

Space-based observations of water-related variables by the Advanced Microwave Scanning Radiometer (AMSR) series and its applications

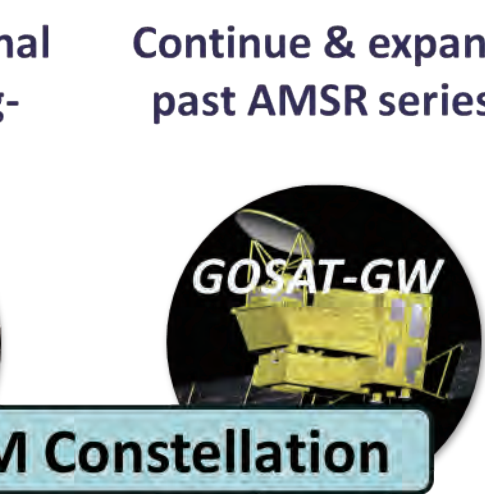
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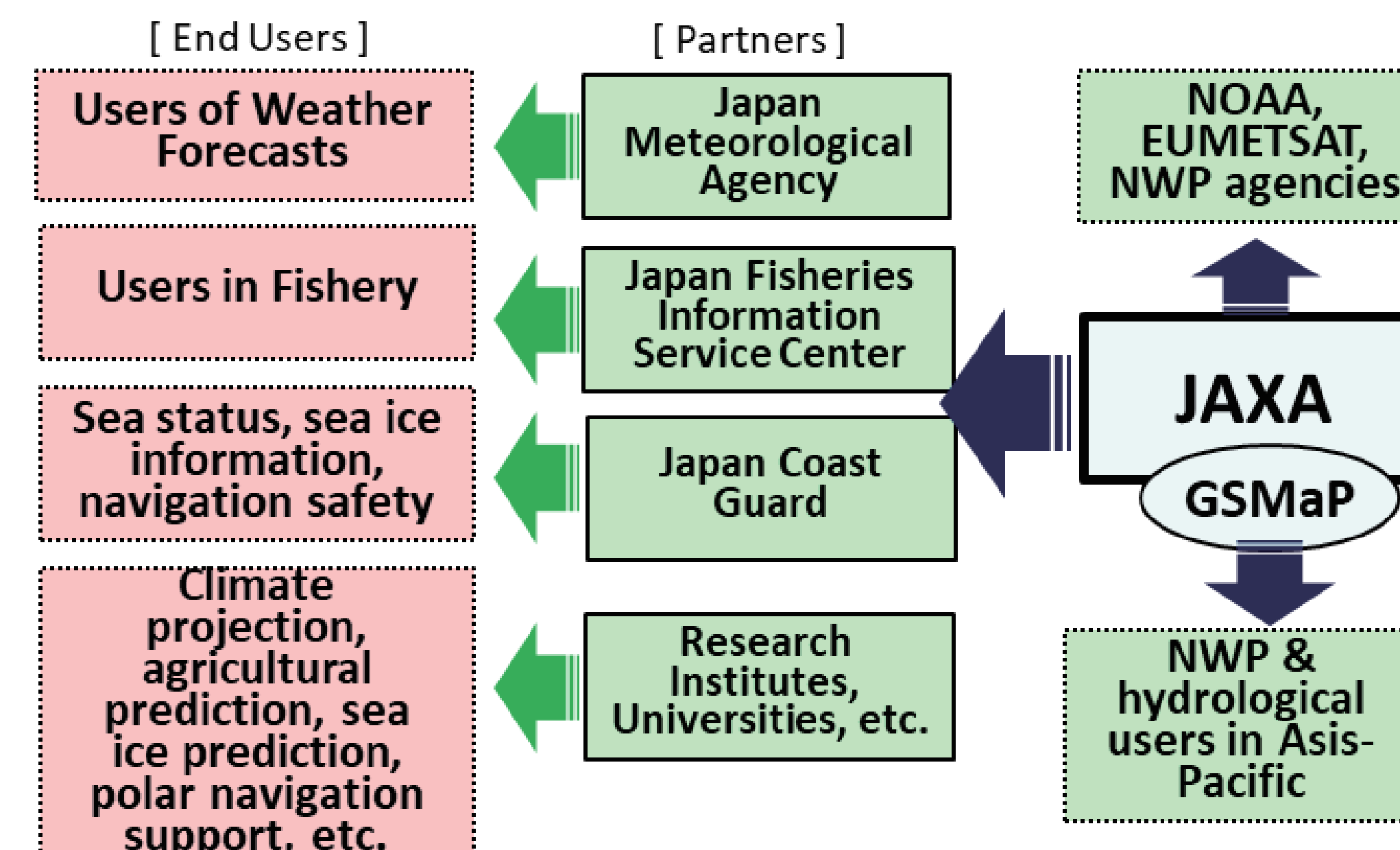
The Advanced Microwave Scanning Radiometer (AMSR) Series

