Referee 3

Our responses to your comments are marked in *italic* below.

This submission follows up some earlier work by these authors which made use of reanalysis data (namely NCEP and ERA-I) for the period 1979-2015 to explore teleconnections between the Arctic and the Baltic. This present work attacks a similar issue using model data. The submission has the potential to make a significant contribution to the literature, but it is not quite there yet. Before I would be able to recommend acceptance, there are a number of issues which need to be addressed.

Lines 29-30: Also here to cite the recent analysis of Mika Rantanen, Alexey Yu Karpechko, Antti Lipponen, Kalle Nordling, Otto Hyvärinen, Kimmo Ruosteenoja, Timo Vihma and Ari Laaksonen, 2022: The Arctic has warmed nearly four times faster than the globe since 1979. *Communications Earth & Environment*, **3**, 168, doi: 10.1038/s43247-022-00498-3.

We reworded the sentence: "*The Arctic region is warming at least twice (IPCC, 2021; Nakamura & Sato 2022; Overland et al., 2018; Meleshko et al., 2020), some authors showed that nearly four times (Rantanen et al., 2022) as fast as the whole planet …*"

Line 30: What 'average' is referred to here?

Corrected: average → global average

Line 38: 'Screens' should be 'Screen'

The correction has been made.

Line 42: Question raised here is to which specific region of the Arctic is of importance. Add to this reference to Wenqin Zhuo & co-authors, 2023: The key atmospheric drivers linking regional Arctic amplification with East Asian cold extremes. Atmospheric Research, 283, 106557, doi: 10.1016/j.atmosres.2022.106557.

Thank you for the excellent reference; we added it.

Lines 44-45: Valuable here to cite the more recent analyses of

Overland, J. E., Ballinger, T. J., Cohen, J., Francis, J. A., Hanna, E., Jaiser, R., Kim, B.-M., Kim, S.-J., Ukita, J., Vihma, T., Wang, M. and Zhang, X. 2021. 'How do intermittency and simultaneous processes obfuscate the Arctic influence on midlatitude winter extreme weather events?', *Env. Res. Lett.* **16**, 043002, doi: 10.1088/1748-9326/abdb5d,

Luo, D., X. Chen, J. Overland, et al., 2019: Weakened potential vorticity barrier linked to recent winter Arctic sea ice loss and midlatitude cold extremes. J. Climate, 32, 4235-4261, doi: 10.1175/JCLI-D-18-0449.1, and

Rudeva, & coauthors, 2021: Midlatitude winter extreme temperature events and connections with anomalies in the Arctic and tropics. J. Climate, 34, 3733-3749, doi: 10.1175/JCLI-D-20-0371.1.

Thank you for the excellent references; we added these.

Lines 79-80, …: The paper makes frequent allusions to 'forecasting', but it is not always clear what timescale is meant. Please make these parts more specific. One could argue that anything longer than 2-3 weeks is really an 'outlook'.

As for forecasting, we are thinking of timescales 1 – 3 months. Line 80, we changed "long-term weather forecasting" to "long-term weather forecasting for the next couple of months".

Lines 121-129: The value of very long simulations as used here is that it is 'easier' to achieve statistical significance. However, such long integrations may not be able to reveal PHYSICAL significance. The threshold correlations here are very small and explain less than 1% of the variance. Strongly suggest the authors add some remarks to point out these issues.

Correlations stronger than ±0.1 are, for our database, statistically very significant, but you are right – to find physical connections behind the correlation, often higher correlations are needed. We just wanted to point out that we ignore all correlations weaker than 0.1, not that we will analyze all correlations stronger than 0.1. We changed the text to clarify it from "This paper only looks at correlations stronger than ±0.1" to "This paper only presents correlations stronger than ±0.1".

Also, the time series considered here will possess considerable autocorrelation. This, in turn, with reduce the 'effective' degrees of freedom with which the tests for significance are conducted. Was allowance made for this effect (see, e.g., Bretherton C S et al 1999 The effective number of spatial degrees of freedom of a time-varying field J. Climate 12 1990-2009).

When working with hourly or daily time series, then the autocorrelation is definitely important. In our paper, we compare monthly and seasonal data on a yearly basis, and there is no substantial autocorrelation, so the effective degrees of freedom are not considerably affected.

Lines 132-134: Not all readers will be familiar with Ridge regression. Helpful here to reference the recent (and accessible) monograph of Saleh, A. K. Md. Ehsanes; Arashi, Mohammad; Kibria, B. M. Golam (2019). Theory of Ridge Regression Estimation with Applications. New York: John Wiley & Sons. ISBN 978-1-118-64461-4.

Thank you for the hint – we hadn't noticed this book before. We added the reference to the manuscript and included a sentence to describe it.

Lines 146-150: The demonstrated link here to the NAO is interesting. A little more physics-based discussion is required on this. Make reference here to the investigation of Luo, D., Y. Xiao, …, 2016: Impact of Ural Blocking on winter Warm Arctic–Cold Eurasian anomalies. Part II: The link to the North Atlantic Oscillation. J. Climate, 29, 3949-3971, doi: 10.1175/JCLI-D-15-0612.1.

