**Intermediate water masses, a major supplier of oxygen for the eastern tropical Pacific ocean" by Olaf Duteil et al.**

**Reply to Referee #1**

**Main Objective of this Study and General Comments**

This study investigates the impact of intermediate water masses (IMW) and it's pathway and supply along Equatorial Intermediate Current System (EISC) on dissolved oxygen content in the Pacific Oxygen Minimum Zone (OMZ) (in the eastern tropical Pacific ocean). The authors utilized a suite of simulations to address these questions.The manuscript consists of) mean state diagnostics and evaluations from suite of models (NEMO (ocean stand-alone simulation), UVIC (coupled, energy moisture balance model, forced wind stress), GFDL (coupled) and ii) sensitivity simulations (or transient simulations over 60 years) (oxygen restoring, conservative tracer release, and Lagrangian tracking of tracers) elucidating the role of subtropical IMW on dissolved oxygen supply (through EICS) in eastern tropical Pacific ocean. Despite the limitations (or discrepancies) in simulating properties of IWM in the current climate models, the authors did a nice set of simulations tackling how bias in IMW and EICS could impact on dissolved oxygen (and possibly impact on projections of OMZs due to climate change). This could provide insights on improving ocean bio-geochemistry in ESMs and I think the work contains interesting and important results.

We thank the reviewer for her/his positive evaluation.

However, I have several comments and some sections and figure presentations should be revisited before publication. Therefore, I suggest a major revision. I state specific comments below and hope this helps to improve the manuscript.

**Major Comments**

[1] The heterogeneous subset of models (simulations) will be an advantage exploring model and resolution dependencies (as author stated in L116−118) on IMW characteristics and tracers (here dissolved oxygen) but also makes the results difficult to interpret to some extent. I still think the results will have impacts from not only the differences in model structures and resolutions, but also the forcing (forcing dataset, prescribed vs. coupled) and model integration time (spinup states) (some specific comment on forcing dataset is stated below). I would like to ask authors to discuss further on these points since for example, the wind and buoyancy forcing bias could be one of the reasons introducing errors in climate (and ocean) models as stated in the introduction.

We agree with the reviewer that extracting information from a heterogeneous subset of simulations is not straightforward and needs a specific conceptual reasoning, that we clarify in a first step. In a second step, we reply specifically to the comments of the reviewer.

1. Conceptual reasoning

We compare the oxygen levels in a set of models characterized by different resolutions, integration time scale, forcings, etc.. Despite all these differences, we found common behaviours (part 3.1): the properties of the intermediate waters are poorly represented in all simulations that we analyzed and we found a correlation between oxygen levels in intermediate waters and oxygen levels in tropical regions (part 3.1 of the ms).

It suggests that intermediate waters affect oxygen levels and OMZ volume in tropical regions. We test this hypothesis using a “what if ?” experiment : “If the oxygen levels are realistic south of 30°S and/or below 1500m does it have an impact on OMZs ?”. These sensitivity simulations are performed using a single model framework: same resolution, same forcings, same integration time. (part 3.2)

Another second hypothesis that we investigate is “do the intermediate circulation and associated jets play a large role in setting oxygen levels in the equator region ?”. To reply to this question, we performed a set of sensitivity simulations using again a single model framework: same integration time, same forcings, but different spatial resolution. (part 4.2).

In addition (part 4.3) we compare the oxygen levels in a climate model suite: similar model framework, same integration time, different ocean resolution.

In summary, we investigate the mechanisms impacting tropical oxygen levels at intermediate depths in a very heterogeneous set of models, by performing dedicated sensitivity simulations that are easy to interpret.

2. Reviewer comment on the heterogeneity of the models and model set-ups that makes it difficult to pinpoint causes for differences of the simulations.

- Atmospheric forcing

We agree that the atmospheric forcing data play a large role in setting ocean properties. Differences in wind stress between reanalyses data are of the order of 5-20 % (zonal mean wind stress), as shown by the figure below (Chauduri et al., 2013)

Chaudhuri, Ayan & Ponte, Rui & Forget, Gael & Heimbach, Patrick. (2013). A Comparison of Atmospheric Reanalysis Surface Products over the Ocean and Implications for Uncertainties in Air-Sea Boundary Forcing. Journal of Climate. 26. 153-170. 10.1175/JCLI-D-12-00090.1.

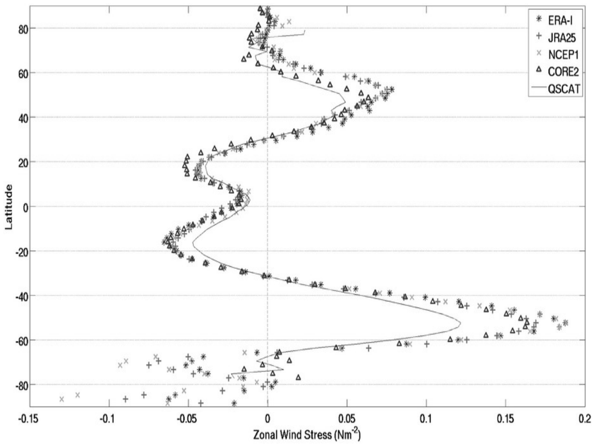


Figure 1: Zonally averaged profiles of zonal wind stress from 1999–2006 for ERA-Interim, JRA-25, NCEP1, CORE2, and QuikSCAT (Chauduri et al., 2013).

Large differences exist especially in the eastern tropical Pacific Ocean where the wind is weak. The Figure 2 below shows the relative difference in wind speed between NCEP and CORE (Large and Yeager, 2009), i.e., it shows that winds of the different products in the eastern tropical Pacific differ by up to 50%.

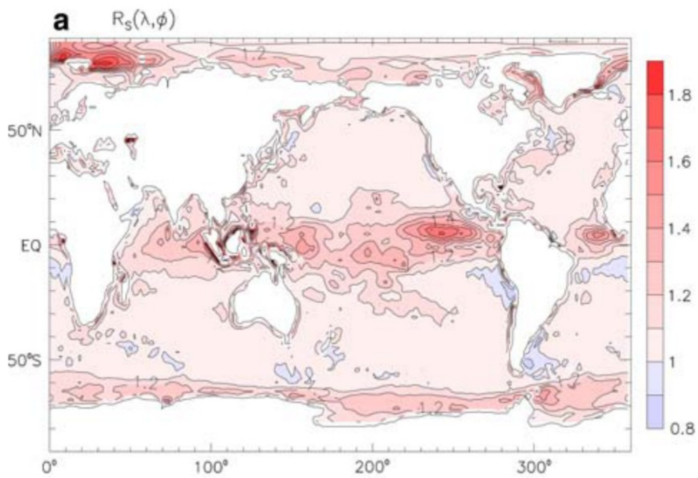


Figure 2: Global distributions of the multiplicative speed applied to NCEP wind vectors to obtain CORE wind vectors (Large and Yeager, 2009)

Large, W.G., Yeager, S.G. /2009). The global climatology of an interannually varying air–sea flux data set. Clim Dyn 33, 341–364. 10.1007/s00382-008-0441-3

To investigate this aspect, we performed two additional sensitivity simulations using the UVIC model: (i) using the CORE Normal Year Forcing wind stress and (ii) applying the NCEP wind stress data. Both simulations have been integrated for 10000 years. While the oxygen levels show significant differences, the general shape of the OMZ (oxygen lower than 20 mmol.m-3) is similar in both simulations (see Figure 3 below).

