Reviewer 4

I thank the authors for responding to my previous remarks in the revised manuscript. Largely, the changes that have been made are satisfactory. The revised version is clear and well structured. However, there are some typos in the manuscript, and I would like to suggest the authors really go through the manuscript several times including the text and figure. I still have some minor comment that might help to improve the manuscript. I suggest a minor revision before considering publication of this manuscript.

We thank the reviewer for her/his positive evaluation and reply below to the comments :

1. Where do the authors download the GFDL model results? Please add it in the data and code availability.

The model data has been directly provided by GFDL. The data that we use here will be made available on the GEOMAR data server after eventual acceptance for publication of the present study.

2. Line 251, the models presenting the poorest oxygenated water at 30S are GFDL025 and GFDL1. If I understand correctly, these models should be GFDL025 and UVIC model according to Fig. 2B?

The boundaries of the region used to compute the average oxygen profile in Figure 2B were indicated incorrectly in the figure caption (we apologize for that and thank the reviewer for picking that up). Figure 2B was not consistent with Fig 2C,2D,2E. The correct figure is now displayed. The text L251 is therefore correct.
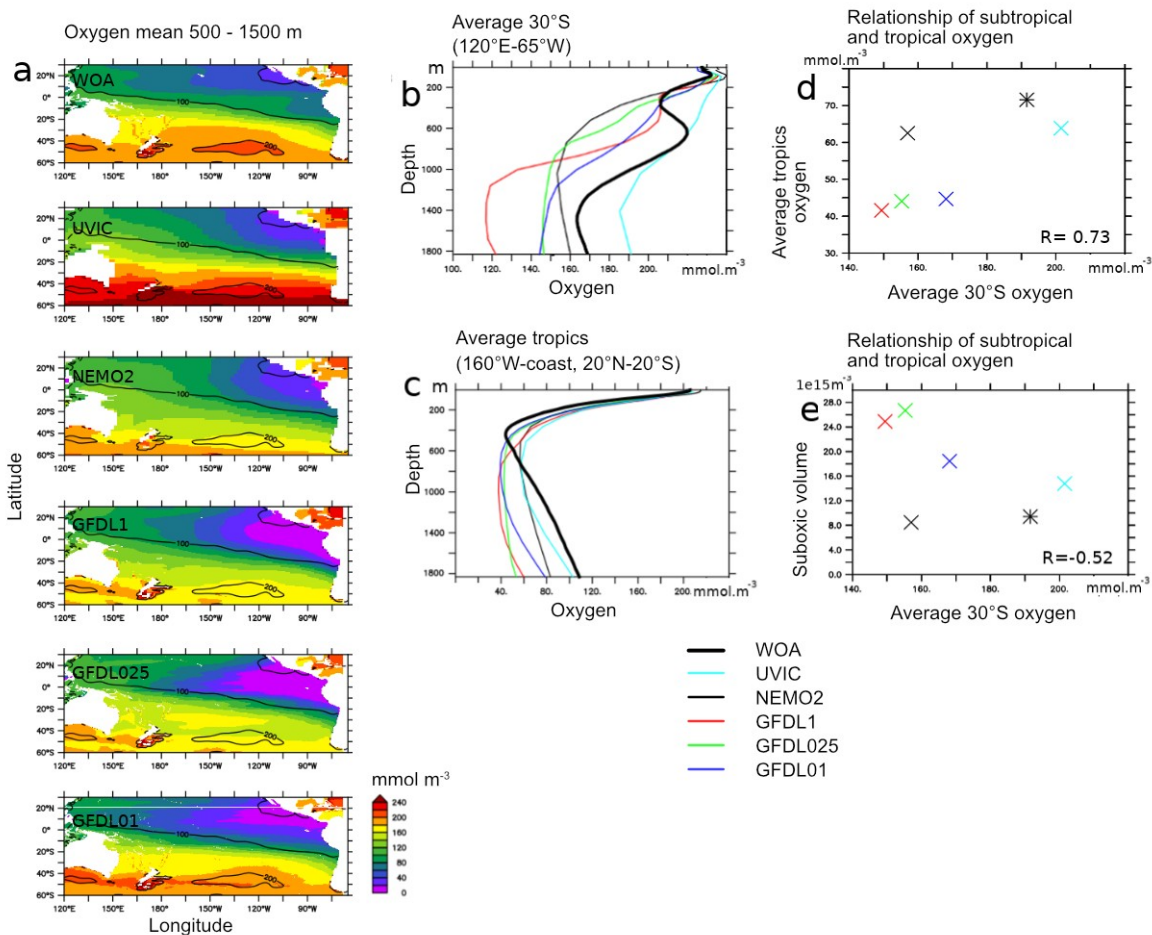
Figure 2 : a- oxygen levels (mmol.m^{-3}) in observations (World Ocean Atlas - WOA) (mean 500 – 1500 m) and models (UVIC, NEMO2, GFDL1, GFDL025, GFDL01). Contours correspond to WOA values. b: average "30°S" (120°E-65°W, 30°S) c : average "tropics" (160°W-coast, 20°N-20°S). d: average "30°S" vs "tropics". e: average "30°S" vs volume of tropical suboxic ocean (oxygen lower than 20 mmol.m^{-3}) regions (1e15m3). b-e : UVIC : black, NEMO2 : cyan, GFDL1 : red, GFDL025, green; GFDL01 : blue, WOA: bold line (b,c) and star (d,e).

