

Development of the 3rd Generation of AMSR series (AMSR3)

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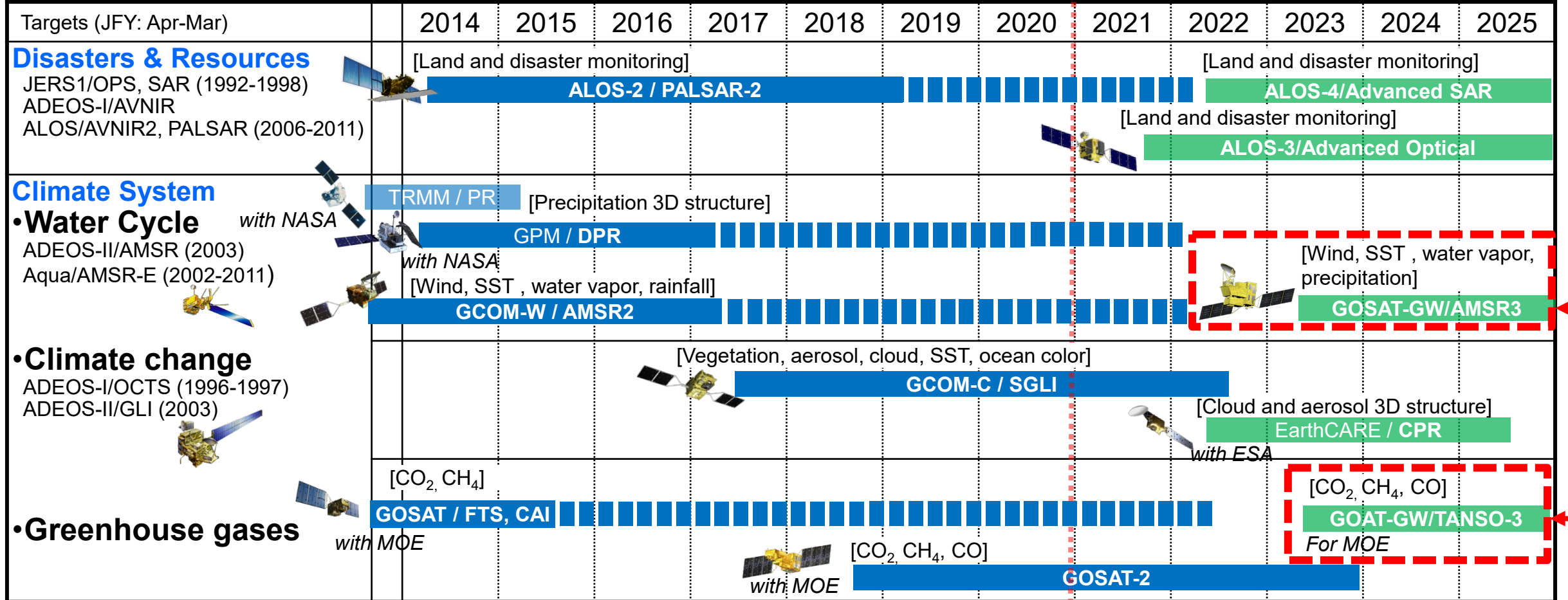
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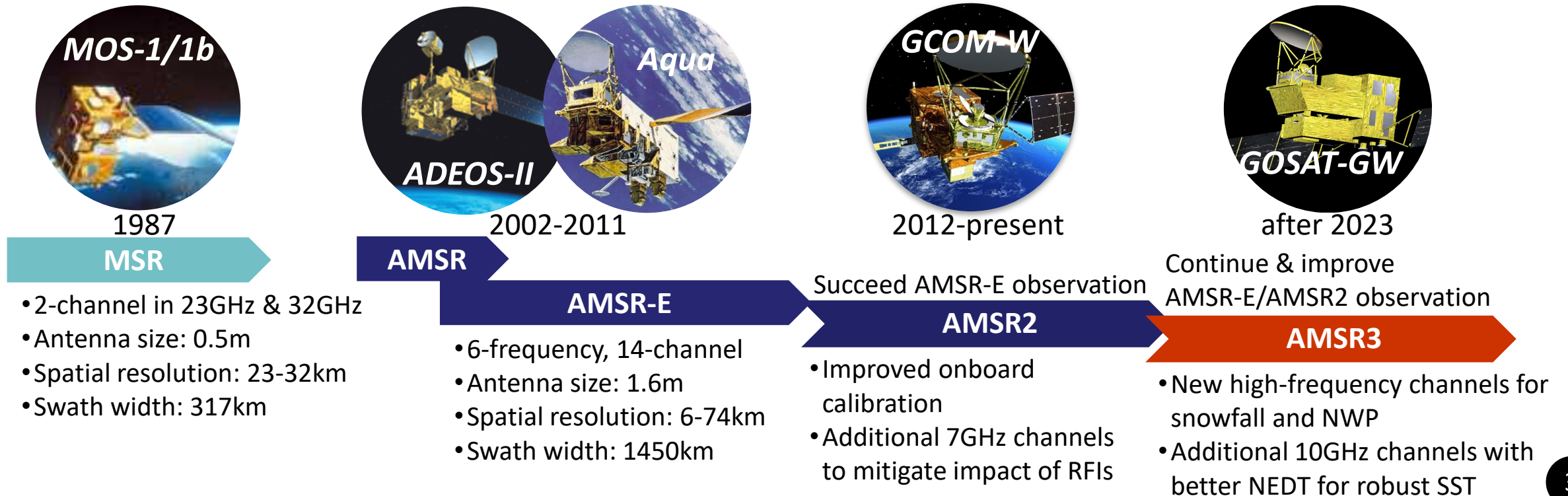
JAXA's Earth Observation Satellite/Instrument



