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Interactive comment on "Bottom-water deoxygenation at the Peruvian Margin during the last deglaciation recorded by benthic foraminifera" *by* Zeynep Erdem et al.

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We appreciate the remarks and suggestions of the reviewer and are grateful for the effort the reviewer has invested. Below we respond to each comment (RC: referee comment; AR: Authors' response) and indicate how we plan to revise the manuscript accordingly.

RC1: In the current format, the authors have not demonstrated that the live population are identical to the dead population in the core tops, and without this evidence downcore reconstructions are not scientifically scrutinized.

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Discussion paper

AR1: We thank the reviewer for addressing this important point, and we take the opportunity to emphasize again that living faunas and dead assemblages are generally different in species composition, and that standing stocks are not mirrored in the concentrations of empty tests in near-surface sediments in most environments. These fundamental differences are intrinsic. Living faunas represent the conditions during the weeks before sampling, whereas dead assemblages are a product of many generations added over an unconstrainable time period. Therefore, species richness and density of the dead assemblages are generally higher than the respective values of the living fauna. Another biasing factor is the taphonomic processes altering the composition of the dead assemblages through time, in particular during successive burial under the influence of different redox and pH conditions. The fossil assemblage in sediment cores thereby differs markedly from the dead assemblage at the sediment surface. Therefore, an identical composition of living faunas and dead assemblages in the topmost layers of sediment cores is impossible to be found, and this should not be imposed as a prerequisite for downcore applications of foraminiferal proxies. The very reason why benthic foraminifera are proven reliable paleoindicators is because they live in equilibrium with the ecological conditions in their immediate environment. Due to their short generation times of usually less than a year, they respond quickly to changes in the setting of abiotic or biotic environmental factors. Once a foraminifera reproduces, an empty test is conveyed to the sedimentary record. If the species is reduced in abundance due to environmental changes, a lower number of empty tests is produced per unit of generation time. Conversely, a species benefiting from the change and increasing in abundance will deliver more tests to the fossil record. A transfer function, as it has been applied in the present study, relates the relative abundances of those species to the change in environmental conditions and accommodates for taphonomic alterations. The reviewer is referred to the interesting textbook of Fisher and Wefer on "Use of Proxies in Paleoceanography" for further reading. In summary: our approach is scientifically valid and verifiable through comparison with other proxies for past oxygen conditions.

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RC2: Information concerning age models of the different cores is missing. The age model needs fully discussed and shown in the article as it is crucial to consider the context and interpretations of the reconstructions.

AR2: We follow this suggestion and give a detailed age model description in the revised version. We will modify Figure 6 and add age model tie points for each core. We will also link available Pangaea datasets concerning the radiocarbon dating results of these cores.

RC3: The authors should have a good look at their data and critically reflect whether their conclusions really reflect the data. The main Figure 6, I presume, shows reconstructed O2 plus error. Main changes seem to occur during deglaciation. There does not appear to be any differences between LGM and core tops/late Holocene (the authors suggest a 30 uM change from the LGM to Holocene at the lower OMZ boundary): -The first site at 626 m shows (within error!) similar O2 values during the LGM as core top; e.g. no statistically significant increase in LGM oxygenation. -The second core at 1013 m: all reconstructed values are below present day values: no significant increase in LGM oxygenation here. -Third core site at 1249 m: LGM oxygen concentrations are lower compared with core top; so no significant LGM increase in oxygenation here. –Fourth core at 997 m: perhaps H1, early deglacial higher O2 values; but no reconstructions for the LGM. So none of the cores show that the Peruvian margin, at the water depths investigated, was better oxygenated during the LGM compared to today.

AR3: For modern oxygen values we used the CTD data collected during each expedition at the same time when living benthic foraminifera samples were collected. The stars shown on the figures are indicating the values when the sediment archives were collected. The LGM estimations are indeed either really close or below the actual measurements which is seemingly a concern. We mention our concerns about absolute values and potential bias toward lower oxygen value in quantification in section 4.2. (P. 12, Lines 14-16). Nevertheless, it is possible that bottom waters became more oxic after the late Holocene as reported for the shelf during the last 100-150 years (Cardich et al., 2019). However, we cannot comment further for the rest of the Holocene trend on the basis of currently available information. As this circumstance is apparently not sufficiently addressed in our Discussion, we will detail the respective paragraphs. Concerning the potential bias towards lower oxygen values, we restrain ourselves making comments such as; 'during the LGM at 1000 m water depth oxygen was 50 μmol/kg'. We rather focus on the absolute changes between periods and sediment archives. Still we present all the quantification results for each data point in Supplementary information Table 1. The average values for each time period were calculated according to estimations presented here. Unfortunately not all time periods are covered in every core, therefore we emphasize that the results are stacked (P. 11 Lines: 15-17). We are aware that the approximation of 30 μmol/kg is predominantly influenced by the results of core M77/2-52-2 (LGM ranging between 52 and 61 μmol/kg vs. late Holocene ranging between 23 and 33 μmol/kg), since it is the only core which covers all of the concerned periods. Once again we primarily focus on the change in oxygenation rather than reporting absolute values as given facts for these cores. Concerning the results of core M77/2-47-2 from (626 m), which does not indicate any change during the LGM and deglaciation, we conceded that these results are puzzling in the first glance, Nonetheless, this record also shows that when the OMZ intensifies (or diminishes) the change is profound around its borders and the conditions are rather stable close to its centre. This regional dynamics has also been disclosed with other proxy based approaches (as discussed in section 4.2; P.11 Lines: 22-26). Moreover, during the LGM this core location was at least 100 m shallower which was potentially within the OMZ core.

References: Cardich, J., Sifeddine, A., Salvatteci, R., Romero, D., Briceño-Zuluaga, F., Graco, M., Anculle, T., Almeida, C., and Gutiérrez, D.: Multidecadal Changes in Marine Subsurface Oxygenation Off Central Peru During the Last ca. 170 Years, Frontiers in Marine Science, 6, 10.3389/fmars.2019.00270, 2019.

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