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Interactive Comment

Interactive comment on "Organic nutrients and excess nitrogen in the North Atlantic subtropical gyre" *by* A. Landolfi et al.

A. Landolfi et al.

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[a4paper,12pt]article

Reply to comments by Referee #1:

We would like to thank referee #1 for reviewing the manuscript and for the very constructive comments that have greatly helped to improve the quality of the manuscript.

1. We have reorganized the text to better describe the concept of TNxs, our justification of focusing on variations about $\Delta TN : \Delta TP = 16$, and that our only a-priori assumptions is that mass of N and P is conserved in the ocean. Briefly, our aim is to identify and quantify large scale changes in the total N and P inventories that deviate

from Redfield stoichiometry. Our starting point is the assumption that the formation of organic matter on average follows the Redfield ratio of N:P=16:1. We recognize that an allochthonous constant refractory pool (e.g. a terrestrial TON pool) introduced within the system would impact on the total N inventory and thus on the total N:P. However by focusing on the deviations of actually measured from preformed organic and inorganic nutrient concentrations (which would both include a constant refractory pool) we can detect net accumulations/decrease of the respective N and P inventories. Net deviations from the preformed TNxs value are expected to occur only when a net non-Redfieldian change in the N and P inventories occurs. As reviewer #1 pointed out, deviations from the preformed stoichiometry are commonly observed in the organic fractions as the effect of remineralization processes occurring within the water column. For example, preferentially remineralisation of TOP relative to TON will result in a positive TONxs anomaly. This will, however, not result in a net variation of the total N and total P inventories (as DINxs will decrease by the same amount because an equivalent pool of phosphate would build up as both total N and total P mass is conserved). Hence, we suggest to look not at excess N in the inorganic (DINxs) or organic (TONxs) fractions separately, but instead consider the sum of both (TNxs), which is only affected by changes in total N and P inventory changes.

2. We fully agree with the reviewer that DON and DOP are very complex pools. It is for this very reason that we suggest looking at changes of total nutrient inventories that are not affected by organic-inorganic transformations. As a result, our approach needs no assumptions about the nature and composition of the DON and DOP pools.

3. We changed the text to better clarify that no a-priori assumptions regarding the release of DON by N_2 fixers are made. The motivation for using TNxs instead of DINxs stems from trying to avoid that organic-inorganic transformation affect our estimate of nitrogen fixation. When using DINxs, such estimates could be affected, for example, by DON released by nitrogen fixers, or by non-Redfield production or consumption of DOM by other autotrophs/heterotrophs. We suggest N_2 fixation as a posteriori expla-

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nation of the observed net excess of N relative to P. In the discussion we speculate about processes by which diazotroph-derived N could end up in the TON pool (mass conservation) but these processes are behind the scope of this paper and do not alter the conclusion of our paper.

4. New figures have been made to address this point.

Specific comments:

Pg 687, line 11 - 13: The contradictory statements regarding the discrepancies between direct and indirect N2 fixation estimates have been clarified.

Pg 688: Line 23: The observed concentrations of DON and DOP in the ocean are the result of both production and remineralization processes. If production and remineralization of DOM follow Redfield stoichiometry then changes in the parameters DINxs, TONxs and TNxs are not expected to occur. If the remineralization does not follow Redfield stoichiometry (as it is most likely) then the vertical integral along the water column where the deviations occur is $\Delta DINxs = -\Delta TONxs$ (with opposite sign) and the net $\Delta TNxs = 0$. If production does not occur in Redfield proportions, for example if $DON > 16DOP$ then, it is important to distinguish which is the source of the extra N of the dissolved pool. If the source was to be nitrate, then again the excess of N in the DON pool would balance the loss of N in the nitrate pool (DIN) and the resultant $\Delta TNxs$ would be zero. If the source of excess N of the DON pool is external to the system (e.g. atmospheric deposition, nitrogen fixation) this will have an impact on creating $\Delta TNxs \neq 0$. It is in fact this external source of N (or P) that we aim to record in the changes of TNxs.

Pg 688: The potential use of DOP by diazotrophs does not alter the total P inventory and thus the TNxs. However, preferential DOP uptake would impact DINxs and TONxs. We thank the reviewer for pointing this out and have included this process in the list of

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processes leading to anomalies of DINxs and TONxs.

Pg 688: The erroneous statement of TONxs being independent from differential nutrient remineralization has been eliminated. It has been clarified above that by definition TNxs is only affected by changes in N and P inventories as N and P mass is conserved during inorganic-organic transformations.

Pg 689: 8220: Please refer to previous points

Pg 692: line 4-5: Please refer to previous points

Pg 691: line 14 and below: A statistical analysis of zonal gradients has been added.

Pg 693: The list of possible global processes influencing changes in DINxs, TONxs and TNxs has been removed from this section and inserted into the introductory paragraph where the concept of TNxs is now described on more detail and, we hope, greater clarity. Some brief discussion of specific processes occurring in the North Atlantic gyre has been added in the results section.

Pg 695: While we now discuss the relative importance of the gradients of inorganic and organic nutrients along the water column in more detail, the main analysis is based on the variations of total TNxs, i.e., deviations from a Redfield picture of total N and P. As far as the vertical gradients are in redfield balance, they do not show up in our analysis.

Pg 698: line 9-10 8211: It has been clarified in the text that we refer to organic matter derived from N_2 fixers (diazotroph elemental N/P$>$16). We do not specify the fate of this organic matter, which could be either particulate or dissolved.

Pg 702: We do not assume that DON released by N_2 fixers is going into the bulk DON pool. What we are suggesting is that even if this HMW DON might not directly be accumulating in the bulk DON pool (as suggested by Meador et al., 2008) it could be channeled through the food web and after several process steps through the food chain possibly end up in the bulk DON. This process needs experimental evidence and it is just a hypothesis. The point is, however, that whatever the process is this new N

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derived from N_2 fixers will end up in the TN pool.

Fig. 2 has been modified

Fig. 3 the TOP maxima has been removed as suggested also by referee 3

Fig. 7 this figure has been eliminated

Fig. 11 has been improved

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