<u>Authors' Response to Reviewer's Comments</u>

Reviewer's Comment: Title. Salinity influences d18Osw and indirectly d18Oruber. The title should be more specific.
Authors' Response: We agree with that the salinity indirectly influences the oxygen isotopic ratio of planktic foraminifera. The title has been changed to
'Large fresh water influx induced salinity gradient and diagenetic changes in the northern Indian Ocean dominate the stable oxygen isotopic variation in *Globigerinoides ruber*'

Reviewer's Comment: Introduction. The distinguishment of s.s. and s.l. morphotypes in G. ruber is crucial for the subject of the paper dealing with. which one(s) was (were) used? or was it a mixture.
Authors' Response: The following details have been added.
'We picked *G. ruber* s.s. wherever sufficient specimens were available. Unfortunately, several samples yielded very small carbonate fraction. In such samples, we picked mixed population of *G. ruber* to get sufficient specimens for isotopic analysis.'

Reviewer's Comment: Include other factors that impact in the d18Oruber, for example, photosynthesis, symbionts, pH, alkalinity, among others.
Authors' Response: The following text has been added in the introduction.
'The ambient seawater pH, carbonate ion concentration (Bijma et al., 1999), presence/absence of symbionts (Jørgensen et al., 1985) also affect the isotopic composition of *G. ruber*. However, limited glacial-interglacial variability in these parameters is masked by the dominance of temperature and fresh water influx induced salinity changes in oxygen isotopic ratio of *G. ruber.*'

Reviewer's Comment: How does the oxygen isotopic composition of G. ruber change with shell dissolution? Explain.
Authors' Response: The following sentence has been added.
'The dissolution preferentially removes depleted $\delta^{18}O$ sections of the shells, thus increasing the whole shell $\delta^{18}O_{ruber}$ (Berger and Gardner, 1975; Lohmann, 1995; Weinkauf et al., 2020).'

Reviewer's Comment: Similar studies have been conducted in the Pacific and Atlantic oceans and require citation, for example:
Farmer, E. C., A. Kaplan, P. B. de Menocal, and J. Lynch-Stieglitz (2007), Corroborating ecological depth preferences of planktonic foraminifera in the tropical Atlantic with the stable oxygen isotope ratios of core top specimens, Paleoceanography, 22, PA3205, doi:10.1029/2006PA001361.
Steph, S., Regenberg, M., Tiedemann, R., Mulitza, S., & Nürnberg, D. (2009). Stable isotopes of planktonic foraminifera from tropical Atlantic/Caribbean core-tops: Implications for reconstructing upper ocean stratification. rine Micropaleontology, 71(1-2), 1-19.
Thirumalai, K., Richey, J.N., Quinn, T.M. & Poore, R.Z. Globigerinoides ruber morphotypes in the Gulf ofMexico: A test of null hypothesis. Sci. Rep. 4, 6018; DOI:10.1038/srep06018 (2014).
Sánchez, A., Sánchez-Vargas, L., Balart, E., & Domínguez-Samalea, Y. (2022). Stable oxygen isotopes in planktonic foraminifera from surface sediments in the California Current system. Marine Micropaleontology, 173, 102127.

Authors' Response: All these studies have been referred in the introduction. The following text has been added.

'The $\delta^{18}O$ of surface dwelling planktic foraminifera *Globigerinoides ruber* ($\delta^{18}O_{ruber}$) is often used to reconstruct past surface seawater conditions (Saraswat et al., 2012; 2013; Mahesh and Banakar, 2014). Therefore, continuous efforts are made to understand the factors affecting $\delta^{18}O_{ruber}$ (Vergnaud-Grazzini, 1976; Multiza et al., 1997; 2003; Waelbroeck et al., 2005; Mohtadi et al., 2011; Horikawa et al, 2015; Hollstein et al., 2017; ; Sanchez et al., 2022). The depth habitat of *G. ruber* in the tropical Atlantic Ocean has been inferred from its stable oxygen isotopic ratio (Farmer et al., 2007). The change in stable oxygen isotopic ratio of planktic foraminifera, including *G. ruber*, is suggested as a proxy to reconstruct upper water column stratification in the tropical Atlantic Ocean, based on the good correlation between $\delta^{18}O$ and the ambient seawater characteristics (Steph et al., 2009). A few studies suggested a difference in the $\delta^{18}O$ of various morphotypes of *G. ruber* (sensu stricto and sensu lato) and attributed it to their distinct ecology and depth habitat (Löwemark et al., 2005). However, a recent study from the Gulf of Mexico suggested a similar ecology and depth habitat for both the *G. ruber* morphotypes (Thirumalai et al., 2014).'

