

## ***Interactive comment on “The temporal variability of oxygen inventory in the NE Black Sea slope water” by Alexander G. Ostrovskii et al.***

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We are very grateful to the Reviewer for a very careful reading of the manuscript and useful comments and suggestions. Below we list the comments together with our responses to them.

General Comments In this manuscript the authors present and analyze a extremely valuable dataset gathered from a moored profiler equipped with Doppler and oxygen sensors on the edge of the Black Sea North Eastern shelf. Based on this datasets, they address the issue of the short time-scales of variations for vertical horizons characterizing the density and oxygenation structure. Several recent publication have shown the timeliness of this study, in the context of Black Sea deoxygenation, as such detailed

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experimental data set provides the means to evidence diapycnal ventilation processes and to quantify the variability of bottom oxygen conditions on the narrow eastern shelf. As discussed extensively by other reviewers, the manuscript would gain a lot by revising the structure and language, and therefore requires substantial revision. However, we encourage the authors in tackling this effort since the materials and results absolutely deserves publication. Here follow some additional suggestions, and comments.

1. A major object of the manuscript (and a strong asset of the sampling approach) regards the characterization of the temporal scales of vertical oscillations. In particular, it is very interesting to perceive phenomena acting at time scales shorter than those typical of current sampling in the open sea sampling frequency (eg. Argo). I would suggest, as I think this is accessible, to analyze those time scales more robustly with spectral analysis tools, applied, for instance on the time series of SOL, onset depth of hypoxia, velocity components a certain depth, etc.. This could feed the discussion by putting processes in relation with (ranges of) time scales more clearly. Our respond: The inertial scale oscillations of the hypoxia onset depth were verified by using D. Thomson's multitaper method that became a conventional tool for time series analysis in Matlab. When used with Matlab's sptool the MTM also delivers the confidence intervals if the power spectrum estimate. In the revised ms, the spectral analysis is carried out for the data ensemble of the hypoxia onset depth of January 2016 when there was no gap in the data. The spectrum is plotted and inserted in Results as a new figure.

2. The discussion on oxygen inventory is somewhat confusing, since it may give, at a fast read, the impression that the observed variations in oxygen inventory are to be related to oxygen sinks/sources terms. It later appears that the variations in this oxygen inventory (integrated over depth) is mostly due to widening/thickening of isopycnals intervals, meaning that oxygen waters enter and leaves this particular water column laterally as waves displaces the isopycnal surfaces vertically. I believe this should be clarified earlier. Maybe (suggestion) the wording "local oxygen inventory" may serve this clarification. Our respond: We agree about the term "local" and inserted it at

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proper parts of the text. If our next research grant would be approved by Russian Fund for Basic Research, we hope to deploy two profiler moorings to get the data about the horizontal advection of dissolved oxygen. Perhaps, under international cooperation we can deploy at least 3 profilers to approach this problem more comprehensively.

3. Reporting on velocities : 1) I think there is a confusion in the directions given ' as referential for the velocities. 1a) cross and along-shore directions are switched in legend of Fig 3. 1b) the two direction given are not perpendicular ? Our respond: This mistake is corrected.

2) Could the authors consider the option to report velocities with intensity (magnitude) on one panel, and direction on a second panel (using a cyclic color scale). Our respond: We wanted to focus on the oxygen dynamics rather than the current variability although the latter is very interesting on its own right. The along-shore current component was much stronger than the cross-shore component. This could be shown by using angle histogram. Actually, we are analyzing the current meter data at companion moorings also operated in 2016, which unfortunately were not equipped with the oxygen sensors. The results will be published elsewhere.

Specific comments P1L9 : How the fact that the benthic habitat is small compared to the total Black Sea area does aggravate the stress of the ecosystem? Could you clarify this statement ? Our respond: The reference to the paper by A. E. Kideys (Fall and rise of the Black Sea ecosystem. Science, 297, 1482-1484, doi:10.1126/science.1073002, 2002) is added.

P2L1-2 replace "resistance" with "resilience". ' This sentence should be detailed and referenced. Our respond: The "resistance" is substituted for "resilience".

P2L3-26 Please rephrase this paragraph, the reading is somewhat unclear. (eg. 'downwelling in the coastal part and upwelling in the central part', or refer to curvature of isopycnal surfaces) Our respond: The style is improved.

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P3L25 the term "minimum" is unclear here. "minimum" is replaced by "more than"

P3L28 "Wind-induced upwellings, although .." ( add "-" and ",") Our respond: The style is improved.

P4L13 ".. deployed at a depth of approximately .." ( add "a depth of") Our respond: The style is improved.

P4L22 "smoothly worked" -> "worked smoothly" P5L26 week -> weak Our respond: Corrected

P7L24-26 -> a part of this sentence should go to methods Our respond: Done

Fig 6,7 I suggest to define the vertical referential used here in the methods (for instance referring to "normalized depth" or some similar wordings) , and to use this definition in the figures and captions. In addition, I'd indicate an horizontal mark at the mean depth of maximum density gradient, that is used as a reference. On the same topic: was a shift of vertical coordinates also operated for fig 11? if yes, please indicate so, if no, could you explain why ? Our respond: The estimates of the mean depth of the maximum density gradient re inserted in the ms (P.7 L.17, 26) Our respond: In Fig. 11, the Richardson numbers are plotted vs depth.

Fig 10: To support the discussion on this figure, it would be useful to get a ' similar picture for the cases  $Is_{14} > 3.5$ . Our respond: The figure is added.

References P1L25 Reference Stanev et al 1995 does not appear in the bibliography. Our respond: The missing reference is added.

P1L28 Capet et al 2004 does not appear in the bibliography, P1L28 Capet et al 2014 does not appear in the bibliography. Our respond: The missing reference is added.

P6L24 Middelburg & Levin 2009 does not appear in the bibliography. Our respond: The missing reference is added.

P7L19 Zatsepin et al 2011 does not appear in the bibliography. Our respond: The

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missing reference is added.

Please also note the supplement to this comment:

<https://www.ocean-sci-discuss.net/os-2018-91/os-2018-91-AC4-supplement.pdf>

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