Comment on cp-2022-22
Anonymous Referee #1

Referee comment on "Asymmetric changes of temperature in the Arctic during the Holocene based on a transient run with the CESM" by Hongyue Zhang et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2022-22-RC1, 2022

Review of cp-2022-22: "Asymmetric changes of temperature in the Arctic during the Holocene based on a transient run with the CESM" by Zhang et al.

---------------------

Summary

This paper argues that there was an asymmetric temperature change between the Atlantic and Pacific sectors of the Arctic from the mid- to late-Holocene. The authors find this pattern in the temp12k global Holocene temperature reconstruction and also in transient climate model simulations with CESM. They argue that this is caused by orbital modulation of the Artic Dipole pattern and the Pacific Decadal Oscillation.

---------------------

Main comments:

The paper presents an interesting hypothesis with a lot of analyses to back up the main results. However, in places it seems like the results need to be better supported with evaluation of the uncertainties, while the link to the modes of variability may benefit from more elaboration. My main comments are as follows:

1) If I understood correctly, this Holocene simulation (AF) does not include changes in ice-sheet/sea-level forcing? It so, this might be an important caveat for the response in the Arctic. Although the global sea-level has stabilised by around 6 ka BP, this is right in the middle of the early-Holocene time window that you analyse throughout. I think some discussion of this is needed.
2) A more robust evaluation of the proxy-based signal is needed in section 3.1. The asymmetry is dependent on a relatively small number of points that show a stronger cooling in the Atlantic sector of Figure 1. If the coolest 2-3 of these were removed it looks like the asymmetry could likewise disappear. This makes one wonder whether the asymmetry is an artefact of the limited coverage by the proxies? Could you evaluate this in more detail? Perhaps add a histogram of the reconstructed temperature changes in the two regions?

3) The reconstructed and simulated regional temperature anomalies are given to 2 decimal places which feels overly-precise. It would be more convincing if the estimated uncertainties on these values were presented.

4) Assuming that the reconstructed asymmetry is robust to the choice of points it is not clear on first reading that the model actually replicates the 'asymmetric' temperature response in the annual mean as only the separate seasons are shown. Since the proxies are calibrated to reflect the annual mean signal I think it would be beneficial to show the annual-mean model result.

5) The analysis of the atmospheric dynamics is not easy to follow (see comments below) and it is difficult to understand precisely how the PDO/AD modes combine to produce the seasonal-mean signal in the sea-ice.

6) Changes in ocean circulation are not mentioned, but given they are important for the past 2000 years (Zhong et al 2018), it would be worth evaluating.

---------------------

Minor comments:

Line 102: Is the Glimmer ice sheet model used in this study or is it deactivated?

Line 103: I think you should cite Hurrell et al 2013, instead of this web link.

Line 109: It’s not clear how the Gao et al reconstruction is used for the Holocene as in their paper they only discuss the last 1000 years. Please could you expand on this?

Line 113: I could not find Wan et al. (2020) in the reference list.
Line 138: This link does not appear to describe the Jonkers et al 2020 dataset or anything else that is mentioned in this manuscript.

Line 149: "... with red indicating an increase in temperature between the late and the early-mid Holocene (0-2 ka BP and 5-8 ka BP), while the blue indicating and decreasing." This can be omitted.

Line 154-155: These values to 2 decimal places seem overly precise. Please could you estimate the uncertainty in these two values?

Line 173: again the regional average temperature anomalies should include uncertainties. I suspect 2 decimal places is overly-precise.

Line 206: This sentence starting "Many studies" makes it sound like these are all studies on the Holocene, but I believe that they are all focussed on the present-day. Please reword to clarify this.

Line 223-227: "The difference in SLP between the two periods does show a similar dipole pattern, but combined with the stronger SLP in the late Holocene than in the early-mid Holocene shown above, it can be assumed that the stronger Arctic dipole in the late period had a greater role in influencing sea ice."

Perhaps I have missed something, but I don't follow this.

Lines 236-249: It's not clear how the regressed UV winds and sea-ice on PC2 are responsible for the climatological signal. I think this needs to be elaborated on.

Line 260: "The index indicates that negative PDO dominates the late Holocene, while the positive and negative PDO phases oscillate during the early-mid Holocene." This is not clear from the figure. Please can you provide a statistic that shows this.

Lines 265, 267: Please specify what you are comparing with this spatial correlation coefficient?

Line 280: Your results mirror findings of Zhong et al 2018. However, they invoked a significant role of the ocean circulation. Is that important in the present model results?
Comments on the figures:

Throughout the labels on figures could be tailored for easier reading of the figures. As it is one has to read the caption carefully to understand what the multi-panelled figures are showing.

Figure 1: For clarity could you include in this caption whether this is late Holocene minus early Holocene?

Figure 3: I would like to see the annual-mean model result as the proxies are calibrated to this if I understand correctly?

Figure 6: It would probably be helpful to have the same y-axis limits on panels (c) and (d). Also, are the timeseries of the PC 2 smoothed?

Figure 9: is this the AF or the ORBIT-only simulation? Do they both look similar?

Technical corrections:

Line 148: "while the blue indicating and decreasing." Typo here.

Figure 10: The captions says EOF1 but the figure labels say EOF2. I assume they should both same EOF1?

References: