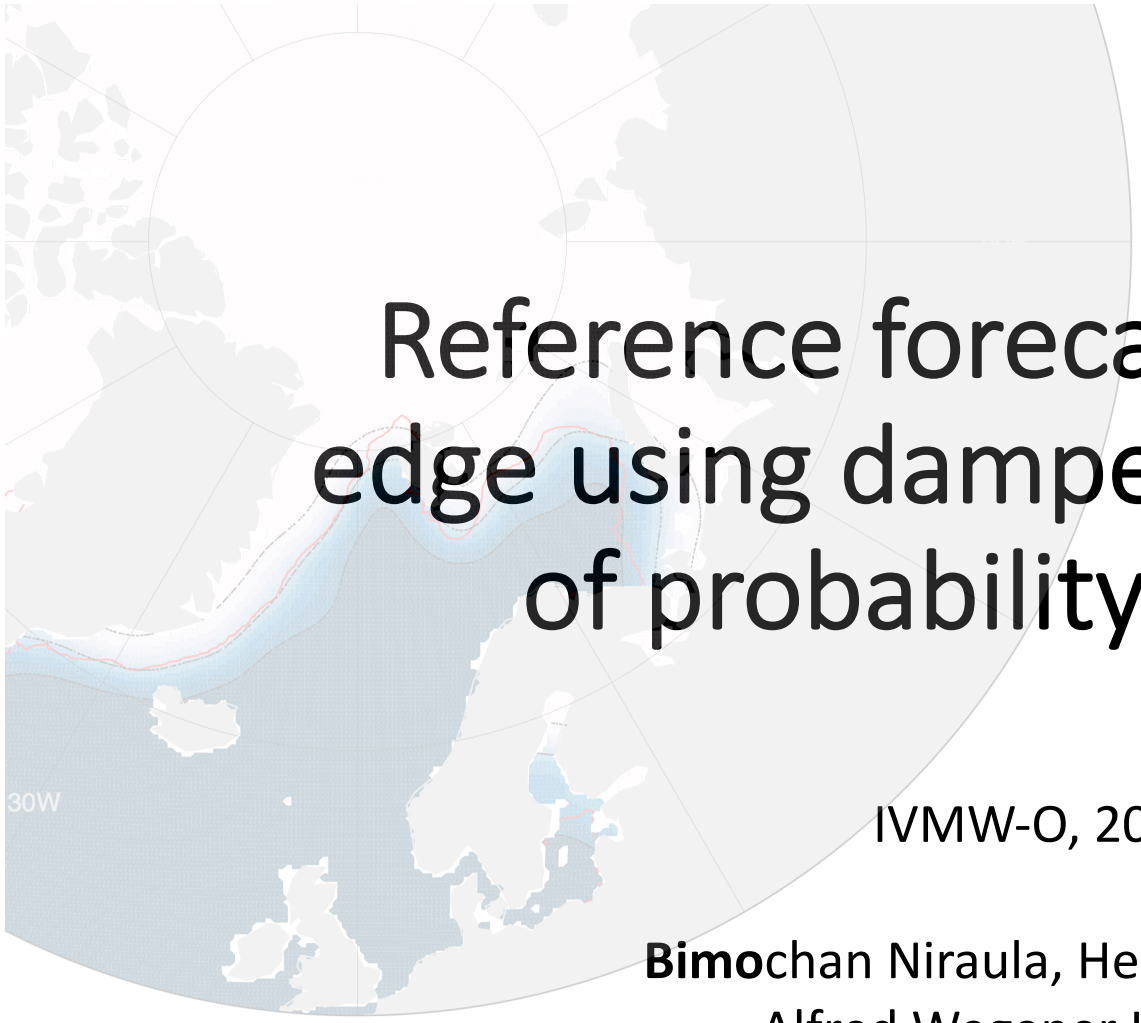

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Reference forecast of sea-ice edge using damped persistence of probability anomaly

IVMW-O, 2020

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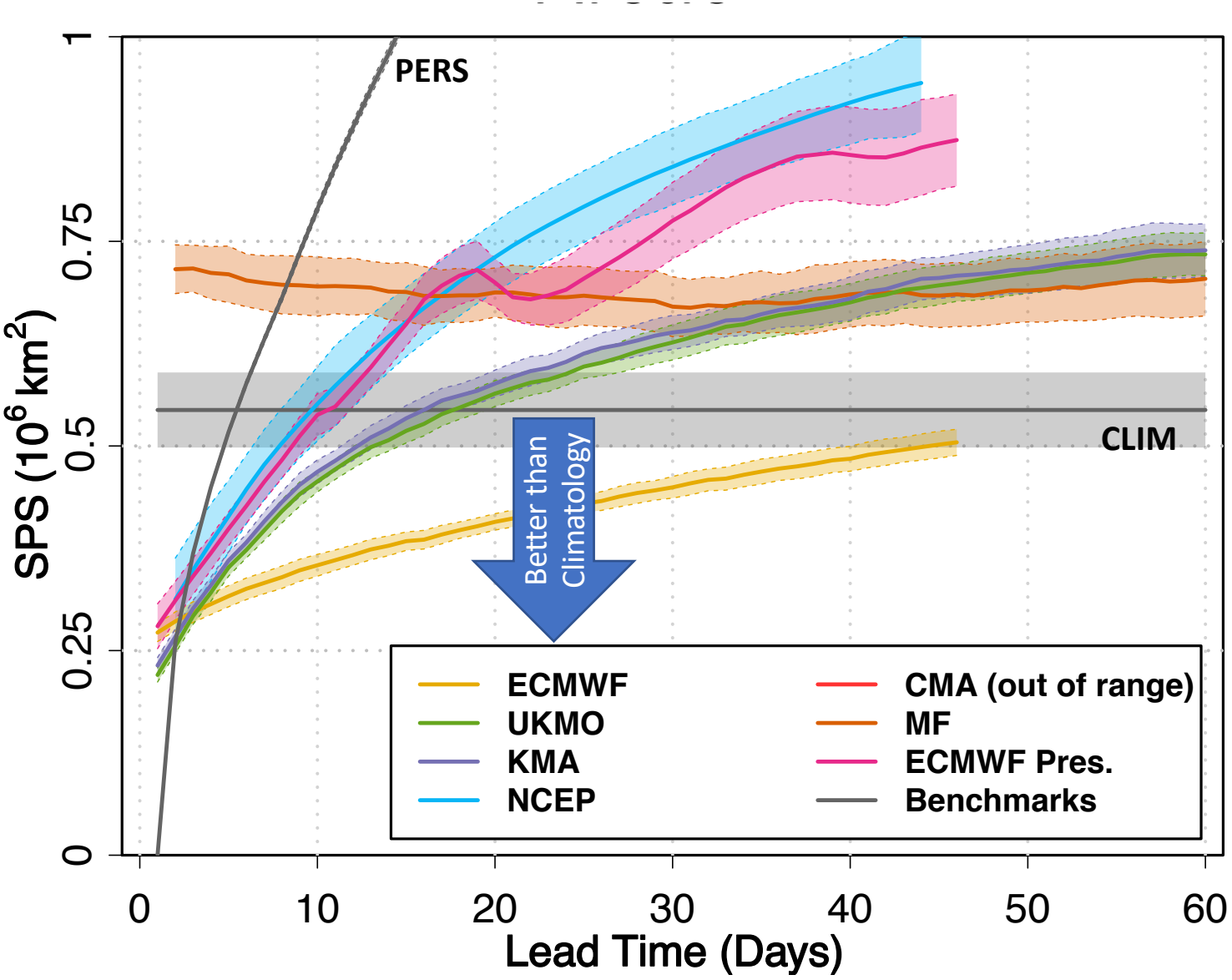
Alfred Wegener Institute

