ICECAP
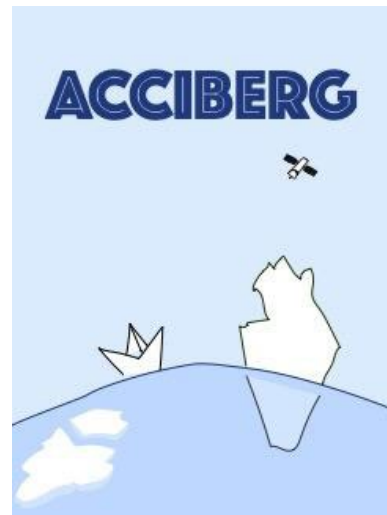
A tool to analyse multi-centre sea-ice forecasts from days to seasons

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Motivation

Several NWP and s2s systems produce sea-ice forecasts. However, end users (e.g. ice services) are often hesitant to use these.

Demand:

- *Meaningful* Information on sea ice variability from days to seasons ahead

- Targeted products

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Motivation

User products need to be provided alongside basic information on sea ice forecast quality → **often not provided**

Demand:

- *Meaningful* Information on sea ice variability from days to seasons ahead

- Targeted products

This requires info on:

- Forecast quality

- Forecast uncertainty

- Calibrated forecasts (often)

- Access to forecasts covering different time scales
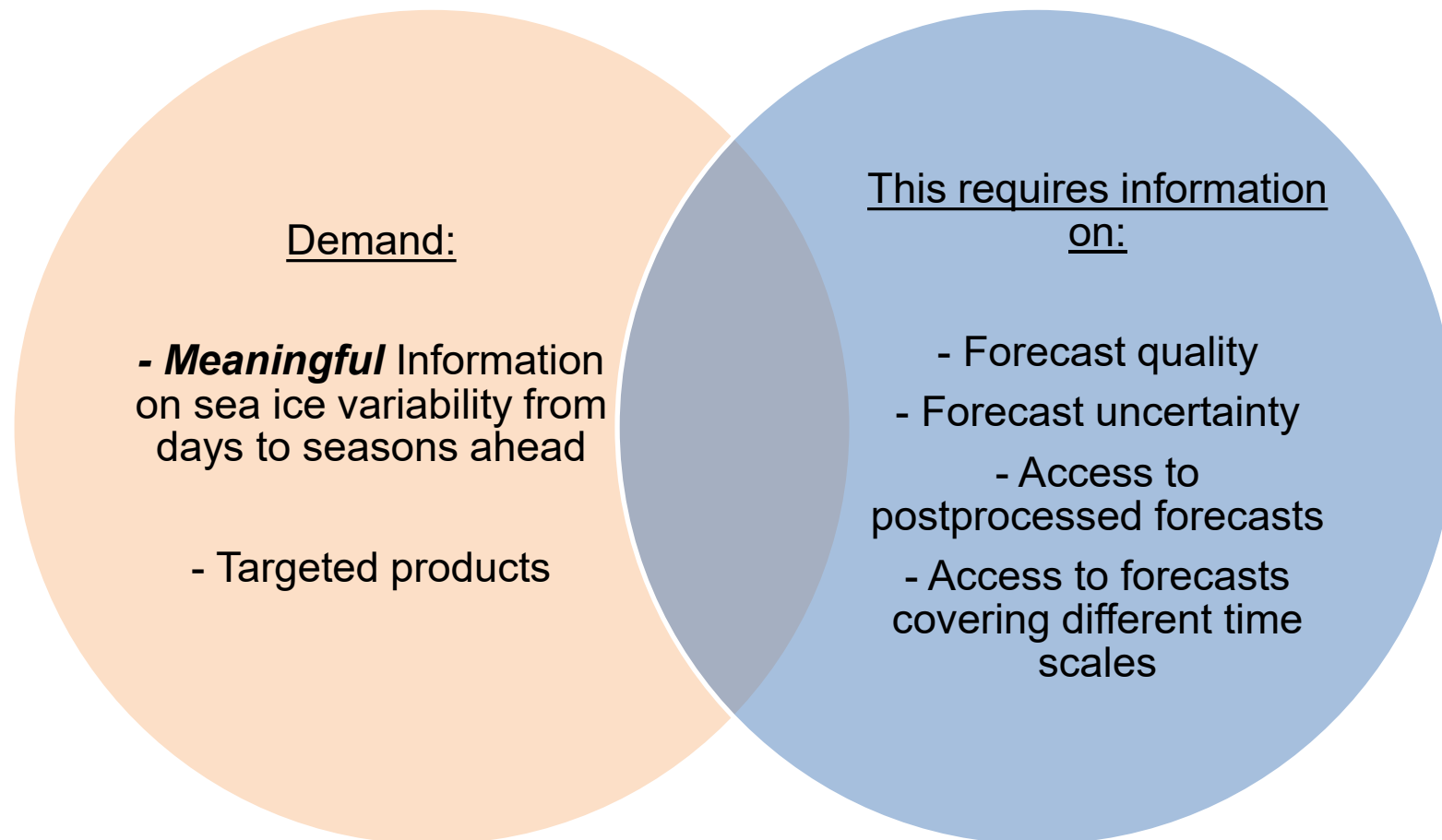
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Motivation

Demand:

- *Meaningful* Information on sea ice variability from days to seasons ahead

- Targeted products

This requires information on:

- Forecast quality
- Forecast uncertainty
- Access to postprocessed forecasts
- Access to forecasts covering different time scales

