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Biogeosciences Discussions

Interactive comment on "Nitrogen assimilation and short term retention in a nutrient-rich tidal freshwater marsh – a whole ecosystem ^{15}N enrichment study" *by* B. Gribsholt et al.

Anonymous Referee #1

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This paper is one of a series of papers that describes various components of a rather unique insitu 15N-NH4+ tracer experiment in a freshwater marsh. Specifically the work focuses on marsh assimilation (litter, plants, etc). As with the other papers it does a solid job of presenting the mechanics of the experiment, sampling, and assumptions behind scaling the data to an ecosystem 15N model. The work provides some additional information regarding possible routes of 15N cycling as well as overall portioning of the label between ecosystem compartments. For example, the discussion regarding the transfer of label between a sorbed fraction-> assimilated particulate fraction -> extractable fraction has generally not been presented in similar studies. It has further bearing on how the N may pass through pools of varying lability which ultimately

helps to determine how the marsh functions (N source, sink, or transformer) at the ecosystem scale. These short-turnover processes are (as the authors point out) the best processes to examine with this pulse-type enrichment. Slow-turnover pools (like plants) are more difficult to characterize with this approach, particularly if different plant species use different N-uptake mechanisms. In general, I have no problem with one of the major findings of the paper that litter (and its associated microflora/fauna) are more important than N sinks than plants. However, the short-term nature of the experiment biases against the long-turnover pools of plants such that the plants may not be as unimportant as the paper suggests. Consider that if plants and litter use the same N pool and have equal access to that pool on the same timescale, then the short-term 15N pulse would yield accurate estimates of N uptake despite the difference in turnover time. The litter would have a high enrichment because it turns over faster (takes up proportionally more of the constant 15N-enriched source) and the plants have a low enrichment because they turnover slower. However, this “equal” access scenario is not likely the case. Plants roots “see” a different pool of N which probably followed a different enrichment trajectory than that of the overlying water which was available to the litter and/or sediment surface. This deeper pool of available N was probably much less enriched than the overlying water either because the tracer water required time to reach the roots and/or because it was isotopically diluted by mineralization of unlabelled organic N during transport. Therefore you could expect that low enrichment in plants could be due to both slow turnover and a lower source enrichment. This is problem is seen in some hyporheic tracer studies where the 15N must be added long enough to achieve steady state enrichment in a particular flowpath. If the total N uptake (14N + 15N) was calculated using the 15N mole fraction of the overlying tracer water, the estimate could be lower (perhaps a lot lower) than the actual uptake. I agree with the assessment that plants are using primarily recycled N, but recycled from where. Undoubted some contribution comes from the water column and as illustrated by this study. But there may be additional routes (e.g. through litter uptake and recycling pathways) that are not captured by this kind of study. For the paper, I think it is just important

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to note that for the above reasons, the plant uptake could be an underestimateĚat least for the deeper-rooted species.

Introduction: There is a very comprehensive freshwater marsh N-cycling paper that was missed (Neubauer et al. 2005, Estuaries 28: 909-922). It is also very relevant for the Discussion, as it supports some of the authors conclusions.

Methods It might be helpful to the uninitiated reader to present the equation used to transform per mil units to mole fraction which was then used to calculate total 15N mass.

Results Overall, I was hoping to see a bit more discussion of the role of the benthic microalgae as far as sediment or litter uptake. There were some difference in benthic chlorophyll between seasons (light related I'm assuming). Can additional connections be drawn between the benthic chla and the pattern of enrichment in the sediments or litter? For example (p. 1096 lines 11-15) could this difference be attributable to more or less benthic microalgae being shaded by more or less litter? - Did you gain much additional information from the HPLC work?

Discussion If one of the inherent goals of these types of studies is to indicate that marsh capacity for removing or transforming N, and given that NO3- comprises a large portion of the total DIN load, it might be worth reiterating that this study is for NH4+ only and that NO3- pathways may differ substantially. -

Are the timescales which you say 15N turnover consistent with the labeling study of White and Howes 1994. My recollection is that their results show label sticking around for much longer?

Since the paper seems to highlight the importance of short-turnover pathways, is it safe to say that the marsh really isn't a very good N sinkĚbut rather just an N transformer?

In the Results and Discussion there is much mention made of the amount of 15N that was processed. Out of curiosity, how much of the Bromide was recovered? The total

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amount of Br recovered and the time series decline might tell you something additional about how much of the tracer was recharged into the marsh subsurface.

Overall, this paper (especially as part of the series of papers describing this overall experiment) presents some interesting conclusions. Namely the in situ characterization of short turnover pools, the importance of litter, and description of extractable and unbound fractions are solid contributions. I do believe that role of plants may be understated because of the very nature of the short-term addition and its inability to address any kind of temporal disconnect between water column uptake (by microflora/fauna)-recycling-porewater transport-and finally plant uptake. I do not see this point as a fatal flaw in the paper, merely an important point worth making from a methodological and N budget perspective.

Interactive comment on Biogeosciences Discuss., 3, 1081, 2006.