

Weather Clim. Dynam. Discuss., referee comment RC1
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Comment on wcd-2022-32

Judah Cohen (Referee)

Referee comment on "Reconciling conflicting evidence for the cause of the observed early 21st century Eurasian cooling" by Stephen Outten et al., Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2022-32-RC1>, 2022

The manuscript tries to reconcile numerous observational analysis studies and model sensitivity experiments of Arctic mid-latitude linkages that offer a wide range of conclusions on whether recent observed Eurasian cooling is related to and/or in response to sea ice loss or the two are coincident in time but unrelated physically and the cooling can be attributed to internal variability of the atmosphere. The authors argue that the modeling and observational studies are not at odds or that we must necessarily conclude either/or that Arctic sea ice loss either contributes to Eurasian cooling or that the cooling is related to internal variability only. Instead, the authors argue that different conclusions can all be at least partially correct and that the cooling can be related to multiple factors at once.

I thought that the discussion of the subject and uncertainty was comprehensive and offered a novel way or at least crystallized the idea better than previous published papers on the subject to frame the debate that can help advance the discussion and how to reconcile all the disparate conclusions. Though it might be obvious that sea ice forcing and natural variability can operate simultaneously, or is not a new idea (this was the thesis of Overland et al. 2021), I think the authors expounded on this idea better than previous studies that I am familiar with. I also thought that the manuscript advanced the conversation beyond Cohen et al. (2020) where it was argued that the conclusion whether sea ice melt can force continental cooling can be grouped into observational and modeling studies and instead the authors here argue that the groups are in reality much more mixed. I also thought that the discussion around Figure 5 that even if sea ice only changed the standard deviation of surface temperatures, that alone can increase the probability of Eurasian cooling even if the sea ice doesn't directly force an atmosphere response conducive to Eurasian cooling.

One suggestion is to maybe shorten the text. I thought that it was a long windup for the punchline. I thought that the concluding remarks were well stated and valuable and I think that it would benefit the reader to get to these important conclusions sooner. But I will not go as so far to suggest text to remove and I leave it totally up to the authors.

As is reflected in some of my minor comments below, I do take issue with this idea that with the inclusion of the most recent observational data, the empirical analysis has come into agreement with the modeling studies that there is no large-scale atmospheric circulation forced response to sea ice variability and that Eurasian cooling has all but disappeared. I am not raising my own paper to require that the authors cite it but rather because it is the paper that most readily comes to my mind that shows trends and the observed relationship between sea ice and large-scale circulation variability over the full reanalysis period. As seen in Cohen et al. 2021 Figure 3, the relationship between sea ice and atmospheric variability remains robust (at least in scale and based on statistical significance) and from Figure S6 Eurasian winter cooling is seen over 41 years of reanalysis and that Eurasia is a clear outlier to the widespread warming elsewhere across the Northern Hemisphere.

I have some more minor comments below and I recommend that the manuscript be accepted pending minor revisions.

Minor comments:

- Line 116 – I agree that the Eurasian cooling trend peaked around 2012/13 and has since dampened but I think to characterize it as passed is an overstatement. To expect a perpetual cooling trend is unrealistic given the rapid rise in global temperatures. Winter temperatures in the region of interest remain cooler relative to other regions of Northern Hemisphere and overall cooler than model forecasts. Do you know what else peaked in 2012? September Arctic Sea ice melt, would the authors claim the era of Arctic sea ice melt has “passed?”
- Line 253 – Not sure why only the reference to GAO (2015) is listed, can the authors

include a more up to date reference?

- Lines 407-408 – again I feel that this statement and conclusion presented as fact – “the recent disappearance of Eurasian cooling along with its associated midlatitude circulation signals” is misleading.
- Lines 435-436 – I think to say “it is unfair to discount modeling results as simply wrong” is overly strong. I think a better way of saying something similar like “it is unfair to attribute differences between observed and simulated Eurasian cooling to model errors or deficiencies only.” The exact wording is not important, but I don’t think anyone would argue that the models are deficient to be useless.
- Lines 437-438 – it is my opinion that the physical mechanism can exist in the models and yet the models can still miss much if not all the Eurasian cooling forced by the ice-atmosphere mechanism especially when looking at the ensemble mean.

Judah Cohen

References:

Smith, D.M., Eade, R., Andrews, M.B. *et al.* Robust but weak winter atmospheric circulation response to future Arctic sea ice loss. *Nat Commun* **13**, 727 (2022). <https://doi.org/10.1038/s41467-022-28283-y>

Cohen, J., L. Agel, M. Barlow, C. I. Garfinkel, I. White. 2022: Arctic change reduces risk of cold extremes—Response, *Science*, **375** (6582), 729-730, DOI: 10.1126/science.abn8954.