Verification of subseasonal sea-ice prediction at both poles

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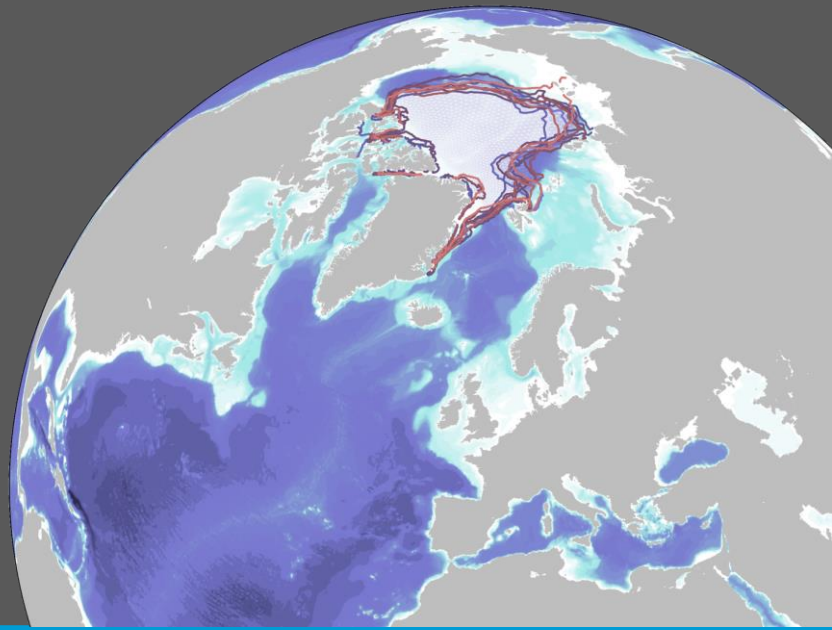
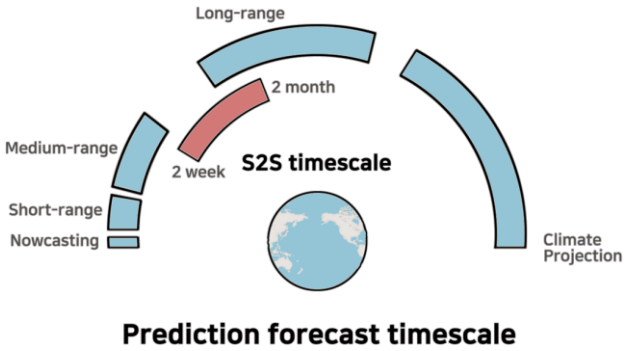


