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ASSEMBLY

COSI (Calibration of sea ice forecasts)

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COSI (Calibration of sea ice forecasts)

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Norwegian Meteorological Institute

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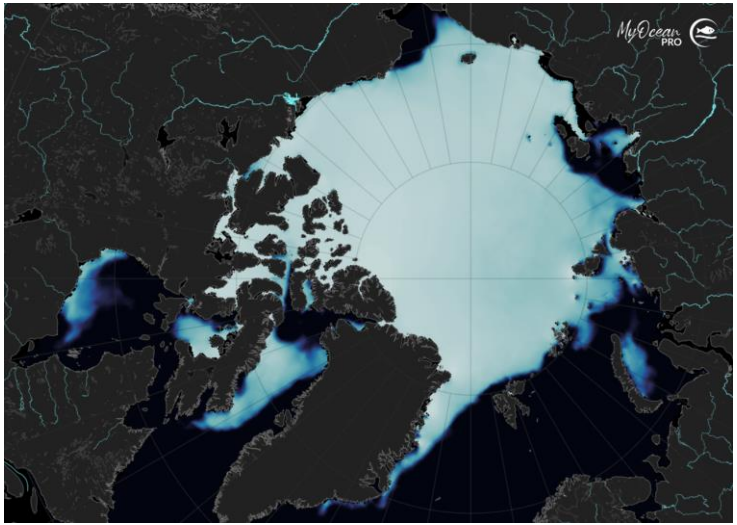
Post-processing / Calibration of sea ice forecasts

- Common in weather forecasting
- Not common in short-term sea ice forecasting
- Sea ice forecasts have considerable biases following spatio-temporal patterns
- Machine learning models are suitable for correcting forecast biases



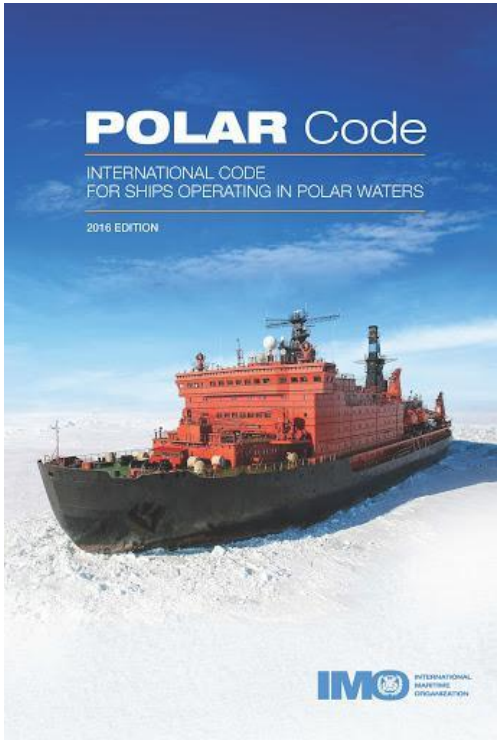
Developing sea ice forecasts tailored to end-user needs

Polar code:

- Ship crews planning to navigate in areas with a risk of sea ice concentration higher than 10 % must acquire sea ice information before their journeys
- Different requirements for ship operating in areas with a sea ice concentration between 10 % and 20 %, and higher than 20 %

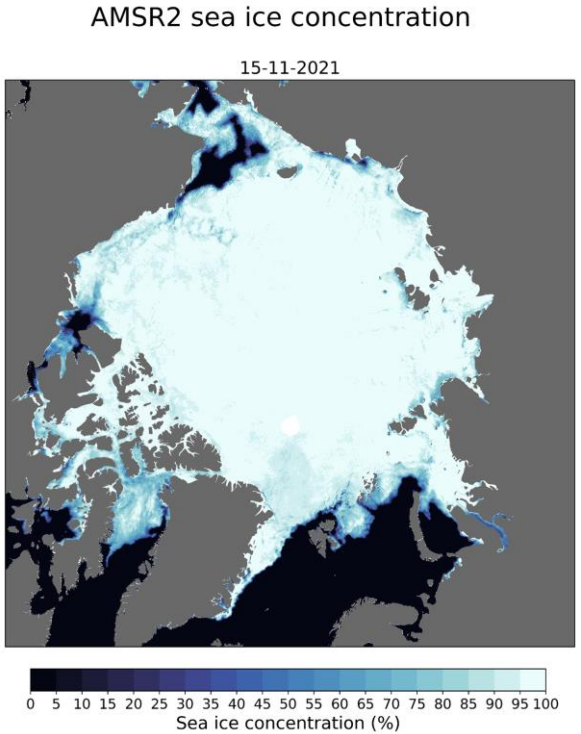
In COSI:

