AMSR2 Research Product Validation Result of Thin Ice Thickness (Thermal Ice Thickness)

Japan Aerospace Exploration Agency
Earth Observation Research Center

Thin ice thickness algorithm

Algorithm developer

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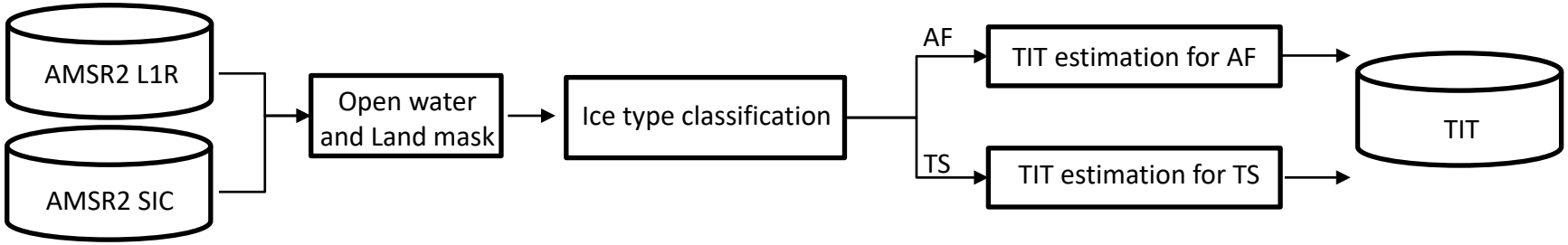
Algorithm overview

This algorithm detects thin ice thickness of <20 cm with 12.5 km spatial resolution using 36GHz and 89GHz brightness temperatures. This algorithm derives thermal ice thickness, defined as the thickness at which the calculated total heat flux would be realized if the ice thickness were uniform in the satellite footprint. The thermal ice thickness is suitable for calculating heat flux in the microwave footprint.



AF: active frazil, a mixture of grease/frazil ice and open water formed under turbulent conditions
TS: thin solid ice, a relatively uniform thin ice region formed under calm conditions

Validation method

AMSR2 thin ice thicknesses were compared with those estimated from heat flux calculations that use ice surface temperatures from Aqua/MODIS thermal infrared images (Band 31 and 32). As the atmospheric input data, we used air temperature at 2 m, dewpoint temperature at 2 m, wind speed at 10 m, and surface sea level pressure from 1-h ECMWF ERA5 reanalysis data.

Target accuracy

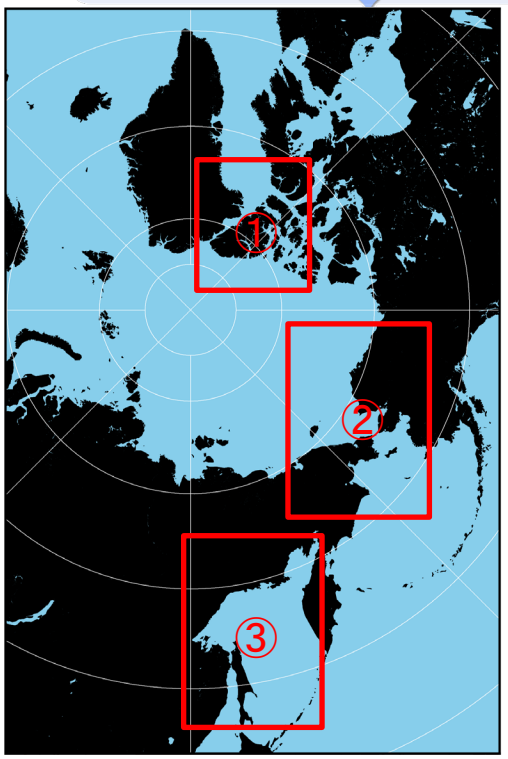
Thin solid ice: ±10 cm, Active frazil: ±3 cm

