The role of arctic forecast errors in the evolution of northern extra-tropical forecast skill

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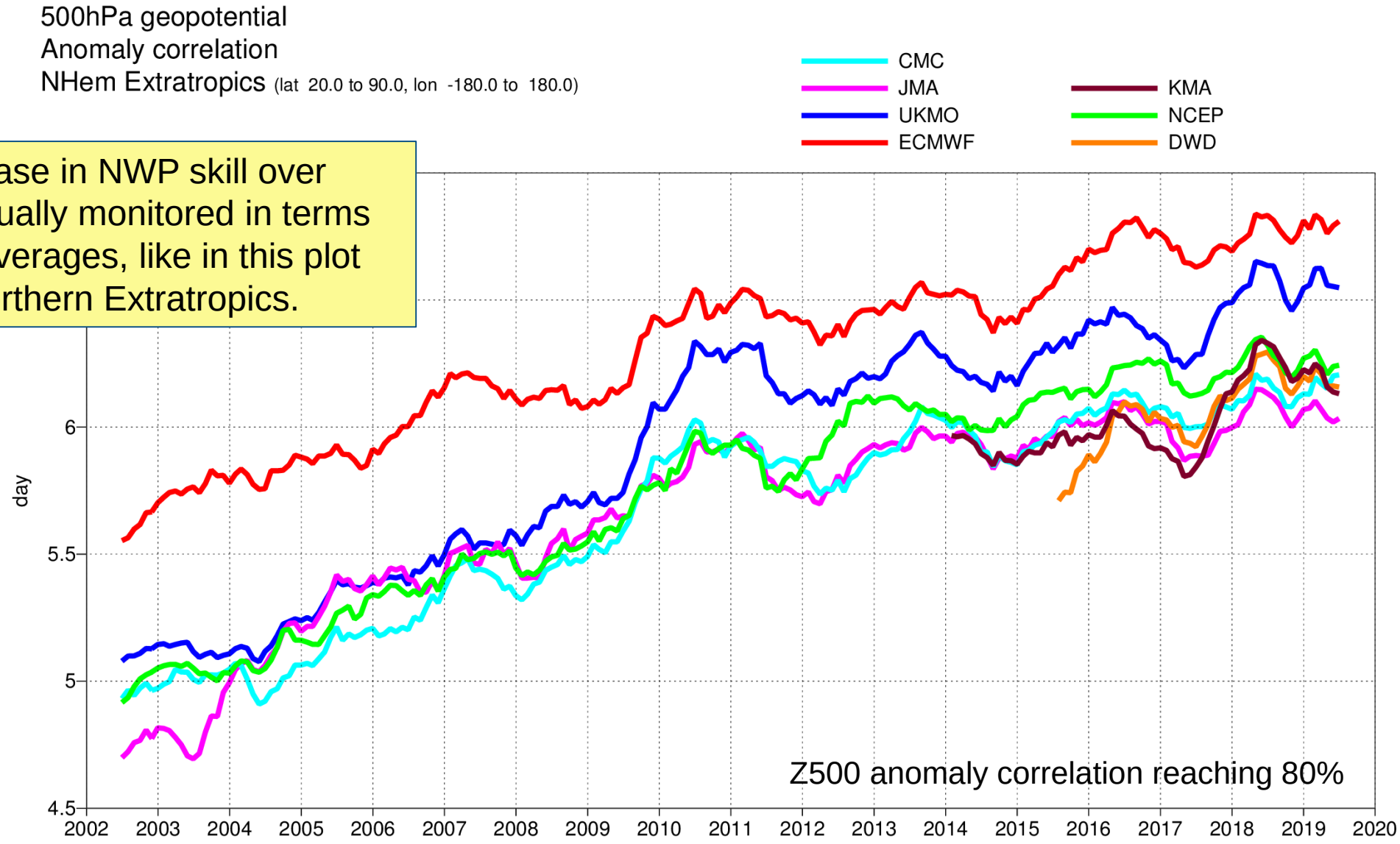
Thanks to: Martin Janousek, Linus Magnusson

ECMWF

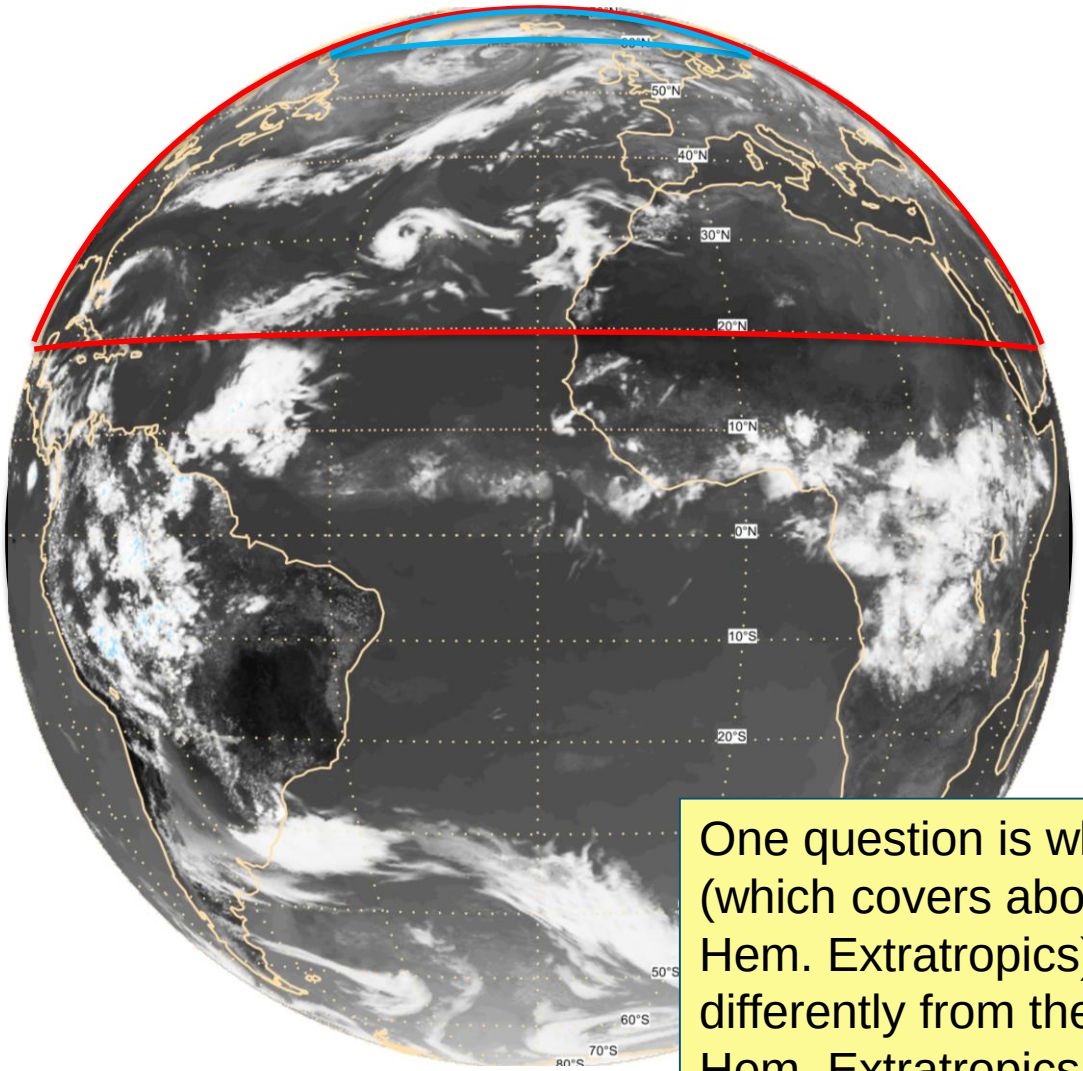
YOPP YEAR OF POLAR PREDICTION

Global NWP skill evolution



The increase in NWP skill over time is usually monitored in terms of areal averages, like in this plot for the Northern Extratropics.

