

# Reply to Editor and Referees

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We sincerely thank Editor Laurie Menviel and reviewers Quan Liu and the anonymous reviewer for their careful and constructive comments on the revised version of our manuscript. All the comments have been addressed accordingly. [Blue text below is our response to the referees' comments](#) (reproduced in black).

## File validation

- 5 Notification to the authors: Please ensure that the colour schemes used in your maps and charts allow readers with colour vision deficiencies to correctly interpret your findings. Please check your figures using the Coblis – Color Blindness Simulator (<https://www.color-blindness.com/coblis-color-blindness-simulator/>) and revise the colour schemes accordingly with the next file upload request. -> Fig. 2, 9

- 10 [Thanks for the reminder. We have revised figures 2, 5, 8 and 9 by using different colors with different brightness and different markers with distinguishable shapes. The colors for the MH, LIG, LGM and 4xCO2 experiments have been changed from olive, green, blue and red to orange, red, blue and purple \(with different brightness\), respectively. In plots, the markers for the four experiments have been changed from dots only to dot, square, triangle and diamond.](#)

## Editor

Dear Anni Zhao and co-authors,

- 15 Thank you for submitting the revised version of your manuscript.

Reviewer 1 considers that you have addressed the previous comments appropriately and has identified only a few additional minor points to be resolved prior to publication. In light of this, I am happy to accept your manuscript for publication in *Climate of the Past*, pending minor revisions.

- 20 Please revise your manuscript in accordance with the remaining comments from the reviewer, as well as the additional remarks provided below. I look forward to receiving your final manuscript.

Best regards, Laurie

[Massive thanks for arranging the reviewing process and providing remarks to improve the manuscript. We greatly appreciate your support. The manuscript has now been revised as suggested.](#)

Lines correspond to the tracked-change version of the manuscript.

25 L. 44. I suggest to rephrase as “a deepening of the subpolar low (Iceland low) and strengthening of the subtropical high (Azores high). “

Thanks! The sentence has been rephrased as suggested.

L80-81: Please rephrase this sentence, which is not grammatically correct and therefore its meaning is unclear.

30 The sentence has been revised to "The MH simulations from the Palaeoclimate Modeling Intercomparison Project 2 (PMIP2) show diverse changes in NAO variability relative to pre-industrial (PI) conditions, with studies reporting reduced variability (Lü et al., 2010), no change (Otto-Bliesner et al., 2006), or enhanced variability (Gladstone et al., 2005)."

L. 98: Please rephrase “awkward terminology” is awkward.

"awkward" has been replaced by "confusing".]

L. 110: “of” the PMIP simulations. Please also mention here which phases of PMIP you analyse.

35 It has been revised as "... the analysis of the PMIP3 and PMIP4 simulations."

Section 2.2. It might be helpful to include the GHG concentrations used as forcings in the different experiments. The atmospheric concentrations of CO<sub>2</sub>, NH<sub>4</sub> N<sub>2</sub>O in all the experiments have been added.

L. 214: Please specify that you are only assessing the North Atlantic climate here.

"the North Atlantic" has been added before "climate states".

40 L. 232, L. 261 and elsewhere: I don't think it is appropriate to discuss such features for specific model-experiment without showing them. Either you simply say that one model is very different from the other without naming, or you actually i) either add letters on your figures 2-5 to show these specific models, ii) show all the graphs in the supplementary so that the reader can appropriately assess the differences.

Thanks for the suggestion. We have removed model names, and replaced them by model numbers instead.

45 Fig. 8d,e,f: You could consider removing the mean SAT change to better highlight the relationships.

Panels for the mean SAT change have been removed from Fig 8. Text in Section 6 has been revised accordingly.

## Reviewer 1

We would like to thank Quan for considering our previous revisions appropriate and only having a few additional minor points to address. We have completed all minor revisions.

50 Minors: 1. Use an em dash (—) in line 20 rather than a hyphen (-).

Fixed.