ICECAP: one tool to

- Provide prototype end-user products

- Validation of forecasts incl. deterministic and probabilistic metrics

- Calibration of forecast data

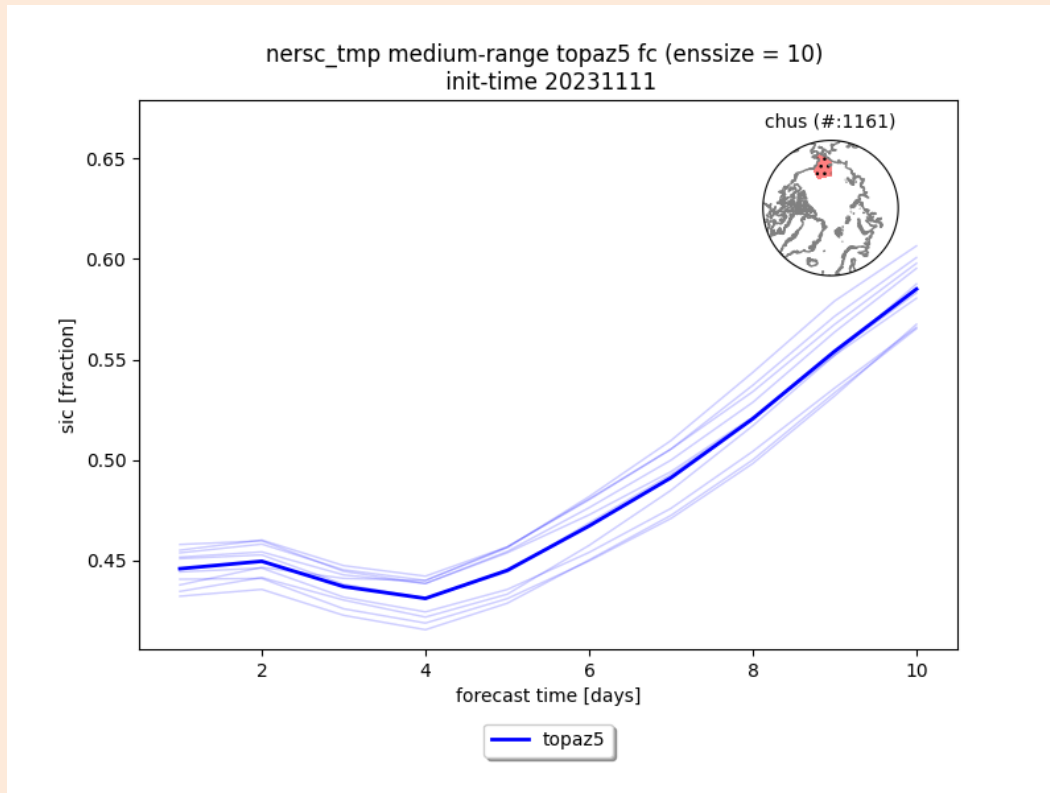- Access medium, sub-seasonal and seasonal sea ice forecasts

ICECAP aims to foster user uptake and support model development and can be easily further developed by the scientific community

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1. Example for medium-range forecast

Medium-range example: TOPAZ5 – Forecast plumes
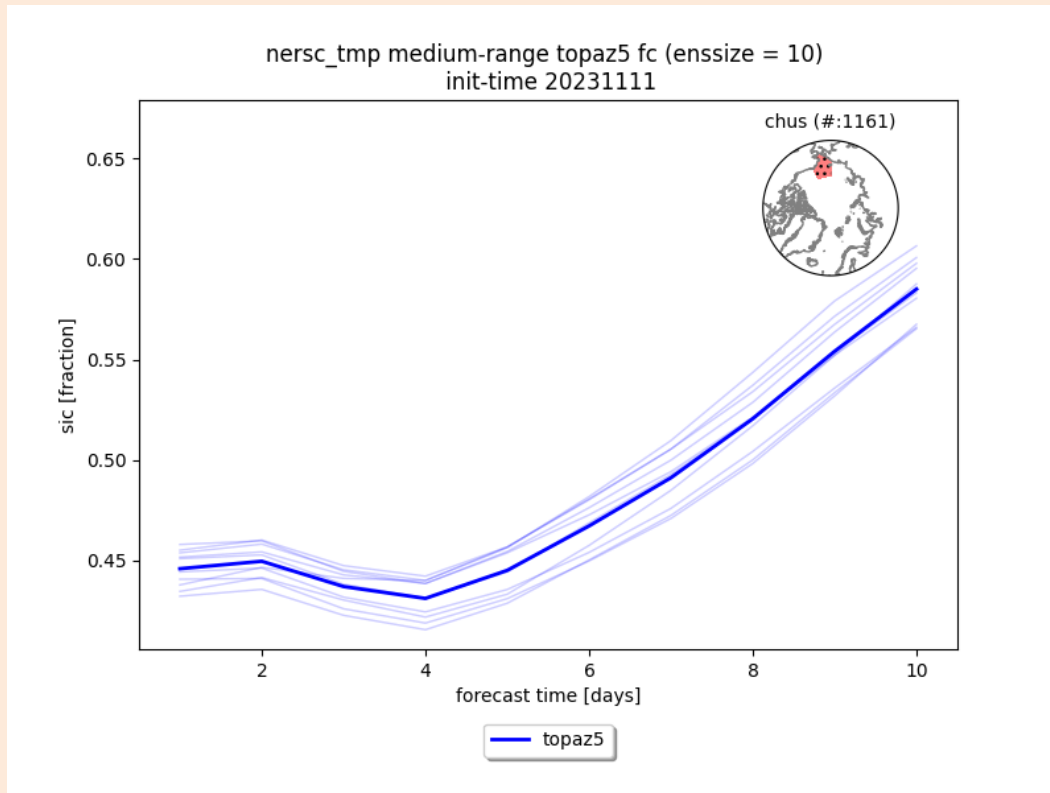
Example user product:

Forecast plume (one forecast)
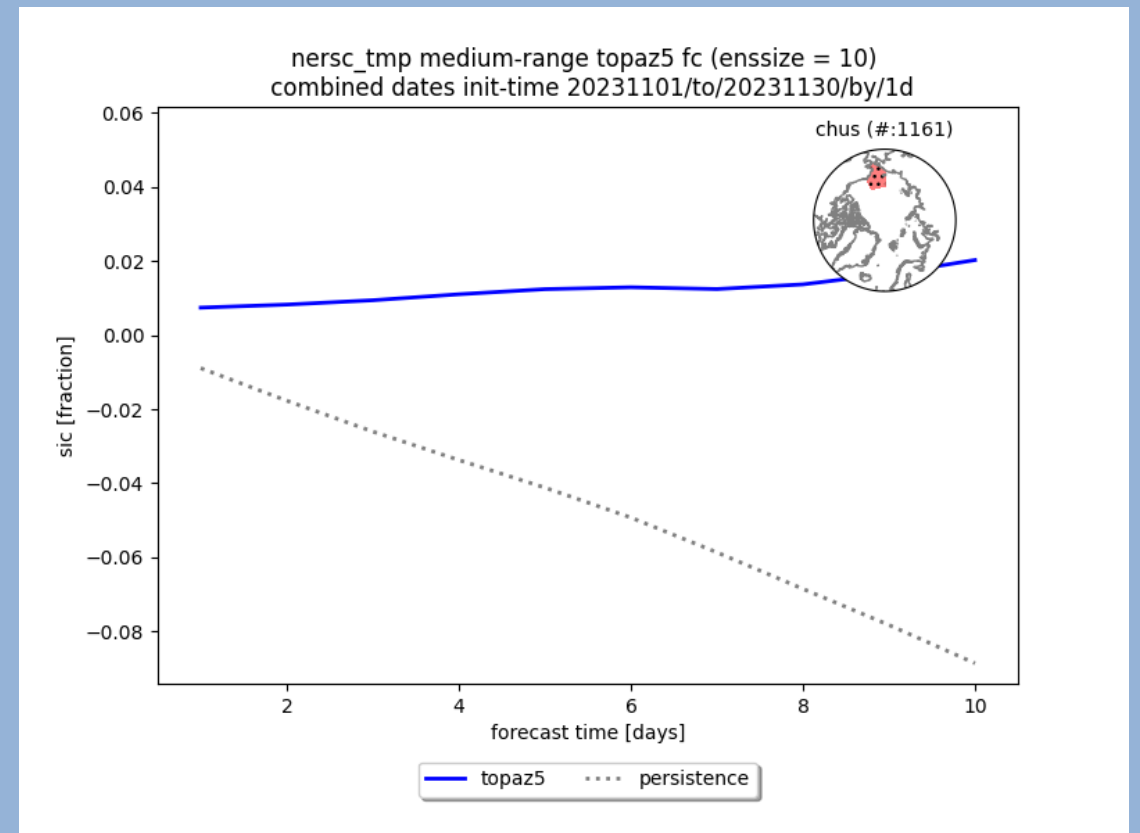

Can we trust the forecast?

