We reproduce the reviewers comments in blue. Our replies are in black.

Reviewer #1

I thank the authors for addressing the comments.

I have been in the "oxygen community" for a while so I received the core message and potential importance of this study but I also see the other reviewer's points that it could be confusing to understand the aim in the previous manuscript. I think revising the introduction and conclusion improved this part and addressed the points.

Along with the reply to other reviewers comments, the authors stated the aim and objective more clear and the diagnostics and metrics based on this study will be useful for further evaluating a suite of models (such as CMIP6, and statements included in the conclusion).

We thank the reviewer for her / his positive evaluation.

I have few minor comments on the revised manuscript.

Section 2.1: Sub-section title 2.1 Mean state : I think you should state a bit more in details such as "evaluations of simulated mean states".

This part is now called “2.1 Description of models” (see also General comment from #Reviewer 4)

Section 2.2: Sensitivity simulations sub-section 2.2.1 Forcing of oxygen to observed values in the subtropical regions

- NEMO2-30S30N: I think it is informative to also state that the oxygen boundaries are forced to observed concentrations at the boundaries 30N and 30S for "the full depth (surface to the bottom)" (at least this is how I interpreted).

We now state “NEMO2-30S30N: the oxygen boundaries are forced to observed oxygen concentrations (WOA) at the boundaries 30°N and 30°S in the whole water column”

- NEMO2-30S30N1500m: Since you replied and discussed why you choose the depth interface of 1500m in the Reviewer #3's comment, I think you should include a short statement in this part justifying the choice of the depth interface.

We now state “NEMO2-30S30N1500M: same as NEMOO2-30S30N; in addition oxygen is forced to observed concentrations below 1500m, mimicking a correct oxygen state of the deeper water masses (lower part of the AAIW, upper part of the PDW)”

L248: "restore oxygen": you should replace to "force oxygen" (as you explained in the response and to make the terminology consistent in the manuscript).

Corrected

L350: a "primitive" EICS: could you clarify what you meant by "primitive" EICS?

We replaced “primitive” by “incomplete” : “NEMO2 and NEMO05 display an incomplete EICS as the LLSCs are not represented.”

Section 4.3: title "Model resolution and oxygen levels":

I thank for the authors for revising this section and replying why you choose not to include NEMO for the comparison here.

However, I still feel that there is a slight jump from the previous sensitivity sections to this section comparing a suite of models. Perhaps you should consider changing the sub-section title including words "discussion" or "implications" for example (something more informative to smoothly make transition from the previous sections). You might also consider including the NEMO MKE figures and short statements in the Annex A.

The section 4.3 is not strictly necessary to understand the processes at play (described in 4.2). It is however useful, as it provides a validation of the processes at play in another set of models. We therefore transfert section 4.3 in Supplementary materia - Annex CI (see also General Comment 5 from Reviewer #4)

L472: take in account: this should be "take into account".
Corrected

Reviewer #4

Duteil et al. examined the role of intermediate depth water (IDW, 500-1500m) in affecting oxygen level in the eastern Pacific Ocean using a set of ocean models. They found the correct oxygen level at extra tropical boundaries (30oS and 30oN) and correct EICS simulation are important factors in simulating oxygen in the eastern Pacific Ocean. These findings could help to explain model bias in the climate models. The work is interesting. However, the numerical experiments are not well designed to convincingly obtain the conclusion and the oxygen analysis based on a certain depth without considering specific water mass are confusing. I suggest a major revision before considering the publication of this manuscript.

We sincerely thank the reviewer for taking the time to make a critical, fair, and in-depth review of our manuscript. Thanks to these comments, we believe that the manuscript has been significantly improved, in particular regarding the confidence in the experiments based on NEMO (major comment 2) and the quantification of the transport in the coarse / high resolution configuration (major comment 3). The wording (general comment 1) and structure (general comment 4 and 5) has also been improved.

General comments
1. IDW is not a specific water mass, but the text makes readers feel like this is a water mass. Lines 83-84 reads “They (models) generally display too shallow and thin IDW”. If the IDW refers to a water in a certain depth, it could not be shallow and thin. This would make the readers confused. There are some similar descriptions in the text and these confused descriptions should be corrected.

