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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A novel algorithmic framework for identifying changing streamflow regimes: Application to Canadian natural streams (1966–2010)" *by* Masoud Zaerpour et al.

Anonymous Referee #1

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General comments

The analyses presented are interesting, and may be useful in establishing the changes in the regimes of Canadian rivers. Unfortunately, the results are undermined by their presentation. With some revisions, I believe that the paper can make a good contribution.

The writing needs quite a bit of editing. There are too many grammatical mistakes to list here, and the writing is often unclear.

There are missing articles in many of the sentences, such as the first one:

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Page 1, Line 28

"Natural streamflow characteristics have been critical consideration"

This is sentence is missing the article “a” before “critical”, or needs to make “consideration” a plural

In many sentences there are disagreements in number, i.e. between singular and plurals:

Page 2, Line 34

“some others determines”

As was stated above, the writing is often unclear, as in the caption of Figure 9:

“Figure 9. Mapping shifts in natural streamflow throughout Canada during 1966 to 2010. Rates of shift among various regime types in each stream are shown by shades of grey that quantifies how much decline in the giver regimes shown in the x-axes in each panel can result into incline in the receiver regime type corresponding with the column in which the panel is located. Columns filled with diagonal lines show the identical regime types with the receiving regimes identified in the column where the panel is located.”

Specific comments

There appears to be only one gauging station within the Canadian Prairies. This is disappointing as the hydrology of the region is very important and has seen many effects of changes in climate. There are several RHBN stations within the prairies, according to this website https://www.canada.ca/en/environment-climate-change/services/water-overview/quantity/monitoring/survey/data-products-services/reference-hydrometric-basin-network.html.

Whitfield et al. (2020) grouped responses of streams into 3 clusters in the Prairies and adjacent areas, using a very different clustering methodology. I assume that there were

no other prairie stations which met the authors' criteria. However, it would be good to have this explained. Would the use of a slightly different analysis period have allowed the inclusion of more prairie streams?

Whitfield, P.H., Shook, K.R., Pomeroy, J.W., 2020. Spatial patterns of temporal changes in Canadian Prairie streamflow using an alternative trend assessment approach. Journal of Hydrology 582, 124541. https://doi.org/10.1016/j.jhydrol.2020.124541

Although hydrologists are used to working with river basins, grouping the stations by basin is not always useful. As shown in Table 2, Canadian river basins are very large. Wong et al. (2017) identify 15 ecozones in Canada, many of which are spanned by single basins. For example, the Nelson River system spans the Montane Cordillera, Prairies, Boreal Plains, Canadian Shield and the Hudson Plain. Stations in differing ecozones would not be expected to behave in similar ways, given that their elevations, geologies, topographies, vegetations and climate forcings are very different, even if they are within the same basin.

Wong, Jefferson Razavi, Saman Bonsal, Barrie Wheater, Howard Asong, Zilefac Elvis. (2017). Inter-comparison of daily precipitation products for large-scale hydro-climatic applications over Canada. Hydrology and Earth System Sciences. 21. 2163-2185. 10.5194/hess-21-2163-2017.

Furthermore, many ecozones are split among several basins. The Montane Cordillera stations are divided among the Nelson, Peace-Athabasca, and Fraser basins. These stations would be expected to show some similarities, although local conditions would also apply.

It would be very useful to have the ecozones superimposed on the maps. It would also be useful to take the ecozones into account when grouping the analyses.

Line 338

"...the Arctic has the least diversity in the streamflow regime. All considered 12 streams are associated with large degrees to glacial regime, out of which five and six streams show increasing and decreasing trends in the membership, respectively."

The fact that half of the streams in the basin change in each direction is confusing. Does this imply that the changes are not a result of climate shifts, but rather of short-duration weather trends? Or is it that the streams are in different climatic zones?

It would be very useful to have a map, or maybe more than one map, of the sites showing their changes in regime type. This would allow the reader to see if the changes are spatially related. Again, it would be very useful to have the ecozones superimposed.

The "glacial" type is problematic. Looking at Figure 6, at least 16 of the "glacial" basins cannot include any glaciers at all, as they are not in mountains. No doubt many of the mountain basins do not contain glaciers, either. The same issue is true of the "niveo-glacial" type. I understand that the authors are using the term "glacial" to refer to the shape of the cluster's annual hydrograph, but the term is confusing. Worse, the authors are grouping together streams with very different causes for their behaviours.

The source of the archetypal "glacial" stream, Kazan River above Kazan Falls, is in northern Saskatchewan, where there are no glaciers. Looking at Figure 7, the main difference between the "glacial" and "nivo-glacial" types would appear to be that the former has a shallower recession limb. According to en.wikipedia.org/wiki/Kazan_River:

"The river headwaters are in northern Saskatchewan[7] at Kasba Lake... Along its course the river flows through several lakes, including Ennadai Lake and Yathkyed Lake."

So the cause of the shallow recession limb is almost certainly storage within the lakes in the basin.

Line 245:

"Architype (sic) streams are those streams that have the highest association to the

identified regime types and can represent the characteristics of a given regime better than other members of the cluster."

As the Kazan River is controlled by lakes, it would be very difficult to transition to another cluster type. I see that many of the "glacial" and "niveo-glacial" streams lie within the Canadian Shield. Are many of these also dominated by lakes?

Where an unglaciated stream transitions between "glacial" and "niveo-glacial" types, as in the Hudson Bay and Arctic Seaboard basins, it cannot represent a change in the glacial contribution. It is therefore important to separate those basins containing glaciers, from those which do not. Where there are glaciers, and the stream transitions from "niveo-glacial" to "glacial", would this imply an increase in glacial contributions? If so, would this be justified by what we understand about glacial hydrology?

Line 244

"Figure 5 summarizes the results, showing c = 6 as the optimal number of clusters."

I think this needs to be explained in more detail. Why is 6 the optimum number of clusters? I can see that the indices become quite flat around c = 6, but what do the indices mean, i.e. are small index values better (this is not explained)? If so, why not use c = 7, as it looks to be slightly better for the Separation Index and the Xie and Beni Index? Is there a reason why it is advisable to use fewer clusters?

Figure 7 is useful to demonstrate the differences among the clusters. It would be extremely useful to see similar plots indicating the cluster transitions. For example, what does it look like when the streams transition from "glacial" to "niveo-glacial", or vice-versa? Because so many climate signals are used, it is not easy to see how the changes in the hydrograph relate to the transition from one cluster to another.

Technical comments

How were the calculations performed? I assume that some software was used. It should be credited and described. If possible, the software should be made available

for others to test and use.

I believe that “architype” is a misspelling of “archetype”

Figure 5

The x axis labels are misspelled – “Numer” should be “Number”.

Figure 7

In the interests of space, it would be a good idea to omit the periods in the x-axis label month names, and also the x-axis title “Month”. The caption refers to the “expected” annual hydrograph. What does this mean? Are these the mean (or median) weekly values? The y-axis label is in “mm/week^{-1}", i.e. in mm x week. Obviously this is incorrect.

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