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Spatial resolution of AMSR2 sea surface temperature

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Introduction

JAXA produces the three products of sea surface temperature (SST) from the AMSR2 observations

Product	Freqeuncy (GHz)	Footprint (km)	Expected resolution (km)	Accuracy (°C) (RMSE)
Standard SST	6.9	35 × 61	50	0.48
10-GHz SST	10.65	24 × 41	30	0.66
Multi-band SST	6.9, 7.3, 10.65		30-50	0.49

JAXA GCOM-W websites

The spatial resolution has not been validated yet by the observations. How much is 10-GHz SST better than standard SST? AMSR3 on GOSAT-GW (Global Observing SATellite for Greenhouse gases and Water cycle)

High-resolution SST is an important target

 Additional 10GHz channel (10.25GHz, 500MHz bandwidth)



 Spatial resolution enhancement algorithm for SST retrieval (Maeda et al. 2021)

The validation of spatial resolution is necessary for assessing the achievement of the mission goal

Objective

- Develop the method to estimate the spatial resolution of SST based on the observations
- Apply the method to the JAXA AMSR2 SST product to estimate the spatial resolution

Almost achieved

Method

Compare the AMSR2 SST to the infrared SST measured by Himawari (Japanese Geostationary Meteorological Satellite)

Analysis region



Sharp SST fronts are utilized to estimate the resolution

Method

- 1. Detect sharp SST fronts common in the AMSR2 and Himawari SSTs
- 2. Smooth the SST fronts of Himawari using a spatial filter with different cutoff wavelengths
- 3. Compute the SST gradients from the smoothed Himawari SST profiles
- 4. Find the best fit of the smoothed SST gradient to the AMSR2 SST gradient, whose cutoff wavelength is regarded as the spatial resolution of the AMSR2 SST

Sharp fronts contain broad spectral energy in the wavelength domain

SST and smoothed SST profiles across a SST front



Data

GCOM-W AMSR2

- SST ver. 4 (standard, 10 GHz, Multi band)
- Grid spacing of 0.1° (10 km)
- Provided by JAXA

<u>Himawari AHI (Advanced Himawari Imager)</u>

- Skin SST retrieved from 10.4, 11.2, and 8.6 µm data (Kurihara et al. 2016)
- Grid spacing of 0.02° (2 km)
- Hourly data (produced from every 10-minute measurements)
- Provided by JAXA

Analysis period is 7 years from July 2015 to October 2021

SST and SST gradient on Apr. 30, 2017



Detection of sharp SST fronts

50 km

 ∇SST

front

AMSR2

- ✓ Fronts with the maximum SST gradient within ± 50 km across the fronts
- \checkmark Direction of the SST gradient vectors are almost the same (<30 degree) among the three SSTs (isotherm)

Himawari

- \checkmark Fronts with the maximum SST gradient within the AMSR2 pixel
- ✓ Sharp fronts (> 2°C/10 km) with the same direction of the SST gradient vector as that of the AMSR2 (< 30 degree)
- \checkmark Fronts with no missing data within ±100 km across the fronts

Ascending: 4457, Descending: 2203

Himawari

Composite of the SST profiles across the fronts (SST is subtracted by SST at the front position)



Relationship between AMSR2 and Himawari SST gradients AMSR2 standard SST, ascending

Red curve: Mean and 95% confidence interval (every 2×10⁻⁵ ℃/m bin)



Stronger fronts are smoothed more strongly in the AMSR2 measurements

Ratio of the AMSR2 SST gradients to the Himawari SST gradients

10GHz, Multi band, Standard



- Stronger fronts are smoothed more strongly
- 10-GHz SST is less smoothed than the standard and multi-band SSTs

Smoothing the Himawari SST fronts



wavenumber resolution
$$\Delta k = \frac{1}{N\Delta d}$$
, $N = 1024$, $\Delta d = 2km$

Ratio of the smoothed Himawari SST gradients to the original Himawari SST gradients



As in the AMSR2, stronger fronts are smoothed more strongly

Ratio of the smoothed Himawari SST gradients to the original Himawari SST gradients



Find λc of the best fit with the minimum RMSD between the AMSR2 and smoothed Himawari SST gradients

Summary

Product	Footprint (km)	Expected resolution (km)	Resolution in wavelength (km) Ascending	Resolution in wavelength (km) Descending
Standard SST	35 × 61	50	137 [128-137]	137 [128-158]
10-GHz SST	24 × 41	30	102 [93-108]	102 [98-108]
Multi-band SST		30-50	128 [120-128]	120 [114-128]

The resolution in wavelength is about 2-3 times the footprint size

Plans

- Make use of a 2D filter to smooth the Himawari SST maps
- Examine the dependency of the resolution on temperature

Ensemble-mean zonal wavenumber SST spectrum Zonal profiles with no missing data longer than 800 km