- AMSR series: AMSR, AMSR-E, AMSR2, and future AMSR3
 - Microwave channels of 6.9-89GHz enable to observe water-related variables 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
- Widely used in operational applications (c.f., numerical weather prediction, tropical cyclone analysis, SST analysis, sea ice analysis and fisheries) as well as water cycle variation & climate change studies

- Multi-frequency in 6.9-89 GHz
- Fine resolution with large size antenna
- Global observation



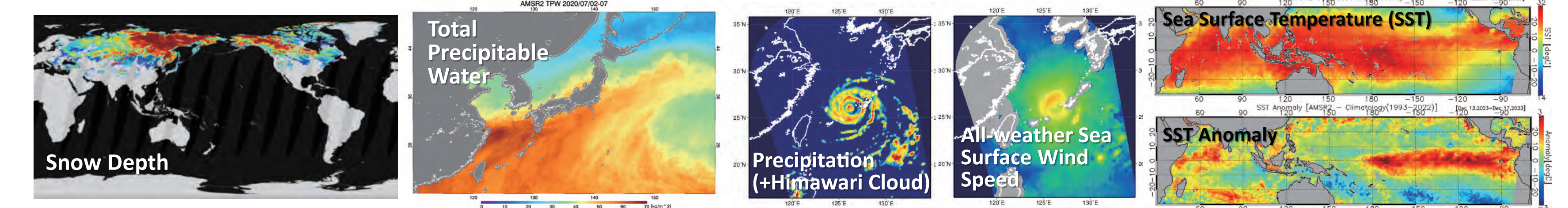
Sensor	AMSR	AMSR-E	AMSR2	AMSR3
Mission Period	2002.12-2003.9	2002.5-2011.10	2012.5-present	JFY2024
Altitude	803 km	705 km	700 km	666 km
Swath Width	1600 km	1450 km	1617 km	> 1530 km
Frequency (GHz)	6.9,10,18,23,36,50,52,89	6.9,10,18,23,36,89	6.9/7.3,10.65,18,23,36,89	6.9/7.3,10.25/10.65,18,23,36,89,166,183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



List of current AMSR2 Products

Standard Product	Area	Developer	Status
Brightness Temperature	Global	JAXA	Released (V2.2)
Integrated Water Vapor Content	Global Ocean	M. Kazumori	Released (V2.2)
Integrated Cloud Liquid Water Content	Global Ocean	M. Kazumori	Released (V2.2)
Precipitation (rainfall)	Global (except high-lat)	K. Aonashi	Released (V3.1) in Jul. 2023
Sea Surface Temperature (SST)	Global Ocean	A. Shibata	Released (V4.11) in Apr. 2024
Sea Surface Wind Speed	Global Ocean	A. Shibata	Released (V4)
Sea Ice Concentration	High-lat. Ocean	J. Comiso & K. Cho	Released (V3) → Minor update in JFY2024
Snow Depth	Global Land	R. Kelly	Released (V2) → Updated version in Sep. 2022 as research product
Soil Moisture Content	Global Land	T. Koike & H. Fujii	Released (V3) → Updated version in Sep. 2022 as research product

