Importance of Monitoring Sea Ice with GOSAT-GW/AMSR3

Kohei Cho [1*], Kazuhiro Naoki [1], Misako Kachi [2], Rigen Shimada [2], and Josefino Comiso

[1] Tokai University, Japan
[2] JAXA , Japan
[3] NASA, USA
*kohei.cho@tokai.ac.jp

Abstract: *JAXA has successfully launched the Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW) on June 29, 2025 (JST). GOSAT-GW carries two sensors, which are Advanced Microwave Scanning Radiometer 3 (AMSR3) and Total Anthropogenic and Natural emissions mapping SpectrOmeter-3 (TANSO-3). AMSR3 is the follow-on of AMSR2 onboard GCOM-W, which was launched in 2012 and is still in operation. Microwave radiometers on board satellites such as AMSR3 can penetrate clouds and can observe the global sea ice distribution on a daily basis. Ice concentration (IC) is one of the most important parameters of sea ice, which can be calculated from brightness temperatures measured by the passive microwave radiometers. The IC data is used for calculating the global sea ice extent, and the historical sea ice extents observed by the passive microwave radiometers onboard satellites are used to monitor the trend of global sea ice distribution. In this paper, the initial result of AMSR3 for sea ice monitoring is presented.*

Keywords: *passive microwave radiometer; GCOM-W; AMSR2; sea ice extent; global warming*

1. Introduction

According to the Sixth Assessment Report of the IPCC (IPCC, 2023), "human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming", and "Human-caused climate change is already affecting many weather and climate extremes in every region across the globe". Global warming is one of the most serious problems facing mankind in the 21st Century. Sea ice plays an important role in reflecting solar radiation into space. However, once sea ice starts to melt, the reflectance from the sea ice decreases, which in turn enhances global warming. This is called ice albedo feedback (see Figure 1). Thus, sea ice is quite sensitive to global warming. Since microwaves can penetrate clouds, the global sea ice distribution can be monitored daily with the passive microwave sensors from space. Microwave observations from space began in 1978 with the SMMR onboard the Nimbus-7 satellite. Since then, a series of passive microwave radiometers, namely, SSM/I, AMSR, AMSR-E, and AMSR2, have been continuously observing the Earth for over 45 years. In June 2025, JAXA launched a new satellite, GOSAT-GW, carrying a new passive microwave radiometer, AMSR3. In this paper, the initial result from the AMSR3 observation and the outcome of the historical observation by the microwave radiometers will be presented.

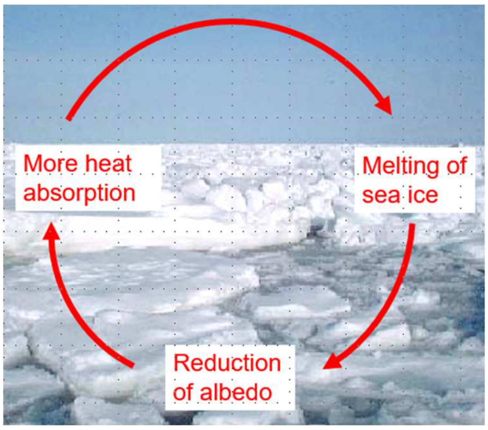


Figure 1. Ice albedo feedback

2. Outline of GOSAT-GW/AMSR3

The Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW) was successfully launched on June 24, 2025, from the Tanegashima Space Center, Japan. GOSAT-GW is a Japanese Earth observation satellite that is a collaboration between the Japanese Ministry of Environment (MOE), National Institute for Environmental Studies (NIES), and the Japanese Aerospace Exploration Agency (JAXA). GOSAT carries two sensors which are the Total Anthropogenic and Natural emissions mapping SpectrOmeter-3 (TANSO-3), and the Advanced Microwave Scanning Radiometer 3 (AMSR3). TANSO-3 is a high-resolution nadir-scanning infrared spectrometer that will monitor whole-atmosphere monthly mean concentrations of greenhouse gases, while AMSR3 is a multi-spectral imaging microwave radiometer that will help to understand water cycle variation and its impact on climate change, as well as improve Numerical Weather Prediction (NWP)(JAXA, 2025). Table 1 shows the specification of GOSAT-GW, and Table 2 shows the specification of AMSR3.

