Weather Clim. Dynam. Discuss., referee comment RC1
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# Comment on wcd-2021-80

Anonymous Referee #1

Referee comment on "Summertime changes in climate extremes over the peripheral Arctic regions after a sudden sea ice retreat" by Steve Delhaye et al., Weather Clim. Dynam. Discuss., https://doi.org/10.5194/wcd-2021-80-RC1, 2021

General Comments:
In this new study, the authors evaluate the boreal summer thermodynamic response (temperature and precipitation) to a sudden reduction in Arctic sea ice. In particular, they run targeted experiments using two fully-coupled climate models and two different horizontal resolutions for evaluating changes in climate extremes over nearby high latitude regions. Sea-ice loss is imposed in these experiments using a modified sea ice albedo scheme, which is consistent with previous studies. However, the temperature and precipitation responses are scaled by the amount of sea-ice loss, which helps to more easily compare the two climate models that show different sea-ice forcing (both regionally and in overall magnitude). In summary, the authors find an increase in frequency and persistence of maximum surface air temperature in the high latitude regions of the Arctic, which is especially large near Svalbard. In contrast, the extreme precipitation response is less robust compared to atmospheric internal climate variability.

Overall, this is a useful study for understanding the local response to rapid changes in Arctic sea-ice loss during the boreal summer. While there is an abundance of literature for assessing Arctic-midlatitude climate linkages (especially due to sea ice), there is less work on understanding the response in summer (relative to remote linkages in winter). For the most part, the methods here are logical, and the text is well-written. However, the paper is generally too long and can be substantially shortened to focus on the novel results of these climate model experiments. The introduction is quite long and confusing as it conflates winter and summer Arctic-midlatitude linkages, which are quite different in their respective dynamical tropospheric/stratospheric mechanisms and pathways. Instead, it would be helpful to compare this study's results with those that have focused on summertime changes within the high latitude regions. Again, focusing on 'what is new here.' I have some more detailed comments, suggestions, and references below. After some shortening of the main text, this paper should be acceptable for publication in Weather and Climate Dynamics.

Recommendation:
Major Revisions.

Specific Comments:

1. L2-3; This sentence is a bit confusing to me. It makes it sound like this is the first study to conduct experiments with a large reduction in Arctic sea ice, which is not the case.
2. L18-82; This introduction is quite long. I think it can be more concise by focusing on the direct connections with this work (e.g., L37-62), rather than restating Arctic climate change, which is already well documented in plenty of studies.
3. L28; Latest data from observations/reanalysis reveal that warming is now at least "three" times as fast as the global average
4. L29; Ballinger et al. (2020) can be updated to the newest Arctic Report Card 2021 (referenced below)
5. L35; Review papers, such as Cohen et al. (2018) and Overland et al. (2021), are more appropriate studies to cite here
6. L44-46; This might be the case for historical forcing, but some studies have shown that the remote response to future Arctic amplification is more robust than sea-ice loss alone later in the 21st century (see Labe et al. 2020)
7. L52-53; In my view, this is a key/novel point for this study and should further be distinguished in the introduction (rather than conflating studies that have only focused on the peripheral response during winter).
8. L52-53; Coumou et al. (2018) should be cited here. See references within for summertime studies.
9. L70-71; Are the perturbations here realistic compared to CMIP projections of sudden/rapid ice loss events (on this timescale)?
10. L79-82; This outline paragraph is extra text and unnecessary.
11. L88; This table is very helpful!
12. L107-108 & L127; Do the models include an internally generated QBO? This has been shown to modulate the response to Arctic sea-ice loss in some climate models.
13. L139-140; Sun et al. (2021) compared methods between modifying ice albedo and nudging
14. L142-143; Although this may still be an underestimate (Peings et al. 2021) for some of the regions outlined in Figure 2 (e.g., "ER")
15. L154; This is just a suggestion, but it might be helpful putting these climate indices in a table. It can be a bit cumbersome to read in the paragraph.
16. L188; This study is not relevant here.
17. L194-196; How does the effective sea-ice thickness actually change between PERT and CTRL in these experiments? Is the mean state realistic, such as compared to CryoSat-2 or PIOMAS? Changes in sea-ice thickness can influence surface turbulent fluxes and thus the local thermodynamic response.
18. L209-210; Again, could this also be due to difference in the sea-ice thickness mean state?
19. L224-235; Is there any role for changes in ocean heat transport that result in the temperature response? This is one advantage in using the fully-coupled experiments here.
20. L228; This is not necessarily the case during summer, where sea ice is mostly confined to the Fram Strait and northern Greenland.
21. L228-229; And major differences in topography/elevation
22. L258-264; This transition paragraph is a bit confusing to me. I suggest rewriting to improve clarity for the readers, especially when discussing the effect of temperature extremes over the continental regions. While there is a quick investigation of the NAO response, is it possible there is another dynamical contributor to the changes in temperature extremes (i.e., not just a turbulent heat flux response)?
23. L324; Some studies have considered the response to very rapid ice loss events (e.g., Semmler et al. 2016)
24. L325-328; Sorry, but I am not sure I understand what you mean here.
25. L334-335; It may be helpful to remove "cold days" and "warm days" to improve interpretation of this result

