Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2018-511-RC2, 2019

Biogeosciences Discussions

Interactive comment on "Nutrient distribution and nitrogen and oxygen isotopic composition of nitrate in water masses of the subtropical South Indian Ocean" *by* Natalie C. Harms et al.

Anonymous Referee #2

Received and published: 11 February 2019

This is an interesting paper, with a lot of valuable information from a region that has not had much attention with respect to nitrate isotopes. The connection to the water mass structure was well done. There are some points that require clarification, especially the calculation and discussion of nitrogen fixation inputs. These comments and others are detailed below.

Abstract

Page 1, line 20: I would remove 'strong' here, as N* of -1 μM would not generally be considered "a strong N deficit".

Page 1, lines 21-23: Please clarify what you are referring to here using "preformed ver-

sus regenerated". The preceding sentence referred to nitrate isotope signals coming from SAMW and from denitrification in the Arabian Sea. Where is the 'regenerated' signal that you are referring to?

Page 1, lines 23-25: If there is significant N2 fixation, I would not expect low nitrate to phosphate ratios. Revisit the N2 fixation discussion below.

Introduction

Page 2, line 21: I think a reference to Gruber and Sarmiento, 1997 would be appropriate here.

Page 2, lines 29-30: The isotopic fractionation factor, ε, relates the instantaneous product, not the accumulated product, to the substrate. Though neither is explicitly stated, I think the implication is that this always holds true. This should be clarified.

Materials and Methods

Page 6, line 14: How is the 'single point correction' for δ15N applied? Is this simply a standard subtraction?

Results

Page 6, line 29: What water mass does the 34.6 PSU feature represent?

Figure 2: It might be more helpful to include contours for the potential density surfaces, rather than contouring the same properties represented on the color bar.

Pages 7 and 8: I don't understand the choices behind what is shown in Tables 2 and 3. Why are these specific density/depth intervals selected, and why look at different density levels in the different latitude zones? Why are only one nitrate and phosphate concentration (Table 2) or nitrate δ15N and δ18O value (Table 3) given for each line? How many measurements are included in these values? Shouldn't there be a range or uncertainty given for these if they derive from a range in latitude?

Throughout this presentation of results in sections 3.2 and 3.3, I found referring to Figure 5 more useful than consulting Tables 2 and 3. I would suggest moving Figure 5 earlier in the paper, and removing Tables 2 and 3, or perhaps moving them to the supplement, unless their relevance can be better explained.

Page 7, line 6: I would delete 'strongly'. When working in oligotrophic areas, I'm not sure 5.9 μM nitrate qualifies as "strongly depleted". Otherwise, you could perhaps cite the concentration of nitrate in the surface waters, rather than at 310 m.

Discussion

Page 10, line 27: Please clarify "decrease of the oxygen minimum". Do you mean that the oxygen concentration is increasing? If so, please rephrase.

Figure 3: I didn't find this figure necessary, and suggest that it be moved to the supplement.

Figure 4: I think this figure is extremely helpful for thinking about the water mass structure of the region! My only question is what determines where the lines dividing water masses are drawn? Are these specific sigma theta surfaces? Please clarify.

Figure 6: The figure legend states that the color bar indicates potential density, but what is actually used is depth. Perhaps sigma theta would, in fact, be better.

Page 15, line 16: Doesn't iron availability also play a role in incomplete nitrate assimilation in the Southern Ocean?

Page 17, line 3: Please clarify "lower water depths". Do you mean shallower or deeper?

Figure 8: The yellow star representing the mean nitrate δ15N does not stand out. I would suggest making this symbol a different color or shape. Also, please provide the slope of the solid line in the figure legend.

Page 17, line 11: Typo, should be 'SAMW' rather than "SAWM".

Page 17, line 14: Please give Sigman et al., 2005 reference to Δ(15,18). Rafter et al (2013) is also a good reference, but uses Δ(15-18) instead.

Page 18, line 16: I would include a reference here to Gruber and Sarmiento 1997 for their seminal work in this area.

Page 18, line 24: One could also reference work in the Atlantic from Knapp et al., 2008, and a variety of work from the Pacific.

Page 19, lines 7-8: What are the implications of assuming Redfield stoichiometry here?

Page 19, line 10: This equation appears incomplete, if not incorrect. From the text, I would not expect PO43-sample to appear in the denominator.

Page 19, line 12: What is the N:P ratio assumed for newly fixed N? This seems important to the calculations performed here.

Page 19, lines 20-23: A newly fixed δ15N of 4.8‰ is not within the range of expected values for N2 fixation. This seems problematic, and requires reevaluation and justification of the approach used to arrive at this value. In my mind, a value of +4.8‰ argues against this N deriving from N2 fixation. What other explanations have the authors considered?

Figure 9: It is difficult to distinguish the symbols used to represent the two geographic areas in panel a. What calculation is used to derive the gray line in panel a?

Page 20, line 16: Is low temperature the only other possible explanation? Increasing numbers of reports are finding N2 fixation at low temperature, thus the temperature limits seem to be a less convincing argument. What other contributing factors could be here?

Page 21, lines 10-11: Can you make any connection here to the results of Martin and Casciotti, 2017 from the Arabian Sea?

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