

General comments

The description of the SOM and the transition between nodes is good.

Please refer to figures more throughout the results section. I'd cite the figure number each time you change which figure you are discussing. For example, on line 230 you mention Figure 6, but then in the following line you are referring to Figure 5 but you do not give the figure number. It would be easy here (and in other places) for the reader to be looking at the wrong figure. The paragraph starting at line 277 is another instance where figures should be referred to more frequently.

Good suggestion. We have gone through the manuscript carefully and added citations to figures whenever appropriate.

Datasets and methods section – this section provides a good explanation of SOMs, including what SOMs are and how you will apply them to temperature data, but there is no explanation of how you analyse the other variables (i.e. create composites based on the SOM for temperature data), or the use of principal component analysis. Please include this here.

Thanks for pointing out this oversight. We have added more description about the other methods we also used in the analyses, in addition to SOM, in the Method section.

Consider adding analysis to show what portion of the trend in the warm Arctic-cold Eurasia pattern is due to mean warming. What trend is removed from the 20CR data? It seems an oversight to not consider mean warming when so many other variables are being examined.

Trend in wintertime surface air temperature anomalies for the 1854-2014 period for the 20CR data was removed.

In this study, we mainly focused on the role of the interdecadal variability of SST anomalies over northern oceans in trend in the warm Arctic-cold Eurasia pattern. In Conclusions and Discussions section, we increased some discussions of the role of Arctic warming in the trend.

Specific comments

Lines 23-36 – Abstract nicely sums up the major findings of the paper.

Thanks

Line 53 – This line states that the warm Arctic-cold continents pattern has been observed on an interannual timescale. Please state here whether the pattern has been strengthening linearly over time, or whether it's a cyclical pattern, or something else.

We have added a statement here about increasing trend in the occurrence of the warm Arctic-cold continents pattern.

Line 75 – What changes in the Gulf Stream are you referring to here?

Changed the statement to "... the sea surface temperature anomalies over the Gulf Stream."

Line 85 – "Using regression method" should probably read "using regression", or "using linear regression" (if this is correct).

Changed to 'using linear regression'

Lines 90-98 – This first part of the Datasets and methods section seems to be replicating some of what is said in section 2.2. I'd suggest starting the datasets and methods section with section 2.1, and incorporating lines 90-98 into section 2.2.

Removed the replications

Line 94 – Should this say “41 winters”? Or are you only considering complete winters, i.e. December 1979-February 2019 (thus excluding January and February 1979, and December 2019)? Which months do you use for winter? I assume it’s DJF.

Winter is defined by DJF and we only consider complete winters from December 1979 through February 2019. This is now clarified.

Line 102 – What is the resolution of the ERA-Interim data?

The resolution of the ERA-Interim was added.

Lines 137-138 – What dataset are these lines referring to? Both ERA-Interim and 20CR? If both, which 40-year period do you use? I.e. do you subtract the 1979-2019 mean from both datasets?

These lines refer to ERA-Interim reanalysis. We subtract the 1979-2019 mean from ERA-Interim.

Line 150 – Do the SOM-explained trends mean something physically, i.e. are they the fraction of the total trends that are explained by changes in circulation (or something else)?

The SOM-explained trends are the fraction of the total trends that are explained by the changes in circulations.

Lines 161-162 – This sentence compares the “first node” in each group, however node 9 appears to be the second node in group one, and node 1 is the first node in group two.

Changed

Lines 164-165 – It is not clear from Figure 1 that the maximum anomalies are centered near Svalbard. Please consider adding contour lines to the SOMs, or use a discrete color scale. When you say maximum, are you referring to the greatest departure from zero (i.e. positive or negative values)?

Contour lines are added. Maximum refers to largest values of the anomalies

Line 165 – This line states that nodes 3 and 7 are the second most frequently occurring of their groups, but node 3 occurs most frequently. The comparison of pairs is good, but needs to be worded more carefully. Maybe pick the most frequently occurring node in group 1 then identify its pair.

Good suggestion. Statements rephrased.

Lines 171-172 – Why can’t this SOM consider temperature trends? I think this should say “does not” not “cannot”.

Changed to “does not”

Lines 176-180 – Consider moving these lines to the methods section.

We have added some description on composite method in the Method section, following another reviewer’s comment.

Line 193 – Please add figure reference.

Referred more to figures whenever appropriate.

Line 223 – Nice explanation of turbulent heat flux!

Thanks

Line 229 – Maybe refer back to Figures 2 and 3 if that is where this statement comes from.

Made references back to the figures

Lines 229-230 – Are you sure this is the correct order? I.e. over the Barents Sea in node 1, is it possible that the sea ice melt causes a reduction in the albedo which results in an increased

turbulent heat flux?

We believe the cause-effect is correct based on previous studies (Blackport et al., 2019)

Line 231 – When you say “larger” do you mean larger spatially, or a greater magnitude anomaly?

A greater magnitude anomaly. Clarified

Line 238 – “composted” should probably be “composited”.

Changed

Line 239 – What happens if you do the same lag analysis for sea ice concentration? I think it is important to know that sea ice does not also peak before the day the nodes occur. Similarly, what happens if you do this lag analysis on the geopotential height patterns?

It seems strange to say that circulation leads sea ice cover without mentioning the geopotential height patterns.

The pattern of the composited anomalous 500-hPa geopotential height, turbulent heat flux, and sea ice concentration 2 days prior to the day when the nodes occur (not shown) is similar to the simultaneous pattern in Figures 2, 5, and 6.