Medium-range example: TOPAZ5 – Forecast plumes

Example user product:

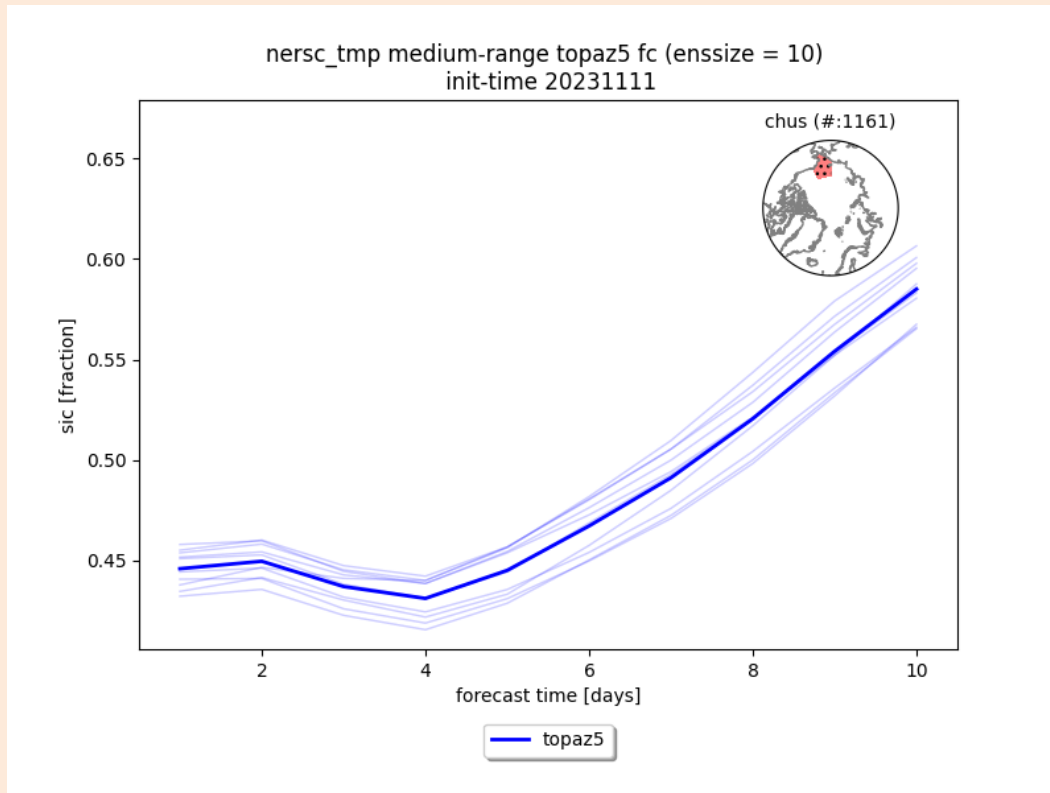*Forecast plume (one forecast)*

Can we trust the forecast?

Information on forecast quality + uncertainty

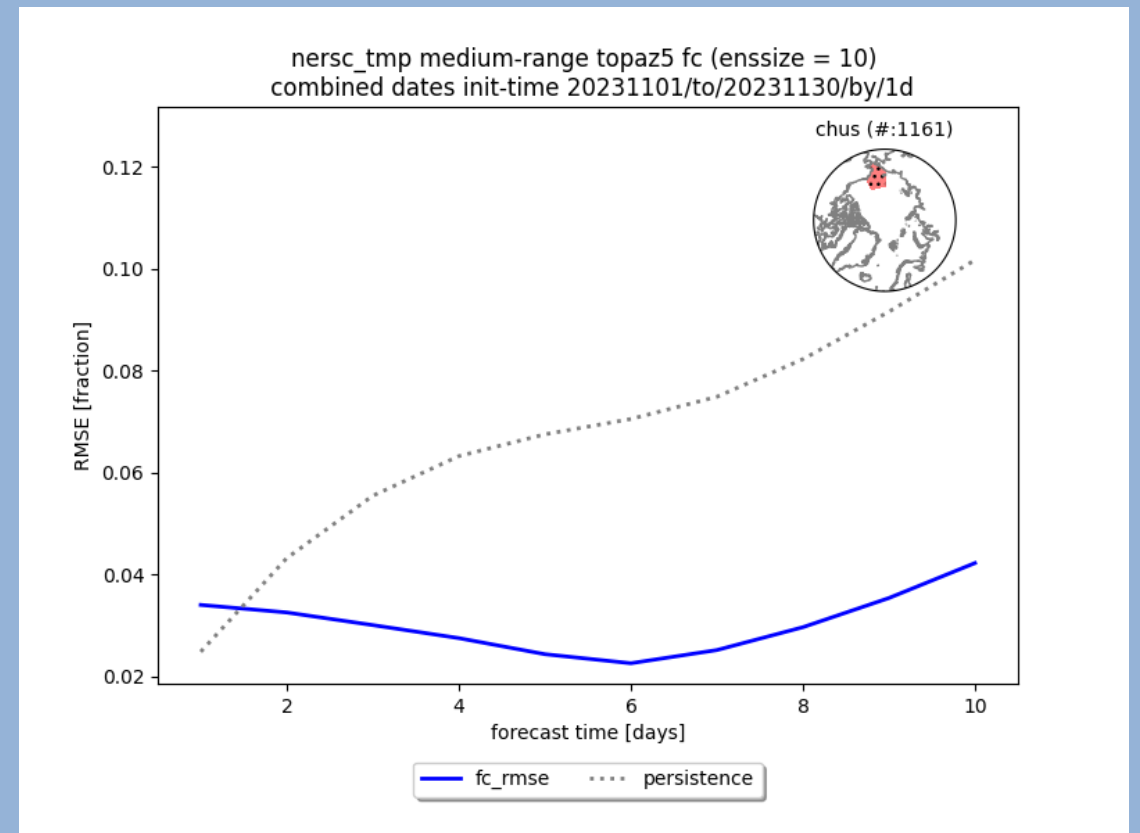*Average forecast bias (statistic of one month)*

