

Comments on “Nitrification in the oligotrophic Atlantic Ocean”

General comments:

This study presents a high horizontal resolution dataset of ammonia oxidation (AO) rate over a 13, 000 km transect of the Atlantic Ocean. The dataset could be valuable to improve our understanding of the interaction between AO and environmental factors in the open ocean, and to facilitate the oriented-development of ocean biogeochemical models. However, the methodology, structure of this manuscript, the presentation of the results, and the Discussion need to be further condensed and reorganized. The comments are as follows:

Specific comments:

1. By measuring the NO_2^- concentration and nitrogen isotope before and after the incubation, the dilution method of obtaining the ammonia oxidation rate contains some issues worthwhile discussing: there are some potential influencing factors for the NO_2^- product that are not carefully discussed in the manuscript. For example, the incomplete assimilatory reduction of nitrate by phytoplankton can produce NO_2^- especially in light condition, probably resulting in AO overestimation in this study. On the other hand, NO_2^- consumption term during the incubation can be derived, e.g., oxidation by nitrite oxidizing microorganisms and assimilation by phytoplankton. (2) The equations for calculating the AO rate were not provided in the manuscript.
2. Pity that ammonium concentration, which is one of the key factors controlling ammonia oxidation rate in open ocean, was not measured to achieve their goal of "clarifying the relationship between the AO rate and environmental factors".
3. The water-column-integrated AO rate that the authors used to explore the difference of AO rate between northern and southern hemispheres, was only three-water-layer based. The vertical resolution of this data was not enough to address the scientific

questions.

4. The literature survey was insufficient, some highly relevant literatures were not included, resulting in misleading statements. e.g. Line ~295: “there is relatively little information for the temperature sensitivity of nitrification in the open ocean”, references like Baer 2014; Horak et al., 2017; Zheng et al., 2020 were recommended; Line ~315: “Evidence demonstrates that light structures the distribution of nitrifying organisms, whose activity may be suppressed within the photic zone (Shiozaki et al., 2016; Olson et al., 1981)”, Xu et al. (2019) gave a thorough discussion on light effect on ammonium oxidation”; Line ~410: When the paper talks about the vertical distribution of ammonia oxidation, the work by Wan et al. (2018) should be mentioned. Wan et al. (2018) found the nitrification was low or undetectable in the mixed layer and increased rapidly downward around the nitracline. And the depth of the nitracline represents a robust spatial boundary between ammonium assimilators and oxidizers in the stratified ocean.

Technical corrections:

1. Line 9: The product of ammonia oxidation is nitrite, not nitrate.
2. Line 58-60: “Evidence identifies roles for light, NH_4^+ concentration, organic matter flux and competitive interactions with phytoplankton (Fawcett et al., 2015; Shiozaki et al., 2016; Olson, 1981; Smith et al., 2014; 2016; Bressler and Boyd, 2009; Newell et al., 2011).” is suggested to change it to “Evidence identifies roles for light (Olson, 1981; Shiozaki et al., 2016; Xu et al., 2019), NH_4^+ concentration (Smith et al., 2016; Xu et al., 2019), organic matter flux (Ward and Zafiriou, 1988; Newell et al., 2011) and competitive interactions with phytoplankton (Fawcett et al., 2015; Smith et al., 2014).” Moreover, the paper Buesseler and Boyd (2009) focused on processes that control particle export and flux attenuation in the open ocean, not relevant to nitrification.
3. Line 190-199: To make a clear description of results, please match the figure to the corresponding text, e.g. “The dissolved oxygen concentration ,,, where

concentrations approaching $100 \mu\text{mol L}^{-1}$ were measured (Fig. 3d)".