Research Product	Area	Developer	Status
All-weather Sea Surface Wind Speed	Global Ocean	A. Shibata	Released (V3)
High-resolution SST (10GHz)	Global Ocean	A. Shibata	Released (V4.11)
Multi-band SST	Global Ocean	A. Shibata	Released (V4.11)
Soil Moisture Content & Vegetation Water Content by Land Data Assimilation	Global Land (non snowfall region)	Y. Sawada	Released (V1) in Mar. 2024 → see ACG36-17
Land Surface Temperature	Global Land	T. Jackson & R. Bindlish	Released (V1)
Vegetation Water Content	Global Land	S. Paloscia	Validated in JAXA
High-resolution Sea Ice Concentration	High-lat. Ocean	G. Heygster & G. Spreen	Released (V1)
Thin Ice Detection	High-lat. Ocean	K. Cho	Released (V1)
Sea Ice Motion Vector	High-lat. Ocean	K. Shimada & N. Kimura	Released (V1) → S.H in JFY2024
Integrated Water Vapor Content over Land	Global Land	M. Kazumori	Released (V1)
Thin Ice Thickness (Thermal Ice Thickness)	High-lat. Ocean	K. Ohshima	Released (V1) in Mar. 2024
Sea Ice Thickness (<=20cm)	High-lat. Ocean	K. Shimada, K. Tateyama	Under development



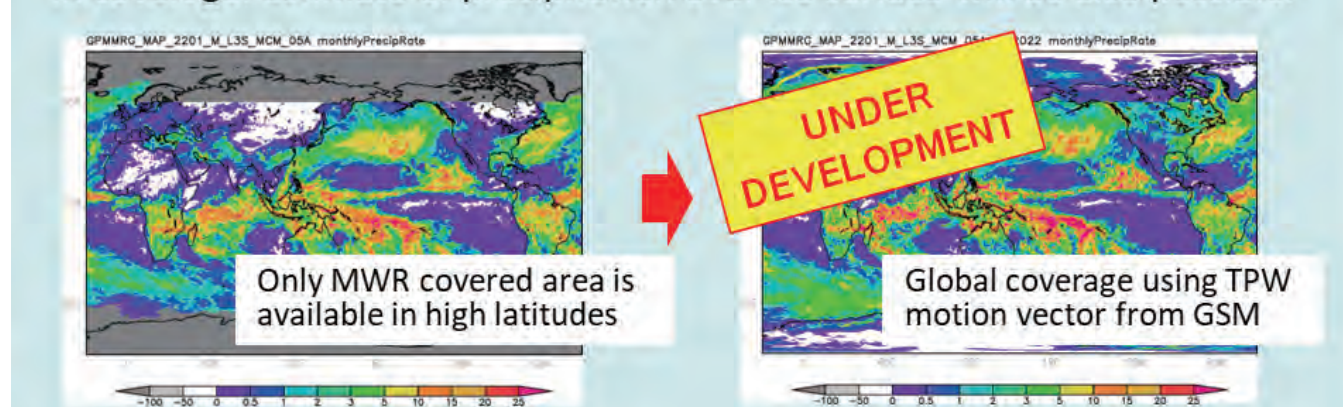
Mission Targets of the AMSR Series

ATMOSPHERE TARGETS

- Highly-developed observation of cloud-precipitation microphysics and prediction of extreme events related to cloud and precipitation, advancement of GSeMaP (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/GSeMaP, global precipitation map. Snowfall algorithm developed for AMSR3 will be also applied to future GSeMaP.