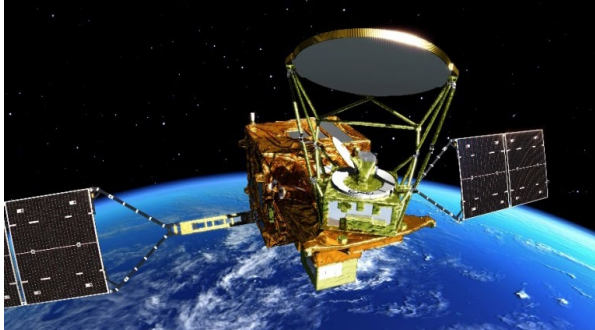
Mission status: ■ Completed ■ On orbit ■ Development

History of Passive Microwave Observations

- With experience of development and operation of MSR, JAXA developed 1st generation of AMSR (AMSR and AMSR-E) with large antenna size and C-band channels. AMSR-E continuous its science observation about 9.5-year, and its high capabilities enable to expand utilizations in operational and research areas.
- 2nd generation of AMSR (AMSR2) was launched in 2012 and succeeds AMSR-E observations to establish its data utilization in various areas.
- 3rd generation of AMSR (AMSR3) is being developed and to be launched in JFY2023.



AMSR2 on GOM-W

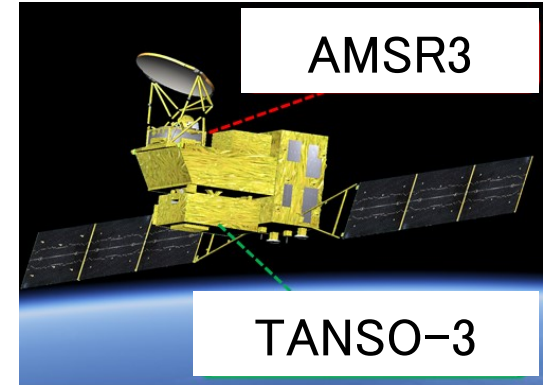


Instrument	Advanced Microwave Scanning Radiometer 2 (AMSR2)
Altitude	705 km
Orbital inclination	98.2 deg
Local sun time at Ascending node	13 :30
Launch vehicle	H-IIA
Launch	May 18, 2012
Designed lifetime	5 years

- ✓ Successor of Aqua/AMSR-E, providing continuous data for climate studies and operational applications
- ✓ Carrying AMSR2, a multi-polarization and multi-frequency microwave imager
- ✓ Improving on-board calibration target has resulted reduction of annual TB variation due to calibration and improvement of TB stability
- ✓ Achieved designed mission life (5-year) on May 18, 2017, and continues observation
- ✓ Recent Highlights
 - ✓ Version-up of SST and Sea Surface Wind Speed & release of new research products in Oct. 2020
 - ✓ Release of AMSR Environment Viewer on web in Jun. 2020
 - ✓ Capturing TPW & SST variation during heavy rainfalls around Japan in Jul. 2020
 - ✓ Capturing SST decrease during passing of three typhoons in Aug.-Sep. 2020
 - ✓ Capturing second minimum sea ice extent in Sep. 2020

AMSR3 on GOSAT-GW: Global Observation SATellite for Greenhouse gases and Water cycle

