BJERKNES CENTRE
for Climate Research

Tracing North Atlantic Oscillation Forecast Errors to Stratospheric Origins, with a new analysis of the 2021 winter

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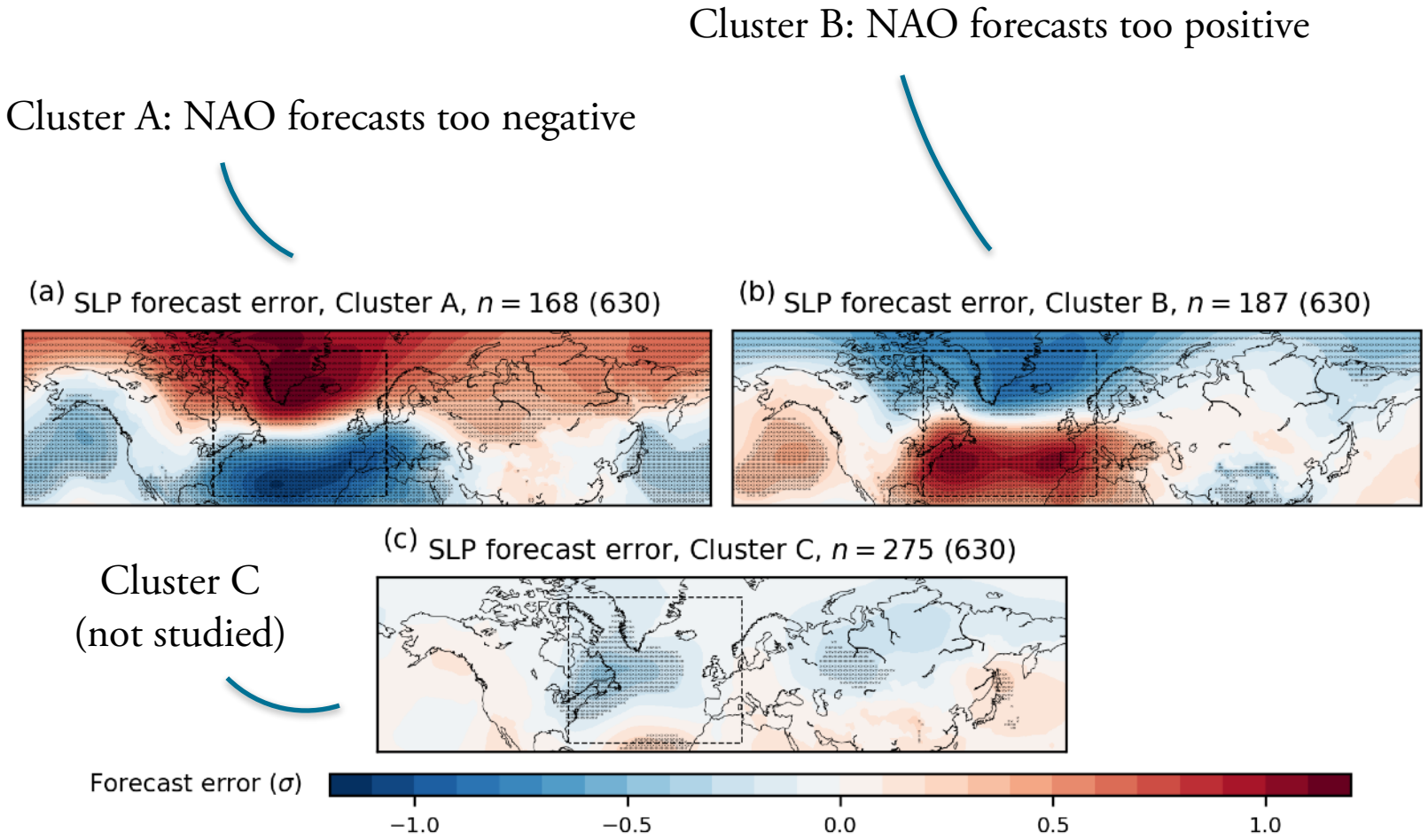
Motivation

- The North Atlantic Oscillation (NAO) is one of the key indicators of midlatitude weather surrounding the North Atlantic Ocean
- Forecast skill has been demonstrated in the seasonal scale, but the subseasonal scale (2–4 weeks ahead) is important for businesses and the public sector
- In the transdisciplinary Climate Futures research centre, we are working with about 30 partners to integrate climate risk forecasts into planning tools and procedures
- Can we identify systematic NAO forecast errors and possibly mitigate them through post processing or targeted model improvements?