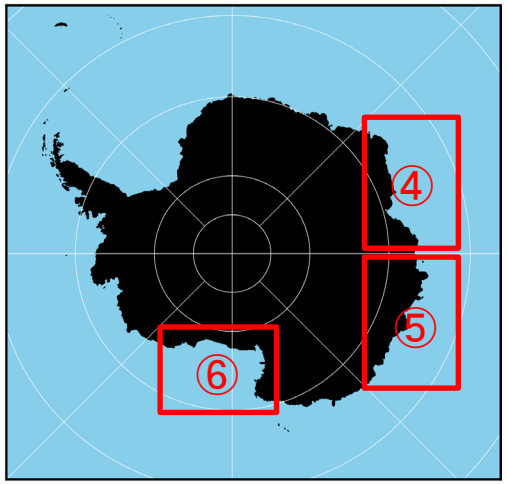
Calculation of MODIS Ice Thickness

Target area
-Northern Hemisphere (Nov.-Apr. for 2012/2013-2014/2015)
① Baffin Bay
② Chukchi Sea + Bering Sea + East Siberian Sea
③ Sea of Okhotsk
-Southern Hemisphere (Apr.-Oct. for 2013-2015)
④ East Antarctica (Indian Ocean Sector)
⑤ East Antarctica (Western Pacific Ocean Sector)
⑥ Ross Sea

MODIS pixel selection
- AMSR2 sea ice concentration of >30%
- Sun zenith angle of <15°
- MODIS sensor zenith angle of <40°
- No cloud cover (identified by a visual inspection approach)

Calculation of ice thickness from MODIS data.
1. MODIS surface temperatures were downscaled to match the AMSR2 36GHz resolution (12 km x 7 km) by using the AMSR2 antenna pattern.
2. Using the above surface temperature and ERA5 atmospheric data, heat flux between the atmosphere and sea ice is calculated and converted to sea ice thickness.

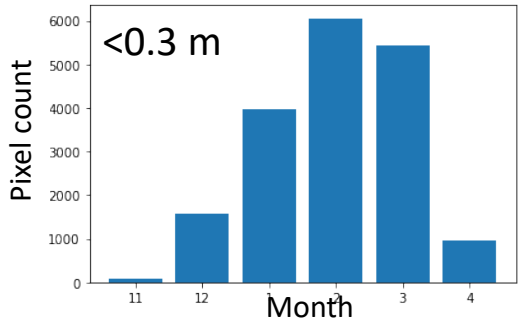




Validation Data

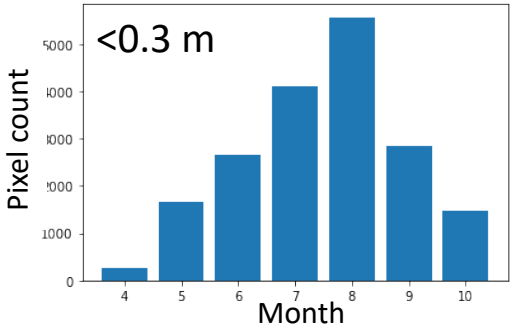
Northern Hemisphere

	Scene	Total pixel	Thin ice pixel of <0.3 m
①	28	12193	1210
②	40	64058	7509
③	35	16244	9199
Total	104	92495	17918