4. In Figure 3a-d, squares stand for samples from 1% sPAR depths, while in other figures (2 and e-f) squares represent 0.1% sPAR.
5. Line 214: show the profiles of cyanobacteria *Synechococcus* and *Prochlorococcus* or delete “, in contrast to the profiles of the photosynthetic cyanobacteria *Synechococcus* and *Prochlorococcus* (results not shown)”.
6. Keep the format of all the secondary headings consistent. For example, “3.3. Microbial cell distribution and abundance.” ended with a period, while secondary headings of “3.4., 4.2.-4.4.” did not have periods.
7. Line 219: Figure 6 did not show the vertical profile of ammonium oxidation rate; The rate unit in the text is $\text{nmol L}^{-1}\text{d}^{-1}$, different from $\text{nmol L}^{-1}\text{h}^{-1}$ in the Figure 7. There were two Figure 7f in the figure 7 (Line 830).
8. Line 223-224: What’s the meaning of “the concentration of ammonium-N oxidized”; Provide the full name of “NAG” and “SAG”.
9. Line 234 and Figure 9 would be misleading when describe the PC2 as “representing latitudinal variation”, PCn just representing the combinations of the linear transformations of variables without explicit meaning. Furthermore, it is hard to infer the implications of PC1 and PC2 from 2-way ANOSIM results.
10. The result 3.6 and Figure 10 can be moved to supplementary information. And the title of color bar of Figure 10 (a) and (c) should be add on the figure.
11. Line 264-265: The Hovmöller diagrams should be shown to prove the conclusion that “these features had travelled from the Agulhas Retroflexion, taking 2.5 years to get to this location.”
12. Line 275-285: Delete the paragraph of 4.1 “Overview and objectives” or move to introduction.
13. Line 315-320: This paragraph is more than summarized the light effect on nitrifier without linking to their own data.
14. Tremendous typos and mistakes, e.g., Line 323: “Fig. 3.a, b, f” should be “Fig. 3a, b, f”; Line 364: “(Kieber and Seaton, 1999))” should be “(Kieber and Seaton, 1999)”; Line 372: “Fig. 4d” should be “Fig. 4b”; Line 373: “(Ward, 2002, Beman

et al., 2008; 2012)” should be “(Ward, 2002; Beman et al., 2008, 2012)”;

Line 447: “Shiozaki et al., (2016)” should be “Shiozaki et al. (2016)”;

Line 484: “(Fig. 4d; 7a-c), ” should be “(Fig. 4d, 7a-c)”;

Line 493: “Nencioli et al., (2018)” should be “Nencioli et al. (2018)”...

15. Line 409: “a decline in rates was measured as depth increased below 1 % sPAR (Fig. 6; 7d, e;”, there is no rates data in Fig. 6.
16. Line 509-510: “Considering all rate data, results implied that more active nitrogen cycling took place in the South compared to the North Atlantic Gyre.” This conclusion may not true since the NH_4^+ concentrations in South and North Atlantic Gyre may be different.
17. Nearly the same sentences occur repeatedly, e.g., Line 221-224 vs Line 417-419; description about labile dissolved organic matter (Line 453-455 vs 520-524)...

Ref:

B.B. Ward, O.C. Zafiriou (1988). Nitrification and nitric oxide in the oxygen minimum of the eastern tropical North Pacific, Deep Sea Research Part A. Oceanographic Research Papers, 35(7), 1127-1142.

Zhenzhen Zheng, Liwei Zheng, Min Nina Xu, Ehui Tan, David A. Hutchins, Wenchao Deng, Yao Zhang, Dalin Shi, Minhan Dai, Shuh-Ji Kao (2020). Substrate regulation leads to differential responses of microbial ammonia-oxidizing communities to ocean warming. Nature Communications, 11, 3511.

Min Nina Xu, Xiaolin Li, Dalin Shi, Yao Zhang, Minhan Dai, Tao Huang, Patricia M Glibert, Shuh-Ji Kao (2019). Coupled effect of substrate and light on assimilation and oxidation of regenerated nitrogen in the euphotic ocean. Limnology and Oceanography, 64(3), 1270-1283.

Wan, X.S., Sheng, H.-X., Dai, M., Zhang, Y., Shi, D., Trull, T.W., Zhu, Y., Lomas, M.W., Kao, S.-J. (2018). Ambient nitrate switches the ammonium consumption pathway in the euphotic ocean. Nature communications 9, 915.