Comparison of SSMIS and AMSR2 Sea Ice Concentration in the Amundsen Sea, West Antarctica, with KOMPSAT-5 SAR Images

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Abstract: The Special Sensor Microwave Imager/Sounder (SSMIS) and the Advanced Microwave Scanning Radiometer 2 (AMSR2) are the representative passive microwave sensors, which have produced sea ice concentration (SIC) since 2008 and 2012, respectively. As the SIC products are widely used in climate change researches, it is very important to evaluate their accuracies, especially in sea ice melting season. In this study, the SSMIS and AMSR2 SICs over the Amundsen Sea, West Antarctica were assessed by using KOrea Multi-Purpose SATellite-5 (KOMPSAT-5) Synthetic Aperture Radar (SAR) images obtained during January-February 2016. Sea ice and open water were classified from the SAR images based on Random Forest (RF), a rule-based machine learning approach, in which texture features derived from backscattering intensity and gray level co-occurrence matrix (GLCM) were used as input variables. SIC was computed from the RF-derived sea ice maps and compared with the SSMIS and AMSR2 SICs. The AMSR2 SIC showed root mean square deviation (RMSD) of 16.1% which is smaller than the SSMIS SIC (RMSD of 25.9%). However, both the SSMIS and AMSR2 SICs over the Amundsen Sea in the Antarctic summer were underestimated.

Background and Objectives

- Sea ice concentration (SIC) from passive microwave (PM) observations
  - has been used for assisting human activities in polar region and climate change researches since 1970s
  - The Special Sensor Microwave Imager/Sounder (SSMIS) and the Advanced Microwave Scanning Radiometer 2 (AMSR2) are the representative PM sensors
  - it is important to evaluate accuracy of SIC from the PM sensors
- Synthetic aperture radar (SAR)
  - a powerful tool for observing sea ice with high resolution regardless of weather conditions and sun altitude
  - can be used to evaluate the accuracy of SIC from PM observations

The objectives of this research are…

- to develop sea ice mapping model for KOrea Multi-Purpose SATellite-5 (KOMPSAT-5) SAR images based on a rule-based machine learning approach
- to evaluate the performance of sea ice mapping model
- to assess the accuracy of SIC derived from SSMIS and AMSR2 observations

Data and methodology

Mosaic of KOMPSAT-5 SAR images in the Amundsen Sea
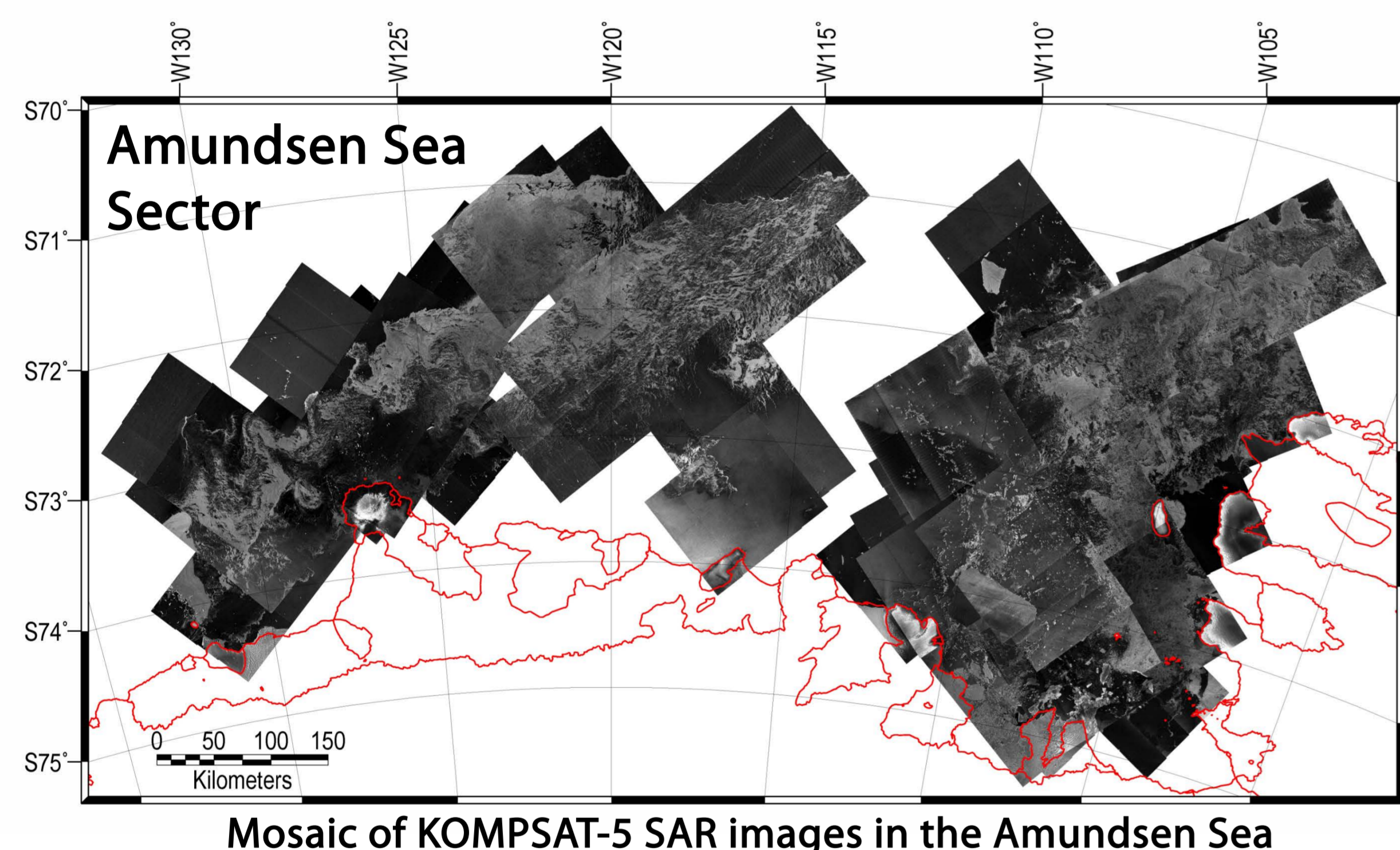
- KOMPSAT-5 SAR
  - 1 Jan.~11 Feb. 2016
  - 84 scenes
  - 100 km × 100 km coverage
  - HH-pol, 6.25-m grid spacing