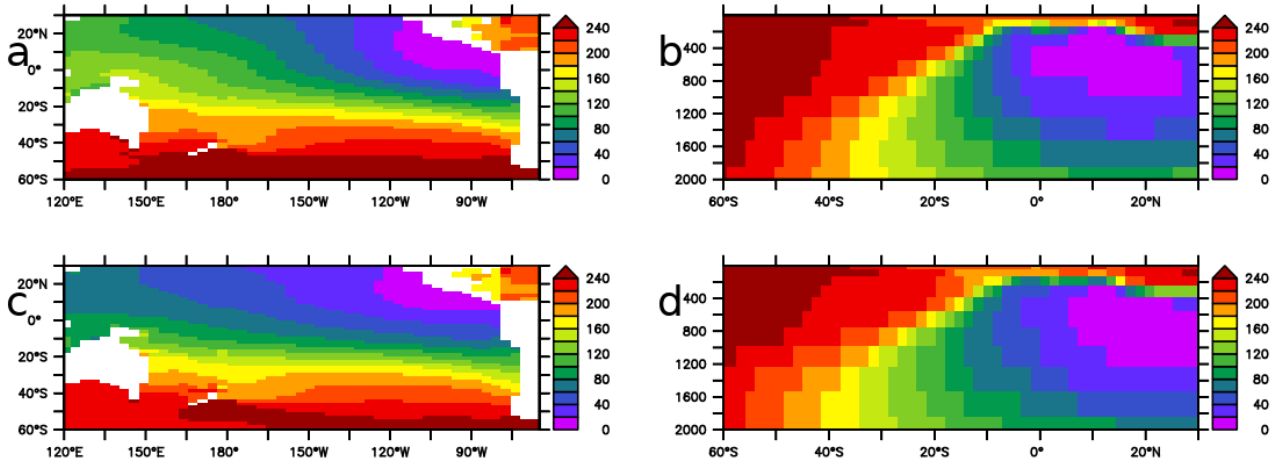


Figure 3: Oxygen levels in UVIC (10000 years integration) a- mean 500-1500 m forcing NCEP. b- section 120°W forcing NCEP. c- mean 500-1500 m forcing COREv2, d- section 120°W forcing COREv2.

Coupled ocean atmosphere experiments

Coupled ocean-atmosphere experiments introduce further discrepancies compared to the use of realistic atmospheric forcings. However, the mean surface velocity is similar in the suite of GFDL models (especially GFDL01 and GFDL025) that we analyzed, suggesting that the effect of atmospheric forcing is likely not dominant when comparing this subset of models (part 4.3).

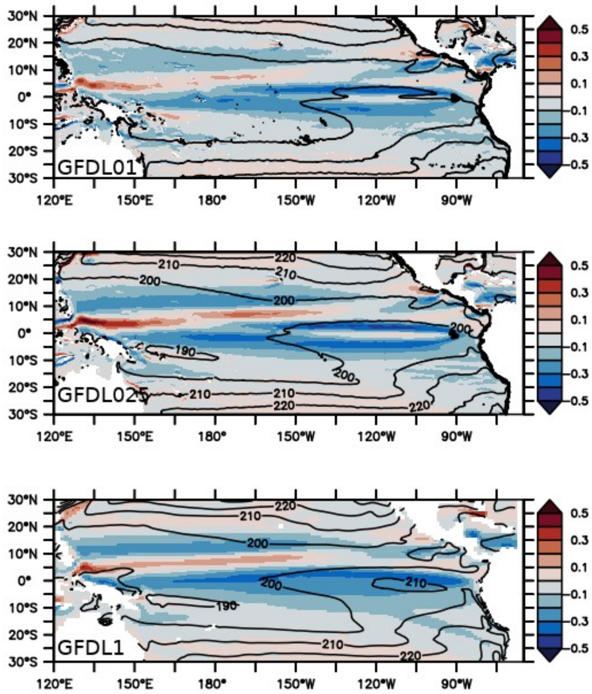

Figure 4: ocean zonal surface velocity (ms-1) in GFDL01, GFDL025 and GFDL1

Model integration time

To fully equilibrate, models have to be integrated for a time period of the order of several ten thousand years, the same order of magnitude as the time scale of the thermohaline circulation. The figure below shows snapshots of NEMO2 after 50,100,500 and 1000 years integration. It shows that despite the drift, the main features (in particular the shape of the low oxygen region, the oxygen levels south of 30°S) are already present after a couple of decades. The OMZ shrinks at centennial time scale, a possible explanation being the inflow of well oxygenated intermediate water originating from the Southern Ocean. It may partly explain why the GFDL experiments (190 years integration) are characterized by much lower oxygen concentrations than UVIC (equilibrium – 10000 years) and NEMO (1000 y integration)

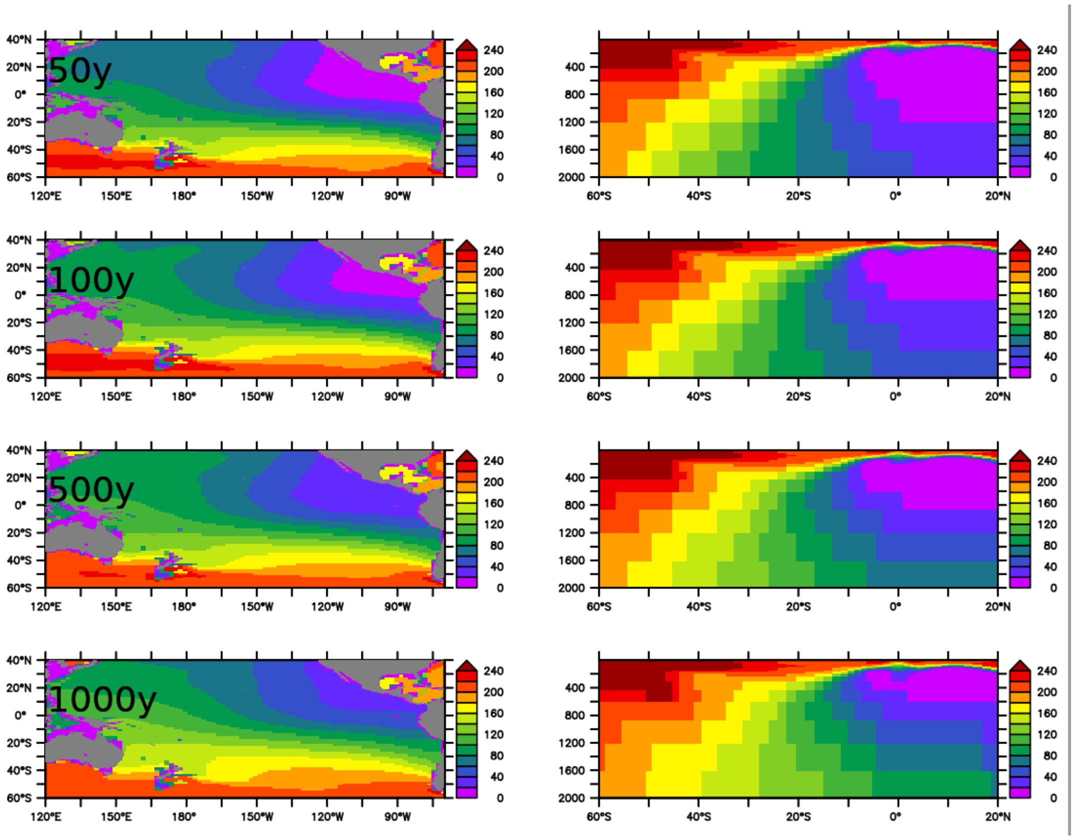


Figure 5: oxygen levels at intermediate depth (500 – 2000 m) and 120°W in NEMO2 after 50, 100,500 and 1000 years integration

3. Conclusion

We agree with the reviewer, the differences induced by the different forcings and integration time have (not surprisingly) an impact on water masses and oxygen levels. Despite the heterogeneity of our simulations, our results nevertheless suggest a strong coupling between subtropical and tropical oxygen content and justify our questioning and the experiments performed in the part 3 and 4 of this study (see 1. Conceptual reasoning)

[2] Regarding to sensitivity of tropical IWM oxygen to subtropical and deep dissolved oxygen levels, the authors refer AAIW, NPIW (and the upper part of the PDW) as IWM in this study. I was wondering what will be the relative contributions of each water masses to dissolved oxygen supply, ventilation in the eastern tropical Pacific ocean (particularly North (NPIW) vs South (AAIW)). My impression is that AAIW could be more dominant (e.g. Talley, 2013) but I would like to know what sensitivity simulations indicates. At least, I think it is possible to obtain insights from the Lagrangian tracking diagnostics (or if possible, conducting additional restoring simulations with 30◦S boundary only for example).[Reference] Talley, Lynne D., (2011), Descriptive Physical Oceanography: An Introduction, Academic Press.

