

Interactive comment on “Warming temperatures are impacting the hydrometeorological regime of Russian rivers in the zone of continuous permafrost” by Olga Makarieva et al.

Anonymous Referee #1

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General Comments:

This manuscript presents findings after analyzing temperature, precipitation, and streamflow in a previously understudied region. Its content is within the scope of The Cryosphere, and it is well structured. However, it could be made clearer and more convincing by utilizing stronger visuals to communicate results, more thoroughly explaining the novelty of the study, improving sentence structure and grammar, including further discussion, and by using more precise language. I will detail specific examples of changes to make below. The specific comments are not exhaustive of every instance of the above general comments and should not be taken as so.

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Specific Comments:

Stronger visuals:

1. In the final paragraph of the introduction, you mention that a study of this kind has never been done. This would be more convincing if you provided a map that shows the study region in context, with sites of other studies labelled. Make it clear that this study is new, and in a region where a study like this is important and required.
2. Section 2.1: Refer to a figure that shows what you describe.
3. Section 2.3: It could be helpful to see the stations plotted over land category.
4. Section 3.1: Histograms or kernel density estimation may be helpful in expressing some of this information. ie: y-axis: frequency, x-axis: catchment size, or elevation above sea level, or length of series, etc.
5. Tables 3-8 are hard to interpret as a reader. Express this information in graphical form, either instead of or in addition to the tables. The green and brown colours are also hard to see as a colour-blind person. You could label the rows instead.
6. Of the figures that are shown in the supplementary information, why were those specific stations chosen?
7. Section 4.2.1: Refer to a figure that shows what you describe.
8. Section 4.4.1: Where do these subclusters exist in space?
9. Section 4.4.5: Is this information displayed somewhere in a table or figure?

Further Discussion:

1. Line 221: Why was twenty percent chosen as the threshold? Is this robust? Do spring rain events ever falsely trigger this threshold?
2. Section 3.2: What assumptions underpin these statistical tests? Can you briefly justify their use here? What are limits to applying these tests?

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3. Line 246: “proved” or “suggested”?
4. Line 278: Why was change point analysis not conducted for all thirteen stations?
5. Does the variability of the variables studied change after a change point?
6. Line 505: How can you draw conclusions about trends in winter precipitation if there are uncertainties of over one hundred percent?
7. Line 515: Why is it controversial?
8. Line 517: What is the mechanism that would cause an increase in liquid precipitation to cause soil temperature to drop? I would think that liquid precipitation would warm permafrost through advective heat transport, so please explain to me why I would be wrong.
9. Line 520: You say that the trends agree with each other. Explain the mechanisms that cause you to conclude that they agree.
10. Line 546: Is there a correlation between streamflow to liquid precipitation fraction that you could use to bolster your argument?
11. Section 5.4.3: Are trends in freshet related to elevation of the station? Are changes occurring faster at higher elevations?
12. Section 5.5.2: You should focus this section to discussing your results. You mention a longer growing season, but is agriculture significant in your study region? Is the reanalysis data for the study region? You say that “Rawlins et al. (2010) argue that evaporation is growing”; do you mean evapotranspiration is increasing?
13. Section 5.6.2: In addition to contributing to total streamflow, glaciers tend to reduce the year to year variability of summer streamflow. This is because in hot/dry summers, increased melting partially compensates for reduced rain, while in cool/wet summers, reduced melting partially compensates for increased rain. You could also investigate the year to year variability of July/August total streamflow to further investigate if/where

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glaciers are important in these basins.

14. Section 5.7: How does the input from these rivers into the Arctic Ocean compare in magnitude to input from other rivers (such as the Big 6 that you mention earlier)? If the input from your study is much less, then it is harder to link your results to ocean circulation.

15. Line 727: You say that increases in air temperature are reflected in soil temperature and length of the thaw season. Is it? You have soil temperature stations that behave differently than each other and I am not convinced that you can conclude that increases in air temperature are reflected in the soil temperature. I am not saying that the increased temperature isn't reflected in the soil temperature, only that you need to be more clear, explicit, and convincing in your discussion.

16. Line 757: Your study does not investigate how the changes are impacting large-scale features in Arctic ecosystems, and so you cannot conclude that "these changes are having large-scale effects on the Arctic ecosystem". Keep your conclusions within the scope of your results and discussion.

17. Line 758: This is your first mention of how your study relates to the livelihood of northern peoples. Don't introduce new information in your conclusion, and again, keep your conclusions within the scope of your results and discussion.

Other:

1. In the introduction, it is hard to mention the dynamics of major Arctic rivers without mentioning glaciers. Briefly consider the analysis of large-scale basins, including Mackenzie, Yukon, and Ob, for example as presented in "Global-scale hydrological response to future glacier mass loss" by Huss and Hock, 2018

2. Line 85: What are the "other complex hydrological consequences" you refer to?

3. In the final paragraph of the introduction, it would improve clarity if you give more details about what you will do. I.e.: "This study is structured as follows: in Part II, we

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will [blank]. In Part III, we will [blank]" etc. Make it clear what your methods will be and how they will achieve the goal you state.

