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Comment on **essd-2022-107**

Anonymous Referee #1

Referee comment on "Large salinity gradient and diagenetic changes in the northern Indian Ocean dominate the stable oxygen isotopic variation in *Globigerinoides ruber*" by Rajeev Saraswat et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2022-107-RC1>, 2022

Saraswat et al. present an extensive core-top compilation of new and published $\delta^{18}\text{O}$ values of the species *Globigerinoides ruber*. *G. ruber* is the most commonly measured planktic species and the new data set has the potential to improve the coverage in the Indian Ocean and can complement existing global compilations (i.e., Waelbroeck et al. 2005). The data set itself would benefit from additional documentation (data source, sampling depth, $\delta^{13}\text{C}$ of *G. ruber*) that can be added with minimal effort. As outlined below, the scientific analysis and interpretation of the data need revision:

Title/L18, 20, 23, 25, 34...This is probably only a wording issue but "salinity" is not influencing or controlling the $\delta^{18}\text{O}$ of carbonate, $\delta^{18}\text{O}$ of sea water is. The authors probably use "salinity" because salinity is often reconstructed from $\delta^{18}\text{O}$ of seawater and because both parameters are locally highly correlated and influenced by precipitation and evaporation. However, I think the authors should be precise. Salinity and $\delta^{18}\text{O}$ are related but can be decoupled to some extent, i.e., if the source of the freshwater endmember changes, the same salinity might be associated with different $\delta^{18}\text{O}$ seawater values. This is demonstrated by the large scatter of the the $\delta^{18}\text{O}$ -salinity relationships in Figure 8 and the different freshwater endmembers in the Arabian Sea (-2.84 ‰) and the BOB (-4.23 ‰).

L39: There are earlier examples of $\delta^{18}\text{O}$ seawater reconstructions based on *G. ruber* that should be cited here including Wang et al. (1995), Kallel et al. (1997) and Schmidt et al. (2004).

L44: I disagree with this statement. The relationships between the physicochemical conditions and foraminiferal $\delta^{18}\text{O}$ seems to be quite constant since we have a very good agreement between laboratory derived equations and field data when the ambient conditions of shell formation are known. The reasons why there are offsets in different basins is that, particularly when core tops are used, the exact conditions of shell formation ($\delta^{18}\text{O}$ sea water, light intensity, temperature, depth of calcification, seasonal flux, pH...) are not well constrained.

L113/Methods: I suggest to show a table with all the relevant information, the expeditions, number of samples, region etc.

L131: There seems to be a small discrepancy between the values obtained from published sources and the original data. According to PANGAEA and the appendix in the cited thesis by Sirocko (1989), the core top value for MD76-135 is -1.81 ‰ (this paper: -1.89 ‰) and for MD76-136 -1.78 ‰ (this paper: -1.82 ‰). Perhaps this offset is just due to a different sampling depth or averaging. I have not checked the other sites. Please check and document the sampling depth in the core and the actual source of the data (table in paper, supplement or data base with doi/link)

MD76-136: <https://doi.org/10.1594/PANGAEA.77485>

MD76-135: <https://doi.org/10.1594/PANGAEA.77484>

Sirocko (1989): <https://doi.org/10.2312/reports-gpi.1989.27>

Figure 1, 2, 7: The maps have been produced with OceanDataView. Please give proper credit to the author of the software and cite Schlitzer, R., Ocean Data View, <https://odv.awi.de>, 2018. What kind of interpolation technique has been used to produce

the maps?

L146: State the laboratory where the samples have been measured.

Figure 4: The relation of $\delta^{18}\text{O}$ with water depth is interesting. To what extent is this relation influenced by the fact that shallow sites are more exposed to freshwater input (=lower $\delta^{18}\text{O}$) than the more remote deeper sites? To isolate the effect of water depth, it might help to plot the difference to the predicted $\delta^{18}\text{O}$ vs water depth rather than absolute $\delta^{18}\text{O}$.