Motivation

- Operational ice-forecasting centers are producing sub-seasonal to seasonal (S2S) forecasts, whose prediction skill needs to be properly assessed.
- To determine the skill, the Forecast output is measured against 'truth', for example by using the Spatial Probability Score (SPS)

$$\mathrm{SPS} = \int_V \{P_\mathrm{f}(\mathbf{x}) - P_\mathrm{o}(\mathbf{x})\}^2 \, \mathrm{d}V$$

- This score is compared against the score of some reference forecasts. Most common references are:
  - Climatology (historical pattern for that date) and
  - Persistence (assume initial state to stay constant).



(Zampieri et al, 2018)

Knowledge Gap

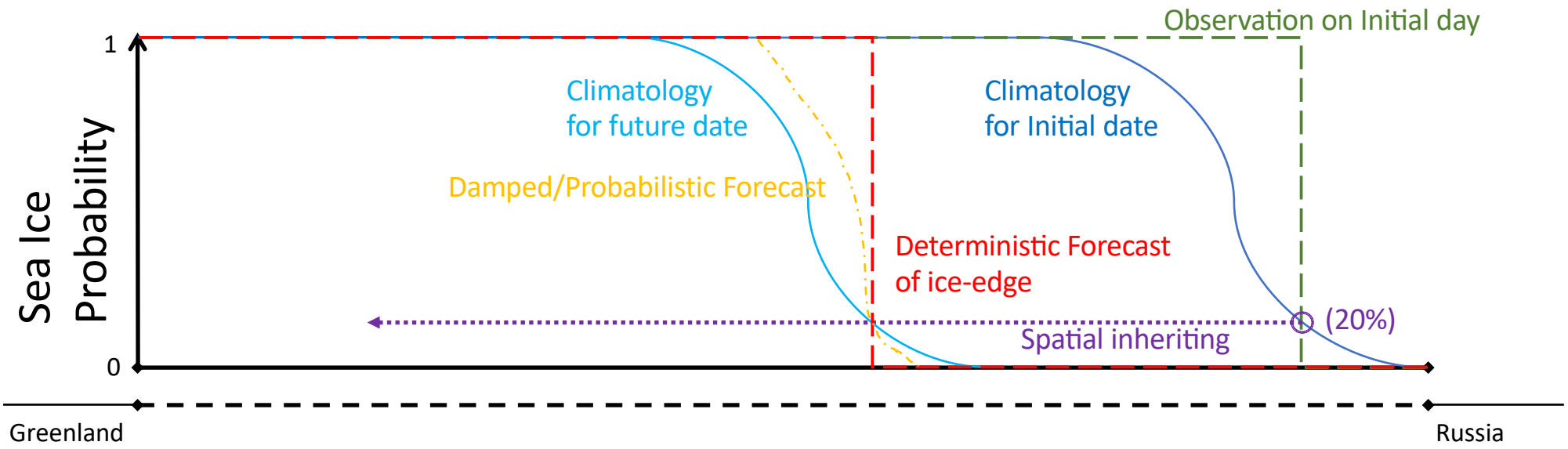
Issues with Climatology and Persistence

- take information from either historical or current state, ignoring other.
- compare grid to grid – so what happens in the neighbourhood is ignored.

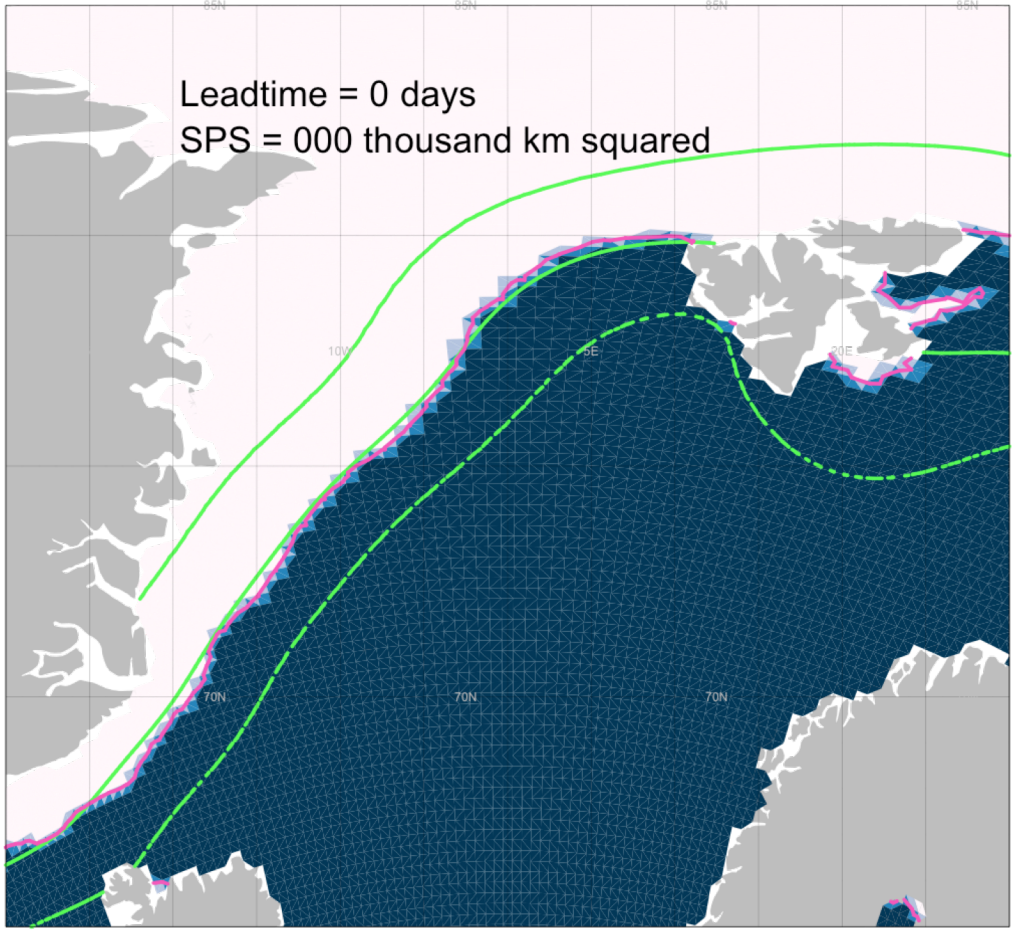
So, is it possible to have a better reference forecast for other dynamical models to compare against?