Table 1. Specification of GOSAT-GW

Official name	Global Observing SATellite for Greenhouse gases and Water cycle
Mission instruments	Advanced Microwave Scanning Radiometer 3 (AMSER3) Total Anthropogenic and Natural emissions mapping SpectrOmeter-3 (TANSO-3)
Weight	Approximately 2.6 t
Power generation	Approximately 5,300 W
Designed lifetime	7 years or more
Orbit type	Synchronous sub-recurrent orbit
Altitude	666 km
Recurrent period	3 days
Local Sun Time	13:30±15 minutes

Source: JAXA, https://www.eorc.jaxa.jp/AMSR/satellite/gosat-gw_en.html

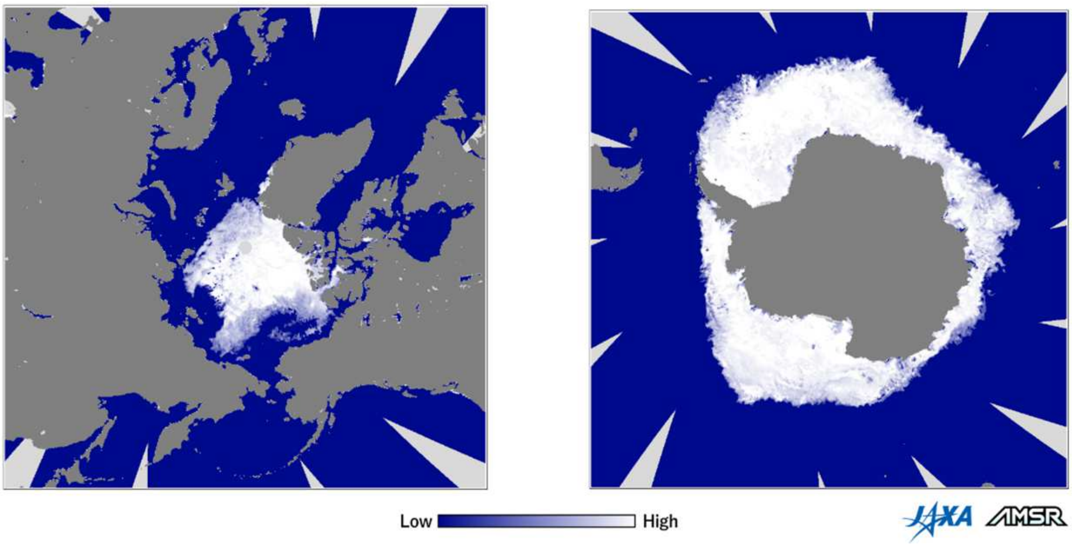
Table 2. Specification of AMSR3

Scan rate	Conical scan at 40 rpm
Antenna	Offset parabola with 2.0m diameter
Swath width	Approx. 1535 km
Incident angle	55.0-degree
Digitization	12 bits
Dynamic range	2.7 ~ 340 K
Polarization	Vertical (V) and Horizontal (H)
Frequency	6.925 GHz, 7.3GHz (33km x 57km)
	10.25 GHz, 10.65GHz (22km x 38km)
	18.7GHz (12km x 21km)
	23.8GHz (14km x 14km)
	36.42GHz (6km x 11km)
	89.0GHz (3km x 5km)
	165.5GHz (4km x 9km)
	183.31±7GHz, 183.31±3GHz (4km x 8km)

Source: JAXA, https://www.eorc.jaxa.jp/AMSR/satellite/gosat-gw_en.html

3. Initial Product of AMSR3

Sea ice concentration is the most typical sea ice parameter which can be calculated from brightness temperatures observed by the microwave radiometers. Sea ice concentration can be defined as the percentage of ice within the unit size of the sea ice area, usually one pixel in size of the brightness temperature data. As for AMSR3, the AMSR Bootstrap Algorithm (Comiso et al., 2013) is used as the standard algorithm for calculating sea ice concentration from AMSR3 data. Figure 2 shows the sea ice concentration images of the Northern and Southern Hemispheres of August 15, 2025, derived from AMSR3 data (JAXA, 2025). Figure 3 shows the trend of sea ice extent in the Arctic derived from the time series of passive microwave radiometer observations from space (NPIR, 2023). The reduction trend of the sea ice in the Arctic is clear. The sea ice concentration data of AMSR3 will be added to this product after the initial verification of AMSR3 sea ice products.