Reviewer's Comment: Materials and Methodology. what certified or secondary reference standards were used?.

Authors' Response: The reference material NBS 18 limestone was used as the calibration material and a secondary in-house standard was run after every 5 samples to detect and correct the drift. The details have been added in the methodology.

Reviewer's Comment: In which laboratories each group of samples were measured.

Authors' Response: The following details have been added.

'The $\delta^{18}O_{ruber}$ was measured by using Finnigan MAT 253 isotope ratio mass spectrometer, coupled with Kiel IV automated carbonate preparation device. The samples were analyzed in the Alfred Wegner Institute for Polar and Marine Research, Bremerhaven, MARUM, University of Bremen, Bremen, Germany and the Stable Isotope Laboratory (SIL) at Indian Institute of Technology, Roorkee, India.'

Reviewer's Comment: Provides a table specifying the date, number of samples, type of instrument used for collection and other relevant information for each cruise, including literature data.

Authors' Response: The following details have been added for the newly analysed samples.

Sr.No.	**Cruise**	**Month/Year**	**Area**	**Total Samples**
1.	SK117	September-October 1996	Eastern Arabian Sea	27
2.	SK175	April-May 2002	North-eastern Bay of Bengal	45
3.	SK237	August 2007	South-eastern Arabian Sea	26
4.	SK308	January 2014	Northwestern Bay of Bengal	29
5.	SSD004	October-November 2014	Gulf of Mannar, Lakshadweep Sea	41
6.	SSD055	August 2018	North-eastern Arabian Sea	11
7.	SSD067	November-December 2019	South-western Bay of Bengal, Lakshadweep Sea, Eastern Arabian Sea	45
8.	SSK035	May-June 2012	Western Bay of Bengal	13

9.	SSK098	January-February 2017	Andaman Sea	15

Reviewer's Comment: Include the distribution of salinity and temperature under contrasting conditions with and without freshwater input.

Authors' Response: We have included the following figure with sea surface temperature and sea surface salinity during the non-monsoon months of April-May and summer monsoon months of August-September.