The following sentences have been corrected :
L83-84 “It is known that current climate models, in particular CMIP5 (Coupled Model Intercomparison Project phase 5) models, have deficiencies in correctly representing the IDW and in particular, the AAIW. They generally display too shallow and thin IDW with a limited equatorward extension compared to observations.”
has been replaced by :
“It is known that current climate models, in particular CMIP5 (Coupled Model Intercomparison Project phase 5) models, have deficiencies in correctly representing the IDW. In particular, the AAIW is too shallow and thin, with a limited equatorward extension compared to observations”

L203-205 “...The IDW subducted in mid/high latitudes are highly oxygenated waters. As part of the deficient representation of IDW, the subducted “oxygen tongue” (oxygen values up to 240 mmol.m^{-3}) is not reproduced in most of the models part of CMIP5”
has been replaced by :
“The water masses subducted in mid/high latitudes are highly oxygenated waters. The subducted “oxygen tongue” (oxygen values up to 240 mmol.m^{-3}) located at IDW level is not reproduced in most of the models part of CMIP5”

L488 “Intermediate Depth Waters (IDW) are subducted in the Southern Ocean and transported equatorward to the tropics by isopycnal processes”
has been replaced by :
“IDW are constituted by waters masses which are subducted in the Southern Ocean and transported equatorward to the tropics by isopycnal processes”

L498 “1. Subducted IDW properties and tropical oxygen”
has been replaced by : “1. Subtropical IDW ..”

2. The numerical experiment NEMO2-30S30N and NEMO2-30S30N1500M are not well designed that use a correct oxygen level at 30N and 30S without considering density level. If the water mass is not at the correct depth in the model, the interpolation of oxygen at 30N and 30S may bring bias to the experiment. It would be more convincing if the authors at least could discuss this in the manuscript, such as a simple analysis of oxygen in the water mass to prove the bias is small.

The figure below shows that the density profile is well represented in the NEMO2 experiment

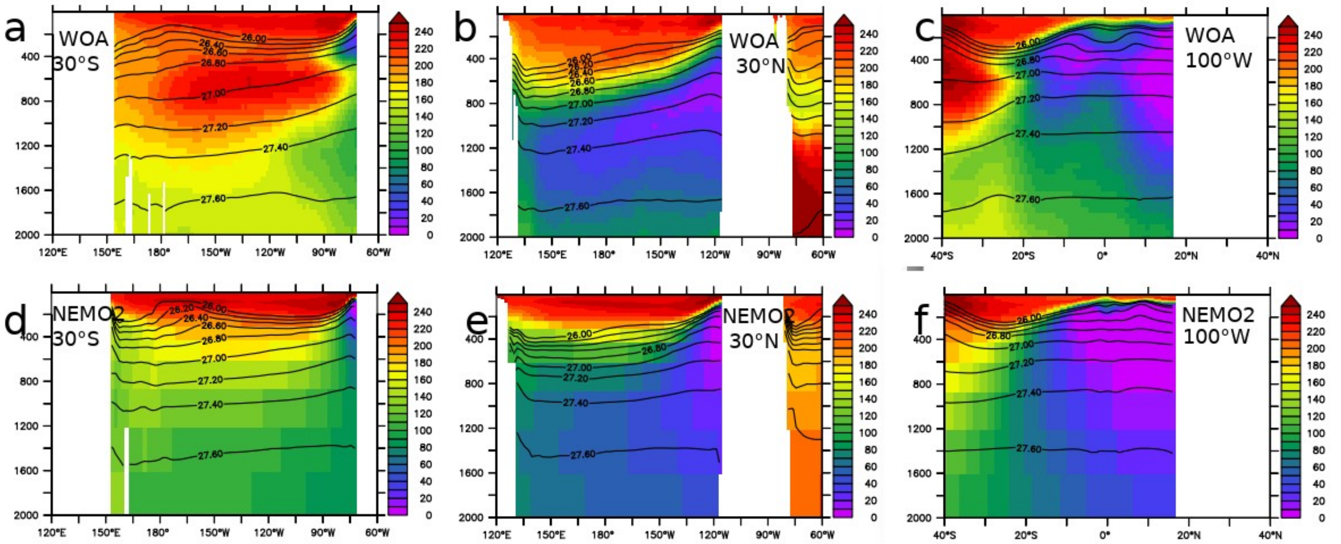


Fig : oxygen levels (colors) and density anomalies (contour) at 30°S, 30N and 100°W in the WOA dataset (a,b,c) and NEMO2-REF experiment (d,e,f)

The deficiency in oxygen in NEMO2-REF is clearly highlighted at 30°S, between 400 and 1500m. In comparison, the density field is well represented in NEMO2-REF. At 500m, density is about 26.6 in both WOA and NEMO2-REF. At 1500 m, the density is 27.6 in WOA and only 27.4 in NEMO2-REF, highlighting some potential water mass formation issue in NEMO2, as in most of models. A section at 100°W shows that isopycnals are almost horizontal at intermediate depth (500 – 1500 m) in WOA and NEMO2 in the subtropical and tropical ocean.

