Author's response

Dear Prof. Fleitmann,

Please find enclosed our revised manuscript "*Accurately calibrated XRF-CS record of Ti/Al reveals Early Pleistocene aridity/humidity variability over North Africa and its close relationship to low-latitude insolation*". We modified the manuscript following the constructive comments from the two reviewers (we thank them in the Acknowledgements). Copies of the manuscript with tracked changes, the revised manuscript (without tracked changes), and a file with additional supporting information (as requested by Reviewer 2) are all uploaded.

Based on the reviewer comments, we have amended the manuscript as follows (note: below we refer to lines in the manuscript *with* tracked changes):

- We emphasize the novelty of our study (lines 73 to 97) by making the last two paragraphs of the introduction clearer (RC1; RC2; Editor comments). We now also clearly state the connection between the more methodological (i.e., calibration testing) and paleoceanographic parts of the study (RC2 comment) (lines 73 to 79).
- We clarify briefly in the Introduction the differences/similarities with Grant et al. (2022) (lines 94-97), and in more detail in the Methods (lines 149-153). Moreover, we added the Grant et al. (2022) calibrated data to Figure 3a to facilitate comparison and adjusted the text accordingly (lines 205-206). We have removed the statement on the novelty of our study from the data availability section. (RC2 comment)
- We have added a more detailed description on the expected age uncertainty (lines 110-114). (RC2 comment)
- We provide the Xelerate figures with reference vs predicted concentrations as a supplement and added to lines 139-140 that 10 named elements are calibrated. We now discuss briefly that other elements are potentially calibrated better with automatically selected sampling (lines 169-170). (RC2 comment).
- We have added *p*-values to Table 1. Moreover, in the caption, we now state that to correct *p*-values for multiple comparisons, we used the Bonferroni method. We added this to the Methods (lines 144-145). (RC1 comment)
- We clarify and emphasize in the Discussion that there is a general misconception that proper calibration of XRF-scanning data is only necessary to quantify geochemical data, but we show that it modifies the variability (because of the multivariate nature of the calibration and matrix + sensitivity corrections) (lines 197-201). (RC2 comment)
- We clarify why we use the 1060 sample calibration (lines 203-205). (RC1 comment)
- We briefly address details of the Bosmans et al. (2015a; b) model in lines 261-262. (RC2 comment)
- We applied change point analysis to our dataset (Figure 4g) and now refer to this in the text (lines 276-277). (RC1 comment)
- Based on comments from both reviewers (RC1 and RC2) and recent sea-level proxy record updates, we removed the running correlation (Fig. 5c in the initially submitted manuscript) between Ti/Al and sea-level change at Gibraltar (RSL_{Gib}) from the revised

paper. Instead, we now present a straightforward cross-correlation between sea-level and ODP967 Ti/Al values older/younger than 1.2 Ma and box-whisker plots of the same values (new Figure 5). Hence, we also adjusted the associated text in the caption and Discussion (lines 290-296). (RC1 and RC2 comments)

- We added the suggested literature (RC1) and slightly expanded the text at the end of the Discussion to further support the suppressive effects of glacial termination meltwater discharge on the North African monsoon system (lines 296-301). (RC1 comment)
- We briefly address why we chose a 401-kyr window in our running correlation (lines 538-540). (RC1 comment)
- We incorporated the minor/grammatical notes of the reviewers following our replies to reviewer comments (including the change in shade of blue lines in the figures).

We think that the current manuscript meets the high standards for publication in *Climate of the Past*.

On behalf of all co-authors, yours sincerely,

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