Response to Anonymous Reviewer 2 - egusphere-2023-1792. Author responses added in blue.

Reviewer 2:

> "In the submitted manuscript, 'Seasonal carbon dynamics of the Kolyma River tributaries, Siberia' by Keskitalo et al., the composition and source of organic carbon in the Kolyma River network was spatially and seasonally measured to improve the understanding of carbon dynamics in the Arctic region. The results of this study are interesting, as there is limited research on the topic in lower order Arctic streams, and important to understanding how warming and hydrological changes to the Arctic in the future may impact inland water carbon dynamics."

Thank you for taking time to review our manuscript. We appreciate the positive comments.

General points:

1. "Include information about the snow/ice melt during the freshet period in the methods. This is important in understanding the results and conclusions made".

We have included a phrase in the method section regarding snow/ice melt conditions. See also our response to questions 6 and 7.

2. The results section could be restructured to separate out the spatial and seasonal aspects so that it can more clearly be followed.

We have restructured the results section. For details, see our response to questions 12 and 14 for details.

Abstract:

3. *L16: "What kind of studies?*

We have specified the kind of studies we mean (in italics the change): "Most studies *on carbon dynamics* to date have focused…"

4. *L20: Weather -> temperature*

Have changed the word weather to "water temperature".

1 Introduction:

5. *Concise and to the point.*

Thank you.

2 Material and methods:

6. *L45-55: Could information be added in this section about the snow/ice cover in the catchment/river?*

We have added the following information regarding snow/ice cover in the method section:

"*During the spring freshet sampling campaign, all the rivers were ice-free during sampling. A few larger lakes in the area still had visible ice cover (5th of June 2019), but snow had largely melted and was only present in landscape depressions. The ice broke up in the Kolyma River mainstem 1st of June 2019 around the North East Science Station in Cherskiy.*"

7. *L63: Was ice/snow present during the spring sampling?*

There was no ice in any of the rivers during sampling and snow had largely melted apart from occasional patches in depressions in the landscape. We have added this information to the method section, see also our response to the previous question.

8. *L90-95: were the methods used the same between labs?*

Yes, both laboratories use OI Analytical TOC analyzer connected to an IRMS (model Delta V Advantage in KU Leuven and Delta Plus^{xp} in North Carolina State University) to measure DOC concentrations and δ^{13}C-DOC. The method is based on wet chemical oxidation and all sample runs were accompanied with internationally renowned standards. We trust that our DOC and δ^{13}C-DOC results are comparable.

9. *L135-137: Report the n values for freshet and summer here.*

The n values were added here.

10. L138-129: I assume for the ANOVA test both summer and freshet data was combined, please clarify in the text and add the n values for the three groups.

For the ANOVA test, the seasons were not combined as here we wanted to test the differences between different sized rivers separately in each season to identify differences in carbon parameters within a season rather between seasons, thus we conducted separate tests for freshet and summer. This has been clarified in the method section (as well as in Text A3) and additionally, n-values have been added.

11. 140: It could be nice to have an opening sentence as to why you used liner regression, e.g. to look at how carbon related to catchment characteristics and water chemistry.

Thank you for this suggestion, we have added the following sentence on lines 141-143:

"*We used linear regression to test how water temperature affects δ^{13}C-POC, and how carbon isotopes depict POC-% to better understand river carbon dynamics. Additionally, we used linear regression to relate spatial catchment characteristics to organic carbon concentrations in rivers.*"

3 Results:

12. *In general, this section could be restructured slightly. It was confusing to know which test (i.e. t test, Anova, linear regression) related to which result and also to separate out*

the spatial vs seasonal aspect. One suggestion would be separate section 3.2 out into a separate seasonal and spatial section. Further the 2.6 stats section could be rearranged to follow how the states are presented in the results, first linear regression and then the t test and anova. And in the results section when presenting the p value, you can write what test it is referring to.

Thank you for these suggestions. We have split the section 3.2 in two (see also our response to question 14 below) to make it easier to follow the results and re-arranged section 2.6 as suggested.

13. *L 155: larger **spatial** variability during freshet **compared to the** summer*

We have made the clarification to the text as suggested.

