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Interactive comment on "Glacial-Interglacial changes and Holocene variations in Arabian Sea denitrification" *by* Birgit Gaye et al.

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General Comments Gaye et al., studied changes in the Arabian Sea denitrification on glacial/interglacial and millennial scales and within the Holocene period and demonstrated how the intensity of denitrification coupled with OMZ intensity varied spatially across the Arabian Sea. They also discussed various plausible causes/mechanism (atmospheric and ocean circulations) for temporal and spatial variations in denitrification and the OMZ using sedimentary δ 15N and SST records. In this effort, authors used their two new sediment cores data from Oman upwelling region and previously published records. Authors suggested that the present OMZ pattern with intensified denitrification in the northeastern region evolved during the late Holocene induced by the intensification in the winter (NE)monsoon coupled with reduced inflow of Bay of

Bengal low-saline water. But, there are certain vital issues remain either unaddressed or less focused while drawing inferences based on various proxies considered in this paper. Specific Comments: Abstract Authors should provide timings (kyr) of events or intervals of major changes, instead of using early, late Holocene, interstadials, stadials etc; as they have data sets with well time constrained. And this approach should be followed through out the manuscript, wherever relevant. 1 Introduction Page3, 51-52; . . ...during the transition from the last deglaciation to early to mid-Holocene (please mention time interval ?) due to adjustment to changes in ocean circulation and nutrient as well as trace metal supply from land. Variations in Sea level and wind/atmospheric circulation my also have significant influence on nutrient supply ?

2 Material and Methods 2.1 Study Area Page 6, 120-126; please provide data of present day water masses (RSW, PGW) characteristics such as salinity values and O2 concentrations and extent of present day distribution. If possible; add one figure showing surface and deep ocean circulations in the Arabian Sea Page 7, 147âĂŤ148; In general, oxygen deficient conditions enable denitrification below 100 m (up to what depth ?) in the Arabian Sea (Gaye et al., 2013a). It has been suggested that nitrate reduction occurs between 100 and 500 m depth (Brandes et al., 1998; Ganeshram et al., 2000).

Age Model: (i) Readers would be interested to know the ages of early/ middle, middle/late Holocene boundary. I would prefer to follow concept of Walker et al. (2012) for subdivisions of the Holocene Series/Epoch. I suggest authors should add in the text few lines on this aspect . Also, cite reference for ages of millennial scale climate events used in discussion. (ii) Please elaborate a little bit how a hiatus was identified. 2.4 Integration of averaging of SST and d 15N reconstructions: p.10, 228-229: Authors have missed an important reference (Anand et al. 2008 ;Paleoceanography) and probably this is the first Mg/Ca-SST record from the eastern Arabian Sea. I feel data of Anand et al., 2008, should be included in Table 1, and figures and discussed in the manuscript. 3 Results General: Authors often used words like Glacial; last Glacial, (capital 'G' ?)

; and sometimes IS, IS 2; warm IS 2. ...I am really confused with usage of these terminologies and inconsistency throughout the MS . In order to have more clarity; I suggest authors to be precise and mention ages and age intervals and should have consistency throughout the manuscript. P. 13, 289-290: The d15N values increase between. . .. .. . .8ka BP (Fig.6). I think authors are referring to Banakar et al., 2010 eastern Arabian Sea record. Please note that this core comes from much below the OMZ . Please refer core MD 131 (Ivanochko; work) located near lower OMZ. Another important feature of Figure 6 is a close similarity in patterns between northern Arabian Sea record and GISP record: this feature should be incorporated and discussed in the text. 4. Discussion 4.1 P. 13, 301-304: In winter, the WICC (West Indian Coastal Current) reverses and the Northeast Monsoon Current (NMC) transports waters from the Bay of Bengal (BOB) into the southeastern Arabian Sea up to 130 N (Sarma, 2002; Shankar et al., 2016) only. The high-salinity water (Arabian Sea Water: ASW) is generated in the northern Arabian Sea in winter and spreads southward to the equator with its core at a depth of about 200 m (Kumar and Prasad, 1999; Schott and McCreary, 2001). P.14, 309: Fluvial runoff from western Ghats in summer produces low salinity surface condition in eastern Arabian Sea. This would be another factor for surface water stratification and warming. P.14, 313-317; Are you sure that upwelling was shutdown during the Glacial (I think you mean LGM ?) ; please see Anand et al., 2008. Furthermore , Anand et al 2008 , recorded low-salinity event in the eastern Arabian Sea during the LGM. P.14, 328-329: I do not agree. Anand et al (2008) demonstrated that the patterns and amplitude of SST and SSS changes in off Somali and eastern Arabian Sea varied.