- GOSAT-GW will carry two instruments, AMSR3 and TANSO-3.
 - AMSR3, led by JAXA, will succeed AMSR series observations adding new high-frequency channels for solid precipitation retrievals and water vapor analysis in NWP.
 - TANSO-3, led by Japanese Ministry of Environment (MOE) and National Institute of Environment Studies (NIES), will improve observation capability of greenhouse gases from GOSAT-2/TANSO-2.
 - Target launch is JFY2023 (Apr. 2023 - Mar. 2024)
- Mission targets of AMSR3
 - To produce long-term continuous data record
 - To enhance operational utilization of near-real time data
 - weather forecast including hurricane analysis
 - fishery in coastal area
 - navigational assistance on arctic shipping route
 - new geophysical parameter products



GOSAT-GW Satellite Specifications

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 (for GHG) AMSR3 (for Water Cycle)	



Comparison of Orbit Specifications

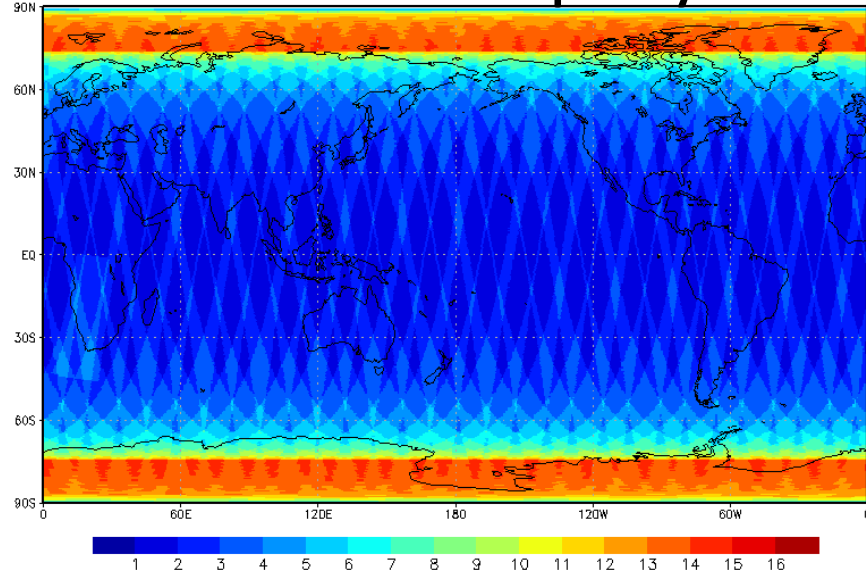
- Orbit specification of GOSAT-GW is decided to satisfy requirements from both AMSR3 and TANSO-3 missions.
- Ascending orbit will be during daytime (same as GCOM-W), orbit altitude is same as GOSAT, and local sun time is same as GCOM-W. Orbiting number of one recurrent day is 44 and smaller compared to that of GCOM-W (233), so there are some differences in observation frequency.

Orbit conditions	GCOM-W/AMSR2	GOSAT-GW/AMSR3
Altitude	699.6 km	665.96 km
Inclination angle	98.2 degrees	98.06 degrees
Local sun time in Ascending node	13:30	13:30
Swath width	1600 km	1530 km
Recurrent day	16 days (233 orbits)	3 days (44 orbits)