Medium-range example: TOPAZ5 – Forecast plumes

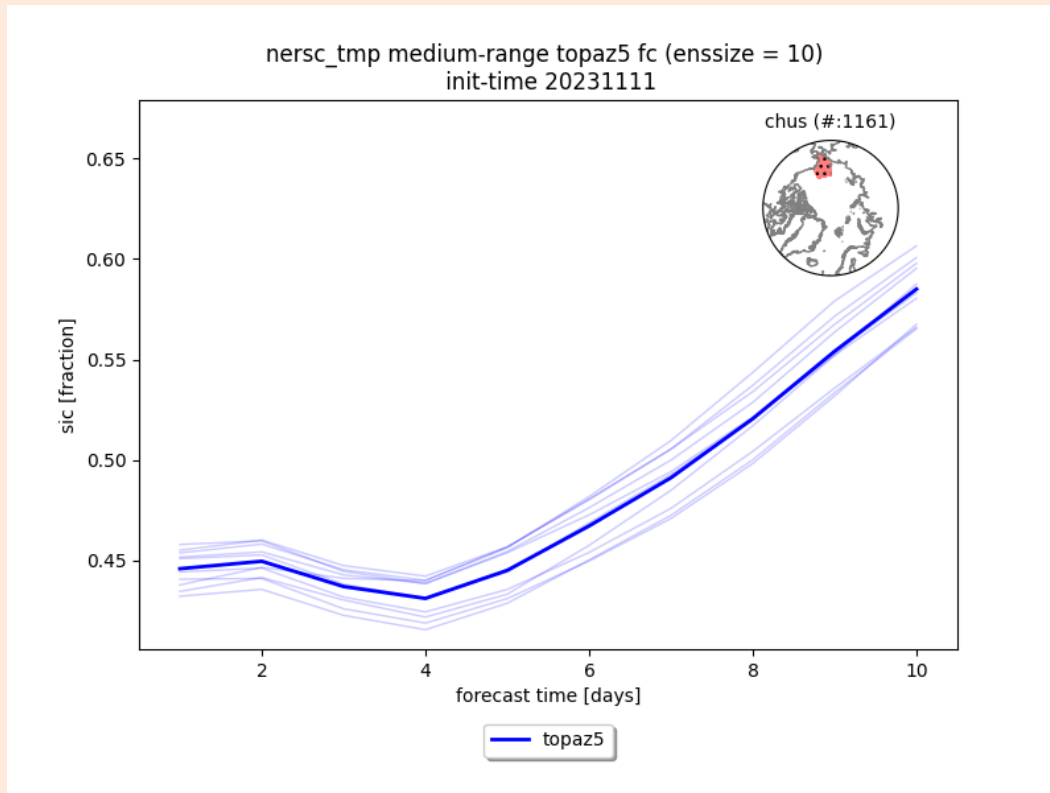**Example user product:**

Forecast plume (one forecast)

Can we trust the forecast?

Information on forecast quality + uncertainty
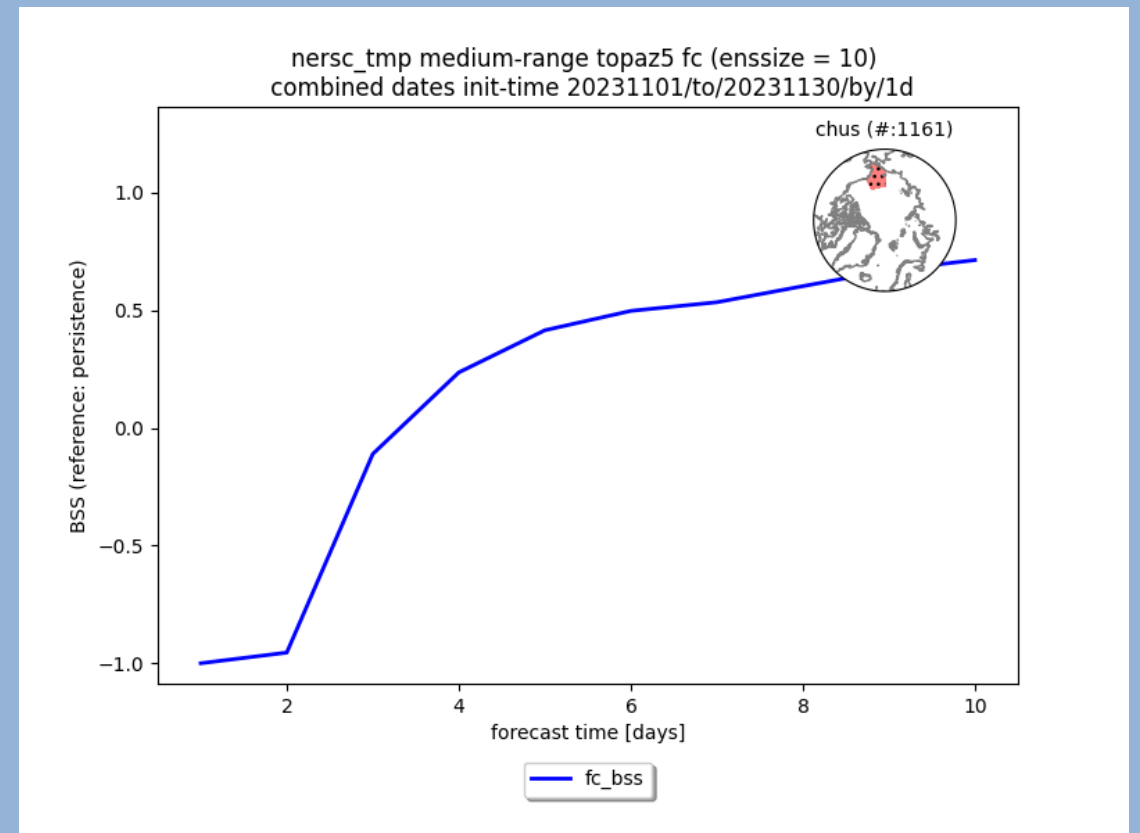
Average forecast RMSE (statistic of one month)

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Medium-range example: TOPAZ5 – Forecast plumes

Example user product:

