

## ***Interactive comment on “The suspended small-particles layer in the suboxic Black Sea: a proxy for delineating the effective N<sub>2</sub>-yielding section” by Rafael Rasse et al.***

**Rafael Rasse et al.**

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Dear reviewer,

Thank you very much for spending part of your valuable time reviewing our manuscript. We also thank you for your constructive feedback because it allowed us to improve the original version of the manuscript. Below, you will find our answers and actions taken for each of your comments.

King regards,

Rafael Rasse Hervé Claustre Antoine Poteau

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## Comment #1

What is the typical depths ??

Are these depths vary among different ODZs?

Answer. OK

Action taken. This sentence was modified. We indicated the depths at which this layer can be found. This information is based on data from The Black Sea (this study), and the ODZs of the Arabian Sea and ETSP (Whitmire et al. 2009; Wojtasiewicz et al. 2018).

## Comment #2

Are these factors listed in order of their importance?

Answer. According to the literature, we consider this is the most likely order.

Action taken. No actions were taken.

## Comment #3

Will not the chemical composition, salinity and temperature of water column would also matter for resultant optical visibility / abundance of anammox and denitrifying bacteria ??

Answer. Organic matter composition should be key driving the microbial activity (e.g. anammox and denitrifying bacteria, e.g. Van Mooy et al. 2002) but this not be critical for our case (see line 165 in the old manuscript and the cited work). We mentioned an array of chemical variables (levels O<sub>2</sub>, NO<sub>3</sub>, and HS, OM) at the line 34 of the old version. We don't have information about salinity but T can affect their activity in sediments (e.g. Rysgaard et al. 2004; Canion et al., 2014).

Action taken. No actions were taken.

## Comment #4

Here authors are attempting to investigate measured Bbp layer (absorption ?) with chemical parameters such as O<sub>2</sub>, NO<sub>3</sub>, H<sub>2</sub>S and N<sub>2</sub> produced.....all chemical parameters is there any way to provide Bbp thickness and its absorption correlation with actual density of microbial mass...(just wondering samples collected on filters??)

Answer. We did not have such data .

Action taken. No actions were taken.

Comment #5

How much thick it is?

Answer. It can be highly variable with time, and between ODZs and anoxic basins. Please see section 4.1, where we indicate the thickness of the bbp-layer for the case of the Black Sea.

Action taken. No actions were taken.

Comment #6

Suppose this factor is negligible in some locations ??

Answer. Please, see how the ventilation of subsurface O<sub>2</sub> defines the characteristics of the bbp-layer and how we used such information to explain what are the main particles contributing to its formation (e.g. section 4.2).

Action taken. No actions were taken.

Comment #7

why ? what is another factor for second sub-zone?

Answer. This is related to the biogeochemical processes that control the content of suspended small particles and N<sub>2</sub> excess in the chemical zones of the poorly-oxygenated water masses. This is better described in the new version of the manuscript.

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Action taken. We included a new “background section” to describe the key biogeochemical processes and associated inorganic-biogenic particles contributing to the formation of the bbp-layer. The interlinks among biogeochemical processes, and the vertical profiles of small-particles and N<sub>2</sub> excess are described in the discussion as well.

These changes are highlighted in yellow in the following lines of the new version: - 71-94, 171-197, and 207-230.

Comment #8: Sentences highlighted in yellow without suggestions

- of chl and bbp and due to particle

Answer. Both spikes are due to particles-aggregates. We thus consider this sentence is OK

Action taken. No actions were taken.

- o free-living bacteria (0.2-2  $\mu\text{m}$ ), and those associated with small-suspended particles (> 2-20  $\mu\text{m}$ ).

Answer. These ranges of particles size are explained in the introduction.

Action taken. No actions were taken.

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- hypothesized

- Optical proxies of tiny particles can be applied as an alternative approach to assess the vertical distribution of N<sub>2</sub>-yielding microbial communities in upper suboxic ODZs

- particle content inferred from bbp and N<sub>2</sub> produced by microbial communities are at least qualitatively correlated microbial communities in upper suboxic ODZs

- bbp and O<sub>2</sub> can be exploited as a combined proxy for defining the N<sub>2</sub>-producing section of the suboxic Black Sea

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- fluorescence and total backscattering were converted into Chlorophyll concentration (chl) and particle backscattering (bbp) following standard protocols
- HS- was not used to delimit the bottom of this zone because the maximum concentration of H<sub>2</sub>S that denitrifying and anammox bacteria tolerate is not well established.
- NO<sub>3</sub><sup>-</sup> and O<sub>2</sub> are two of the key factors that modulate the presence of denitrifying and anammox bacteria
- bbp-layer is partially composed of N<sub>2</sub>-yielding microbial communities such as anammox and denitrifying bacteria.
- bbp-layer is at least partially composed of anaerobic microbial communities involved in the production of N<sub>2</sub>

Answer. OK

Action taken. The sentences above were modified.

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Comment #9: Other sentences highlighted in yellow without suggestions

- How key drivers of anammox-denitrifying bacteria dynamics impact on the vertical distribution of bbp and the thickness of the bbp-layer.
- Optical proxies of tiny particles can be applied as an alternative approach to assess the vertical distribution of N<sub>2</sub>-yielding.
- Slightly sulfidic conditions of the deepest isopycnal at which anammox bacteria can be still recorded.
- It is still debated whether the oceanic nitrogen cycle is in balance or not.

Answers. Because it is not specified what are the issues with the sentences above; we assumed that these are only semantic issues.

Action taken. No actions were taken.

## References.

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Rysgaard, S., Glud, R. N., Risgaard-Petersen, N., & Dalsgaard, T. (2004). Denitrification and anammox activity in Arctic marine sediments. *Limnology and Oceanography*, 49(5), 1493-1502.

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