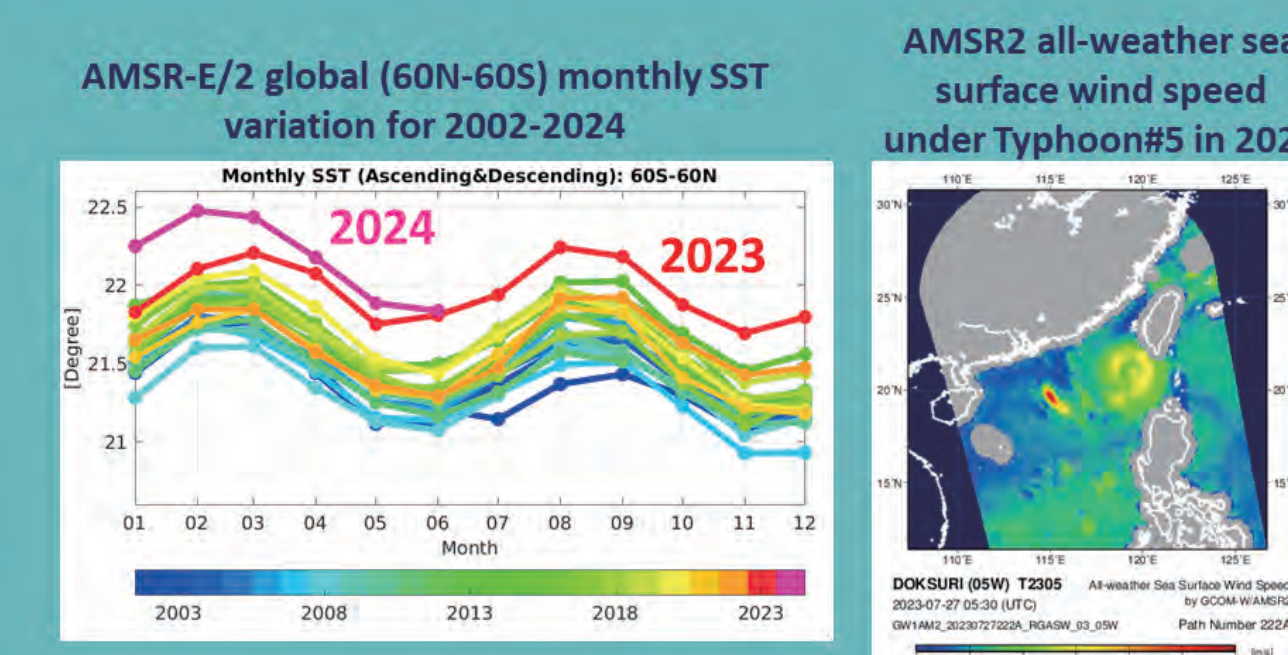
Currently developing new GSeMaP algorithm to extent global coverage including polar region by using model TPW motion vector for outside of GEO-IR coverage. Estimate of precipitation over ice surface will be also possible.



OCEAN TARGETS

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

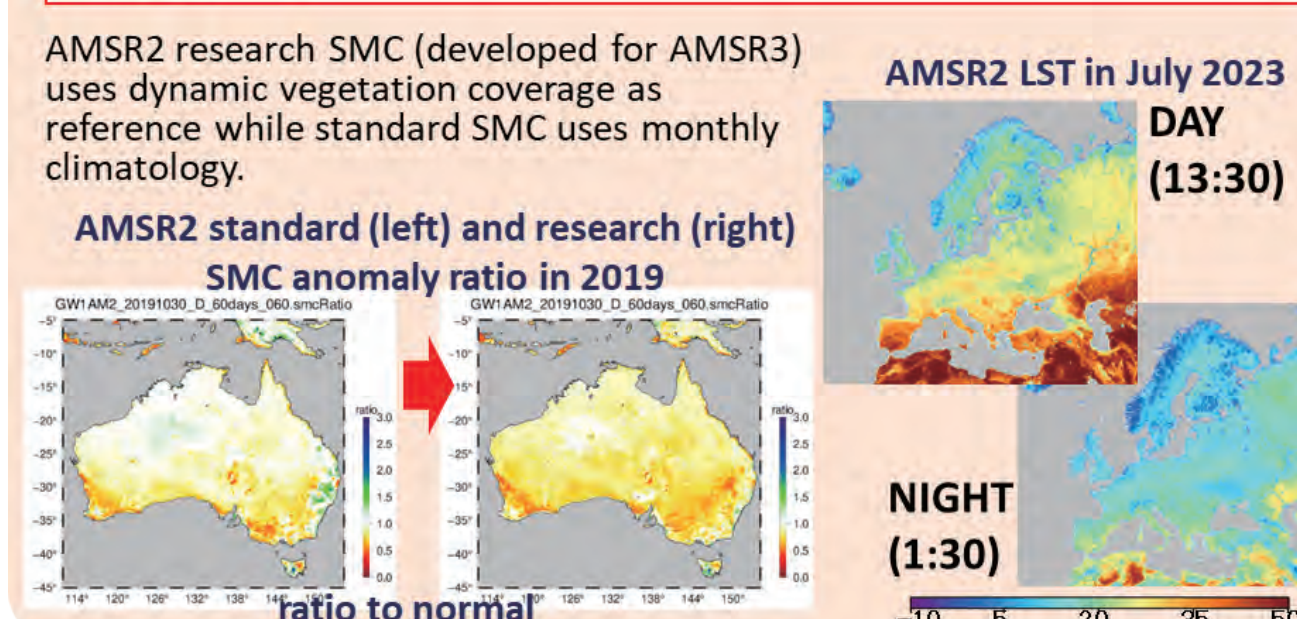
Cloud-free and fine-resolution SST and sea surface wind speed data are unique and critical for NWP, typhoon analysis and ocean state monitoring. Recent anomalous warming of SST can be clearly seen by AMSR's +20 years dataset.