We agree. Thank you for reading our manuscript very carefully – corrected.

We corrected the figure.

The model is forced poleward of 30°, i.e WOA data have been used. The difference in oxygen poleward of 30° is the difference between model and WOA.

L183 now reads "the oxygen boundaries are forced to observed oxygen concentrations (WOA) poleward of 30°N and 30°S, that is in the mid and high latitudes".

"Poleward" has been added L275.

The following sentence has been added to L267 : "The mean state 1997 – 2007 of each experiment is used in the analyses below."

We prefer to stay with Diff_iso as we think that separating Diff_iso in its x and y components in the equation introduces some complexity without clear benefits, as the two terms are merged together in the analyses. In terms of formalism, considering "small scale physics" as a single term is widely used, e.g see below (Gurvan Madec and NEMO System Team, *Scientific Notes of Climate Modelling Center (27)* – ISSN 1288-1619, Institut Pierre-Simon Laplace (IPSL)).

$$\frac{\partial T}{\partial t} = -\nabla \cdot (T\,\mathbf{U}) + D^T + F^T \tag{2.1d}$$

$$\frac{\partial S}{\partial t} = -\nabla \cdot (S\,\mathbf{U}) + D^S + F^S \tag{2.1e}$$

$$\rho = \rho\,(T, S, p) \tag{2.1f}$$

where ∇ is the generalised derivative vector operator in $(\mathbf{i}, \mathbf{j}, \mathbf{k})$ directions, t is the time, z is the vertical coordinate, ρ is the *in situ* density given by the equation of state (2.1f), ρ_o is a reference density, p the pressure, $f = 2\mathbf{\Omega}\cdot\mathbf{k}$ is the Coriolis acceleration (where $\mathbf{\Omega}$ is the Earth's angular velocity vector), and g is the gravitational acceleration. $\mathbf{D}^\mathbf{U}$, D^T and D^S are the parameterisations of small-scale physics for momentum, temperature and salinity, and $\mathbf{F}^\mathbf{U}$, F^T and F^S surface forcing terms. Their nature and formulation are discussed in §2.5 and page §2.1.2.

8. Line 339, I cannot see deep oxygen anomaly is upwelled in the eastern equatorial part of basin from Fig 3g. I would suggest rephrasing the word here. The text should rely on the figure. In addition, a vertical advection like Fig. 4g should be provided for experiment of NEMO2-30S30N1500M (you could plot it in the supporting information). I am curious about the vertical advection difference between nemo2_30S30N_1500m and nemo2_ref (similar to fig 4g).