- Improving the accuracy of deterministic sea ice concentration forecasts
- Sea-ice probability forecasts for thresholds of 10 % and 20 % in the sea-ice concentration (in agreement with the Polar Code requirements)



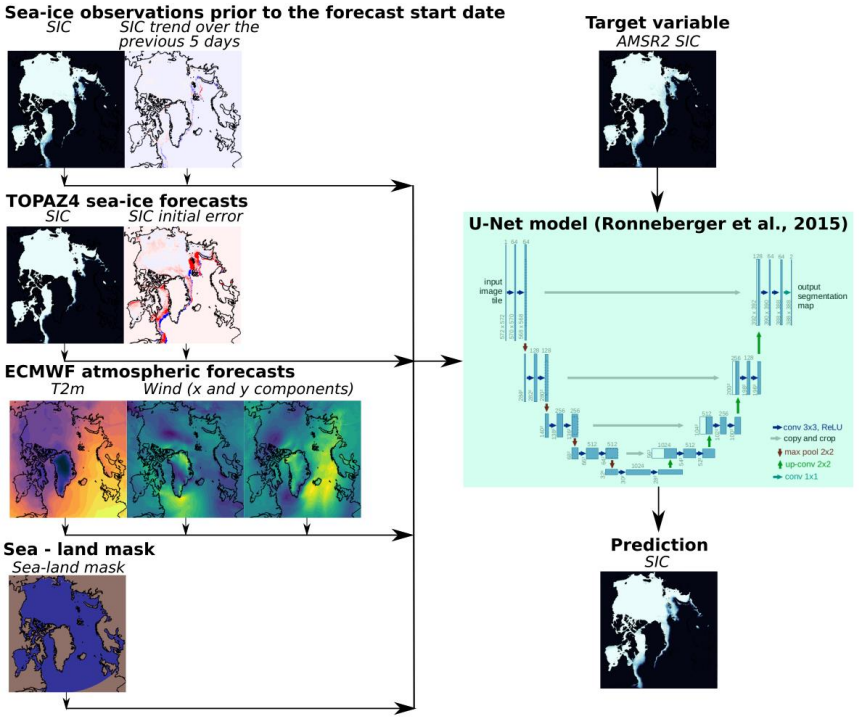
Post-processing of sea ice concentration forecasts from the TOPAZ prediction system

- Supervised machine learning →Need a dataset with at least the same spatial resolution as the sea ice forecasts from the physically based model
- In COSI: post-processing of TOPAZ4 forecasts (12.5 km resolution)
- Goal post-COSI: post-processing of TOPAZ5 forecasts (6.25 km resolution)
- Development of new satellite sea ice concentration observations at 5 km resolution in COSI