Approach

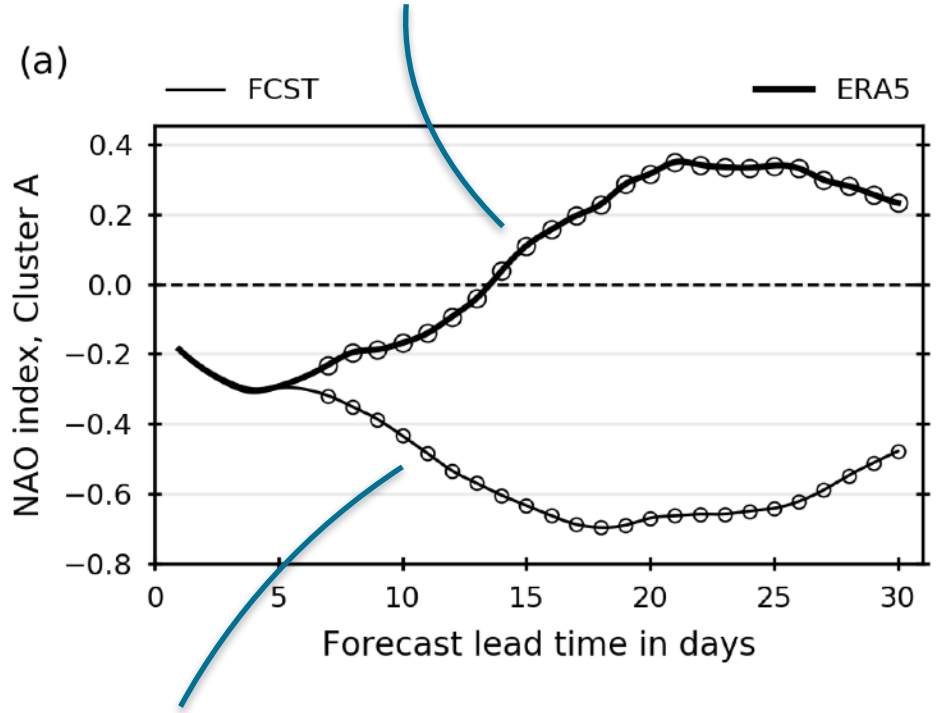
- We used the ECMWF monthly forecasting model hindcasts and forecasts, giving us 21 years of data (630 model runs)
- We computed SLP forecasts on lead times of 15–30 days and compared with ERA5
- We divided the errors (forecast minus ERA5) into three clusters