Yes!

Method – 1D example



Notes:
i) We are using OSI SAF ice-concentration data (15% contour) to determine ice-edge.
ii) Climatology is based on the previous 10 years.

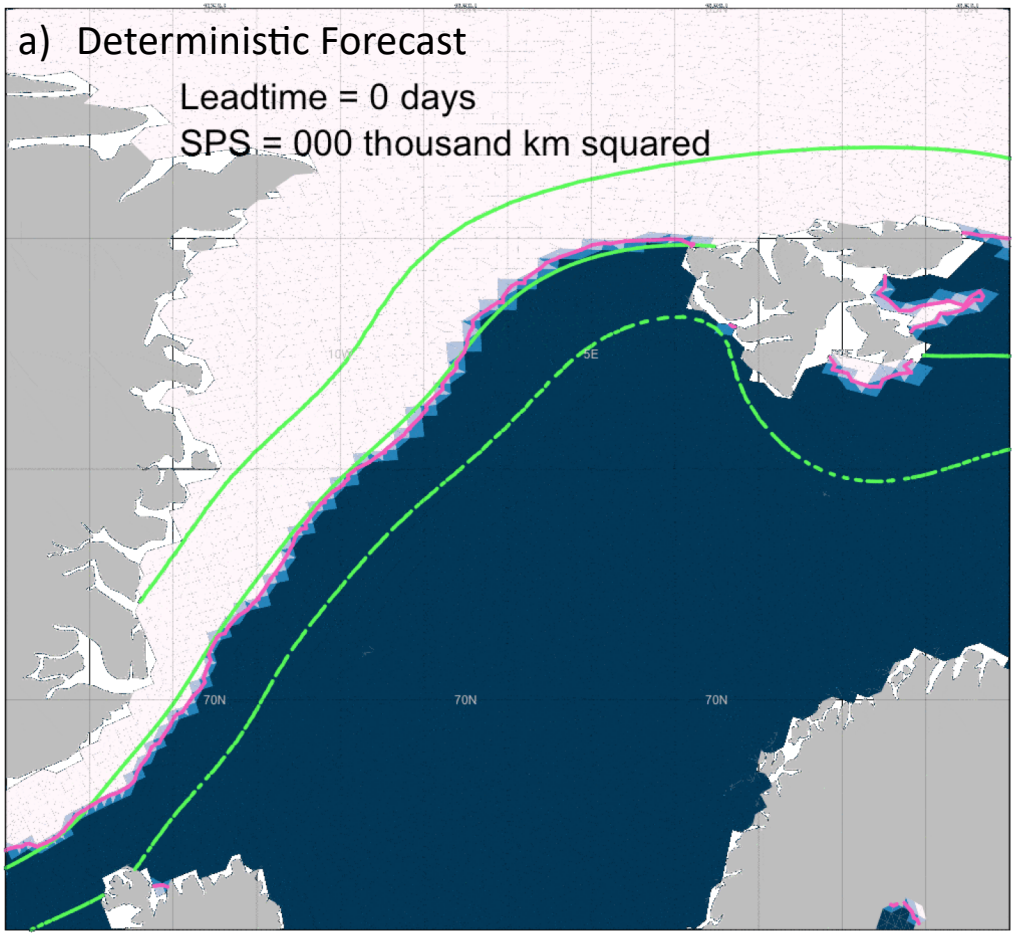


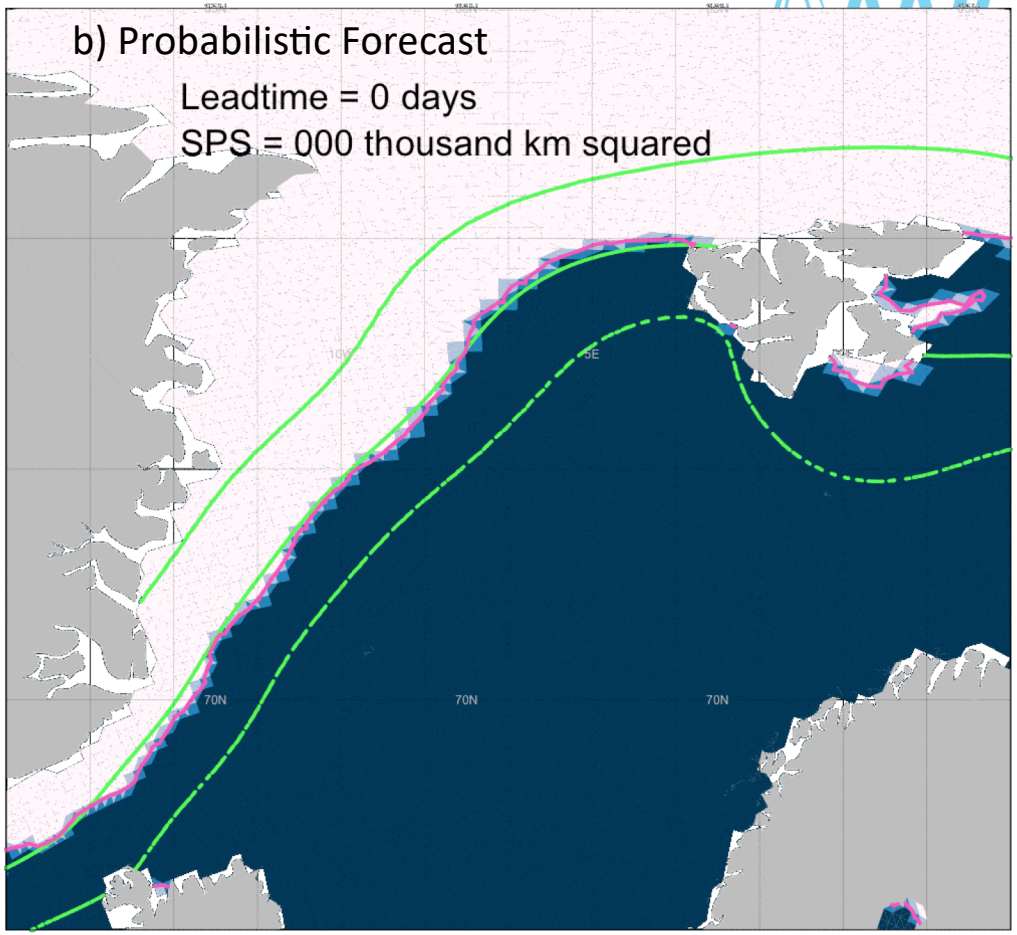
Legend:

--- Climatology (10%, 50%, 90% probability of historical ice presence)

--- Observation (15% ice-concentration contour)

■/ ■ forecast (background color = forecasted ice-probability from 0 to 100)





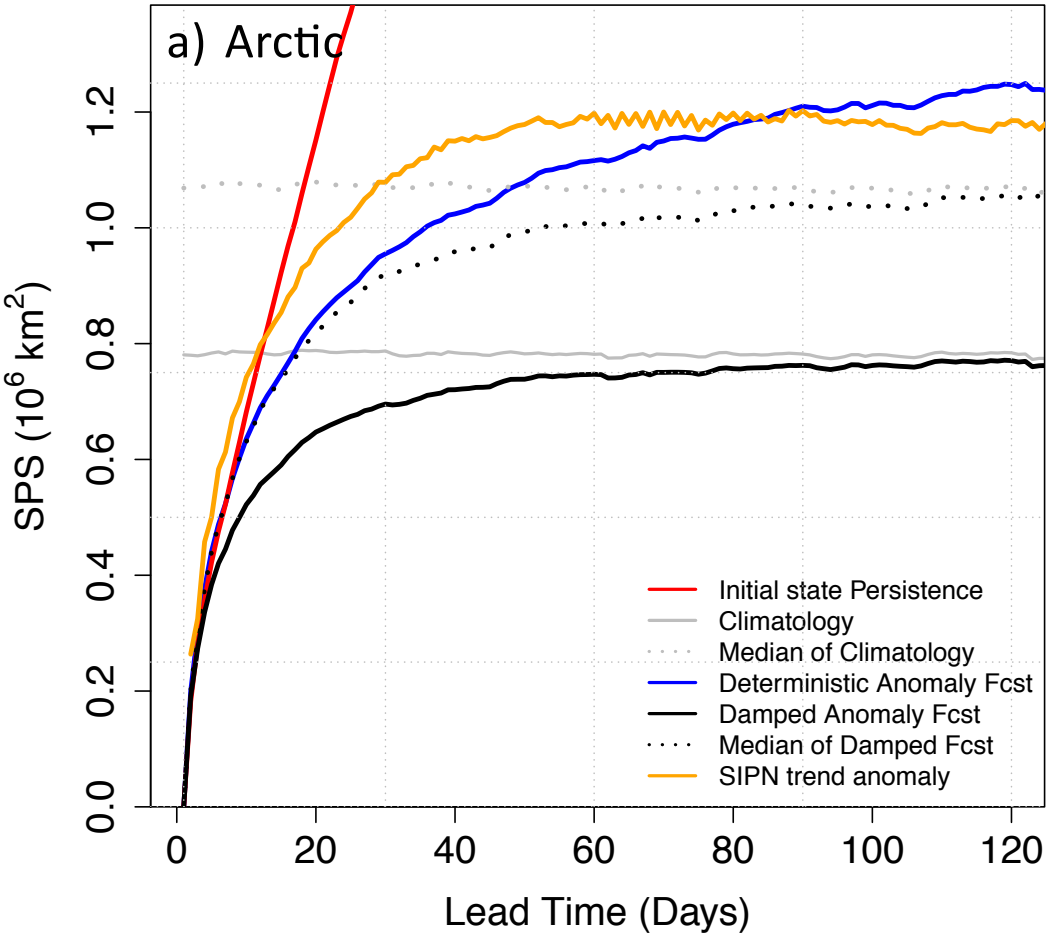
Legend:

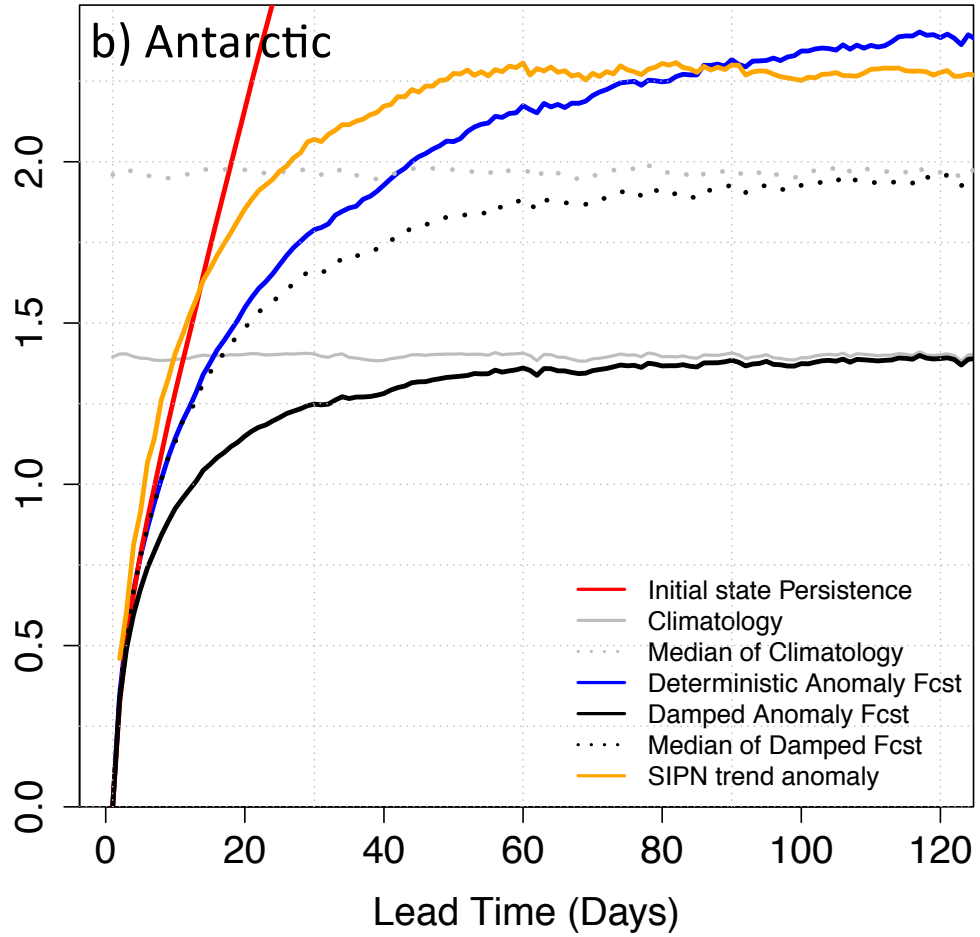
--- Climatology (10%, 50%, 90% probability of historical ice presence)