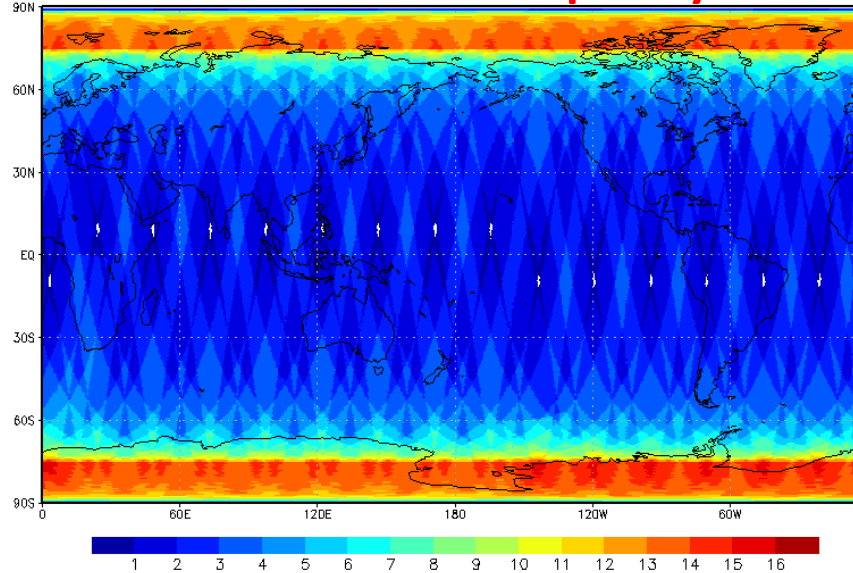


AMSR3 Observation Frequency

AMSR2: Observation frequency in 2-day

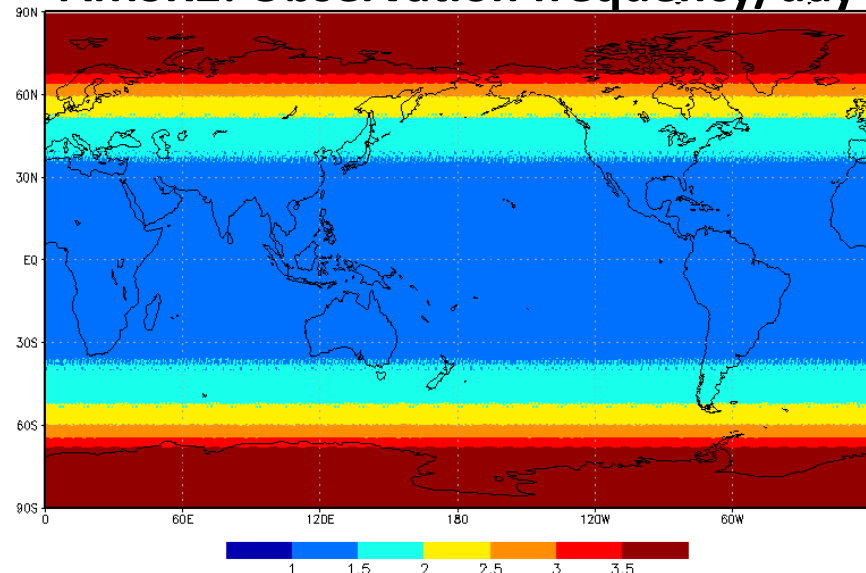


AMSR3: Observation frequency in 2-day

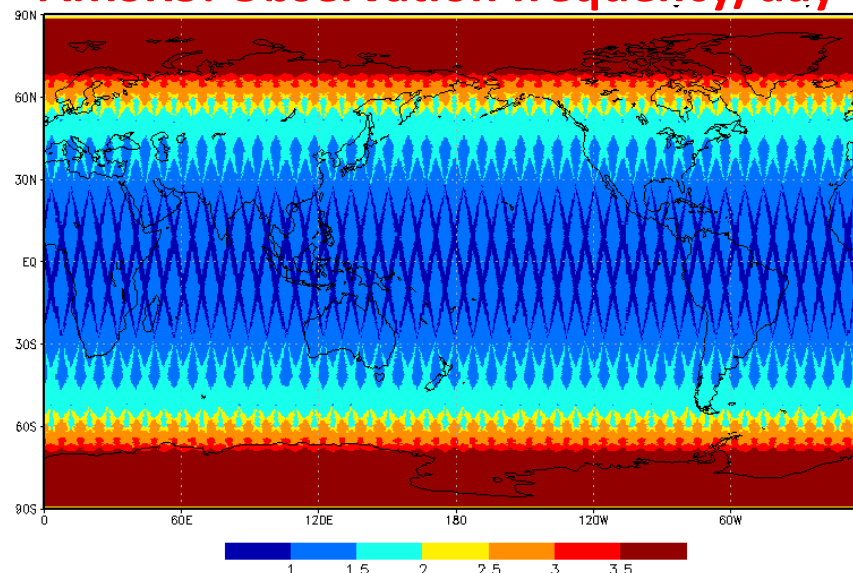


Unlike AMSR2, **AMSR3 cannot cover global area within 2-day** and small missing areas (white) are remained.

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).