- Passive microwave SICs
  - SSMIS NASA Team (NT) SIC with 25 km grid
 - AMSR2 ARTIST Sea Ice (ASI) SIC with 6.25 km grid

Data processing flow

1) 2×2 block averaging of KOMPSAT-5 SAR images
2) Extracting texture features of backscattering intensity and GLCM
3) Normalizing texture features
4) Sampling the texture features for sea ice and open water
5) Training and validating sea ice mapping model based on Random Forest
6) Comparison of SIC from KOMPSAT-5 sea ice map with PM (SSMIS and AMSR2) SICs
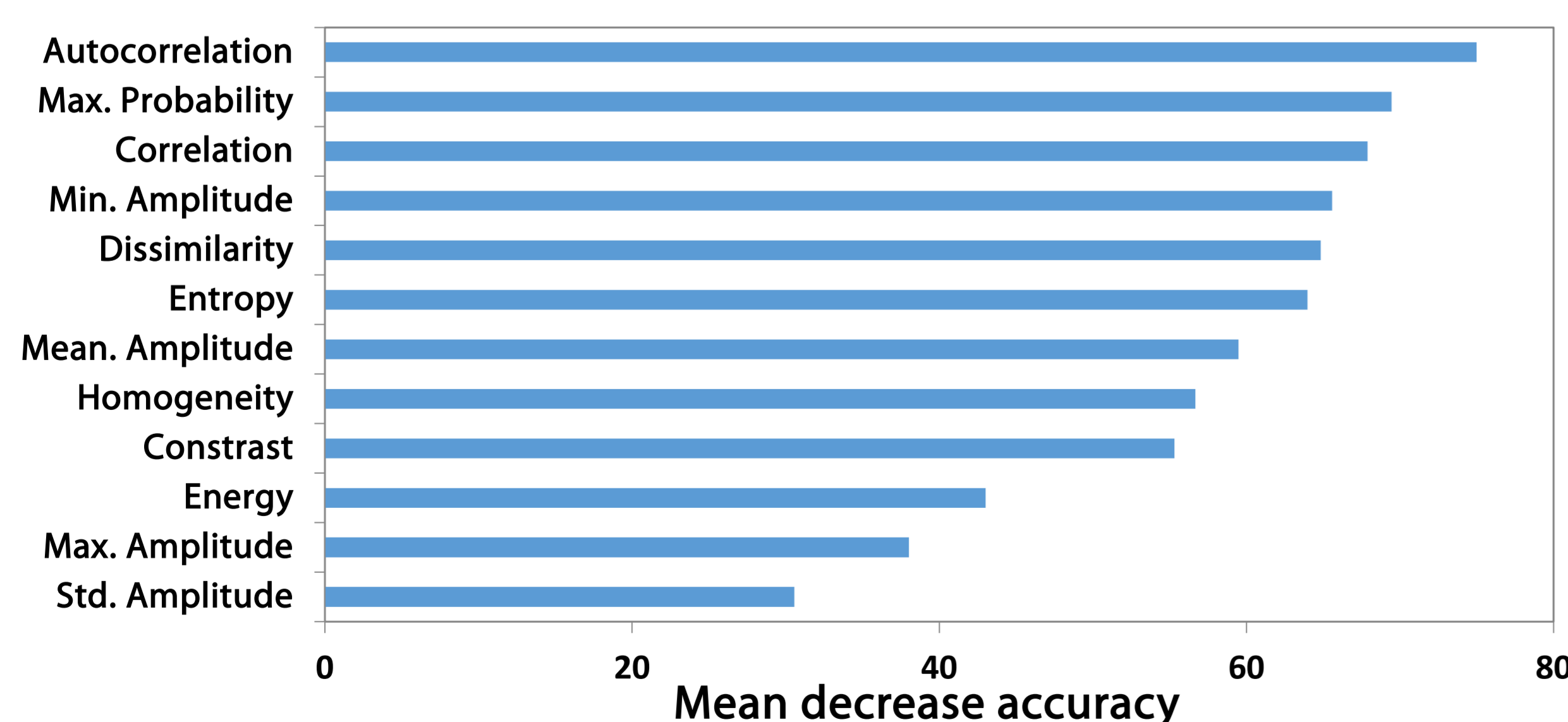
Results

