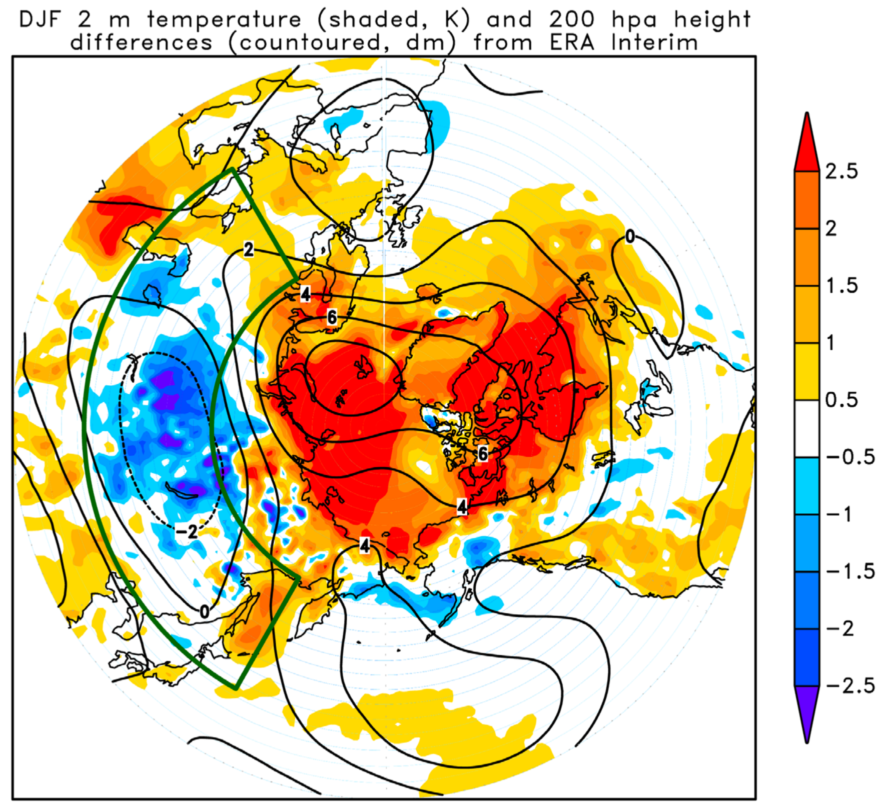
# Arctic sea ice loss and mid-latitude temperature response in coupled and uncoupled CFSv2 model simulations

Thomas Collow[1,2] (thomas.collow@noaa.gov), Wanqiu Wang[2], Arun Kumar[2]
1. INNOVIM, LLC; 2. NCEP/NOAA/NWS Climate Prediction Center

## Introduction and Motivation

- Previous studies present conflicting results into the reasoning for the mid-latitude cooling seen in recent years, particularly over Eurasia during winter.
- Can we separate the effects of changes in forcing (sea ice and sea surface temperatures (SST)) from internal variability?
- In terms of fully coupled operational simulations, is there any lead time dependency in representing this cooling?

DJF 2 m temperature (shaded, K) and 200 hpa height differences (countoured, dm) from ERA Interim

