EGUsphere, referee comment RC2
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Comment on egusphere-2022-671

Anonymous Referee #2

Referee 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-RC2, 2022

The manuscript by Francis et al. presents an interesting study on the extent of permafrost degradation effects on nutrient speciation, cycling and processes in Artic rivers using isotopes. It is a comprehensive study and the sampling design is well-thought of, taking into account both spatial (catchment versus permafrost degradation zone) and temporal scales. On a catchment scale, the authors found that the extent of permafrost coverage was controlling the variability of nitrate but not DON – an important finding which also suggests the potential impact of climate change on nutrient dynamics through permafrost degradation. The permafrost thaw exhibited distinctive isotopic signatures of nitrate and DON which significantly inferred the applicability of isotopes in identifying the transport pathways of nutrient either via surface runoff or subsurface flows. The dynamics of nitrate, DON and associated isotope values downstream of that zone suggested a combination of physical (dilution) and biogeochemical processes (mineralisation, denitrification, nitrification) although disentangling the contributions of these processes require further studies. Overall, the manuscript is well-written and their ideas are well-articulated but the manuscript could be more concise (particularly the introduction) and clearer in some places. See below for more specific comments:

Line 68: Be more consistent with the term used throughout the manuscript especially when the terms indicate the same meaning, e.g. thaw versus degradation, intact versus continuous?

Line 100-106: The sentences here seem contradicting. At first, the authors indicated that with limited permafrost thaw, nitrogen export is predominantly DON then later on, when permafrost begins to thaw (which to me indicates more permafrost thaw), DON concentrations in streams increased rapidly. Is the timing of thawing that affects the variability of DON or is it the extent of permafrost thaw that is the controlling factor? Be clearer here?

Line 107: While it is discussed in the introduction that peat layer is also an important factor affecting the preferential flow/transport of nutrients but this information was not presented for the study sites. Suggest including this piece of information in site description given its importance in controlling the transport mechanism and thus the variability of nutrients within the catchment.

Line 174: Was the sample collected from the same site for Kolyma at two different scales (i.e. catchment vs. PT zone)?

Line 177: Is there a specific reason why samples were filtered through 0.7um filters and not smaller pore-sized filters (i.e. 0.45um and 0.2um) as the common procedure for collecting dissolved nutrient and isotope samples?

Line 254: Were ammonium concentrations measured in this study or it was assumed that ammonium was negligible? Referring to Holmes et al. 2012, ammonium concentrations were much higher than nitrate in all the studied Russian rivers draining into the Arctic Ocean almost throughout their study period. Given the high DON concentrations and low nitrate particularly in the permafrost thaw zone, there is a possibility that ammonium could be present and could significantly affect the isotopic values of TDN. Without the concentration data, I don't think the assumption that d15N-DON is the difference in concentration weighted isotopic values between TDN and NO3 can be justified, particularly in the permafrost thaw zone.

Line 243: Given the persulfate digestion could potentially introduce fractionation if recovery of the conversion is not close to 100% (which is very likely). Was there any standard (internal?) used in this method to ensure that fractionation is minimal and is representative of the actual d15N of DON.

Line 359: Why would d15N be lower in this case? You meant the preserved organic matter had low d15N to start with? If yes, then be more specific here

Line 369: d18O 'resets' not just to ambient water but dissolved oxygen as well unless DO did not vary throughout the study period

Line 504, 563, 608, Fig. 8: A few other places are confusing – whether the samples were analysed or just solely based on assumption/literature values e.g. soil, groundwater and water isotopes. If they were being measured, include the description in the method sections. If the values were taken from the literature, then these should be referenced appropriately.

Figure 2b:

(1) Y-axis for (i) – DON instead of nitrate?

(2) Standard deviation for the concentration averages?

(3) I am wondering if there is any relationship between the isotopes of nitrate, DON and % catchment with continuous permafrost. I believe the authors might have considered this and have found no relationships?

Figure 3: Considering breaking the y axis for PT data so concentrations of other samples are visible on the plot. Another suggestion is to present the ratio of DON to nitrate concentrations. This will make it easier for the readers to follow

Figure 7: (a)-Kolyma, what is the dotted line for?

Suggest combining Figure 3 and 4 into a plot with three panels (a) d18O versus d15N (b) d15N-TDN versus TDN conc (c) d15N-DON versus DON conc. This will make it easier for the readers to follow and compare the concentrations and isotopes of different analytes.