Forecast plume (one forecast)
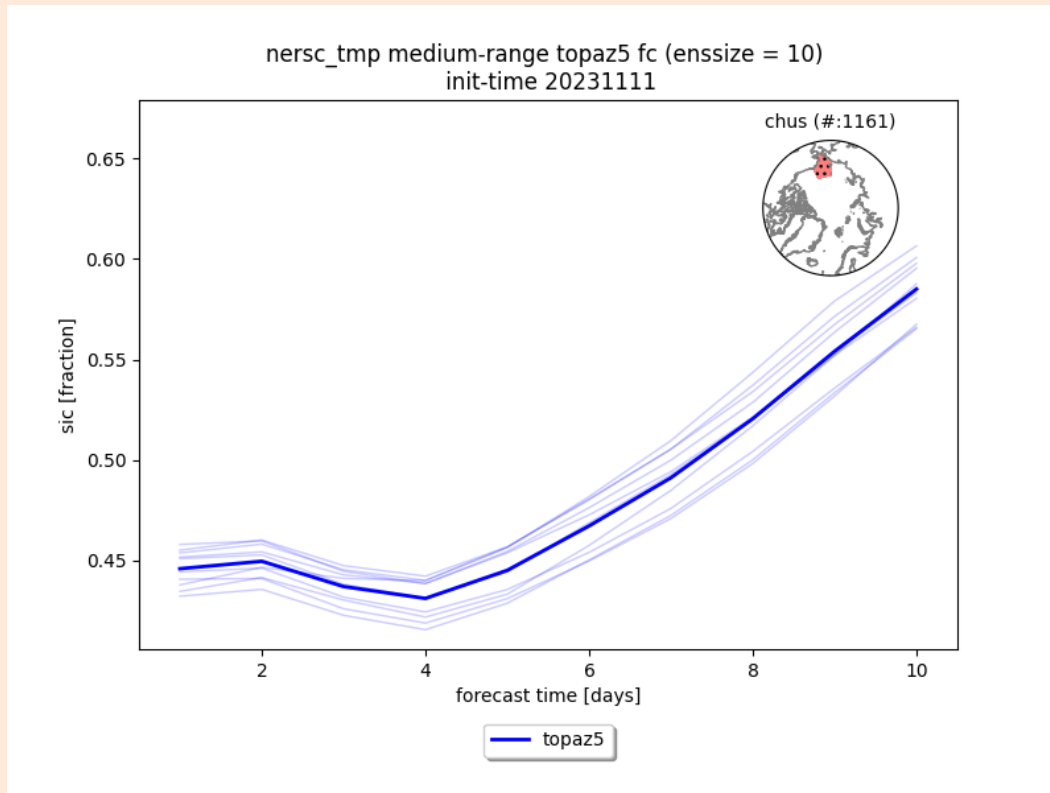

Can we trust the forecast?

Information on forecast quality + uncertainty

Brier Skill score (statistic of one month)
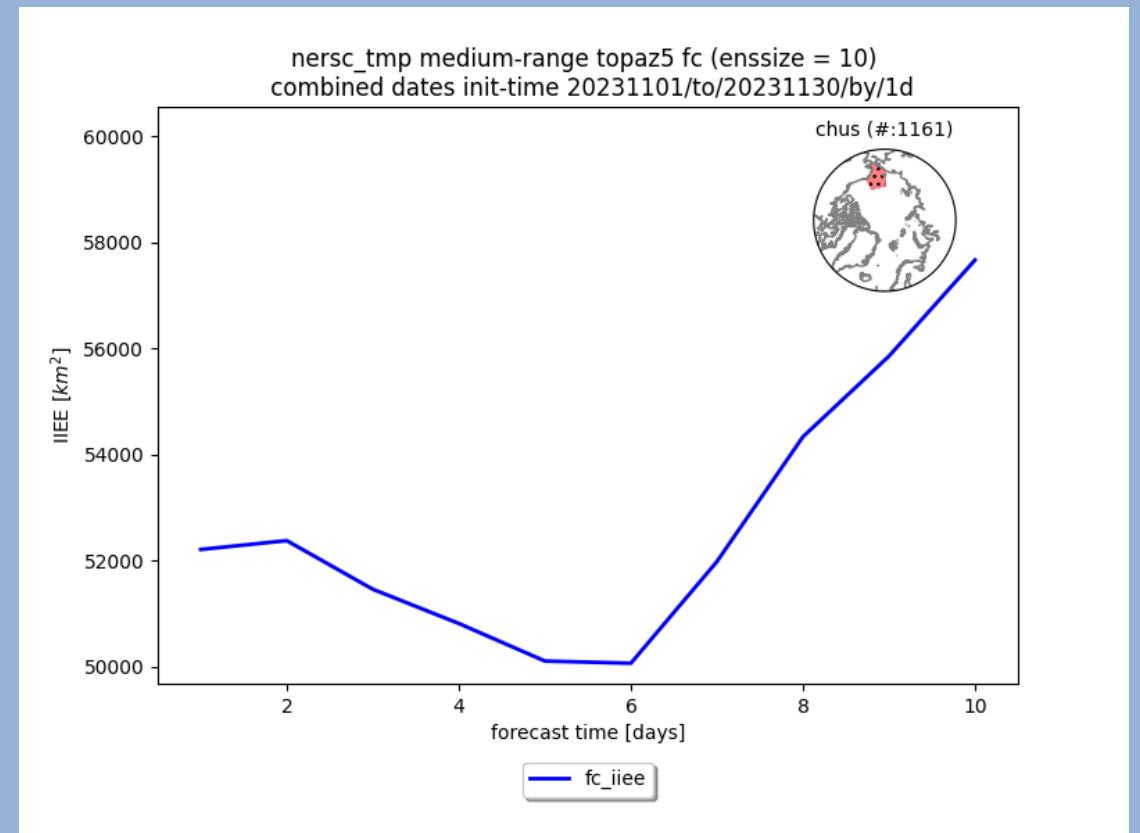

Climatology as reference

Medium-range example: TOPAZ5 – Forecast plumes

Example user product:

Forecast plume (one forecast)

