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Biogeosciences Discussions

Interactive comment on "Sources and Transformations of Anthropogenic Nitrogen along an Urban River-Estuarine Continuum" *by* Michael J. Pennino et al.

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General comments: The authors have used mass balance models, constrained with stable isotopes to identify the sources and fate of nitrogen in the Potomac river-estuary continuum. A large outfall from a tertiary sewage treatment plant contributes 8-47% of the total upstream N loading depending upon the season. The goal of the study is to evaluate how well this high N load is attenuated before being transported downstream to Chesapeake Bay. They highlight the importance of making these measurements under different flow regimes since many studies have shown that N assimilation can be very sensitive to discharge. The approach the authors have taken serves as an excellent model for other studies but also illustrates some of the difficulties in this ap-

proach. Overall it is a very useful contribution and the findings can also help inform management to help understand where source reduction might be the most effective. I do believe the authors could make better use of the data they have to constrain some of the possible findings. Specific comments Line 141 and 381 – this spans the period of time both before and after the nitrate in the effluent decreased by nearly half from the treatment plant. Would Fig 4 be a better fit if the data was separated into pre and post periods? 173-179 – Given how well studied this system is I suspect there is nitrite data? Based upon that data is nitrite high enough to be of concern? 192 – single values are given here but fig. 6 shows a range of values which makes more sense. These uncertainties could be incorporated into the estimates. 195, 202 I was a bit confused by this, aren't manure based fertilizers also used in region as well? The discussion is section 4.2 suggests this is a major input. Was the nitrate fertilizer value chosen because the authors know that is what is used here and manure is only important upstream? 204 – I thought putting this in the methods was an odd way to present this. In spite of the uncertainty the isotopes do put some constraints on the data. I think it makes more sense to present the data and then discuss the limitations and errors. 218, and section starting on 422 – How are additional lateral inputs of freshwater being dealt with here? There has been a lot of modeling of this region so I'm sure they are known but it would be good to state the assumptions/data behind this. Lateral sources of freshwater might also have significant nitrate concentrations and different isotopic signatures. If the amounts are trivial this should be stated. 290 – I did not like the assumption that these other treatment plants would have little impact. An additional 32% is significant and depending upon where it is added could be very important. The locations of the plants are not given but could this account for the lack of change further downsteam post treatment change (line 367)? The authors also don't mention what types of plant these other WTP are (secondary or tertiary). Some secondary plants get to very high values 15N values if there is extensive open aeration. I agree that the net impact of all of these plants will probably be to underestimate biological assimilation but it would seem to be beneficial to constrain the system to the extent possible.

Instead, it is dismissed here and then brought up in the discussion (526) where we find out that the total flows are nearly as large as the Blue Plains plant. It is then brought up again on line 674-5. I believe the authors will have a more robust story if these plants are incorporated into the model. 414 – Fractionation will only be apparent if only part of the pool is used. While this would seem to be the case, because, nitrate does not completely disappear, there is data from a variety of sources that indicates that sometimes denitrification occurs in hot spots (like hyporheic zones) where part of the pool is completely denitrified without any change in the isotopic composition. I think this at least deserves some mention. 458-475 - I think this could be made clearer. I was initially quite concerned about the very large error bars. The authors attribute some of this to the uncertainties in the last box but in looking at Table 1 things don't improve that much when box 6 is omitted. If I assume all of the seasons are of equal length (3 months) than the seasonal averages presented on 458-460 work out to a loss of 9.03x106 kg/year. With the propagated error this is nearly +/- 100%! But this can be compared to the independent estimates of burial and denitrification rates presented in Boynton et al. 1995 (lines 469-474) of 9.89 x106 kg/year. This agreement is quite good, and I wonder if these huge error bars are due to the method of error propagation. A monte carlo approach might result in smaller errors. I think I would point out the good agreement before going on to attribute the % loss to burial and denitrification.

Section 4.2 and 4.3 This discussion is quite long and discusses many possible explanations for some of the data but seldom comes to strong conclusions. The authors have some great data here, I'm not sure they are making the most of it. These section contains a lot of statements such as those on line 607 "15N-NO3 values were likely higher in warmer months due to denitrification" since monthly measurements were made don't you know whether or not this is true? No mention is made on line 198 of seasonal changes so I had assumed this was not true. If it is true, the model should be run with different values for different seasons correct? The isotopes are not sufficient to tell when nitrate removal is due to assimilation or denitrification but doesn't the Boynton et al. 1995 data provide some insights that could be used? As mentioned above, on

lines 674 the possible role of N from additional treatment plants is brought up when it had been dismissed earlier. So, overall, I think the authors may be able to constrain this system better and come up with more robust conclusions.

Conclusions – the importance of hydrology and temperature in N transformation is a critical issue for management and often discussed but removal is also a function of total load. I agree with all of the authors statements but differences in the N behavior in the manuscript is largely discussed by season and I think the conclusions could do a better job talking about all three factors.

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