

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

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This manuscript is on the seasonal and inter-annual variability of the oxygen minimum zone and biogeochemistry of the Arabian Sea OMZ.

The manuscript is in the seasonal an interannual variation of the secondary nitrite maximum (SNM), which occurs at the top of the OMZ.

The authors are trying to establish that the OMZ of the Arabian Sea has expanded over the years and have also included some aspects of N cycling processes in the region. Based on the available data in 1991, Naqvi (1991) demarcated the region of the SNM, thereby the OMZ of the Arabian. This would give an approximate feel for the geo- graphical extend of the Arabian Sea OMZ. By no means this was the limit or exact

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boundary of the OMZ, due to paucity of data. The geographical extend of this zone depends on the intensity of the upwelling and thereby the productivity that supplies organic carbon load to the mid depths and the physical forces that supply DO to the western Arabian Sea, as rightly pointed out by the authors themselves. The main focus of this manuscript is to show that the Arabian Sea OMZ has increased by 63%. Due to paucity of historical data and seasonal and interannual variability of this feature, the authors have not convincingly shown that the OMZ has expanded. Dissolved oxygen by Winklers method is not sensitive enough to address changes between 0 and 5uM. Recent results from the OMZs show that the DO concentration in the core of the OMZ is essentially zero (Dalsgaard et al 2012).

response: Here are some misunderstandings: 1) The manuscript is on the seasonal an interannual variation of the secondary nitrite maximum (SNM), which occurs at the top of the OMZ. Nowhere in the ms we ever defined the OMZ as layer characterized by oxygen concentrations between 0 and 5uM and used this or a similar definition to discuss seasonal and interannual variation of the OMZ. 2) Naqvi (1991) demarcated the region of the SNM, and mentioned problems caused by the paucity of historical data. We first added US JGOFS obtained in 1995 to the ones which were used by Naqvi in 1991 and concluded that: (see e.g. the abstract) the area, which is characterized by a pronounced secondary nitrite maximum (SNM) was by 63% larger in 1995 than (known) before (1991). Due to the strong seasonal and interannual variations of the SNM as shown within the ms, we believe that even the expanded data set presented in the ms is still insufficient. We therefore refrained from postulating an expansion of the SNM due to natural processes.

Dissolved oxygen by Winklers method is not sensitive enough to address changes between 0 and 5uM. Recent results from the OMZs show that the DO concentration in the core of the OMZ is essentially zero (Dalsgaard et al 2012). Nevertheless, a major portion of the discussion is on the changes in DO concentration in the OMZ in the low range.

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response: During the JGOFS expedition the Winkler methods was improved and revealed a precision of better than $2.3 \mu\text{M}$ (see Morrison et al 1999). The methods used during the JGOFS expedition are described also in the WOCE Report No. 68/91 and the JGOFS protocol 19. According to chapter 3 in the "JGOFS protocol 19" Dissolved Oxygen was measured by a SBE 13-02 (Beckman polarographic type). The range of the SBE 13-02 was 0-15 ml/l (0 – 670 μM) and the resolution was 0.01 ml/l (0.45 μM). During our cruise we used a SBE 43 is the latest version of SBE.

Although the focus of the manuscript is the expansion of the OMZ, the introduction is all on N cycling.

response: The introduction is on N cycling because the ms is on N. More specifically on the seasonal and interannual variation of the secondary nitrite maximum (SNM). The SNM often occurs in the upper part of the OMZ and is considered as core of the denitrifying zone. Denitrification is considered as one of the main processes controlling the N cycle.

The manuscript provides no new insights in understanding the biogeochemistry of the Arabian Sea OMZ,

response: not exactly it is on N cycling and that is why the introduction is on the N cycle and most of the data presented in this manuscript has been published previously,

response: It is correct, the number of historical data used here exceed the number of data we contributed to the overall data set. Data sets suitable to study temporal changes of important processes such as denitrification are crucial to better understand global change. Considering the paucity of data due to which so far no hypotheses on the long-term trend of the SNM can be proven, we instantly hope that the used data set will continue to grow. However, the ratio between the number of historical and newly added data is to our understanding no argument against a publication presenting additional data and new insights into important processes.

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hence I am not in favor of publishing this manuscript

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