

General Comments: This manuscript uses an isotopic mass balance approach to quantify microbial production and consumption in a High Arctic glacial catchment. The premise of the article is that isotopes of nitrate, along with concentration data, can be used to quantitatively estimate microbial nitrate production and consumption. This is an excellent premise, worthy of publication in The Cryosphere.

The quantitative isotope mass balance approach is both a strength and a weakness as applied in the study. The attempt is noteworthy, but the execution is somewhat lacking. While the author does a nice job of propagating analytical error and standard deviations on means, error associated with other assumptions is ignored. I'm surprised, for example, that the author does not explore the uncertainty associated with the 1:1 assumption for isotopic fractionation of ^{15}N and ^{18}O associated with assimilation and denitrification. The paper the author cites for using this ratio discusses the uncertainties associated with this ratio. In their 2012/2013 Biogeochemistry paper, the author invokes a different ratio (by a factor of 2), at least in the case of denitrification. I found the terminology with regard to microbial 'removal' of nitrate confusing. In some cases assimilation and denitrification are treated together, which is not unreasonable as these processes may exhibit similar isotopic fractionation effects. In other cases, however, based on a modeling study, assimilation (also termed consumption in the manuscript) is assumed to be the dominant process. In Figure 6, this is 'microbially removed' N. Clear use of terminology and stating of assumptions would be beneficial. I also don't understand why the author chose a single value for $\delta^{15}\text{N}$ of microbial nitrate rather than propagating the uncertainty in this value as derived from the $\delta^{15}\text{N}$ of reduced N sources. Similarly, the variation in the oxygen isotopic composition of water could be propagated through estimation of $\delta^{18}\text{O}$ of microbial nitrate.

I have read and cited the author's excellent Biogeochemistry paper on similar samples from the same study site. I was surprised that there wasn't more reference to the previous paper. Without such discussion I had a hard time determining if the work was a significant advance or incremental. The greatest advance I saw was the attempt at quantification via the isotopic mass balance approach. As such, however, all major sources of uncertainties should be propagated through the analysis.

The conclusion that microbial production is significant is not particularly novel in light of the author's earlier work. However, the finding of how tightly cycled nitrate consumption may be with production is important, but deserving of a more robust quantitative approach that considers significant sources of uncertainty.

I believe this paper is suitable for publication in The Cryosphere, but only after significant revision.

Specific Comments:

Abstract: Please state where the study took place.

Ln 19. I don't understand the sentence starting with "These overwhelming amounts....". Do you mean similar rates of production and consumption?

Methods: Surely we don't need this much material on the denitrifier technique. Please cite another paper and only detail any deviations from the standard technique.

Equation 1. Please site the conservative CI assumption when this equation is first presented.

Lns 301 to 304. Values given don't match Table 1. You are supposed to be giving the ranges for two isotopes at MLU and other sites, but only two isotopic ranges are provided. The reference to Figure 2 is incorrect. I believe you mean Figure 5.

Ln 323. Is it Ansari et al. 2012 or 2013?

Figure 1. You have the label MLU on the Figure (and in other plots) but UPW in the caption.

Figures 3,4. These figures are too busy. I'd consider separating the isotope and concentration data.

Figure 5. I found the assumption of assimilation being more important than denitrification unconvincing. Please label both as possibilities on the plot. I'd prefer to see a field rather than a line for the presumed microbial nitrate source.

Table 5. Define S-NO₃ and S-NH₄ in a footnote. Put these columns next to their respective measured values and provide additional columns with the delta between the two.