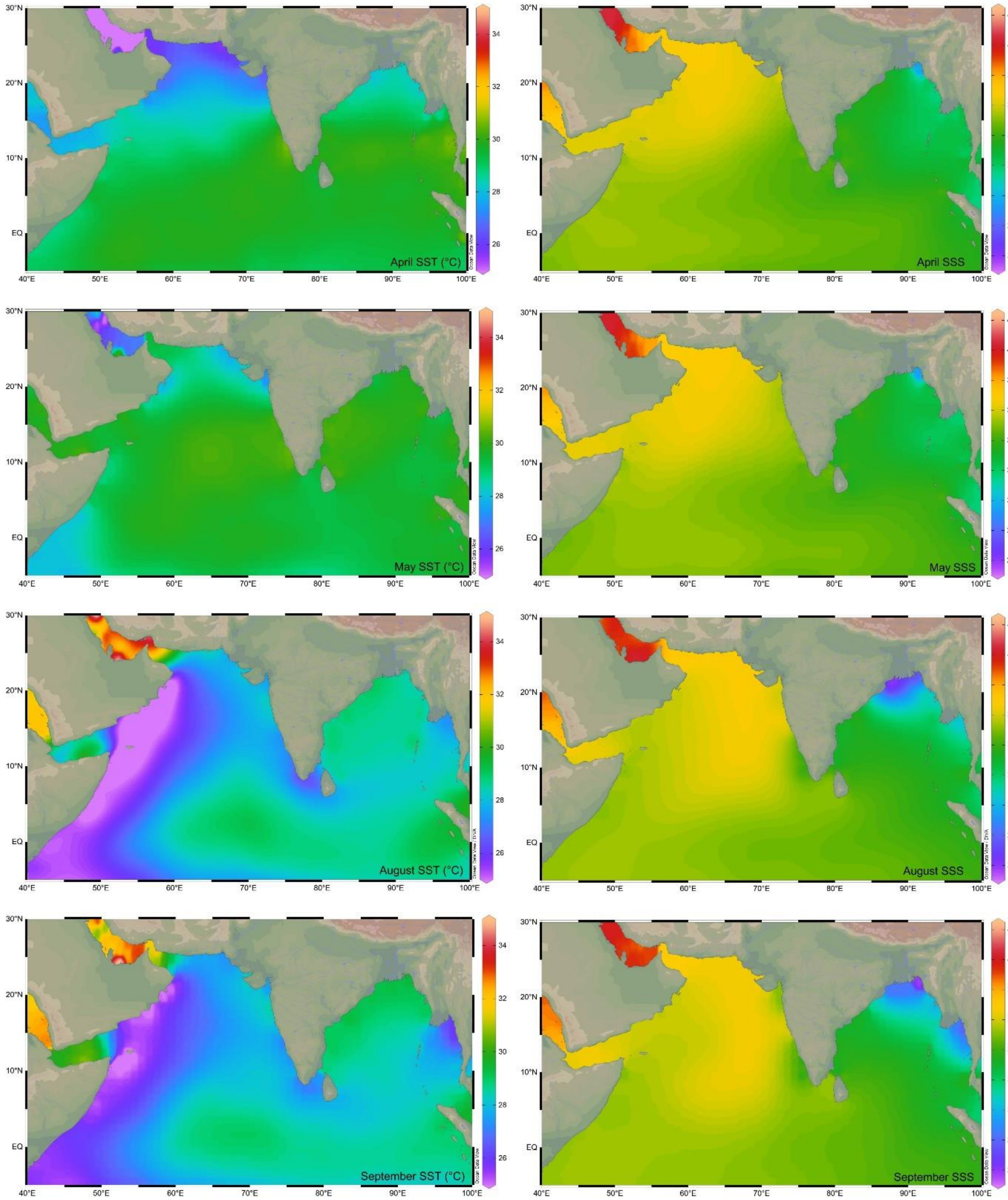

Figure 1: The sea surface temperature (SST) (°C) (Locarnini et al., 2018) and salinity (SSS) (psu) (Zweng et al., 2018) in the northern Indian Ocean during the monsoon (August-September) and non-monsoon (April-May)

months. Major rivers draining into the northern Indian Ocean, are marked by blue lines. The map has been prepared by using Ocean Data View software (Schlitzer, 2018).

Reviewer's Comment: Results. Include the P value in the correlation analysis.
Authors' Response: The correlation value (R2 = 0.5, n = 400) has been added.

Reviewer's Comment: Figure 9: Use color symbols to differentiate the d18O values of Arabian Sea and BoB. Why is R2 different in the figure with respect to the figure caption?.
Authors' Response: The figure has been revised to show the samples from the Bay of Bengal and Arabian Sea in different coloured symbols. The R^2 was wrongly mentioned in caption. It has been revised now.