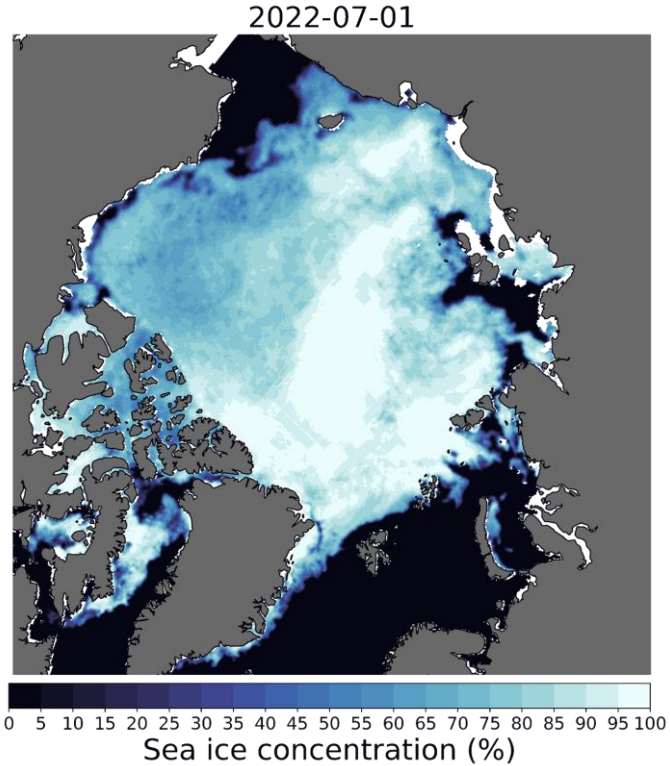


Post-processing sea ice concentration forecasts from TOPAZ4

- Attention residual U-Net architecture (39 million parameters)
- Loss function: mean squared error
- Training period: 2013-2020, validation period: 2021, test period: 2022
- Training the deep learning models takes about 3 hours on a GPU
- Predicting the sea ice concentration for the next 10 days takes about 4 minutes (including data preparation)



How do the deep learning forecasts look like ?



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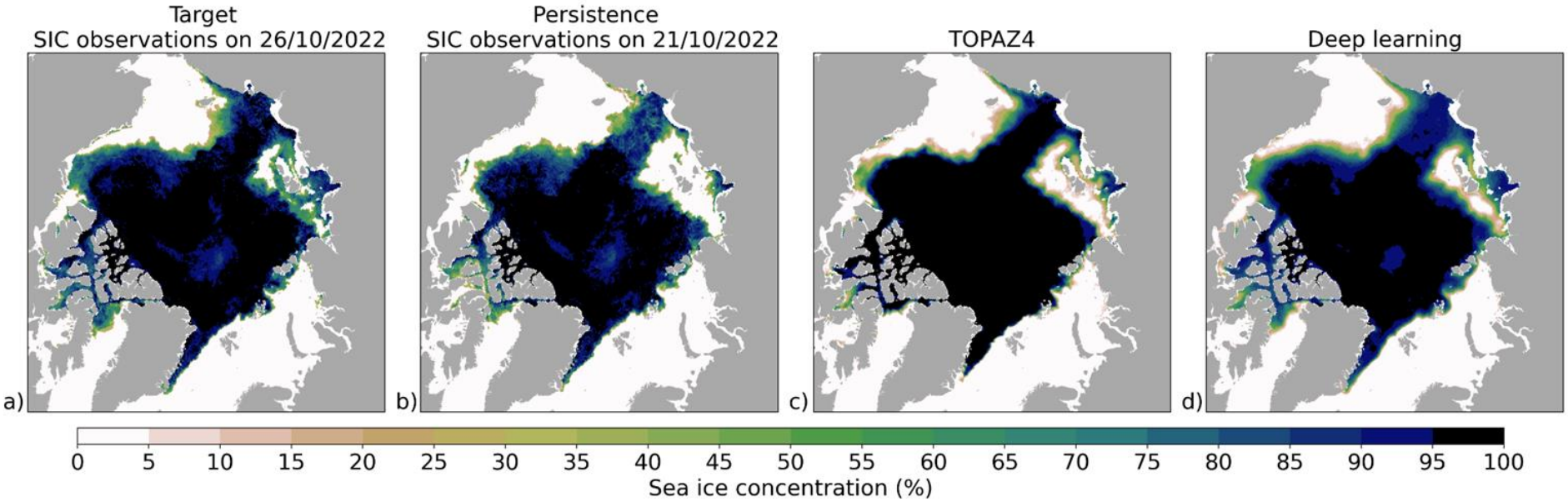
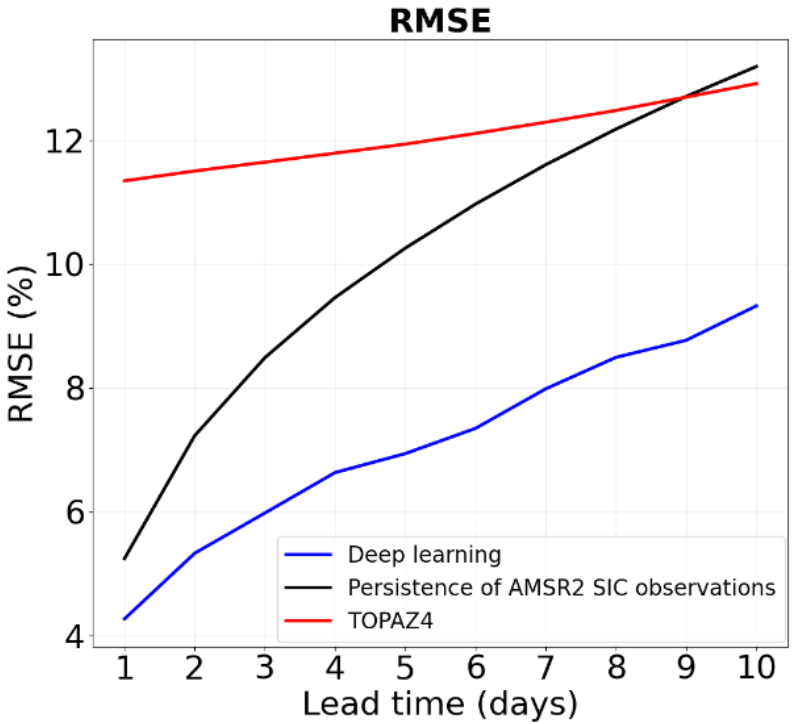