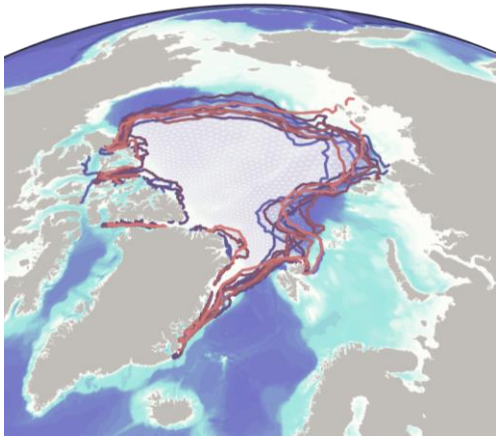
S2S Forecasts



Prediction forecast timescale

Ensemble Forecasts

Probabilistic sea ice description



Subseasonal to Seasonal time scale

2 weeks to 2 months

…with dynamical sea ice models

12 years of reforecasts 1999-2010

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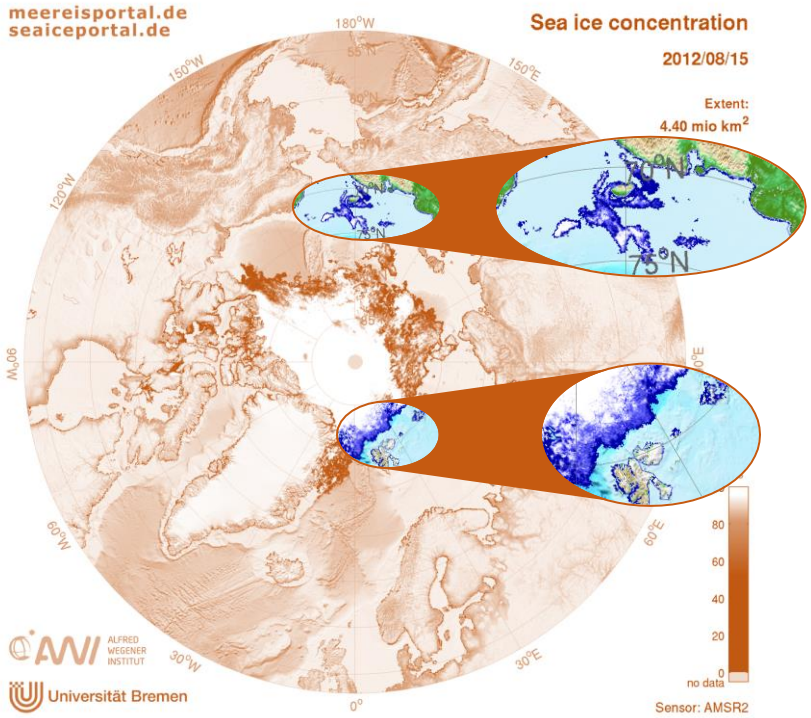
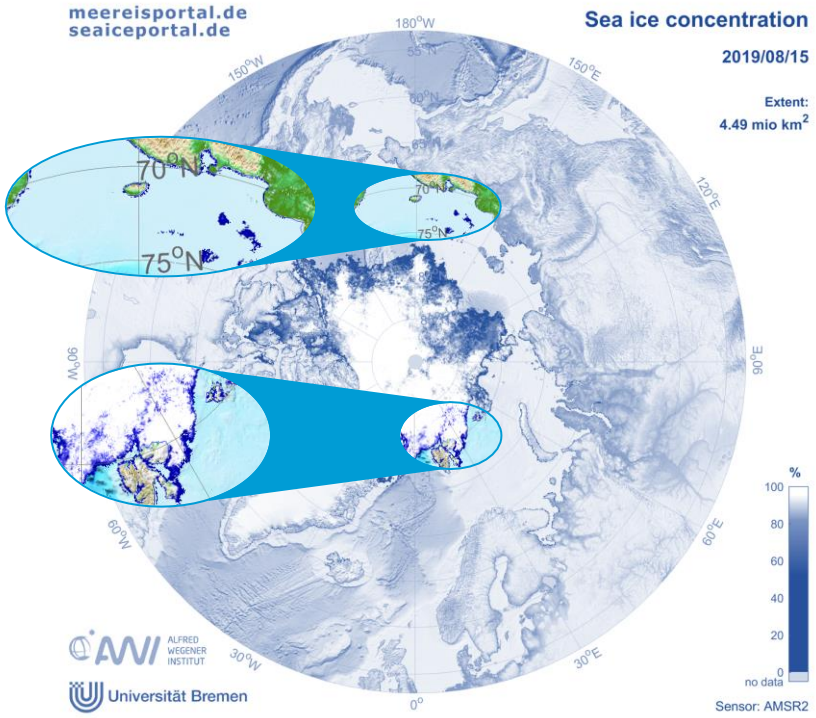
Beyond the sea ice extent

August 15th 2012
Extent: 4.40 x 10^6 km^2



August 15th 2019
Extent: 4.49 x 10^6 km^2



Spatial Probability Score

$$SPS = \int_A (p_F - p_O)^2 \, dA$$

A Integration domain
either NH or SH

p_F Forecasted sea ice probability
p_O Observed sea ice probability

$[\mathrm{m}^2]$ SPS is an area

Goessling & Jung (2018) QJRMS

Probabilistic version of the IIEE
(Integrated Ice Edge Error)