Error development

NAO in ERA5 becomes positive

A



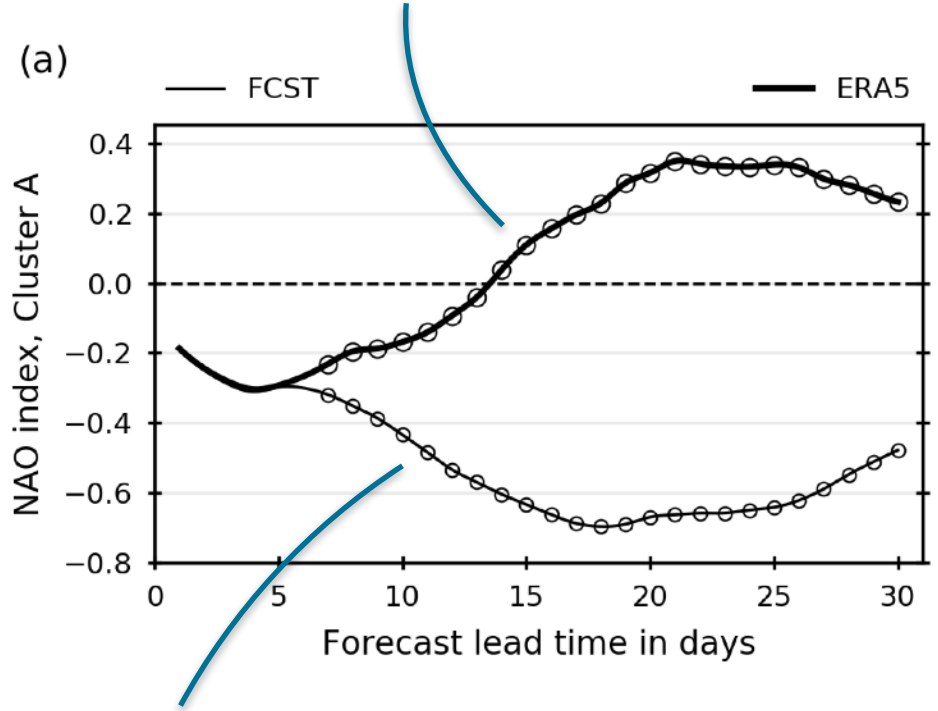
Forecasts develop into more negative NAO

