Response to reviewers' comments for "An assessment of equatorial Atlantic interannual variability in OMIP simulations".

We thank the reviewer for their comments and suggestions that helped to improve the manuscript. Please find our detailed responses below. The reviewer comments are in black and our answers in blue. **When line numbers are given, they refer to the revised manuscript with track changes accepted.**

This study compares tropical Atlantic variability among forced ocean simulations (CORE-I and CORE-II) and a subset of CMIP6 models and identifies a diffusive thermocline bias among models.

My primary concern with this study is that the model representation is biased towards Eulerian vertical coordinate models such as MOM5 . NorESM is the only isopycnal coordinate configuration , however it is using a high background vertical diffusivity (nominally 1-1.5e-5 m2 s-1). Near-equatorial background levels are reduced in several CMIP configurations, notably NOAA/GFDL-CM2G (https://doi.org/10.1175/2008JPO3708.1) ,which is a quasi-Isopycnal coordinate model, similar to NorESM.

We agree with the reviewer that the study is biased towards Eulerian vertical coordinate models. However, we have used all available models participating to OMIP phases 1 and 2 with a resolution higher than 1° by 1° and presenting all the variables needed for our analysis (L102-103). The NOAA/GFDL-CM2G is a coupled model and therefore is not participating to the Ocean Model intercomparison Project.

Echoing the reviewer's concern, we believe that diversity among ocean models should be encouraged, whereas we observe instead a global convergence towards a handful of global ocean models, often using similar numerical approaches and parameterizations. Hence, more isopycnal coordinate models, or models using generalized vertical coordinates and the vertical Lagrangian-remap method (Griffies et al., 2020), contributing to OMIPs and CMIPs would be beneficial for both model development and assessment.

We have added a note on this topic in the Discussion section (L400-405).

Griffies, S. M., Adcroft, A., & Hallberg, R. W. (2020). A primer on the vertical Lagrangian-remap method in ocean models based on finite volume generalized vertical coordinates. *Journal of Advances in Modeling Earth Systems*, 12, e2019MS001954. https://doi.org/10.1029/2019MS001954

Model sensitivity results suggest that increasing model resolution slightly reduces the diffuse thermocline bias (MOM5-HR). This is not discussed further and deserves further attention. Would an implication be that additional high resolution studies are needed to assess to what degree stratification bias can be reduced by increasing horizontal resolution? To what extent could improved representation result from numerics (e.g. Lagrangian coordinate models)? Including an isopycnal with low equatorial diffusivities (CM2G) would help to address this question.

We agree with the reviewer that this topic deserves more attention. As mentioned in the manuscript, we have 3 model pairs ACCESS-OM2 and ACCESS-OM2-025, MOM5-LR and MOM5-HR, as well as CMCC-CM2-HR4 and CMCC-CM2-SR5 which have the same number of vertical levels but they differ in their horizontal resolution, going from coarse ($1^{\circ}\times1^{\circ}$) to refined ($0.25^{\circ}\times0.25^{\circ}$). This comparison, based only on three model pairs, suggests that increasing the ocean horizontal resolution does not lead to consistent changes in the equatorial Atlantic mean-state and interannual SST variability in boreal summer (Figure 9 of the revised manuscript). One notable change is the increase of the vertical ocean temperature gradient and subsurface temperature variability in boreal summer when comparing MOM5-LR to MOM5-HR. However, this change is not observed in the other two model pairs. A larger number of model pairs would be required to properly assess the impact of resolution. (L393-400)

Furthermore, Zhang et al., (2022) investigated the impact of the wind forcing and ocean vertical mixing parametrization on the tropical Atlantic subsurface ocean temperature bias in the tropical Atlantic using sensitivity experiments made with the POP2 model. They found that the wind forcing has only a marginal effect on the subsurface temperature bias in the tropical Atlantic. However, they showed that the overestimated vertical mixing in OGCMs play a major role in the formation of subsurface warm biases in the tropical Atlantic.

As mentioned above, comparing Eulerian versus Lagrangian coordinate models would help to shed light on this aspect, but it is not presently feasible with the available OMIP simulations.

Zhang, Q., Y. Zhu, and R. Zhang, 2022: Subsurface Warm Biases in the Tropical Atlantic and Their Attributions to the Role of Wind Forcing and Ocean Vertical Mixing. *J. Climate*, **35**, 2291–2303, https://doi.org/10.1175/JCLI-D-21-0779.1.

Figure quality is good. In Figures 3 and 4 (and perhaps 5), it would be helpful to show anomalies for all fields, with respect to ORA-S5.

We thank the reviewer for the appreciation of our figures. In the revised manuscript, we do not show the anomalies for all fields with respect to ORA-S5, as we think it is important for readers to properly see the phasing of each variable. Nonetheless, we have added, as suggested by reviewer 1, the ATL3 or ATL4 indexes for each variable in Figures 2, 4, and 8 of the revised manuscript, allowing for direct comparison. In addition, supplementary Text S1 is devoted to the comparison of the MOM5 model runs, MOM5-LR and MOM5-HR, to ORA-S5.

Did the authors consider analyzing mean and time-varying contributions to the upwelling heat budget, i.e. how much of the variability is related to changes in the background stratification/upwelling versus eddy contributions? This could be helpful for the disussion, however, the existing figures reasonably convey the point of the dominance of vertical processes in this region.

We thank the reviewer for the suggestion. A comprehensive heat budget analysis will be performed in a future study using only one model at varying resolution, and performing multiple sensitivity runs to investigate the role of the background stratification on the variability of the equatorial Atlantic.