Specification of AMSR3 Instrument

AMSR3 Sensor Characteristics

Sensor type	Conical scanning total power microwave radiometer
Antenna	Off-set parabolic antenna (φ2.0m aperture)
Swath width	> 1530km
Quantization	12 bit
Incidence angle	55 deg. except 89G-B, 166G, 183G
X-polarization	< -20dB
Beam efficiency	> 90%
Range	2.7-340K
Sampling interval	5-10km
Data rate	87.4 kbps (average)
Life time	7 years

Red: Changes from AMSR2 including additional channels

AMSR3 Channel Sets

Center frequency [GHz]	Polarization	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)
36.42	H/V	840	< 0.70 K (TBD)	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	0.30° (4km × 9km)
183.31 ± 7	V	2000 × 2	< 1.50 K	0.27° (4km × 8km)
183.31 ± 3	V	2000 × 2	< 1.50 K	0.27° (4km × 8km)



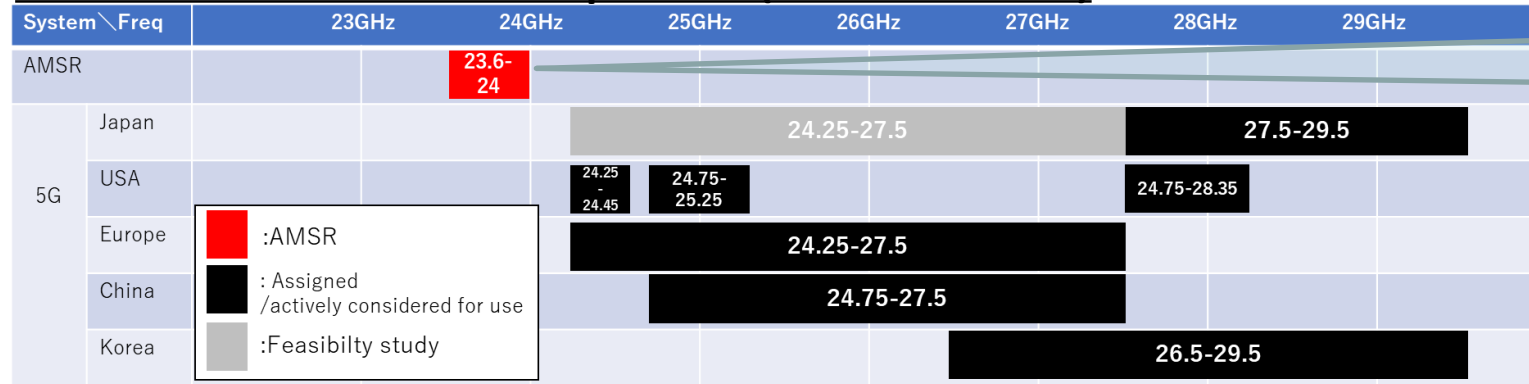
Change of Bandwidth for 36GHz (1/2)

- As a result of the allocation of new frequency bands for the 5th Generation Mobile Communications System (5G) at the World Radio Conference (WRC-19), the frequencies used in the 23 GHz and 36 GHz bands of the AMSR series were close or adjacent to those of 5G as shown in the chart on the next page.
- JAXA evaluated necessity of the 5G countermeasure for AMSR3, which is under development, on the assumption that use of 5G will be widespread in the future. As a result of impact evaluation, the bandwidth, which will affect temperature resolution ($NE\Delta T$), of 36 GHz band needed to be narrowed in order to avoid the influence of 5G. On the other hand, its impact on 23 GHz will be negligible by improving the out-of-band frequency characteristics.
- JAXA interviewed the algorithm developers and users who directly use the brightness temperature products in July-August 2020 and received acceptable comments on the impact on bandwidth reduction.
- After that, as a result of the study to minimize the reduced bandwidth, **the bandwidth of 36 GHz was changed from 1000MHz to 840 MHz**. As for the temperature resolution, the value will remain unchanged, but with TBD, and will be fixed with critical design results.



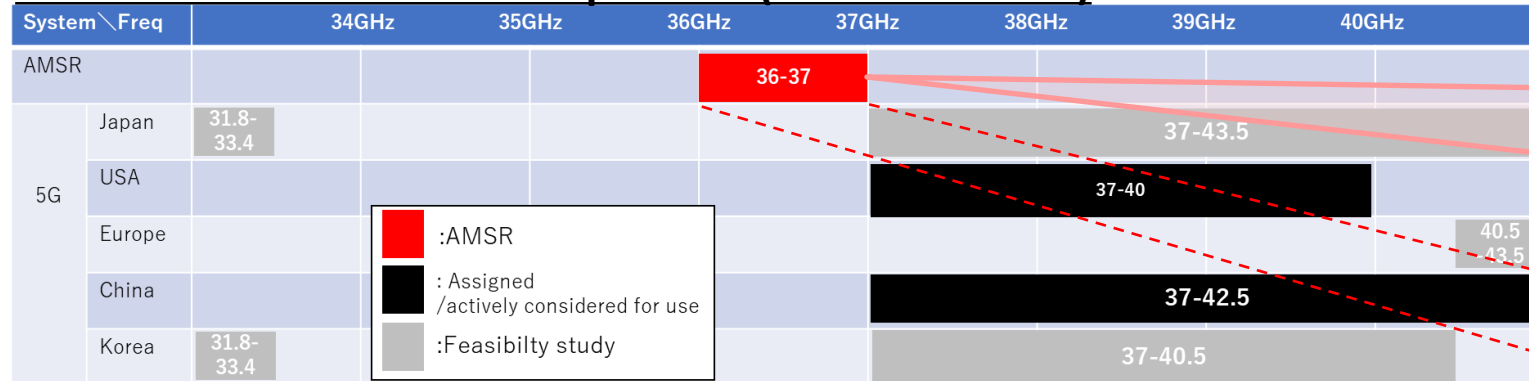
Change of Bandwidth for 36GHz (2/2)