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

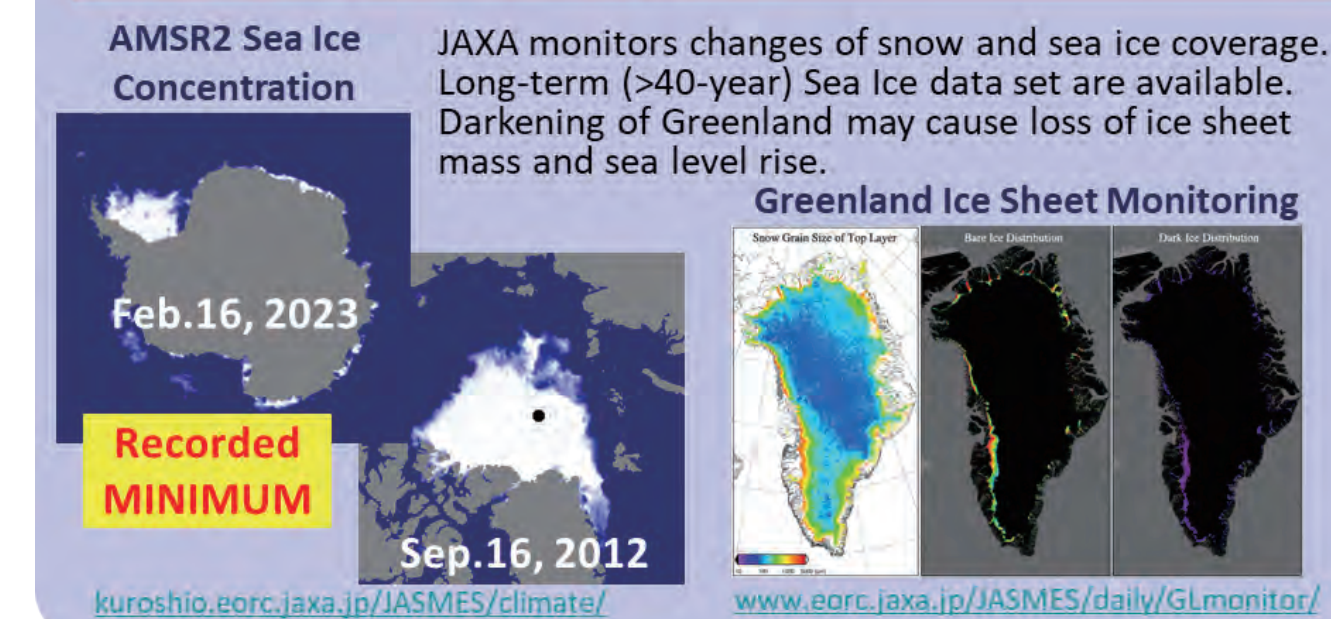
Cloud-free and fine-resolution land surface information is important for land surface simulation. Soil moisture content (SMC) and land surface temp. (LST) are used to make outlook and prediction of essential grain yield as food security.