2. Fig. 4 caption, please clarify the sentence as following: “Multi-model mean DJF SLP spatial pattern for NAO (hPa) in each experiment (shadings, left column) and ensemble variation (right column), ...”. The same for Fig. 6.

"shadings" have been added in both captions.

55 3. Fig. 6, Could you add notes about why there are large areas of gaps in the temperature fields?

Thanks for reminding the gaps issue. We have re-done the ensemble averaging process with the different land/sea masks. Coastlines have been extended and gaps have been removed.

4. Typos in line 278: “the N. Atlantic Ocean between 40°N and 65°N” should be “the North Atlantic Ocean”.

Fixed.

60 5. For the title of Section 6 (currently “NAO Amplitude Changes and Associated Climate Teleconnections”), I apologies for the misunderstanding. I suggest keeping only “Associated changes in the climate teleconnections” because “NAO amplitude changes” overlaps with the focus of the section 5.

Section title has been changed to "Associated Changes in the Climate Teleconnections".

65 6. Line 395: “while the enhanced NAO in the abrupt4xCO2 causes a warmer and wetter northern Europe as compared to the piControl”. This statement is debatable. On the one hand, the authors show that the northern Europe mean temperature is “warmer” (Fig. 3 j), and there seem to be a positive correlation between changes in the NAO amplitude and changes in the Northern Europe temperature (Fig. 8a); On the other hand, the temperature pattern associated with the NAO doesn’t show a “warmer” northern Europe, but a “cooler” northern Europe (Fig. 6g). In this case, I will avoid using strong causal wording such as “causes”.

70 Thanks for the suggestion. We have replaced "causes" by "is associated with".

## Reviewer 2

First of all I would like to thank the authors for constructive engagement during the review process. Based on the revised manuscript version 4 I provide some more comments. These suggestions are mostly of technical nature (except for two, see below). Since the comments are mostly relatively short, I order them by line numbers as per the revised manuscript.

75 Huge appreciation for carefully reviewing our manuscript and providing constructive and useful comments. We have revised the manuscript as suggested.

line 12: "to cooling and strengthens <as a result of> warming"

"to" has been replaced by "as a result of" here, also in Conclusion.

80 line 21: SLP has not been defined before if I did not miss it, please define (also check other abbreviations, there is at least one that had not been defined before first use)

Thanks! We have corrected them, including SLP, AMOC, DJF, JJA,

line 55: delete of

85 Based on the Editor’s suggestion, the sentence has been revised to "The MH simulations from the Palaeoclimate Modeling Intercomparison Project 2 (PMIP2) show diverse changes in NAO variability relative to pre-industrial (PI) conditions, with studies reporting reduced variability (Lü et al., 2010), no change (Otto-Bliesner et al., 2006), or enhanced variability (Gladstone et al., 2005)."

line 103: "in Table 1 here<, Table> 9.A.1 of Flato et al. (2013) for the CMIP5 models, and Table AII.5"

Done.

line 106: If I did not miscount your study features five experiments, not six

90 Yes, you are right. Thanks for pointing out this mistake. The number has been corrected.

line 119: "at the beginning<, > and then maintaining CO2 values constant"

A comma has been added.

line 151ff: this is more severe than a technical comment: regarding the statement of the abrupt4xCO2 simulation reaching a near-equilibrium state after 150 years: while the term "near-equilibrium" may leave room for interpretation, I would altogether  
95 avoid the use of the term equilibrium with abrupt4xCO2 after such a short integration period. The runtime of 150 years has been established towards allowing quantification of climate sensitivity via Gregory plots, for example. Nevertheless, even for such an analysis there is still an extrapolation to quasi-equilibrium conditions involved. To reach a state that remotely resembles something like an equilibrium, models have to be integrated for well over 1000 model years (see Fig. 11 by Stepanek et al., 2020, for an example). To avoid this I would formulate differently, just speaking of an analysis period that you define for the  
100 purpose of your study.

