Response to the reviewer and editor

We thank the reviewer for their constructive feedback and for recognizing our revisions. Below, we address the remaining two minor comments.

I would like to thank the authors for carefully addressing the comments in detail. I agree to the changes made to the manuscript.
Two minor points remain and I apologize for not being fully clear in my initial review:
• DOC inventory: Thanks for providing the total DOC inventory. My recommendation was rather to assess the DOC inventory in your future simulation, i.e. how much more or less carbon is stored, instead of only focusing on the DOC export. I recommend to add this information to the main text.

We have added this information to the main text as follows (L290-292):

"For comparison, the modeled total oceanic DOC inventory is 704 PgC under present-day conditions and decreases by 0.6 PgC in the simulated future period, illustrating the scale of annual export in relation to the total DOC reservoir and its role in the marine carbon cycle."

• Fixed production ratios of the non-bacterially mediated pools (i.e., the percentage of total production entering respective pools): The initial concern was not about evolutionary changes, but rather that these pools are modelled based on first-order kinetics, which is a concept derived from modelling _net_ removal rates (Hansell et al., 2012; Kirchman et al., 1993) that by definition obscures the underlying production and consumption (i.e. fixed parameters based on net removal dynamics). As your results show for the labile pool, production and consumption may respond differently to environmental drivers. As these pools form the largest part of the total DOC pool, their dynamics play a relatively large role in the carbon export you calculate. Extrapolating net removal rates into the future, without accounting for the distinct dynamics of these underlying processes, introduces uncertainty and should be acknowledged.

We agree with the reviewer. This uncertainty is already acknowledged in several parts of the discussion, and we have refined the relevant sections to emphasize the point more clearly.

L314-320: *"Despite good agreement with present-day observations, applying temperature sensitivity only to labile DOC may limit the accuracy of future projections. Semi-labile and semi-refractory DOC pools have empirically based constant decay rates implicitly reflecting contemporary environmental conditions, so future temperature-driven changes are only partly captured through remineralization of these pools into labile DOC. Although this approach remains valid for contemporary DOC cycling, the lack of dynamic or mechanistic process representation adds uncertainty to climate change projections. Addressing this limitation, ongoing development of our model aims to incorporate environmentally sensitive decay rates for semi-labile and*

semi-refractory DOC pools to enhance the robustness of future projections.”

We also modified the following paragraph to further address the reviewer’s concern (L264-270):

“In interpreting these results, it is important to consider how certain model assumptions may influence the robustness of future projections. Our modeled distribution of DOC and other relevant biogeochemical variables aligns well with present-day observations (Fig. 2; Appendix, Fig. A1), although temperature-sensitive remineralization is currently applied only to labile DOC. Semi-labile and semi-refractory DOC pools use empirically based constant decay rates reflecting current conditions, so future temperature effects are partially captured through remineralization into labile DOC. These decay rates follow first-order kinetics representing net removal, thereby implicitly combining production and consumption processes. While suitable for analysis of present-day cycling, this approach formulation may introduce uncertainty in future projections.”

We finally refer to the specific uncertainty again in the conclusion (L386-389):

“We recognize a limitation in our analyses concerning the dynamics of semi-labile and semi-refractory DOC pools, whose degradation rates are not explicitly sensitive to environmental drivers. Consequently, any conclusion regarding contribution of DOC to long-term carbon sequestration must be interpreted with caution.”