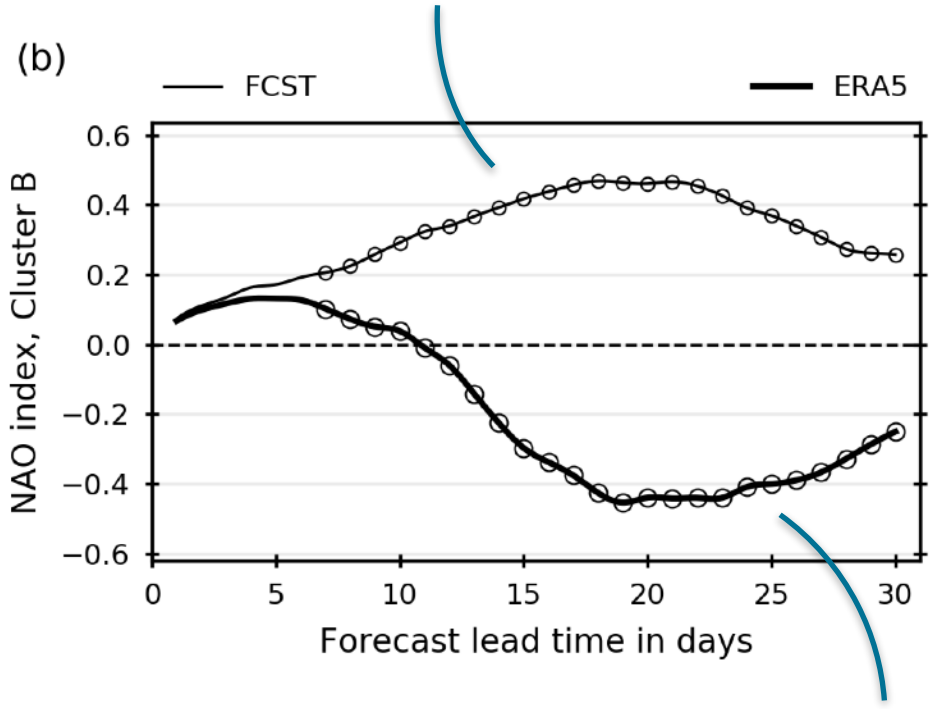
Error development

NAO in ERA5 becomes positive

Forecasts stay positive

A





B

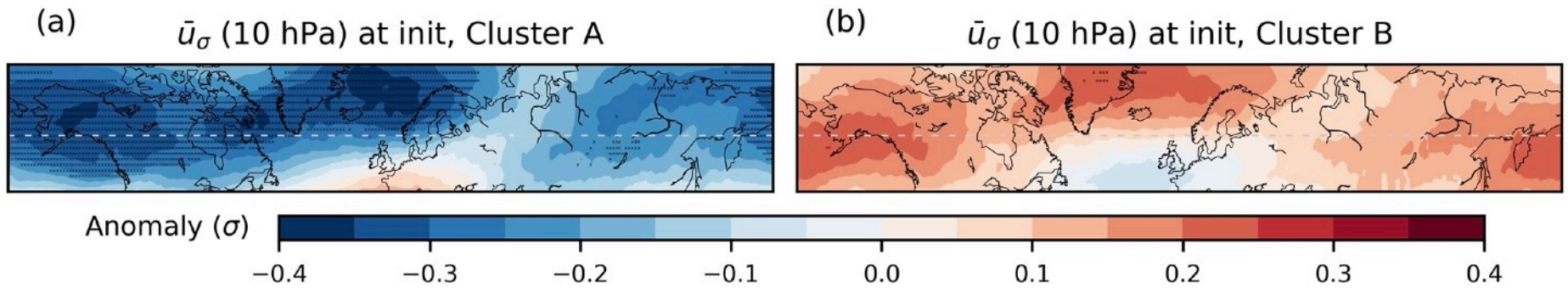