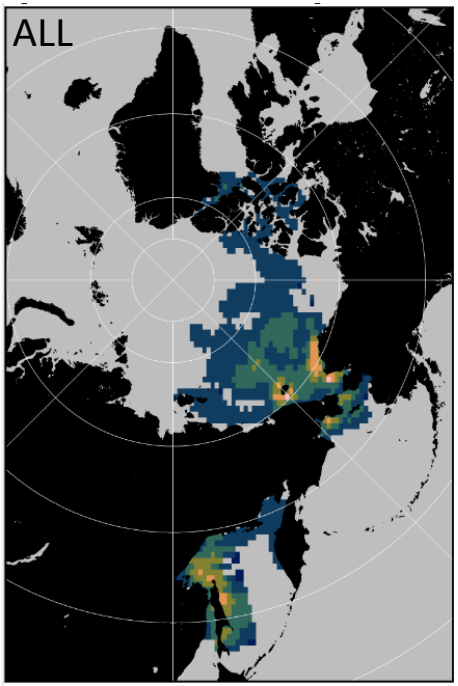


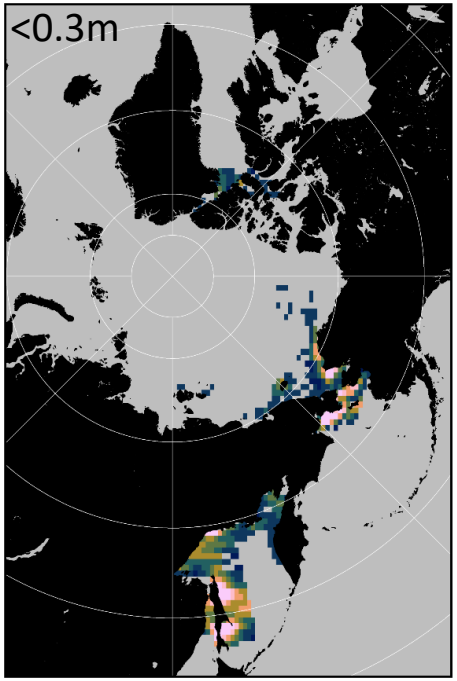
Southern Hemisphere

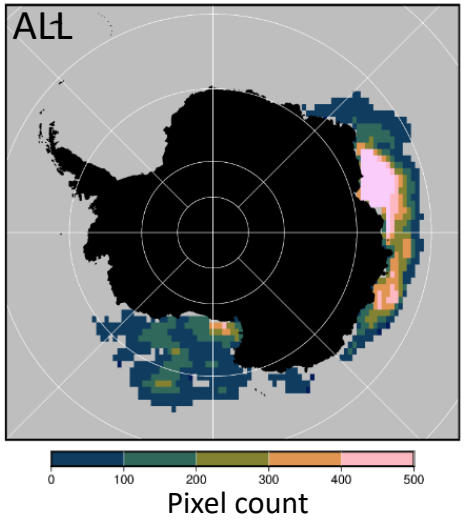
	Scene	Total pixel	Thin ice pixel of <0.3
④	42	85805	9451
⑤	38	28553	4655
⑥	42	52218	4270
Total	122	166576	18376

