

Comments on manuscript by Gaye et al titled “**Glacial-Interglacial changes and Holocene variations in Arabian Sea denitrification**”

General comments

Gaye et al., have compiled available published data along with two new records from the Arabian Sea to demonstrate changes in the denitrification (using $\delta^{15}\text{N}$) and temperature (using M/Ca and Alkenones) for the past 25 ka. They have used two new cores (though supplementary data shows three) that has data for ~ 1 Ka in top section, data missing from 1 to 5.6 ka and extrapolated up to 6.1 ka without any dates. The second core also has no record between 2.5 to 5.7 ka with dataset going up to 8 ka. Gaye et al have explained glacial inter glacial variations that is up to 25 ka. For the discussion and interpretation of the data they have combined the their data with other available data in 1 ka intervals but their data and most of the data they have used do not have age model tie points that can give resolution of 1 ka. There are also shortfalls while normalizing the $\delta^{15}\text{N}$ data with average taken for records ranging from 68 years to 25 ka (please see detailed comments age model). I find that most of the interpretation of data is already given by respective published papers. Moreover the temperature and denitrification signals are subdued due to combining dataset region wise (with limitations of dates to give 1 ka accuracy). I would suggest to authors to restrict to Holocene where they have new data (with some additional dates within the hiatus and lower part of the core)

Specific Comments.

Abstract

Please modify to give clarity to readers.

e.g. Ln 19-20 “Sediment cores show..... (from which area)..... in other regions (which other regions).

I would suggest to give general trend rather than compiling the data set in 1 ka intervals and restrict to Holocene. Derive interpretation based on your record (so that there will be something new in the data) and then compare with other records.

Introduction

Ln37-38 Add reference

Ln39 respond to external perturbation (like what?)

Ln 41 rate measurements?

Ln 42 Water mass age or O_2 consumption?

Ln 57-59 Only in certain areas of the world ocean.

Please also add processes like incomplete utilization due to advection, diagenetic effect etc..

Ln. 70 Please add “e.g.” before Glabraith et al., 2013, as there are many papers stating low denitrification in the Arabian Sea

Ln 77 Please add “e.g.” before Glabraith et al., 2013

Ln 78-80 Not clear, How decrease in iron supply at the end of LGM can increase d15N during LGM [but in Ln 69-76 you discuss decrease in d15N]

Ln 83-87- This is a different process compared to open ocean denitrification on which your manuscript is based. It is bit confusing here- if you want to mention about it elaborate a bit so that readers can understand.

Ln 89 Please add “e.g.” before Glabraith et al., 2013

Ln-87-89 Is it because of the shallower depths where OMZ is located in Pacific compared to Arabian Sea?

Ln94- Please mention age range (see if you could restrict to Holocene)

Ln 117- Somali, Oman and SW coast of India

Ln 129-130- do you mean IOCW

Ln 133- please add reference (present day or Paleo ?)

Ln 134- The intensity of the OMZ and denitrification (add Ref.)

Ln 142- Add Naqvi et al, 1990 DSR, 37, p593-611; Shetye et al., 1990 J. Mar Res, vol 48 p 359-378

Ln141-145 Naqvi et al., says central Arabian Sea has high denitrification (present day) please correct

Ln159-160 Please see Banakar et al., 2005 high productivity during LGM (Since you are discussing whole Arabian Sea, please discuss this if you take data up to 25 ka--- Please correct the data d15N to Banakar et al., 2005 (Banakar et al., 2010 is wrongly quoted in the supplement)

Ln. 162 Add some Ref. From the eastern Arabian Sea like Naik et al., 2015 GRL, 42, p 1450-1458, Rao et al., 2008, P3, vol 270, p 347

Ln 166 May be in the east, but Naik et al, 2014, Holocene, p 749-755 suggest increasing denitrification

Ln164-166 – Boll et al during Holocene Stable OMZ and Ln 172-174- Ball et al during Holocene changes in the OMZ intensity – Plz correct

Sample Collection

Ln 183- Sampled -do you mean subsample of the core or samples analyzed?

Please add total nitrogen data.

Ln 215 Please add more AMS dates if you want to discuss at 1 ka interval changes

Age Model

Some part of the data is missing in the supplement please explain how you came to the point of hiatus, it could be slumping of the part of the sediment as your core is located on the slope region.

Please also check models of the other cores used. E.g. Banakar et al., 2005 (you wrongly quoted as 2010) do not have single age

By comparing the Age models of the respective cores you may consider larger time slices

Did you digitize the data? Please mention or source from where you have got the data.

Ln 255-256- Though you have taken four to seven individual curves all data does not cover 25 ka.

Ln 234-235 When you binned time slices please check age models and dates of that particular core

There is another problem with normalization of d15N (Fig. 6)

- 1) record is for past 68 years – Normalized with d15N average of 68 years
- 2) record starts at 6 ka ends at 25 ka – Normalized with Average
- 3) record with missing data 1ka to 5.69 ka – Normalized with Average
- 4) record with 16 to 24 ka- Normalized with Average
- 5) record with 10 to 23 ka -Normalized with Average
- 6) record from 0 to 25 ka - Normalized with Average

There are many records with many combinations my point is “how can you use avg. d15N for the each data set that is not representation of avg of 25 ka”

Water column d15N values changed within past 25 ka and combining and taking average will give biased values.

Results

Please explain your new data that will be new in results

Discussion

Ln 304- Add NMC in the Figure

Ln 310- Fig. 4a you get this pattern because world atlas does not have data from the eastern Arabian Sea. (Please see the data of the World ocean Atlas)

Ln. 314 “Shut down” I think this is too old reference

LGM taken as 18 to 25 ka and Glacial SST is given at 17-18 (its bit confusing) please explain why this particular time 17-18?

Ln. 330- Please also add clockwise circulation and upwelling by ekman pumping

Ln333- remove inactive

Ln 336-338- There is upwelling in the northern Arabian Sea off Pakistan?

Ln 334- IS2 expand

Ln356-360- not very clear to me

Ln360-362 Why Oman and Somali upwelling are different during B-A event

With limitations in ages (dates) it will be premature to comment on delayed response of the ocean

Ln-378 – Glacial (17-18 ka) is it not end of glacial?

Ln 408- eastern Arabian Sea- it is because of the data, see kessarkar et al., 2013 clearly shows d15N variations during B-A event.

440-441 HIGH PRODUCTIVITY IS DURING THE SW MONSOON AND low saline water from the Bay of Bengal comes during North east monsoon. Please don't combine the two.

Ln 442-444- Undercurrent Ref. Naqvi et al., 1990 and Shetye et al. 1990

About the undercurrent and oxygenation is mentioned by Kessarkar et al., 2010 and 2013 please use the appropriate reference.

Ln 469- Do you mean southwestern Indian Coast ?

Low Organic carbon in the model may be due to lack of data. High Organic carbon is observed from 15°N to 7°N during LGM cannot be local.

Conclusions

High productivity is during the sw monsoon –when currents are in clockwise direction AND low saline water from the Bay of Bengal comes during North east monsoon-when currents are in anticlockwise direction. Both cannot take place at the same time!

Conclusions looks more like continuation of discussion, please try to be specific.

Ln491 Why Bay of Bengal here?

References:

Some references mentioned in the text and figures are missing.

Figures

Fig. 3- too clumsy-

Fig. 4 Is there any specific reason for choosing 17-18 ka please take full LGM

Fig. 6-TOC does it cover entire Arabian Sea?

30°N for which month and reason for choosing this month?