Hydrometeorology and landscapes control sediment and organic matter mobility across a diverse and changing glacier-sourced river basin

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Response to Referees Document

Author comments: We sincerely thank both anonymous reviewers for taking the time to review and provide helpful suggestions to improve our manuscript. In this response document, the original comment will be in bold-type and the response will be below each comment in red normal type.

RC1: Anonymous Referee #1, 18 Jul 2025 https://doi.org/10.5194/egusphere-2025-1971-RC1

This study addresses the impact of hydrometeoerological extremes on various landscapes – particularly with respect to TSS and DOC. Uses North Saskatchewan River between 2019-2022 as case study. Study finds that warming and wetter periods resulted in greater TSS and DOC export, with DOC behaviour being more predictable than TSS during these periods.

I could easily understand the paper and it was the methods seem sound and appropriate for answering the key research questions of the impact of hydrometerological extremes on TSS and DOC export across different landscapes.
Thank you.

I only have a few suggestions that will hopefully make it easier for the reader to fully appreciate and understand the study and its findings.

Line 41-42: "During higher water" -> consider changing to "During wetter years"
This will be changed as suggested.

Line 53: "Recently" -> consider specifying when
We will add "since the 1980s" in place of "recently".

Line 103: "Ongoing changes" -> for international audiences, please state what changes are being experienced
We will change this to, "In addition to ongoing changes in summer flows and sediment yields experienced by Rocky Mountain rivers…".

Line 105: "recently endured" -> for international audiences, please specify when these extremes have been occurring (how recent have they been?)
Thank you for the comment. This line is a bit of a teaser for the rest of the paper, so it's these extremes that form the basis of the paper. We want to leave description of the extremes to other portions of the paper. However, we will add "2019-2022" in parentheses following "recently" in that sentence to make the connection with the rest of the paper.

Line 105: "High runoff years" -> please specify how high the runoff is
Please see previous response. We go through these specifics through the rest of the paper, so we feel that information is best left off this sentence.

Line 245: "yet" -> implies that one day these data will be available.
Correct. These data, in fact, are now available since the submission of this paper. However, considering that this paper does rely on historic data, these sites are still not considered for this paper since they only have 4 years of record accumulated.

Line 252: "Phosphorus" -> in this sentence, unclear if it is total and/or dissolved phosphorus here
Thank you for your comment. This will be revised to, "…while DOC concentrations showed patterns similar to total and dissolved forms of nitrogen and phosphorus, and…"

Line 285-287: "The three fixed factors…autoregressive approach" -> Having the equation structure shown here might help clarify how the model was set up for the reader.
Thanks for the helpful comment. The equation will be added in-text with some minor changes to surrounding words to help explain the parts of the equation.

Line 288: "normality standards" -> would like some indication of whether they actually ended up meeting normality standards, or whether they just got a little bit closer to normality after transformation
For our TSS and DOC yield datasets, our data were strongly and positively skewed and failed multiple normality tests with high values for skewness and kurtosis. Log transformation of these values resulted in much more defined bell-shaped curves, with improved skewness, but still rejection of normality statistics in several cases. Similar findings were observed for the dissolved organic matter model (skewness, etc.). We were happy with these transformations considering that linear mixed models are inherently robust to slight to moderate non-normality and do not typically impose interpretation problems for linear mixed models (Knief and Forstmeier, 2021). We will update this sentence to, "Daily catchment yield data (dependent variable) were strongly and positively skewed and were log-transformed to improve normality to meet linear mixed model standards (Knief and Forstmeier, 2021).".

Line 289: "Sidak multiple comparisons" -> please provide a citation for this as I (and other readers) might not be familiar with this approach.
We will add a reference to the original paper outlining this multiple comparison approach (Sidak, 1967).

Line 295: This is a great way to get around the fact that many catchment characteristics are cross-correlated with each other
Thank you for the kind comment.

Line 337: "NSR-Edmonton Station" -> is this the downstream most station? Would be good to specify where this is in the context of the catchment for readers unfamiliar with the area.
Good observation. No, this is not the most downstream flow station. We will add reference to Figure 1 here, which shows the location of the NSR-Edmonton flow station.