14. *L175–199: This section could be split into two, e.g. 3.2.1 Carbon across seasons and 3.2.2 Carbon across river network*

We have split this paragraph in two with the following subheadings:

"3.2.1 Seasonal carbon patterns across the catchment"

"3.2.2 Carbon patterns between different sized rivers during freshet and summer"

15. *L175: Rewrite, suggestion, "Concentrations of TSS were higher during fresher compared to summer at most sites, except at FPS1, FPS2 and Y3, but was not statistically significant (p=0.3)"*

Re-written as suggested.

16. *L175 and L179 include the "not statistically significant" as part of the sentence and only the p value in ().*

Changed accordingly.

17. *L227: missing "." At end of sentence*

Full stop added to the end of the sentence.

Discussion:

18. L 260-263: If there is snow still in the catchment during this time of year (see comments in methods section as to why this is important to mention), could the smaller streams that are more connected to the snow melt be experiencing a dilution effect?

As mentioned in response to questions 6-7, there was not a substantial amount of snow during our spring freshet sampling in 2019 thus we think that dilution was not a major reason explaining differences in TSS and POC concentrations.

19. L296: In section 4.1 the conclusion is that primary production starts earlier in small and warmer streams. How does this relate to trends in higher DIC in warmer waters mentioned here? Could the higher temperatures indicate more terrestrial inputs during the freshet? In particular, for the floodplain streams, which seemed to have highest DIC and temperature. Was there water pooling in the floodplain area during the freshet? Even though the streams have high primary production, they are still very hydrologically connected to the landscape. Could consider adding water to table 1 since it is referenced in the text here.

We agree that the smaller watersheds are hydrologically connected to the landscape and likely receive terrestrially derived DIC as shown for example in a study by Denfeld et al. (2013). It is possible that warmer water and air temperatures warm stream/river banks and thus facilitate more DIC leaching to the river. Warmer water temperatures have also been shown to increase primary production and promote faster microbial degradation. We think that all these processes are likely happening simultaneously. We have added the likely possibility of addition of terrestrial DIC to the streams as a DIC source.

As Table 1 is already rather large, we prefer not add water temperature to this table. However, we have added a reference to Table A3 (with water temperature data) here so that location of these data will be easily detectable for the reader.

Conclusion:

20. Could a sentence highlight the importance of the freshet season and how by not including it we miss an important time of year for carbon cycling.

We agree that this is important to highlight and have included the following sentence to the conclusions (in *italics* the addition):

"Here, we present seasonal contrasts, *including the hydrologically important spring freshet period*, in water chemistry and carbon characteristics of lower order streams and the Kolyma mainstem."

21. L350: Wouldn't there be an initial uptake of CO2 before fueling CO2 evasion?

That is correct and we agree that it is important to include, thus we have added mention of CO_2 uptake processes. See also our response to comment #6 of Reviewer 1.

22. Figure 2: In the legend you write which regression is significant but can this also be displayed in the graph, e.g. an * nest to the regression that is significant. In (a) the spring freshet line isn't shown and in (c) the summer line isn't shown and in (d) both freshet and summer aren't shown, write this in the legend text, e.g, "Linear regression for summer only was not significant, or for tributaries and Kolyma mainstem separately (not shown).". Include the n = for the freshet and summer (L1709. Can the line colors (black, brown and blue) be added to the figure legend?

We have added an asterisk and p-values to the statistically significant regression lines in all panels and clarified in the text that the non-statistically significant regression lines are not shown. We have also added line colors to the legend.

23. Table 1: Ave -> Avg. Consider adding water temperature to table 1 (see L 296)

We have changed the abbreviation Ave to Avg.

24. Figure 3: Fractions -> Fraction

Changed.

25. Figure 4: If so, could consider adding the significance results to the figure. L 255 add "during freshet and summer" at the end of the sentence.

We have added 'during freshet and summer' to the end of the sentence. We decided not to include any indication about significant results to the figure itself as we thought that it would be difficult and potentially confusing to show in one panel differences between three groups (small and midsized, midsized and large and small and large). However, we have added this information to the caption of the figure.