This Figure and the above text are now part of the Annex B

A further suggestion that the authors may use a regional model to do such an experiment instead

of a global ocean model. For example, one is forced by global ocean model results (salt, temp, o2), the other is forced by WOA results (salt temp o2).
The experiments that we perform is actually similar to what the reviewer suggest, as we compare 2 experiments using the same model but different oxygen boundaries conditions. We however do not force T,S at 30°S/30°N : by doing so, the circulation and ocean dynamics in the subtropics / tropics will be very different in both set of experiments and assessing the specific impact of a change in oxygen concentration at 30° very difficult. A solution may be to force velocities (e.g apply velocities of the experiment “Model boundaries” into the experiment “WOA boundaries”) as well, but in this case T,S and velocities will not be consistent.
However, we agree that the approach suggested by the reviewer is generally interesting and modifying the open ocean boundaries of a regional model allows us to better understand the regional / large scale connections.

3. The conservative tracer release experiment (S2.2.2) cannot convincingly help readers to reach the conclusion that EICS is important in transporting oxygen from western Pacific to eastern Pacific. It would help to reduce confusion if the authors could give more explanation from result to conclusion. Except for tracer release, I would also suggest analyzing the volume transport or other convincing variables. If possible, remove the part that talking about surface circulation which makes the manuscript unfocused.

The part has been completely rewritten and reads now :

4.2.2 Equatorial IDW circulation

The analysis of the dispersion of Lagrangian particles (see 2.2.3) permits us to understand the origin of the waters circulating in the eastern part of the basin at IDW level. A total of 26515 particles have been released in the area located at 100°W, 10°N-10°S, 500-1500 m. These particles have been integrated backward in time in order to determine their origin and the ventilation of the eastern tropical Pacific ocean (Fig 7).

After 5 years of backward integration we find that the particles originate from a well defined region, which extends from 110°W and 80°W to NEMO05 (Fig 7a). This region extends westward till 150°W, as a result of the stronger currents in NEMO01 (Fig 7b). This larger dispersion and westward origin of the particles is clearly visible after 10, 20 and 50 years of integration. In order to quantify the dispersion of the particles, we define the Intermediate Eastern Pacific Ocean (IETP) as the region 10°N-10°S, 500 – 1500 m, 160°W – coast. The particles originating outside of the IETP in close to 5 % / 50 % of the cases in NEMO05 and 10 % / 60 % of the cases of NEMO01, after a time scale of respectively 10 and 50 years. The Fig 7c shows a lag between NEMO01 and NEMO05 : while 10 % of the particles originate outside the IETP after 10 years in NEMO01 the same quantity is reached only after 20 years in NEMO05, suggesting a stronger transport in NEMO01. However, after the time period of 20 years, the number of particles originating outside the IETP does not grow faster any more in NEMO01 compared to NEMO05. A hypothesis is enhanced recirculation in NEMO01: the same particles may recirculate several times in the equatorial region due to alternating zonal jets in NEMO01.

The transport has been quantified based on this Lagrangian particles release (Fig 8). The volume transport is higher in NEMO01 (up to 0.2 Sv) (Fig 8a) compared to NEMO05 (less than 0.1 Sv at the equator) (Fig 8b). It also shows recirculating structures and alternating eastern and western transport in NEMO01 (Fig 8c). These recirculating structures are absent in NEMO05 and foster the dispersion of particles as shown above. The mean transport (zonal, meridional and vertical integration) in the region 10°N-10°S, 12E0°E-100°W is [value1] in NEMO01 and [value2] in NEMO05.

