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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "Effects of upwelling duration and phytoplankton growth regime on dissolved oxygen levels in an idealized Iberian Peninsula upwelling system" *by* João H. Bettencourt et al.

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We thank the Referee for his/hers comments that helped to greatly improve our manuscript. Below, we provide a point-by-point reply to the referee's comments.

Ref. #1: There is no mention to the numerical method to integrate the advection-reaction-diffusion Eq(1). Is it Eulerian, semi-Lagrangian, other? What about numerical diffusion, is it relevant?

Auth. : Eq (1) is solved online by the ROMS model itself, i. e., concurrently with the hy-

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drodynamic equations, following an Eulerian approach. The model splits the advective part in horizontal advection that is solved by a 3rd order upstream method and vertical advection that uses a 4th order centered method. The horizontal diffusive operator is harmonic and the reaction term is solved by an iterative method, with three fractional time steps to achieve implicit discretization of the biological interactions. The 1D model is solved in the same manner as we used the 1D version of ROMS to perform the simulations. Since the numerical schemes chosen to solve the equations are known to be over diffusive, we did not include explicit diffusion in the model; hence, numerical diffusion is the only source of diffusion in the simulations.

Ref. #1: Contrasting with this, Appendix A was very detailed. Is it necessary to include so many details to obtain a numerical fixed point when standard softwares (mathematica, matlab,...) makes the work easily? In any case I found this Appendix difficult to follow and I would ask the authors to smooth it out.

Auth. : We have dropped the details of the fixed point search and we have considerably shortened Appendix A to make it easier to follow.

Ref. #1: I think it can be helpful for the discussion if you show the full set of advection-reaction- diffusion equations with all the terms and not in different pieces (Eq (3-4), and all the discussion below). In particular, the way the authors address the air-sea exchange flux term was unclear for me.

Auth. : We have improved the way we present the model equations in the new version of the manuscript. All terms pertaining to dissolved O2, P and Z are now shown as one fully-developed differential equation for each species : please see equations (1) – (3) in page 4 of the MS. We have also rewritten the text and developed our explanations to better describe the Air-Sea exchange term.

Ref. #1: After reading several times, I do not understand Fig. 6e. Please clarify its meaning. Is it really helpful?

Auth. : Figure 6e displays the alongshore averaged concentrations of O2 for each binned value of the Okubo-Weiss criterion (OKW) . It is computed from the data of figure 6d by averaging the values in the map "horizontally", that is along the x-axis for a constant OKW level. It emphasizes the result that, on average, there are higher O2 concentrations in the rotation-dominated regions (OKW<0) as compared against strain-dominated regions (OKW>0); this information is not readily observable in figure 6d.

Ref. #1: In the discussion/conclusions section I missed some discussion on the relevance of the results of this work on permanent marine oxygen minimum zones

Auth. : Thank you for this pertinent suggestion; we have added a few words about this topic in the discussion section. The revised discussion now reads as: "In more permanent and extended OMZs, changes in physical forcing (e.g. wind regime) and/or biological structure can have dire implications for marine ecosystems and fisheries management. Indeed, the measured expansion of the Tropical Atlantic and Pacific OMZs (Stramma et al., 2008) implies a shallower upper boundary of the low O2 core and an increased sensitivity of the shelf oxygen levels to upwelling winds, which are indeed predicted to intensify with climate change (Sydeman et al., 2014). Future work could be focused on understanding this high sensitivity and on anticipating how it would affect the stability of the coupled-system in a changing climate."

Sydeman, W.J., García-Reyes, M., Schoeman, D.S., Rykaczewski, R.R., Thompson, S.A., Black, B.A., Bograd, S.J., 2014. Climate change and wind intensification in coastal upwelling ecosystems. Science 345, 77–80. https://doi.org/10.1126/science.1251635

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