--- Observation (15% ice-concentration contour)

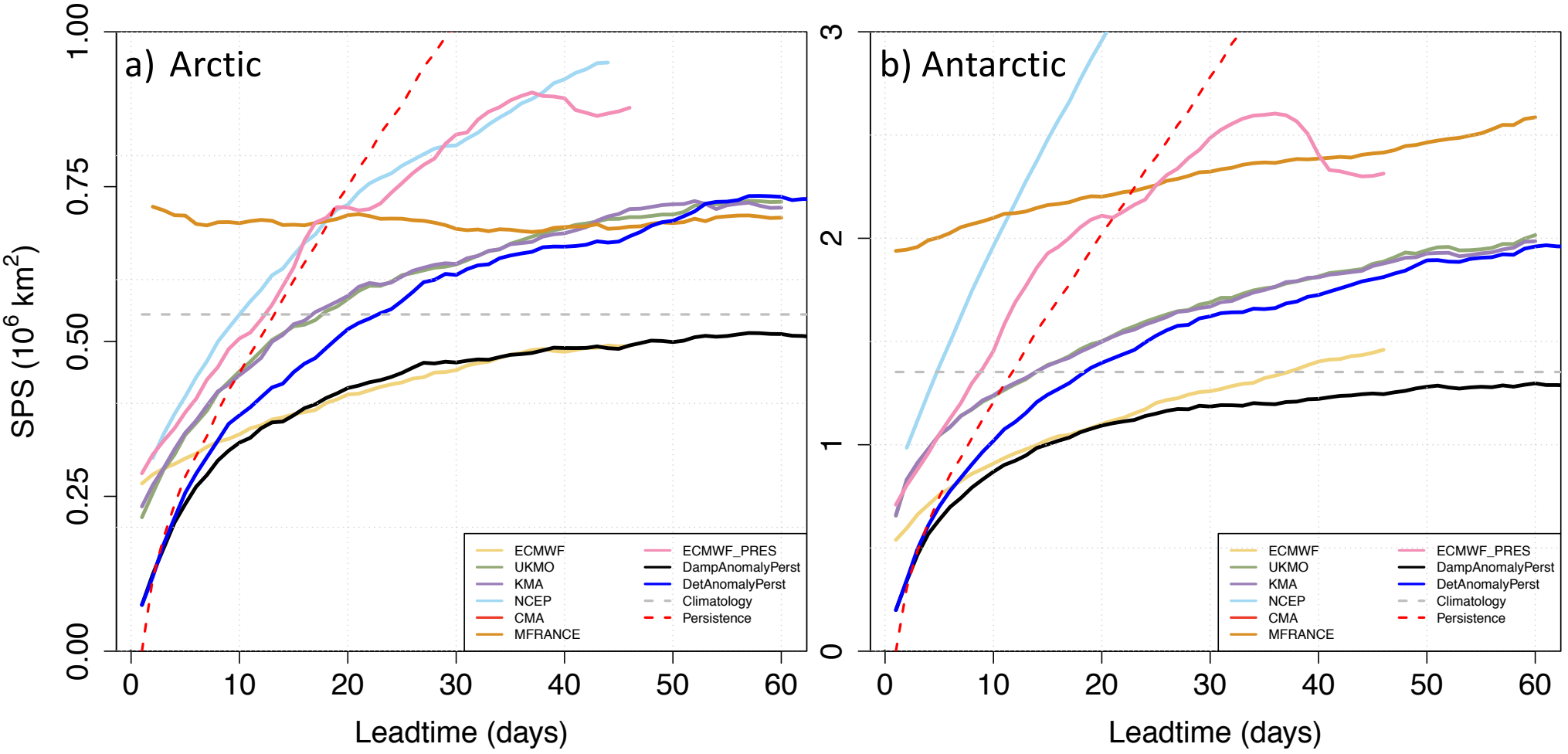
■/□ forecast (background color = forecasted ice-probability from 0 to 100)