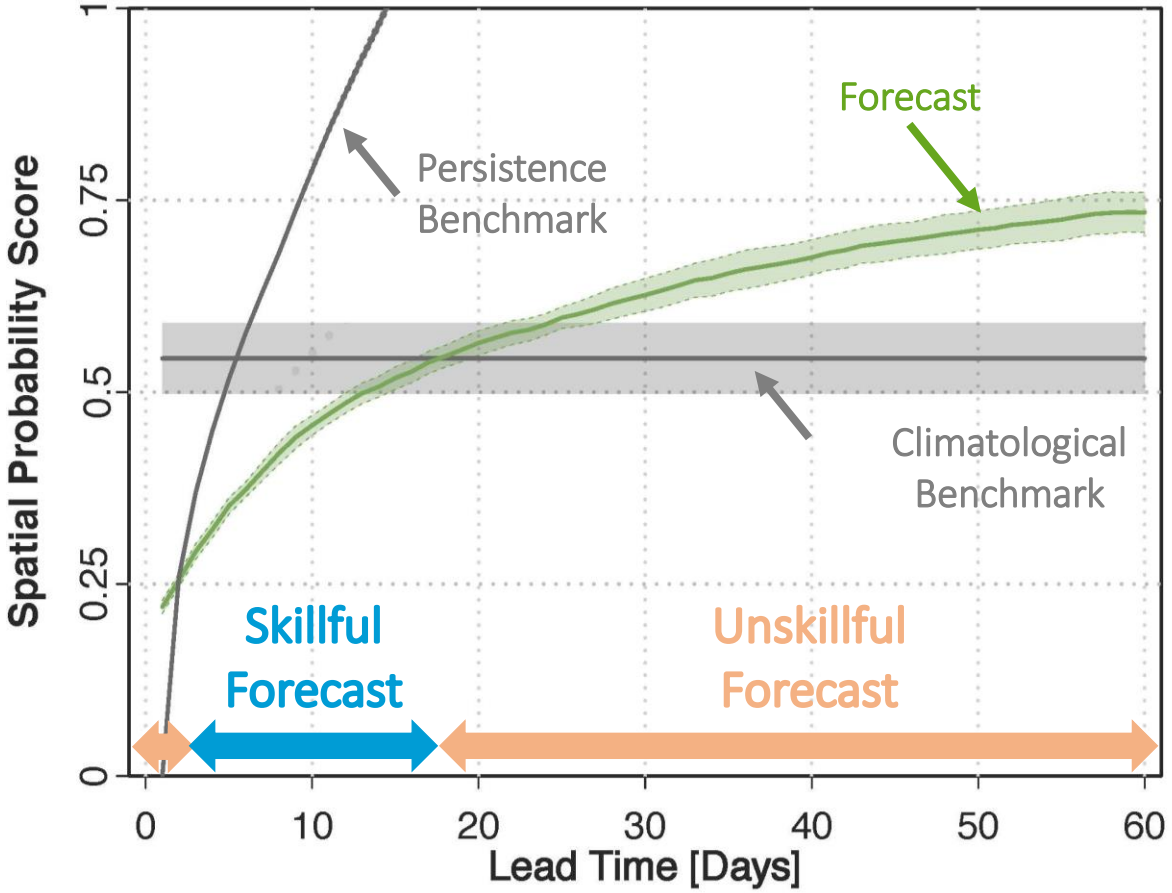
SPS measures the correctness of the ice edge location

Can handle directly sea ice probabilities
→ ideal for ensemble forecasts

Can be decomposed into Overestimation and Underestimation errors

Can be normalized
→ Normalized Spatial Probability Score

Benchmark Forecasts



Measuring the forecast error is not enough!

The definition of proper benchmarks is a crucial step to assess the forecast predictive skills

!! Next talk will expand this topic !!

