The Cryosphere Discuss.,
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The Cryosphere Discussions

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

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Reviewer #2 states that the central research question addresses an important topic and that the paper provides a valuable in-depth examination of the two basins using relevant data and appropriate methods. Their detailed comments focus on improving the communication of results, agreeing with reviewer #1 that the material in some of the tables should be displayed as figures.

We thank all three reviewers for their positive comments on the manuscript, and their detailed comments to help improve the manuscript. Their numerous, detailed comments will make the manuscript much better overall. We agree that some of the material currently presented in tables should also be presented in figures to assist with interpretation and have made those changes. We have also incorporated the vast majority of individual comments as detailed below.

Major comments

Comment: Some of the most important findings in this study are shown in tables that are very complicated to interpret for a reader, e.g Table 3, 4, 6, 7, and 8. I urge the authors to display the information in figures, which is a more effective way to communicate data to the average reader (see any textbook about data visualization). I do not have the time to analyze these tables as they are currently designed, but I would be happy to provide a complete review of the findings if the authors provide a revised version where the data is shown in a more accessible format.

Response: An additional figure (Figure 1) was added to the manuscript to represent the main results of the paper – the assessment of changes of monthly and annual stream flow. However, the Tables have been retained to provide the reader with the full set of actual numbers. We agree that our tables need some effort to understand them, but they also have a lot of information about the percentage and absolute value of the change for the whole period and the year of abrupt change. We added the description of general structure of the tables at the beginning of the Section 4 before the description of the results to assist in interpreting them. "The results of trend analysis are presented in the Tables 3-8. The Tables have the same structure and designations. The cells filled with grey color correspond to statistically significant trends with $p<0.10$. If any value is bold, it has significance $p<0.05$; if a value is in italics, it has significance $0.05<p<0.10$. In Tables 4 (precipitation) and 7-9 (streamflow) each cell with significant trend contains three numbers: 1) the value of total change for the whole period of observations in the characteristic unit (for example, mm) 2) percentage of total change (%); 3) where available – the year of change point or letter "m" for monotonical trend. If there is neither year, nor "m", the Pettitt's test was not carried out due to many gaps in the data. Statistically significant trends values are divided into 4 groups and marked with different colors accordingly: change points around 1966 – magenta, 1970-1985 – green, 1986-1995 – violet, 1996 and later – yellow. Monotonous trends and where change points were not available due many gaps are in black. For streamflow the year of change point marked with * indicates that the gauge has long-term series more of than 70 years with change point in about 1966 and no significant trend after that period (last 50 years). In some cases second year of change point is given in brackets, it was estimated with Buishand range test. We used the same colors as in the Tables 3-8 in Figure 3 showing the percentage change of monthly and annual streamflow and Figure 4 which presents spatial patterns of change periods."

Comment: The majority of the figures in the supplementary material are key to study and need to be moved to the main manuscript. Additionally, many figures are only showing a sample. This sample should be motivated, or even better – show all the data.

Response: These stations show the best examples of the behaviour we are describing, and so were therefore included in the paper. The figures were moved to the supplementary at the request of the Editor at the stage of submitting the paper.

Comment: The figure captions can be improved throughout. It should be possible to understand the figures without having to read the manuscript text. Provide more contexts in all captions.

Response: We provided more explanations in all captions.

Comment: I suggest the authors expand their analysis of the spatial pattern of the changes within these two catchments by preparing effective maps. It would help the reader understand if there are spatial clustering and local coherence in trends and changes in various variables.

Response: We try to present spatial analysis at Figures 1 and 2. Figure 1 shows the total changes of monthly streamflow in (%) and the periods of changes. The gauges are sorted by basin area. Figure 2 presents the periods of changes of streamflow in August, September, October, November, December and annually. Red and black colours indicate the presence and absence of trends, respectively.

Minor comments Comment: Study Area. Some references are missing, e.g. the sections 2.3, 2.5, and 2.6 lack references about key statements.