Spatial Probability Score

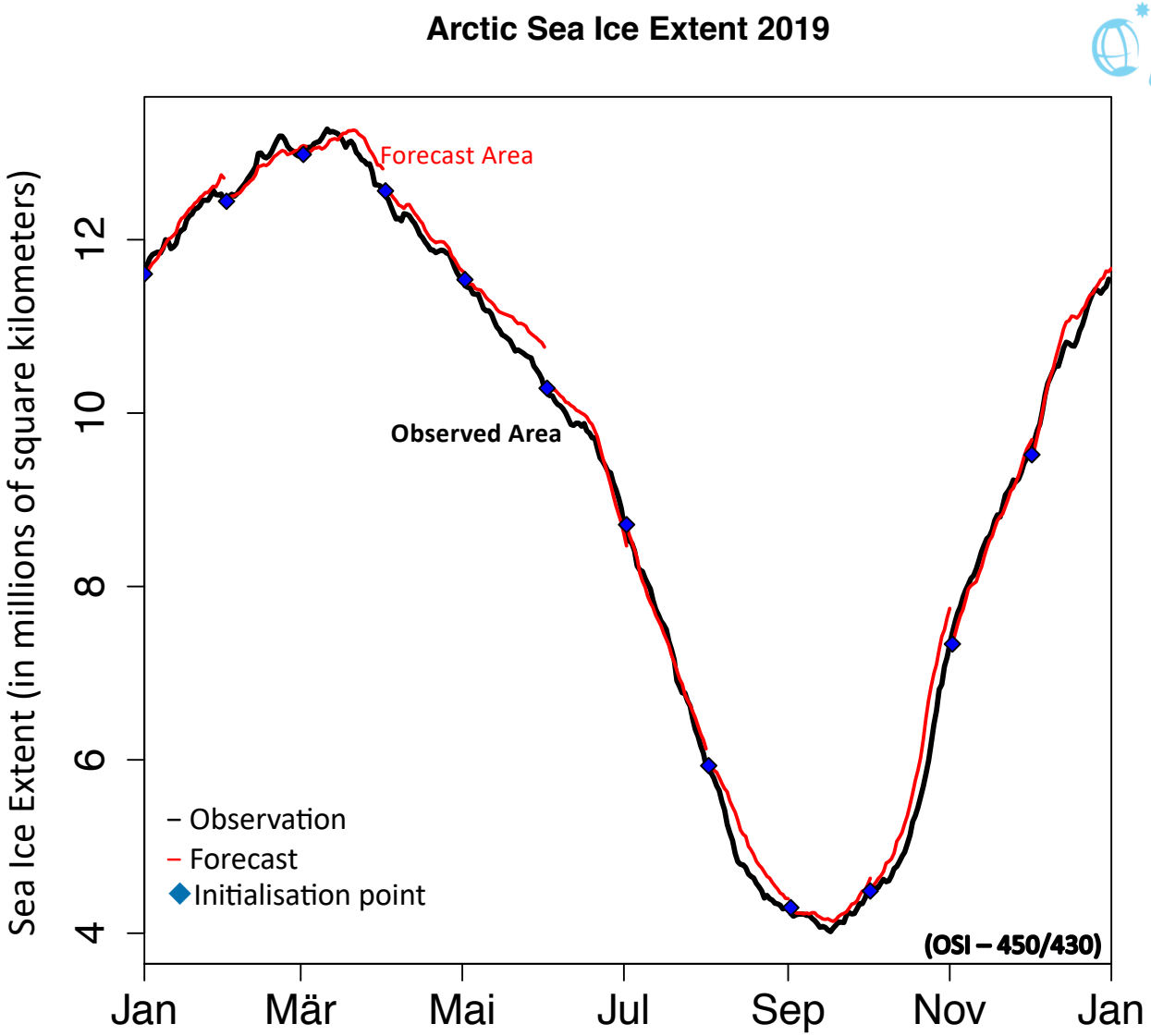




Skill compared to other models in S2S dataset

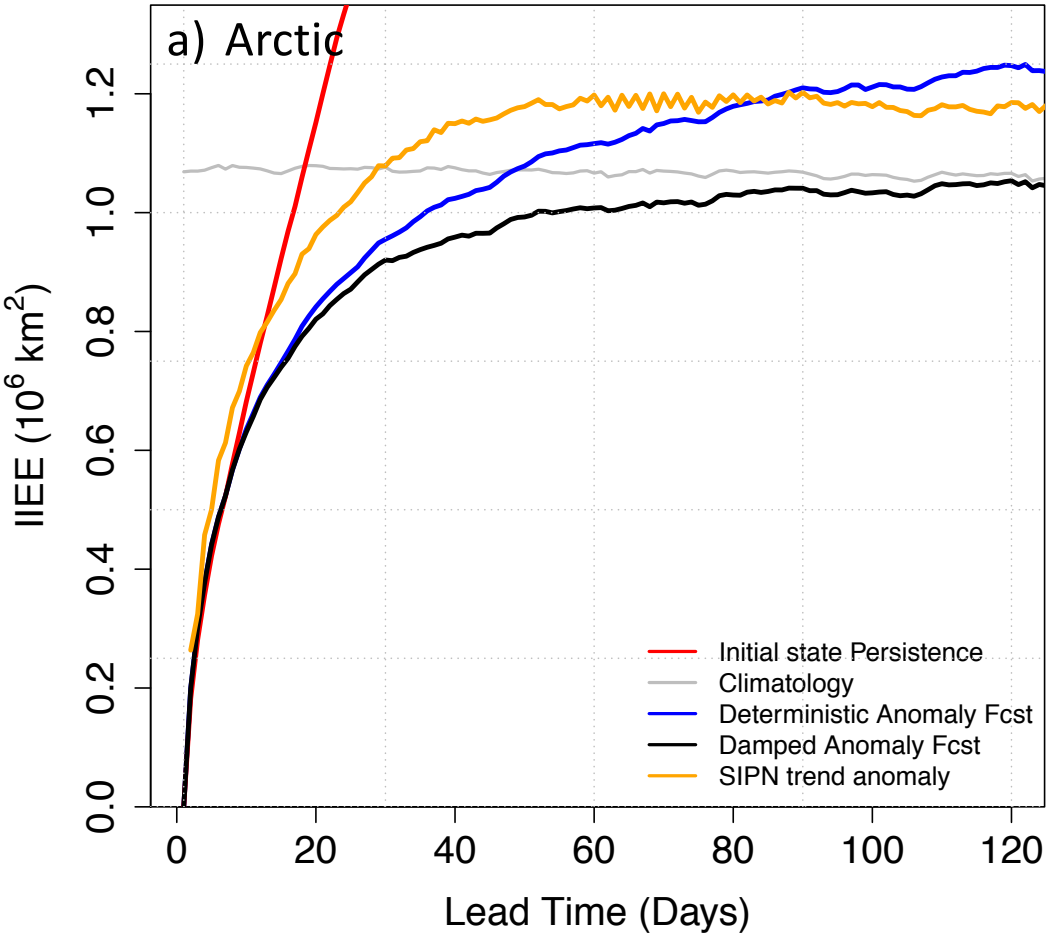


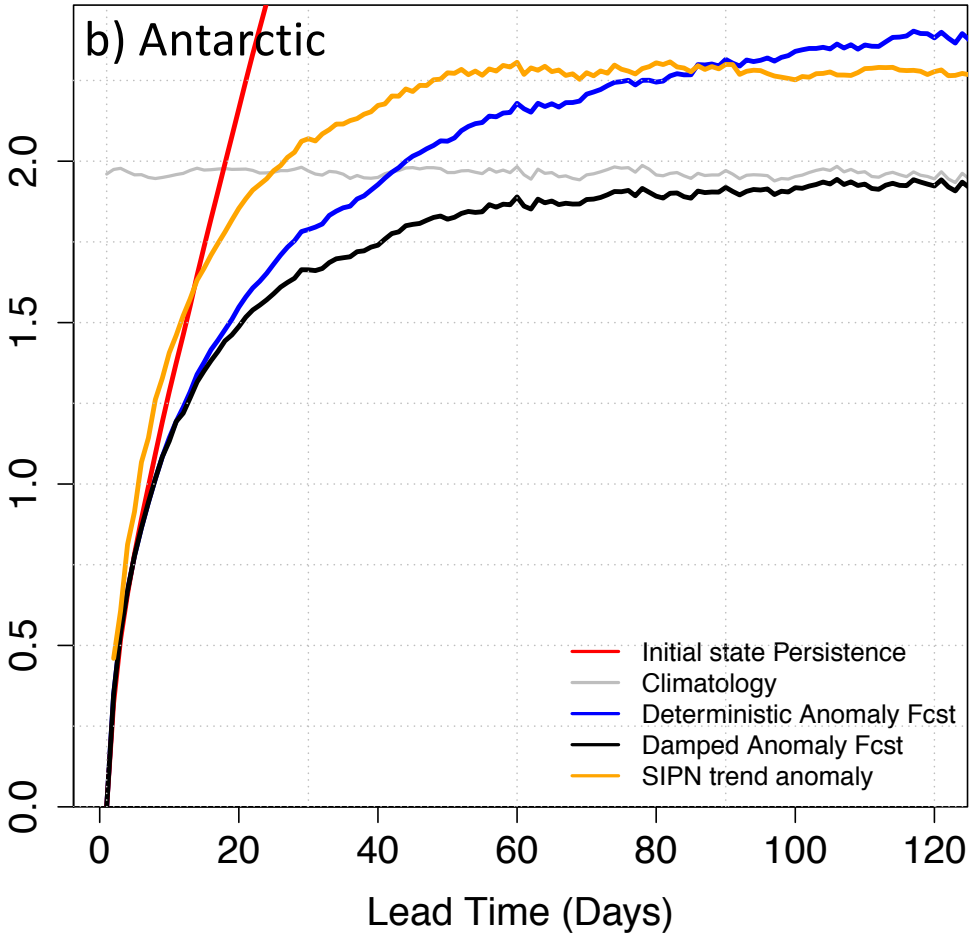
We can also look at sea-ice extent using our forecast. Here, we show the 30 day forecasts initialized at the start of each month in 2019, compared to the actual observed area.