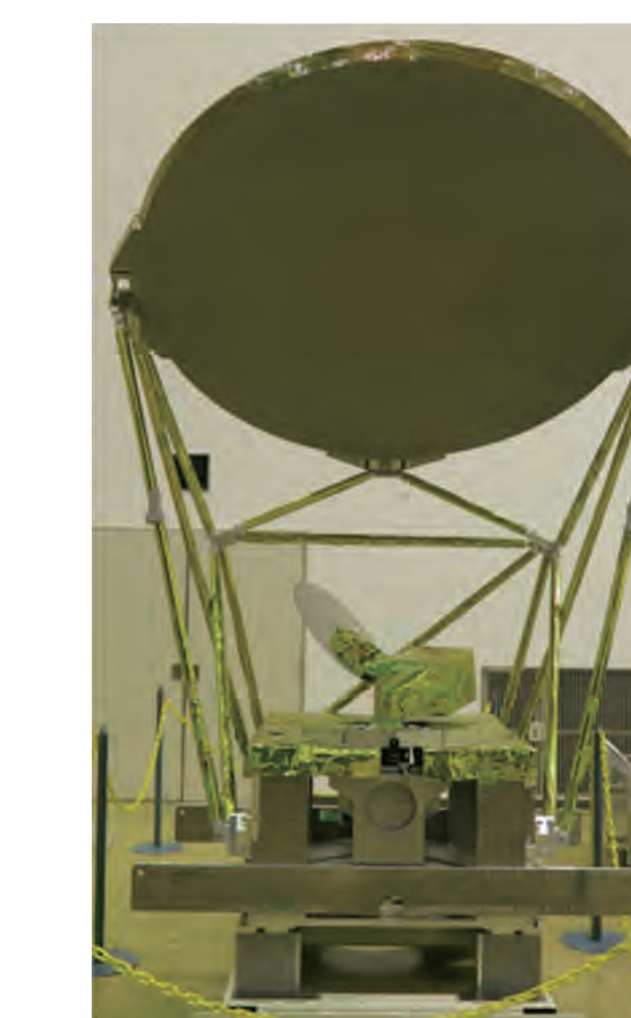
CRYOSPHERE TARGETS

- 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).



AMSR3 onboard GOSAT-GW in JFY2024



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

Center frequency [GHz]	Polarization	Bandwidth [MHz]	NEDT (1σ)	Beam width (spatial resolution)
6.925	H/V	350	< 0.34 K	1.8° (33km x 57km)
7.3	H/V	350	< 0.43 K	1.8° (33km x 57km)
10.25	H/V	500	< 0.33 K	1.2° (22km x 38km)
10.65	H/V	100	< 0.70 K	1.2° (22km x 38km)
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)
36.42	H/V	840	< 0.70 K	0.35° (6km 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

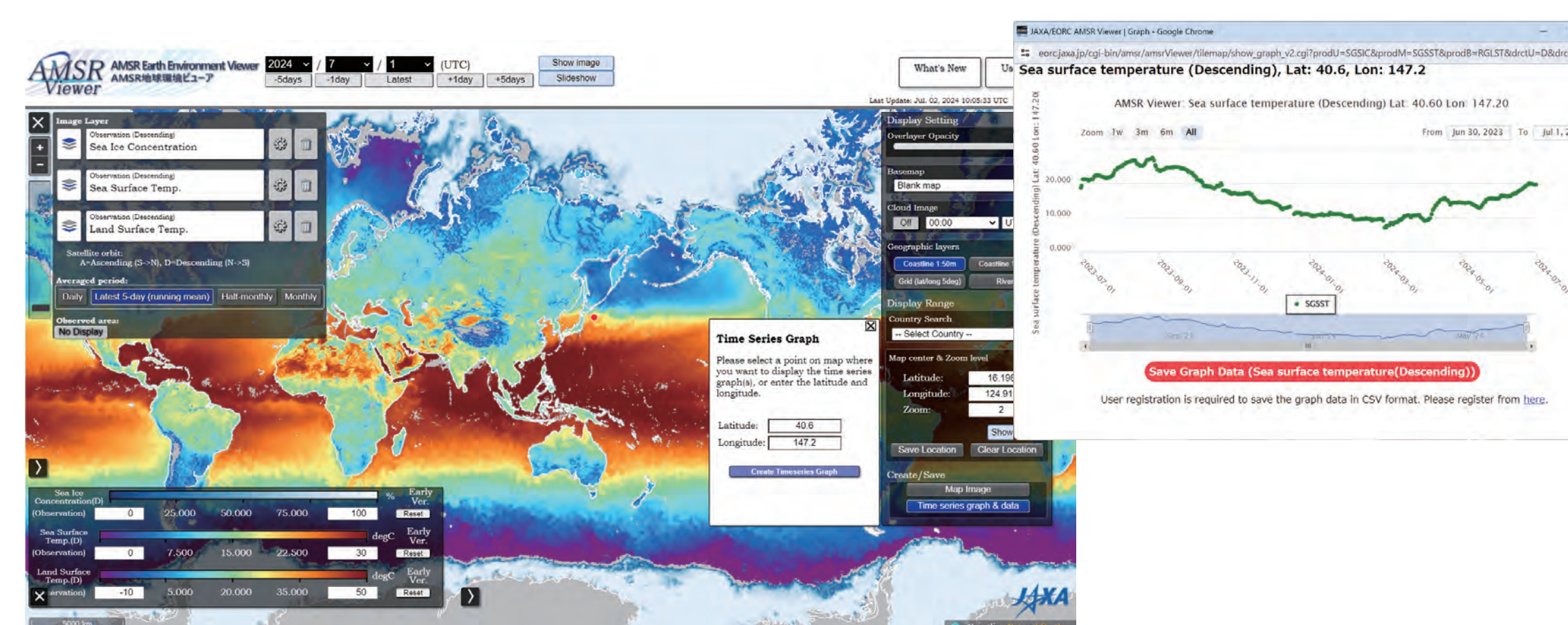
Modify to reduce possible risks of RF interferences from the 5G communication systems