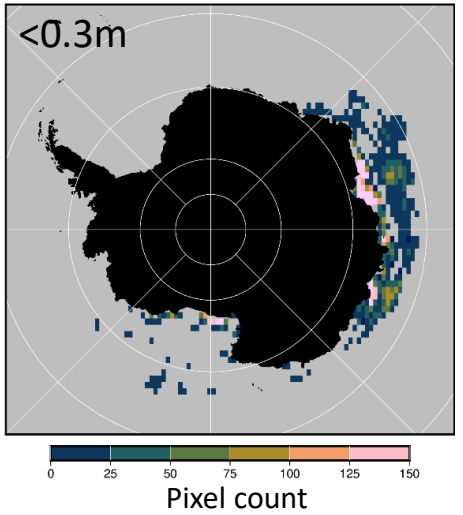


Number of collected MODIS TIT



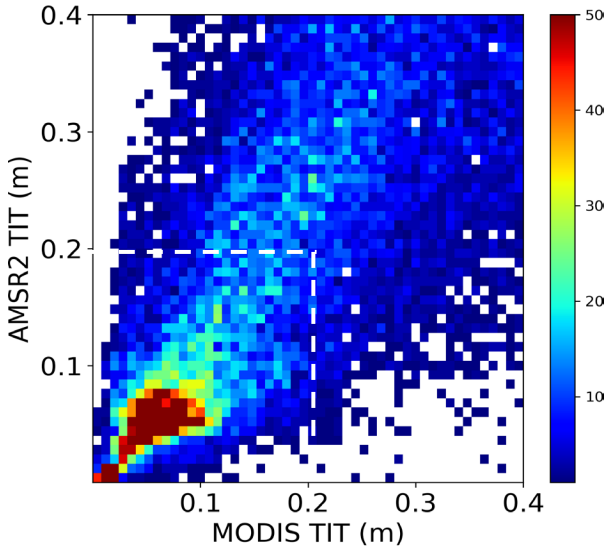




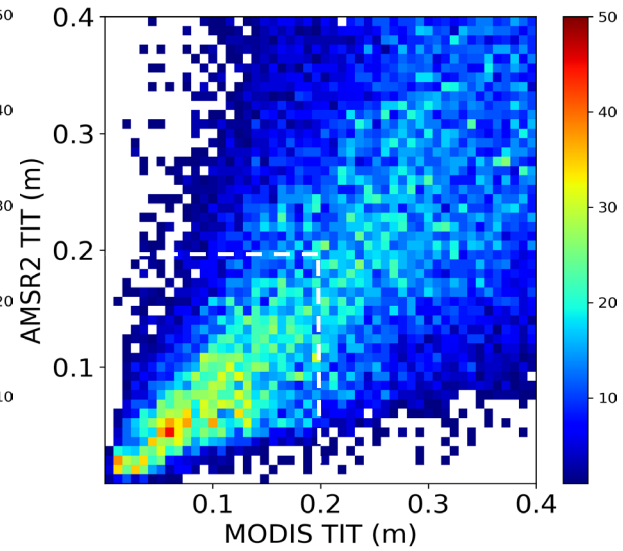


Validation Result

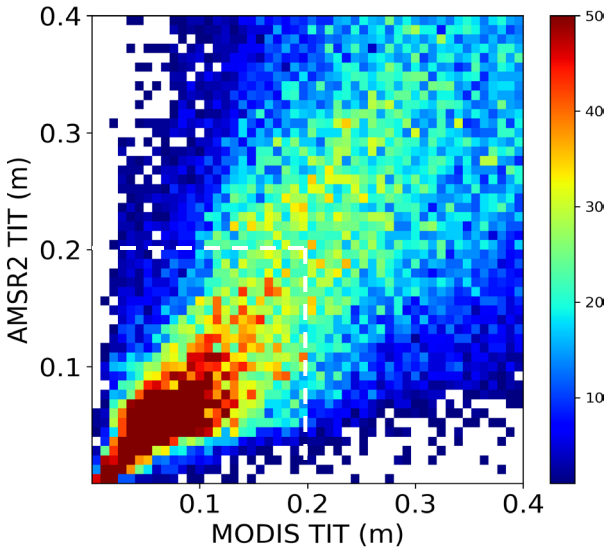
Northern Hemisphere



Southern Hemisphere



Total



- Accuracies calculated by using AMSR2 and MODIS TIT of <0.2 m and <0.3 m.

	AF	SI	Total
MAE	**1.4 cm**	**4.0 cm**	**3.8 cm**
RMSE	2.9 cm	5.3 cm	5.2 cm
Bias	-0.1 cm	-0.1 cm	-0.1 cm

	AF	SI	Total
MAE	**2.8 cm**	**5.8 cm**	**5.7 cm**
RMSE	4.8 cm	7.5 cm	7.4 cm
Bias	-2.0 cm	-4.2 cm	-4.1 cm

	AF	SI	Total
MAE	**2.0 cm**	**5.0 cm**	**4.8 cm**
RMSE	3.8 cm	6.6 cm	6.5 cm
Bias	-1.6 cm	-2.7 cm	-2.6 cm

Achieved the target accuracies

- Confusion matrix

AMSR2

MODIS	<20cm	>20cm
<20cm	8490	3463
>20cm	1366	79176

	<20cm	>20cm
<20cm	7310	2653
>20cm	10173	146440

	<20cm	>20cm
<20cm	15800	6116
>20cm	11539	225616