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Comment on egusphere-2022-953

Anonymous Referee #1

Referee comment on "On the linkage between future Arctic sea ice retreat, Euro-Atlantic circulation regimes and temperature extremes over Europe" by Johannes Riebold et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-953-RC1, 2022

Review for "On the linkage between future Arctic sea ice retreat, Euro-Atlantic circulation regimes and temperature extremes over Europe" by Riebold et al.

Recommendation: minor revision

Summary

In this manuscript, the authors analyze the Polar Amplification Intercomparison Project experiments with ECHAM6, focusing on the response of five Euro-Atlantic winter circulation regimes to future Arctic sea ice reduction, and their linkage to cold/warm extremes. Some significant regime frequency changes have been identified such as more frequent occurrences of a Scandinavian blocking pattern in midwinter under reduced sea ice conditions. The authors also decomposed the sea ice induced winter extreme temperature frequency change into thermodynamical and dynamical changes. They compared the results with SST-induced results and found that Arctic sea ice loss-induced effect is of secondary relevance. Overall, I found this manuscript interesting and well fits the scope of Weather and Climate Dynamics. I also have some comments and hopefully they can help improve the manuscript. Minor revision is recommended.

Major comments:

1. I am interested in the conditional extreme event attribution framework that the authors presented. According to the section 3.2, the total ratio can be decomposed into thermodynamical component and dynamical component within the framework of circulation regimes. This is somewhat similar to the previous dynamical adjustment work. However, I find it hard to interpret how the thermodynamical processes contribute to the

increase in cold extremes (e.g., Fig. 6b Eastern Europe). I wonder if this implies some unexplained physical processes or simply noise. In other words, why is it still common to observe increased cold (decrease warm) extremes in Fig. 6, 7, 8, and A6, A7?

Also, maybe this is because I didn't fully understand section 3.2, I wonder why the is different from the regime pattern. For example, Fig. 3a indicates that SCAN tends to causes increased cold extreme occurrence in central Europe and decreased occurrence in UK, Ireland, Ice land and Northern Europe, while Fig. 6c showed that in response to Arctic sea ice loss, associated with increased SCAN frequency (Fig. 2a) there is increased frequency of cold extremes in central Europe, Ireland, UK and Ice land. I would encourage the authors to elaborate on these issues for readers to better understand this approach and results.

2. The authors noticed that "reductions in cold extreme occurrences are not necessarily accompanied by less frequent occurrences of warm extremes, and vice versa" (line 475), and demonstrated that "Such asymmetric responses in the tails of the temperature distributions can not be explained by simple thermodynamical arguments and are certainly a result of other contributing factors such as changes in the dynamical situation leading to a certain extreme." (line 365). This reminds me an earlier paper by Screen (2014), who found that Arctic sea ice loss decrease midlatitude temperature variability because northerly winds and associated cold days are warming more rapidly than southerly winds and warm days. In this context, I wonder if asymmetric response is still likely caused by thermodynamical argument.

Specific comments:

1. Sampling issue: while 100 members are the recommended sample size for polar amplification-model intercomparison project, recent studies have found that atmospheric response to Arctic sea ice loss still subjects to large uncertainty even with 100 members (e.g., Peings et al. 2021; Streffing et al. 2021; Sun et al. 2022). I don't think the authors need to rerun another 100 members, but just feel that this is one caveat that should be kept in mind.

2. Line 170: this is very minor since the authors mentioned that it does not matter whether the individual or merged climatology is used. But I do wonder if there is a reason for the authors to prefer using merged climatology. My understanding is that the climatology between pdSI and futArcSI might be very similar in the midlatitude, but might not in the Arctic. Therefore, using individual climatology appears to be better unless they have other considerations.

Editorial comments:

Line 115: sea surface temperature (SST)

Line 120: readers will benefit if the authors can provide a very brief description of ECHAM6

Line 160: Is PCA principal component analysis?

Throughout the manuscript (e.g., lines 130, 155, 165, 200) the authors use pdSI, futArcSI and futBKSI, I suggest to use "SIC" so as to be consistent with the PAMIP convention.

Line 175: It is hard for me to understand why global SST warming is causing negative phase of the NAO. Shouldn't it be positive NAO (e.g., Fig. 8 of Blackport and Kushner 2017; Fig. 8 of Sun et al. 2018)?

References:

Blackport, R., & Kushner, P. J. (2017). Isolating the Atmospheric Circulation Response to Arctic Sea Ice Loss in the Coupled Climate System, Journal of Climate, 30(6), 2163-2185.

Peings, Y., Labe, Z. M., & Magnusdottir, G. (2021). Are 100 ensemble members enough to capture the remote atmospheric response to+ 2°C Arctic sea ice loss?. Journal of Climate, 34(10), 3751-3769. https://doi.org/10.1175/JCLI-D-20-0613.1.

Screen, J. Arctic amplification decreases temperature variance in northern mid- to high-latitudes. Nature Clim Change 4, 577–582 (2014). https://doi.org/10.1038/nclimate2268.

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. DOI:10.1175/JCLI-D-19-1005.1.

Sun, L., M. A. Alexander, and C. Deser, (2018): Evolution of the global coupled climate response to Arctic sea ice loss during 1990–2090 and its contribution to climate change. J. Climate, 31, 7823–7843, https://doi.org/10.1175/JCLI-D-18-0134.1.

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