Accuracy assessment result of the RF-based sea ice mapping model for the KOMPSAT-5 EW SAR images

Classified as \ Reference	Sea ice	Open water	Sum	User's accuracy
Sea ice	29186	256	29442	99.13%
Open water	814	29744	30558	97.34%
Sum	30000	30000	60000	
Producer's accuracy	97.29%	99.15%		
Overall accuracy			98.22%	
Kappa coefficient			96.43%	

Some examples of KOMPSAT-5 SAR images and the RF-based sea ice maps

KOMPSAT-5 SAR images

RF-based sea ice maps for the KOMPSAT-5 SAR (sea ice in green)
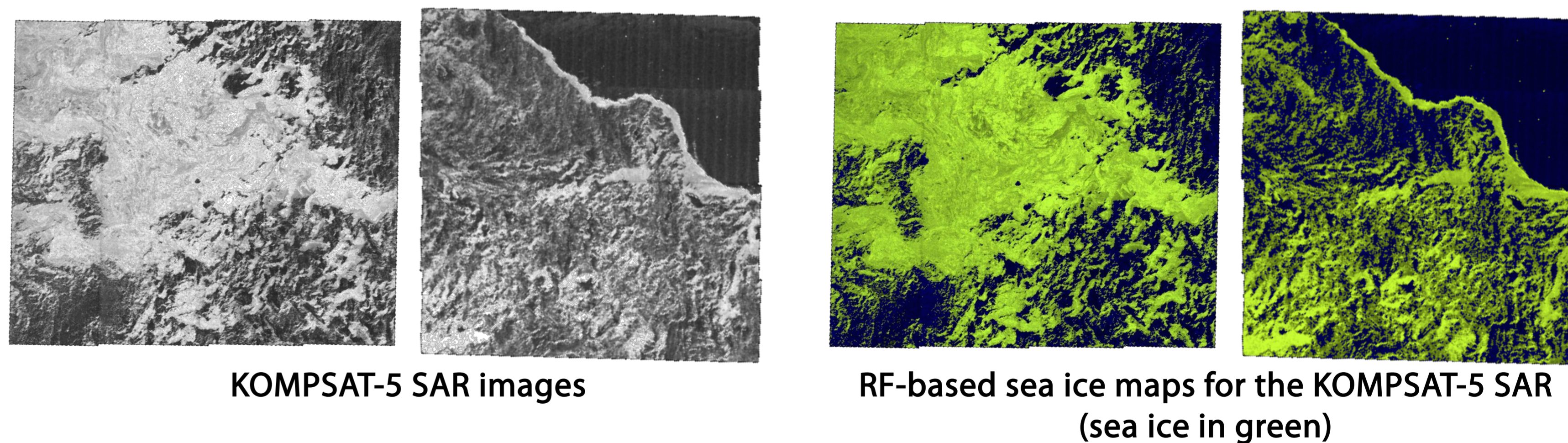
Importance of input variables (texture features) of the RF-based sea ice mapping model