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Method Summary

UKMO CMA
ECMWF MF
KMA NCEP

Ensemble S2S sea-ice forecasts

Verification against satellite observations using the SPS

Compare forecast SPS to the benchmarks

Assessment of the forecast predictive skill

Indications about errors and biases

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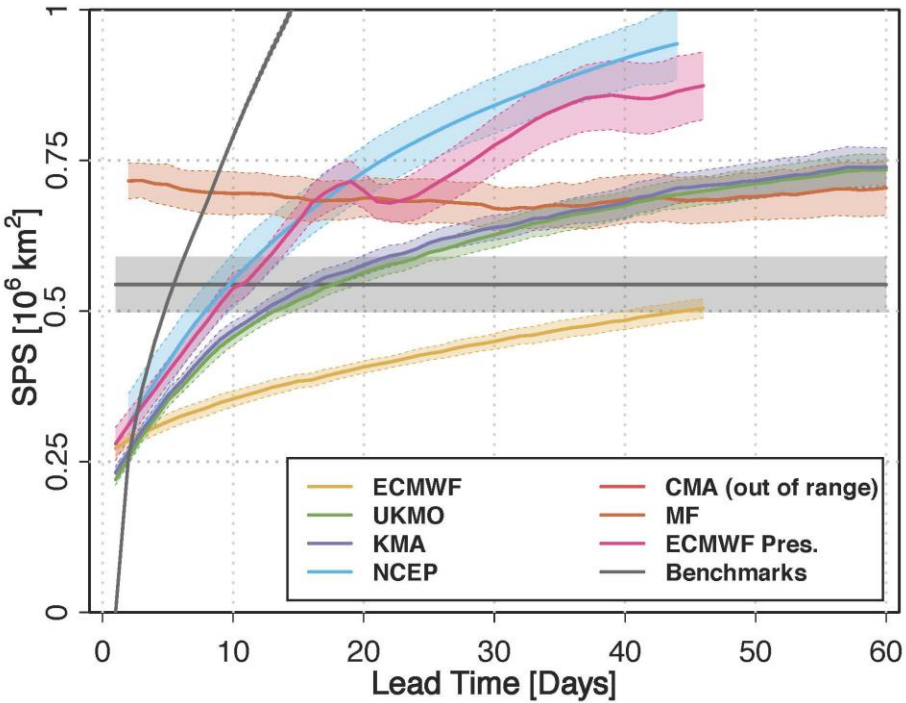
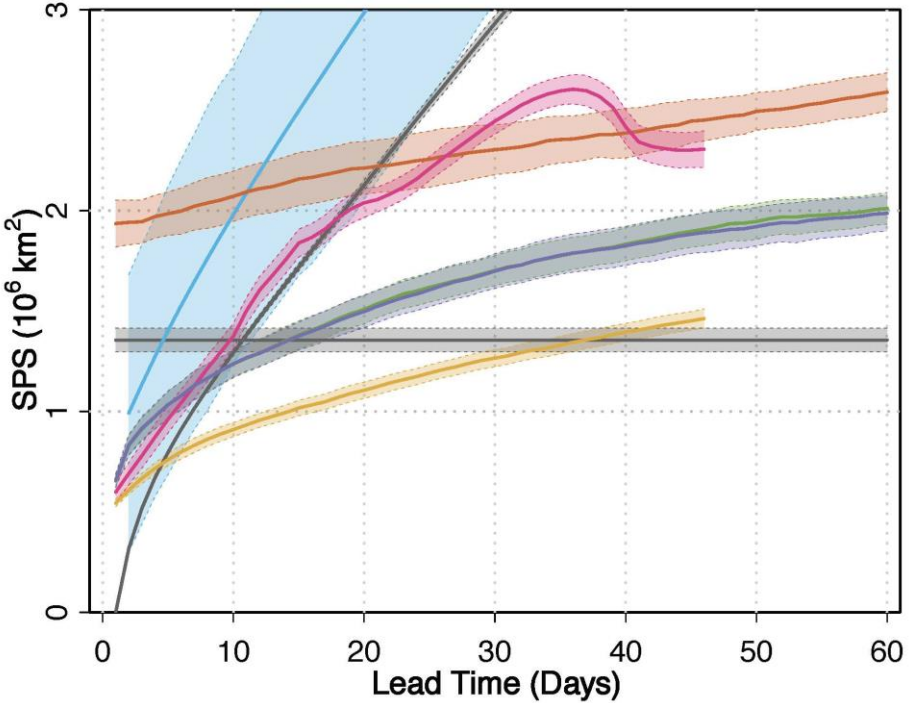
S2S forecasts predictive skill