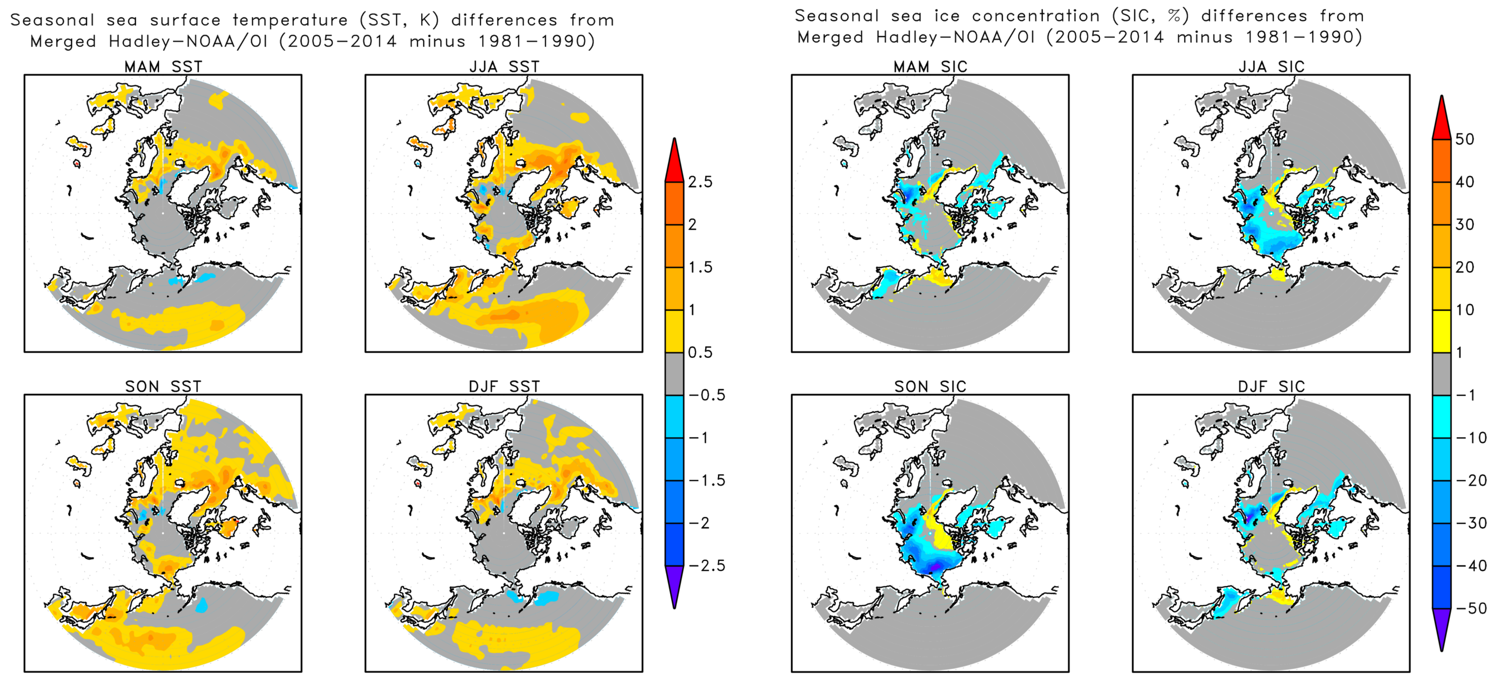


- A large region of cooling is seen over Eurasia (green boxed region on plots) based on DJF ERA Interim 2 m temperature differences (2005-2014 minus 1981-1990).
- Strong warming and 200 hpa geopotential height increases exist in the Arctic.

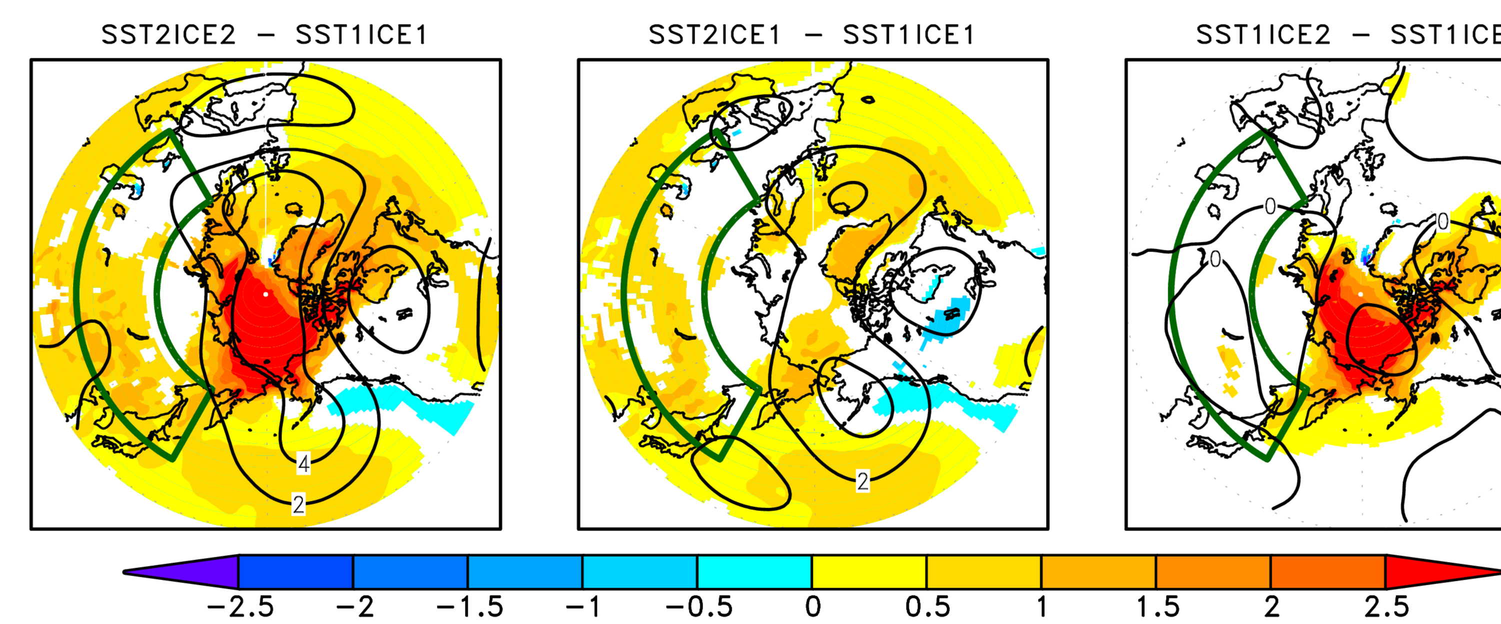
- Performed uncoupled model simulations using CFSv2 with repeating sea ice and SST boundary conditions from the merged Hadley-NOAA/OI dataset for 100 years
- Different combinations of SSTs and sea ice boundary conditions were used to assess the impacts of each
- SST1 and ICE1: Monthly SSTs and sea ice from 1981-1990 used
- SST2 and ICE2: Monthly SSTs and sea ice from 2005-2014 used
- Seasonal differences of boundary conditions are shown below