Northern Extratropics and Arctic



60-90N: 6.7% of Earth's surface

6.7/32.9=**20.4%**

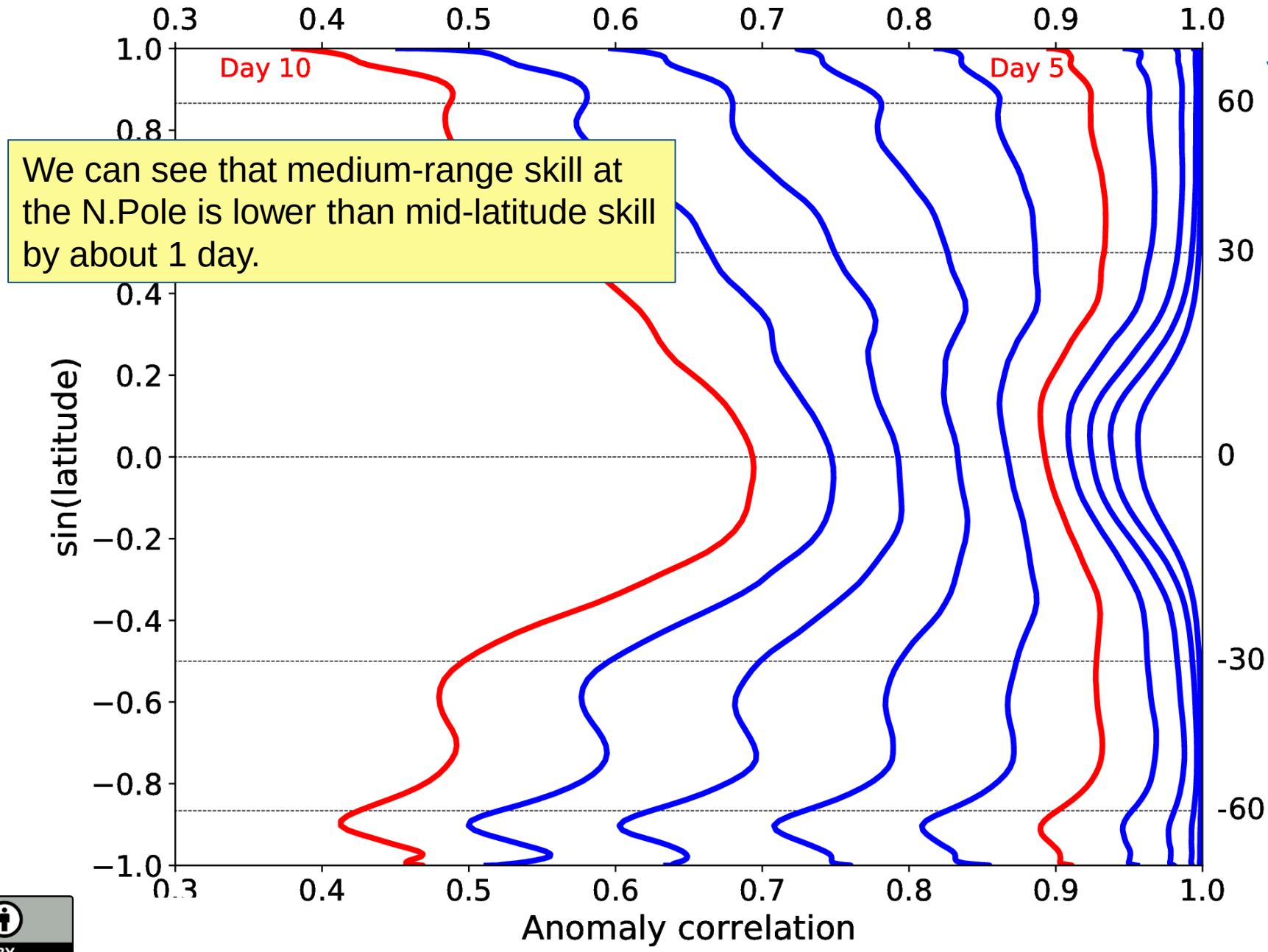
20-90N: 32.9% of Earth's surface

Bauer et al. (2016): 'Polar forecast verification against analyses shows a similar trend of forecast improvement over the past 12 years compared with improvements at lower latitudes.' (based on data up to 2015)

Is this still true in 2020?

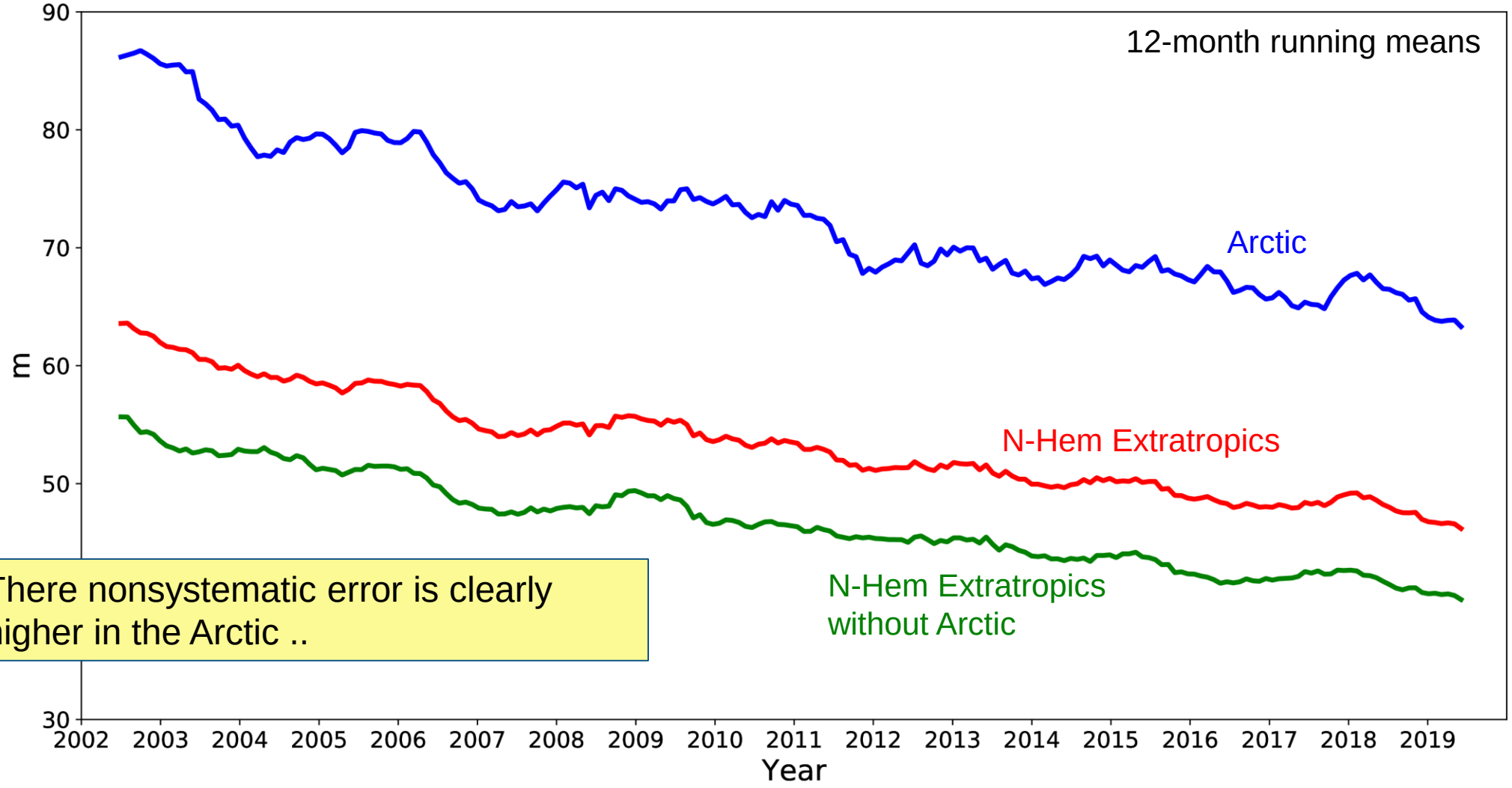
One question is whether the Arctic (which covers about 20% of the N-Hem. Extratropics) behaves differently from the rest of the N-Hem. Extratropics in this respect.

Anomaly correlation of 500 hPa geopotential (Days 1-10)



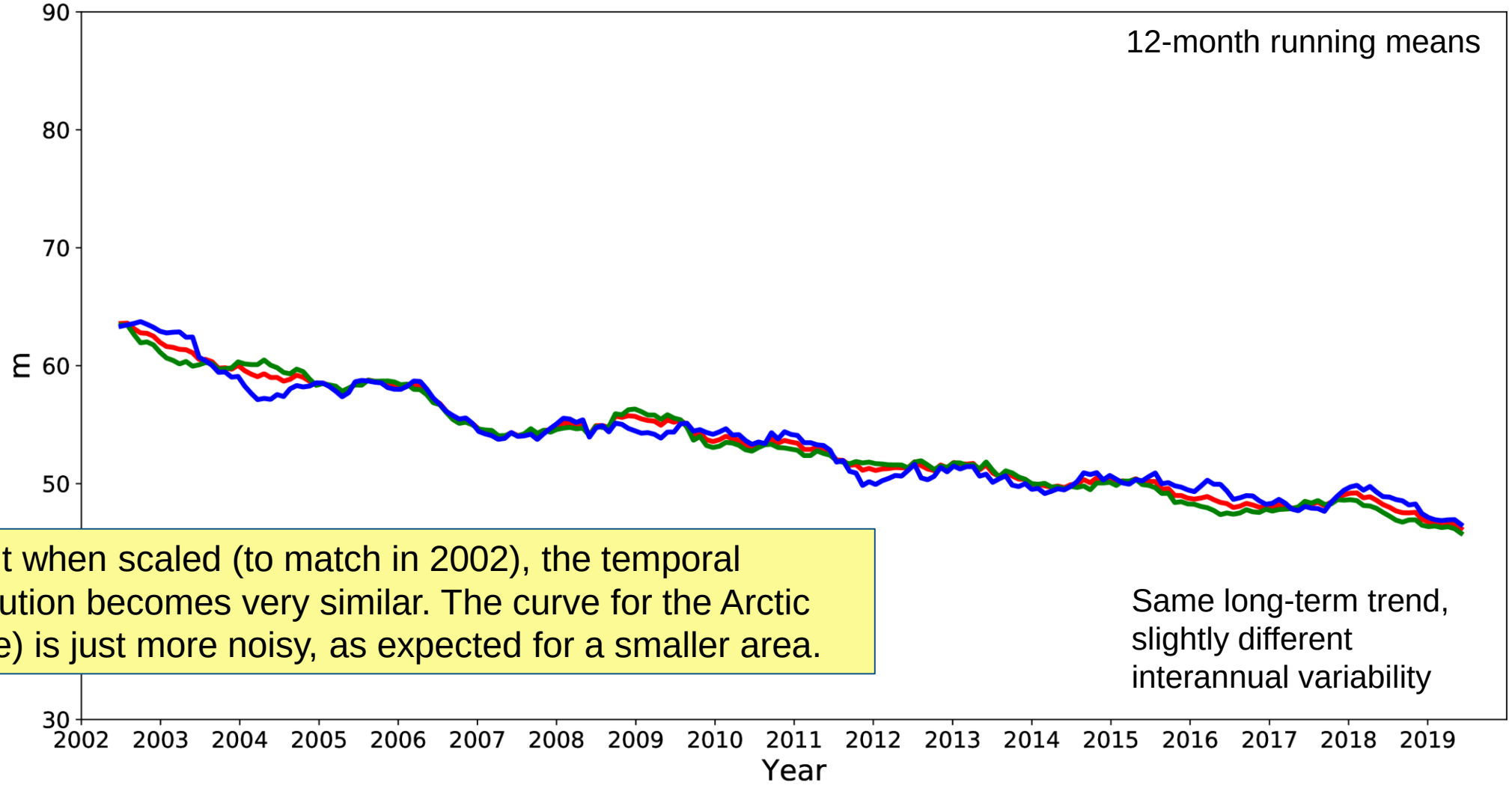
July 2016 - June 2019 average

Error standard deviation of 500 hPa geopotential at day 6



There nonsystematic error is clearly higher in the Arctic ..

