# Present Status of AMSR2 on GCOM-W and AMSR3 on GOSAT-GW



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# JAXA's Earth Observation Satellite/Instrument



GOSAT-GW = Global Observing SATellite for Greenhouse gases and Water cycle



## JAXA's Mission of Passive Microwave Sensors



Sensor	MOS-1/MSR	ADEOS-II/AMSR	Aqua/AMSR-E	GCOM-W/AMSR2	GOSAT-GW/AMSR3				
Coverage	Direct receive only		Global						
Swath	317km	1600km	1450km	1617km	> 1530km				
Frequencies (GHz)	2 (23,31)	9 (6.9,10,18,23, 36,50,52,89)	6 (6.9,10,18,23,36, 89)	6 (6.9/ <mark>7.3</mark> ,10.65,18,23,36, 89)	8 (6.9/7.3, <mark>10.25</mark> /10.65,18,23, 36,89, <mark>166,183</mark> )				
Polarization	Mixed V and H	V and H	V and H	V and H	V and H (166/183 are V only)				
Antenna Size	0.5m	2.0m	1.6m	2.0m	2.0m				
Spatial Res.	23km @31GHz	8x14km @36GHz	8x14km @36GHz	7x12km @36GHz	7km x 11km @36GHz				



### AMSR2 on GCOM-W



- ✓ Successor of AMSR-E on Aqua and AMSR on ADEOS-II.
- ✓ Deployable main reflector system with 2.0 m diameter (1.6 m for AMSR-E).
- ✓ Frequency channel set is identical to that of AMSR-E except 7.3GHz channel for RFI mitigation.
- ✓ Two-point external calibration with improved HTS (hot-load).
- ✓ Add a redundant momentum wheel to increase reliability.

Global Change Observation Mission

GCOM-W	/1/AMSR2 characteristics	AMSR2 Channel Set						
Scan and rate	Conical scan at 40 rpm	Center Freq. [GHz]	Band width [MHz]	Pol.	Beam width [deg] (Ground res. [km])	Sampling interval [km]		
Antenna	Offset parabola with 2.0m dia.	6 925/						
Swath width	1450km (effective > 1600km)	7.3	350		1.8 (35 x 62)			
Incidence angle	Nominal 55 degrees	10.65	100	v	1.2 (24 x 42)	10		
Digitization	12bits	18.7	200	and	0.65 (14 x 22)	10		
Dynamic range	2.7-340K	23.8	400	H	0.75 (15 x 26)			
5 8		36.5	1000	]	0.35 (7 x 12)			
Polarization	Vertical and horizontal	89.0	3000		0.15 (3 x 5)	5		

https://www.gportal.jaxa.jp/gp/



### **AMSR2 Standard Products**

Product		Coverage	Resolutio n	Release Accuracy	Standard Accuracy	Target Accuracy	Validation Result	Latest version
Brightness Temperature		Global	5-50km	±1.5K	±1.5K	土1.0K (bias) 土0.3K(random)	< 1.4 K	Ver.2.2
	Total Precipitable Water	Global Ocean	15km	土3.5 kg/m²	土3.5 kg/m²	$\pm$ 2.0 kg/m <sup>2</sup>	1.5 kg/m <sup>2</sup>	Ver.2.1
	Cloud Liquid Water	Global Ocean	15km	±0.10 kg/m²	±0.05 kg/m²	$\pm 0.02$ kg/m <sup>2</sup>	0.04 kg/m <sup>2</sup>	Ver.2.1
G	Precipitation	Global (except high latitude)	15km	Ocean 土50 % Land 土120 %	Ocean ±50 % Land ±120 %	Ocean $\pm 20$ % Land $\pm 80$ %	Ocean 48% Land 86%	Ver.2.1
E O	Sea Surface Temperature	Global Ocean	50km	±0.8 ºC	±0.5 ºC	±0.2 ºC (zonal mean)	0.46 ºC < 0.2 ºC (zonal)	Ver.3.0
	Sea Surface Wind Speed	Global Ocean	15km	±1.5 m/s	±1.0 m/s	±1.0 m/s	0.96 m/s	Ver.3.0
	Sea Ice Concentration	Ocean in high latitude	15km	±10%	±10%	±5%	9 %	Ver.3.0
	Snow Depth	Land	30km	±20 cm	±20 cm	±10 cm	18 cm	Ver.2.1
	Soil Moisture	Land	50km	±10%	±10%	土5 %	4 %vol	Ver.3.0