Response: We added additional references in the section 2.3 GLIMS and NSIDC: Global Land Ice Measurements from Space glacier database. Compiled and made available by the international GLIMS community and the National Snow and Ice Data Center, Boulder CO, U.S.A., doi:10.7265/N5V98602, 2005, updated 2017. Fedorov, A.N.; Vasilyev, N.F.; Torgovkin, Y.I.; Shestakova, A.A.; Varlamov, S.P.; Zheleznyak, M.N.; Shepelev, V.V.; Konstantinov, P.Y.; Kalinicheva, S.S.; Basharin, N.I.; Makarov, V.S.; Ugarov, I.S.; Efremov, P.V.; Argunov, R.N.; Egorova, L.S.; Samsonova, V.V.; Shepelev, A.G.; Vasiliev, A.I.; Ivanova, R.N.; Galanin, A.A.; Lytkin, V.M.; Kuzmin, G.P.; Kunitsky, V.V. Permafrost-Landscape Map of the Republic of Sakha (Yakutia) on a Scale 1:1,500,000. Geosciences, 8, 465. 2018. Section 2.5 Grave N., Gavrilova M., Gravis G., Katasonov E., Klyukin N., Koreysha G., Kornilov B., Chistotinov L. The freezing of the earth's surface and glaciation on the ridge Suntar-Hayata (Eastern Yakutia). Nauka, Moscow. 1964 (in Russian) Hydrological Yearbook: Volume 8. Issue. 0-7. The basin of the Laptev and East-Siberian seas to the Kolyma river, Yakutsk Department of Hydrometeorology, Yakutsk, 1936-1980. State water cadastre: Annual data on the regime and resources of surface terrestrial waters. Volume 1. Issue 16. The Lena River basin (middle and lower course), Khatanga, Anabara, Olenka, Yana, Indigirka, Yakutsk Department of Hydrometeorology, Yakutsk, 1981-2007. Section 2.6 Shepelev, V.V.: Suprapermafrost waters in the cryolithozone. Novosibirsk. Geo. 2011, 169 pp (in Russian) Mikhailov, V. M.: Floodplain taliks of North-East of Russia. Novosibirsk. Geo. 2013, 244 pp. (in Russian)

Methods Comment: Clarify if a separate test of stationary was applied or if stationarity was determined with Mann-Kendall and Spearman rank.

Response: The stationarity of the time series was checked with respect to: 1) a monotonous trend (Mann-Kenndall and Spearman) and 2) abrupt changes (Pettitt's and Buishand tests).

Comment: Explain why both Mann-Kendall and Spearman rank were used to determine trends.

Response: In most cases the interpretations of Kendall's tau and Spearman's rank correlation coefficient are very similar. Two tests were selected mostly selected to check and compare the results because no statistical test is perfect even when all test assumptions are met; more than one statistical test is good practice (Kundzewicz and Robson, 2004. Change detection in hydrological recordsâĂŤa review of the methodology. Hydrological Sciences Journal des Sciences Hydrologiques 49: 7–19).

Comment: Explain the serial correlation better. Why and how was it applied? More details are needed.

Response: Serial correlation increases the number of errors of the first kind when checking for the presence of a trend, overestimating the significance of the assessment, and the probability of finding a trend where there is none in reality increases. On the other hand, the presence of a stationary trend overestimates the value of the autocorrelation coefficient. The method proposed in [Yue et al., 2002] and known as trend-free pre-whitening (TFPW) was used to increase the reliability of statistical trend assessment. At the first step, the linear component is subtracted from the time series, the coefficient of which is determined by the Theil-Sen method. In the second step, the time series is decorrelated by subtracting from it the component corresponding to the first-order AR (1) autoregressive process. Then the two series are summarized, after which the values of the rank correlation indicators are determined for the final series.

Comment: Use either autocorrelation or serial correlation term to make it easier for the reader to follow along.

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Response: Used serial correlation. Corrected.

Comment: More context for the Pettitt's test and the Buishand range test would be welcomed.

Response: The Pettitt's test and the Buishand range test are widely used to identify change points in series of hydrometeorological data. The Pettit test for a change in the median of a series with the exact time of change unknown is based on ranks, which implies that it is less sensitive to outliers. The Buishand test is used to detect a change in the mean by studying the cumulative deviation from the mean, it assumes a normal distribution of data.

Results Comment: The stations are referred to as numbers in tables 3 and up, but by name in the text (e.g. the section about precipitation). Please choose one or the other, it is too much to ask for the reader to cross-reference with table 1 and 2.