We believe that reasonable physics-based discussion would take too much volume (and of course a lot of additional analyses), so we hope that it is OK if we just mention this direction in the text. We added: „The volume of physics-based analysis of these correlations does not fit in this paper, some methods and ideas can be found in Luo et al (2016).“

That paper also implies a role of the Ural Mountains, and the atmospheric blocks situated over them. The Urals are only a short distance 'downstream' of the Baltic and would be expected to influence this local region. The paper would greatly benefit from some thoughts on this aspect, and of changes and variability in blocking. Beneficial in this to cite analysis of

Luo, Dehai & coauthors, 2017: Increased quasi-stationarity and persistence of winter Ural Blocking and Eurasian extreme cold events in response to Arctic warming. Part II: A theoretical explanation. J. Climate, 30, 3569–3587, doi: 10.1175/JCLI-D-16-0262.1.

We didn´t make any calculations on Ural Mountains blockings, but the theme definitely deserves attention. We added this paragraph to the Introduction:
„Furthermore, some direct impacts are influenced by remote processes in the Arctic. For example, possibly the Barents and Kara Seas warming associated with the sea ice loss affects the Ural blocking (Peings et al., 2023; Yao et al., 2017; Luo et al., 2017), which has been identified as precursors of sudden stratospheric warmings (Lu et al., 2021, Statnaia et al., 2020; Lee et al., 2019; Cohen & Jones, 2011; Martius et al., 2009), and extreme temperature/precipitation anomalies over Europe (Yang et al., 2022; Peings, 2019; Cattiaux et al., 2010).“

Lines 181-188: The 'local' correlations are similar to what one would expect. It is not clear to me that they are 'necessary to better understand the teleconnections …' Please clarify.

We are afraid that if we don't mention the local correlations at all, some readers might get stuck with them.

Lines 193-194: See my earlier point on sample size and 'statistically reliable results'. May wish to reword this.

We changed the text from "To get statistically reliable results" to "To get statistically significant results". We assume that for 99.5% confidence level results, we can say without hesitation that they are statistically significant.

6. Lines 195-206: I have trouble interpreting these results, as it is not made clear what the sea ice is doing in these simulations. The integrations to 2100 are performed with RCP8.5 forcing and the reader is entitled to some (limited) information as to how the Arctic ice is changing over the period. As the changes will almost certainly be large the correlations in the last epochs of this century will essentially refer to physical associations which are different from those in the earlier part of the 21st century. The interpretation here needs much more thought. Of relevance to these considerations is the recent analysis of Yeon-Hee Kim, Seung-Ki Min, Nathan P. Gillett, Dirk Notz and Elizaveta Malinina, 2023: Observationally-constrained projections of an ice-free Arctic even under a low emission scenario. Nature Communications, 14, 3139, doi: 10.1038/s41467-023-38511-8.

Most of these results are about winter when there is no significant change in the ice conditions (Fig 4), only between Greenland and Iceland does the decrease in the correlation concur with the decrease in the ice concentration.

Line 216: Insert 'of the variance' after '10%'.

We added the variance there.

Line 228-233: An interesting point is made here in connection with the potential influence from the Greenland Sea. It would be worth mentioning in the text that Zhuo, Yao et al., 2023: The key atmospheric drivers linking regional Arctic amplification with East Asian cold extremes. Atmospheric Research, 283, 106557 found sea ice cover this Greenland region to be one of the most influential of all Arctic regions on teleconnections to, and conditions in, the Baltic.

We completed this paragraph, added the reference you suggested, and in addition, this reference:
Deng, K., Yang, S., Ting, M., Lin, A., &Wang, Z. (2018). An intensified mode of variability modulating the summer heatwaves in eastern Europe and northern China.Geophysical Research Letters,45,11,361–11,369. https://doi.org/10.1029/2018GL079836
We added the paragraph about Arctic regions' connections to Europe to the introduction (as suggested by another referee).

4. Lines 243-245: What are the physics behind this correlation. Is it 'on shore' flow, Ekman effect. Also here may be informative to reference the recent work of. Vavrus, S. J., and R. Alkama, 2022: Future trends of arctic surface wind speeds and their relationship with sea ice in CMIP5 climate model simulations. Climate Dyn., 59, 1833-1848, doi: 10.1007/s00382-021-06071-6.

We added a sentence: "The negative correlation between SIC and W10 originates from the reduction of both stratification and aerodynamic surface roughness with a reduction of SIC (Vavrus and Alkama, 2022; Jakobson et al., 2019)."

Lines 263-265: Please to note that the year of Lantao Sun's paper is '2018', not '2016'. The reason(s) for this disagreement must be canvassed. Sun t al. used the GFDL model (with RCP8.5). Related to my earlier point part of this difference may be due to how the sea ice evolves over the century. A more critical examination is required here.

The Sun's paper we are referring to was published online 25 MAY 2016.

We improved the text as follows: "This correlation is constant up to 2100 (not shown). Sun et al. (2016) declared that the "Warm Arctic, Cold Continents" regime is transient and becoming increasingly unlikely as the climate continues to warm. There seems to be a discrepancy between these two results, but it is not necessary. A strong negative correlation in winter means that warmer than average Arctic concur with colder than average Baltic Sea region, it does not exclude that both regions' climate can continue to warm at the same time."

Line 411-416: These two reference are the same, except the dates are different. I strongly suspect that the authors meant the first of these to be

Lantao Sun, Judith Perlwitz and Martin Hoerling, 2016: What caused the recent "Warm Arctic, Cold Continents" trend pattern in winter temperatures? Geophysical Research Letters, 43, 5345-5352, doi: 10.1002/2016gl069024

Yes, you are correct. We corrected it.