We perform a complementary experiment using NEMO2 where the oxygen levels are restored to WOA solely south of 30°S (experiment NEMO2_30S. The experiment where oxygen is restored both to the south and to the north. NEMO2_DEG30 has been renamed NEMO2_30S30N). It shows clearly that AAIW has a dominant impact in setting tropical Pacific Ocean intermediate oxygen levels and the OMZs volume. This is not surprising as AAIW recirculates till about 20°N and NPIW has a much smaller, regional extension (Talley, 2011)

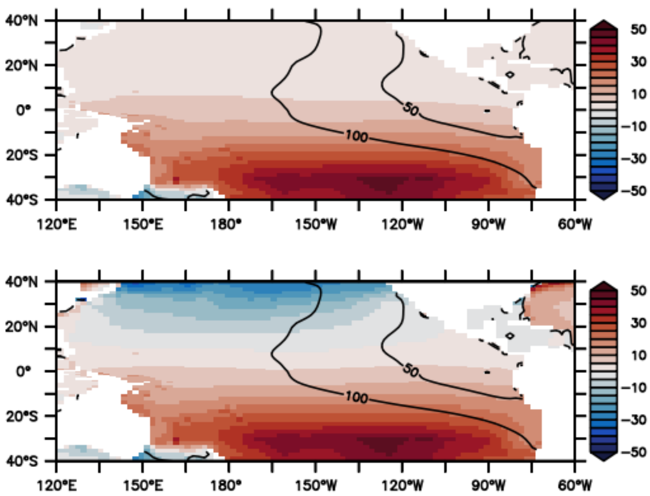


Figure 6: NEMO2-30S minus NEMO2-REF and NEMO2_30S30N minus NEMO2_REF (average 500-2000 m).

[3] The core of the study is based on a suite of sensitivity simulations from NEMO(NEMO2). In the first reading, I struggled a bit on connecting aim and each sensitivity experiments. The dissolved oxygen restoring simulations aim on investigating sensitivity of tropical IWM oxygen to subtropical and deep dissolved oxygen levels (as stated in section 3.2) and the conservative tracer release simulations are more dedicated to investigate spreading of tracers towards the eastern tropical

Pacific (transport by the EICS, as stated in section 4.1). While the standard structure of the manuscript is to introduce overall data and methods in the beginning, (section 2), I suggest to move some of the objective and details of sensitivity experiments to each corresponding sections (referring to sections 3.2 and 4.1) so it is much easier to follow the aim bridging to sensitivity experiments (I think it is still fine to keep brief general descriptions in section 2 including Table 1). Alternatively, the methods section could be revised to include additional descriptions connecting to corresponding result sections. I will leave this decision to the authors regarding to the structure of the paper but I think the flow could be improved.

We agree and improved the flow of the experiment in the final version of the manuscript.

[4] Another major issue is the figures. Figure labels and captions are not easy to interpret (and in some part, the authors are referring to figure does not appear,e.g.L267, Fig.4i). Therefore, I suggest the authors to carefully revisit all the figures and add necessary caption, labels for better presentation. For example, for time series plots (e.g.Fig. 2,3g−i,8), the difference in color (models, configurations etc.) should also be informed in the label (not just in figure captions) because it is not easy to follow.

The figures/labels/captions are revised in the final version of the ms. See the new set of figures at the end of the reply.

Similar issues for multiple maps (such as Fig.5), it will be reader friendly to label maps with "zonal advection", "meridional advection" etc.

The transport terms (Fig 4) are labeled in the final version of the ms. See the new set of figures at the end of the reply.

Also, some of the model names(labels) are not obvious because those are overlaid on color shading (e.g. Fig.9).

The names are labeled in a more obvious way in the final version of the ms. See the new set of figures at the end of the reply.

I put few more specific suggestions below and hope this helps to point out the difficulties I am referring to.

Thanks to the reviewer for these suggestions. We have rechecked all captions to make sure that they are correctly describing the panels.

[4.1] Fig.1caption, (L762−763) oxygen levels (mean 500 - 1500m) at 160W, I think color shading in b) is not vertical mean (because it is depth-latitude section). Also, is dissolved oxygen in Fig.1from observations such as World Ocean Atlas?

The new legend of the Figure 1 is reproduced at the end of this reply

[4.2] Regarding to Fig.4, I have several suggestions to improve figure presentation. I am still a bit confused what is in color shading and contours. For example, in L789,it states the vertical current as contour in c) but the contours do not look like vertical current values. Also the continent shading ing) is missing (no gray shaded). Similar confusion occurred to me in other panels and I suggest to revisit and clearly state what is presented in color shading and contours for each panels with units.
The Figure 4 has been revisited (missing shading of the continent, captions, legend). See the new set of figures at the end of the reply.

Also, why did you only present the results from NEMO2-30DEG (not including NEMO2-30DEG1500M or NEMO2-30DEG1500M minus NEMO2-30DEG)?
The experiment NEMO2-30DEG has been renamed NEMO2_30S30N for clarity (see above comment). We show in Fig 4 both the transport terms of NEMO2_30S30N and of NEMO2_30S30N minus NEMO2_REF. We do not show NEMO2_30S30N1500M as from Figure 3i it becomes clear that the processes transferring oxygen from the deeper layer toward the intermediate ocean are vertical advective processes. This is now stated explicitly in the new version of the ms.

[4.3] Add information labels for Fig.7a)−c)the first release, and d)−e)the second release, respectively.
Information labels have been added and the figure revisited. See the new set of figures at the end of the reply.

[4.4 ]Add information labels (like figure title) for Fig.9, zonal sections and meridional sections, respectively.
Information labels have been added and the figure revisited. See the new set of figures at the end of the reply.

3 Minor Comments
[1] I am curious whether CORE v2 climatological forcing (used for NEMO) and NCEP/NCAR climatological forcing (wind stress, used for UVIC) makes a difference in paper spinup states. As far as I know, CORE v2 forcing is based on NCEP/NCAR reanalysis but it has several corrections and adjustments in the forcing and difference between the two could lead to different results, particularly after long-term spinup. Do authors think this is a minor thing ?
The different climatological forcings have indeed a significant impact (see Figure 3 of our response). However we think that differences in resolution play a larger role by resolving additional processes (in particular deep equatorial jets)

[2] Are all the GFDL model simulations integrated for the same period following high-resolution

(GFDL01) for comparison (I assumed 200 years from Busecke et. al.,2018) or the low-resolution configurations are integrated for longer durations ?

All configurations have been integrated for 190 years (more precisely 48 years physics only + 142 years biogeochemical cycles), including the lower resolution version.

[3] Because of the high resolutions configurations for GFDL01, the integration time is limited but does this impact on IWM (and upper part of PDW) characteristics and tracers (i.e. insufficient spinup, drift in certain properties etc.)? Upper ocean could be quasi-equilibrated (say few hundred meters) but I am wondering about mid∼deep ocean you are more focusing on in this study.

We agree with the reviewer, the model spin-up has a large impact on ocean properties. The mid-depth (500 – 1500 m) ocean is not fully equilibrated after 100/200 years. However, the experiments part 3.2 : "If the oxygen levels are realistic south of 30°S and/or below 1500m does it have an impact on OMZs ?" and 4.2/4.3 "do the intermediate circulation and associated jets play a large role in setting oxygen levels in the equator region ?" (see 1 - Conceptual reasoning) clearly show that a timescale of 100 - 200 years is sufficient to investigate the connectivity between midlatitude / tropical regions, as well as the role of the intermediate current system in controlling oxygen (and more generally tracers) concentration. Even if a short integration timescale does not allow to characterize the steady state and the relative importance of all the processes at play, it permits nevertheless to assess the importance of specific processes (especially that the experiments, e.g the GFDL suite of models, have been integrated for the same duration (190 years).

[4] Regarding to dissolved oxygen restoring, are the boundaries (and depth inter-face at 1500m) all in the Pacific ocean only (e.g. thinking of for example, 30◦N and 30◦S zonal walls and 1500m layer in the entire Pacific ocean) or globally ? Also, how strong (i.e. timescale) is the restoring in these simulations ?

The term "restoring" is maybe inadequate and has been replaced by "forcing to the observations" in the manuscript as the oxygen levels are forced to the WOA monthly climatology. The latitude where the forcing is applied has been set globally (however as it is a "forcing", it does not make any difference if it were applied solely in the Pacific Ocean).

[5] Regarding to the respiration rate (in L144), did you set all the simulations respiration rate (similar to fixing oxygen utilization rate I would assume) to NEMO2-REF?

Respiration rates (as all other biogeochemical fluxes) are the same in all the experiments. Only the oxygen concentrations are forced by WOA values at 30/N/S/1500m depth. Forcing phosphate levels would complicate the picture, as the resulting differences of productivity and respiration would counteract the difference of advection of modified oxygen concentrations. Quantifying the sensitivity of respiration to a change in nutrients is an important aspect, but is outside the scope of this study which focuses on the transport of oxygen by intermediate water masses. Furthermore our Figure 2 (correlation oxygen content at 30°S and in tropical regions) suggests that differences in ocean circulation are dominant compared to differences in biology in the simulations that we consider.