Forecasts develop into more negative NAO

ERA5 NAO becomes negative

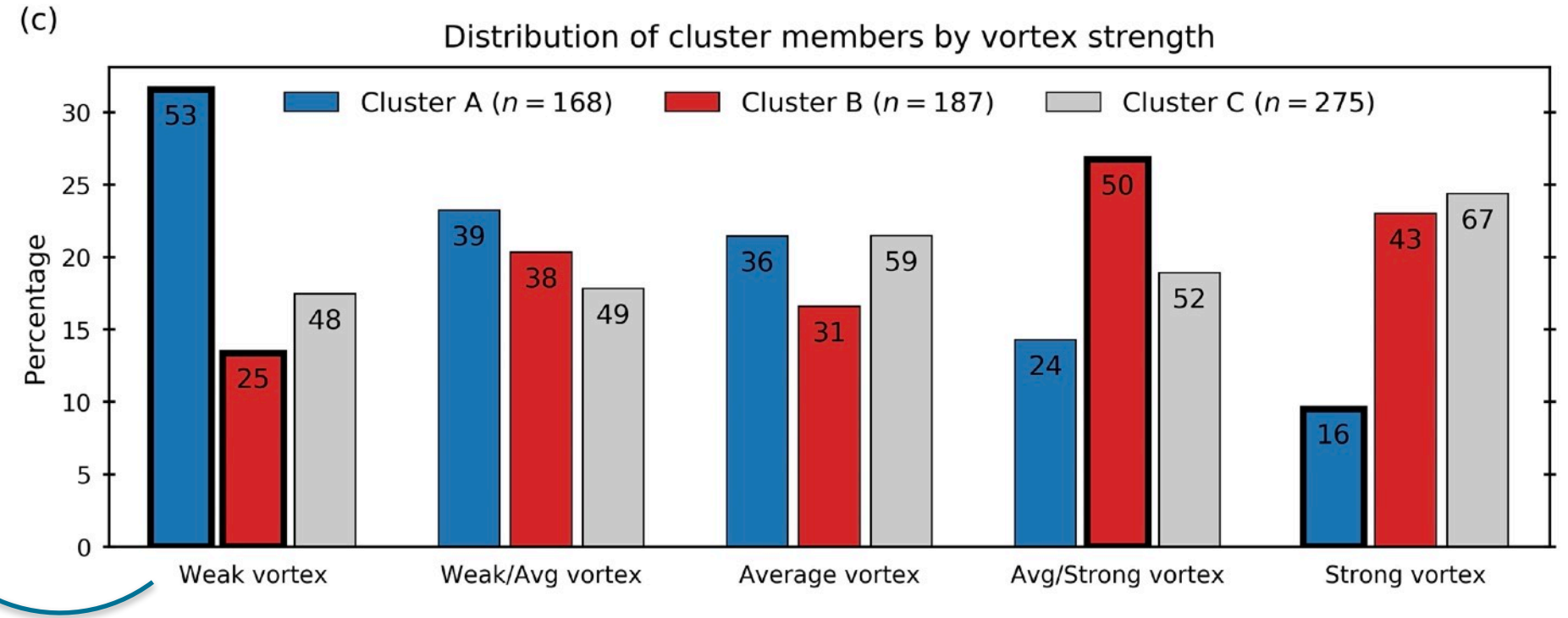
What's causing the errors?

