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Biogeosciences Discussions

Interactive comment on "Evidence for microbial mediated nitrate cycling within floodplain sediments during groundwater fluctuations" *by* Nicholas J. Bouskill et al.

Anonymous Referee #1

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The authors report a sparse dataset of mineral N and N2O concentrations and stable isotope compositions in groundwater samples collected at the Rifle site. They use these data to test a detailed mechanistic model of microbial N cycling, which predicts the nitrate concentrations relatively poorly. The main conclusion from these data appears to be that significant denitrification occurred in the sediment following groundwater rise driven by snowmelt. This finding is not novelâĂŤthe importance of riparian denitrification has long been known and has received extensive study in montane, snowmelt-dominated systems. See for example the extensive work by Paul Brooks, Michelle Baker, Mark Williams, and others.

The nitrate isotope data are nice to see, but the marriage with the microbial model seemed forced to me. Where are the microbial data needed to test the main predictions of the model (e.g. Fig 4)? There are skilled microbial ecologists on this team and working on this site. I didn't find the model results compelling in the absence of microbial data, especially given the poor performance of the model in predicting nitrate at the three (!) depths where it was apparently compared (Fig. 4). The microbial simulations come off as entirely speculative given that there are no data presented, as does the speculation as to the importance of annamox vs. canonical denitrification vs. chemolithotrophic processes. Contrary to the conclusion (P17 25), I don't think the authors can make any concrete claims as to the mechanisms driving the patterns observed, especially given that the nitrate isotope fractions are not well constrained for these pathways, and that there is enormous variation in nitrate isotope fractionation during denitrification.

The spatial replication of the field data seems inadequate given the heterogeneity of the system under study. Why are no isotope measurements from the vadose zone and shallow soils reported? This seems critical to get at the question of biogeochemical processing of N vs. dilution or mixing that comes up throughout the paper, and the enormous spatial heterogeneity of nitrate isotope compositions that is increasingly documented in the literature. What is the composition of the water that is posited to be diluting the sediment zone of interest? There was almost no discussion of the hydrology of the site and potential source waters, which are critical for getting at this point. To interpret the isotopes, you would need to consider mixing rather than pure dilution unless you could demonstrate that you were mixing nitrate-rich vs. nitrate-free water. This is especially critical in the context of the heterogeneity in buried organic lenses that has been demonstrated at this site.

I am very surprised that the authors report nitrate concentrations of $\sim$5 mMâĂŤsurely they must mean 5 micromolar or 5 mg NO3- L-1? Note that nitrate concentrations this high (5 mM) are rarely observed even in heavily contaminated agricultural streams or

sewage effluent. If this is correct, what is the source of this extremely high nitrate? It seems implausible that this would be produced via natural organic matter decomposition, and the authors report low NH4+ values. There is a rich literature on N cycling in the Rockies, and the reported values are totally out of context with this. I suspect that this is either a silly mistake or a serious technical problem.

The manuscript is riddled with errors. In the title alone there is a grammatical error and a misspelling of one of the author names. I urge the lead author to give the paper a proper proof reading before sending out for review! For example, P8 line 18, δ15N is given as -1.8. At line 23, this same value is referred to but the minus sign is missing. There are many more examples...

P4 30: “Samples of pore gas from 2 m bsd” do you mean below 2 m? How many depths were sampled? P9 15: what do you mean by “highest (most reduced) value” The message in Fig. 3 is not at all clear as presented. Try putting the same values (δ15N, e.g.) on a common plot so we can compare the trends among depths over time. P13 20: Need citation P15 25: “the measured in N2O peak”

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