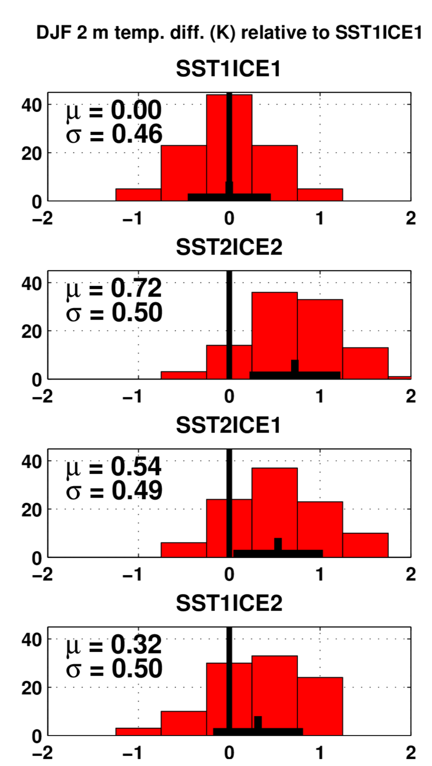
Seasonal sea surface temperature (SST, K) differences from Merged Hadley-NOAA/OI (2005–2014 minus 1981–1990)

Seasonal sea ice concentration (SIC, %) differences from Merged Hadley-NOAA/OI (2005–2014 minus 1981–1990)