# **Snapshots from AMSR2**

1 Jan. 2013

6.6

[mm/h]

#### Sea surface temperature



Vertically-integrated water vapor<sup>[deg C]</sup>



Sea surface wind speed



#### Precipitaion



AMSR Viewer: https://www.eorc.jaxa.jp/AMSR/viewer/index\_e.html

# Monthly Averages (Dec. 2012)



Downloaded from "JAXA G-Potal" site (https://www.gportal.jaxa.jp/gp/top.html)



### AMSR2 Research Products

GCOM-V

nge Observation Mission

Released	Released Not released		http://suzaku	.eorc.jaxa.jp/GCOM_W/researc	:h/resdist_j.html
Geophysical Paran	neters	Target (Rel	ease) Accuracy	Latest Validation Results	Product Status
All-weather sea su wind speed (V	All-weather sea surface wind speed (V3)		(high winds)	±3.95 m/s (>= 16 m/s)	Released
10 GHz sea surface ter (V4)	mperature	±0.8 degC		$\pm$ 0.48 degC (>= 9 degC) $\pm$ 0.62 degC (all temp.)	Released
Land surface tempera	iture (V1)	Forest Nondense veg	: ±3 degC jetation: ±4 degC	Forest: ±3 degC Nondense vegetation: ±4 degC	Released
Vegetation water c	ontent	±1	l kg/m²		Validating
High-resolution sea ice concentration		±15 %			Validating
Thin ice detection	(V1)	80 % (corre	ect answer rate)	> 88 % (Okhotsk, Bering sea, Hudson bay)	Released
Sea ice motion vector		$\pm$ 3 cm/s (x & y components)			Validating
Soil moisture & vegeta content by land assimila	tion water ation model	Soil moi Vegetation v	sture: ±8 % vater: ±1 kg/m²		Developing
Integrated water vapor (V1)	over land	±6.5 kg/m² (except ice & vegetation area)		RAOB: $\pm 3.5 \text{ kg/m}^2$ GPS: $\pm 2.6 \text{ kg/m}^2$	Released
Sea ice thickness (<	20 cm)	Thin solid Active fr	l ice: ±10 cm razil: ±3 cm		Developing
Sea ice thickness (>=	= 20 cm)	±	20 cm		Developing
Multi-band sea su temperature (V	rface ⁄4)	±0	.8 degC	±0.47 degC	Released

## Precipitation Map composed from Multi-Satellite MW Radiometer Obs. "GSMaP"

0.1 x 0.1 deg. resolution, 1-hour interval



Rain rate 0.1 0.5 1.0 2.0 3.0 5.0 10.0 15.0 20.0 25.0 [mm/hr]

#### GSMaP (https://sharaku.eorc.jaxa.jp/GSMaP/)



# **Global SST Monitoring**



#### **Global-mean SST anomalies**

**ENSO** monitoring





Scatterometer Altimeters MW Radiometer ASCAT Zonal Wind (m/s) ALT Sea Level Anomaly (m) AMSR2 SST Anomaly (deg.C) VindSat - AMSR-E AMSR-2 (deg.C) AMSR2 AMSR-E 0.5 Months from Jan 2014 A n oma l y SST WindSat 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 130E m/s cm °C



### Long-term Sea Ice Record

AMSR series data is essential to monitor environmental changes in polar regions



Global Change Observation Mission

# Second Minimum in the Sea Ice Extent Record in Sep. 2020



Images by JAXA & NIPR (National Institute of Polar Research)

Yearly Arctic Sea Ice Extent in September and July



- ✓ AMSR series enable frequent (3-7 times per day), highresolution (15km) and all-weather observation of polar region.
- ✓ Sea ice extent in the Arctic recorded the minimum value in the record in July 2020, less than that in 2012 in that time.
- ✓ In Sep. 2020, it recorded the yearly minimum value (3.55 million km<sup>2</sup>) and the second minimum in the record.