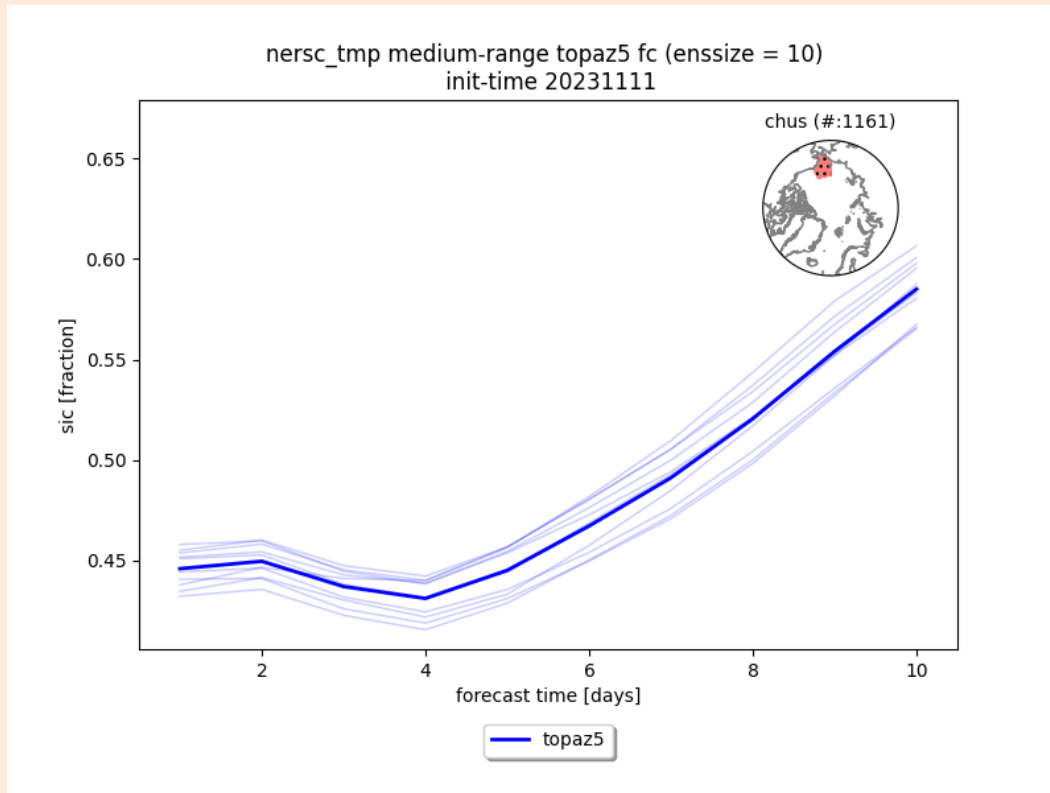Can we trust the forecast?

Information on forecast quality + uncertainty

Integrated Ice Edge Error (statistic of one month)

Climatology as reference

Medium-range example: TOPAZ5 – Forecast plumes

Example user product:

Forecast plume (one forecast)

nersc_tmp medium-range topaz5 fc (enssize = 10)
init-time 20231111

Can we trust the forecast?

Information on forecast quality + uncertainty

Probabilistic metrics

- Spatial Probability Score
- Brier skill score
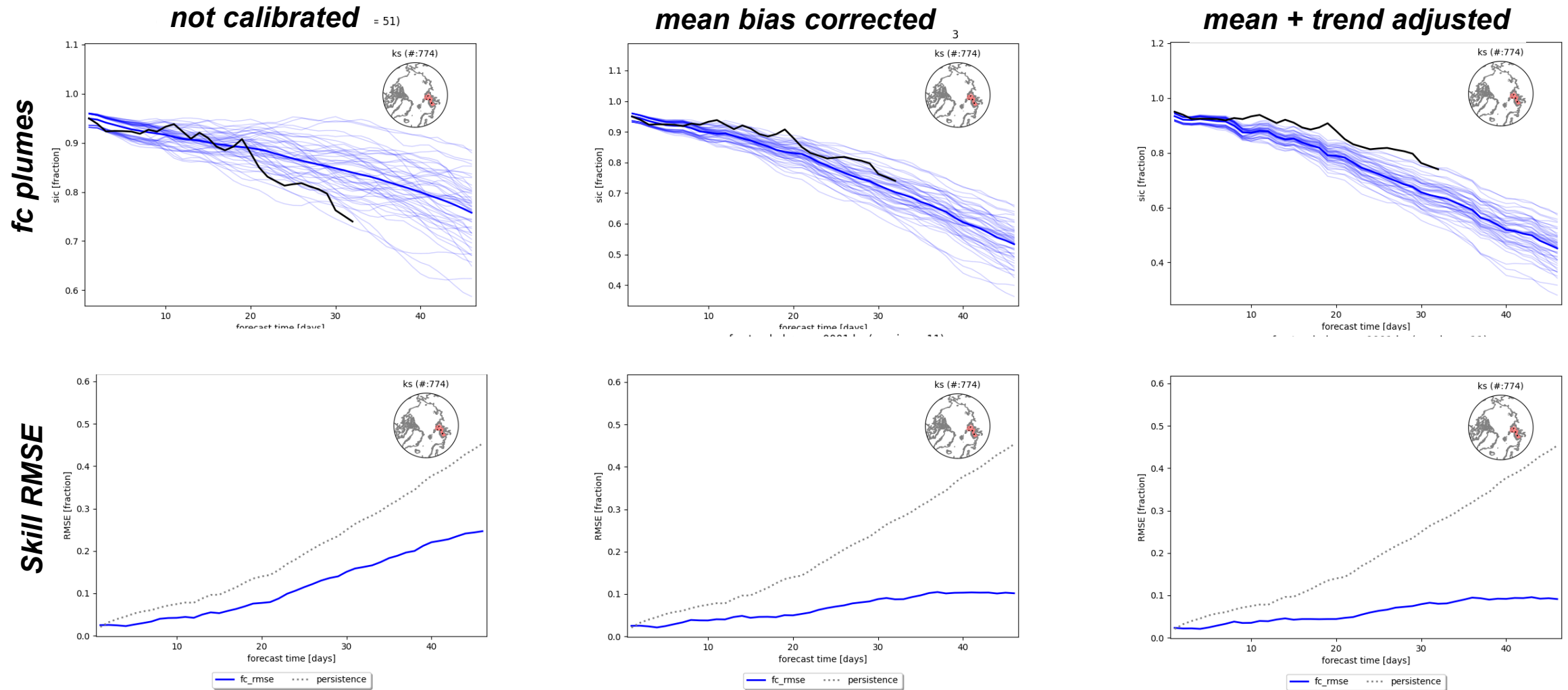- CRPSS
- Reliability

Deterministic metrics

- Ensemble mean
- RMSE
- BIAS
- IIEE

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2. Example for calibration of sub-seasonal forecasts

ICECAP supports two different calibration techniques:

- Mean lead-time dependent bias correction
- Lead time dependent trend-adjusted calibration

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Calibration example: ECMWF sub-seasonal forecast initialized on 9.5.2024

Skill assessment can be used to determine best calibration method

3. Some prototype end-user products

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Forecasting the distance of the ice edge from a given location

