Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2018-252-RC1, 2018

Biogeosciences Discussions

Interactive comment on "Remote and local drivers of oxygen and nitrate variability in the shallow oxygen minimum zone off Mauritania in June 2014" *by* Soeren Thomsen et al.

Anonymous Referee #1

Received and published: 24 August 2018

This manuscript describes a series of glider and ship-borne hydrographic and biogeochemical measurements in the oxygen minimum zone (OMZ) off Mauritania. Through a series of cross-shelf glider transects between 13 and 26 June 2014, the authors show highly variable oxygen distributions within and around the shallow oxygen minimum. Using analytical tools (OMP, etc.) and an outstanding set of biogeochemical data, they identify the role of local (remineralization of organic matter) vs. distant (penetration of the relative oxygen-rich SACW) drivers of the oxygen distribution. The manuscript is well written, the data set is extensive, the analytical methods are clever and useful, and the results are interesting and relevant for the dynamics of the OMZ. I can definitely support its publication but some concerns have to be addressed first. In my opinion,

the main weakness of the manuscript is the lack of dynamical insights. From my point of view, the paper would be much improved by including a description of the circulation patterns in the area and a discussion of their relation to the oxygen distributions. Other than that, I have only some suggestions for the improvement of some particular points and minor comments.

GENERAL COMMENTS: - As reported in previous studies, the authors claim that the ventilation of the upper thermocline waters is mainly driven by the "remote" supply of SACW with the boundary currents along the African shelf. The dynamics of these currents are described in the introduction, and also mentioned in the discussion in relation to their representation in ocean models. However, in the manuscript, the remote ventilation of the OMZ by SACW is only studied with an "static" interpretation of the water masses distribution. I miss a more dynamical characterization of the study area at the time of sampling. Could you show some ADCP velocities to illustrate what is the mean circulation during the glider samplings and the impacts on O2 distribution? In figures 3 and 4, strong isopycnal tilting is observed at the shelf break, suggesting some meridional flow. Does this relate to the observed high-oxygen anomalies associated with the penetration SACW or with the location of the OMZ?

- I also have some concern regarding the description of the oxygen anomalies in relation to the proportion of SACW. From Figure 4 it seems that the relationship between relatively high-oxygen concentration and the presented distribution of SACW is by far not univocal. For example, the lowest oxygen concentrations close to the shelf break between the 26.1 and 26.28 isopycnals coincide with high proportions of SACW. The TS diagram (Fig 2) and the distributions of the different variables (Figs. 3-5) seem to suggest that the ventilation of the study area is carried out mostly by the densest variety of SACW. I would suggest to separate the contribution of both SACW end-members in figure 4a,f,k and this would help to illustrate how the densest variety ventilates the area (if my interpretation is right). This is something similar as Peña-Izquierdo et al. (2012) did by defining local and a remote varieties of SACW.

- The authors describe a third type of oxygen anomaly (low oxygen with non-turbid offshore waters), but they do not describe their drivers in much detail. These anomalies are rather persistent and have some interesting characteristics: they are located just below the pycnocline, they are observed only with the OMP analysis, and generally associated with low contribution of SACW, but there is sometimes an enhancement of SACW in their core. These anomalies correspond generally to relatively high salinities, and I could associate them with the low oxygen values located along the line (15°C, 35.7 g/kg) – (16°C, 35.9 g/kg) in the TS diagram. With this information and some hint about the circulation in the area, the authors could speculate a bit more about the origins of this water body.

SPECIFIC COMMENTS:

1 – Section 3.1. Could the authors show the reference profiles for the AOU analysis and the polynomial fit in the T/S or O2/S diagram? I think it could help to the interpretation of some O2 anomalies and the differences with the OMP method.

2 – Section 3.2. I think a more detailed description of the OMP method would be desirable. I would like to see which equations have actually been solved. For example, how do you exactly implement the resolution of non-conservative tracers, do you solve the NO (NO = O2 + r*NO3, where N is the Redfield O2:NO3 ratio) (quasi-)conservative tracer? Also, what is the weight given to each equation?

3. Figure 4. Can you label the end-members in this figure? They are difficult to identify, particularly in panel B. The oxygen color scale in this figure is inverted with respect to Figures 3 and 4.

4 – Section 3.2, Figure 4 and corresponding description. The oxygen and nitrate anomalies obtained with the AOU and OMP methods have different definitions of the zero value, which makes a bit difficult to identify differences between both methods. You could solve that by choosing different predefined O2 values for the end-members used to compute the anomaly. Instead of using the extreme values (highest oxygen

concentration around the end-member) you could use some measure of the mean O2 value around each end-member. This would make the OMP anomalies more evenly distributed around zero.

5- Section 4.1. I would suggest to briefly outline in the text how the distributions in Figure 3 were generated. You could also show the distribution of mixed layer depth in Figure 3, as it is extensively described in the text.

TECHNICAL CORRECTIONS:

P4 – L24: “low frequent” → “low frequency”

P6 – L17: “See also (Yücel et al., 2015) and (Fiedler et al., 2016) [...]” → “See also Yücel et al., (2015) and Fiedler et al., (2016) [...]”. There are a number of other references for which the parenthesis are not properly placed, particularly in the discussion section. Please revise them: P20 – L9, P21 – L2, P21- L13.

P11 – L7: Add a reference to Figure 3b at the end of this sentence: “Highest absolute salinities of 36.08 g/kg were found offshore (> 60 km) and just below the mixed layer at 30 to 35 m depth associated with the STUW.”

P11 – L19: Add a reference to Figure 3d at the end of this sentence: “NOx concentrations towards the surface of up to 30 μmol kg$-$1 are found at 250 m 115 km offshore”

P14 – L11: “The OMP method reveals a a higher respiration [...]”, please remove one “a”

P16 – P5: “ The continues* advection of SACW from the south via the boundary current system is an oxygen source for the density levels discussed here”, continues→continuous

P17 – L12: “[. . .] at 150 m depths”, remove depths

P21 – L11/14: “Nevertheless it is important to note that we observe high concentrations of DOC at the outer edge of the transect pointing the importance of offshore DOC

transport as already suggested by (Alvarez-Salgado, 2007) for the northern part of the upwelling area": important → importance, (Alvarez-Salgado, 2007) → Alvarez-Salgado, et al.. (2007). This reference is incorrect in the reference list, there are multiple coauthors of this paper.

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-252, 2018.