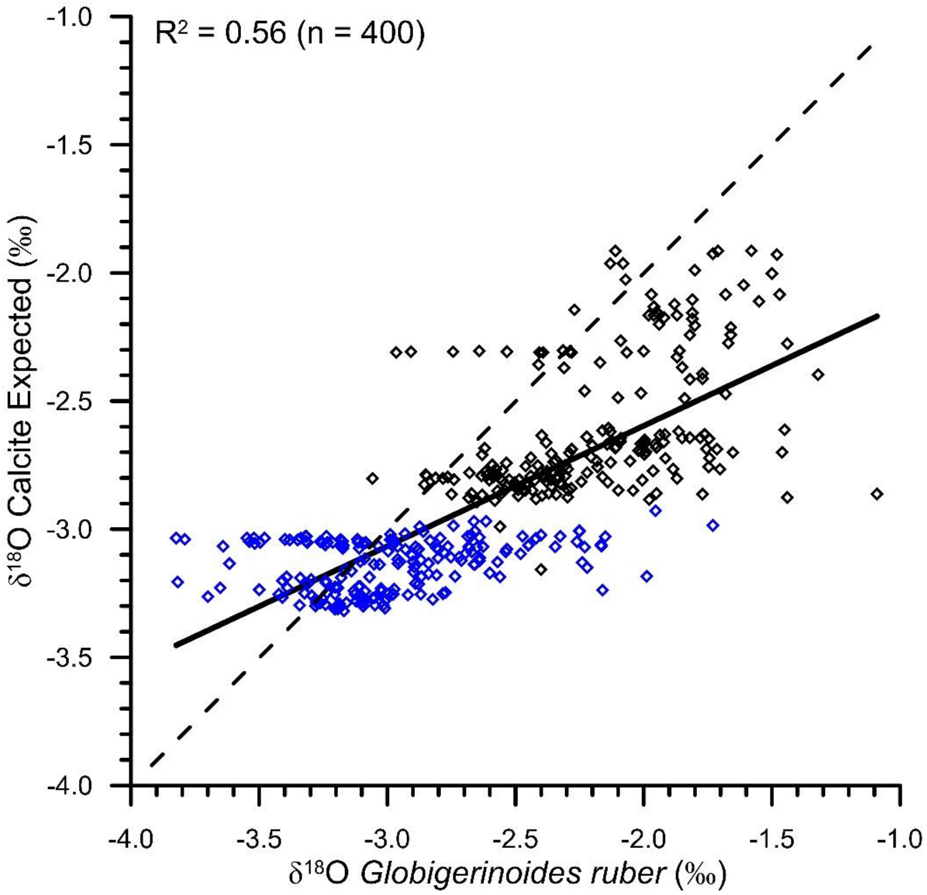

Figure 9: The scatter plot of expected $\delta^{18}O$ calcite as estimated from the ambient salinity-temperature and the analyzed $\delta^{18}O_{ruber}$. The two are significantly correlated (R^2 = 0.56), suggesting that *Globigerinoides ruber* correctly represents the ambient conditions. The blue diamonds are the samples collected from the Bay of Bengal and the black diamonds represent the samples collected from the Arabian Sea. The dotted line represents the 1:1 relationship between the measured and expected $\delta^{18}O$.

Reviewer's Comment: Fig. 4: The coefficient of determination (R2) is very small, what other parameters are involved in this relationship?. Note that the isotopic change is larger over the same depth interval with respect to the 0.18 change. Why do you avoid describing this change in the d18Oruber?
Authors' Response: The oxygen isotopic ratio is mainly affected by the ambient seawater $\delta^{18}O$ (which in turn depends on fresh water influx), temperature and pH. The digenetic changes and secondary

calcification also affects the $\delta^{18}O_{ruber}$. Here, we wanted to see the effect of depth related digenetic processes on $\delta^{18}O_{ruber}$. The correlation is low because depth related processes exert significant but very low control on $\delta^{18}O_{ruber}$ as compared to the effect of fresh water influx induced change in ambient seawater $\delta^{18}O$ and temperature, as discussed in further sections.

Reviewer's Comment: Fig. 5B: Describe in results and explain in discussion, the large variability in d18Oruber values with respect to the temperature range of 28 to 29oC.

Authors' Response: The following sentence has been added in the results.

'A large scatter (~-3.8‰ to -1.4‰) was observed in the $\delta^{18}O_{ruber}$ of the samples collected from a narrow range of ambient temperature (28-29°C).'

The following details are already mentioned in the discussion.

'The low correlation between $\delta^{18}O_{ruber}$ and temperature in this dataset is attributed to the limited temperature variability (1°C, 28-29°C) at a majority of the stations. The large salinity difference (~6.5 psu) between stations further obscures any significant correlation between uncorrected $\delta^{18}O_{ruber}$ and temperature.'

Reviewer's Comment: Include a Fig. of the spatial distribution of d18O of calcite in isotopic equilibrium.

Authors' Response: In response to a comment by other reviewer, we have included a figure of the spatial distribution of equilibrium isotopic composition minus the observed $\delta^{18}O_{ruber}$. Based on that figure, the possible factors responsible for the shift of $\delta^{18}O_{ruber}$ from the equilibrium isotopic composition are discussed. We believe that figure addresses the point raised by the reviewer. If not, then we will add another figure of the equilibrium isotopic composition.

Reviewer's Comment: Discussion. The discussion is very descriptive. The discussion needs improvement. So I recommend the authors to review the recent literature. Some aspects of interest are distinguishing between s.s. and s.l. morphotypes and how it affects oxygen isotopic composition, depth of calcification of G. ruber in the Indian Ocean and other oceans, symbionts and chlorophyll, carbonate ion, depth of lysocline i.e. dissolution, shell size. All these aspects will enhance the discussion.

Authors' Response: The discussion has been thoroughly revised in view of the comments by both the reviewers.

Reviewer's Comment: Please also note the supplement to this comment:

Authors' Response: The comments/suggestions in the annotated manuscript have been addressed and included in this rebuttal.