Distance of open-water location to sea ice edge
Forecast initialized on 7.10.2021 → major shipping incident on the Norther Sea Route
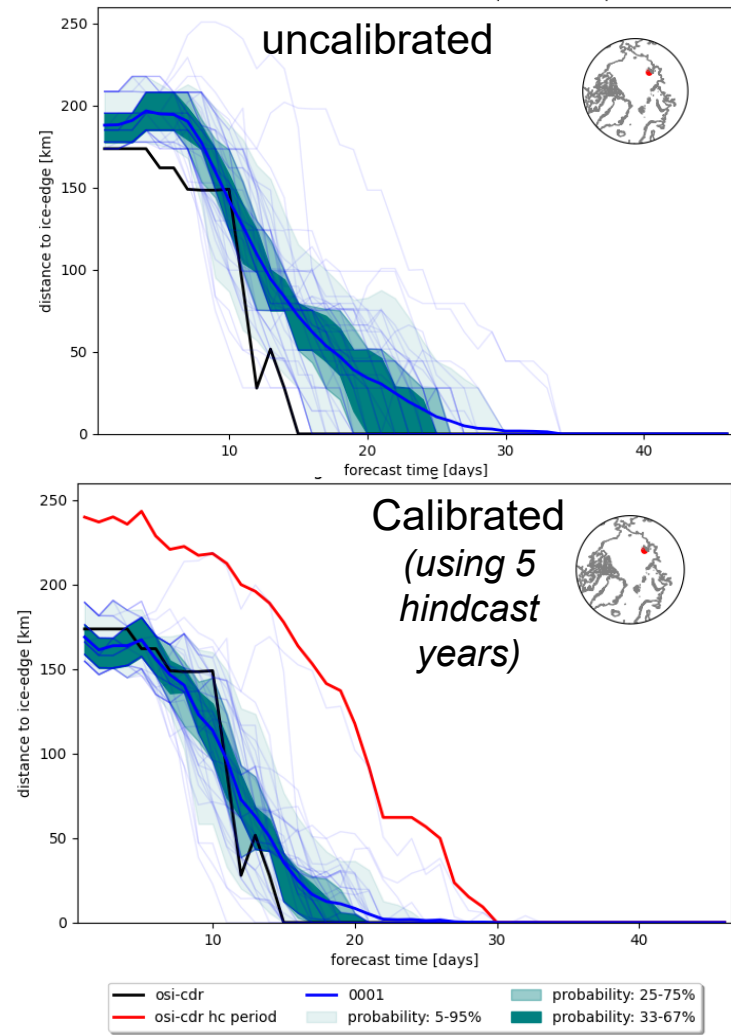

Illustration photo: Rosatomflot

A critical situation might be in the making on the Northern Sea Route

An early freeze has taken shippers by surprise and a big number of vessels are in danger of getting stuck in thick sea-ice.

Seasonal outlook for sea-ice retreat
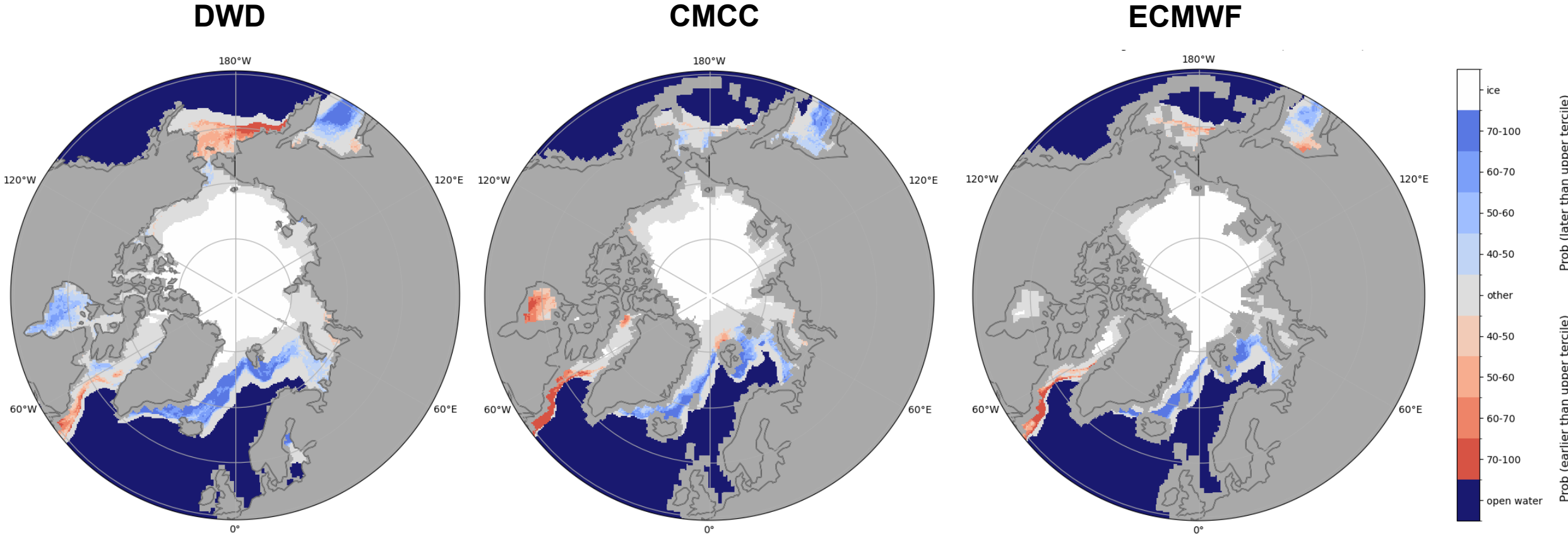
C3S seasonal forecast from DWD initialized 1 Jan 2024

Temporal anomaly of
ice breakup (days)
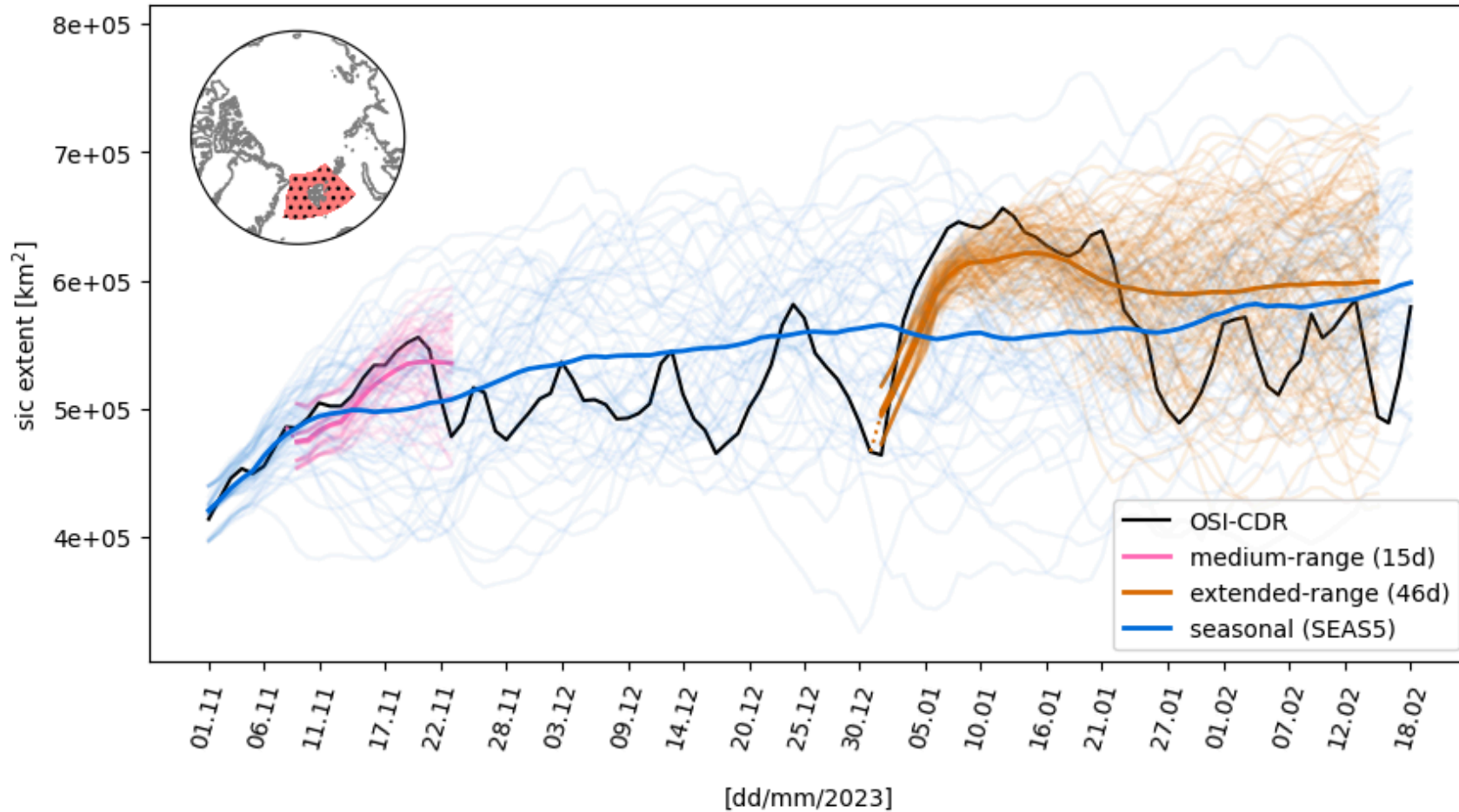
high probability of early break up