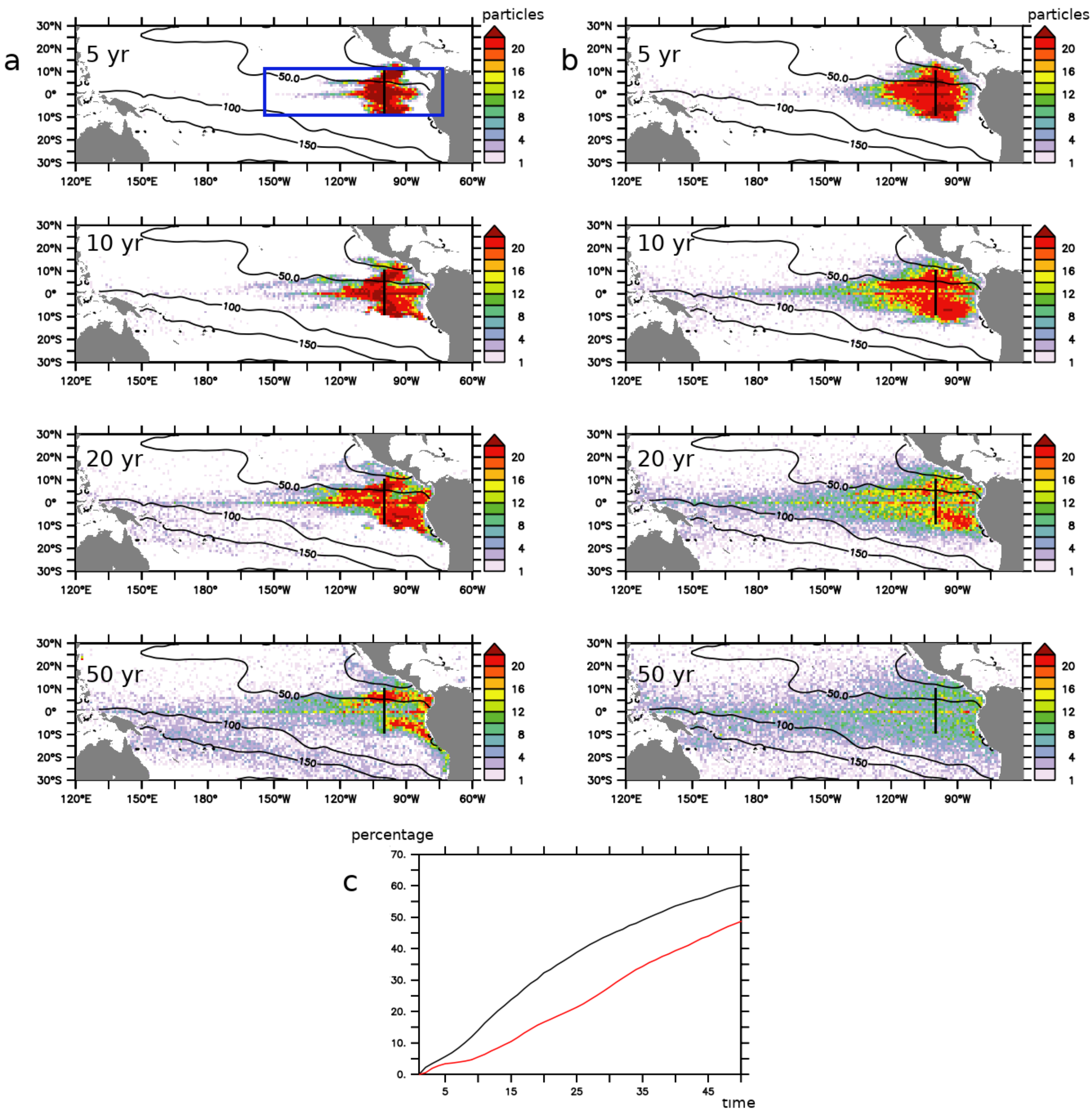


Figure 7 : Density (number of particles in a 1°x1° box) distribution of the location of released Lagrangian particles (backward integration in years) in a - NEMO05 and b- NEMO01. The release location is identified as a bold black line and is located at 100°W/10°N-10S/500-1500 m depth. The number of particles have been integrated vertically. The observed mean (500 – 1500 m) oxygen levels (WOA) are displayed in contour. The blue contour represents the Intermediate Eastern

Tropical Pacific basin (IETP). c – percentage of particles originating outside the Intermediate Eastern Tropical Pacific (IETP) basin (160°W, 10°N-10°S, 500-1500 m) in NEMO05 (red) and NEMO01 (black) over time (years)