(a) Northern Hemisphere (b) Southern Hemisphere

Figure 2. AMSR3 sea ice concentration image (August 15, 2025)
source: https://www.jaxa.jp/press/2025/09/20250905-1_j.html

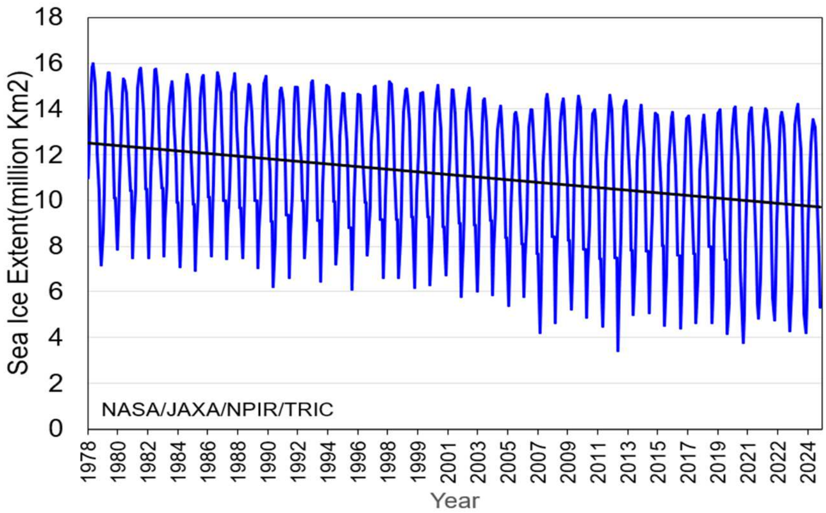
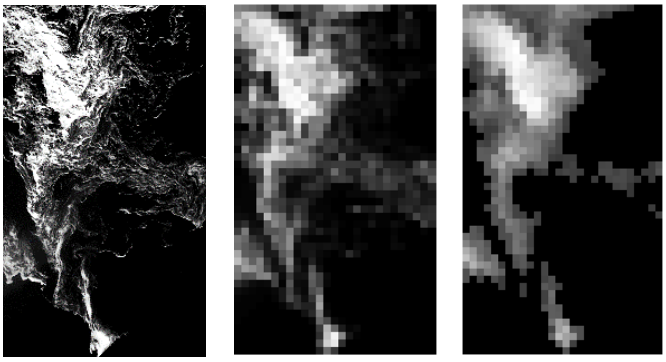


Figure 3. Interannual variability of the Arctic sea ice extent
(1978-2025, *source: https://ads.nipr.ac.jp/vishop/*)

4. Verification procedure of the sea ice concentration product of AMSR3

The authors are evaluating the accuracy of sea ice concentration (IC) derived from the AMSR series for years by comparing it with IC derived from optical sensor MODIS data under cloudless conditions (Cho et al., 2020). Figures 4 and 5 show an example of the verification result of the IC product derived from the AMSR2 observation. Most of the verification results suggested that the RMSE of the AMSR2 IC was less than 10%. The authors plan to use the same procedure for verifying the AMSR3 IC and expect equivalent performance to that of the AMSR2 product.



(a)MODIS IC (250m) (b)MODIS IC (25km) (c)AMSR2 IC (25km)

Figure 4. Comparison of MODIS & AMSR2 IC images of the test site (Sea of Okhotsk, Mar. 29, 2023)

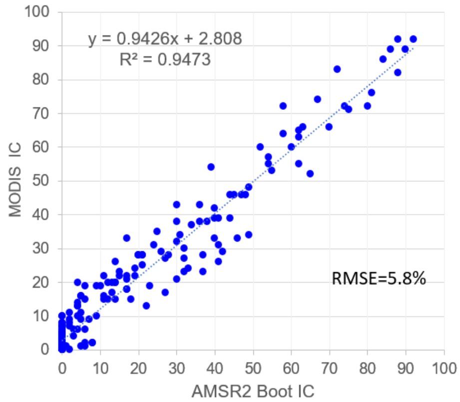


Figure 5. Scatterplots of MODIS IC vs AMSR2 IC(Sea of Okhotsk, Mar.29, 2023)

5. Conclusion

The initial result of the sea ice observation from AMSR3 onboard GCOM-GW is introduced in this paper. The initial sea ice concentration images from AMSR3 indicate that the sensor and the sea ice concentration algorithm are functioning properly. After initial calibration and validation of AMSR3, the authors will be evaluating the AMSR3 Level 1 Ver.01 product for tuning the sea ice concentration algorithms.

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