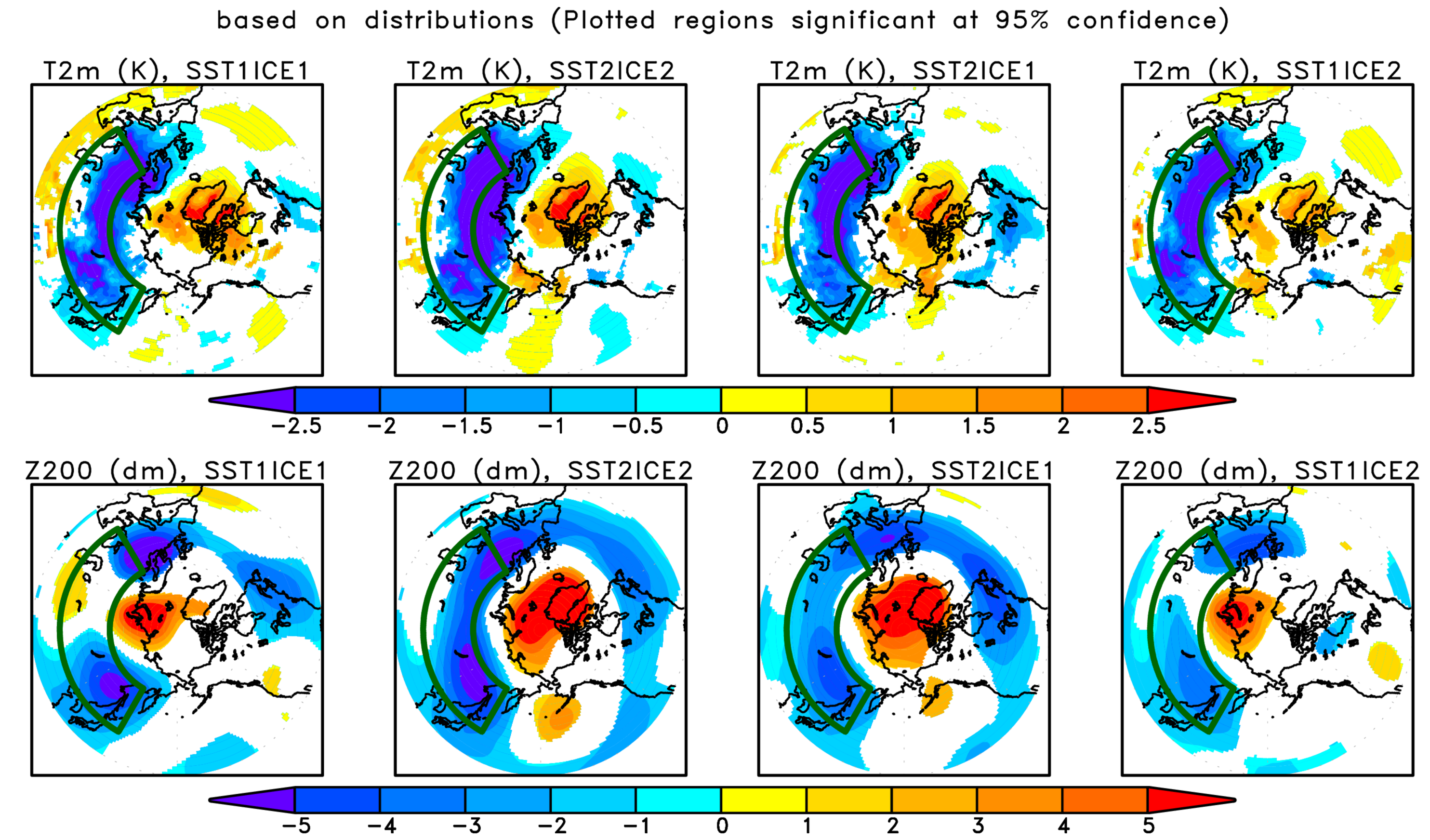

100 year mean DJF 2 meter temperature (K, shaded) and 200 hpa geopotential height (dm, contoured) differences (temperatures plotted significant at 95% confidence)




- Applied a 10 year smoothing to the model output to match the ERA-I periods (10 sets of 10 years for each config.) and used all combinations generated (100 total) to create the distributions shown to the left, which show 2 m temperature differences relative to SST1ICE1 averaged over Eurasia.
- The short vertical lines denote the mean and the horizontal lines represent +/- 1 standard deviation from the mean