We corrected the sentence L339 to "In the experiment NEMO2-30S30N1500, in complement to the isopycnal propagation of the subtropical anomaly, the deep (> 1500 m) oxygen anomaly is upwelled in the eastern equatorial (500 – 1500 m) part of the basin (see Fig 3g and Fig S1)."
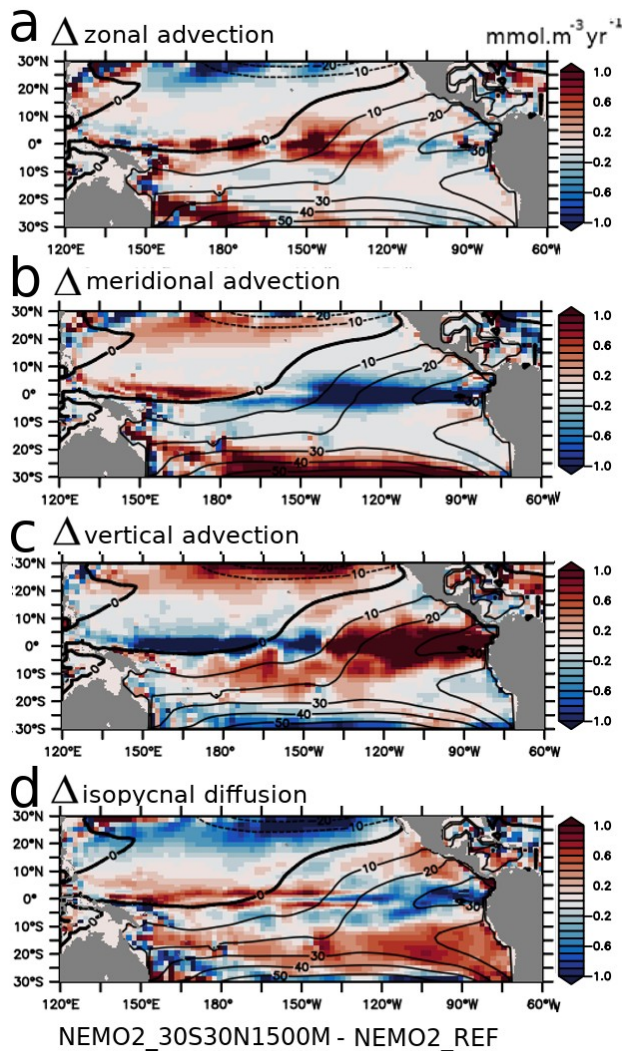
a Δ zonal advection .... mmol.m⁻³ yr⁻¹

b Δ meridional advection

c Δ vertical advection

d Δ isopycnal diffusion

NEMO2_30S30N1500M - NEMO2_REF

Figure S1: Difference in oxygen supply processes (mmol.m^{-3}.year^{-1} – average 500-1500m) between NEMO2_30S30N1500M and NEMO2_REF : a- zonal advection, b- meridional advection, c- vertical advection, d- isopycnal diffusion. The NEMO2_30S30N1500M – NEMO2_REF oxygen anomaly (mmol.m^{-3}) is displayed in contour.

9. Lines 349-350. I would suggest the authors rephrase the conclusion here. In my understanding, the NEMO2-ref shows the equatorward transport of oxygen should be dominated by zonal and meridional advection (Fig. 4a-d). In the experiment of NEMO2-30N30S, the contribution of small-scale isopycnal processes increase very significantly in the region of 30s-5s. This indicates the role of small-scale isopycnal processes might be larger than what we expect if we have a correct oxygen level at 30S. If I understand correctly, please reconsider how to conclude a more scientific results here. Similar re-consideration is suggested in the lines 481-483.