Arctic



Antarctic



Zampieri et al. (2018) GRL
Zampieri et al. (2019) GRL

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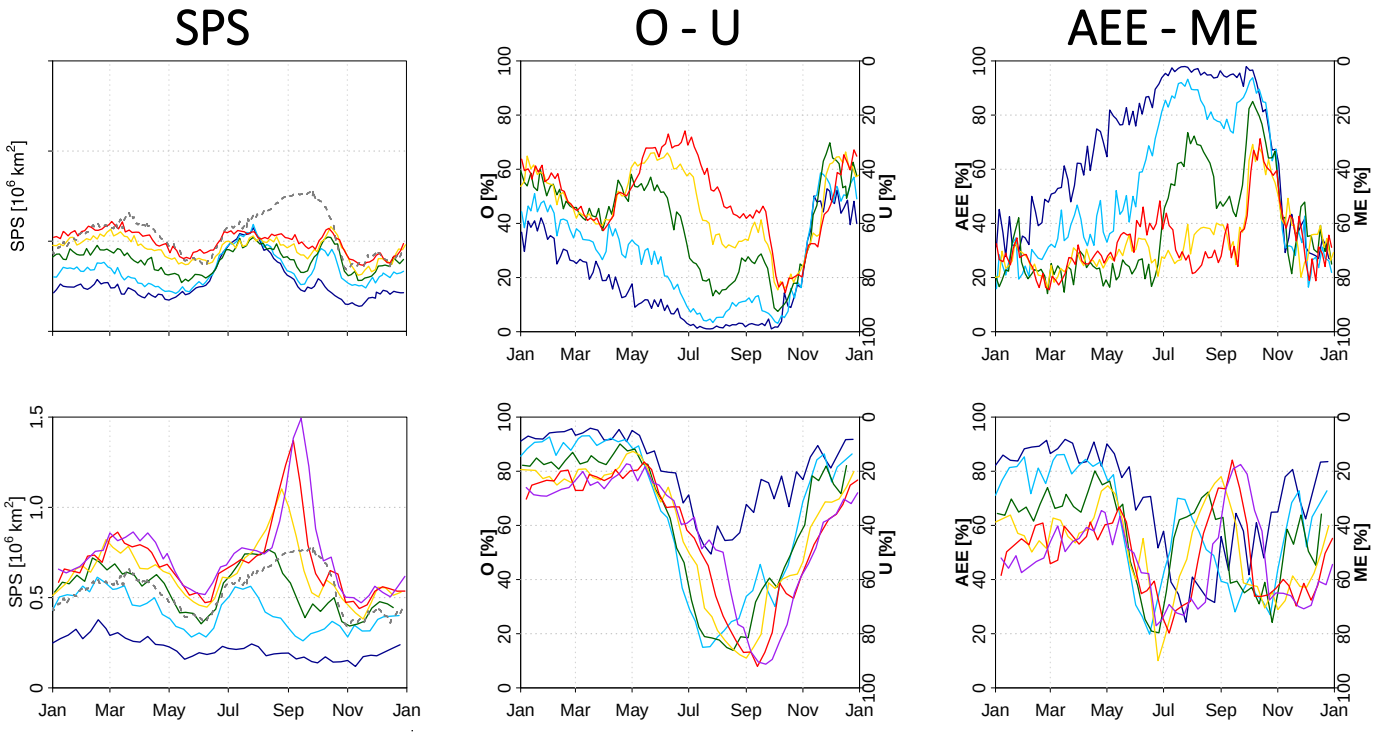
Seasonal variation of the forecast error – Arctic



