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Biogeosciences Discussions

Interactive comment on "Anammox, denitrification and fixed-nitrogen removal in sediments of the Lower St. Lawrence Estuary" *by* S. A. Crowe et al.

Anonymous Referee #1

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This paper reports mechanisms of fixed nitrogen loss in the sediments of Lower St. Lawrence Estuary (LSLE). Strictly speaking, N loss mechanisms are those that, regardless of the pathway, produce NO, N2O and/or N2. So far, denitrification, anammox and nitrification (producing N2O) are the best known and identified processes, all others have not been well-studied.

In particular, this research includes denitrification and anaerobic ammonium oxidation by nitrite (anammox) and by metal (Fe and Mn). The latter not well explored yet so it is a very good scientific contribution. It also have measurements of dissimilative nitrate reduction to ammonium (DNRA). The authors include the latter as a removal process, but it transforms nitrate into ammonium, a very reactive and bio-available nutrient. Therefore, strictly speaking, it is not a loss mechanism. This warrants clarification or a

change in the title of this paper.

This is a well written and comprehensive manuscript, with very complete and detailed methodology involving two approaches (slurry and intact cores). Similarities and differences in rate measurements between both techniques helps to better understand the regulation of biogeochemical processes and biases of used methodologies. Both issues should, therefore, be the strength of this research.

I have two major concerns:

The first is that this research only presents experiments from one station, so it may not be representative of the entire study area as the title suggests. Furthermore, the introduction is focused on the role of sediment in the N budget. I think that one station is insufficient for scaling up to large ecosystems. I believe a simple way to resolve this issue is by changing the title, and reorganizing and focusing the introduction, redirecting the MS towards a comparison of both methodologies used.

My second concern is that I believe that there is an error in the interpretation of anammox rates in slurry sediment. I cannot figure out how you have obtained an anammox signal (when the addition of 15 NH4+ did not produce any results in 29N2 recovery), nor how you can compare a volumetric (from slurries) with areal rates (from intact cores). This should be clarified and emphasized, in particular the magnitude of denitrification rates and the fact that both techniques produced similar trends.

In this sense, the abstract did not reflect the contents of the Ms. It started with the importance of anammox, included a rate value (only measured from intact sediment), but what about mentioning the other method and denitrification rate? Then, it mentioned the role of nitrification in oxygen utilization during the oxidation of ammonium and nitrite, but this work measured oxygen utilization rates?. Again one station is not enough to extend the conclusion to the whole of the LSLE.

Minor comments:

Methodology is complete and easy to follow.

In this section the location of station 23 should be mentioned (upper or middle part of the estuary?). Also, the hydrographic setting should be provided: what kind of estuary is LSLE? Is there any temporal variation along an annual cycle?

Regarding the slurry, sediment parameters should be included (apparent density and porosity), in order to ensure reproducible measured rates. In order to do so, it is necessary to estimate real rates, taking into consideration the proportion of water (pore water and added water) vs. used sediment (solid matrix).

Table 1 is not well explained and expected results for each treatment should be included. Also, the role of ATU (a metabolic inhibitor of aerobic ammonium oxidation) should be clarified.

Another point, did you expect coupling between nitrification and denitrification. If possible, you could distinguish between 29N2 and 30 N2.

Results

They must be put into a scientific context. In terms of style, do not use slurry incubation, extractions, etc as sub-titles. Replace these terms by the processes being quantified.

Discussion

The first paragraph is very general and must be moved to the introduction.

Regarding the vertical pore-water profiles, explaining whether ammonia profiles reflect the observed ammonium consuming processes (e.g. aerobic and anaerobic ammonium oxidation vs. organic matter regeneration) would be a scientific contribution.

Why estimate diffusional flux if most of the used nitrate for the dissimilative process comes from nitrification?

Part of the discussion should be focused on why anammox rates are rather different

depending on the methodology used. Please discuss about what others process could be responsible for unaccounted N sink?

Table 3 seems skewed: values do not correspond to column titles. mass balance based on one single station is very speculative.

Conclusion:

The role of anammox is highlighted neglecting other processes and their actual role.

Interactive comment on Biogeosciences Discuss., 8, 9503, 2011.