[6] I am a bit confused by the locations of particle release and IETP/IWTP regions you were referring to (L363−383, Fig.7 and 8). While the the locations of particle release is in sections (shown as black bold lines (or dot) in Fig.7), I thought the IETP/IWTP are basins in specific rectangles and this is different from the locations of particle release (it contains of course) if I understand correctly. If that is the case, I suggest to revise the main text and Figure to include these information more explicitly (I think adding boxes in Fig.7 could help and you can refer to that interpreting Fig.8).
A new Figure 8a has been added, which shows the IETP/IWTP boxes and the release locations.

[7] Just for clarification: do ocean stand-alone simulations (i.e. NEMO and UVIC) paper also use preindustrial pCO2for spinup (related to mean state diagnostics)?
Preindustrial pCO2 is used. This is now stated in the text.

[8] In section 2.1, Table 1, and part of the main text: The author mix use the NEMO and NEMO2 through the manuscript and I have got a bit confused. Since all the simulations use NEMO2, you should make the terminology consistent through the text after introducing (or just NEMO, I will leave this to the authors).
Three versions of NEMO are used : NEMO2 (with biogeochemical cycles), NEMO05, NEMO01 (physics only). We now refer specifically to these versions in the text.

[9] For Table 1, I would suggest to include model integration time information.
The model integration time has been added in the Table 1 (see last section of this document)

3.1 Line Specific Comments
[L70]Cabre et l., : should be Cabre "et al.,"
This is corrected in the final version of the ms

[L85]eastern tropical (20◦S-20◦N): I think you should add longitude information since you mentioned "eastern" tropical Pacific.
We added “east of 160°W” in the final version of the ms

[L104](see Keller Keller 2012 for ... : delete "Keller" (duplicates).
This is corrected in the final version of the ms

[L124]more than 50 years: suggest to change to "60 years" (the same as the statement in latter section, L160).

This is corrected in the final version of the ms

[L167]5 daily means: I think "5-day mean" is more common.

This is corrected in the final version of the ms

[L262−263]Where is the information (figure) of total advective term? Fig. 4g is the vertical advection term difference and I could not find specific information on total term in the figure (although it is possible to infer from all the terms).

The objective of the Figure 4 is to better explain the differences between the model experiments (Fig 3g). As the patterns are mostly zonal, we did not show in Fig 4 the total term (the zonal mean of the total term is already displayed in Fig. 3g).

[L301]Tsuchuya jets: should be "Tsuchiya jets".

This is corrected in the final version of the ms

**Updated Figures and Table**

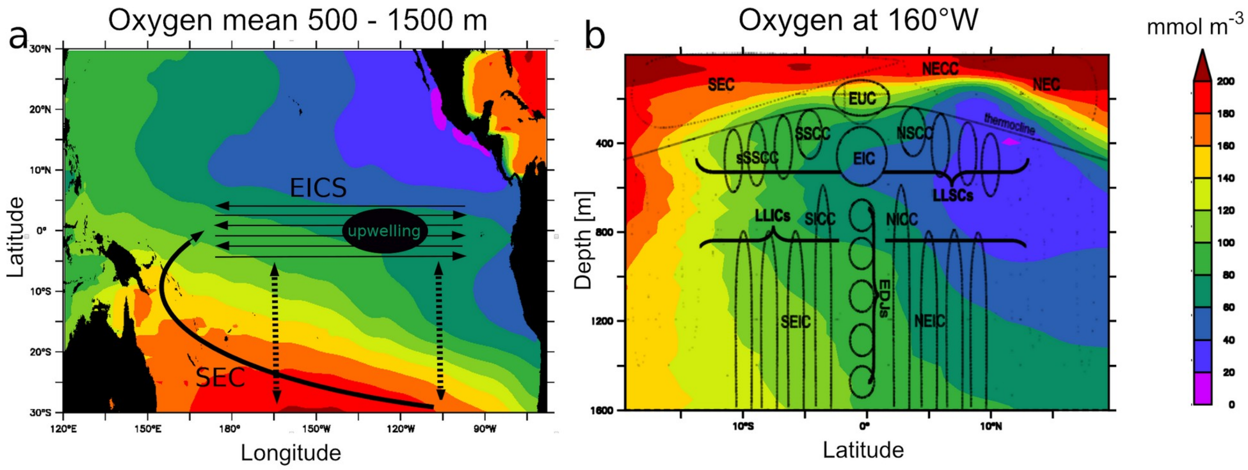


Figure 1 : a- schema summarizing the intermediate water masses (IWM) pathway from the subtropics into the equatorial regions. EICS : Equatorial Intermediate Current System. SEC : South Equatorial Current. Dashed line : isopycnal diffusive processes. Observed (World Ocean Atlas) oxygen levels (mmol.$m^{-3}$) in the lower thermocline (mean 500-1500m) are represented in color. b - schema (adapted from Menesguen et al., 2019) illustrating the complexity of the EICS, extending below the thermocline till more than 2000 m depth (see section 4.1 for a detailed description). Observed (World Ocean Atlas) oxygen levels at 160°W are represented in color.

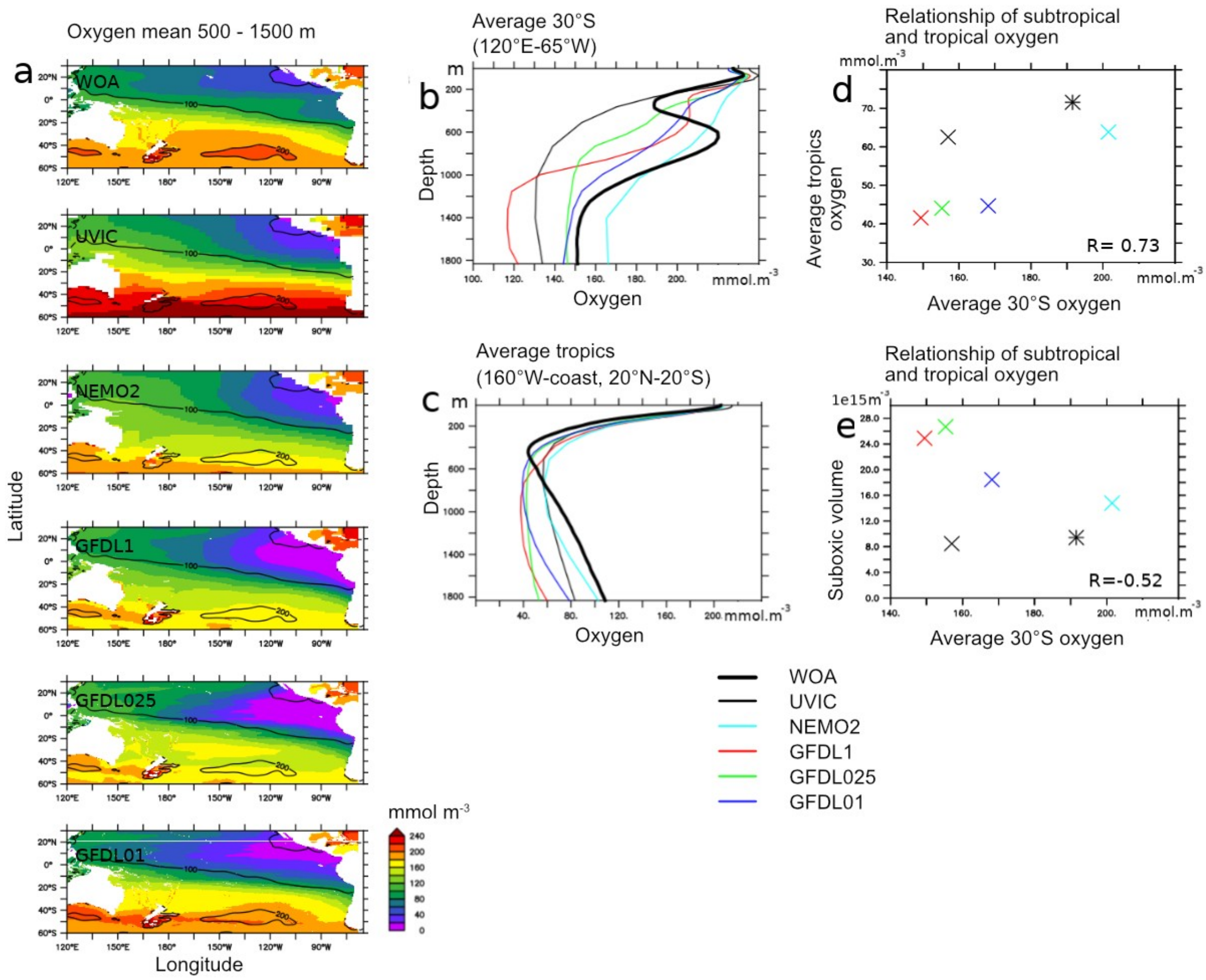


Figure 2 : a- oxygen levels (mmol.m$^{-3}$) in observations (World Ocean Atlas - WOA) (mean 500 – 1500 m) and models (UVIC, NEMO2, GFDL1, GFDL025, GFDL01). Contours correspond to WOA values. b: average "30°S" (120°E-65°W, 30°S) c : average "tropics" (160°W-coast, 20°N-20°S). d: average "30°S" vs "tropics". 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).

