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Biogeosciences Discussions

Interactive comment on "Heterotrophic denitrification vs. autotrophic anammox – quantifying collateral effects on the oceanic carbon cycle" *by* W. Koeve and P. Kähler

Anonymous Referee #1

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The paper presents a theoretical evaluation of of how the stoichiometry of carbon and nitrogen mineralization and conversion of fixed nitrogen to N2 depends on the relative importance of different types of nitrogen metabolism oxygen-deficient waters such as oxygen minimum zones (OMZs) and anoxic basins. It takes off from a recent comment by Voss and Montoya in Nature about how differences in the relative importance of denitrification and anammox, the two important pathways of N2 formation, may affect the balance between heterotrophy and autotrophy. In contrast to what was stated in this comment, and somewhat counterintuitively, the authors here demonstrate that a system where autotrophic anammox dominates N2 production is "more heterotrophic" (has a higher ratio of CO2 to N2 production) than a system dominated by heterotrophic

denitrification.

This is a well-written paper, which, beyond merely correcting an apparent mistake, provides a useful theoretical framework for understanding the stoichiometric aspects associated with the ongoing revision of our understanding of the marine nitrogen cycle with particular relevance in the light of expanding OMZs. My only general remark is that the authors should consider further stoichiometric constraints that can be deduced from the natural systems. Specifically, the ratio of nitrite accumulation to nitrate consumption which is used as master variable in the plots does not seem to reach values close to 1 in OMZs, and therefore the more extreme values of, e.g., $\Delta CO2/\Delta N2$, which are attained at high nitrite/nitrate ratios, are probably not realistic. I have not checked the paper but I believe that Anderson and coworkers (Deep-Sea Res. I, 29:1113-1140, 1982) concluded that the ratio never exceeds 0.7 (i.e., nitrite accumulation is always associated with some DIN deficiency, for some reason), which constrains many of the parameters to a more "boring" range. The extreme values could, e.g., be shaded in the plots.

Specific comments: p. 1816 l. 13: DNRN, denitrification, and DNRA are not always heterotrophic processes as claimed here but corrected in section 2.3.

p. 1818: The stoichiometry of autotrophic CO2 fixation by anammox bacteria (and nitrifers) is likely not fixed due to the energy requirements of maintenance. It seems that the value of 0.07 determined under substrate replete conditions may be a maximum reletive to the oligotrophic conditions found in natural waters.

p. 1825: I don't understand the "thermodynamic" argument concerning the relative importance of nitrification and anammox. But Lam and coworkers (PNAS 2007, doi:10.1073/pnas.0611081104) observed experimentally the co-ocurrence of nitrification and anammox in the Black Sea.

Figures: The ratio nitrite(accum):nitrate(deficit) is referred to as the N-conversion efficiency. This is confusing when 1 indicates inefficient and 0 efficient conversion, re-

spectively. Please find another name for this term.

Interactive comment on Biogeosciences Discuss., 7, 1813, 2010.