Line 352: "substantially" -> would be good to quantify this here
Thanks for the comment. We will add, "(99th percentile of flows)" after "substantial".

Line 383: "statistically" -> I'm interpreting this as the slope having p<0.05
We should be more explicit here. We are linking to Table S3 that shows both the coefficient of determination for the model (r2; assesses the variability in the dependent variable explained by the independent variable) and the statistical significance of the F-statistic in the model. For clarity, we will remove, "and statistically" and will improve the caption in Table S3 to:

"**Table S3** Loadest and log-log regression export model concentration-flow relationships for total suspended solids (TSS) and dissolved organic carbon (DOC) from the North Saskatchewan River (NSR) mainstem (emphasized) and its tributaries from 2019 to 2022 water years. r^2 is the coefficient of determination of the regression and Loadest models and statistical significance (α=0.05) of the model, as determined by the F-statistic, is denoted by an asterisk. C-cordillera; F-foothills; MA-mixed agriculture; A-agriculture."

Line 387: "statistically stronger" -> I'm not actually sure what this means – does this mean that the slopes are steeper?
Thanks for this helpful comment. Similar to the previous comment, we have removed "statistically" here and since this sentence still refers to Table S3, we will rely on the new Table S3 caption to properly explain statistical significance.

Figure 4: I'm struggling to understand what the letters mean in the mixed modelling results here. If you can provide an explanation in the caption, it would be helpful.
Thanks for your comment and it is a fair critique. We will update the caption as follows to help out the reader, "Linear mixed model results (right of graphs) assess statistical differences between landscapes, water years, and their combination across all export models. Different letters within a given category (i.e., landscape, water year) denote statistical differences as determined by the linear mixed model."

Line 524: "C-Q" -> these relationships feature a lot throughout especially the discussion. I wonder whether it is worth having a figure/table of these relationships in the main text instead of just in the supplementary materials. Or at least putting some examples of the relationships in the text.
Thanks for the comment. We will include a new supplementary figure that shows the C-Q associations (as biplots) for all the stations to support the reader.

Line 545: "we observed…changes in flow" -> at this point would like to see which specific result this finding is being drawn from. I think this is pretty important, but am unclear as to how the results of the analysis have led to this conclusion.
Thanks for this comment. Though you can dig through our export tables in the supporting information or compare differences between years in figures 4 and 5, we rely on Table S7 to specifically show the threshold-type behaviour observed in some rivers between years relative to the amount of flow occurring in the rivers. Your point is taken that this is quite important to the manuscript, so we suggest moving this table to the main manuscript.

Line 552: "model results" -> I assume this refers to the linear mixed models, but would be good to specify
Thank you and good comment. We will add "export" in front of "model" in this sentence to link with the four models used to determine loading, which were outlined in the Methods section.

Line 553: "high end" -> I assume this means high C and Q?
Yes, that is correct. We will alter the sentence to make that more explicit. The sentence will be updated to, "…events perturb model fits at high flows and concentrations of C-Q associations."

Line 583: "weaker" -> again here - providing some numbers from comparison (as evidence) would be really useful to help the readers understand the conclusions being made.
We will add reference to Table S3 in this sentence to remind the reader where to find the numbers related to this comparison statement.

Line 592: "stronger C-Q associations" -> I assume this means a steeper C-Q slope?
This actually means that the coefficient of determination is larger, which describes more variability is captured by the fitting of the model to the data. To be more explicit, we will update this line to, "…cordillera rivers had stronger C-Q associations (i.e., larger coefficients of determination; Table S3) but did not produce…".

Line 621-623: "little evidence in…DOC mobility" -> would be great to refer specifically back to what findings/results points to this not happening
Sure, we can refer back to Figure 6 and the off-channel "unmonitored" additions.

Table S4-S5: would be really good to show error bars in load estimations too (max-min)
Thanks for the comment. We will attempt to fit these in this table, but space requirements may dictate that we split this table to show export and yield separately.