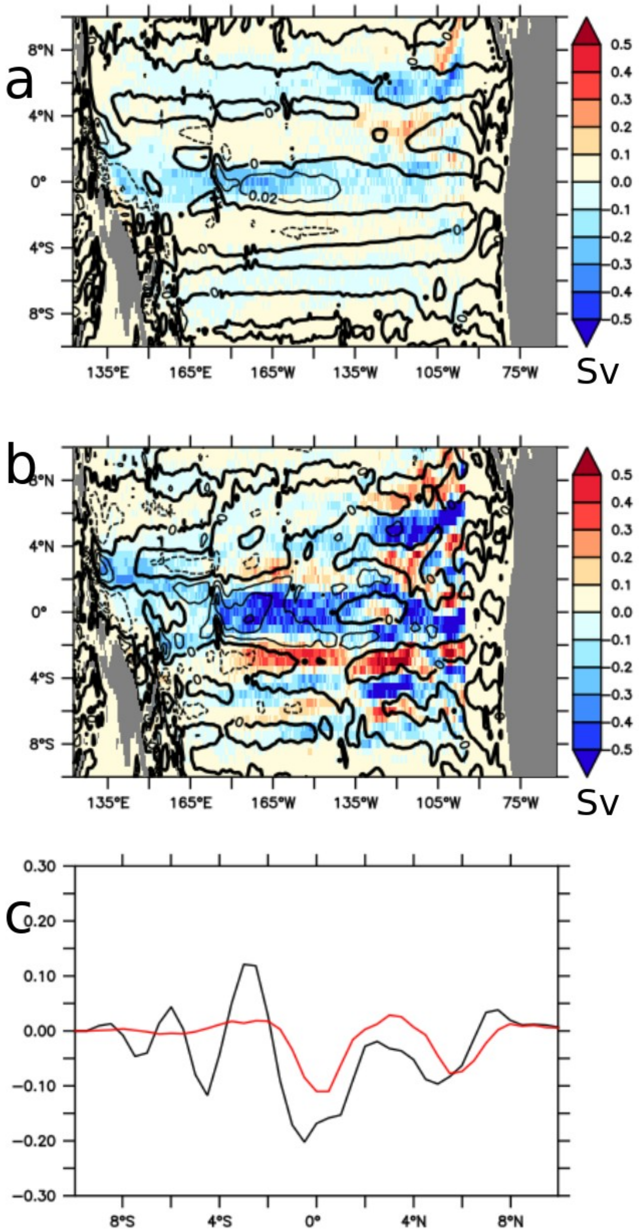


Figure 8 : mean transport (Sv) in a- NEMO05 and -b NEMO01 derived from the release of particles at 100°W, 10°N-10°S, 500-1500m (backward integration). The mean zonal velocity (ms^{-1}) is represented in contour. c- zonally integrated transport (Sv) derived from the release of particles at 100°W, 10°N-10°S, 500-1500m in NEMO05 (red) and NEMO01 (black)

4. It would be clearer if the author could give more introduction to NEMO in the Section 2.1. The NEMO is explicitly used in this work and it need a detailed introduction. Also the two-way nest should be introduced here. More configurations should be written, such as mixing scheme, vertical coordinate, initial conditions.

The paragraph below has been added in section 2.1 and replaces the original text :

The NEMO (Nucleus for European Modelling of the Ocean) model (Madec et al., 2017) has been used throughout this study in different configurations. We first use a coarse resolution version (part 3 of this study). This configuration is known in the literature as ORCA2 (Madec et al., 2017) but we call it NEMO2 in this study for clarity reasons. The resolution is 2°, refined meridionally to 0.5° in the equatorial region. It possesses 31 vertical levels on the vertical (10 levels in the upper 100 m), ranging from 10 m to 500 m at depth. Advection is performed using a third-order scheme. Isopycnal diffusion is represented by a biharmonic scheme along isopycnal surfaces. The parameterisation of Gent and McWilliams (1990) (hereafter GM) has been used to mimick the effect of unresolved mesoscale eddies. The circulation model is coupled to a simple biogeochemical model that comprises 6 compartments (phosphate, phytoplankton, zooplankton, particulate and dissolved organic matter, oxygen). The same configuration has been used in Duteil et al., 2018; Duteil, 2019. The simulation has been forced by climatological forcings based on the Coordinated Reference Experiments (CORE) v2 reanalysis (Normal Year Forcing) (Large and Yeager, 2009) and integrated for 1000 years. Initial fields are provided by the World Ocean Atlas (temperature, salinity, phosphate, oxygen) (Garcia et al., 2019; Locarnini et al., 2019)

Two other versions of NEMO have been used (part 4 of this study). The configuration ORCA05 (that we call here NEMO05) is characterized by a spatial resolution of 0.5°. It possesses 46 levels on the vertical, ranging from 6 to 250 m at depth (15 levels in the upper 100 m). Advection is performed using a third-order scheme. Isopycnal diffusion is represented by a biharmonic scheme along isopycnal surfaces. Effects of unresolved mesoscale eddies are parameterized following GM. In the configuration TROPAC01 (that we call NEMO01 in the rest of this study), a 0.1° resolution two-way AGRIF (Adaptive Grid Refinement In Fortran) nest (Debreu et al., 2008) nest has been embedded between 30°N and 30°S in the Pacific Ocean into the global NEMO05 grid. Since the model is eddying in the nested region GM is not used. Both configurations are forced by the same interannually varying atmospheric data given by the Coordinated Ocean–Ice Reference Experiments (CORE) v2 reanalysis products over the period 1948–2007 (Large and Yeager, 2009), starting from the same initial conditions. The initial fields for the physical variables are given by the final state of a 60 year integration of NEMO01 (using 1948–2007 interannual forcing and following an initial 80 year climatological spin-up at coarse resolution). The interpretation of differences in the ventilation in the IDW is aided by the use of a passive tracer.

