

Interactive comment on “Seasonal and interannual variations of the nitrogen cycle in the Arabian Sea” by T. Rixen et al.

Anonymous Referee #2

Received and published: 18 February 2014

General comments

I suggest to the authors that as part of revision process that they give a careful read of their ms. There are a number of indications (i.e., odd grammar; logic jumps that rely too much on the reader to intuit the intended meaning) that suggest a quickly developed document that was not subjected to a careful final editing pass prior to submission. I have noted a number of these occurrences, but authors should make concerted effort to fully identify and rectify these.

Overall, this is a very interesting line of research and I look forward to seeing it appear in the literature. I believe it will be very well-received by the Indian Ocean research community.

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Specific comments

Page 19542, lines 1-3. Please clarify this statement. It could be interpreted to mean that the paleo record preserves signature of N₂.

Page 19542, lines 8 and 9. This statement is a bit awkward. First, should say “was 63% larger . . .”. Also a bit unclear on the date. I consider the meaning to be that based on JGOFS data from 1995, the SNM was 63% larger than a similarly determined estimate based on all pre-JGOFS (or is it largely IIOE-period) observations. Also, please make it clear whether the 63% increase is reflecting the areal extent of the 2-D expression of denitrifying waters (i.e., Fig. 1) or a volumetric estimate. This statement is drawn directly from the text (page 19554, lines 16-18), so need to modify both similarly.

Page 19543, line 18. Specify that this is oceanic. I.e., “global ocean’s water-column . . .”. OMZ is not defined in the text at this point, just in the abstract.

Page 19544, line 3. Should clarify by noting “these additional reactions . . .”. Minor point but would reduce reader’s need to successfully interpret.

Page 19544, line 24. This description is confusing. How do SE winds become the southwesterly winds of the SW Monsoon that flow over the Arabian Sea? The cited figure (Fig. 1) does not show sea surface wind vectors and does not extend down to the equator.

Page 19545, lines 1-4. The SWM can not be said to replace the NEM (or vice versa). The transition one to the other and back both occur through ~ 2-month Intermonsoon. I realize authors are fully aware of this monsoonal cycle, it is just that the description here needs to be more carefully and precisely stated. Simplest fix would be to say SWM represents a reversal of the winds from NEM period, or something to that effect.

Page 19545, lines 7-11. Suggest splitting this sentence into two. It is rather complex and a challenge to follow in current form, and information is in a disjointed order. The point is to note that the core OMZ is not directly beneath the most productive waters.

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Page 19545, lines 3-20. The characteristics of the ICW needs to be clearly and carefully documented here. A bit more comprehensive background from the cited literature would be useful. It is particularly unclear from what is stated here whether the ICW is oxygen-enriched (line 12) or oxygen-depleted (line 16) when their influence on SNM manifests. Narrative suggests that ICW evolves toward oxygen-depleted state as it progresses eastward

Page 19545, lines 20-22. This statement on IODW impact to water mass balance is an interesting injection and has relevance vis a vis maintenance of the OMZ. A bit of an expansion could be useful as a way to provide global consequence and linkage of IO to global ocean, and past/early efforts (e.g., (Warren 1994)).

Page 19545, line 24. Would be useful here to re-state the time frame of this cruise.

Page 19547, line 17. "concentrations increase within ..." would be better stated as "concentrations increase in conjunction with ..." or something similar.

Page 19548, line 13. "support currently" would be better stated as "lend support to".

Page 19549, line 27. Statement seems incomplete. Seems that meaning is "an increase in N^* of ..." is what is intended. Page 19551, line 15. The last portion of this sentence is confusing, but seems to be through a need for some punctuation (i.e., insertion of commas -> "and, until the peak of the SWM, also in (the) SNM."). I would also suggest that authors follow up this statement to reinforce/clarify whether what they are reporting is that the SNM oxygen concentration is augmented by ICW or that the westward expansion of SNM signature is inhibited. Basically, the current statement may be attempting to convey several messages that get confused when kept in a consolidated statement.

Page 19552, lines 3-4. This sentence needs revising so that its meaning is clear.

Page 19553, line 1. Please give the time frame used in performing the SST averaging. Documenting precisely how this cooling index was determined will be very interesting

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for readers interested in using this method to further explore the climate - monsoon intensity connection in their own endeavors.

Page 19554, line 12. End of this sentence seems incomplete. Please fix.

Page 19554, line 26. The low oxygen waters are from open water OMZ as well as Indian shelf waters I would think. Clarification needed here.

Page 19555, lines 1-9. The concepts here are really intriguing and need to be precisely/clearly articulated for the reader's benefit.

1) "An associated reinforced propagation of ICW increases the transport of accumulative denitrification tracers from the SNM into the upwelling region ...". Transport of accumulative denitrification tracers here means that stronger ICW will fuel surface production with subsequent export and oxygen utilization -> DNF at depth for the SNM waters being drawn into the coastally upwelled waters??

2) "from Indian Ocean into the Arabian Sea.". Need to refine this statement, since Arabian Sea is part of the Indian Ocean. More specific geographic descriptors are needed to set the source of these ICW waters.

I would suggest fleshing out the paleo climate connections. In particular, during weaker monsoon there would also be reduced production and export, and therefore, oxygen demand at depth. How does this feedback into the scenarios considered in these closing remarks?

Figure comments

Figure 7. Suggest enhancing the labeling on the SWM panels for clarity. For the distribution shown from the 2007 cruise, the label in lower left is "late 2007", which could be confused to mean latter part of year rather than late SWM as intended. Including SWM and year in all of these distributions (i.e., early SWM (1995) etc.) would make this straightforward to follow.

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For sake of consistency, could similarly label all the panels of figure 7 (and possibly figure 4).

Suggested References Warren, B. A. (1994). "Context of the suboxic layer in the Arabian Sea." *Proceedings of the Indian Academy of Sciences-Earth and Planetary Sciences* 103(2): 301-314.

END OF REVIEW

Interactive comment on Biogeosciences Discuss., 10, 19541, 2013.

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