L349 reads now : "Between 30°S and 5°S the oxygen transport occurs mostly by small scale

L487-489 (originally L481-483) :

"The equatorward transport of the anomaly in the subtropics from 30°S to 5°S is largely due to the isopycnal subgrid scale mixing processes away from the western boundaries, as shown by the NEMO2 budget analysis". Note that we discuss here the anomaly.

10. Line 387: 10 cm-1 should be 10 cm/s. Also in Line 386, 5 cm.s-1, should the dot be in the middle (i.e., ·) instead of period? Please follow the requirement of journal.

Corrected : 10 cm/s and 5 cm/s

11. Fig. 8, What's the meaning of negative and positive values? The word in line 457-458 of final version and line 533-535 of track version are different. Please double check.

Negative values correspond to a westward transport while positive values correspond to an eastward transport. This is now stated in the legend of Fig 8. The wording of the final version is the correct one (we apologize for the difference between the final and track version).

12. Line 410. I am still confused about the release location even you answer it previous. This experiment should set the tracer in the initial status, then run the simulation. Is there any release location that continue releasing tracer during the simulation ?

We added to L410 a reference to section 2.2.2, where the location of the tracer release is specified.

See L203 : "In these experiments, we initialized the regions with climatological (WOA) oxygen levels greater than 150 mmol.m^{-3} with a value of 1 (and 0 when oxygen was lower than 150 mmol.m^{-3})". We now state L204 : "The tracer is initialized at the beginning of the experiment and not continuously released."

13. Is there any specific reason that the authors plot the current at 1000 m in Fig. 5? Most of analysis in figs. 3 and 4 is based on the mean between 500-1500m.

We plot the current at 1000 m as to illustrate the complexity of the intermediate current system and minimize vertical averaging (the vertical alternation of the currents direction is clearly visible on Fig 5b)

14. Lines 361-363. A reference or figure should be provided to show the model well reproduce the upper current structure.

This sentence has been deleted as it is redundant with the following sentence : "Previous studies already discussed the upper thermocline current structure in the GFDL models suite (Busecke et al., 2019), NEMO2 and NEMO05 (e.g Izumo, 2005, Lübbecke et al., 2008), and UVIC (Loeptien and Dietze, 2013)"

The sentence was "The southern "shadow zone" is well individualized in NEMO01 compared to NEMO05 as the oxygen levels are high in the equator in NEMO01".

Indeed, the shadow zones are regions characterized by a poor ventilation. In NEMO05, the boundaries of this region are not clearly defined (Fig 6a,c) as it encompasses the equatorial region. Conversely in NEMO01, the region 10°S-20°S is significantly less ventilated compared to its surroundings.

We rephrased this sentence : "The poorly ventilated southern "shadow zone" (Luyten et al., 1983) is well characterized in NEMO01 compared to NEMO05, as its northern boundary is clearly defined by higher oxygen concentrations due to strong equatorial ventilation in NEMO01" and added a reference for the shadow zone :

Luyten, J. R., , J. Pedlosky, , and H. Stommel, 1983: The ventilated thermocline. *J. Phys. Oceanogr.*, **13 ,** 292–309.

16. Line 247, pacific should be Pacific. Double check other similar typos.

The P of Pacific is now in upper case. We corrected the same typo in line 45.

17. In Fig. 4a and 4b, a vector length-scale bar for current vector should be provided? Otherwise, it is hard to know the current size.

The Figure 4 has been updated with a vector length-scale bar.

18. Title in section 5 is suggested to be "discussion and conclusions" or "Summary and implications". It is okay if the author insists on the current one.

We concur with the reviewer's suggestion, the title is now "Summary and implications"

19. Line 475: at 1500 m depth --> below 1500 m depth

Corrected

20. Line 238 in track version. The region change from 5S-5N to 10S-10N. Is the simulation re-run or a typo in the previous version?

The Lagrangian experiments have been rerun. The release location is now 10°S-10°N, as this meridional band is characteristic of the equatorial jets (see Fig 1, Fig 5, Fig 8)