Thanks for this important and constructive comment. The sentences have been revised to "The CMIP protocol specifies a minimum length of 150 years for the *abrupt4xCO2* simulations (Eyring et al., 2016). For consistency in our analysis, we take the last 50 years of the *abrupt4xCO2* simulations for a direct comparison with other simulations employed in this study."

line 157: I think "initial" carries some characteristic of change which probably is not what you want to state here, consider  
105 replacing the term by "native"

"initial" has been replaced by "native".

line 170: I think the abbreviation "NAM" has not been defined yet

Sorry for the oversight. The definition has been given.

line 218: should the text read "neither experiments incorporate some regional processes"? The question is after what you  
110 mean with experiments. I think you mean midHolocene and lig127k, which then would suggest to apply the suggested change - yet, this is not fully clear from the context

To clarify, the sentence has been revised as "Meanwhile, neither of the two experiments (*midHolocene* and *lig127k*) incorporate some regional processes that can cause regional coolings. For example, the *lig127k* simulations ...".

line 221: use plural "reconstructions"

115 Fixed.

line 236: consider adding an "it" after "the continent"; furthermore, use plural continents instead of the singular?

"s" has been added after "continent". Adding "it" might not be appropriate. The sentence has been revised to "Shi et al (2023) decomposed the contributions of individual boundary conditions and forcings to the LGM cooling, finding that the cooling over the sea within the region is mainly due to the GHG forcings, and cooling over the continents is caused by changes  
120 in ice sheets."

line 239: Some proper nouns have not been capitalized throughout the manuscript. This includes Laurentide Ice Sheet here, but also Greenland Ice Sheet at other locations. If this was not on purpose, consider capitalizing

We thank the reviewer for this careful comment. We have now standardized the capitalization of all proper nouns.

line 243: this is more severe than a technical comment: the term "condense" implies, to everything I know, a phase change  
125 from gaseous to fluid, which does not apply to the AMOC surface current. I think you would like to speak here of "densify" (I think that this term exists, but I am not a native speaker), or similar attributes

We agree that the term "condense" is inappropriate here. The word has been replaced by "densifies".

line 250: the terms inactive and prescribed mean the same and the formulation is a bit complicated. I would just state "The prescribed Greenland Ice Sheet in simulations". Furthermore consider whether to use plural or singular. If you change to the  
130 latter, adapt "cause" to "causes"

The sentence has been revised to "The inactive prescribed Greenland Ice Sheet in simulations (Eyring et al., 2016) causes the SLP to increase over the region."

line 253: I very much appreciate the clarification of the text regarding the major forcings for the simulation lgm that authors have applied during the revisions. Nevertheless, lgm is also orbitally forced. Since you therefore have three orbitally forced  
135 experiments in your study, I think it would make sense to reformulate for clarity: "the two orbital experiments <midHolocene and lig127k> are not distinguishable"

Thanks for pointing out this issue. "(midHolocene and lig127k)" has been added for clarification.

line 258: consider adding a comma after "a clear weakened"

Added.

140 line 287: consider replacing "than" before "the piControl" by an "with respect to"

Done.

line 288: capitalize "Ice Sheets"?

Done.

line 311: "but <this finding> is affected by"

145 "it" has been replaced by "this finding".

line 338: consider deleting "in the lgm" - the term already features in the sentence in line 336 and seems to be to be superfluous at this location.

"in the lgm" has been deleted.

line 386: consider adding a comma after "observed mean state"

150 Added.

caption of Fig. 2: add space before "explained", the experiment name abrupt4xCO2 in the second line should not be capitalized

Fixed.

caption of Fig. 3: add a space after "SAT;" in the second line, consider changing the last line to "at least two-thirds <of the  
155 models> disagree"

Corrections have been done as suggested.

header of Table 1: use singular in "an idealised CO2 experiment"; consider adding the word "column" before "Participation"

Done.

Reference:Stepanek, C., Samakinwa, E., Knorr, G., and Lohmann, G.: Contribution of the coupled atmosphere–ocean–sea  
160 ice–vegetation model COSMOS to the PlioMIP2, *Clim. Past*, 16, 2275–2323, <https://doi.org/10.5194/cp-16-2275-2020>, 2020.