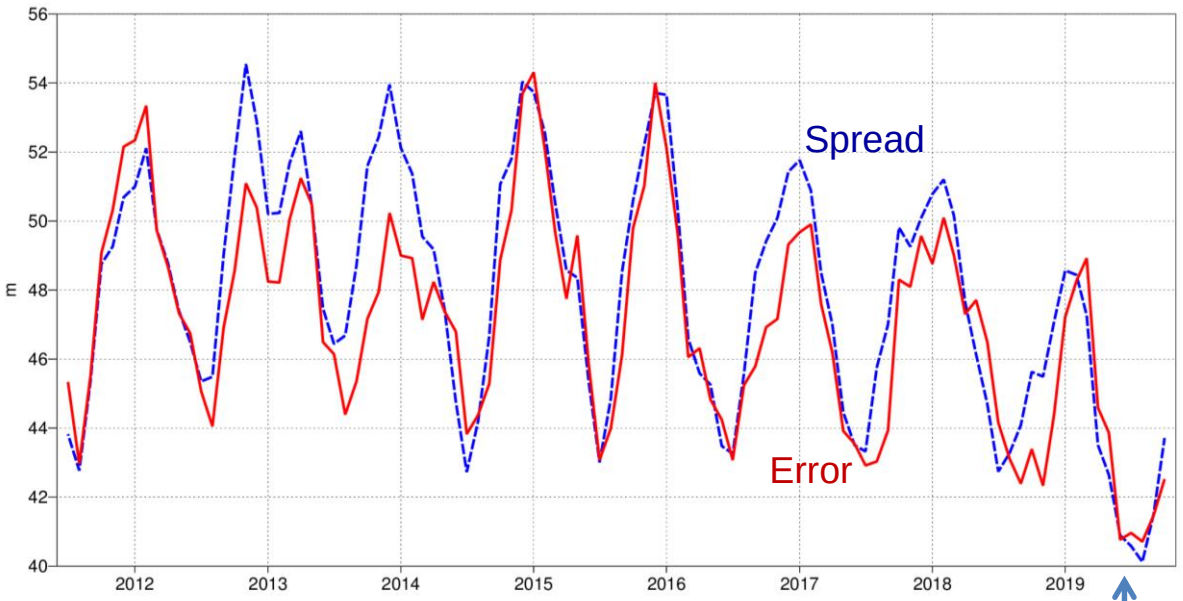
Error standard deviation of 500 hPa geopotential at day 6



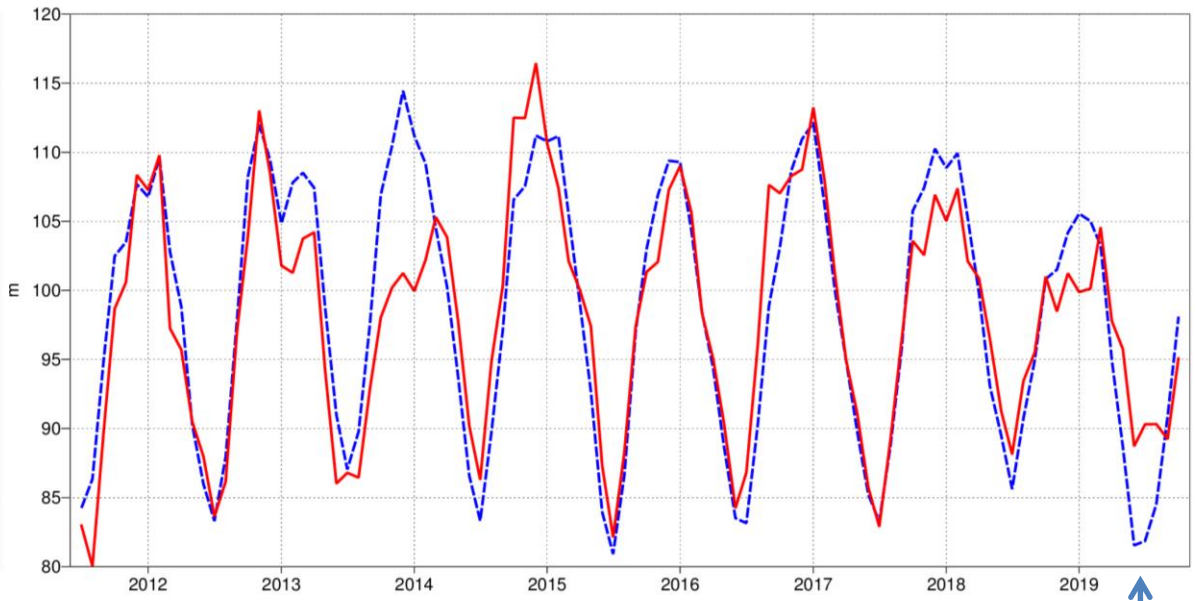
.. but when scaled (to match in 2002), the temporal evolution becomes very similar. The curve for the Arctic (blue) is just more noisy, as expected for a smaller area.

Same long-term trend, slightly different interannual variability

Ensemble forecast 500 hPa Geopotential – Arctic (60-90N)



Day 5



Day 10

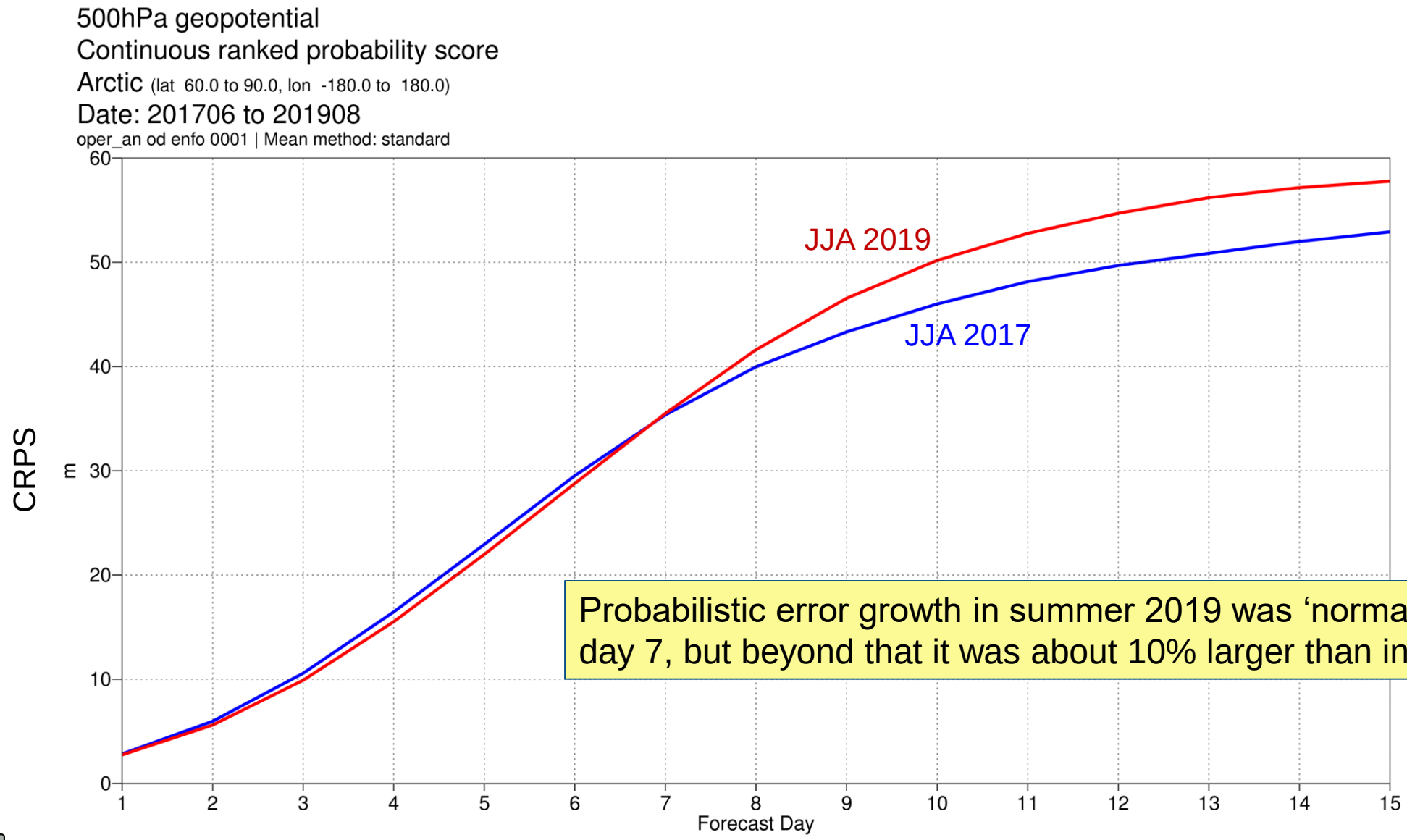
Small error and spread

Large spread-error mismatch

However, the Arctic can be a significant driver of inter-annual variations in skill. In summer 2019, error and spread of the ENS forecast at day 5 were unusually small ..

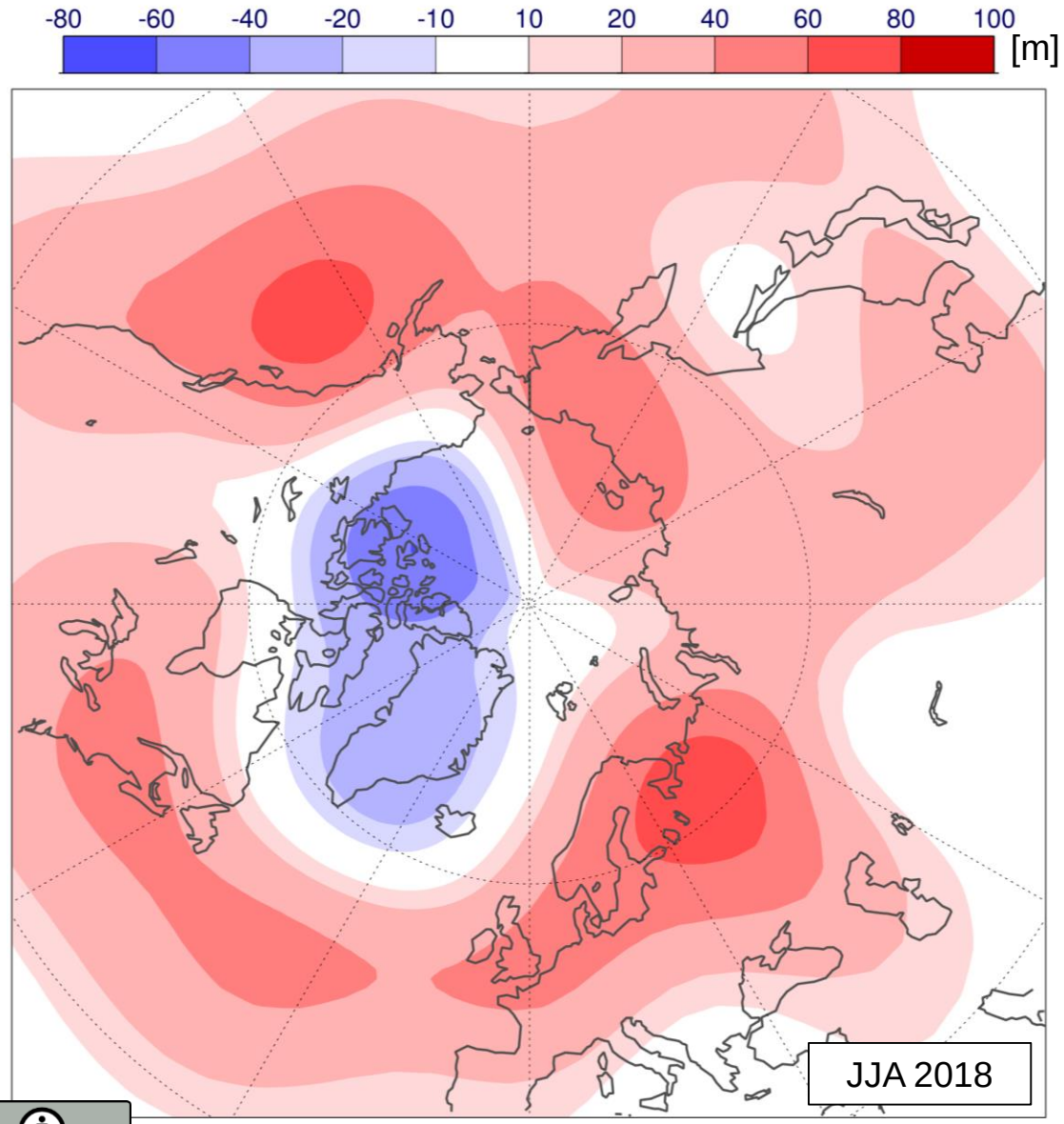
.. and the mismatch between error and spread at day 10 was unusually large.