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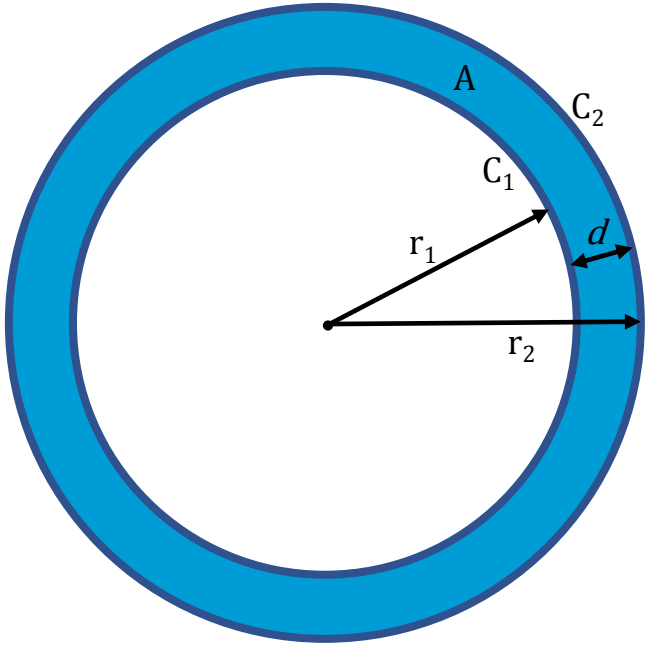
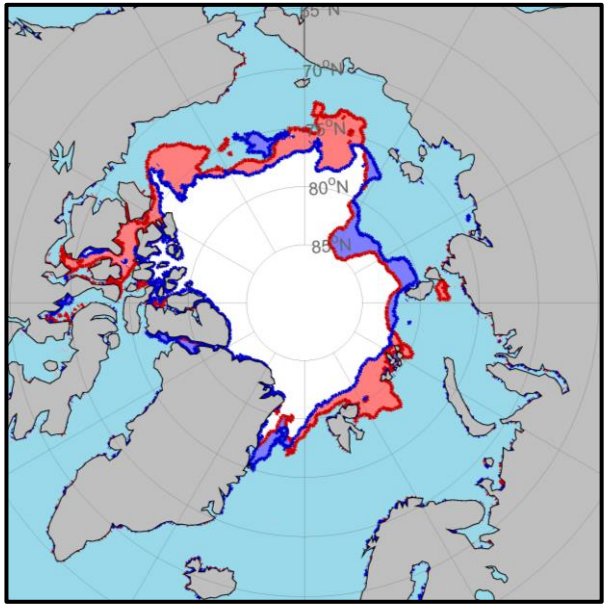
Normalized Spatial Probability Score



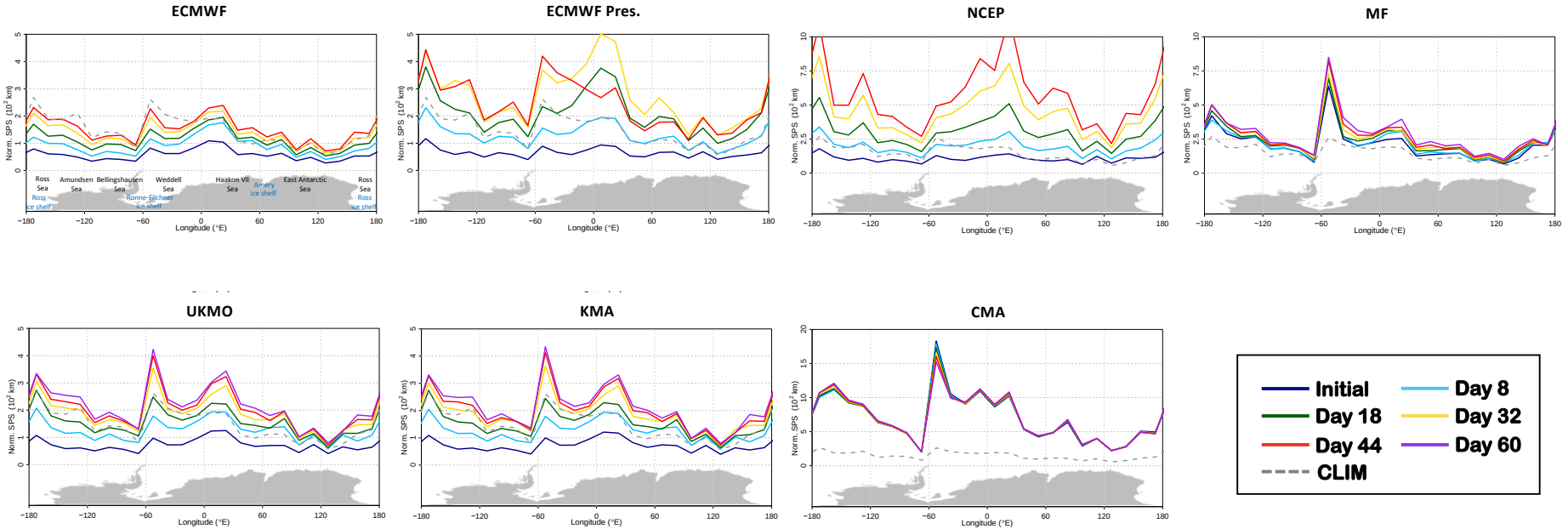
$$r_2 - r_1 = d = \frac{\mathrm{A}}{\overline{\mathrm{C}}}$$