# **Targets of AMSR3 Mission**

- To produce long-term continuous data record for climate studies
- To enhance operational utilization of near-real time data
  - ✓ weather forecast including typhoon/hurricane analysis
  - ✓ fishery in near-shore/off-shore regions
  - ✓ navigational assistance on arctic shipping route
- To obtain new geophysical parameter products
  - ✓ solid precipitation, water vapor over land, high-resolution sea surface temperature, all-weather sea surface wind speed and high-resolution sea ice concentration





### **Characteristics of GOSAT-GW**



Orbit	Туре	Sun-synchronous, Sub-recurrent orbit					
	Altitude	666 km, recurrent cycle 3days (same as GOSAT)					
	MLTAN	13:30 ± 15 min (same as GCOM-W)					
Mass		2.6 ton (Including propellant)					
Power		> 5.3 W					
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					
Instrument		TANSO-3 AMSR3					





		Center				
Sensor type	Conical scanning total power microwave radiometer	frequency [GHz]	Polarization	Band width [MHz]	NEDT (1σ)	Beam width (spatial resolution)
Antenna	Off-set parabolic antenna (	6.925 7.3	H/V	350	< 0.34 K	1.8° (34 km x 58 km)
Swath width	> 1530m	10.25	H/V	500	< 0.34 K	1.2° (22 km x 39 km)
Quantization	12 bit	10.65	H/V	100	< 0.70 K	1.2° (22 km x 39 km)
Incidence angle	55 deg. except 89GB, 166G,183G	18.7	H/V	200	< 0.70 K	0.65 <sup>°</sup> (12 km x 21 km)
X-polarization	<-20dB	23.8	H/V	400	< 0.60 K	0.75 <sup>°</sup> (14 km x 24 km)
Beam efficiency	> 90%	36.42	H/V	840	< 0.70 K (TBD)	0.35 <sup>°</sup> (7 km x 11 km)
Range	2.7-340K	89.0 A/B	H/V	3000	< 1.20 K	0.15 <sup>°</sup> (3 km x 5 km)
Sampling interval	5-10km	165.5	V	4000	< 1.50 K	0.3 <sup>°</sup> (4 km × 9 km)
Data rate	87.4 kbps (average)	183.31±7	V	2000 × 2	< 1.50 K	0.27 <sup>°</sup> (4 km × 8 km)
Designed lifetime	7 years	183.31±3	V	2000 × 2	< 1.50 K	0.27° (4km × 8km)

- Red indicates additions to AMSR2
- Blue indicates changes from AMSR2 due to avoid 5G RFI



# Impact of G-band Channels

# Addition of 165 & 183 GHz channels for snowfall retrievals and water vapor sounding



With G-band

G





# Impact of 10-GHz additional Channel

 10-GHz channels with improved NEDT for high-resolution SST



AMSR2 7 GHz-SST Spatial resolution: 50km <u>Better NEDT</u>



AMSR2 10 GHz-SST Spatial resolution: 30km



### **AMSR3 Products**

#### Standard Product

Brightness Temperature (6.9-183GHz) (L1B)

Resampled Brightness Temperature (L1R)

Total Precipitable Water (over ocean & land)

Integrated Cloud Liquid Water Content (over ocean)

Precipitation (liquid & solid)

Sea Surface Temperature (7GHz & 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)

#### **Research Product**

FOV-center Matched Brightness Temperature (L1C)

High-resolution Brightness Temperature (6-10GHz) (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

\* Red indicates additions to AMSR2





### **Current Status of AMSR3**

Pre-Phase A	Pha	se A	Phase B	Phase C	Phase D	Phase E		Phase E	Phase F	
Concept Study	Concept Design	Approval of Plan	Preliminary Design	Critical Design	Manufacturing & Testing	Launch Initial Nominal Ops. Ops. Ops.		Post-mission Ops. (Incl. disposal)		
MD Jun	R SRR	SD Oc	R PD	R CE	DR PQ	R R				
201	8 2018	201	19			Sched	uled to	be laur	iched in .	JFY2023

- Jun. 2018: Mission Definition Review (MDR)
- Dec. 2018: System Requirement Review (SRR)
- Oct. 2019: System Definition Review (SDR)
- Nov. 2019: Project Approval Review (management review)
- Dec. 2019: Started GOSAT-GW Project
- Feb.-Mar. 2021: GOSAT-GW Satellite System Preliminary Design Review (PDR) (AMSR3 PDR was completed in Aug. 2020)

