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Interactive comment on "The Spatial Extent of Hydrological and Landscape Changes across the Mountains and Prairies of the Saskatchewan and Mackenzie Basins" *by* Paul H. Whitfield et al.

Anonymous Referee #2

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General comments:

Paper The Spatial Extent of Hydrological and Landscape Changes across the Mountains and Prairies of the Saskatchewan and Mackenzie Basins examines spatial distribution of streamflow regime types, trend patterns and satellite indices (NDVI, NDWI, NDSI) based on large number of streamflow and satellite data sets covering large area of continental Canada, east of Continental divide. Main contributions of the paper are: (1) applications of methodology such as dynamic time-warping which enabled alignment of stream flow hydrographs according to the point of inflection and K-means clustering enabled classification of seasonal streamflow regimes; (2) large spatially

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distributed data sets offering insights into changes in hydrological regimes and trend in large area covering several climate and topographical zones ; (3) increasing number of available datasets with applied methodology.

Overall this is very ambitious study done with the large data set covering large portion of continental Canada which offers new insights on hydrological changes in (especially) streamflow regimes and opens new research questions and deserves to be published in HESS. However, information and ideas presented in the paper are very difficult to follow so I recommend restructuring the text and adding some additional clarification to the questions presented in the next section. I recommend this article for final publication after the MAJOR revision, mainly regarding the paper structure and more concise communication of (very interesting and valuable) results.

Specific comments:

Remarks that should be addressed in order to make paper more concise are listed below. Three main open questions/remarks that need to be addressed are: 1) Different concepts are presented and used in the text: e.g. landscape and ecozones are used throughout text interchangeably. What is the difference between them? This comment is also related to the title – landscape is stressed in the title and in the paper, but analysis is done related to the ecozones maps. What was the main motivation for the introduction of ecozones and what additional information does it offer in the explanation of e.g. streamflow regime types and trend patterns? Although ecozones are connected with the climate and topography (and with analysed satellite indices), from the aspect of hydrological processes and streamflow regimes, watershed level is the most important unit that would offer additional insights (this is also stated by the authors in the paper Pg. 13 L 300-303, Pg. 21 L 580-581). Also, maps that give information about climate zones and topography of researched part of Canada would be more useful for analysis of results, especially about streamflow regime types and trend patterns, but also satellite indices. Authors should decide what would be the main goal and main information that they would like to convey in the paper and then should choose appropriate spatial

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representations of the data. Question is again raised regarding landscape change and its influence on hydrological change on Pg. 30 L841 but answer or explanation is not given.

2) In the Pg. 6, L 140 it is stated that only time window between 19th April to 31st October for the streamflow data is used, and that satellite indices (NDVI, NDWI, NDSI) are extracted from the Landsat composite images for every sixteen days between 1980 and 2013 for the entire year (if I understood correctly). Although different time period is used for the hydrological storage (satellite) indices than for the streamflow regime and trend patterns, the reason why the same warm season time window of the data (between 19th April to 31st October) for the satellite indices is not used should be addressed. This would reduce the size of available data sets, but methodologically seasonal data would be comparable. Maybe this important methodological aspect of the paper, i.e. spatial analysis during the warm season, should be stressed and added to the title of the paper?

3) Methodology regarding dynamic time-warping and trend pattern analysis need additional clarification or at least more clear explanation of the idea and of the conducted steps.

Remaining questions / remarks:

4) After the introduction, I recommend adding one (sub)chapter named “Data” where more specific information would be given about used dataset and (sub)basins, before any processing of the data. After that (sub)chapter, chapter about used methods for processing and selection of the data could follow. Readers would especially benefit if the map with Saskatchewan and Mackenzie Basins location in Canada and location of analysed stations would be provided. Also, table with summary statistics of streamflow data collected from 395 basins would offer additionally information important for understanding of the analysed streamflow and watersheds (e.g. min, max, mean of analysed streamflow, dataset lengths, (area and mean elevation of analysed watersheds, etc.).

5) In Pg6, L144 - it is not clear for the reader what does “periods 23 to 61 (of 73)“ represent. Also, this periods need to be marked appropriately in related figures (Fig 1-5,7,8, 11, S1-12, S14-20) and information about months or dates in the year (is it from 19th April to 31st October?) would be more useful. Especially since these are main figures for the understanding of the results presented in the paper.

6) Overall, information and ideas presented in the paper are difficult to follow so I recommend restructuring the text and careful reviewing of naming used: e.g. main spatial areas of change introduced in the discussion are [i] North of 60°; [ii] Boreal [iii] Prairies [iv] Mountains and in the conclusion are: [i] The Mackenzie Basin, [ii] The western Boreal Plains, [iii] the western Prairies, [iv] The Cordillera. Naming of the areas are different, and are also different from the three areas mentioned in the abstract: [i] north of 60°, [ii] in the western Boreal Plains, [iii] across the Prairie. Also, these areas should be mentioned and explained earlier in the discussion, not just to start section with this naming.

7) Abstract should be more concise, shortened and connected more with the main conclusions (one example just mentioned in the previous section). Questions opened in the abstract are very general (Pg. 5 L 103-108) and have not been answered in the discussion nor in the conclusion. Information about the data used in this study are presented in different sections of the text and it is difficult to follow what was available (e.g. in chapter 2.1. Data streamflow data and satellite data is introduced and 3 pages later in 2.3 Landscape and hydrological storage trends satellite data is introduced).

8) Pg. 6 L155-159 – it is not explained clearly enough why Figure 2 is important.

9) Pg. 7 L 175-176 “Only the data in the periods between the two vertical dashed lines in Figure 3 were used in the clustering”. These lines are not marked consistently in the remaining Figures (both in text and supplemental S1-S12) and they are important for the understanding of the analysed period. 10) Results presented in Tables 5-7 show that fraction of stations showing a trend at $p \leq 0.05$ is decreasing with the number of

stations increasing. This would be interesting to comment in the text.

11) Introduction of the analysis of the recession limb of streamflow regime hydrographs is made for the first time in the discussion (Pg. 22 L601). This makes no sense because it has not been mentioned earlier as one of the goals of this research. Although this analysis offers new interesting insights, it should be introduced and explained earlier in the introduction and in the methodology.

12) It is not clear why would authors want to introduce questions regarding PDO and AO (Pg. 29 L829-836) and how is that connected and important with the results that they presented in their paper. What would be methodology used to incorporate these signals in their future work?

Technical corrections:

Figure 4 – 6 trend patterns (clusters) should be marked on vertical axis? Figure S2 - description of the figure should be cluster number 2, not 3? Figure S4 / S5 – it is not clear where does description of the Figure belong

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