$$Norm.SPS = \frac{SPS}{\bar{l}}$$



Goessling et al. (2016) GRL

Zonal error variations around Antarctica

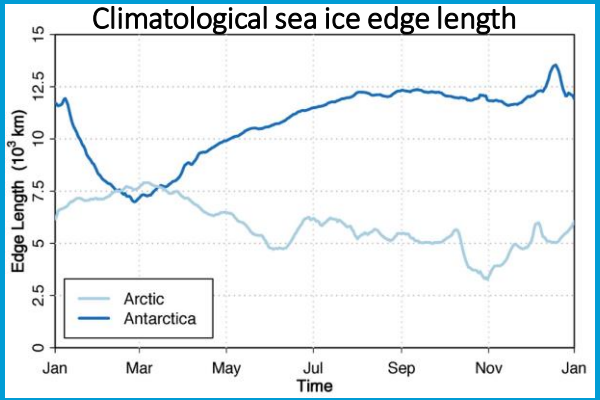


What causes hemispheric differences?

The forecast error (SPS) is larger for the Antarctic sea ice than for the Arctic one

70%

The Antarctic ice edge is longer

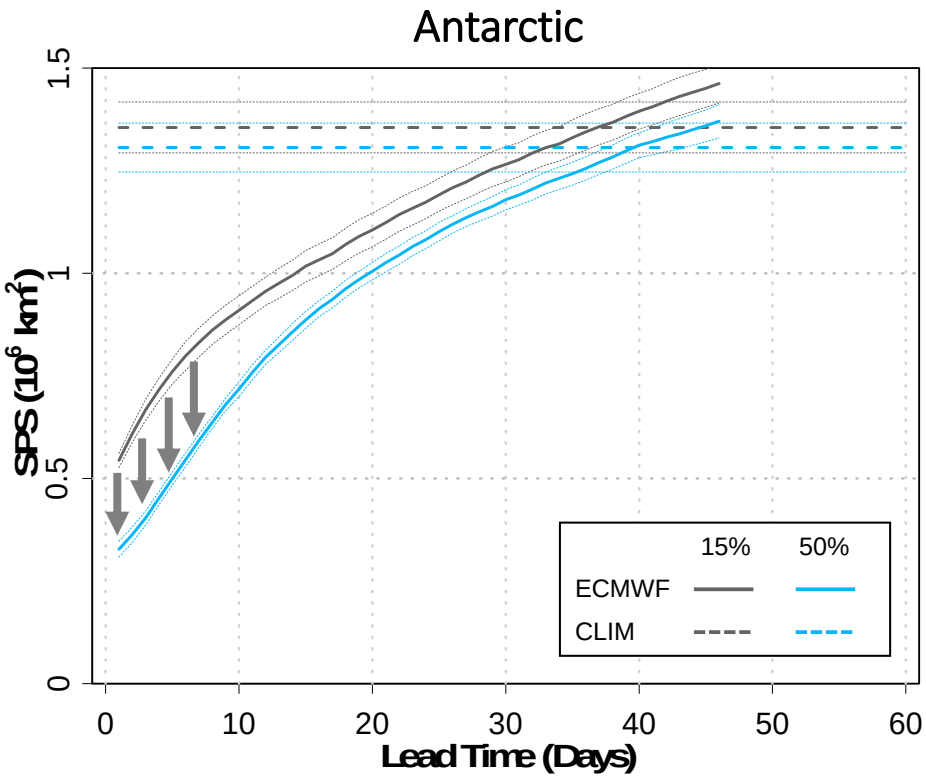


30%

Lower predictive skill

- Sea ice models are not properly tuned for the Antarctic sea ice
- Important physical processes are not included in the forecast systems
- Antarctic sea ice might be less predictable than the Arctic one
- Less observations assimilated in the southern hemisphere
- …

Predictive skill and concentration thresholds



Non-significant changes in predictive skill at longer time scales

Substantial reduction of the forecast initial error

Summary

Some sea ice edge forecasts are already skilful up to subseasonal time scales (in the Arctic)

The predictive skills of the Antarctic forecasts is on average 30% lower than the Arctic one