How do the deterministic deep learning forecasts perform ?

On average, the Sea Ice Concentration RMSE from the deep learning forecasts is:

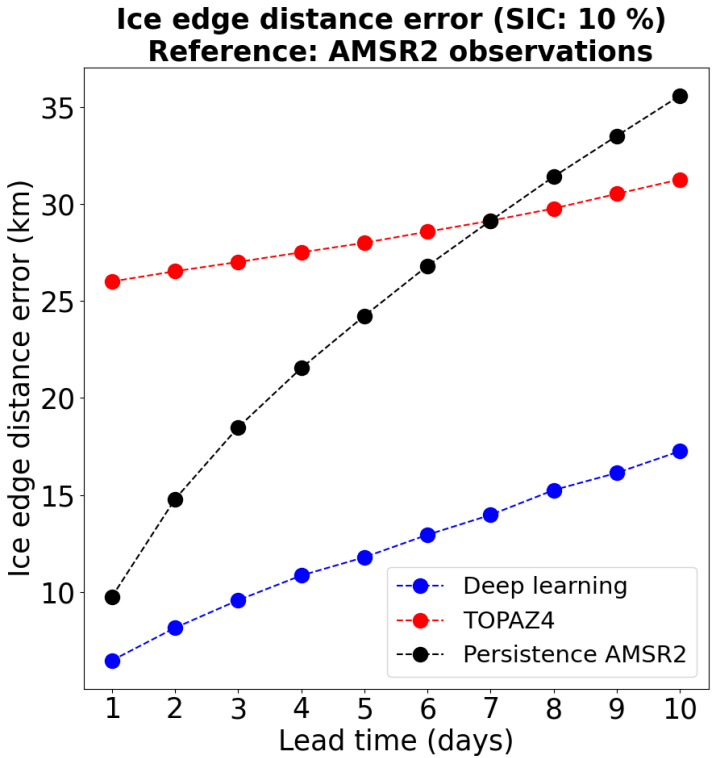
- 41 % lower than from TOPAZ4 (between 28 % and 62 % depending on lead time)
- 29 % lower than from persistence of AMSR2 satellite observations (between 19 % and 33 % depending on lead time)



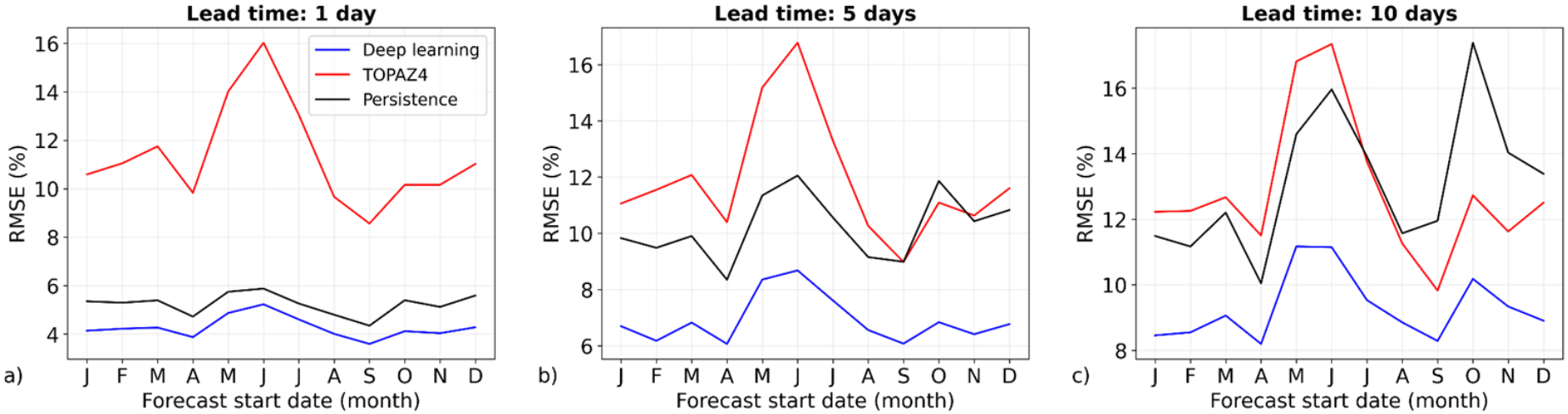
How do the probabilistic deep learning forecasts perform ?