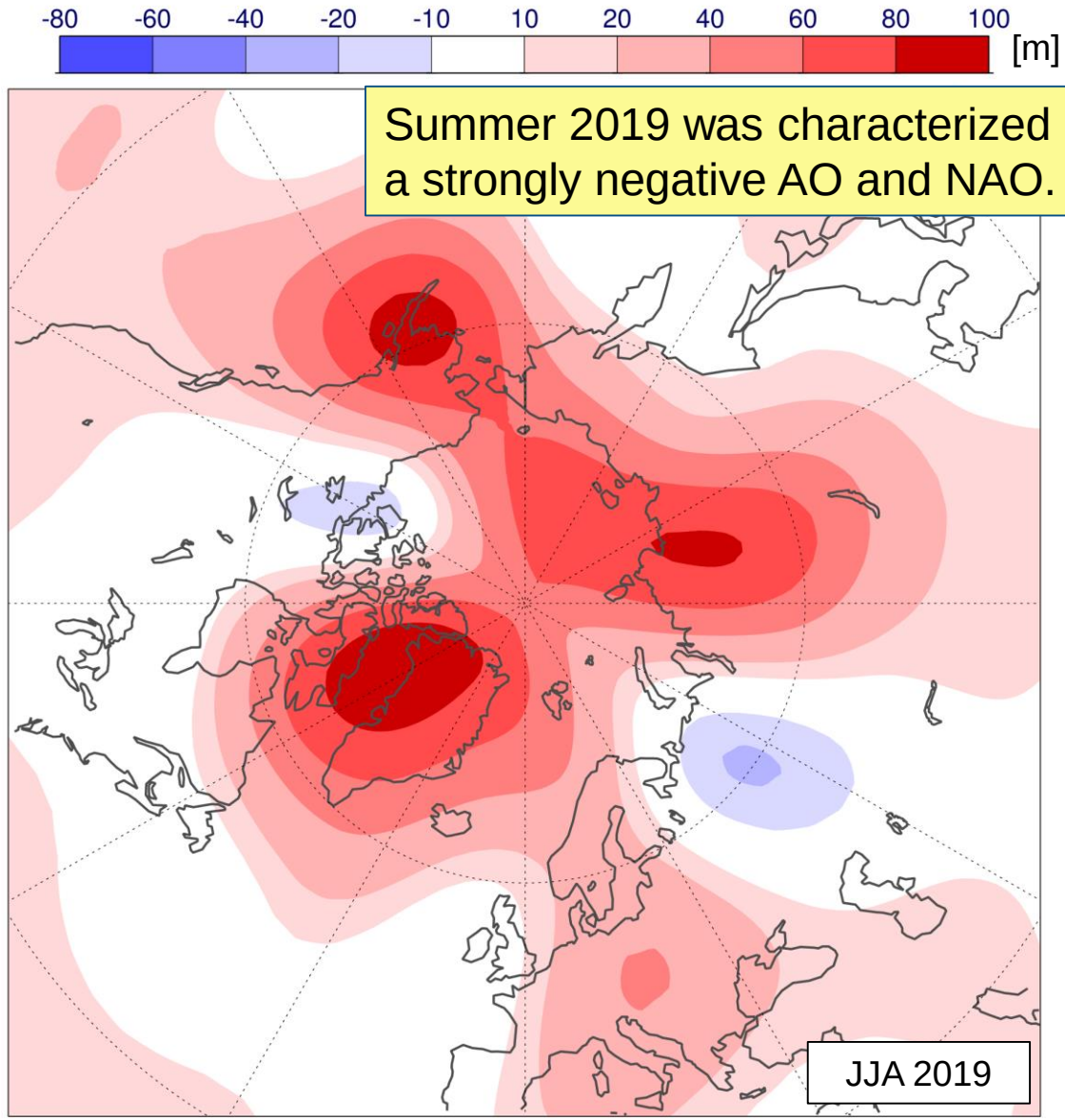
500 hPa Geopotential – Arctic (60-90N)



Probabilistic error growth in summer 2019 was ‘normal’ up to day 7, but beyond that it was about 10% larger than in 2017.

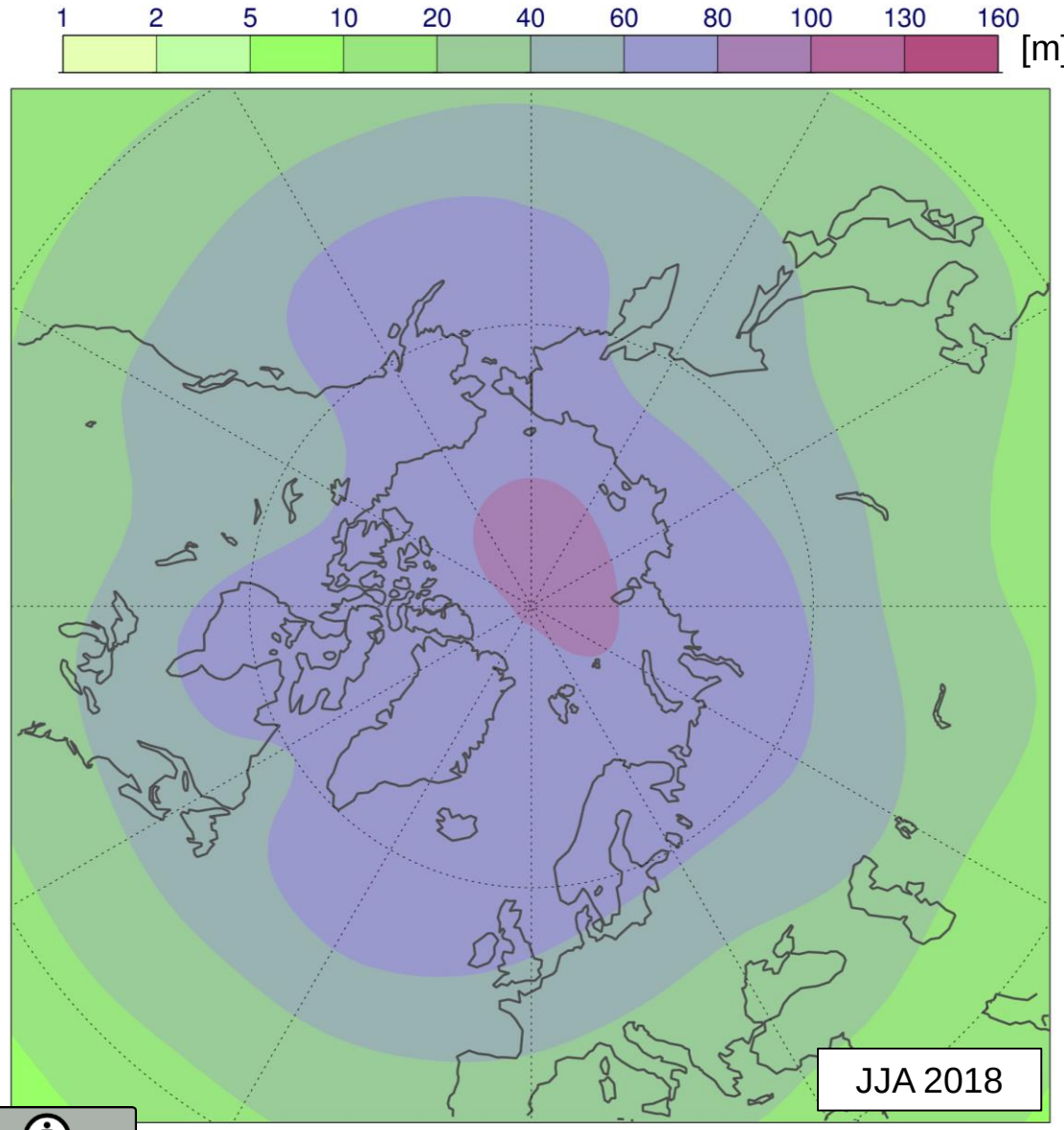
Z500 anomaly at STEP=240 in JJA 2018 and 2019

