

Interactive comment on “Contrasting biogeochemistry of nitrogen in the Atlantic and Pacific oxygen minimum zones” by E. Ryabenko et al.

Anonymous Referee #2

Received and published: 4 October 2011

The authors present a comparison of N species concentrations and nitrate isotope ratios in the OMZs in the Eastern Tropical North Atlantic (ETNA) and the Eastern Tropical South Pacific (ETSP) off Peru. They report on significant differences in both N concentration profiles and N isotope behaviour.

Such measurements have been made before in the same ocean regions, and depth distributions of N₂O, NO_x, as well as nitrate $\delta^{15}\text{N}$ have been described and attributed to specific N cycle transformations (e.g., Codispoti et al. *Sci. Mar.* 2001; Casciotti and McIlvin, *Mar. Chem.* 2007). This paper does not really provide new insights with regard to the N biogeochemistry of the two OMZs, and I do not really see the added value in

C3437

comparing the two environments. In fact, I was wondering about the sense of such a comparison. Yes, we know that the OMZ of the ETSP displays O₂ concentrations in the core of the OMZ, which allow for denitrification and anammox. We also know that water column fixed-N elimination does not occur in OMZ with O₂ concentrations >50 $\mu\text{mol/L}$, as observed in the ETNA. And finally, we also already know that nitrate reduction occurs with a significant N isotope effect, and it seems obvious that we thus see clear N-isotope signals of such N-elimination in the Pacific but not in the Atlantic (at least not in the studied region). In this regard, the concluding statement in the summary “This difference can be due to N-loss in the Pacific, increasing the $\delta^{15}\text{N}$ signal. . .” appears trivial to me.

What we do not know in detail is the importance of anammox in active nitrate-reduction zones, what controls the anammox-denitrification ratios in N-eliminating OMZs, and how we can use the information from N species concentration and isotope ratio profiles to constrain the relative importance of anammox versus denitrification. This aspect has been mentioned in the introduction, but it is essentially not addressed in the discussion. Obviously, the upper water-column N₂O concentration and nitrate isotope signals have nothing to do with the processes that occur, or do not occur, in the OMZ below. So, these parts of the discussion seem to be out of the scope of the paper, at least according to the title of the paper. However, I concur with the other reviewer, that the most interesting feature of the presented data set is the difference in the surface/subsurface nitrate $\delta^{15}\text{N}$. The extremely low nitrate $\delta^{15}\text{N}$ values in the ETNA subsurface are astonishing, and I agree that N₂ fixation cannot be the sole factor that plays a role here. Maybe the paper should focus on this aspect.

With regards to the observed low $\delta^{15}\text{N}$: The authors mention that the lowest $\delta^{15}\text{N}$ values were measured at shallowest depths. I am afraid that part of the low- $\delta^{15}\text{N}$ signature is due to the biasing effect of nitrite in the sample, pushing the $\delta^{15}\text{N}$ of NO_x down. Was nitrite removed in these samples? The authors mentioned that, where NO₂ was below 0.1 $\mu\text{mol/L}$ nitrite was not removed. However, in samples where the NO₃

C3438

concentrations are as low as 0.2 $\mu\text{mol/L}$, just minute amounts of NO_2 can compromise the nitrate $\delta^{15}\text{N}$ measurements. Put another way, to my knowledge, it is quite difficult to measure nitrate isotope ratios in samples that contain less than 1 $\mu\text{mol/L}$ nitrate. In this regard, measuring 0.2 $\mu\text{mol/L}$ nitrate samples at a precision of 0.2‰ seems truly heroic.

The explanation with regards to the decreasing difference between the nitrite and nitrate $\delta^{15}\text{N}$ towards the upper boundary of the OMZ is not clear to me. Also, the authors state that the observed increase in nitrate $\delta^{15}\text{N}$ and the observed decrease in nitrite $\delta^{15}\text{N}$ yields differences in the $\delta^{15}\text{N}$ that are much greater than the N isotope effect for denitrification. They infer nitrite oxidation with an inverse N isotope effect as possible mechanism to generate such signals. Couldn't this be an anammox signature?

Details: P 8004, l. 11: $\delta^{15}\text{N}$ of what?

P 8007, l. 5: Two nitrite maxima at 50 and 300m depth. I see a more prominent (compared to 50m) maximum at 150m.

P 8008, l. 8: "can be attributed to different stages of canonical denitrification"...this is a completely vague statement P 8011, l.22: The AOU vs. $\Delta\text{N}_2\text{O}$ relationship is not only linear at $[\text{O}_2] > 50 \mu\text{mol/L}$. It is also linear $< 50 \mu\text{mol/L}$, just with a different slope.

P 8014: Sedimentary denitrification can have an N isotope effect that is significantly greater than 1.5 ‰ (Granger et al. J. Geophys. Res., doi:10.1029/2010JC006751, in press; Lehmann et al., GCA 2007)

Throughout text: be aware of the difference between N isotope effect and fractionation.

Interactive comment on Biogeosciences Discuss., 8, 8001, 2011.