Hamburg, December 15, 2023

Dear Editor,

thank you for the comment of the reviewer, and for granting us sufficient time to complete a revised version of the manuscript. We gratefully acknowledge the thoughtful comments and suggestions of the reviewer for further improving our manuscript. Generally, we have followed most of the suggestions. We have revised one figure and enhanced our text in order to provide clearer interpretation. The modified passages of the manuscript are marked in the "track changes" mode. Below, please find a point-by-point account (in "red") of how we have dealt with the comments.

Reviewer #1:

The authors expanded their discussion and provided more background for readers in this revision. Here are some suggestions to further improve the manuscript.

Thank you for reviewing our revised manuscript (again) and helping us to further improve it.

Age models: 14C dates can be updated using newer calibration curves. I also recommend using software such as Undatable to derive age uncertainties of both cores of KL11 and GEOB5844-2. This is because the calculation of Dd18O is highly dependent on age uncertainty. Although I agree that benthic d18O of both cores are generally well aligned, some periods seem to be offset by a few kyrs that can artificially cause changes in Dd18O (e.g., 55-60 kyr). While I am not here to dismiss using Dd18O to infer circulation changes, I think these caveats of the method should be discussed.

We are aware that radiocarbon-based age models can be continuously updated using new calibration curves. However, to maintain consistency with the published version of Arz et al. (2007), we preferred to adopt their age model without further modifications. For the lower part of this age model (for ages older than 40 ka B.P.) no calibration can be adjusted anyway, since it is based on correlation of the magnetic paleointensity record of GeoB5844 to the North Atlantic paleointensity stack. We have added some information on the potential uncertainties in the revised manuscript.

Dd18O Calculation: Showing Dd18O at GEOB5844, which is not complicated by the age model and would be similar to the GEOB5844-KL11 Dd18O, may help to strengthen the argument about changes in deep water formation.

We have generated an updated version of figure 7 by adding the Dd18O for site GeoB5844-2 based on the d18O records of the infaunal *Bulimina aculeata* and the planktic *Globigerinoides*

ruber data from this sediment core. The fluctuations in both Dd18O records resemble each other supporting our original conclusion for a dominant northern hemisphere climate control of the northern Red Sea deep-water formation during MIS3. However, we consider the Dd18O record based on the epibenthic d18O of KL11 and the planktic d18O of GeoB5844-2 more reliable since *B. marginata* inhabits an infaunal microhabitat. Therefore, its d18O signal may additionally reflect changing carbonate ion gradients of the porewater and, thus, may be in disequilibrium to the bottom water. The text in the manuscript has been updated.

Section 4.2: having a section titled "Monsoonal influence on biogeochemical cycling in the Red Sea' in the discussion about the circulation change still seems odd to me. I recommend combining this section with the part in section 4.1 related to d13C for another section.

We have merged chapters 4.1 and 4.2 accordingly.

Lines 59-60 repetitive.

It seems that the line numbering of the document used by the reviewer was different from the uploaded manuscript. However, we think that the present comment refers to the caption of figure 2 (lines 49-50 in our pdf-file). We specified the caption accordingly.

Line 245: How the NH changes affected SSS via evaporation can also be discussed here.

We added a sentence to clarify the potential effect of short-term changes of aridity and associated evaporation on salinity.

Line 270: Benthic d13C alone cannot reflect residence time. Combining the lack of changes in planktic d13C at GEOB5844 can help to argue for a strengthened circulation.

We agree with this comment.

Fig.2 I think instead of showing the surface hydrography, showing deep water S, T, density, O2 etc would be more relevant to this study.

We agree that information on deep-water salinity, temperature and O2 are relevant for this study. Therefore, we already displayed the modern O2 concentration in figure 3. However, both temperature and salinity lack significant gradients below 100 m water depth (see Figs. 3, 4 in Sofianos & Johns, 2007, J. of Geophys. Res.), for which reason it appears not useful to present figures for these parameters. Instead, strong SST and SSS gradients are found in the

surface waters, as shown in figure 2. We think that this information is useful since these gradients control the S-N density gradient creating the boundary conditions for deep-water formation in the North.

Line 339-341 …"increasing deep-water formation" redundant

We have modified the sentence accordingly (please note that in our pdf-file, this sentence appeared in lines 329-330).

Line 345: suggest tuning down "links to the strength of the Siberian High and related inflow of cold air masses to the sites of Red Sea deep-water formation". This is speculative and cannot be directly derived from this study.

We prefer not to remove this part since it was requested by one of the earlier reviewers. However, we modified the text to indicate that an influence of the Siberian High is rather speculative.