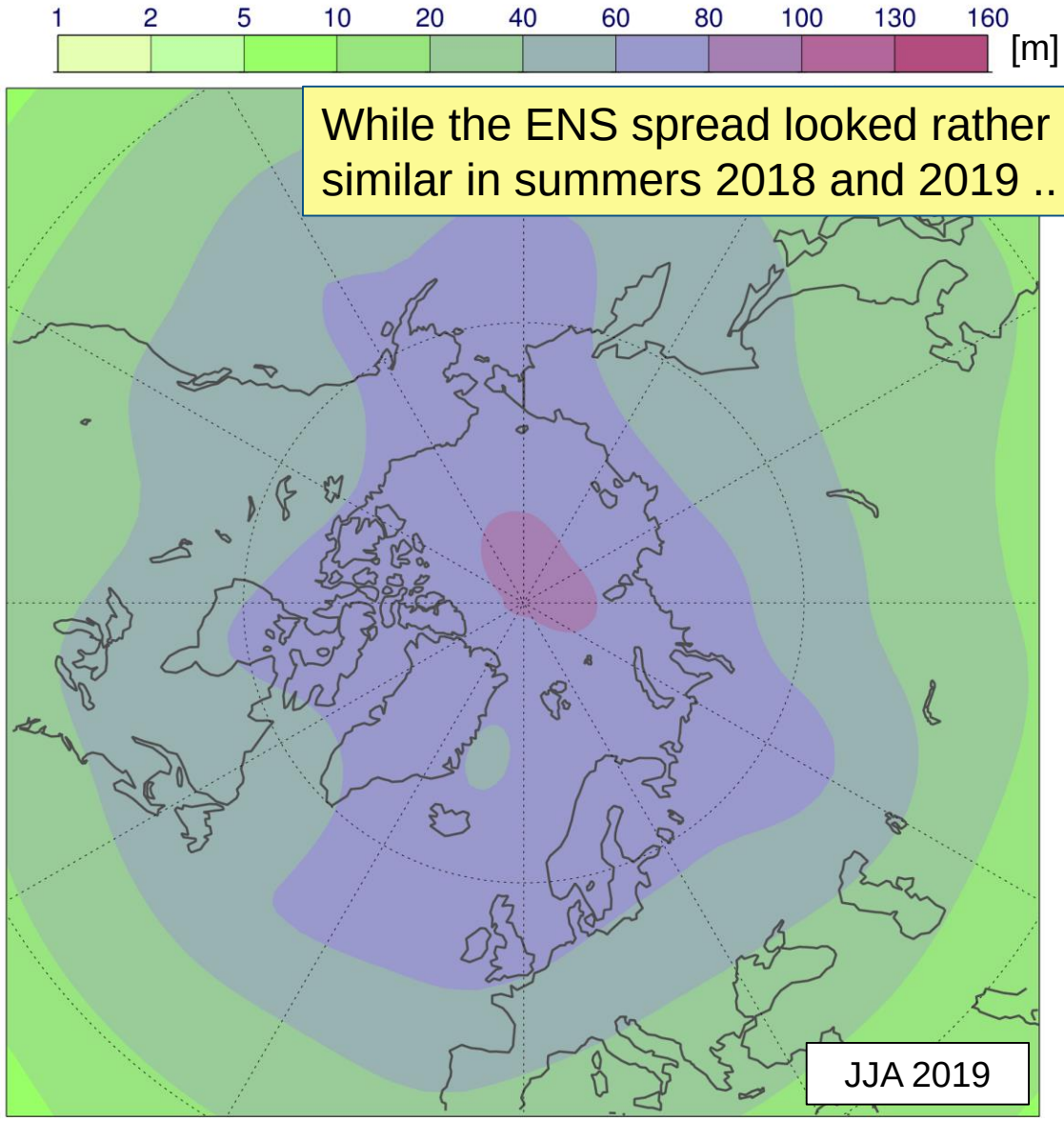




Summer 2019 was characterized by a strongly negative AO and NAO.

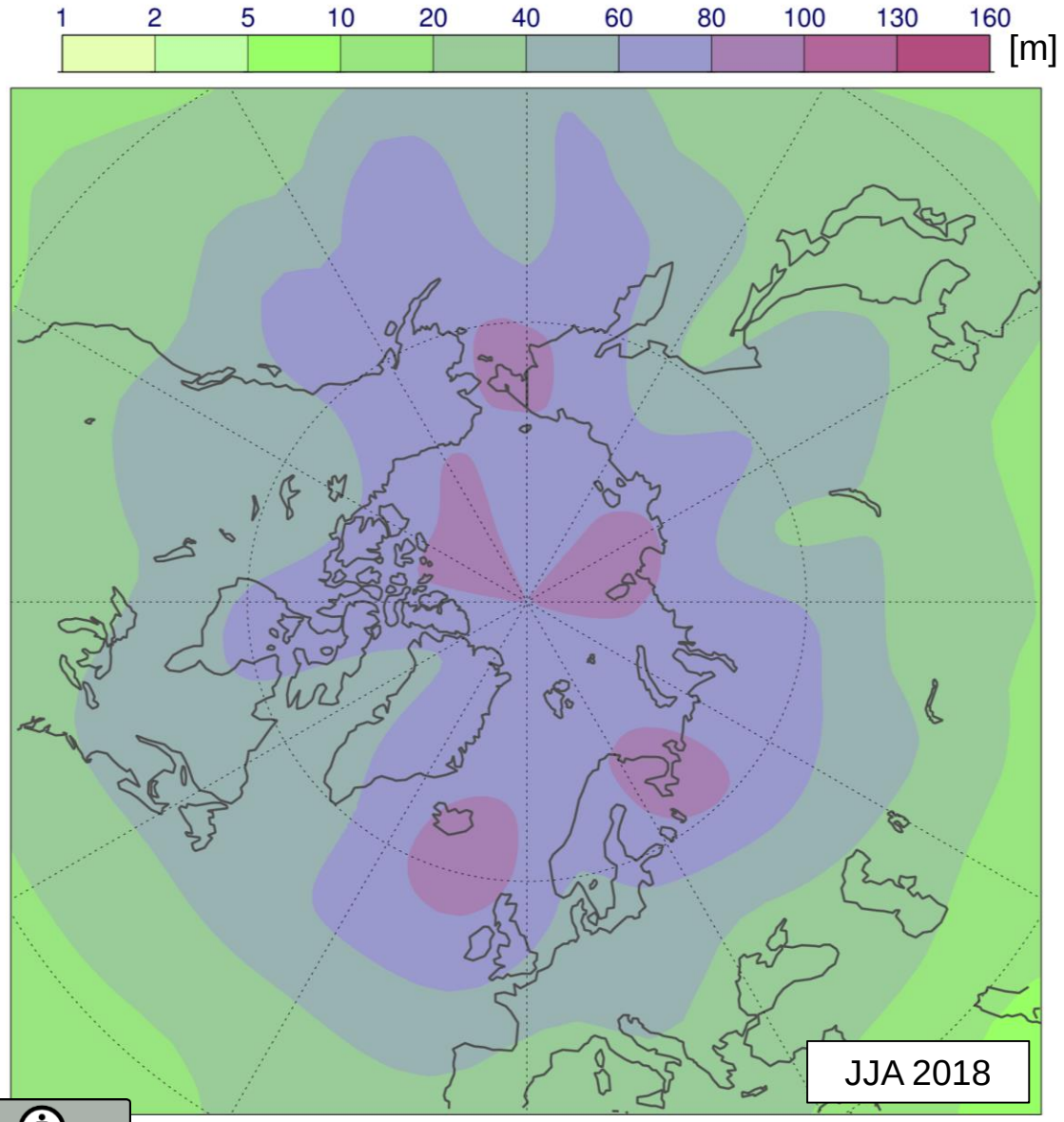
Z500 spread at STEP=240 in JJA 2018 and 2019

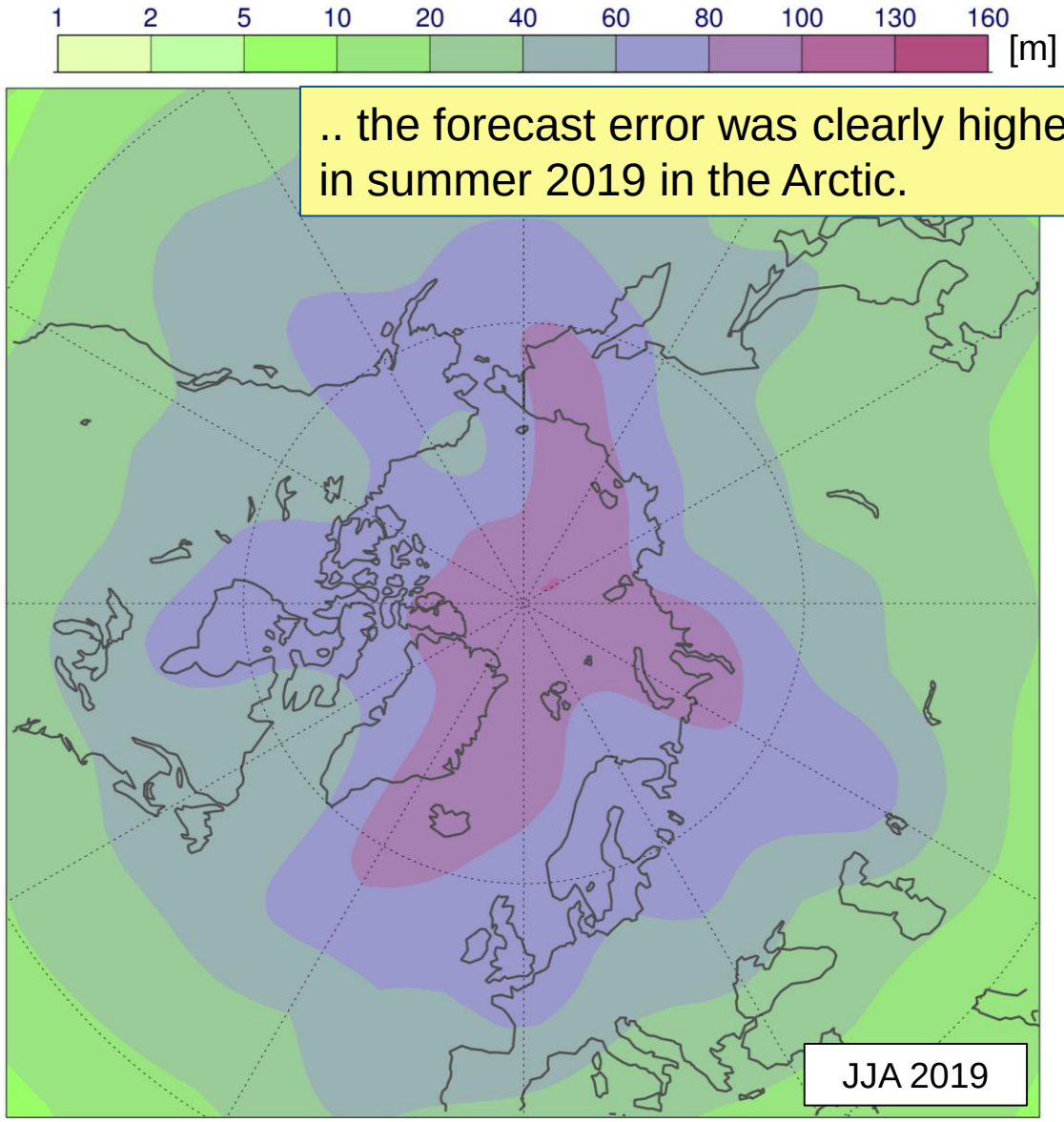




While the ENS spread looked rather similar in summers 2018 and 2019 ..