5. Section 4.3 is an extended section of 4.2 with oxygen instead of tracer release. However, this section 4.3 is confused to me. I would suggest rewriting with a focus that directly connect with section 4.2.

The section 4.3 is indeed not strictly necessary to understand the processes at play (described in 4.2). It is however useful, as it provides a validation of the processes at play in another set of models. We therefore transfert section 4.3 in Supplementary material.

Specific comments

1. Line 9, "intermediate depth waters (IDW)", give a specific depth (500-1500m).
The sentence has been completed by "defined here as the 500 – 1500 m water depth"

2. Line 10, "test" --> analyze?
Analyze reads indeed better

3. Line 29, either it should say the euphotic zone or biological processes.
"biological respiration" has been replaced by "biological processes"

4. Lines 40-41, what is upper oxygen level?
We rephrased the sentence. It now reads " These studies focus on the mechanisms at play in the upper 500 m of the water column"

5. Line 49, which water mass is formed in North Pacific at depth 500-1500m? If there is, please describe it in the introduction part. If not, please delete the "North Pacific".
We deleted "North Pacific"

6. Line 106, title in section 2.1 should be model description, model introduction, or similar things.
The title reads now "Models description and experiments"

7. Lines 123-133, I suggest using the official name instead the name given by the authors. It is up to the authors if they prefer a given name in the text. But at least they should tell readers the official names of GFDL1, GFDL025, GFDL01.
The official name of GFDL1 is CM2-1deg, GFDL025 is CM2.5, GFDL01 is CM2.6. These names have been added into the text.

8. Line 145, the authors should discuss or show if the experiment reach an equilibrium status or not.
The role of spinup has been discussed in Annex A.

9. Line 160, "same as NEMOO2-30S30N" should be "same as NEMO2-30S30N"
We corrected the name "NEMO2-30S30N"

10. Line 160. The experiment description of NEMO2-30S30N1500 is not clear. Is it forced from 0-1500m, from bottom to 1500m, or only at 1500 m?
The sentence has been modified "in addition oxygen is forced to observed concentrations below 1500m"

11. Line 173, "In a second set" -- > "in the second set"?
Corrected

12. Lines 176-178. What is the 0.1o two-ways nest? The authors should introduce them in the model description part. In addition, it should be "two-way."
The model description has been updated. See major point above 4

13. Lines 189-190. "They (Lagrangian) are not affected by subgrid scale diffusive and advective processes." Why the Lagrangian is not affected by these two processes? This is confused. May be you want to say these processes are not considered in this work?
This sentence has been deleted. NEMO05 is not eddy resolving, therefore subgrid processes are parameterized by the Gent and McWilliams scheme. NEMO01 is eddy resolving and this subgrid parameterization is therefore not implemented. In order to allow a fair comparison between NEMO01 and NEMO05, we interpolated both models on the same NEMO05 grid, thus smoothing out a large part of the NEMO01 mesoscale activity. We consequently decided not to take in account NEMO05 subgrid processes. In any case, at the considered depth range (500 – 1500 m)

mesoscale activity is weak. We added a sentence “We do not take in account subgrid processes in NEMO05”.

14. Lines 208-210. It there any reason that make authors conclude or propose that the high oxygen is due to diffusion from mixing layer?

UVIC is a very coarse resolution model and is generally characterized by a too diffusive thermocline. However, the high oxygen levels may be due to isopycnal diffusion as well. Too oxygenated water at 30°S may originate from too oxygenated subducted water masses, as vertical mixing has been increased south of 60°S to enhance the overturning (Keller et al., 2015). However the aim of the present ms is not to discuss specifically the mechanisms at play in the UVIC model. We therefore remove this sentence.

15. Lines 217-219. Is there any paper describing this circulation? Please cite one or two papers here.

We added 3 references. The sentence now reads : “.. consistent with the circulation of IDW with the gyre from the mid/high latitude formation regions towards the northwest in subtropical latitudes (Sloyand and Rintoul. 2001), and followed by a deflection of the waters in the tropics towards the eastern basin (Qu et al., 2004; Zenk et al., 2005). This oxygen peak is missing in all the models analyzed here.”