Add to get snowfall and water vapor in higher levels

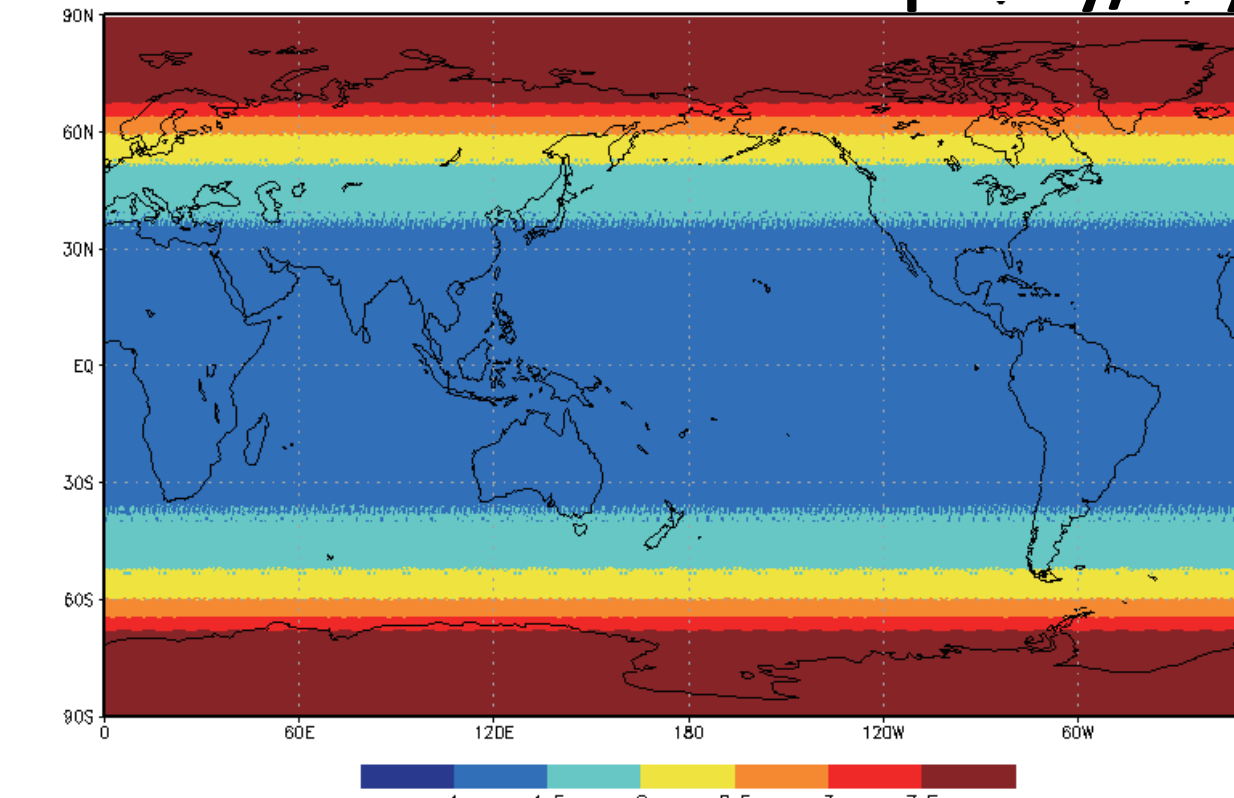
- Additional 166 & 183 GHz channels to enable monitoring of global precipitation (rain & snow) and contribute to water vapor analysis in NWP
- Additional 10.25 GHz channels with improved NEDT to enable robust SST retrievals in higher spatial resolution