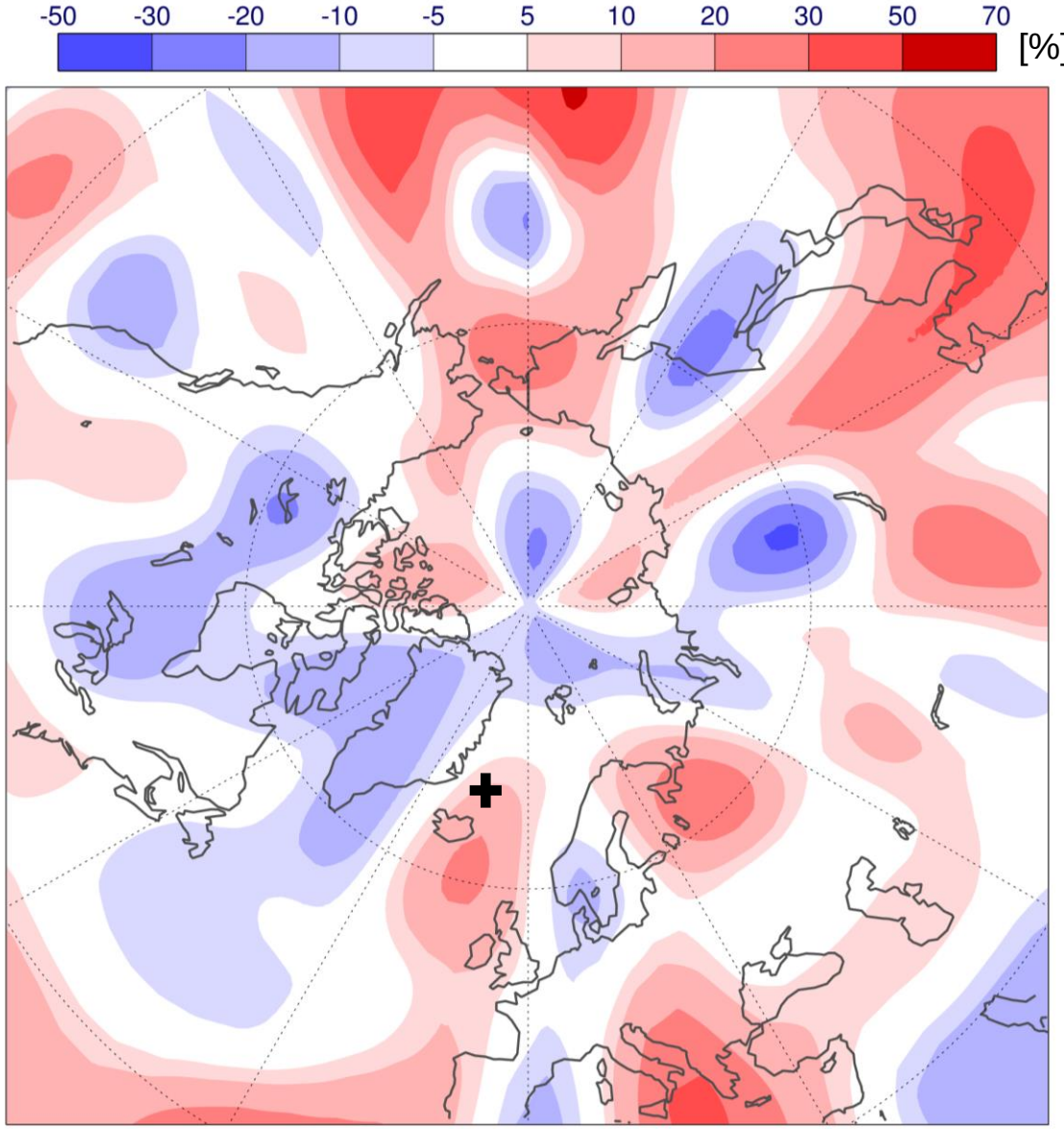
Z500 error at STEP=240 in JJA 2018 and 2019



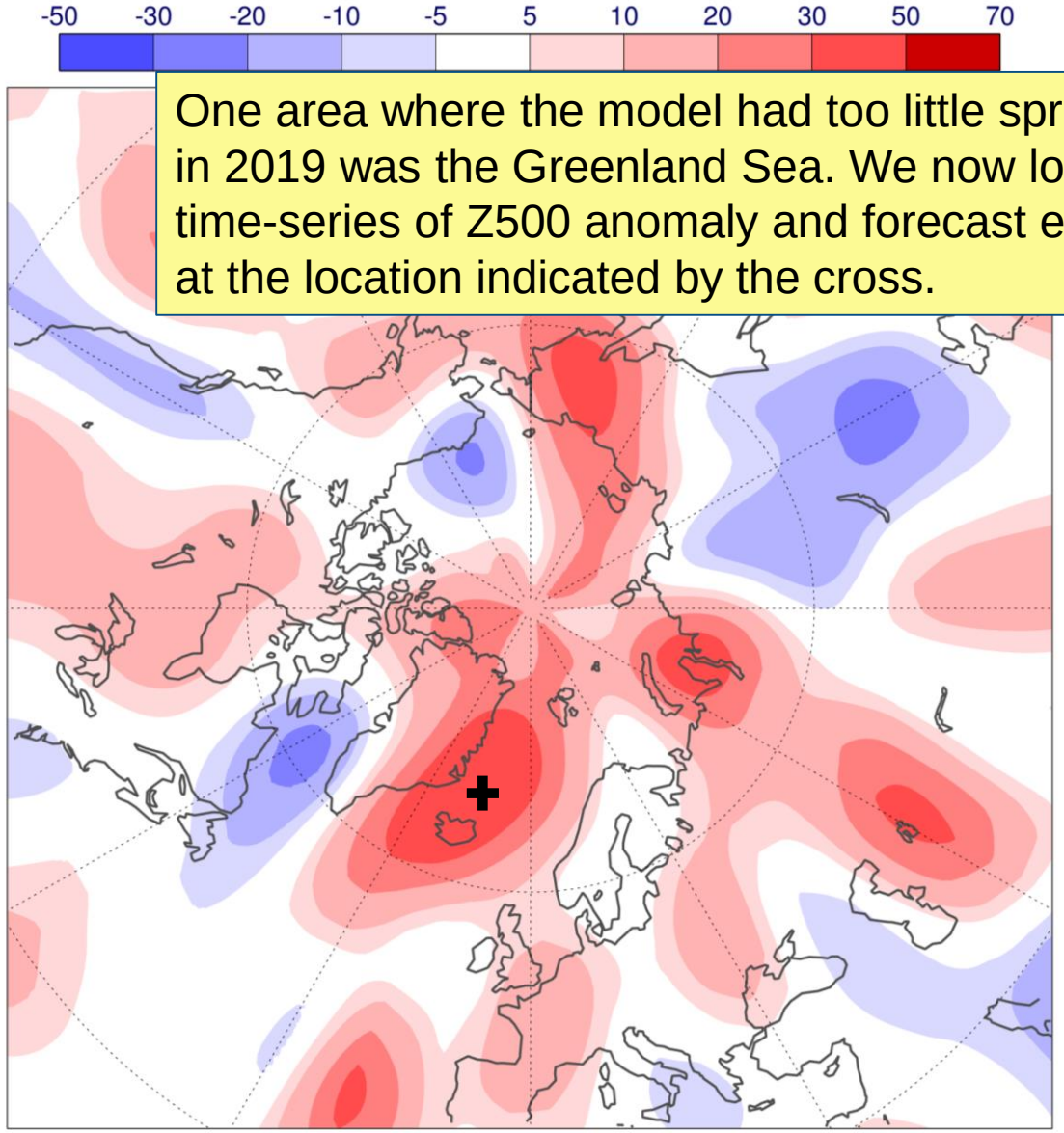


.. the forecast error was clearly higher in summer 2019 in the Arctic.