AMSR3 and 5G allocated frequencies (22GHz ~ 30GHz)

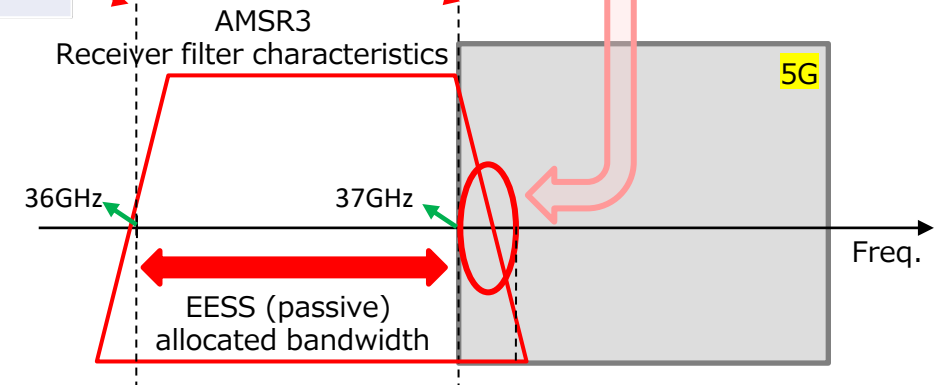


AMSR3 and 5G frequencies have a buffer band of 250 MHz (24.0 to 24.25 GHz)

AMSR3 and 5G allocated frequencies (33GHz ~ 41GHz)



AMSR3 and 5G frequencies are adjacent to each other with no buffer band. Its impact cannot be avoided by improving the out-of-band frequency characteristics while maintain the bandwidth.





List of AMSR3 Products

Standard Product
Brightness Temperature (6-183GHz) (L1B)
Resampled Brightness Temperature (6-183GHz) (L1R)
Total Precipitable Water (over ocean & land)
Integrated Cloud Liquid Water Content (over ocean)
Precipitation (liquid & solid)
Sea Surface Temperature (6GHz & 4-frequency)
Sea Surface Wind Speed
All Weather Sea Surface Wind Speed
Sea Ice Concentration
High-resolution Sea Ice Concentration
Soil Moisture Content
Snow Depth (snow depth & SWE)

Red indicates differences from AMSR2

Research Product
FOV-center Matched Brightness Temperature (L1C)
High-resolution Brightness Temperature (L1H)
High-resolution Sea Surface Temperature (20km res.)
Sea Ice Motion Vector
Land Surface Temperature
Vegetation Water Content
Thin Ice Detection
Soil Moisture Content & Vegetation Water Content by Land Data Assimilation (L4)
Climate Data Record (CDR) for each parameter

(as of Oct. 2020)



Summary

Current Status

- Dec. 2019: Started GOSAT-GW Project
- Mar. 2021: Completed Preliminary Design Review (PDR) of GOSAT-GW Satellite System
 - Aug. 26, 2020: Completed AMSR3 PDR
 - Dec. 23, 2020: Completed TANSO-3 PDR
- Changed the specification of Ka-band passband to reduce the future risk of RF interference from 5-G mobile communication system
- Being coordinated major characteristics and performances of G-band
- Being conducted manufacture and test of engineering models of AMSR3 component (ex. G-band antenna sub-system, Receivers)

Future Plan

- Critical Design Review (CDR) of AMSR3 in first half of JFY2021
- Completion of AMSR3 Development in second half of JFY2022
- Launch of GOSAT-GW Satellite in JFY2023
 - AMSR3 Product will be released to the public about one year after the launch