Response: Corrected.

Comment: Figure 1: Add an inset map that shows the study area in a larger context (e.g. Siberia)

Response: Change made as requested (Figure 3).

Please also note the supplement to this comment:
https://www.the-cryosphere-discuss.net/tc-2018-157/tc-2018-157-AC2-supplement.pdf

Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2018-157, 2018.

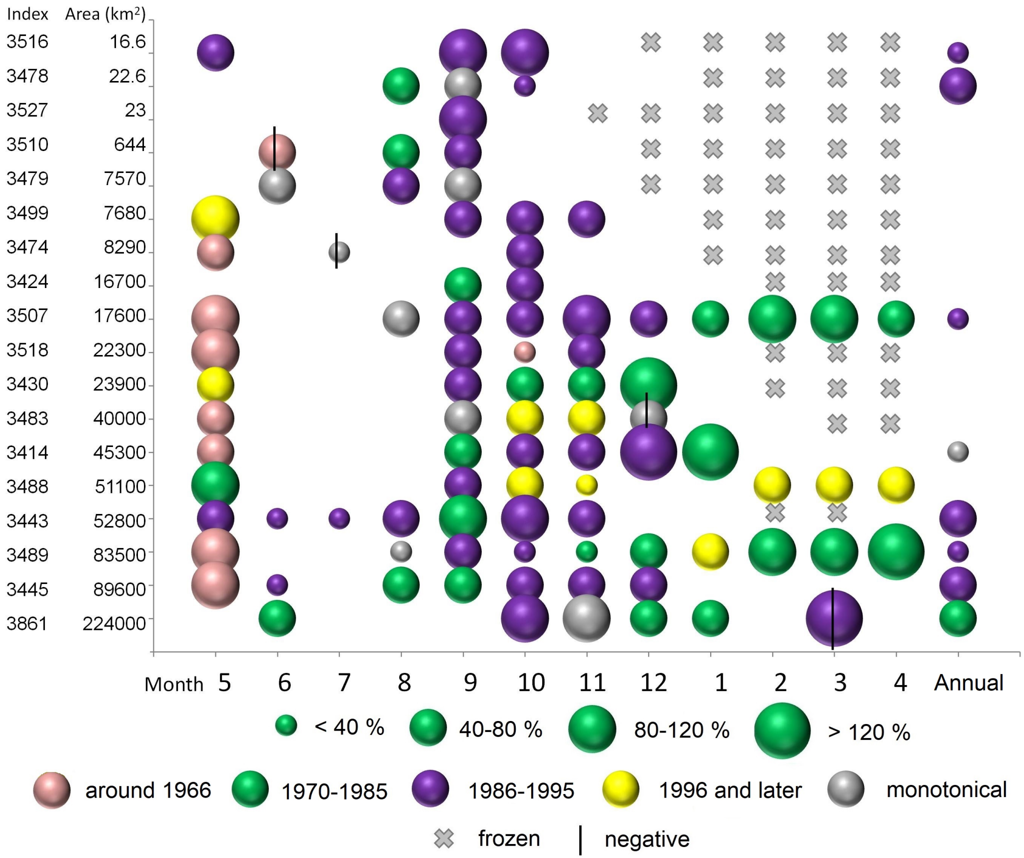

Fig. 1. Change in monthly streamflow represented as a %, along with the period in which that change occurred. Data are for both Yana and Indigirka river basins and are sorted in order of basin area.

