

Review 2 of Berthet et al. – How does the phytoplankton-light feedback affect marine N₂O inventory?

The authors have carefully revised their manuscript in response to the reviewer comments, and I believe the manuscript has improved substantially as a result and is ready to be published with a few minor revisions. Below I focus on the responses to my own comments and on the revised manuscript. I just have one major comment concerning the steady-state of the model and if this comment is adequately addressed in the revised manuscript, the manuscript can be published.

Major comments

Looking at the response to my previous review and from the revised manuscript, the authors clearly state that their model is in steady-state. I understand that the spin-up is in steady-state after running for 2000 years but I really question the fact that after 20 years of simulations, the model simulations are in steady state. A good argument to say that their simulations are not in steady-state is Fig. 1. This figure shows an increase of OHC300 over the whole simulations (1999-2018). If the model would be in steady-state during the “simulations period”, the OHC300 would be constant and not fluctuate anymore after a certain period of time. I think the simulations are too short (only 20 years) to reach a steady state. This point should be clearly stated in the manuscript.

Moreover, is PLF taken into account in the spin-up ?

Minor comments

The line numbers correspond to the tracked changes version of the manuscript.

Line 34-36: Please rephrase.

Line 41: Replace “effect” by “process”.

Line 43: Replace “biophysical” by “biogeophysical” and same for the rest of the manuscript.

Line 44: Replace “which leads” by “leading”.

Line 67-69: Replace “is consistent” by “is the same as”.

Line 75: Replace “included to” by “included in”.

Line 78: Replace “affected” by “affects”.

Line 91: Replace “than to the” by “than the”.

Line 92-93: Replace “amplifies the mean of PLF-induced changes, but without altering the sign” by “amplifies the magnitude of the PLF-induced changes, without altering the sign”.

Line 107-108: is the remote cooling effect at the surface or at the subsurface ?

Line 122: 265-298 times higher ?

Line 257: Replace “consistent” by “identical”.

Line 261-262: Please rephrase.

Line 285: Replace “the year” by “when”.

Line 287: Replace “OHC of deeper layers” by “OHC in the deeper layers”.

Line 297-298: I am not sure by these two lines. Are you results detailed following two different time periods ? One time period covers 10 years (2009-2018) and a second one covers a longer period (1999-2018) ?

Line 326: Replace “comparable to that of our” by “comparable to our”.

Line 329: Replace “accordance” by “agreement”.

Line 331: Replace “order” by “about”.

Legend Figure 3: I would say that the 60°S-60°N is not the tropical band anymore. I would encompass that you calculate the average over the tropical and mid-latitudes band.

Line 335: Replace “branching of” by “switching on”.

Line 338: Replace “weaker profiles” by “smaller/weaker concentrations”.

Line 341: Replace “by comparison” by “compared”.

Line 351: Replace “spin-ups run” by “spin-up runs”.

Legend Figure S4: I am confused by the units. The potential density (y-axis) should be in kg/m^3 as in the main text (line 360). The OHC300 (x-axis) should be in ZJ and not ZJ/yr.

Line 360-362: The sentence can be reduced and directly state “The opposite trend (a reduced OHC300 compared to REF) is simulated when considering a variable vertical profile of CHL (climZVAR).”

Line 362-365: This sentence can be reduced as well, giving “However Figure 1 highlights that the simulation REF does not amplify one of these two trends, as climZCST and climZVAR surround REF.”

Line 370: Replace “Ranges of uncertainty” by “uncertainty ranges”.

Line 373-375: Please rephrase.

Legend Figure 6: The units of N₂O should be μmolN/m² and the units of OHC300 should be ZJ.

Line 446: Replace “along time” by “through time”.

Line 449: Replace “appear a” by “appears as a”.

Line 464: Please define Dpn2o as it is the first time it appears in the main text.

Line 466: I guess you mean surface oceanic N₂O concentrations.

Line 479-481: I don't get the point of this sentence, there is no conclusion. Does the fact that the global N₂O budget of Tian et al. (2020) is only based on five global ocean-biogeochemical, weakens the estimates of Tian et al. (2020) ? Or does this fact mean that the N₂O budget of Tian et al. (2020) means that this budget has high uncertainties ?

Line 487: Replace “in that regions” by “in these regions”.

Line 489: The authors state that “regional N₂O fluxes by 24%” compared to REF. However, is this number true for climZVAR only, for climZCST only or is this number an average of the overestimation for both climZVAR and climZCST ?

Line 506: Replace “experiments” by “simulations”.

Line 515-518: Please rephrase by “The heat perturbations plus the uncertainty... N₂O production result in three N₂O production trajectories through time...”

Line 521: I think it's Northern Hemisphere with capital letters.

Line 528: Replace “experiments” by “simulations”.

Line 531: Replace “In forced ocean simulations” by “In ocean-only simulations”.

Line 550: Remove “in comparison to REF”.

551-552: This sentence can be shortened. Replace “compared to that of the control run REF” by “compared to REF”.

Thank you for considering my input to your research.

Rémy Asselot