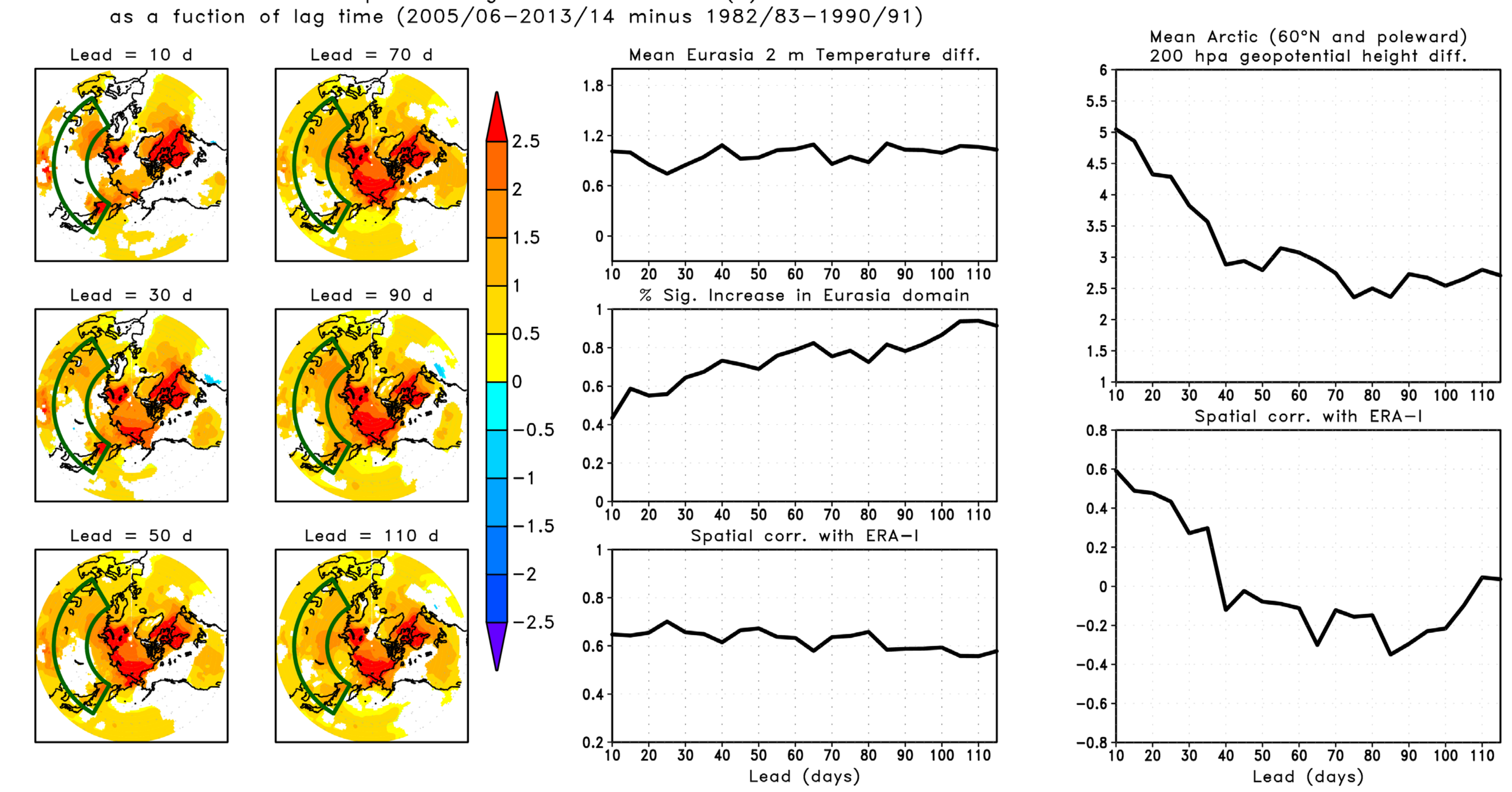
Differences between 10 coldest and 10 warmest Eurasia simulations based on distributions (Plotted regions significant at 95% confidence)




- Shown above are the significant differences in 2 m temperatures and 200 hpa geopotential heights between the 10 coldest and 10 warmest simulated Eurasian winters based on the distributions.

- Coupled runs are analyzed by creating seasonal reconstructions based on the lead time for the individual months within the season.
- As an example, for a 10 day lead DJF reconstruction, initial days around November 20 for December, December 20 for January, and January 20 for February are averaged, four forecast runs from 00 UTC, 06 UTC, 12 UTC, and 18 UTC are used for each initial day.
- The differences between the recent period and historical period are then calculated using different leads.

DJF reconstructed 2 m temperature significant differences (K) at 95% confidence as a fuction of lag time (2005/06–2013/14 minus 1982/83–1990/91)




## Conclusions

- Average of uncoupled CFSv2 simulations does not show Eurasian cooling for any configuration, with sea ice changes only impacting DJF temperatures in the Arctic.
- Eurasian DJF temperature variability is similar for all configurations.
- Compared to the 10 warmest Eurasian winters in each configuration, the 10 coldest Eurasian winters are associated with a warmer Arctic and higher 200 hpa geopotential heights.
- The coupled simulations show some skill in predicting DJF temperature patterns at all leads, although increasing coverage of significant warming over Eurasia is seen at longer leads.
- Higher Arctic geopotential heights are seen only at leads generally less than 30 days, suggesting interannual variability may play a bigger role in Eurasian cooling than SST or sea ice forcing changes.