26. L348-350; But this could be a product of assessing responses in summer versus winter
27. How do these horizontal resolution results compare to Streffing et al. (2021)?

Technical Comments:
1. L19; "more pronounced in [late] summer"
2. L274; change "models" to "experiments"

Figures/Tables:
1. Figures 6/10; Is there any way that statistical significance could be denoted here? For example, comparing the CTRL and PERT PDFs in each respective region and adding a star for statistical significance.

Appendix:
1. Figure A1; Are any of these changes in the NAO statistically significant? If so, could they be indicated on the graph?
2. Could the authors include a data availability statement for the climate model experiments?

References:
Ballinger and Coauthors, 2021: Surface Air Temperature. Arctic Report Card 2021, T. A. Moon, M. L. Druckenmiller, and R. L. Thoman, Eds., https://doi.org/10.25923/53xd-9k68

Cohen, J., Zhang, X., Francis, J., Jung, T., Kwok, R., Overland, J., ... & Yoon, J. (2018). Arctic change and possible influence on mid-latitude climate and weather: a US CLIVAR White Paper. US CLIVAR reports.

Coumou, D., Di Capua, G., Vavrus, S., Wang, L., & Wang, S. (2018). The influence of Arctic amplification on mid-latitude summer circulation. Nature Communications, 9(1), 1-12.

Labe, Z., Peings, Y., & Magnusdottir, G. (2020). Warm Arctic, cold Siberia pattern: role of full Arctic amplification versus sea ice loss alone. Geophysical Research Letters, 47(17), e2020GL088583.

Overland, J. E., Ballinger, T. J., Cohen, J., Francis, J. A., Hanna, E., Jaiser, R., ... & Zhang, X. (2021). How do intermittency and simultaneous processes obfuscate the Arctic influence on midlatitude winter extreme weather events?. Environmental Research Letters, 16(4), 043002.

Semmler, T., Jung, T., & Serrar, S. (2016). Fast atmospheric response to a sudden thinning of Arctic sea ice. Climate Dynamics, 46(3-4), 1015-1025.

Streffing, J., Semmler, T., Zampieri, L., & Jung, T. (2021). Response of Northern Hemisphere Weather and Climate to Arctic Sea Ice Decline: Resolution Independence in Polar Amplification Model Intercomparison Project (PAMIP) Simulations. Journal of Climate, 34(20), 8445-8457.

Sun, L., Deser, C., Tomas, R. A., & Alexander, M. (2020). Global coupled climate response to polar sea ice loss: Evaluating the effectiveness of different iceâ□□constraining approaches. Geophysical Research Letters, 47(3), e2019GL085788.