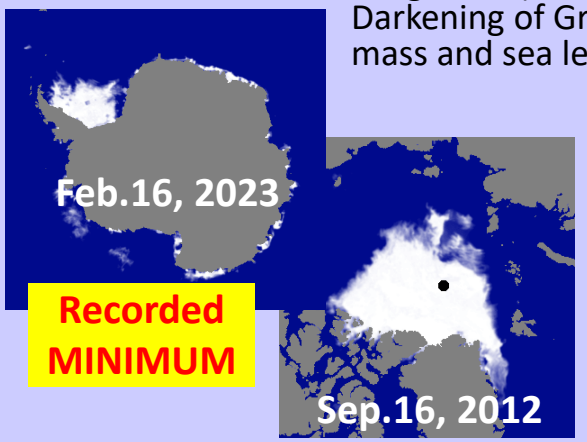


CRYOSPHERE TARGETS

- **Monitoring of variation in Polar environment** and clarification of water budget mechanism, improvement of prediction of sea ice/land snow in short-middle time scale
- **Prediction of variation of Polar region and sea ice** in middle-long time scale including impacts by global warming

Frequent & cloud-free sea ice information (concentration, motion vector, and thickness) contributes to monitor and predict climate & environmental changes.
Monitoring of Greenland ice sheet melting also conducted close collaboration with GCOM-C (optical).

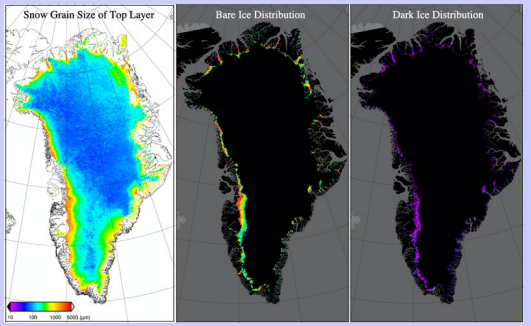
AMSR2 Sea Ice Concentration



JAXA monitors changes of snow and sea ice coverage. Long-term (>40-year) Sea Ice data set are available. Darkening of Greenland may cause loss of ice sheet mass and sea level rise.

kuroshio.eorc.jaxa.jp/JASMES/climate/

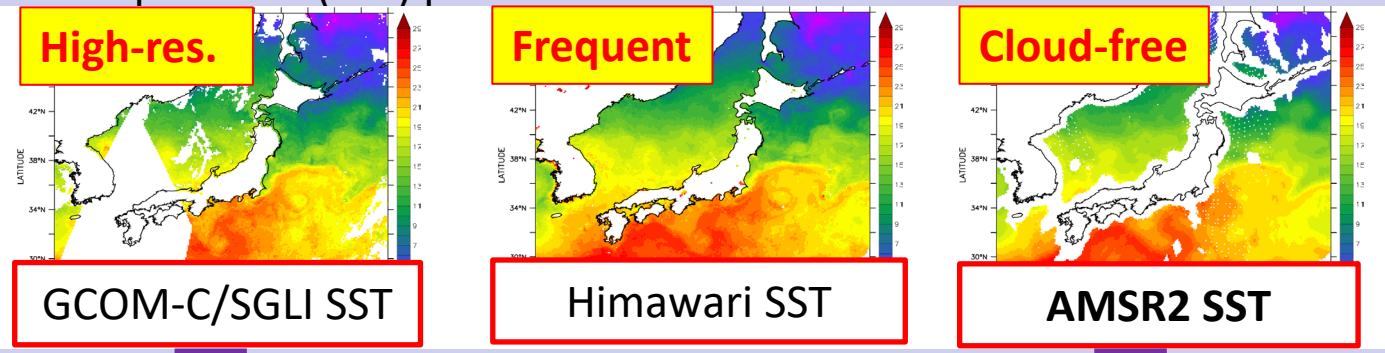
Greenland Ice Sheet Monitoring



www.eorc.jaxa.jp/JASMES/daily/GLmonitor/

Mission Targets (3): Integrating Satellite & Numerical Model – Ocean Analysis & Forecast –

JAXA: Satellite Sea Surface Temperature (SST) products

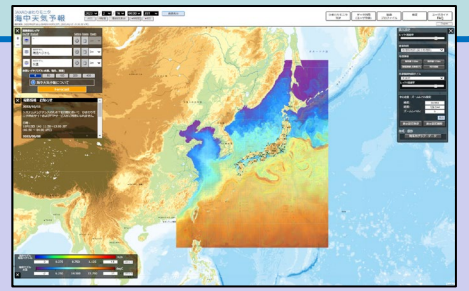


To produce frequent SST datasets without missing and/or gaps

JAMSTEC: JCOPE-T DA (Miyazawa *et al.*, 2022)