Sloyan, B. M., & Rintoul, S. R. (2001). Circulation, Renewal, and Modification of Antarctic Mode and Intermediate Water. Journal of Physical Oceanography, 31(4), 1005–1030. doi:10.1175/1520-0485(2001)031<1005:cramoa>2.0.co;2

Qu, T., & Lindstrom, E. J. (2004). Northward Intrusion of Antarctic Intermediate Water in the Western Pacific. Journal of Physical Oceanography, 34(9), 2104–2118. doi:10.1175/1520-0485(2004)034<2104:nioaiw>2.0.co;2

Zenk, W., Siedler, G., Ishida, A., Holfort, J., Kashino, Y., Kuroda, Y., … Müller, T. J. (2005). Pathways and variability of the Antarctic Intermediate Water in the western equatorial Pacific Ocean. Progress in Oceanography, 67(1-2), 245–281. doi:10.1016/j.pocean.2005.05.003

16. Line 238. I would suggest moving this sentence “A correlation …” before “reasons for this weak”. This would make the readers easy to understand.

We agree

17. Line 246. Why do you choose 1997-2007 for NEMO2-30S30N? In line 374, you choose 2002-2007 for tracer release experiments. If possible, a specific reason like equilibrium status should be discussed or given in the supporting information.

A mean 1997 – 2007 or 2002 – 2007 does not display significant difference. We now use 2002 - 2007 in both cases.

18. Line 286, I would not consider the circulation below subtropical gyre as a branch. You could say below the subtropical gyre at depth in 500-1500m. In addition, it should be gyre instead of gyres if you are only talking about south Pacific Ocean gyre.

Ok

19. Line 296, right bracket is missed. In addition, I cannot see the changes in advective terms (I think you are talking about zonal advection here) are found along the equator. Is it along the 30S?

Right bracket has been added. The whole paragraph has been rephrased (see point 20).

20. Line 294-295. Why is the imbalance apparent in the tropics and why is related to isopycnal diffusion? The authors need to give more explanation here. In addition, what I see about the change of isopycnal diffusion is largest in the sub-tropics instead of tropics.

The whole paragraph has been rewritten :

“Forcing oxygen levels in NEMO2-30S30N at 30°S and 30°N creates an imbalance between respiration (which remains identical in NEMO2-REF and NEMO2-30S30N) and supply. The oxygen anomaly generated at 30°S propagates equatorward. The positive anomaly originated from the southern boundary recirculates in the equatorial region. Isopycnal diffusion is a major process that transport the oxygen anomaly toward the equator (Fig 3g, Fig 4h), in particular from 30°S to the 5°S and 30°N to 10°N. Total advective transport plays an important role in the transport of the oxygen anomaly as well, especially in the equator region (Fig 4e and 4f) and and in the western boundary (Fig 4f). Meridional advection plays a large role close to the 30° boundaries as the oxygen is transported by the deeper part of the gyres. As the vertical gradient of oxygen decreases (the intermediate ocean being more oxygenated), the vertical supply from the upper ocean decreases in the south (increases in the north) subtropical gyre (Fig 4g). Comparatively the impact on zonal term advection (Fig 4e) is small as the zonal oxygen gradient stays nearly identical in both experiments (the oxygen anomaly is almost longitude independent). The model does not display much increase in zonal recirculation at the equator as well, except in the western part of the basin due to the advection of the oxygen provided by the retroflection of the deep limb of the subtropical gyre. The increase of meridional transport (Fig 4f) is caused by the change in oxygen meridional gradient, mainly caused by isopycnal diffusion processes away from the western boundary"

21. Line 315, Why do you say the equatorward propagation is due to small scale isopycnal processes? I did not see it from the figures. Any citations?

The figure 3g (comparison between NEMO2_REF and NEMO2_30S30N) and 4b (bottom right : Δisopycnal diffusion) shows clearly that the increase in oxygen supply in the region (30°S-5°S) is related with an increase in isopycnal diffusion. Maybe our wording was confusing : "small scale isopycnal processes", "subgrid isopycnal processes" and "isopycnal diffusion" are synonyms (at least in our understanding) as isopycnal diffusion is ultimately based on a parameterization of non explicitly resolved processed.

22. Line 375, where is the release location? I tried to find it in the introduction part but cannot find it.

L179-181 state "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})".

23. Line 432. Is there any way that could quantify the contribution of ventilation due to EICS? Currently, the result and conclusion are very descriptive. I suggest digging more on it.

We added a quantification of the transport by the EICS (see major point 3)

24. Line 496. Not consistent. Line 496 says equatorward transport is due to isopycnal subgrid scale mixing processes. However, line 315 says the equatorward transport is due to western boundary current and isopycnal process.