- There are clearly systematic errors
- Forecast skill, especially on the seasonal time scale, has been linked to the stratospheric initial state
- We checked if there was a link between the clusters and the stratospheric polar vortex when the model was initialized

Initial zonal wind weaker than normal

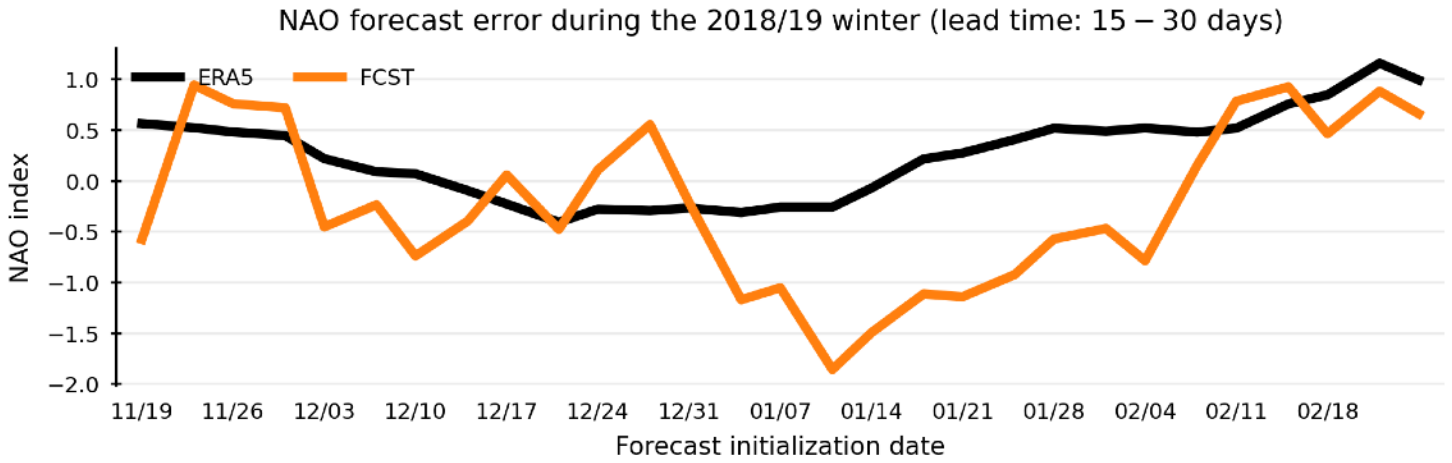


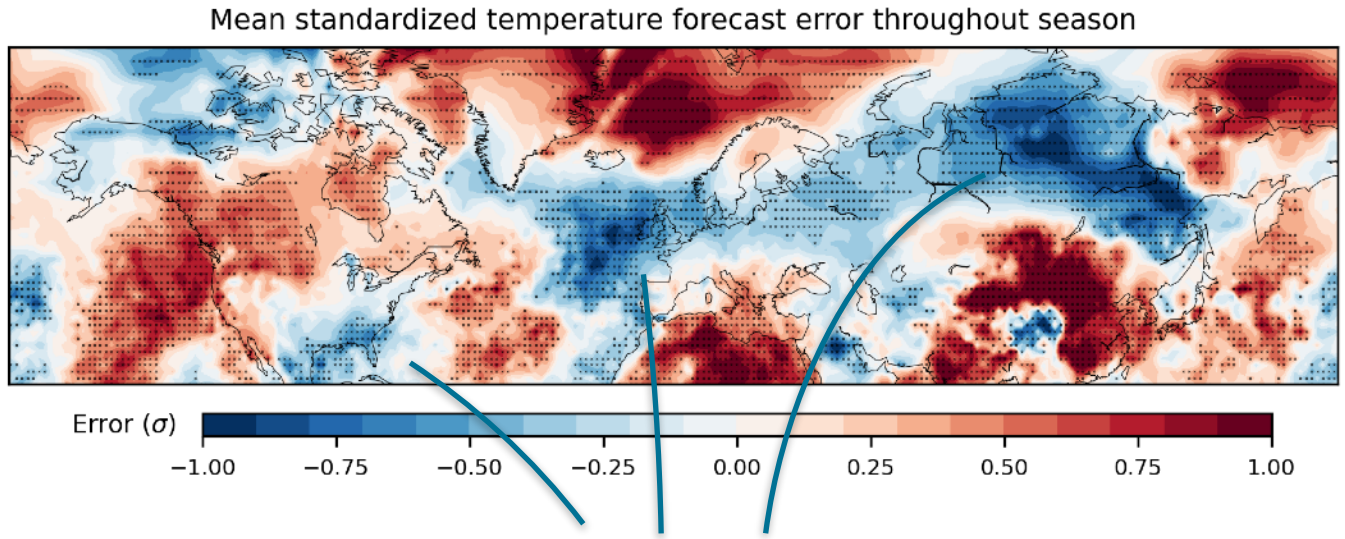
Cluster A members mainly initialized during weak vortex states



The 2018/19 winter

- The stratospheric warming in January 2019 was followed by many Cluster A forecasts (NAO too negative)
- This meant that the forecasts were too cold in the areas that are usually cold during negative NAO conditions (and too warm in warm areas)

