Comment on bg-2021-6

Anonymous Referee #2

Referee comment on "Nitrogen loss processes in response to upwelling in a Peruvian coastal setting dominated by denitrification – a mesocosm approach" by Kai G. Schulz et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-6-RC2, 2021

This paper reports results from an incredible experiment using mesocosms in an upwelling off of Peru and from measurements of in situ conditions in the real ocean. One set of mesocosms received deep water with moderate levels of NO3+NO2 while another got deep water with no measurable oxidized inorganic N. (The authors could say more about can be learned from the differences between the two treatments.) Over time, the authors measured inorganic nitrogen compounds, O2, and H2S, and estimated rates of the two dominant nitrogen loss processes: denitrification and anaerobic ammonium oxidation (anammox).

It would help if the authors identified more clearly the goal of the study. They say it was to "quantify the importance of nitrogen loss processes," but that's a bit vague. We know they are important. The paper has a lot about the nitrogen budget and about comparing the mesocosms to the real Pacific, but I think all that should be minimized. The mesocosms were contaminated by birds and the added 15N apparently stimulated rates.

I think the authors should concentrate on comparing dentification vs. anammox. As mention below in more detail, they don't address why their rates of anammox were low compared with previous studies and why anammox apparently was lower in the mesocosms than in the real ocean. Anything the authors could add to the question about the relative importance of the two processes would likely be very interesting and attract future readers.

 Specific comments

L8: I think "actual" is better than "realized."

L9: I suggest removing the comparison of rates in the mesocosm with rates in the real ocean.

L28: Note the misspelling, "denitriciation."

L40: Higher temperature explains oxygen loss in the upper water column, but only accounts for about half of the loss in deeper waters.

L43: Missing a word like "waters."

L74 and elsewhere: "umolL^-1" should be "umol L^-1"—a space between umol and L.

L83: Rather than emphasizing N:P ratios, I think the authors should emphasize that the extreme condition had unmeasurable NO3 and NO2 and a more negative N* than the moderate condition.

L93: Rather than "aka DNRA", the authors should just define DNRA. It's defined much later in the paper, but it should be here when the abbreviation is first used.

L95: Note the misspelling here, "failry." I will stop noting other misspelling that the spellchecker on Word or other word processing programs would catch. The authors should assume the journal won't do much copy editing.

L143: Rather than "orin-eutrophication," I suggest "avian eutrophication."

L180: Fig A3 seems to be referred to before Fig A1 and A2, which is not standard practice.

L204: The authors emphasize that the "theoretical" sustainable rate of denitrification is based on changes in NO3+NO2 concentrations. But what about nitrification supplying NO3+NO2? The authors seem to imply nitrification didn't occur because of the ack of oxygen, but the gas was measurable, perhaps at levels high enough for nitrification.

L226: The authors have a table and a very complex, four-panel figure (see below) about the multi-variable linear regression work, but all that is accompanied by two short

paragraphs. That's an indication that the figure and the table are overkill. Readers will care only (if they do at all) about the best model, not the rest of the stuff given in the figure.

I guess I see some value of this regression analysis, but there is more about it in the Results than in the Discussion.

L227 and elsewhere: The authors shouldn't use "measured/maximum" because it's ambiguous. Which is it? The measured rate or the highest one? At the very least they should define what they mean, but I don't think the term should be used at all.

L256: I think it doesn't make sense that NO_2^- is more important than NO_3^- in driving denitrification. This is worth a brief explanation, perhaps.

L303: The authors end this section with textbook stuff about denitrification vs anammox with a generalization about which can be observed in the absence of the other. I think much of this can be deleted and replaced a more critical discussion of their data.

The authors need to grapple with the more important and novel findings from their study: that anammox wasn't as high as measured in previous studies and that it wasn't as high (I don't believe) in their mesocosms than in the real ocean.

L204: Not picked up by a spell-checker: it should be "absence," not "absences."

L297: What do the authors mean by "anammox dominance"? They didn't see that, and the theoretical maximum contribution by anammox is only 28%.

L306: This section about organic matter C/N should be deleted. The authors found a typical Redfield ratio, but then spend several sentences arguing against their data. The entire paragraph doesn't add enough to the paper to be worth taking up space in the Discussion.

L381: The paper ends very abruptly. I'm not a fan of ending papers with a summary, but it would be nice to see something about the implications of the authors' work for the Big Picture.

Table 1: Note that NO2- has just one negative charge—it's not NO2^-2.

Table 2: Data in this table can be used to make several comparisons, which complicates it: the moderate vs. extreme treatments, 15N rates vs. concentration changes, mesocosms vs the real ocean, and denitrification vs. anammox. I suggest the authors need to re-think the design of this table and use another format, break it up, or put some data in a figure.

I wonder if the rate data could be displayed better in a figure with the averages for each type of mesocosm. A table with all of the data for each mesocosm could be given in supplemental materials. The reader doesn't need to see results from each mesocosm.

If the table is kept, the formatting needs to be improved. Colors and ( ) to denote different types of data should be avoided because the main body of the table can't be understood without looking at the table caption, making the reader work harder than necessary.

Rather than red and blue, the authors can put "moderate" or "extreme" by the appropriate mesocosm number in the leftmost column. Rather than using green to indicate the anammox numbers, just put another row for each mesocosm and the label "anammox." I think it should be given for each mesocosm and a "0" (zero) given also where appropriate, to make clear the process was examined but the rate was below detection.

The difference in NO3+NO2 concentrations (the "maximum" denitrification rate) is given for only a few of the time points and mesocosms. It should be given for all, even if it is zero. I wonder if this concentration change should be moved to another table. If kept, it deserves to have a row label, like just suggested for anammox.

I think it's important to give integrated rates for anammox vs. denitrification, so readers can evaluate how the two processes compared for the mesocosms versus the real ocean.

Finally, the overall average and its SD for all mesocosms and the Pacific Ocean are rather meaningless. The authors should report the average and error for the two types of mesocosms alone, so that readers can compare them vs. the ocean. To facilitate that, the authors should rearrange the order of mesocosms so that all of the moderate treatment mesocosms are first and its average +/- SD, followed by the extreme treatment and its average +/- SD.

Table 3: The caption should say that the regression analysis was done to explain the rate of denitrification.

Figure 1: This figure is more appropriate for a textbook or a review paper, not this paper. It should be deleted. Maybe one of the figures now in supplemental materials, such as Fig A2, could be upgraded to the main paper.

Figure 3: The authors should say explicitly that M1-M8 are mesocosms. "Bottom" in all of the y-axis labels can be deleted and moved to the figure caption. The labels would be cleaner and easier to read.

Figure 4: Note that NH4- should be NH4+.

Figure 5:   Most of this figure doesn't make sense to me, and it seems overkill. It should be deleted. A table summarizing the best model would suffice.

Figure A4. Explain the symbols and colors, etc. Don't force readers to work and go back to Figure 3.