Web Visualization Tool (<https://www.eorc.jaxa.jp/AMSR/viewer/>)

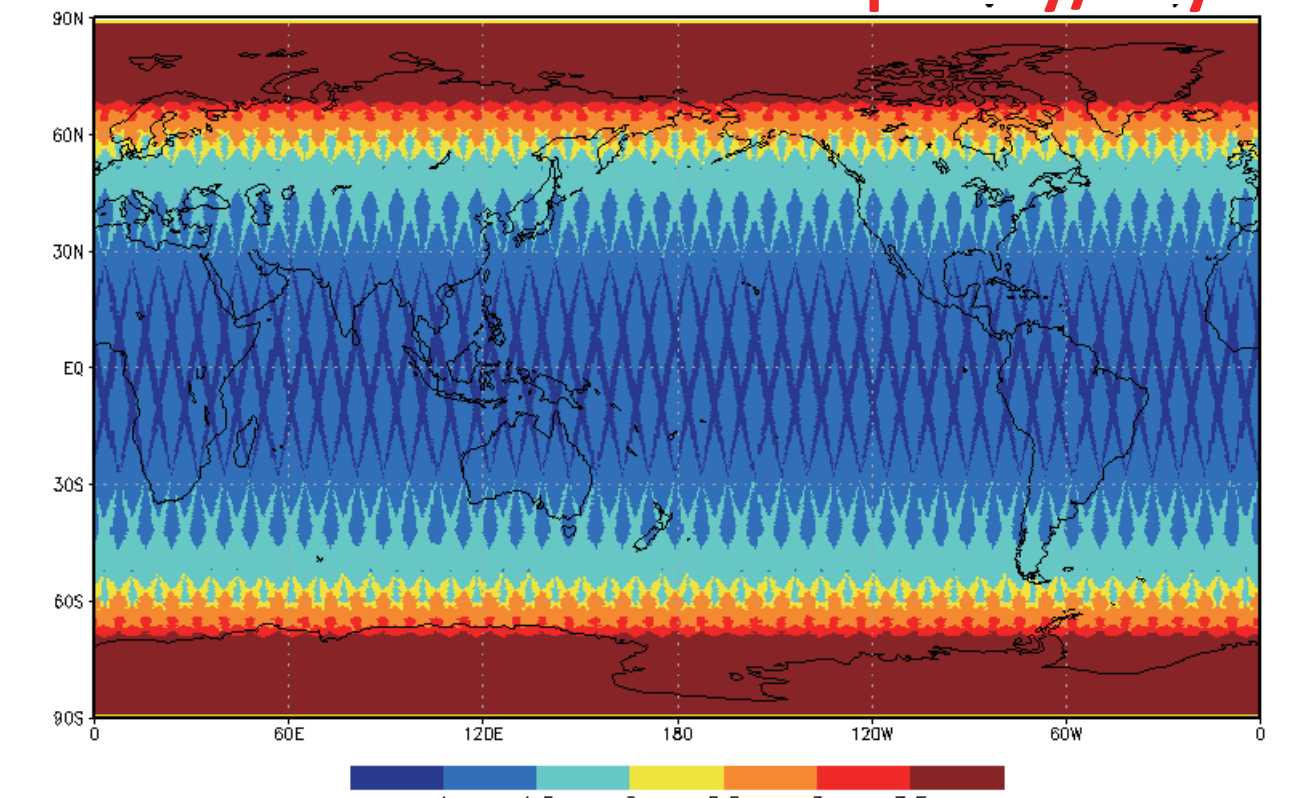
- Browse all AMSR-E & AMSR2 products with zoom-in & -out
- Display 3 products of same UTC day (Asc. & Dsc.) at same time
- Display & download time series graph of specific point
- Scalable color bars, etc.
- New capability in AMSR Earth Environment Viewer, web visualization tool, to display 5-day mean, half-monthly & monthly
- AMSR Viewer for polar region is in preparation



AMSR2: Observation frequency/day



AMSR3: Observation frequency/day



Observation frequency of AMSR3 is NOT homogeneous for every longitude and there are fixed areas less than 1 observation/day (blue).