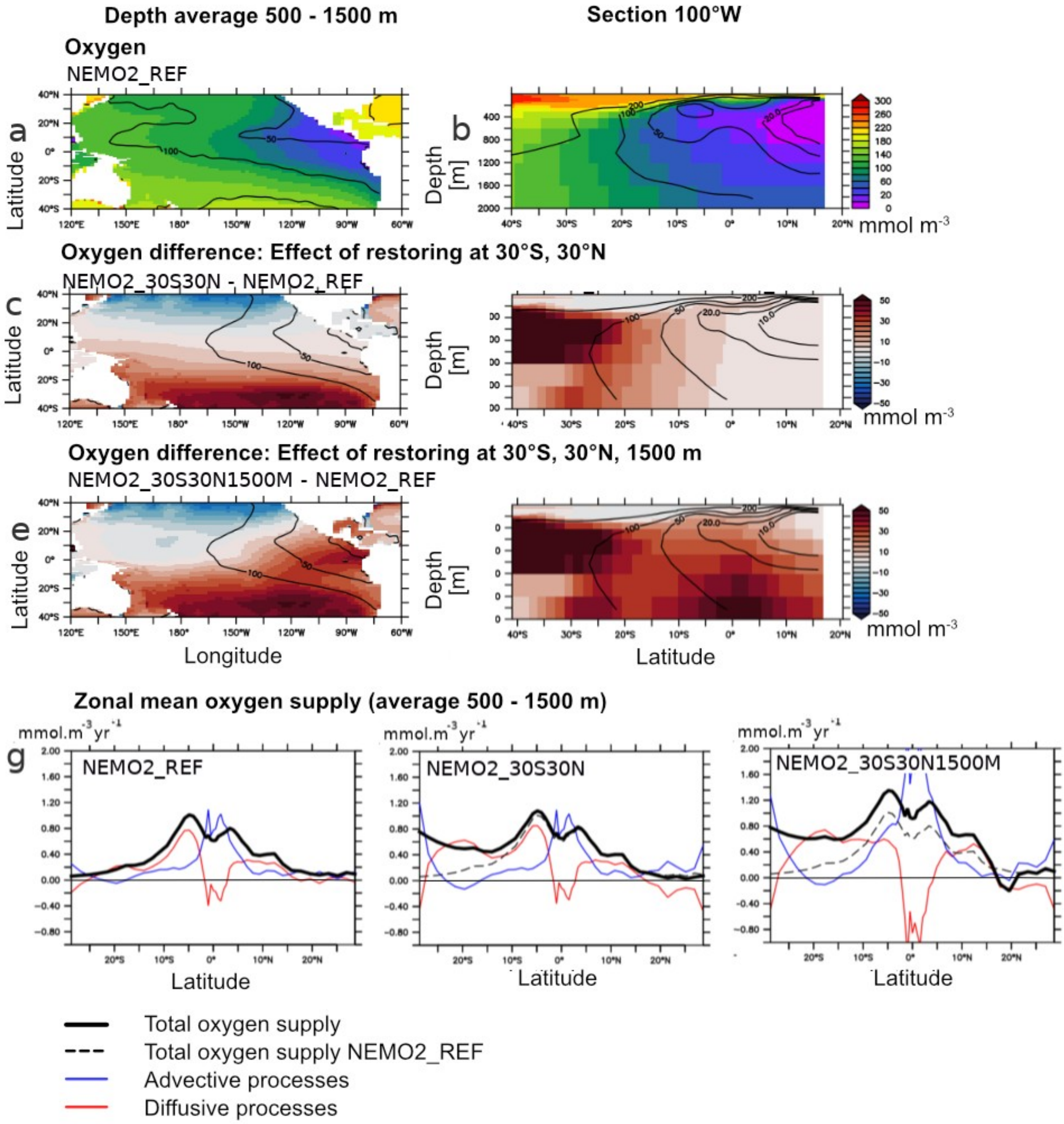


Figure 3 : a,b: Oxygen (mmol.m$^{-3}$) in the experiments NEMO2_REF (color) and World Ocean Atlas (contour) (a- average 500-1500 m, b- 100°W). c,d: Oxygen (mmol.m$^{-3}$) difference (c- average 500 – 1500m, d- 100°W) between the experiments NEMO2_30S30N minus NEMO2_REF. e,f : Oxygen (mmol.m$^{-3}$) difference (e- average 500-1500m, f- 100°W) between the experiments NEMO2_30S30N1500M minus NEMO2_REF. g- basin zonal average (average 500 - 1500 m) of the oxygen total supply (bold) (mmol.m$^{-3}$.year$^{-1}$), advective processes (blue) and isopycnal diffusion (red) in NEMO2_REF, NEMO2_30S30N, NEMO2_30S30N1500M. The dashed line is the oxygen total supply in NEMO2_REF.