Z500 relative under-dispersion at STEP=240



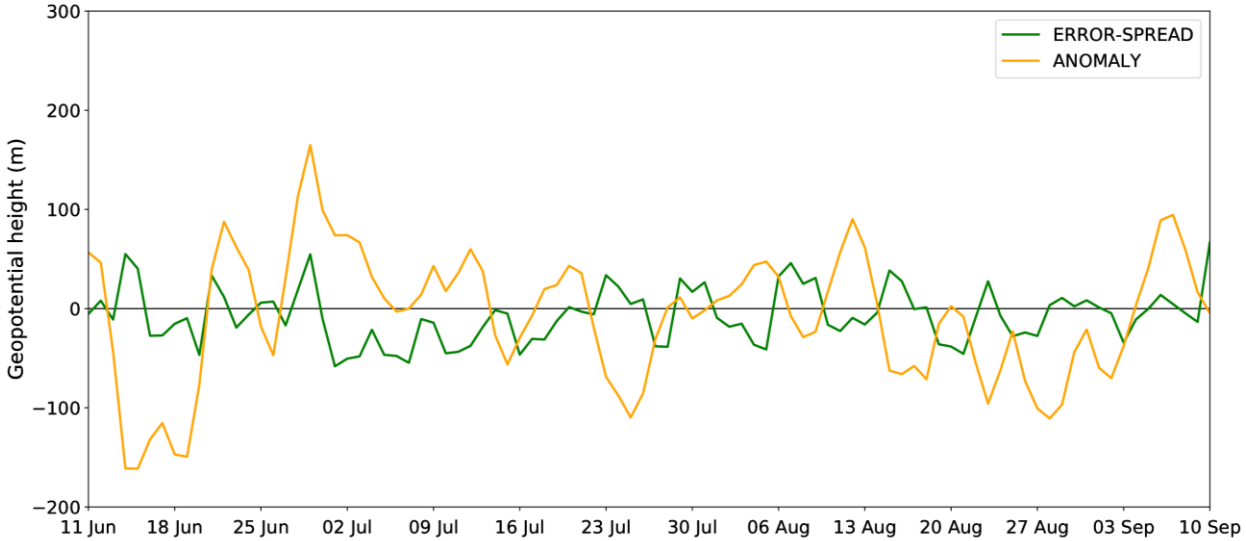
2018



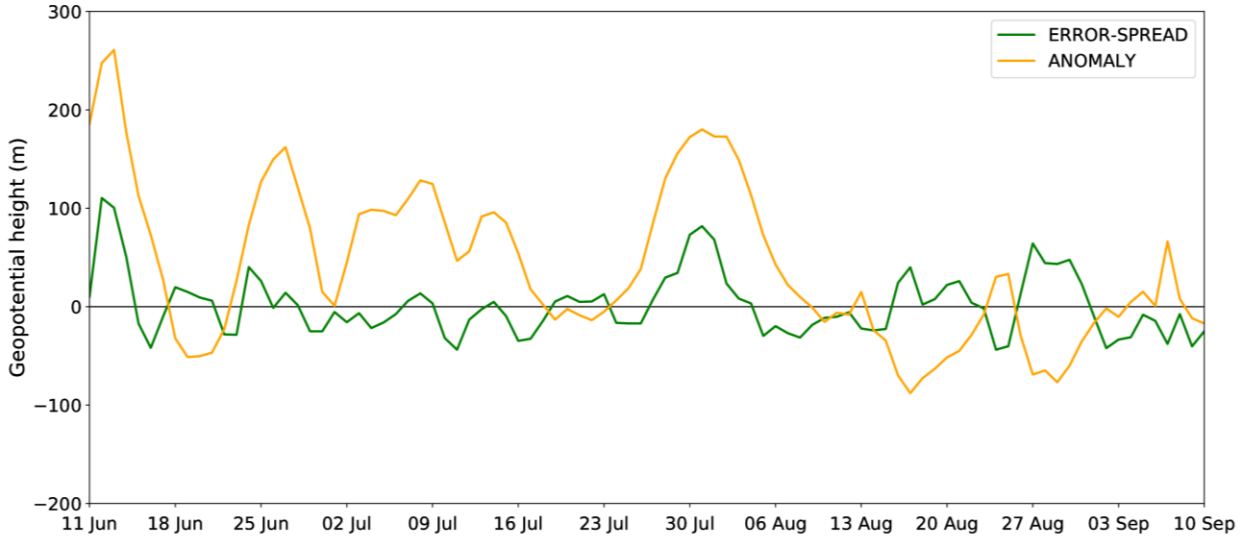
2019

One area where the model had too little spread in 2019 was the Greenland Sea. We now look at time-series of Z500 anomaly and forecast error at the location indicated by the cross.

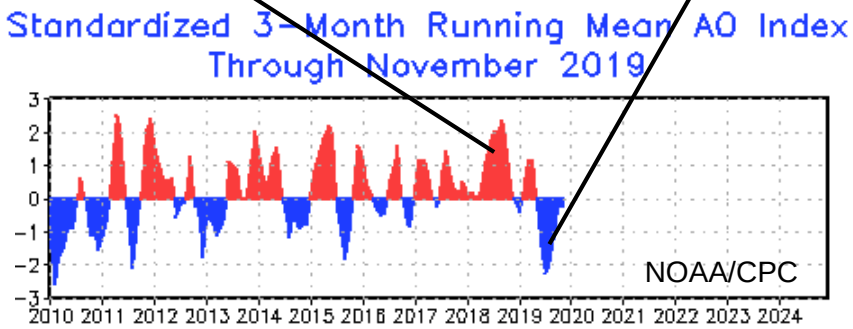
Greenland sea: modes of Z500 variability



2018

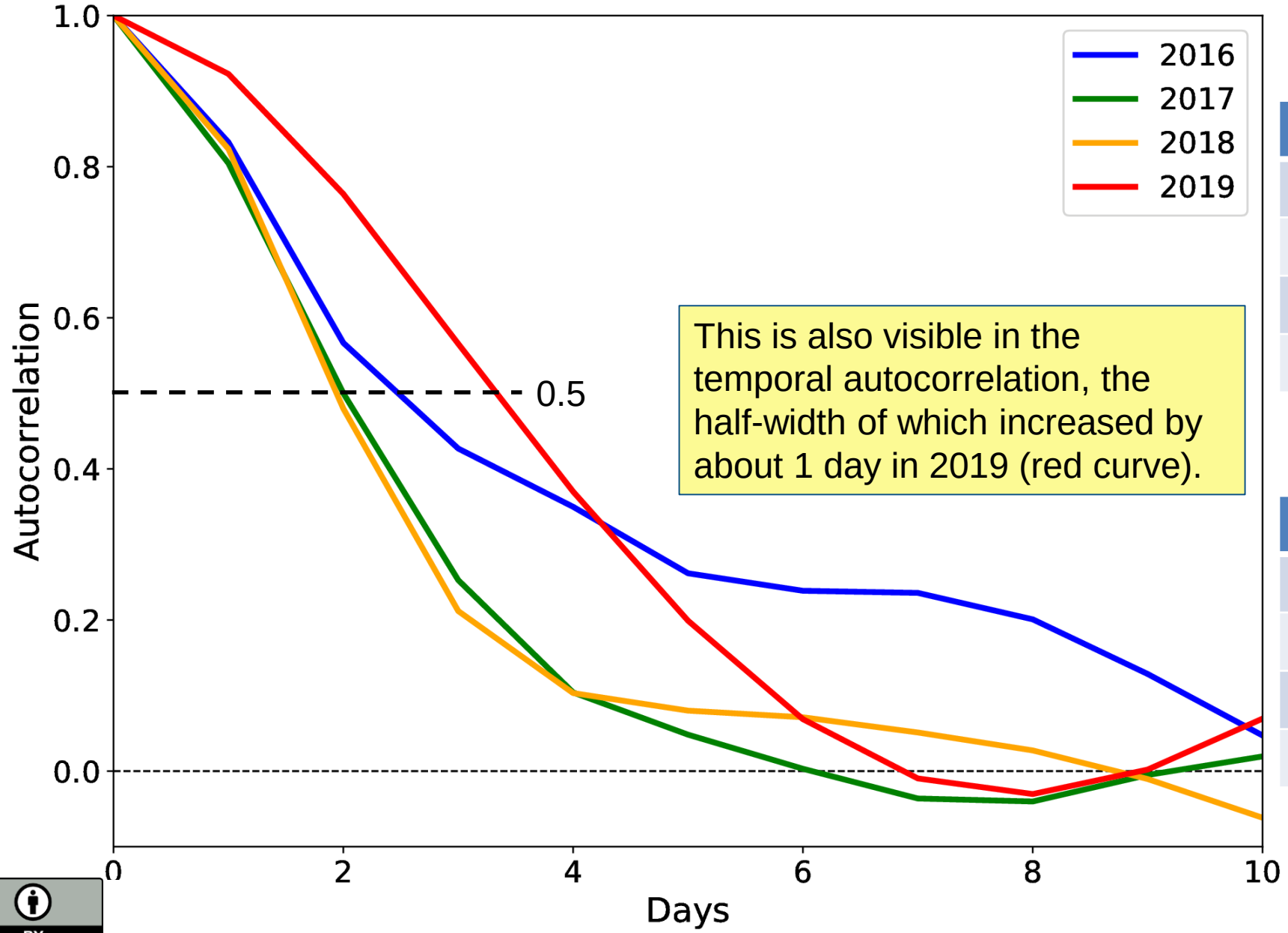


2019



We can see a pronounced difference in the magnitude and duration of anomalies (yellow curves) and associated spread/error (green curves) between the positive and negative AO years.

Greenland sea: persistence of 500 hPa height anomalies (JJA)



Arctic Oscillation Index

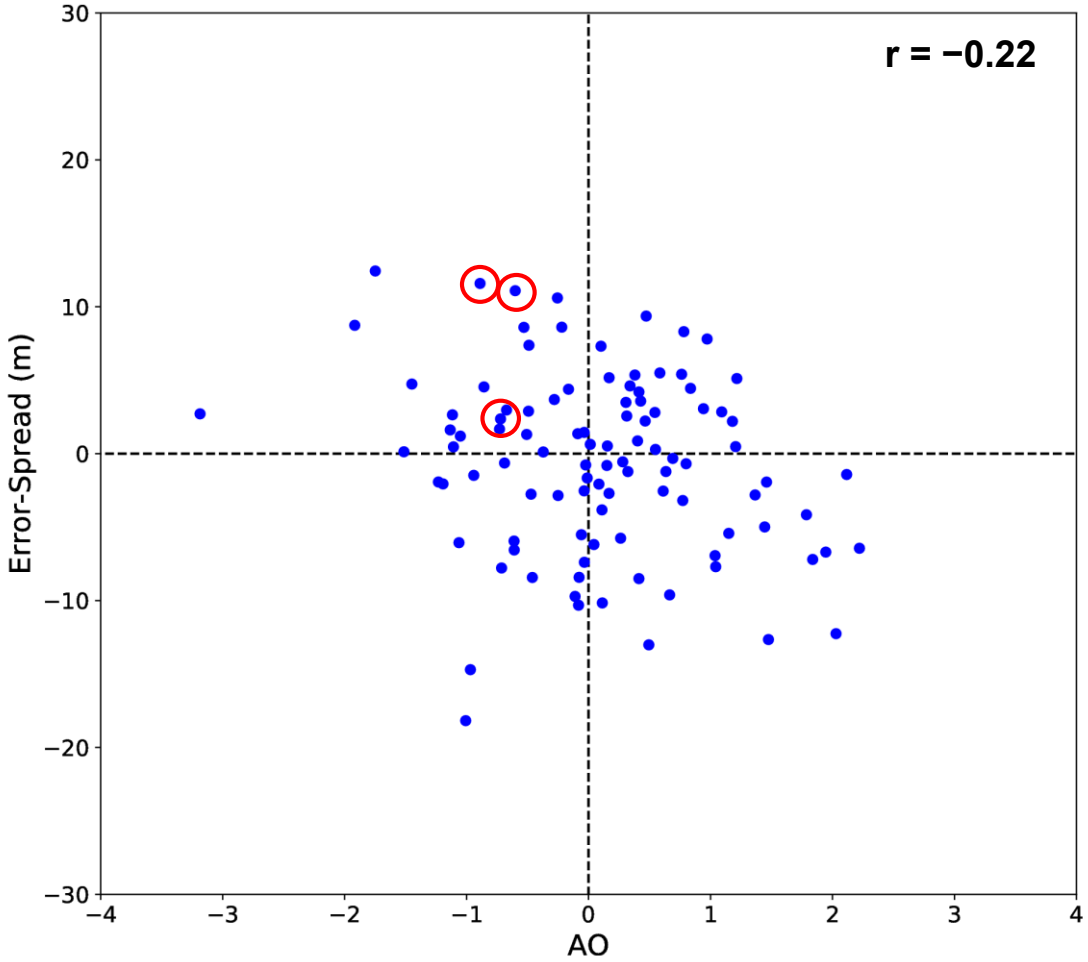
	Jun	Jul	Aug
2016	0.31	0.08	0.47
2017	0.40	0.63	0.15
2018	0.38	0.61	0.84
2019	-0.60	-0.89	-0.72