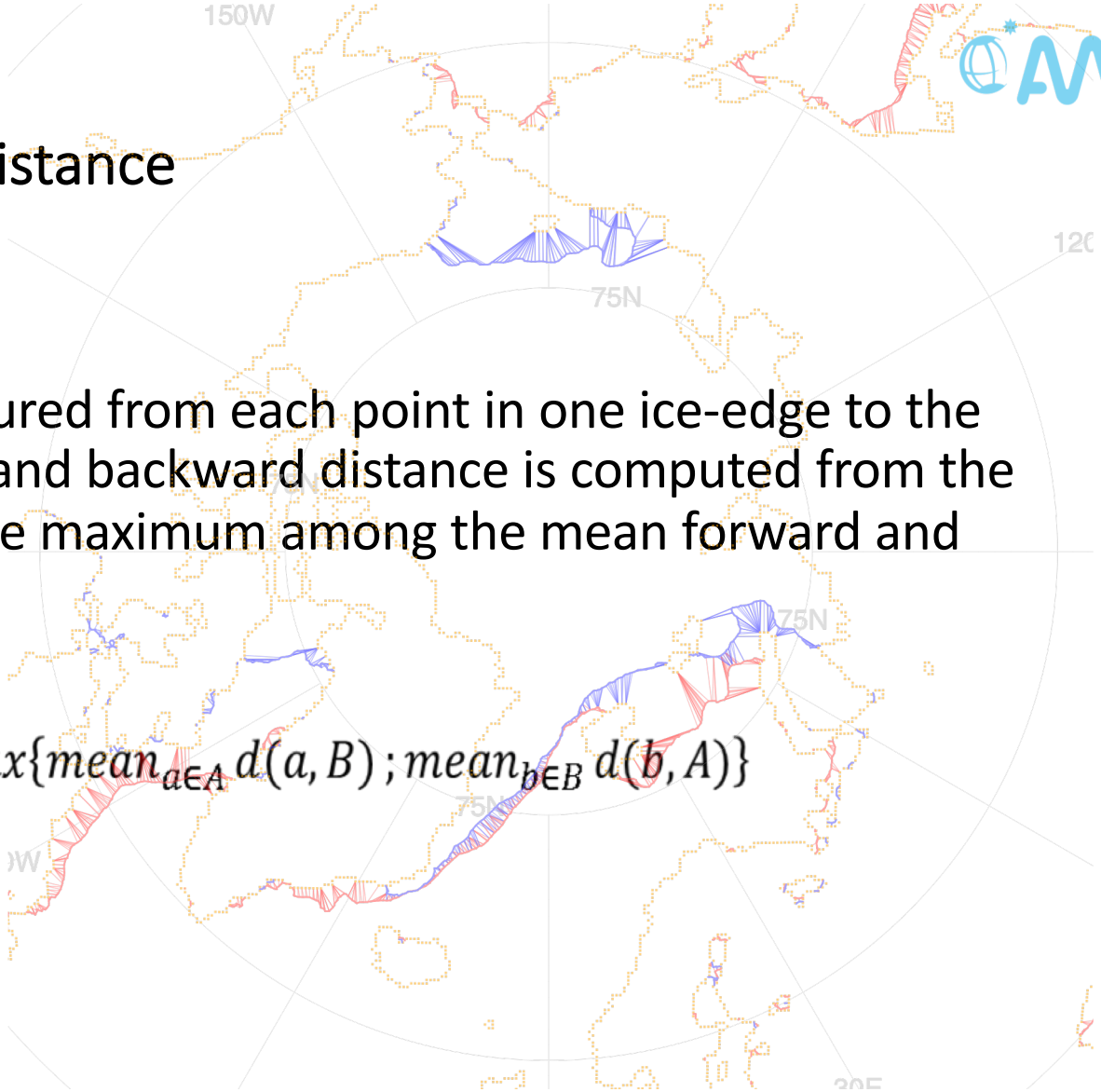
Other verification metrics

Integrated Ice Edge Error





Modified Haussdorff Distance



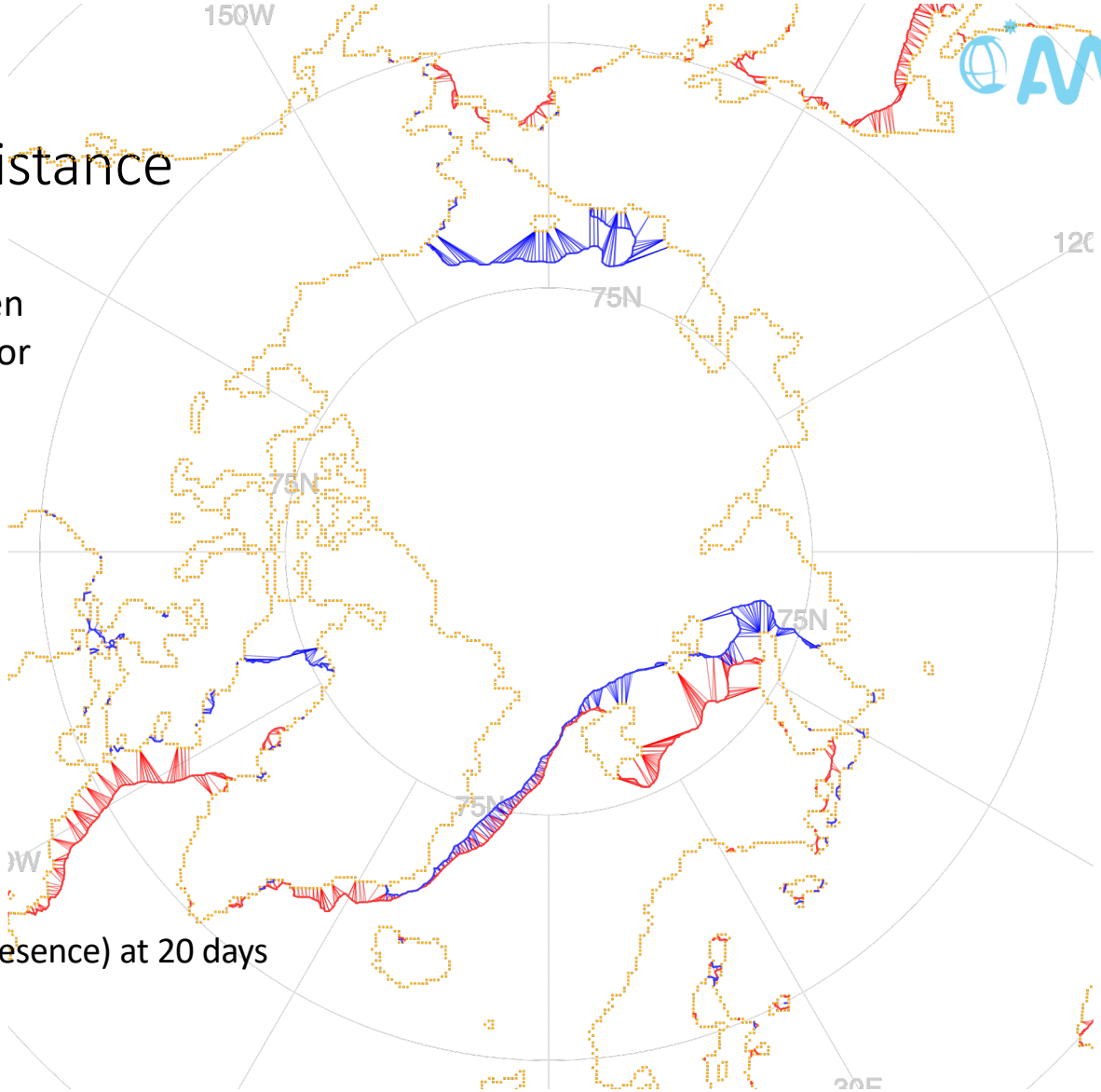
Forward distance is measured from each point in one ice-edge to the other ice-edge (or coast) and backward distance is computed from the other ice-edge. MHD is the maximum among the mean forward and backward distance, in km.

$$ModHaus(A,B) = max\{mean_{a\in A}\, d(a,B)\,; mean_{b\in B}\, d(b,A)\}$$

Modified Haussdorff Distance

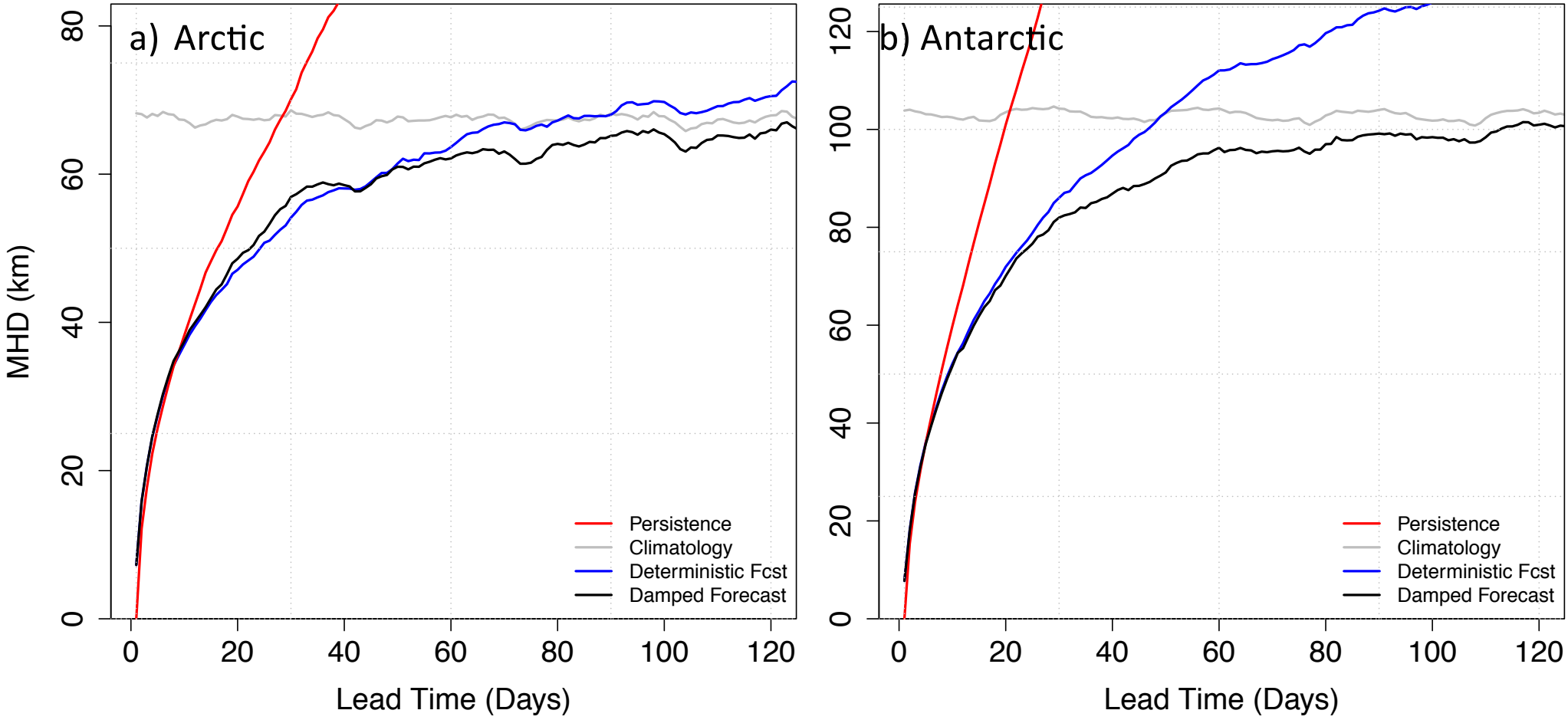
Determining correct distances between two contours is not trivial, especially for non-continuous contours.

Including coastlines in the edge computation stops the distances from being measured across land.



Here, we see two ice-edge contours:
--- observation (15% ice-conc contour)
--- forecast (50%, 90% probability of ice presence) at 20 days leadtime.

Modified Hausdorff Distance



Summary

- We have developed a method to forecast ice-edge in the Arctic and Antarctic using only initial and historical ice-edge information.
- The forecasts based on this method are skillful at sub-seasonal to seasonal timescales and are a challenging benchmark for dynamical sea-ice models to compare against.
- The difference in skill of the forecasts may vary based on the verification metric used.

Thank you – Merci – Danke ☺

Questions / Comments ?

Further contact: bimochan.niraula@awi.de