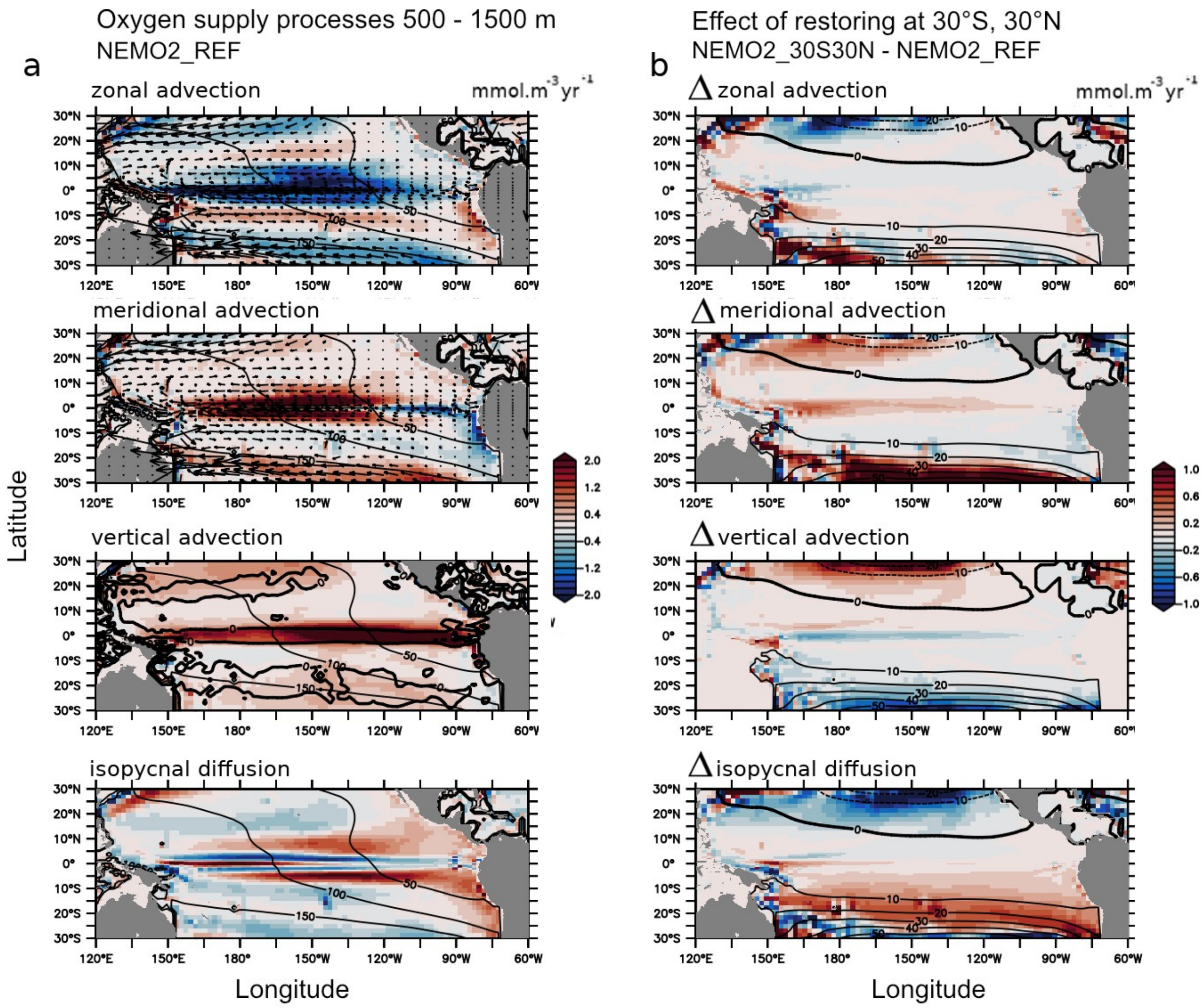


Figure 4 : a- Oxygen supply processes (mmol.m$^{-3}$.year$^{-1}$ – average 500 - 1500m) in NEMO2_REF : zonal advection, meridional advection, vertical advection, isopycnal diffusion. The mean meridional and zonal currents are displayed as vectors (meridional, zonal advection). The mean vertical current (0 isoline) is represented as bold contour (vertical advection). Oxygen levels (mmol-m.$^{-3}$) are displayed in black contour. b- Difference in oxygen supply processes (mmol.m$^{-3}$.year$^{-1}$ – average 500-1500m) between NEMO2_30S30N and NEMO2_REF : zonal advection, meridional advection, vertical advection, isopycnal diffusion. The NEMO2_30S30N – NEMO2_REF oxygen anomaly (mmol.m$^{-3}$) is displayed in contour.

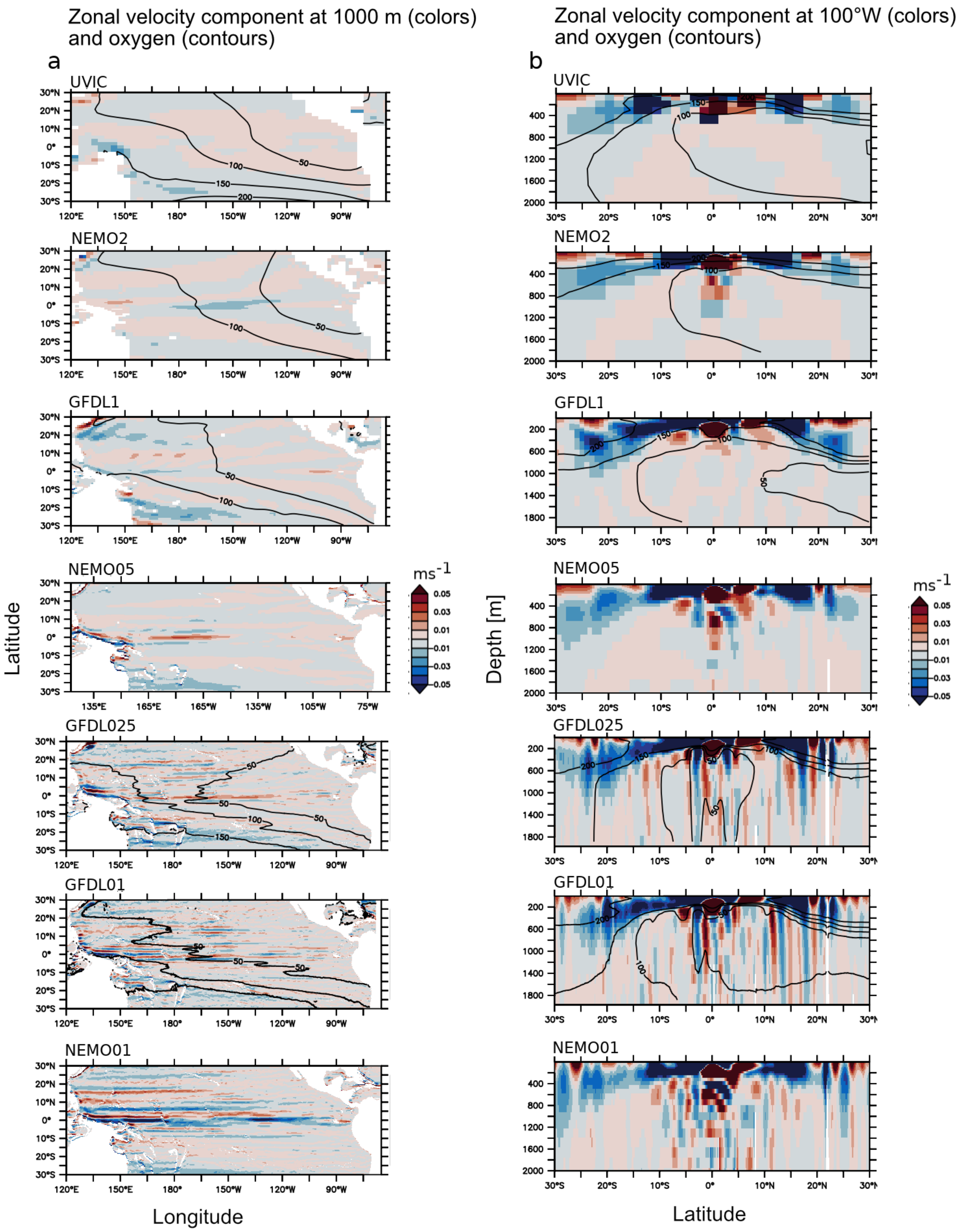


Figure 5 : mean currents velocity ($ms^{-1}$) at a- 1000 m depth b- 100°W in UVIC, NEMO2, NEMO05, GFDL025, GFDL01, NEMO01. The mean oxygen levels ($mmol.m^{-3}$) (when coupled circulation-biogeochemical experiments have been performed – see Table 1) are displayed in contour

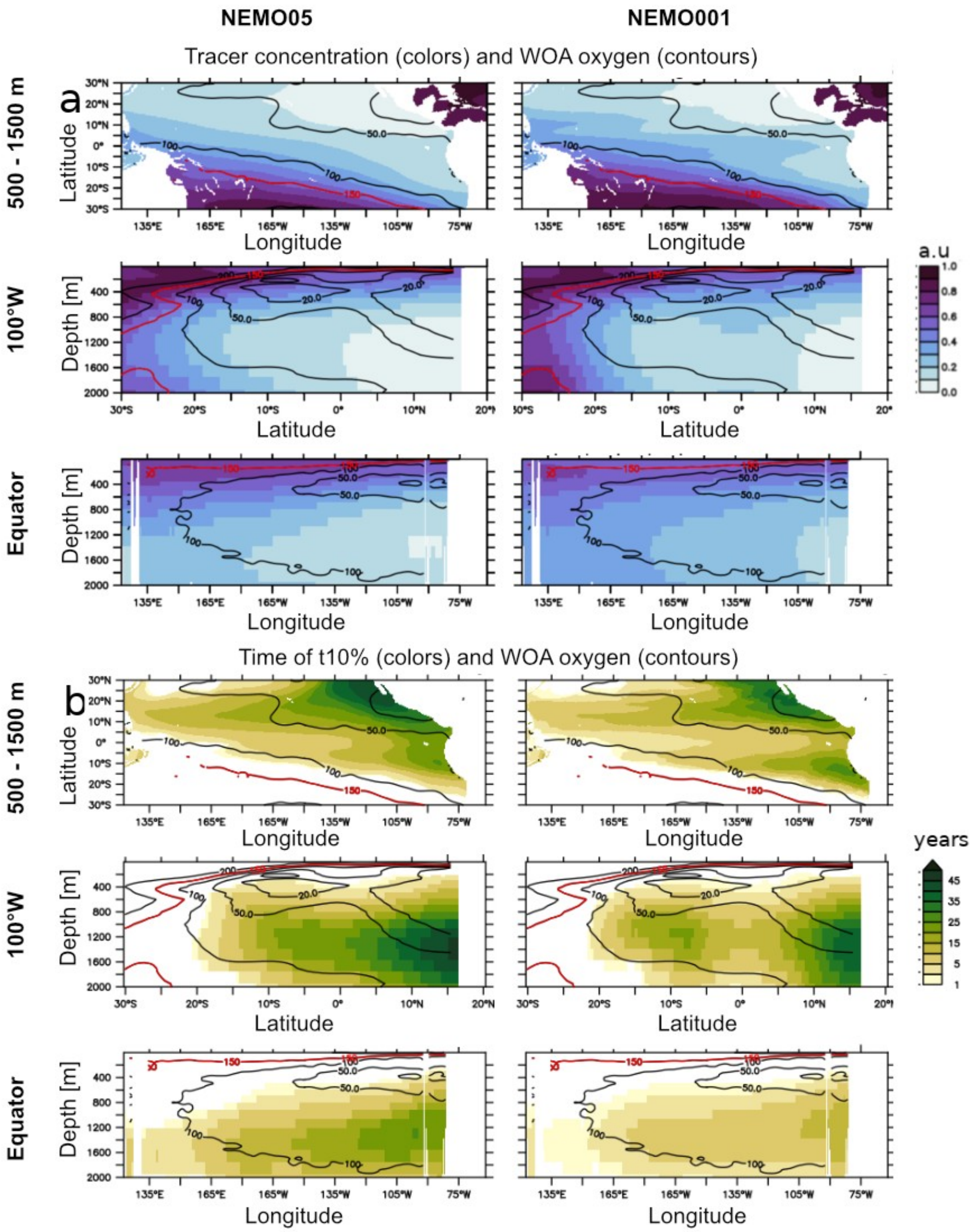


Figure 6: a : tracer concentration (arbitrary unit) after 60 years integration in NEMO05 and NEMO01: average 500-1500m, section 100°W, equatorial section. b: Time (years) at which the released tracer reaches the concentration 0.1 (t10%) in NEMO05 and NEMO01: average 500-1500m, section 100°W, equatorial section. In all the subpanels, the WOA oxygen levels are displayed in contour. The red contour is the WOA 150 mmol.m$^{-3}$ oxygen isoline, used to initialize the tracer level.

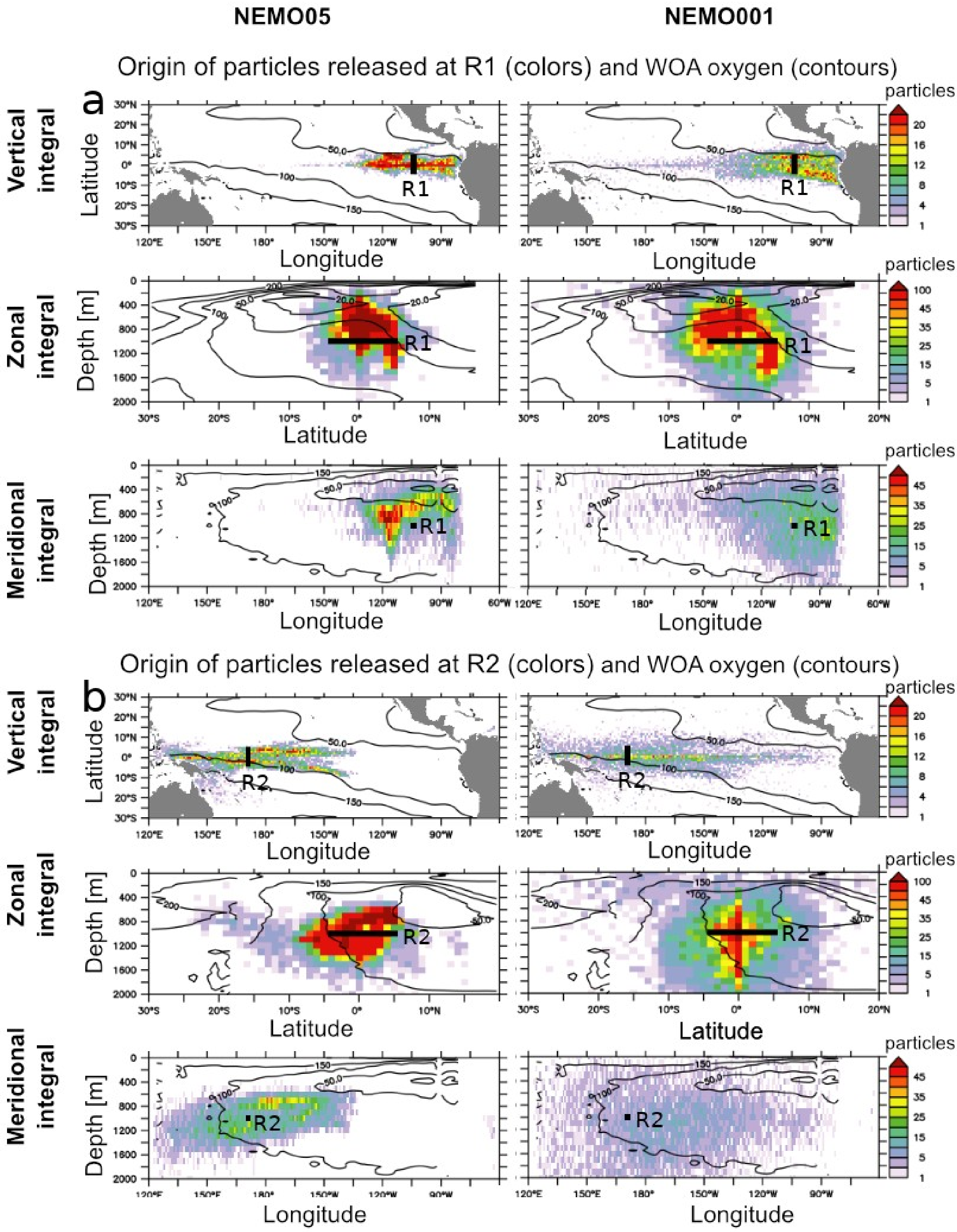


Figure 7 : Density (number of particles in a 1°x1°x100m depth box) distribution of the location of released Lagrangian particles (15 years backward integration starting from the final experiment state) in NEMO05 and NEMO01. The release location is identified in bold and is located a- at 100°W/5°N-5S/1000 m depth (R1). b- at 160°E/5°N-5°S/1000 m depth (R2). The particles have been integrated vertically, zonally and meridionally. The observed mean oxygen levels (WOA) are displayed in contour.

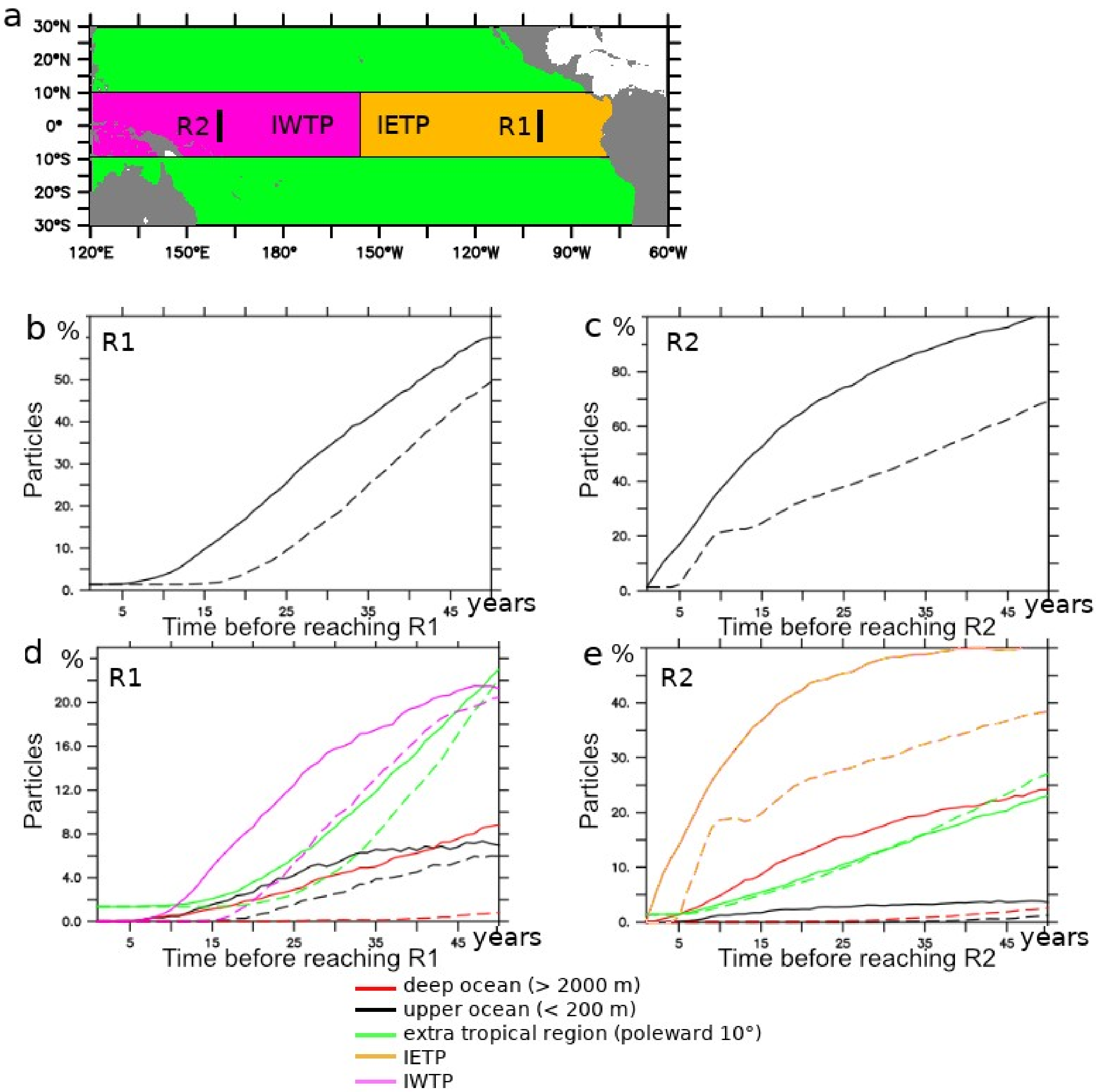


Figure 8 : a- schema summarizing the releases (R1: 100°W / 5°N-5°S / 1000 m , R2: 160°E / 5N°5S / 1000 m) location, the IETP (Intermediate Eastern Tropical Pacific), IWTP (Intermediate Western Tropical Pacific) regional extension. b. percentage of particles (release R1) originating from outside the IETP ocean region. b- percentage of particles (release R2) originating from outside the IWTP ocean region. d- percentage of particles (release R1) originating from the upper ocean (shallower than 200 m), the deeper ocean (deeper than 2000 m), subtropical regions (poleward 10°), the IWTP. e- percentage of particles (release R2) originating from the upper ocean (shallower than 200 m), the deeper ocean (deeper than 2000 m), subtropical regions (poleward 10°), the IETP.

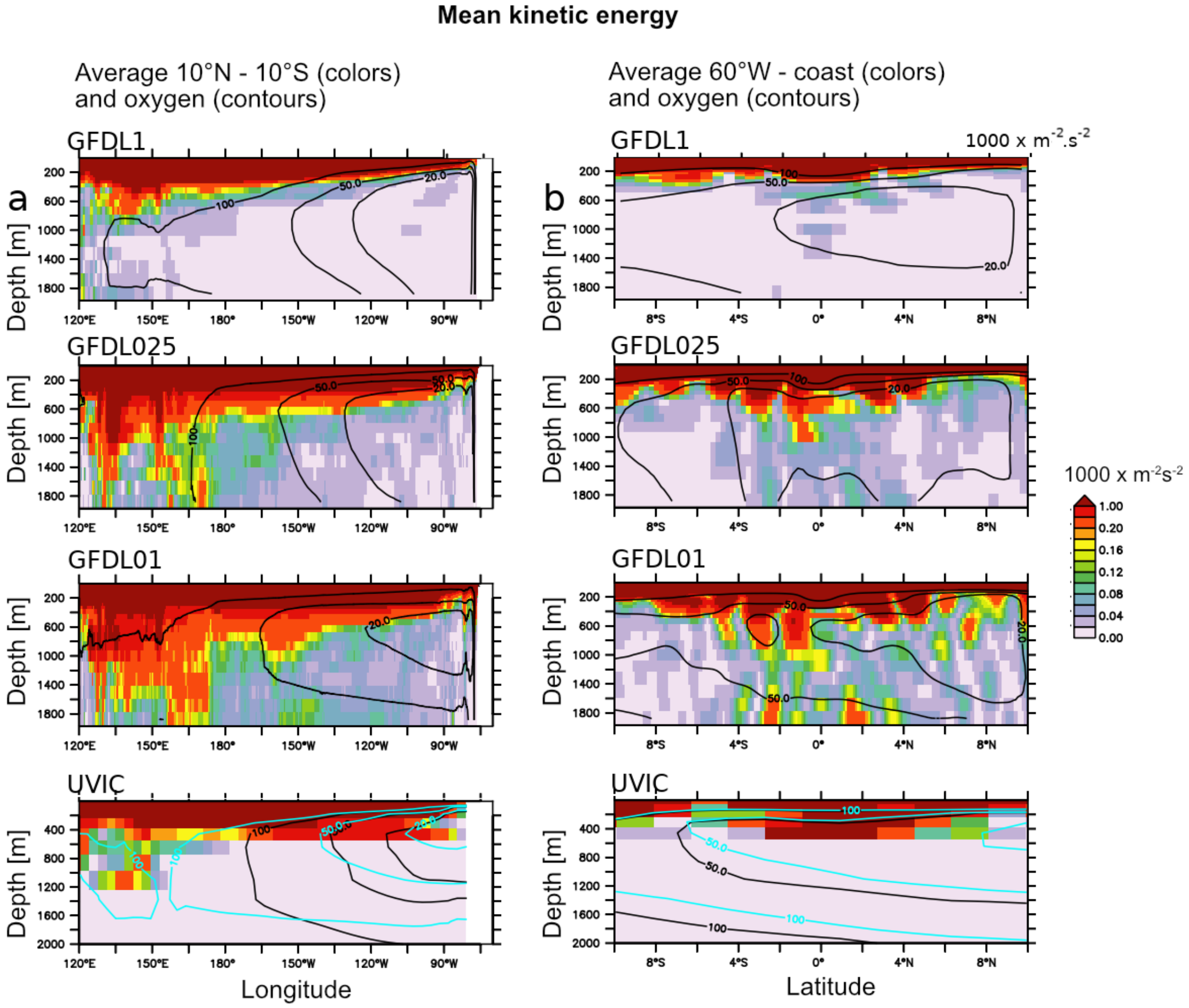


Figure 9 : a - Mean Kinetic Energy (m2.$s^{-2}$ x 1000) (average 10°N-10°S) in GFDL01, GFDL025, GFDL01, UVIC, b - similar to a. but average 160°W- coast. Oxygen levels (mmol.$m^{-3}$) are displayed in black contour. The blue contour corresponds to UVIC GD13 (Getzlaff and Dietze, 2013, including an anisotropical increase of lateral diffusion at the equator)

Table 1 :

| Model | Resolution | Atmosphere | Integration (years) | BGC | Model Reference (circulation) | Model Reference (BGC) |
|---|---|---|---|---|---|---|
| **Mean state comparison** | | | | | | |
| UVIC | 2.8° | Coupled (temperature, humidity)<br>Forced (NCEP/ NCAR wind stress) | 10000 | UVIC-BGC | Weaver et al., 2001 | Keller et al., 2012 |
| NEMO2 | 2° (0.5 eq) | Forced COREv2 "normal year" | 1000 | NPZD-O2 | Madec et al., 2015 | Kriest et al, 2010<br>Duteil et al., 2014 |
| GFDL1 | 1° | Coupled | 190 | BLING | Delworth et al, 2012, Griffies et al, 2015 | Galbraith et al., 2015 |
| GFDL025 | 0.25 ° | Coupled | 190 | BLING | | |
| GFDL01 | 0.1° | Coupled | 190 | BLING | | |

**Process oriented experiments**

| Model | Resolution | Atmosphere | Integration (years) | BGC | Characteristics |
|---|---|---|---|---|---|
| NEMO2<br>-REF<br>-30N30S<br>-30N30S1500M<br>(section 2.2.1) | 2° (0.5 eq) | Forced COREv2 1948-2007 | 60 | NPZD-O2 | - control experiment<br>- O2 restoring to WOA at 30°N/30°S<br>- O2 restoring to WOA at 30°N/30°S/1500m |
| NEMO05<br>(section 2.2.2) | 0.5° | Forced COREv2 1948 - 2007 | 60 | Tracer release | - Tracer initialized to 1 (O2 WOA > 150 mmol.m-3) or 0 (O2 WOA < 150 mmol-m-3) |
| NEMO01<br>(section 2.2.2) | 0.1° | Forced COREv2 1948 – 2007 | 60 | Tracer release | |