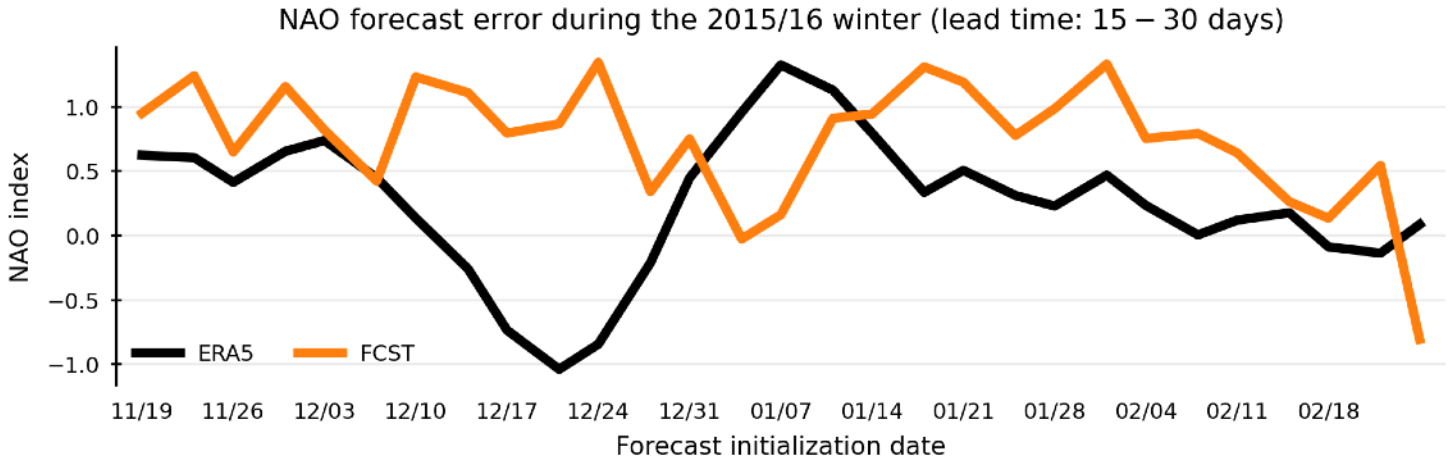


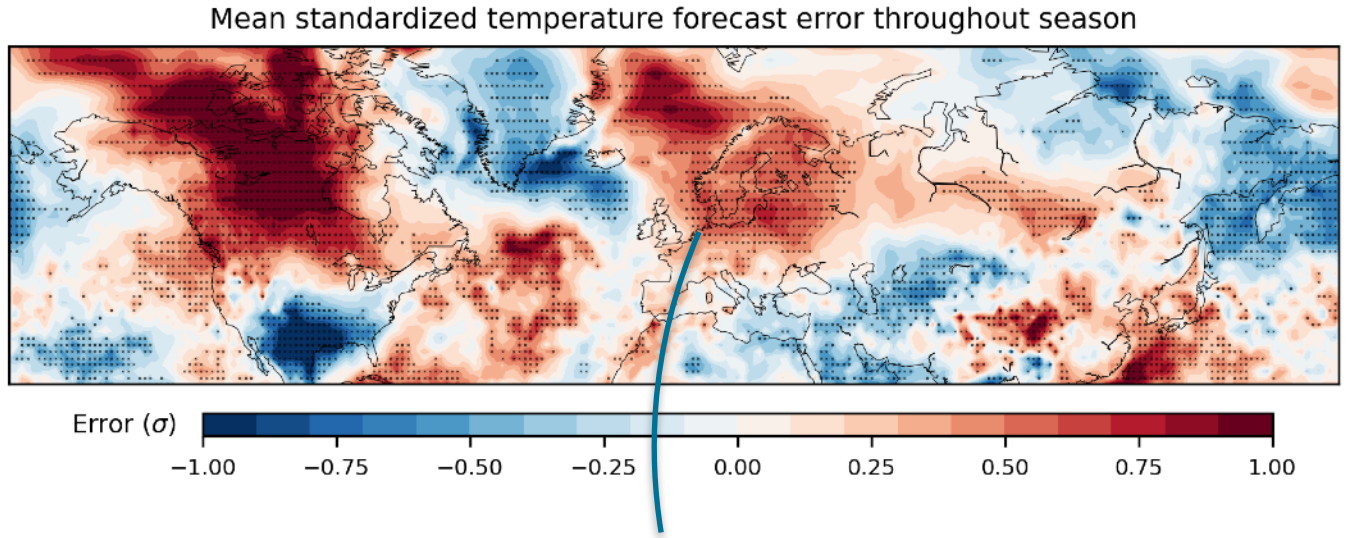


Forecasts too cold

The 2015/16 winter

- By contrast, the strong vortex during the 2015/16 winter contained many Cluster B forecasts (NAO too positive)

