AC1：

We thank the reviewer for taking the time to engage with our manuscript and for providing thoughtful comments. We appreciate the opportunity to clarify our contributions and address the concerns raised.

1. On the novelty of the main conclusion

We agree with the reviewer that Brierley et al. (2020) already clearly showed that the mid-Holocene simulations in PMIP4 are, on average, about 0.2 K colder than those in PMIP3, mainly because PMIP4 used more realistic (lower) greenhouse gas concentrations. We also acknowledge that Kang and Yang (2023), through controlled single-model sensitivity experiments, quantified the effects of orbital forcing and greenhouse gas forcing. This is an important contribution.

However, the direct and indirect thermodynamic responses and feedback processes through which the GHGs changes in PMIP4 produce the quantitative difference are still not fully understood. This is also the direct motivation for our use of the CFRAM method for a more specific quantitative analysis. GHG concentrations in the mid-Holocene are lower than in the PI. When thick snow and ice cover already exists in the PI high latitudes, further cooling usually produces a weaker albedo feedback than warming under melting conditions (Chalmers et al., 2022). Therefore, in theory, it should not show a clear polar amplification feature. However, in both the PMIP4 minus PMIP3 comparison and the comparison between the orbital forcing plus GHGs experiment and the orbital forcing experiment in Kang and Yang (2023), the inferred "GHG-only effect" shows a clear polar-amplified cooling pattern.

Through CFRAM analysis, after decomposing the contributions of different climate feedback processes, we find that the difference between two experiments that differ only in GHG settings should not be regarded as the GHG-only effect. Instead, it also contains nonlinear coupling effects with orbital forcing, that is, it weakens the polar amplification of warming caused by orbital forcing. Therefore, we focus on the nonlinear coupling between orbital forcing and GHG effects, as well as the related feedback processes, and provide a detailed analysis and discussion. As the reviewer pointed out, we also consider this to be an important new insight of our study. We will cite Kang and Yang (2023) as an important basis for this work. In the Introduction, we will highlight the above research inconsistency as the initial motivation of this study, and in the Conclusions we will strengthen the connection to this motivation.

In addition, we also hope to discuss the important issue of the "Holocene temperature conundrum". We aim to relate the differences among existing proxy records to the differences between the two generations of model simulations, and to use model simulations, which allow more detailed diagnosis of climate physics, as a benchmark to discuss the plausibility of proxy records. After the model analysis and evaluation, we will compare model simulations with proxy results by considering features such as the seasonal energy transfer mechanism, in order to obtain some further insights into mid-Holocene temperature changes. However, our discussion of this part was also not sufficiently clear, and we will strengthen it in the revision.

2. On CFRAM as a diagnostic tool and the demonstration of nonlinear mechanisms

We agree that CFRAM is a posterior feedback-diagnostic tool for feedback analysis. However, our judgment of the "nonlinear coupling mechanism" is not based solely on CFRAM diagnostics. As noted above, the comparison between PMIP3 (orbital forcing) and PMIP4 (orbital forcing + GHGs) allows us to isolate the combined effect. CFRAM, by decomposing the temperature effects of individual feedback processes, helps us describe this "nonlinear causal mechanism" more directly. Therefore, the CFRAM analysis is necessary. We will further clarify this logical chain in the revised manuscript to avoid possible misunderstanding.

3. On the alternative explanation of model structural changes (e.g., cloud feedback differences between CMIP5 and CMIP6)

We thank the reviewer for raising this important point. We agree that structural changes between CMIP5 and CMIP6 models—especially the stronger positive cloud feedback in CMIP6 reported by Zelinka et al. (2020)—could in principle affect intergenerational differences.

However, our diagnostic results suggest that such structural differences are unlikely to be the dominant factor behind the specific intergenerational difference analyzed here. As shown in Figs. 3 and 4, the contribution of cloud feedback (CLD) to the temperature difference between PMIP4 and PMIP3 is very small, especially in the polar regions where the two generations differ most strongly. This result is also consistent with Hu et al. (2020), who showed that differences in cloud feedback between CMIP5 and CMIP6 have a relatively limited influence on some aspects of the spread in temperature projections. Based on the diagnostic results of this study, the main differences between the models still lie in external forcing and the feedback responses modulated by it, rather than in cloud feedback itself. On this basis, we consider that model structural changes may have some influence on the differences between the two generations, but they are not sufficient to serve as the main explanation for our results.

We will add a discussion of this alternative explanation in the revised manuscript and more fully explain how structural model differences may affect the temperature response, so that our attribution statement is more cautious and comprehensive.

Once again, we sincerely thank the reviewer for these constructive comments. They will help us substantially improve the manuscript. We believe that, with the clarifications and additions described above, the innovative contribution of this study will be presented more clearly.

References

Brierley, C. M., Zhao, A., Harrison, S. P., Braconnot, P., Williams, C. J. R., Thornalley, D. J. R., Shi, X., Peterschmitt, J.-Y., Ohgaito, R., Kaufman, D. S., Kageyama, M., Hargreaves, J. C., Erb, M. P., Emile-Geay, J., D'Agostino, R., Chandan, D., Carré, M., Bartlein, P. J., Zheng, W., Zhang, Z., Zhang, Q., Yang, H., Volodin, E. M., Tomas, R. A., Routson, C., Peltier, W. R., Otto-Bliesner, B., Morozova, P. A., McKay, N. P., Lohmann, G., Legrande, A. N., Guo, C., Cao, J., Brady, E., Annan, J. D., and Abe-Ouchi, A.: Large-scale features and evaluation of the PMIP4-CMIP6 midHolocene simulations, Clim. Past, 16, 1847 – 1872, https://doi.org/10.5194/cp-16-1847-2020, 2020.

Chalmers, J., J. E. Kay, E. A. Middlemas, E. A. Maroon, and P. DiNezio, 2022: Does Disabling Cloud Radiative Feedbacks Change Spatial Patterns of Surface Greenhouse Warming and Cooling?. J. Climate, 35, 1787 – 1807, https://doi.org/10.1175/JCLI-D-21-0391.1.

Hu, X., Fan, H., Cai, M., Sejas, S. A., Taylor, P., and Yang, S.: A less cloudy picture of the inter-model spread in future global warming projections, Nat Commun, 11, 4472, https://doi.org/10.1038/s41467-020-18227-9, 2020.

Kang, Y. and Yang, H.: Quantifying effects of Earth orbital parameters and greenhouse gases on mid-Holocene climate, Clim. Past, 19, 2013 – 2026, https://doi.org/10.5194/cp-19-2013-2023, 2023.

Zelinka, M. D., Myers, T. A., McCoy, D. T., Po - Chedley, S., Caldwell, P. M., Ceppi, P., Klein, S. A., and Taylor, K. E.: Causes of Higher Climate Sensitivity in CMIP6 Models, Geophysical Research Letters, 47, e2019GL085782, https://doi.org/10.1029/2019GL085782, 2020.