

Interactive comment on “Nitrogen cycling in the Southern Ocean Kerguelen Plateau area: evidence for significant surface nitrification from nitrate isotopic compositions” by F. Dehairs et al.

Anonymous Referee #2

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DeHairs et al. argue that nitrification above the Kerguelan Plateau (in the Southern Ocean) “could account for up to 80% of nitrate uptake” in the region (note to authors, I understand what you are trying to say, but this is awkward phrasing). They base this conclusion on a few lines of evidence: the $\delta^{15}\text{N}\text{-NO}_3$ and $\delta^{18}\text{O}\text{-NO}_3$, nitrate and silicate concentrations, and calculations incorporating all of their observations.

First, the nitrate isotope evidence. The upper ocean $\delta^{15}\text{N}\text{-NO}_3$ and $\delta^{18}\text{O}\text{-NO}_3$ above the Kerguelan Plateau (in the Southern Ocean) has a much smaller difference than the putative source nitrate below, suggesting that nitrification is altering the nitrate pool (see references in text). It is unfortunate that nitrite was not removed from their samples before being measured because (as the authors know and write) the inclusion of nitrite

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will produce the same lowering of $\delta^{15}\text{N}$ versus $\delta^{18}\text{O}$ that they are trying to understand. It is possible and perhaps likely that nitrite is only amplifying the lowering of $\delta^{15}\text{N}$ versus $\delta^{18}\text{O}$, but there is no way to know without the removal of nitrite. I would be much happier if the study showed measurements with and without nitrite so that the readers can understand the impacts these might have on the conclusions. Can this be done? If not, the text should be changed to lower the significance of these results.

As for the nutrient concentration evidence, the nitrate and silicate concentration data in Table 1 does not clearly show a depletion of silicate relative to nitrate except for the 3 stations at the Polar Front. The difference between mixed layer silicate (about $15\ \mu\text{M}$) and nitrate (about $26\ \mu\text{M}$) at the 15 other stations should not be described as silicate “depleted,” even if the uptake does not appear to be 1:1 with nitrate.

It is confusing that the manuscript never proposes a reason to explain such high nitrification. One possible explanation that is not explored in the manuscript is that the sediments are playing a role. Shallow sediments can be an important source of ammonia / ammonium, nitrite, and nitrate (as Granger et al. 2011 showed in Bering Sea shelf sediments). In fact, the ammonium and nitrite concentrations are highest just above the Kerguelan Plateau sediments (see Figure 6a). It may be that sedimentary nitrification has a negligible influence on open ocean waters off the Kerguelan Plateau, but this is not discussed or quantified. As it is, sedimentary ammonification/nitrification is only mentioned as a potential influence from the slope sediments on the deep waters (>2000 m).

Another confusing aspect of the manuscript is the reference station, which shows the same isotopic feature (lower $\delta^{15}\text{N}$ relative to $\delta^{18}\text{O}$) even though this station is “up-stream” of the Plateau. Does this say that there is nitrification occurring on and off the Plateau? Or is this a case of including nitrite in the measurements? These are outstanding questions that need to be addressed.

More detailed comments

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Page 13909 Line 15: “bound to the south” is confusing. I don’t know what you mean by this. Line 20: “till the sill” Don’t understand.

Page 13910 Second paragraph. I cannot understand this paragraph and it is composed of a run-on sentence. Line 14: should read “superimposed”

Page 13912 Line 7: remove “are”

Page 13915 First paragraph. The idea behind identifying the isotope effect of nitrate uptake / utilization using a Rayleigh model needs to be introduced.

Page 13916 Line 23: should be “which is not the case here”

Line 18: define LADCP

Page 13924 The equations (and what they mean) would be significantly improved if there were an equal sign and designation of what they equal!

Line 11: “weighted” instead of “weighed”

Page 13925 Line 19: Sensitivity tests are good.

Last sentence: does this sentence say that nitrification produces 52% of the nitrate consumed? Or is the nitrification rate 52% of the nitrate uptake rate? Confusing sentence.

Page 13927 Line 4: typo? “, and (Mosseri et al., 2008)”

Table 1 Listed stations don’t match stations in Figure 1

Table 2 Asterisk should refer to an asterisk within the table text, which there is none. This comment should probably be integrated into the Table summary.

Table 3 Look over text. Too many plural forms of nouns (e.g., should just read “concentration”).

Figure 1: text is too small and no description of the yellow dots.

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Figure 3: should include plot of $\Delta(15,18)$

Figure 5: the Polar Front stations look green to my eye (not blue). Not sure these figures are necessary.

Figure 6: should include plot of $\Delta(15,18)$

Figure 8: X and Y axes should be equal length. Difficult to interpret the figures when the X axis is so much longer than the Y.

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