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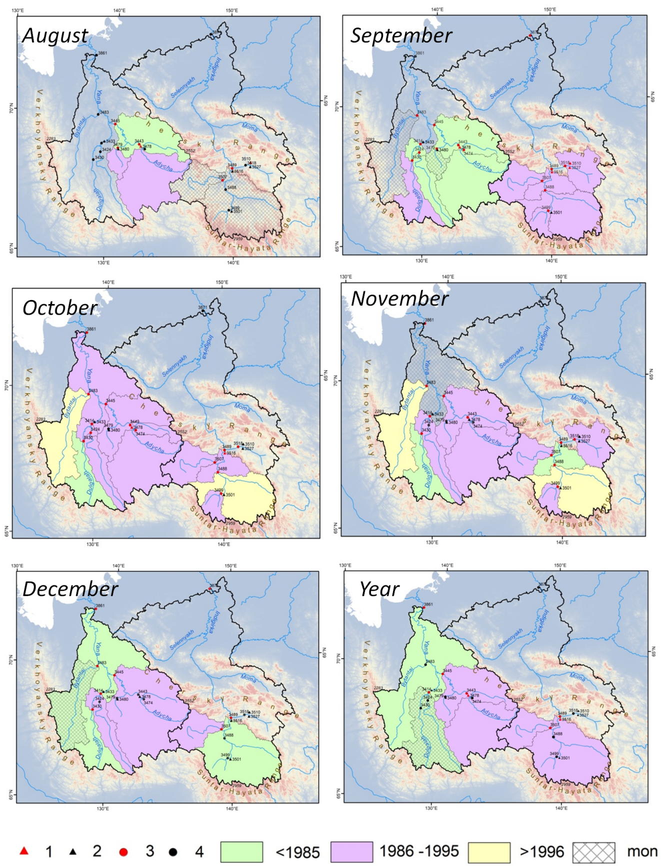

Fig. 2. The periods of changes of streamflow in August, September, October, November, December and annually. Red and black colours indicate the presence and absence of the trends, respectively. The triangles

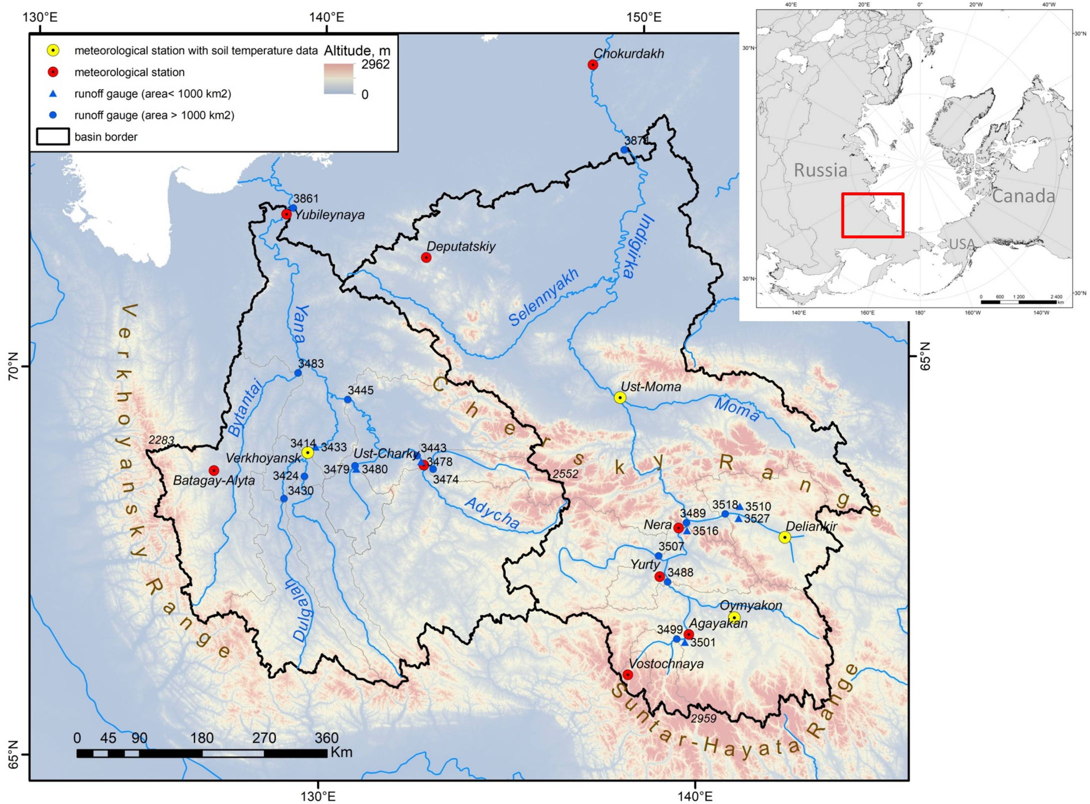

Fig. 3. Meteorological stations and hydrological gauges within the study basins

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