4. Line 119: What is meant by “record”? Is it a regional record? A global record?

5. Line 120: How is “cold” defined?

6. Line 134: How is “small” defined?

7. Line 153: “deglaciation waters” should be “glacier runoff”. Also, melt from glaciers, aufeises, and snowfields contribute to streamflow, not rainfall. Be precise with language.

8. Line 175: Does “they” refer to taliks or to rivers?

9. Line 185: A more up to date reference would be better, if possible. I suspect the number of aufeises and their area has changed since the 1970’s. Line 186: How does a basin have 4% aufeis if you say that the area share ranges from 0.4 to 1.3 percent?

10. Line 198: Glacier modelling has changed since the 1970’s, and so a more up to date reference would be better.

11. Section 2: Are there dams in the region? Are these rivers modified or used by humans in any way (ie: agriculture, municipal water supply)?

12. Section 3.2, and then throughout the study: Trends describe a slope, and in a time series, should be in units of [y-axis unit like mm or C]/time. You need to be more clear about if you are referring to slope of trendline, total difference over period (and how this is calculated), and how percentage change since the beginning of observations is calculated. How do you account for the fact that different stations have different length of observations when you compute the total change over period of observation? Throughout the manuscript you need to be much clearer about what you mean when you refer to trends, total changes, and their units.

13. Line 288: Do you mean per month or per year? It is unclear what this sentence

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means.

14. Line 299-301: It sounds like you are talking about a total decrease over the period of observation, but you refer to it as a “decrease” and “trend”. Be more clear about what you are talking about.

15. Line 337: What is meant by “Change point in increasing tendency”?

16. Line 387: How can you note a negative tendency if no trends are statistically significant?

17. Line 408: What is a “trend rate”? The units then provided are neither trends nor rates.

18. Line 458: How are “small” and “large” rivers defined?

19. Section 4.4.6: Causal links should be explored in discussion, not in results. This causality needs to be further explored as well, and not just presented as fact.

20. Line 471: What is meant by “highest temperature”?

21. Line 476: What is meant by “average cumulative value”?

22. Line 488: “relatively homogeneous”; relative to what?

23. Line 543: Say the number of stations, not “more than 3/4”

24. Line 544: How do you conclude that precipitation has increased at ten stations if nine trends are insignificant?

25. Line 583: You mention decreases in maximum ice thickness, but this means little without mentioning the mean maximum ice thickness for context.

26. Line 593: What is meant by “changes”? Change in daily streamflow? Be explicit.

27. Line 594: What does “extraordinarily high” mean?

28. Line 601: What does “in most cases” mean when you are talking about five basins?

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The phrase "can be attributed" is used without explicitly showing why it can be attributed.

29. Line 671: 0.30% of what? Be clear.

30. Line 685: How is "tiny" defined?

31. Lines 687-688: Why are rock glaciers described in terms of number per 100 km², while aufeis are described in terms of percentage of basin area?

Sentence Structure, Grammar, and Technical Comments:

1. Line 20-21: Do the 9 out of 19 rivers refer to freezing rivers?

2. Line 52: "agree" should be "agrees" since it refers to "change", not "changes"

3. Line 87: "assessment" should be "assessments" and "is" should be "are"

4. Line 109: "Mainly the terrain is mountainous" should be "The terrain is mainly mountainous"

5. Line 120: Do you mean to say "changes" or "ranges"?

6. Line 207: ", two" should be ", but two"

7. Line 224: "values" or "errors"? Additionally, how do you know the errors of these measurements?

8. Lines 289-291: Restructure this sentence so that its format is the same when describing the trends in July and August.

9. Line 297: The phrase "was carried out" is passive. Use active phrases instead. I.e.: "We evaluated cold season precipitation...". Passive phrasing happens multiple times throughout the manuscript.

10. Line 302: "Positive trend" should be "A positive trend". This type of error occurs multiple times throughout the manuscript.

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11. Line 303: “the values” should just be “values”.
12. Line 338: “from by” is a typo.
13. Line 340: “for the last fifteen years” or “over the last fifteen years”?
14. Line 342: Have “along with” clause at the end of the sentence.
15. Line 344: “in average” should be “on average”
16. Line 353: “account for the increase by” is unclear. Do you mean “on average, temperature increases by”?
17. Line 366: It is more clear to say “observed at twelve of the twenty-one studied gauges.”
18. Line 375: missing units when mentioning the minimum area.
19. Line 379: “monotonical” should be “monotonic”
20. Line 473-474: “the anomaly” should be “anomaly”
21. Line 489: Remove the comma
22. Line 525: “comparative” should be “compared”
23. Line 531: “at least in at least” is a typo.
24. Line 574: “larger” should be “larger than”
25. Line 576: “the continuous permafrost” should be “regions of continuous permafrost”, or “the continuous permafrost zone”
26. Line 614: “driver” should be “drivers”
27. Line 661: There is a font change, although this could be an issue of the PDF and not the manuscript.