Lines 250-251 – How does this differ to the other nodes? I assume they only exhibit interannual variability.

The main difference is the decadal variability.

Line 255 – I think this should refer to Table 3 (not Table 2).

Changed

Line 261 – Figure 8 does not appear to cover a large enough region to determine whether there are positive trends over southern Europe. This might need re-wording.

Rewording done

Line 262 – Maybe point out that negative trends are mostly not significant.

Done

Line 267 – Arctic-cold should be Arctic-cold

Changed

Line 281 – Refer to figure number (Figure 11).

Added reference to Figure 11

Lines 282-285 – Which node are you referring to? I assume node 1 but this should be clear.

Added reference to node 1.

Lines 284-285 – Are you determining the direction of propagation from Figure 11 or Figure 12? From the text it sounds like you are only referring to Figure 11, but I am not sure how you are determining that the Rossby wave moves southeastwards to the Eurasian continent from this figure. Please explain and give figure number.

The direction of wave activity flux points to the Eurasian continent (Figure 12). A reference to Figure 12 is added.

Lines 285-286 – What figure(s) support the claim that “large SST anomalies over the Nordic Ocean augment the wave signal through local air-sea interaction”? This statement needs more support and/or more of a description on how you came to this conclusion.

Added more descriptions with reference to figures

Line 290 – Figure number?

Added

Line 302 – Does “these results” refer to the results in Figures 10-12, or to the results you just

mentioned in lines 299-302? If you're referring to Figures 10-12, please state this.

Reference to Figures 10-12 are added

Line 308 – Which figure are you referring to here? If this comparison is not shown, write “(not shown)”.

“(not shown)” was added.

Line 321 – Where it states that the magnitude is smaller for the 20 CR data, could this be because the 20 CR data are detrended and the ERA-Interim data are not?

Added detrending of the 20CR as a potential explanation

Lines 321-322 – This sentence says “frequencies of all the nodes (Figure 14)”, but Figure 14 only shows data for nodes 1, 4, 6, and 9 – please rectify.

Clarified

Line 322 – Please refer to the corresponding figure that shows node occurrence for ERA-Interim.

Reference to corresponding figures added

Line 325 – The occurrence frequencies at the end of the time series in node 1, Figure 7, appear to be slightly greater than those for node 1 in Figure 14. Could this indicate that mean warming amplifies these trends?

Global warming may be a reason

Lines 335-336 – If these results are not shown, please state this.

Stated

Lines 343-344 – Why isn't the central North Pacific Ocean SST index shown in Figure 15 since it is significantly correlated with EOF modes 1 and 2?

The central North Pacific Ocean SST index is added in Figure 15

Line 347 – And the PDO?

Added

Lines 386-387 – Which figures are you referring to here?

References to corresponding figure added

Lines 388-389 – How does this atmospheric process suggest that the relationship between a warmer Arctic and East Asian cold spells are not as strong? If the atmospheric patterns described by your SOMs show changes in circulation patterns lead to increases in Arctic temperatures and decreases in Eurasian temperatures, then there appears to be a strong link. Or are you saying that temperature increases in the Arctic are not the driver of temperature decreases in Eurasia?

Temperature increases in the Arctic are not the driver of temperature decreases in Eurasia.

Figures

In general - Please add the following to the figure captions: - What years the figure covers (if not shown). E.g. Figure 1 - Whether the data have been detrended or not -

Dataset used - Consider making figures more consistent, for example, Figure 10 has the Pacific Ocean in the center, whereas Figure 12 has the Atlantic in the center. It would be easier to compare these figures if they both had the same east/west bounds.

Years and data were added in figure captions. Figure 10 has changed.

Figure 1 - Please consider adding contour lines to the SOM, or use a discrete color scale so it is clearer where the maximum/minimum values are on these plots. – Please mention years and

dataset in the caption.

Figure 1 has been changed into contour lines.

Figure 2 - Please reconsider the use of a rainbow color scale. Reds and greens can look identical to color blind people. - It appears that the stippling/hatching is plotted on top of the contour lines. The plot might be easier to read if the contour lines were on top of the stippling/hatching. - The caption states that this is the “corresponding 500-hPa geopotential height anomalies”, but you do not mention that it corresponds to Figure 1. - The caption states that stippled areas are significant, but what about the hatched areas? I assume they are also significant. - Please mention what contour lines show in caption. - Maybe consider rotating the nodes so they match Figure 1 better, i.e. put Russia at the bottom of the subplots. Alternatively, adding an outline of the region in Figure 1 to the plots like Figure 2 would be helpful.

Rainbow color scale is now used. An outline of the region in Figure 1 is added. We used stippled, not hatched in Figure 2.

Figure 3 - It would be useful to show the contour lines (from Figure 2) on this plot as well (without stippling) so we can see exactly how the contour lines and wind anomalies line up. - What does the gray shading mean?

Adding contour lines made it harder to see vectors. We replaced stippling by shading to denote the above 95% confidence level.

Figure 6 - Node numbers are missing from Figure 6. Please add them.

Added

Figure 7 - Consider adding trend lines and p-values to each subplot (and other similar figures).

Added

Figures 10, 11, and 12 - Consider arranging these plots the same, i.e. all 2x2 or 1x4 for easier comparison between the figures.

Rearranged

Figure 14 - Can the results from Figure 7 be overlaid on Figure 14? Maybe with gray dashed outlines. This would make it clearer to see the similarities/differences between the results.

The time series in Figure 7 is added in Figure 14

Figure 15 - Consider putting r and p values on subplots b and d. Or in caption.

R and P values are added in the caption