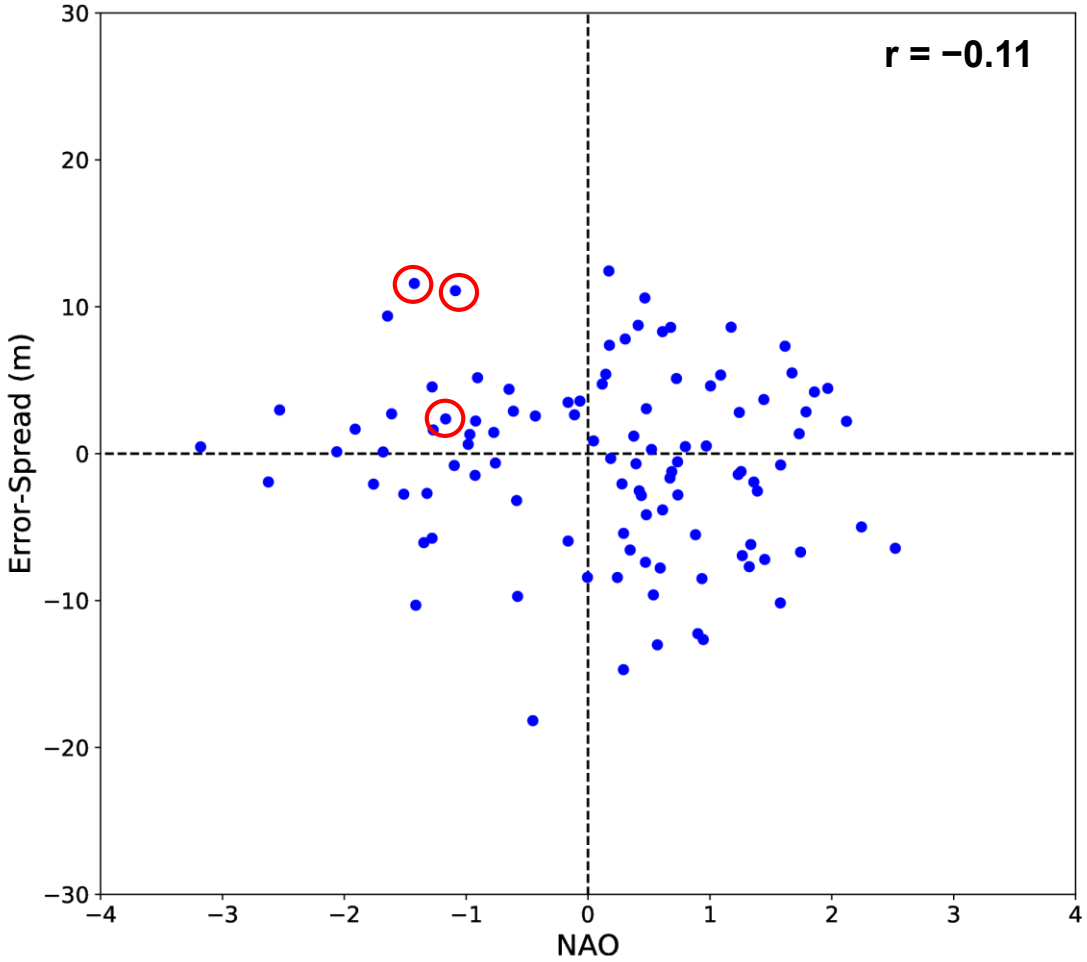
N-Atlantic Oscillation Index

	Jun	Jul	Aug
2016	-0.43	-1.76	-1.65
2017	0.05	1.26	-1.10
2018	1.09	1.39	1.97
2019	-1.09	-1.43	-1.17

Source: NOAA/CPC

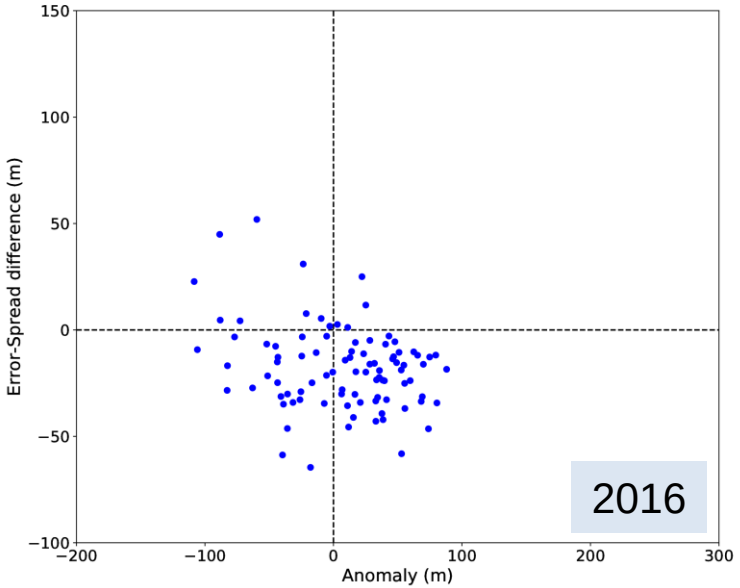
Arctic error-spread vs AO/NAO

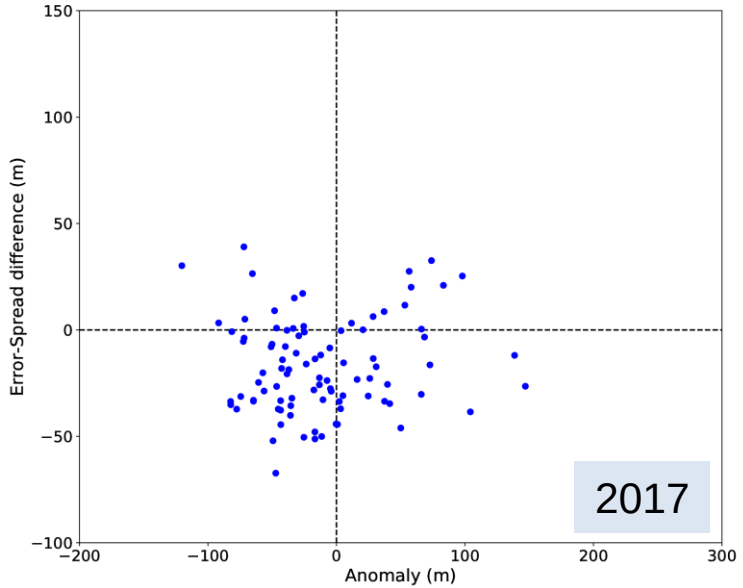


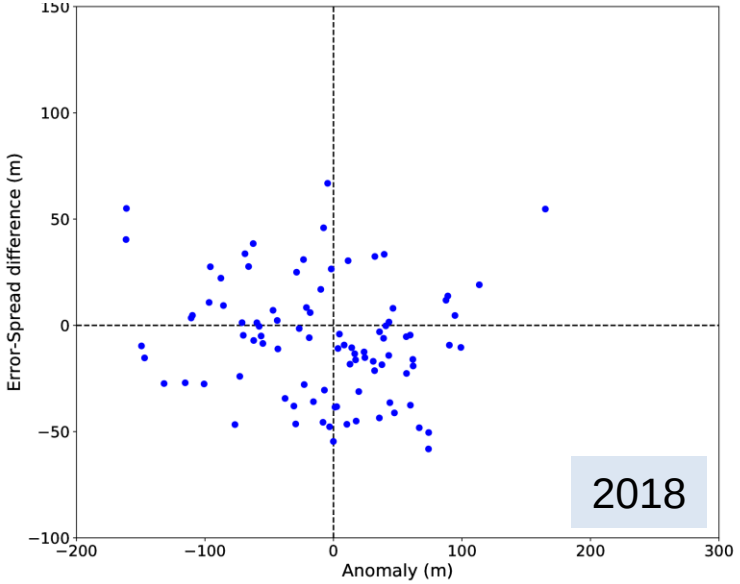


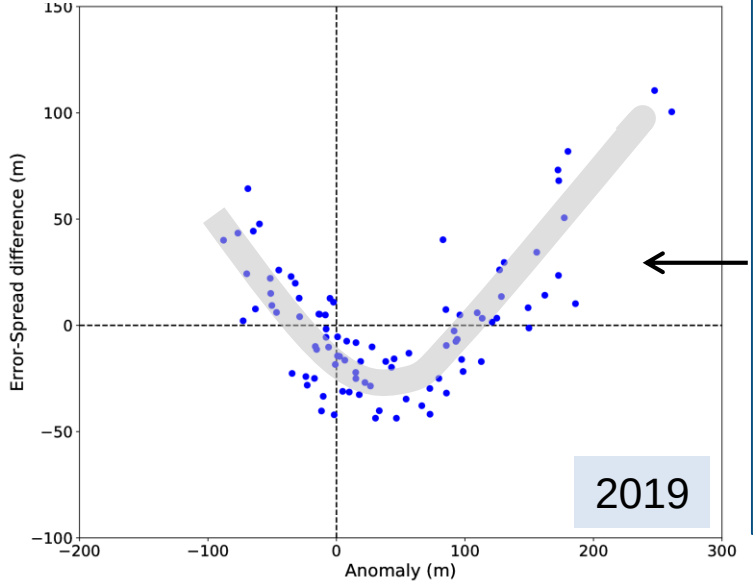
For the Arctic as a whole, the correlation between error-spread and AO or NAO index is quite small. (Red circles indicate June, July, August 2019.)

Z500 error-spread vs Z500 anomaly (Greenland Sea)









However, in the Greenland Sea area, a negative AO/NAO like in summer 2019, has a distinct effect on the strength of the relationship between Z500 anomaly and error-spread.

Summary

- **Long-term forecast skill improvements in Arctic parallel those of mid-latitudes**
- **Substantial seasonal deviations, such as in summer 2019**
- **Missing spread at day 10 appears related to negative AO**
- **Build-up of high pressure over Greenland Sea was not captured at longer lead-times**
- **Very weak relationship between negative AO and increased error-spread**
- **If AO should become more negative in the future, day 5 (day 10) skill may in(de-)crease**

What can we expect in terms of AO/NAO trends over the next decades? If there is a systematic shift due to global climate change, Arctic predictability can be expected to change as a result.

Thank you for your interest in this presentation.
Stay happy & healthy!