A substantial initial error affects all the models

At longer timescales, the predictive skill does not vary with the chosen sea ice concentration threshold

The initial error is partially caused by a misrepresentation of sparse ice in the marginal ice zone

New sea ice and ocean variables available in the S2S database

What else can the S2S database offer?

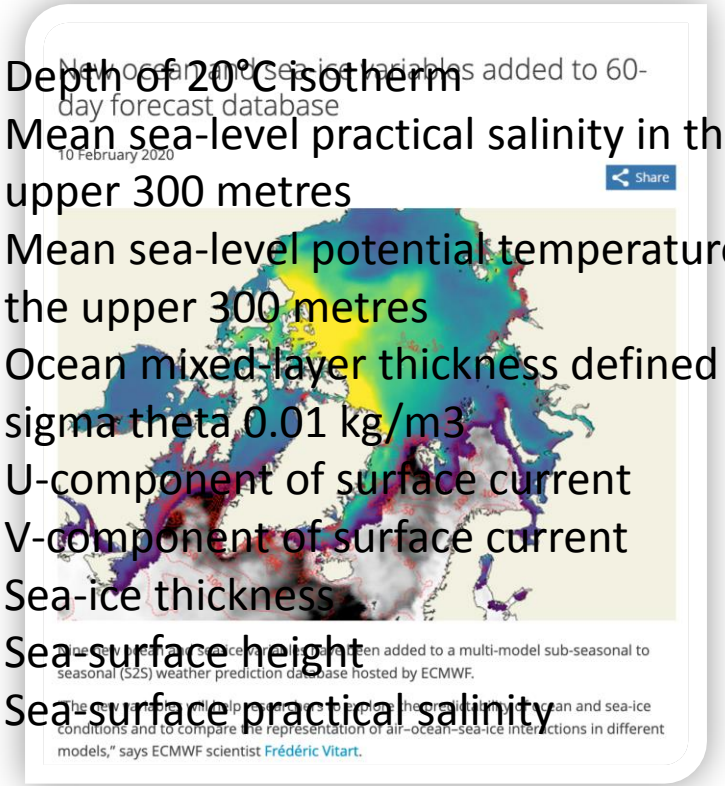
Environment and Climate Change Canada
Canada

METEO FRANCE

ECCC, CMA and Météo France updated the sea ice description in their S2S models

More and more fully coupled models!

- Depth of 20°C isotherm
- Mean sea-level practical salinity in the upper 300 metres
- Mean sea-level potential temperature in the upper 300 metres
- Ocean mixed-layer thickness defined by sigma theta 0.01 kg/m3
- U-component of surface current
- V-component of surface current
- Sea-ice thickness
- Sea-surface height
- Sea-surface practical salinity



Thank you,
Questions?