Figure 5 & 6: What is the purpose of showing separate relations with temperature and salinity (must be $\delta^{18}\text{O}$ of sea water, see above) when we know that both factors influence the $\delta^{18}\text{O}$ of foraminiferal carbonate? Temperature and salinity are also spatially related and it is impossible to quantify the relative influence of both factors in the plots. In my opinion, Figures 5 and 6 and the corresponding discussion can be omitted.

Figure 9: I suggest to have the same ranges/limits for x and y axis and to indicate the 1:1 relation with an additional line. Is the slope of the shown regression statistically significantly different from 1? To assess whether the derived linear equations will help to improve paleoclimatic reconstructions (as stated in L27), it would be important to quantify the error of the regression equations.

L155: Salinity from the World Ocean Atlas is provided on a grid. How exactly was salinity estimated at the core location? From the nearest grid point?

L218/Discussion: It should be mentioned that stratigraphic information is not provided for most of the core tops. Core top sediments can represent older time slices when the sedimentation rates are low or when older sediments are exposed due to erosional processes. This does not matter so much if the Holocene is present and stable. However, in the Indian Ocean large Holocene $\delta^{18}\text{O}$ variations are expected due to variations in Monsoon precipitation.

L 245: Explain how mixed layer depth has been defined/determined?

L246: Provide more context. Why has the *O. universa* low light equation been used if *G. ruber* $\delta^{18}\text{O}$ is better described with the high-light equation (see Thunell et al. 1999)? How big are the constant offsets to the published equations?

L247/Discussion/Figure 9: It would be very interesting to see a map of the residual $\delta^{18}\text{O}$ (predicted-observed). Any spatial pattern in the residuals might point to the environmental/ecological reason for the deviations from expected $\delta^{18}\text{O}$. For example, the chlorophyll maximum is very shallow in the coastal areas of the BOB and the Arabian Sea whereas it is deep in the central Indian ocean. If *G. ruber* exploits the chlorophyll maximum as a food source (Fairbanks and Wiebe, 1980) it might record higher $\delta^{18}\text{O}$ due to lower temperatures and lower light levels (i.e., Spero et al., 1997). Likewise, the deeper central areas should show lower sedimentation rates and stronger signals from dissolution and sediment mixing.

L270. The authors attribute the increase of $\delta^{18}\text{O}$ with water depth to diagenesis and partial dissolution. This is certainly a possible explanation. However, it seems very likely that the deep basins receive much less terrigenous matter than the shallow slope/shelf sites and that the sedimentation rates are significantly lower in the deep parts of the Indian Ocean. When the sedimentation rates are lower than ~ 2 cm/kyr (quite common in deep pelagic

basins) it is likely that the the Holocene is mixed with isotopically heavier material from the last glacial/deglaciation (Broecker 1986), which might also explain the relationship of $\delta^{18}\text{O}$ with water depth. Is anything known about the sedimentation rates in the deep basins?

L291-293: Unfortunately, $\delta^{13}\text{C}$ of *G. ruber* has not been not reported and shown along with $\delta^{18}\text{O}$. As DIC in river water is very depleted in carbon-13, since it derives from the remineralized organic matter, it provides additional information on freshwater input (see for example Pastouret et al. 1978). If freshwater from river input is the reason for some of the low $\delta^{18}\text{O}$ values in *G. ruber* in the BOB, $\delta^{13}\text{C}$ values should be low as well. Since $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ of foraminiferal carbonate are always measured together it should be straightforward to add $\delta^{13}\text{C}$ of *G. ruber* to the data set.

L306-313: Please review and revise the reasons for the different slopes in the North Atlantic and the Indian Ocean. The higher slope of the $\delta^{18}\text{O}$ /salinity relationship in the North Atlantic is due to the fact that precipitation/freshwater in high latitudes is depleted in oxygen-18 (~ -35 ‰) compared to tropical areas (~ -5 ‰) (see for example Figure 10 in Rozanski et al., 1993).

L324: Except for upwelling regions, the variations in surface water pH are indeed small. However, the pH at the foraminiferal shell is strongly influenced by light intensity in the presence of symbionts (see Jorgensen et al. 1985, Fig 6). Small variations in turbidity or calcification depth can therefore influence the stable isotope ratio of *G. ruber* via the pH effect.

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