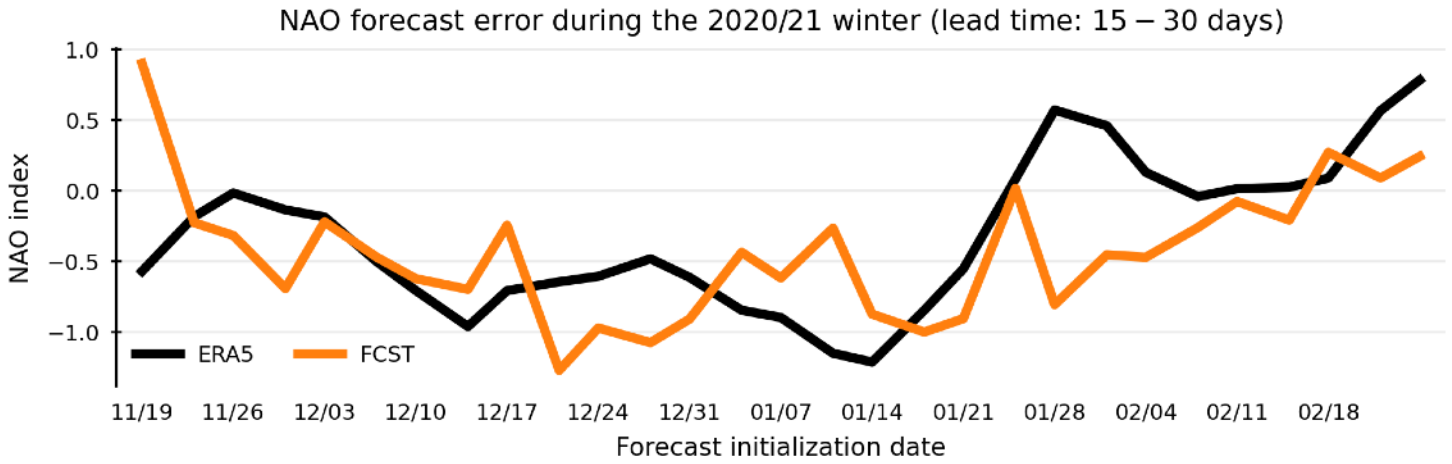


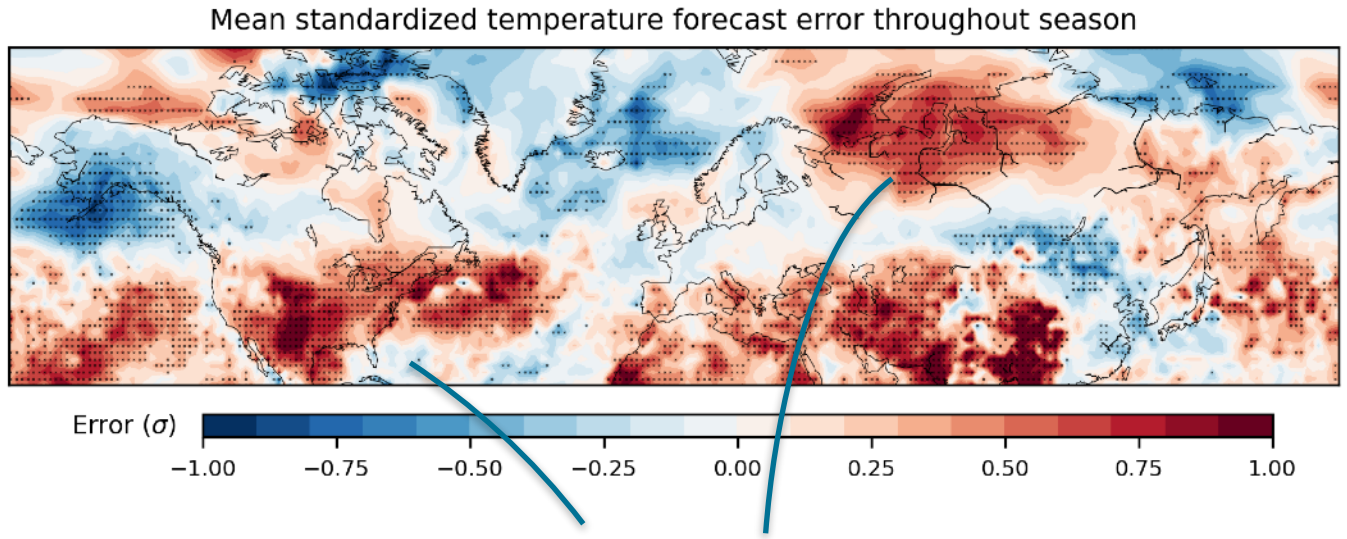


Forecasts too warm

The 2020/21 winter

- As in January 2019, there was a stratospheric warming in January 2021
- However, the NAO was reasonably well forecast, and the temperature errors were distinctly different from the ones in 2018/19





Journal of Climate paper

This presentation is based on a paper published in 2020:

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