

Clim. Past Discuss., referee comment RC1  
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## **Comment on cp-2021-118**

Anonymous Referee #1

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Referee comment on "Dynamic boreal summer atmospheric circulation response as negative feedback to Greenland melt during the MIS-11 interglacial" by Brian R. Crow et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-118-RC1>, 2021

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### Summary

The authors present an interesting modelling study of the Marine Isotope State 11 in order to understand summer temperatures over Greenland. The authors find that during boreal summer Greenland and the surrounding was warmer than pre industrial conditions. The warming of the high latitudes affects the mid latitudes so that the lower tropospheric baroclinicity is weakened and the meridional heat flux is weaker which partly can counteract to additional warming of Greenland.

Clearly, the manuscript touches a very important topic, the understanding of interglacial states which was the longest warm period above preindustrial conditions in the past 800 ka. This is of high interest in particular in the context of current global warming. Overall the study is well structured, sometimes the sentences are a bit too long so readability needs to be increased. The authors are encouraged to apply to all of their plots significance testing and to better discuss the results as specified in the comments below. So I recommend minor to major revision prior to a possible publication in Climate of the Past.

### Major and minor comments

L15: Please say in which region the jet stream is unified, I guess in the North Atlantic

L15-17: The sentence does not read well and is a speculation which should not appear in the abstract, just focus on the main findings here.

L32-35: This is a rather long sentence and the authors use two time indicate which is a bit awkward.

In general: There is a tendency of the authors to write rather long sentences so I suggest to critically reiterate of this issue to increase the readability of the manuscript.

L43: ascribe -> ascribed

L62-63: This part of the sentence is not clear, what is meant by teleconnection potential.

L70: You need to add a reference for the statement on the weakening of the mean hemispheric baroclinicity. Additionally, you need to mention where in the atmosphere the baroclinicity is reduced I guess in the lower part of the troposphere.

Table 1: I suggest to include also the preindustrial values here.

L126-127 and elsewhere in the manuscript: Please use italic for variables like  $r$  and  $p$ .

L130: please use italic for  $n$ .

Section 2.3: This is a good description of how the authors applied the correlation analysis. Still I am interested how the significance and the correlation coefficients change if the authors would use the 600 seasonal values to estimate the correlation.

Fig 1. You need to say That you applied an area weighted average of the "Greenland region". At least this is my guess.

General to the results section:

As far as I understood it the authors do not change the Greenland Ice sheet, e.g., lower it to a certain extent. I think the authors need to discuss in more details how this specific setting affects the results. Merz et al. (2014 and 2016) showed a strong influence via the lapse rate effect but also of the sea ice distribution to Greenland temperatures during another interglacial period.

Moreover, the authors ignore in their discussion of the results that they use equilibrium simulations and the climate during MIS-11 is transient. I know that equilibrium simulations are the only possibility in such a study, but potential problems need to be discussed, e.g., the equilibrium simulations might be too cold compared to a potential transient simulation, also the biases of the preindustrial simulations shall be mentioned somewhere to give the reader an idea how well model performs, e.g., maybe the model underestimates the AMOC and thus has a cold bias in the North Atlantic which certainly affects the results around Greenland.

Fig. 2 and other figures: Please say to which you compare the MIS-11 simulations. I also suggest to apply a significance test, e.g. a student t-test to all figures of similar style and only discuss the significant anomalies, e.g., my guess is that most of the differences in the 403 ka simulation is not significant in Fig 2.

L169-173: The description of the stationary eddy heat fluxes and the transient ones is wrong. There is a difference between  $\overline{v^*T^*}$  and  $\overline{v^*} \overline{T^*}$ . The overbar is the time mean and prime means the deviation of the time mean, so that e.g.  $\overline{v'}$  is zero. Please clarify this. By the way you assess the "meridional" heat flux, so please be more specific about this in the entire manuscript.

Fig.3: Please show the mean state of preindustrial as contours in panels. It makes it easier to see whether the anomaly is a shift or a strengthening or weakening. Also the color scale has too many steps. Do not forget to apply a significance test and double check your results and concentrate only on significant changes.

L181-190: I suggest to rather think in how the meridional heat transport is shifted, in the Mediterranean it looks like a reduction. So I suggest to revise this part and be more specific on the anomalies and how they affect the mean state.

Fig. 4, right panel: Why do you find negative values for some summers of total EHF? On average, cyclones and anticyclones transport heat to the north in the mid latitudes so I would expect only positive values, maybe it is a matter of the region selected.

L202-203: please remove "r-value" as this is puzzling.

Section 3.3. There are studies that the southern tip of Greenland steers the most northern position of the eddy driven jet. I just wonder how this your result e.g. in Fig 5 would affect as Greenland remains in the current setting unchanged.

L228: I am not sure whether this is the best comparison to be made as the publication of Son and Lee assess the behavior in a very idealized model set up, namely an aquaplanet configuration. The configuration of the authors' model is much more complex.

L231-234: This sentence is not well connected to the ones mentioned beforehand. Also the authors refer to Fig 11 before Fig 8, 9 and 10 so either rearrange the figures or move the sentence to the place where Fig 11 is discussed.

L245: The authors discuss eddy growth, but they can also calculate the Eady Growth Rate (EGR) which is the standard measure and show that this is reduced at the poleward flank. Note that EGR is a combination of hori. temperature gradient and static stability.

Fig.8 is not necessary as it is a repetition of Fig. 6 and 3

L257-259: Please reformulate this sentences, it is a bit unclear.

Section 3.5: I think the authors need to include a discussion on the most relevant processes leading to precipitation in Summer over Greenland. So is it extratropical cyclones, convection, orographic lifting?

Fig.11 and 12: Besides the missing significance test I suggest to change to % change.

L313: "we have identified here with CESM1.2 in both of their models" make no sense.

L330: You need to say that baroclinicity is changed in the lower part of the troposphere. In the upper part (say around 300 hPa) my guess is that the meridional temp. gradient is increased and thus baroclinicity is increased. So the vertical structure matters!.

L358:\_ Here you can mention the Merz et al. (2014) publication you assess the effect of lapse rate, albedo changes etc. for the last Interglacial.

## References

Merz, N. et al., 2016, Warm Greenland during the last interglacial: The role of sea ice. *Climate of the Past*, 12, 2011-2031

Merz, N. et al. 2014, Dependence of Eemian Greenland temperature reconstructions on ice sheet topography changes. *Climate of the Past*, 10, 1221-1238