

## ***Interactive comment on* “What prevents nitrogen depletion in the OMZ of the Eastern Tropical South Pacific?” by B. Su et al.**

### **Anonymous Referee #2**

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General comments: The authors use a 5-box model in order to explore controls on nutrient and oxygen dynamics in the ETSP OMZ. This work is complementary to a previous study by Canfield et al. (2006) that used a similar approach. Canfield et al. (2006) found that fixed N will persist in the OMZ provided that there is no N<sub>2</sub> fixation in the overlying water. The addition of N<sub>2</sub> fixation to Canfield's model drove the system to sulfate reduction. Recent work has shown that N<sub>2</sub> fixation is in fact closely coupled to zones of N loss (OMZs), however NO<sub>3</sub><sup>-</sup> is not observed to be exhausted as Canfield's model predicted. The current work by Su et al. explores the mechanisms by which NO<sub>3</sub><sup>-</sup> is maintained at non-zero values in the OMZ even while there is N<sub>2</sub> fixation in the overlying waters. They find that this condition is fulfilled when the remineralization rate by denitrification is substantially reduced relative to aerobic respiration. By also adding lateral ventilation and nutrient exchange with the subtropical ocean, the model

C5229

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produces realistic values of O<sub>2</sub>.

It is an interesting topic given the discrepancy of Canfield's model results compared to observations in the OMZs. My main criticism with this work is that the results are not discussed in a way that is easy for the reader to understand. The authors present numerous model configurations although the physical significance of each configuration is not clear, nor do they all appear to be required to reach the conclusions of this work. The results of QM are similar to STD. It does not seem physically relevant to exchange O<sub>2</sub> and 14C but not NO<sub>3</sub><sup>-</sup> and PO<sub>4</sub><sup>-</sup> (VD, VDRD, VI, VIRD). If those configurations were to test the importance of nutrient vs. O<sub>2</sub> exchange, then I think that is sufficiently accomplished by the sensitivity experiments. Also, numerous sensitivity experiments were carried out but it is unclear on which model configuration and/or the relevance of all of the tests (Fig. 4-7). It may improve the reader's understanding if only the minimum number of model configurations needed to illustrate the conclusions of this work were presented. The rest of the model configurations could be placed in an appendix.

Specific comments: Please number all tables, figures, and appendices sequentially as they appear in the text. Some, but not all, examples: p. 11100, ln. 14. "Table 4 and 5" should be "Tables 2 and 3". p. 11101, ln. 15-16. "Appendix D" should be "B". p. 11102, ln. 9. "Appendix B" should be "C". p. 11102, ln. 13. "Table 2" should be "4". Et cetera.

In the "Biogeochemical tracer concentrations" section, most of the configurations where denitrification was not reduced were discussed though not shown in Figs. 2 or 3. There is a large amount of data presented in the figures for the reader to sort through and so it would be helpful if the authors could be more explicit in the text about what data can be found in the figures and what cannot.

p. 11107, ln. 11-15. "Next, a model of nitrogen fixation. . ." Why is this mentioned only here in the paragraph that discussed the VID configuration? Was this not addressed for all of the model configurations in Appendix D and Fig. 9?

p. 11108, ln. 26-. "Compared with VIDRD configuration, total PO<sub>43</sub>- . ." There is much

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11, C5229–C5232, 2014

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discussion of PO43-. Please add panels to Fig. 2 to show PO43-.

p. 11109, In. 13. “The fluxes associated with the fixed-N. . .” The authors refer to the “OB” configuration, however according to Table 6 it is the “OBRD” configuration being discussed. Please clarify.

p. 11109, In. 21-. “In sensitivity experiments. . .” For which model configuration?

p. 11110, In. 20. “The behaviour of the model domain as a small pelagic net NO3-source. . .” Is it a source of NO3- or fixed-N (as the caption for Fig. 4 indicates)? They are close but not the same especially since we are discussing N2-fixation and assimilatory uptake of N by phytoplankton. Also, I do see that the OBRD configuration results in the model domain consistently being a net source of NO3-. Fig. 4 shows that whether or not the model domain is a net source depends on the ventilation of O2 from the subtropical ocean. Or do the authors mean that WHEN it is a source, it is insensitive to physical transport parameters? How could it be insensitive when increased ventilation involves an increase in physical transport of O2? These seem to be contradictory statements. Please clarify.

p. 11110, In. 23-25. “The finding that the model domain. . .D-box is oxic (Fig. 7).” The text implies that the entire model domain is a source of NO3- yet N-influx for only I and D boxes are presented in Fig. 7. Please show all boxes or at least the net of all of the boxes in Fig. 7.

p. 11110, In. 25-28 and Fig. 6. “The oxygen concentrations. . .increase in sensitivity model runs. . .” This is not what Fig. 6 shows. O2 in UM remains zero across variations in 14C.

p. 11111, In. 1-. “The UM box remains anoxic. . .” This statement appears to contradict the first sentence in this paragraph although is consistent with Fig. 6. Please clarify.

p. 11113, In. 29 and p. 11114, In. 1. “we” The authors must mean “they”, referring to Eugster and Gruber (2012).

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11, C5229–C5232, 2014

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Table 3. Please add a short description of each model configuration so the reader does not have to keep flipping back to the text.

Table 5 and Fig. 1. Please be consistent with variable names. “DS” or “SD” for the southern boundary of the deep box? Same for the intermediate box.

Figure 1. Define “SO” in the caption.

Figure 2. Add panels to present phosphate.

Figure 4. Hard to read. Text is too small.

Figure 5. “N source” and “N sink” w/arrows. It is ambiguous what these mean if OBRD is always a net source of NO<sub>3</sub><sup>-</sup> (as the text states). Is the position of these text and arrows on the graph arbitrary?

Figures 9. Since this is only referred to in the appendices, should this also be appended?

Technical corrections: p. 11110, ln. 6. Second to last word in line should be “high” not “hight”.

Table 5. Last 2 lines should be “Southern boundary OXYGEN concentration. . .” not “phosphate”.

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11, C5229–C5232, 2014

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