Comparison of KOMPSAT-5 SIC with SSMIS and AMSR2 SICs

427 points
RMSD=25.87%
$y=0.429x+20.647$
$R^2=0.408$

268 points
RMSD=16.07%
$y=0.778x+12.647$
$R^2=0.655$
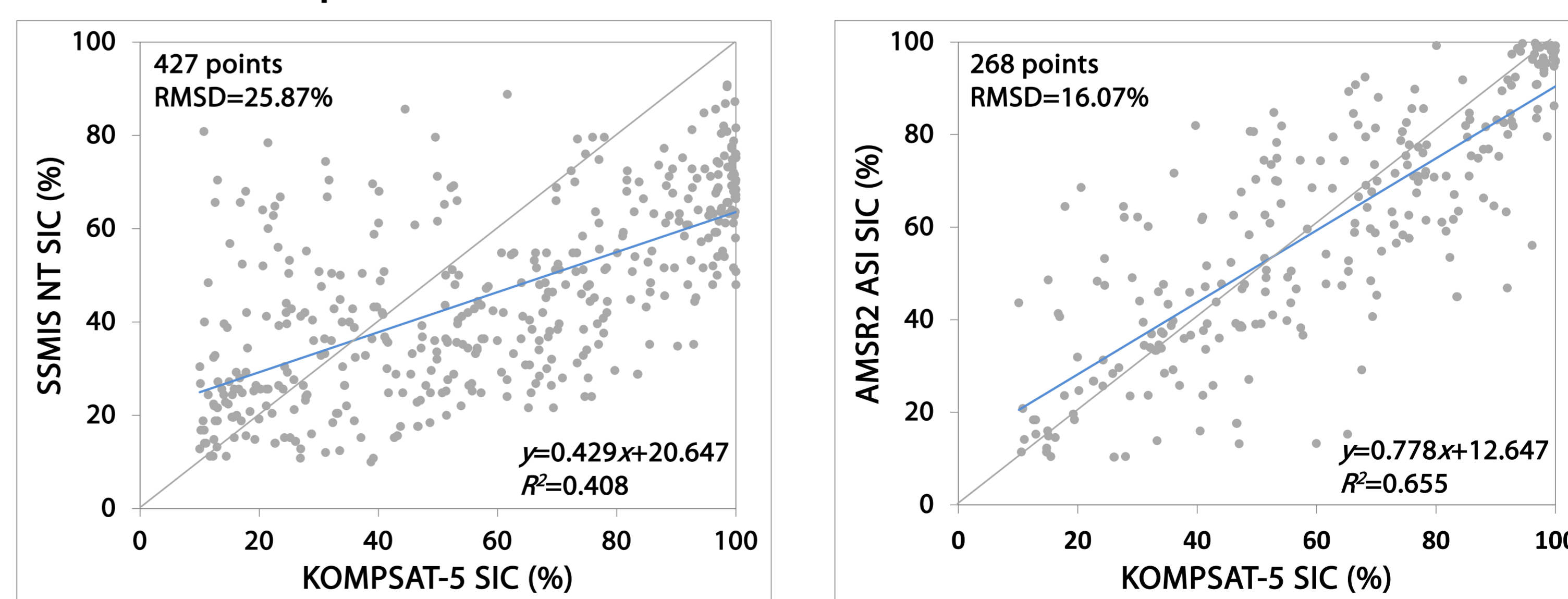
Summary

- A sea ice mapping model for KOMPSAT-5 SAR data over the Amundsen Sea was developed using RF and its performance was validated.
- The overall error in the ASI SIC was smaller than the NT SIC over the Amundsen Sea in summer, while both SICs were underestimated.
- It should be emphasized that the KOMPSAT-5 SAR images can be used to produce high-resolution sea ice maps of the Antarctic Ocean.

Acknowledgement