

Hydrol. Earth Syst. Sci. Discuss., referee comment RC4  
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## **Comment on hess-2020-613**

Anonymous Referee #4

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Referee comment on "The spatial extent of hydrological and landscape changes across the mountains and prairies of Canada in the Mackenzie and Nelson River basins based on data from a warm-season time window" by Paul H. Whitfield et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2020-613-RC4>, 2021

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Whitfield et al detail a study that examined trends in streamflow and satellite indices for a large area in central Canada. Many government operated hydrometric stations in this region are only active during warm or open-water season. Because of this, many previous studies looking at long-term flow trends have not used these stations and instead focused on stations operated year round. The authors overcome this issue by using an approach called dynamic time warping to account for differences in timing of streamflow across latitude and elevation. They apply these methods to 395 stations and classified 12 streamflow regime types. They also looked at seasonal trends in streamflow using k-means clustering. They complemented the flow analysis with an analysis of trends in three satellite indices (NDVI, NDWI and NDSI). They suggest that trends in streamflow are organized spatially and influenced by location and ecozone, but not streamflow regime type. They document regional trends and speculate on the underlying hydrologic changes that may be driving those regional trends.

The study is interesting and the methods applied seem useful. My biggest issue with the manuscript is that it is long and feels like it lacks focus at times (I would echo many of the comments of RC3). During my readings of the manuscript, I often felt that content was repeated numerous times (e.g., the conclusions simply repeat some of the discussion), I wasn't sure what the key points of the study were (e.g., was the application of relatively novel methods or was it the hydrologic insight - in the case of the hydrologic insights, I wasn't always sure what I was supposed to take away from the results), and there were often statements made that seemed to have major implications for understanding the study, but were not expanding upon.

To build on this last point, the following are some statements that I wished were developed more:

- "Clearly historical budgetary and management decisions in the Canadian hydrometric program affect any current analysis of hydrological trends and change." (L217-18) How does it affect analysis? How does it affect this study in particular? What are the implications?

- "The dataset contains nested basins." (L156) Okay - what should the reader make of this? My first thought is that these stations will exhibit correlation and may be considered a form of pseudo-replication... how does this impact the analysis?

- "Determining the magnitudes of trends in annual runoff or other annual attributes using this methodology is not appropriate." (L714-715). Why and what is the implication here?

- "While these GRACE trend regions are consistent with the results presented here, the mechanisms that Rodell et al. (2018) suggest are not." (L823-824). This seems to come out of nowhere. What are the mechanisms presented by Rodell et al? How do they compare with the speculations made in this study? I think this is partially attempted in the following paragraphs, but the comparison between this study and Rodell is not clear.

- "It is important to note that climate signals, particularly for the Pacific Decadal Oscillation [PDO] and Arctic Oscillation [AO] were not considered here. Oscillation in the climate system can be manifest as tests on short time periods." (L970) This seems like a big deal and was an immediate concern that popped into my mind as I was reading the manuscript the first time. Given that the stations sample different years, how does one consider the potential influence of periodic climate signals that may be in different modes for available station records?

- "Interpreting the results from any fixed period may not be representative of historical variability (Hannaford et al. 2013)." (L1026-1027) Can the implications and importance of this statement for this study be expanded upon?

I have a few specific comments listed below, but another part of the analysis that seems to warrant some consideration is how does size of the basin impact the trends in the satellite indices? I would guess that larger basins may aggregate different temporal patterns across the space thereby smoothing out potential trend signals. Are identified (or lack of) trends related to basin area?

Specific comments

Abstract: Agree with another reviewer that this is too long. The first paragraph could be substantially reduced and incorporated into the second paragraph. There's perhaps too

much detail provided here. Distill this down to the key points of the study.

L35-38: Not clear what this sentence is trying to say.

L70-71: 'hydrological' is repeated twice.

L74-77: Run-on sentence.

L78: Change one of the 'dominate'

L87-89: Seems like these two sentences repeat the same point.

L92: The rationale for ecozones comes on a little abruptly. So 'ecozones were chosen as an appropriate level for comparisons', but the reader doesn't really know what we will be comparing yet.

L85-112: Some of this feels more like a description of the methods and data used. Consider revising this to focus the introduction on setting the context of the study and what research gaps are addressed, and use the methods section to focus on details about the data used.

L110-112: The difference in temporal coverage of the streamflow and vegetation/water/snow indices feels like a big deal that is somewhat glossed over here. In addition, I'm not sure what 'trends in these indices over many basins provide another perspective of change over the study domain' means. Could this be clarified?

L115: Do you need both 'separately' and 'individually' here?

L115: What is 'hydrological structure'?

L120: What 'mechanisms' were considered in this study? It seems like some basic indices were related to streamflow patterns. Why should this be considered as 'mechanisms'?

L142: What is meant by 'annual time window' here?

L150-151: Why is the link to CCRN process-based studies important?

L164-166: Check grammar.

L180: What 'related packages'?

L310-314: How much of an issue was this? I can imagine certain regions across the study region are more prone to cloud cover than others. Did this bias the analysis in any way?

Section 3.4: There are a number of speculations made about hydrologic processes underlying the detected trends in streamflow and satellite indices (e.g., increased greenness results in increased ET, increased NDWI is due to increases in PPT). There are a number of limitations to these indices and making some of these links to actual hydrologic fluxes and storages may be confounded by other influences. It seems like some of these speculations could be checked by looking at available meteorological data, such as precipitation trends for some of these NDWI trends, for example.

L730-733: This feels like a major issue - that the key hydrologic runoff event for some of these catchments is not always accounted for using the time window considered in this study.

L745-748: I'm left wondering what the deal is with these flow regime types that contain only one or two stations. Why did these stations stand out? What makes them unique? It seems a lot could be learned about the hydrology and/or the methods used in this paper by looking at these specific classes more closely.

L758-759: Could you elaborate on why these results are different from those reported by these other two studies?

L990: In what way are the available data 'messy'?

L991-994: Run-on sentence.

L1002-1019: The first half of this paragraph is a little strange to read. Stating that this study is important because it connects to existing research programs doesn't seem like a strong rationale. Emphasizing the points in the second half of this paragraph would make for a stronger point.

Table 2: What is the point of including this table? Could be moved to the SI.

Figure 1: The map projection used doesn't look typical for showing this region. The northern region is stretched considerably.

Figure 6: The dashed lines are obscured in some of the plots (e.g., regime type 1 and 5). The axes labels could be more descriptive. Colouring the individual lines doesn't make much sense to me since we have no way to connect these back to stationID.

Many of the figures are not colour-blind friendly. I would suggest using a more colour-blind friendly colour palette.