P.15, 343-345: It is again confusing; earlier you stated that upwelling reduced during glacial; Is 22-23 ka event is interglacial or warm interstadial ? I think it is part of the LGM; what could be probable factors for upwelling increase during this short period ? P.15. 351-352; Do you find this temp minimum event in all Arabian Sea records; I think it is not the case in the eastern sector. Please check ? 4.2 P.17, 390-393: The glacial Arabian Sea quickly switched to enhanced denitrification when the SW-

monsoon strengthened . . .. Please be precise with the age of this major switch. Do you mean the warm phases of late glacial or deglaciation ? P.17, 401-406 : Naidu et al (2014, G-cubed) recently suggested intrusion of AAIW (Antarctic Intermediate Water) into the Eastern Arabian Sea and enhanced ventilation during cold Heinrich events. Therefore, this could be an additional factor for a weak OMZ and reduced denitrification. P.18, 407-408: Please explain why there is no increase in Eastern Arabian Sea ; probably due to high fluvial runoff factor ? P. 18, 413-420: Authors record a weak OMZ and enhanced upwelling during 5-9 ka BP and that they related to intensified IOCW inflow. What are plausible factors/hypotheses for increased ventilation during this period. Do authors have some evidence supporting enhanced ventilation through IOCW? P.21, 489-491: In the eastern Arabian Sea (please see unpublished Ph.D thesis of T.S. Ivanochko); denitrification was significantly reduced during cold glacial phases (Heinrich events); not during LGM. General comments: (i) While interpreting d15N records,; authors should also discuss various probable factors that may influence sedimentary N isotope variation such as : incomplete nitrate utilization, Fe limitations; organic matter mineralization in water column and terrestrial input etc. (ii) authors may also consider the hypothesis of changes in Atlantic Ocean overturning circulation driving the nutrient level in subsurface waters (Schmitter et al., 2007).

Minor comments: Please check that references of figures given in the text are correct and properly placed. There should be consistency in naming of sediment cores. Many references cited in the text are not in Reference list and there are references in list not cited in the text. Please check. Page5, 93. . .history of mid-water oxygenation (what depth interval ?) over the last 25 ka. Page6, 126-129; what is depth of IOCW core in the Arabian Sea ? Page6, 132-133; Progressive oxygen loss . . .. .Arabian Sea (Ref. ?) Page7, 136-146; I understand that in these lines, authors tried to explain how monsoon wind induced seasonally reversing currents produce spatial changes in oxygen deficient waters and renewal process in the Arabian Sea . I think these sentences to be restructured, so that readers could easily follow. Line 141; . . .a northward flowing undercurrent (please name the current). . .. P.15, 333: What do you

mean by cold phases of glacial ? I think you are referring to Heinrich and stadials events ; Please be specific and mention ages of those events. P.15, 336-338: Authors are contradicting to their previous statement (lines 332-335) where they said that low temp off Oman related to intensification of NE monsoon. P.15. 345-348: I do not understand this sentence ? What are those upwelling indices used by previous workers ? P. 16, 365-368: Please cite original references. P. 18, 410-411 This implies. . .. . ..in the entire basin. But, you stated earlier that eastern Arabian Sea is responding differently? Table 1 Include SK 17 (eastern Arabian Sea) and 905 (Somali) Mg/Ca SST data from Anand et al., (2008, Paleoceanography) in Table 1. Figures If possible, add surface and deep ocean circulation in Figure 2 or show separately as a new figure. Fig. 3: YD, H1, LGM should be shown with color bands. Holocene subdivisions (early, middle, late) should be marked . Figures 4 and 5 have two panels representing present scenario and 17-18 ka BP. The time-slice 17-18ka BP represents onset of deglaciation after the LGM; when a rapid, major shift occurs. I think authors should briefly state this feature in caption. This would help authors in justifying why they chose this time slice to compare with present day.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2017-256/bg-2017-256-RC2-supplement.pdf

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