Review of Harms et al.

General comments

Harms *et al.* report concentrations of water-column nutrients and stable isotope composition of nitrate for the subtropical South Indian Ocean. They discuss their results in relation to the different water masses and estimate that one third of the nitrate in the upper ocean is supplied by N_2 fixation in this region. While, the study is interesting as few isotopic data exist for the subtropical Indian Ocean, it is difficult to appreciate the new findings from their discussion. Second, they estimate the contribution from N_2 fixation using N*, and assuming a Redfield ratio of 16, which might not be valid in a region where N_2 fixers are abundant. They do not discuss other N sources (e.g., atmospheric depositions). More importantly, their interpretation would benefit from better exploiting the information derived from the dual isotopic composition of nitrate, perhaps using a simple isotope box model, as in Knapp *et al.* (2008) and Bourbonnais *et al.* (2009).

Specific comments

Abstract

Generally, the abstract should better indicate what are the new findings.

Page 1, line 20: N* < 1 µM is not a strong N deficit relatively to other regions of the ocean where N deficit is close to 40 µM (see Bourbonnais *et al.*, 2015). What is the analytical error on their N* estimate? Also, indicate depth of the minimum N*.

Page 1, lines 23-24: Indicate how the contribution from N_2 fixation was estimated (i.e., using N:P and Redfield ratio assumptions).

Introduction

Page 2, line 12: The transition is awkward. Rewrite.

Page 2, lines 20-22: One important caveat is that N* cannot be used to derive rates of N_2 fixation in region where denitrification co-occurs, as the N* signatures associated with denitrification and N_2 fixation are overprinting each other's. One advantage of measuring the dual isotopic composition of nitrate is that it allows disentangling these different overprinting processes, because, as stated later in the manuscript, N_2 fixation is associated with negative N to O nitrate isotope anomalies. On the other hand, denitrification is not expected to produce such N to O nitrate isotope anomalies because N and O are equally fractionated during this process. This point should be better emphasized in the introduction (and better exploited in their discussion).

Page 2, lines 28-29: change for: "lighter isotopes are preferentially assimilated, leaving the substrate enriched in ^{15}N and ^{18}O."

Page 3, line 1: Add references here, e.g., Knapp *et al.*, 2008 and Bourbonnais *et al.*, 2009.

Page 3, line 4: Which depth range corresponds to $\delta^{15}N_{deep}$ and $\delta^{18}O_{deep}$?

Page 3, lines 14-16: Be more specific about the new findings from this study. Which specific gaps were filled comparatively to previous studies?

Materials and Methods

Page 6, line 13: Why using a single point correction only?

Page 6, line 15: What was blank size?

Results:

Page 6, section 3.1: It would be helpful to show T-S diagrams at this point rather than later in the discussion.

Page 7, lines 6-16: Figure 5 (panels a, b, c, d) should be presented in this section and table 2 moved to the supplementary materials.

Page 8, lines 2-13: Figure 5 (panels e, and f) should be presented in this section and table 3 moved to the supplementary materials.

Discussion

Page 9, line 6-7: What is new in their water mass distribution model (Figure 4)?

Page 9, lines 25-26: Change for "… because of respiration and the absence of effective ventilation…"

Pages 9-12: It would be useful to include the nitrate isotopic composition (end-members) for the different water masses, either in figure 4, or in a table.

Page 12, lines 20-21: The NO_3^-/PO_4^{3-} should however increase if N_2 fixation is significant.

Page 13, lines 10-11: How does the mean NO_3^-/PO_4^{3-} ratio changes along the latitudinal transect? What are the implications for N_2 fixation?

Page 14, line 1: Bourbonnais *et al.* (2009) is incorrectly referenced here.

Page 15, lines 5-6 : Add references to support this statement.

Page 16, lines 17-18: Why nitrate utilization is unlikely? It is too deep?

Page 18, line 16 : Bourbonnais *et al.* (2009) is once again incorrectly referenced in this context.

Page 18, lines 21-24: Bourbonnais *et al.* (2009) report a range of 2 to 5‰ for the $\delta^{15}N$ of nitrate in surface waters of the subtropical northeast Atlantic Ocean. Using a simple isotopic mass balance, they estimated that N_2 fixation could account for up to 40% of the export production in this region.

