EGUsphere, author comment AC1
https://doi.org/10.5194/egusphere-2022-671-AC1, 2022

Reply on RC1

Adam Francis et al.

Author comment on "Permafrost degradation and nitrogen cycling in Arctic rivers: insights from stable nitrogen isotope studies" by Adam Francis et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-671-AC1, 2022

We thank the reviewer for their constructive comments which have helped to improve the manuscript. Below we have outlined point by point the responses to each comment:

The authors present a detailed and novel study of nitrogen dynamics within six major Arctic rivers through collection of water samples analyzed for dissolved nitrogen species and nitrogen isotope values. These six rivers span a gradient of permafrost coverage throughout the watershed with the Kolyma having the most continuous permafrost coverage to the Ob which has the least permafrost coverage. Major findings include large inputs of DON and nitrate with isotopically heavy 15N signature due to the Yedoma permafrost thaw zones along the Kolyma. Evidence for permafrost derived DON being recycled to nitrate is presented within this watershed. The authors also present a great data set on seasonal nitrogen dynamics within the six rivers even though the impacts of permafrost degradation could not be shown in this study. Instead, fresh DON from surface runoff and most likely lateral flow through the organic rich top-soils of the watershed supplies the majority of nitrogen within these rivers. The Ob river is presented as one possible future (due to less permafrost coverage) of nitrogen dynamics for the other 5 rivers. Permafrost thaw could be identified with nitrogen isotopes only within small spatial scales due to dilution and vast catchment differences (and their processes) of the main stem rivers. The authors provide detailed discussion of how different types of permafrost thaw impact and watershed characteristics can impact nitrogen and isotopic dynamics. In general, I would pay close attention to the use of flux and loads throughout the document, particularly with uncited language. Most of the data presented here is concentration (with one figure of flow-normalized concentration).

Figure 1. *Potentially add a table of watershed characteristics (including but beyond continuous permafrost coverage) to Figure 1. Perhaps include amount of peatland area, lake coverage, glacial coverage, etc. that is referred to throughout the article. This could also be a supplementary table*

A table showing some of the watershed information has been added

Lines 61-64
Is Zhang the original citation here? Or is it R.O. van Everdigen, Multi-language glossary of permafrost and related ground-ice terms Definitions (1998), p. 78.
I would probably use the van Everdigen reference in place of the Brabets reference. While that definition is included within the Brabets, I don't think it can be attributed to him.

Thank you for the correction, the van Everdigen paper has now been cited here

68-77
Seems like there are some citations missing here.

Added two references, Streletskiy et al., 2015 and Beermann et al., 2017

78-90
It would be nice to mention some of the limitations and uncertainties associated with these studies.

A mention of some uncertainties has been added

Lines 195-196
The authors could remove the last sentence of this paragraph as they reference the fluid mud stream in line 193.

Changed the wording to make it clearer that samples for this study were collected from a similar fluid mud stream

Line 216- *add "the" between capturing and variability*

Done

Lines 218-220 *It would be good to cite some of the studies regarding the limitations/variability of these discharge records for these rivers*

A few citations have been added addressing the reliability and accuracy of these discharge records and predictions

Figure 2*- "Continuous" is misspelled on each of the X axes within this figure.*

This has been corrected in the figure, thanks for pointing this out

Figure 3-*It might be beneficial to add a secondary Y axis or a second panel to better capture the small scale differences referred to in the text (Lines 290-321)*

An insert plot showing the small scale changes has been added to this figure

Figure 5*-Great figure!*

Thanks!

Figure TK *I think it would be beneficial to have a conceptual figure the visualizes the how different permafrost conditions and other catchment factors influence the nitrogen cycle, isotope fractionation either at this point or earlier in the article. There is a lot of text within the article that does a great job of describing all of these processes, however, you might be able to significantly reduce the amount of text by referencing a new Figure that visually represents these processes and impacts.*

Thank you for the suggestion. However, I feel that this figure might be a little complicated/cluttered to show all of the processes at play. There are many interlinking factors that can affect the nitrogen cycle and associated isotopic fractionations and trying to distil them into a figure might lead to oversimplified view of the underlying processes. The purpose of this paper was to outline some specific processes occurring in permafrost degradation zone and how it changes downstream, not to show how all possible factors

affect the nitrogen cycle. Although some suggestions have been made in the text as to the full controlling factors and I agree that it would be beneficial to have this conceptual figure, the data produced from this study wouldn't really allow a full picture to be shown.

Figure 6- *Yukon X axes for both nitrate and discharge differ slightly from all other rivers (or at least the labeling does). I would also include the years of 2003-2018 within the title of this figure. I wonder if spot calculating loads/flux here for DON and NO3 might provide some interesting insights, especially since the authors*

The x axes and the title have been changed in the figure.
Calculations of fluxes/loads were done originally in this study but after discussion with co-authors it was decided that these should not be included. The reasoning for this was that to compare results with other ArcticGRO published data, fluxes/loads needed to be calculated using the USGS LOADEST software. This required a minimum of n=12 data points which was more than the six data points per year in the sample set of this study. Including the fluxes also didn't change the overall interpretation of the results and the conclusions drawn.

Line 494, *I would move the citation of Figure 1 to Line 493 after 'rivers'. As it reads, to me, it suggests that Figure 1 is a nitrogen cycling figure.*

Done

Line 550*- is this percolation? Or lateral subsurface flow?*

Percolation as the groundwater can move to greater depths vertically through the horizons. However, also added that the lateral subsurface flow will be deeper with a lack of permafrost.

Line 616- *is this "of riverine nitrogen geochemistry" or on?*

Changed to "on riverine nitrogen geochemistry"