"Ocean Weather Forecast"

- **Short-range (10-day) forecast** of ocean status by assimilating satellite SST data, etc.
- High-resolution (3 km -> 1km -> 200m) around Japan
- Operational processing at JAMSTEC to provide current status & forecast

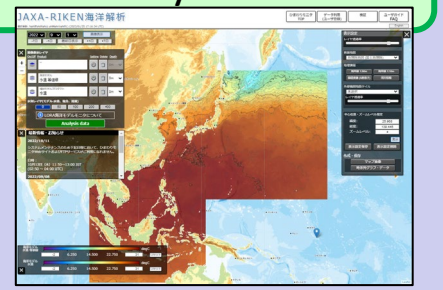


Provide model output images & SST from JAXA Web site (https://www.eorc.jaxa.jp/ptree/ocean_model/)

RIKEN: LORA (Ohishi *et al.*, 2022a, 2022b, 2023)

"JAXA-RIKEN Ocean Analysis"

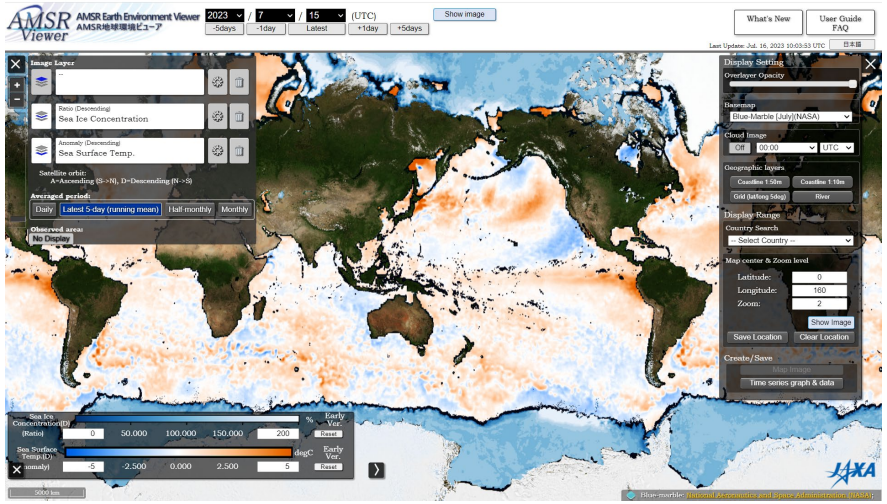
- LETKF-based Ocean analysis with **128 ensemble** members by assimilating satellite SST data, etc.
- 0.1-degree grid resolution over West North Pacific and Maritime Continent
- Processing at JAXA with 1- or 2-month delays



Provide model output images & data from JAXA Web site (https://www.eorc.jaxa.jp/ptree/LORA/)

Concluding Remarks

- AMSR series and upcoming AMSR3
  - AMSR series has achieved **more than 20-year observations** by 6.9-89 GHz channels with large-size real antenna
  - **AMSR3 to be launched in JFY2024** will have **new 166 and 183 GHz** for snowfall retrievals and water vapor analysis in NWP, and contribute to produce AMSR series Climate Data Records (CDR) of 30-year
  - Algorithms for AMSR3 geophysical products in atmosphere, ocean, land and cryosphere are under development with selected principal investigators (PIs) including **collaboration with model community**
  - Recently updated **the AMSR Viewer**, an interactive web browsing tool for the AMSR series, enabling to display average, anomaly and climatology (https://www.eorc.jaxa.jp/AMSR/viewer)



- Data release plan for AMSR3
  - Data format will be **HDF5-compatible NetCDF4**, including Level 3 in EASE GRID2 in addition to Equal Lat-Lon & Polar-stereo
  - **Near-real-time data distribution** will be available (regional data at direct receiving stations & global data with latency of 2-3 hours)
  - Product will be **released to the public about one year after the launch**. **Early data access** will be available to the selected PIs by the research announcement (EORA) and partner agencies during CAL/VAL phase
  - **Next research announcement (EORA4, JFY2025-2027)** for JAXA's EO missions including AMSR3 & GCOM-W will be called in the summer 2024