On average, the error for the ice edge position from the deep learning forecasts is:

- 57 % lower than from TOPAZ4 (between 45 % and 75 % depending on lead time)
- 49 % lower than from persistence of AMSR2 satellite observations (between 34 % and 52 % depending on lead time)



How do the deep learning forecasts perform ?



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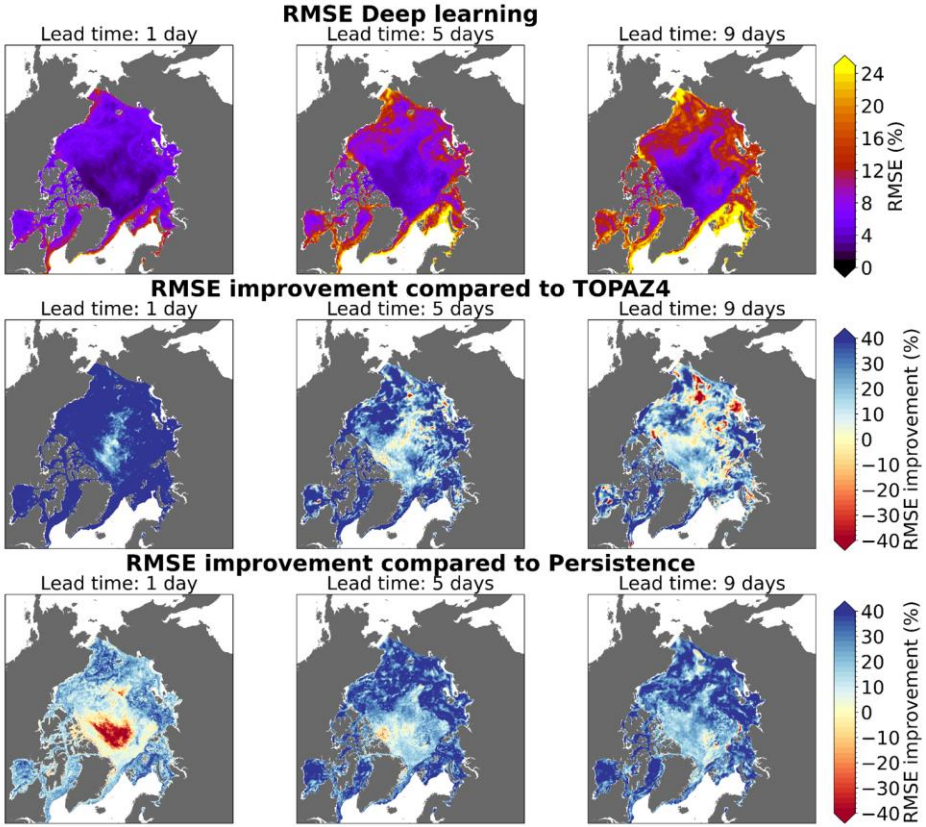

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Potential outcomes for CMEMS

- The production of TOPAZ4 has been stopped in April 2024
- Applying the same post-processing method to TOPAZ5 requires at least 2 years of forecasts
- Post-processing of TOPAZ5 in 2026 - 2027
- Prediction of new variables (sea ice probabilities for ice edges of 10 % and 20 % sea ice concentration)
- Methods described in the COSI final report and in a scientific paper (https://doi.org/10.5194/tc-18-2161-2024)
- The codes are publicly available on Github and can be used for similar applications