Page 18, lines 29-31: It is peculiar to note that the $\Delta(15,18)$ anomalies observed in this studies are at least half of the anomalies observed in the subtropical northeast Atlantic Ocean by Bourbonnais *et al.* (2009) ($\Delta(15,18)$ of -7 to 0‰). Why would that be if the estimated contribution from N_2 fixation is supposedly in the same range (accounting for 30-40% of new supplied nitrate) for these two regions? The N* observed by Bourbonnais et al. (2009) was also up to ~3.5 µmol/kg.

Page 19, lines 8-9: In equation (6), the nitrate to phosphate ratio (NO_3^-/PO_4^{3-}) is divided by the measured phosphate concentrations, not multiplied.

Page 19, lines 1-23: This approach requires many assumptions. One likely invalid assumption is assuming a Redfield ratio of 16. The Redfield ratio is variable in marine microalgae (see Geider *et al.*, 2002). N_2 fixers also have higher N:P ratios (e.g., Letelier *et al.*, 1998). Finally, this approach does not take into account inputs from atmospheric depositions.

Page 19, line 21: This is confusing, as $\delta^{15}N\text{-}NO_{3\,fix}^-$ (i.e. supplied from N_2 fixation) should be about 0‰. I suggest removing the "fix" subscript.

Page 19, lines 20-23: Overall, the dual nitrate isotopic data could be better exploited in their discussion and used in an isotopic box model to derive an independent assessment of the contribution from N_2 fixation (see examples from Knapp *et al.*, 2008 and Bourbonnais *et al.*, 2009).

Page 20, lines 9-10: Bourbonnais *et al.* (2009) did not observe significant positive $\Delta(15,18)$ anomalies in the subtropical northeast Atlantic Ocean. Which make me wonder what is the propagated (analytical) error associated with their $\Delta(15,18)$ measurements. In other words, is their calculated positive $\Delta(15,18)$ significantly different from 0?

Page 20, line 16: N_2 fixation have been shown to occur at lower temperatures in temperate regions (see Moisander *et al.*, 2010).

Tables

Table 1 is not necessary since the information is already presented in Figure 1. I recommend moving it to the supplementary materials.

Table 2 should be moved to the supplementary materials as this information is already in Figures 3 and 5.

Table 3 should be moved to the supplementary materials as this information is already in Figure 5.

Figures

Figure 1: It is difficult to see the shaded arrow representing the South equatorial current.

Figure 6: What is the r^2 and error on the slope?

Figure 7b: Which processes cause the positive $\Delta(15,18)$?

Technical comments

Page 1, lines 30-31: this sentence is repetitive. Replace by something like: "The South Indian Ocean is dominated by a subtropical anticyclonic gyre (refs), the Indian Ocean subtropical gyre" (IOSG), one of the major subtropical gyres in the world's ocean. The IOSG has been, thus far, sparsely investigated."

Page 2: line 2: Use the IOSG acronym defined earlier.

Page 3, line 10: Remove "Therefore" at the beginning of sentence.

Page 12, line 7: change for " nutrient distribution and N cycle processes"

Additional references (not already in cited literature):

Bourbonnais, A., Altabet, M. A., Charoenpong, C. N., Larkum, J., Hu, H., Bange, H. W., & Stramma, L. (2015). N-loss isotope effects in the Peru oxygen minimum zone studied using a mesoscale eddy as a natural tracer experiment. *Global Biogeochemical Cycles*, *29*(6), 793-811.

Geider, R. J., & La Roche, J. (2002). Redfield revisited: variability of C [ratio] N [ratio] P in marine microalgae and its biochemical basis. *European Journal of Phycology*, *37*(1), 1-17.

Knapp, A. N., DiFiore, P. J., Deutsch, C., Sigman, D. M., & Lipschultz, F. (2008). Nitrate isotopic composition between Bermuda and Puerto Rico: Implications for N2 fixation in the Atlantic Ocean. *Global Biogeochemical Cycles*, *22*(3).

Letelier, R. M., & Karl, D. M. (1998). Trichodesmium spp. physiology and nutrient fluxes in the North Pacific subtropical gyre. *Aquatic Microbial Ecology*, *15*(3), 265-276.

Moisander, P. H., Beinart, R. A., Hewson, I., White, A. E., Johnson, K. S., Carlson, C. A., ... & Zehr, J. P. (2010). Unicellular cyanobacterial distributions broaden the oceanic N2 fixation domain. *Science*, *327*(5972), 1512-1514.