We use "subgrid scale mixing" and "isopycnal process" as synonyms (see point 21). The paragraph line 496 has been rewritten for consistency.

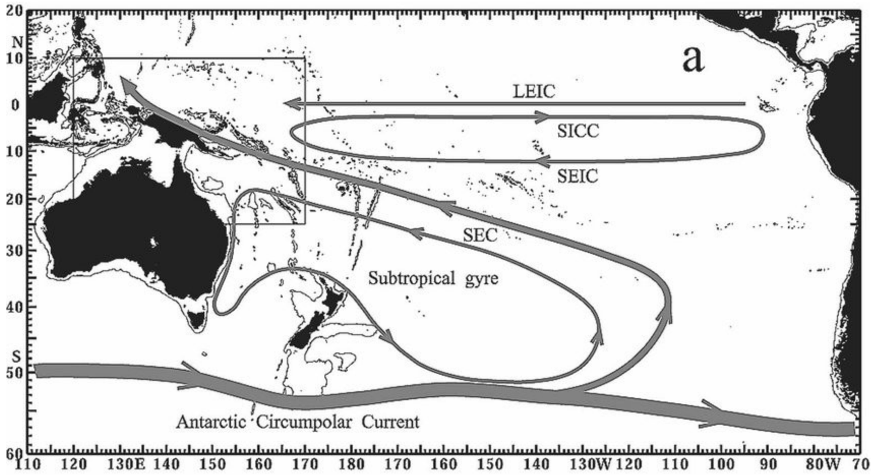
The sentence now reads :

“Intermediate Depth Waters (IDW) are subducted in the Southern Ocean and transported equatorward to the tropics by isopycnal processes (Sloyan and Kamenkovich, 2007; Sallee et al., 2013; Meijers, 2014) and the retroflection of the deeper limb of the subtropical gyre (Zenk et al., 2005)

25. Figure 4 and other figures, a name should be given at each panel. Otherwise, it is really hard to know which panel you are talking about in the manuscript. Figure resolution is not high. The authors should provide a high-resolution version.
Each panel has been named in Fig 4 and when necessary to improve readability. .

26. Fig. 1a, this panel shows the circulation at the 500-1500m. Could the author confirm the SEC arrow here? In the surface, the SEC has a different path. If this is true in the 500-1500m, please cite a paper.

We based the trajectory of the SEC on the Fig 1a the Fig 1 of Kawabe et al. (2008). Their Fig 1 and the associated legend is reproduced below :

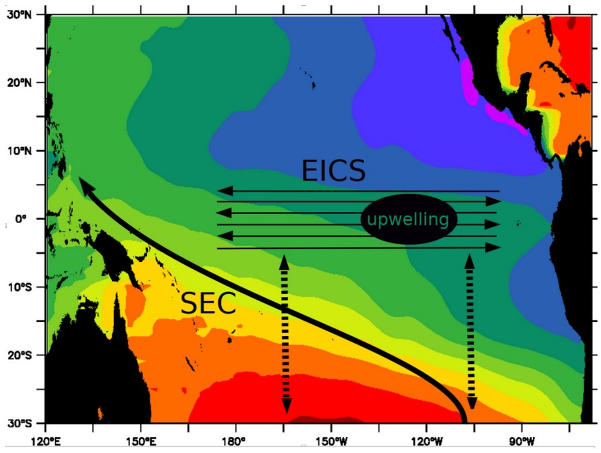


“Fig 1 : Map of the South and tropical Pacific Ocean showing the study area enclosed by a square. Gray curves with arrows are the Antarctic Circumpolar Current, the subtropical gyre in the South Pacific, and the anticyclonic gyre current outside the subtropical gyre at a depth of approximately 800 m, referring to Reid (1997).”

Kawabe, M., , Y. Kashino, , and Y. Kuroda, 2008: Variability and linkages of New Guinea coastal undercurrent and lower equatorial intermediate current. *J. Phys. Oceanogr.*, 38, 1780–1793, doi:10.1175/2008JPO3916.1.

Reid, J. L., 1997: On the total geostrophic circulation of the Pacific Ocean: Flow patterns, tracers, and transports. *Prog. Oceanogr.*, 39 , 263–352.

The Fig 1a has been updated based on this figure.



a- schema summarizing the intermediate water masses (IWM) pathway from the subtropics into the equatorial regions. EICS : Equatorial Intermediate Current System. SEC : South Equatorial Current (Kawabe et al., 2008). Dashed line : isopycnal diffusive processes. Observed (World Ocean Atlas) oxygen levels ($mmol.m^{-3}$) in the lower thermocline (mean 500-1500m) are represented in color.