high probability of late break up
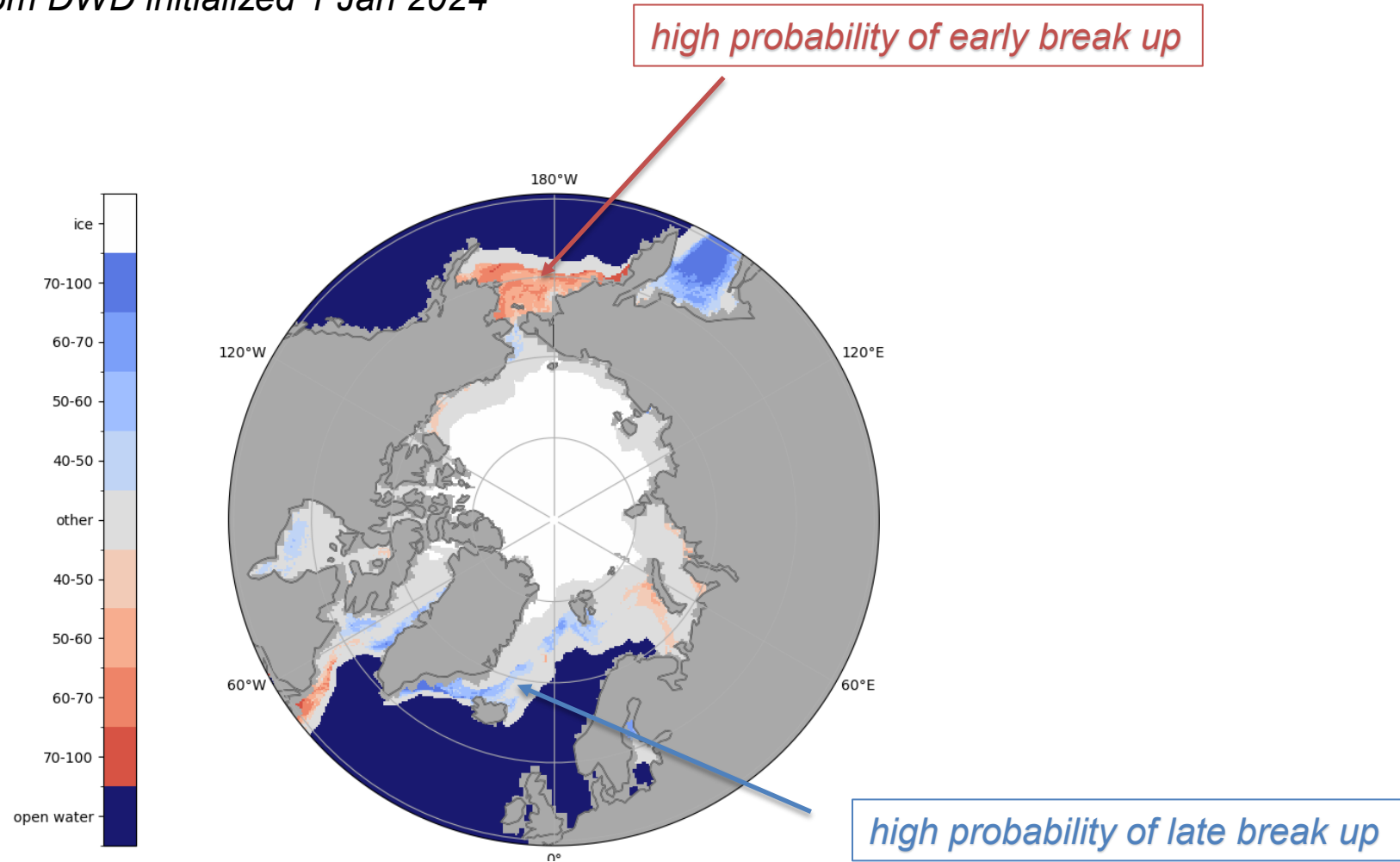
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4. Multi-center seasonal forecast comparison

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Example: Seasonal outlooks from different C3S models from 1. January 2024

5. Seamless information

Example: Information on sea-ice variability from different forecasts

ECMWF forecasts:
    SEAS5 (blue, init 1/11/23), medium-range (pink, init 9/11/23), extended-range (brown, init: 1/1/24)

Summary

ICECAP is designed to:

1. Provide end users with
   - sea-ice forecast products
   - alongside information on forecast quality and uncertainty
   - forecasts from multiple centres
   - seamless information from days to seasons ahead

2. Support model development (in-depth verification of sea ice concentration forecasts)

How to use ICECAP:

1. Run ICECAP on your own computational environment
   - The code will be openly accessible via GitHub from beginning of 2025
   - The code has been tested on Linux and MacOS platforms

2. Run ICECAP on WEkEO platform:
   - ICECAP will be implemented on the cross-Copernicus platform WEkEO (2025-2026)
   - This will allow to get information on latest forecasts from CMEMS and C3S models

ICECAP can be further developed by the community, e.g. adding new verification scores, datasets etc.

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