Comment on hess-2021-349

Eleanor Bash (Referee)

Referee comment on "Recent hydrological response of glaciers in the Canadian Rockies to changing climate and glacier configuration" by Dhiraj Pradhananga and John W. Pomeroy, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-349-RC2, 2021

The manuscript uses a hydrological model, CRHM, to simulate runoff in two glaciated catchments. The authors create a suite of scenarios by combining the climate and glacier coverage of two periods (mid-20th century and early 21st century). The approach of comparing static and dynamic climate/glacier coverage is not entirely new, but the authors' model scenarios present an interesting perspective by including both backward and forward comparisons of these configurations. While the modelling scenarios have the potential to provide new insights, the manuscript is generally unfocused, and I think the main contributions are lost in the text.

Major comments:

Overall, the manuscript needs better structure to guide readers to the salient points. The introduction fails to clearly highlight the knowledge gaps the authors are trying to fill. Given the wealth of modelling studies about glacier retreat and runoff, I think the contribution of their analysis is more nuanced than you suggest. The model you use does not model glacier behaviour, I believe, it uses glacier landcover classes to model runoff response. The clearest statement of what this paper contributes is P4L22-23.

A more thorough review of recent literature on glacier runoff, hydrological contributions, and glacier retreat in Western Canada specifically needs to be included with particular attention to the gaps the authors hope to fill. I would suggest including these references and removing those that are outdated or pertaining to other regions:

Neupane, R. P., Adamowski, J. F., White, J. D., & Kumar, S. (2018). Future streamflow simulation in a snow-dominated Rocky Mountain headwater catchment. Hydrology Research, 49(4), 1172-1190.

Castellazzi, P., Burgess, D., Rivera, A., Huang, J., Longuevergne, L., & Demuth, M. N. (2019). Glacial melt and potential impacts on water resources in the Canadian Rocky Mountains. Water Resources Research, 55.

DeBeer, C. M., Wheater, H. S., Carey, S. K., & Chun, K. P. (2016). Recent climatic, cryospheric, and hydrological changes over the interior of western Canada: a review and synthesis. Hydrology and Earth System Sciences, 20(4), 1573-1598.

Chernos, R. J. MacDonald, M. W. Nemeth & J. R. Craig (2020). Current and future projections of glacier contribution to streamflow in the upper Athabasca River Basin, Canadian Water Resources Journal / Revue canadienne des ressources hydriques, 45:4, 324-344.

Intsiful, A., Ambinakudige, S. (2021). Glacier Cover Change Assessment of the Columbia Icefield in the Canadian Rocky Mountains, Canada (1985–2018). Geosciences, 11, 19.

There is a lot of repeated information in section 2. Introduce study sites, then model, data, and modelling scenarios. The statistical tests you use need more description, since you place a lot of emphasis on them in your results. In addition, the scenarios are laid out in a confusing manor with a description of data in the middle. P5L4 refers to A-D but this has not been described in text. Figure 2 should be update dot include the S1-S5 scenarios. The terms modelling approach, scenario, and scheme seem to be used interchangeably, once they have labels (A-D, S1-5) stick to those.

Section 3 does not focus enough on the modelling experiments. A full page is devoted to describing the climate data and glacier retreat which is described in other papers in great detail. Instead these could be briefly mentioned, with more text devoted to describing the outcomes of all 5 modelling scenarios. The combination of results and discussion leaves the most important outcomes lost in a lot of text. I suggest separating these to interpret the results and bring the reader back to the research gaps identified early on. As it is written, I was left wondering what the new contributions were other than the scenario approach.

Specific comments:

P1 L13 glacier changes

L13-14 Climate trends in Arctic are not relevant for your work, up to date climate trends for W Can.

L21 dependent on what?

L24 compensation by precipitation is not in contrast to the findings of Moore 2009, it is an additional hydrological variable that will affect stream flows and glacier runoff

L31 the previous paragraph you suggest this may not be a real phenomenon

P2 L3 – I think you mean link, not establish?

L6 it is no surprise that pdo and enso are linked with winter mass balance, but did this study link them with net mass balance as you suggested in L3?

L23 introduce the study sites before using these acronyms

P4 L5 this study doesn't validate the model, rather you are using the model to draw conclusions about these two basins

P5 L30 the decade is a sufficient identifier or consider using "recent"

P6 L4 what maximum does this refer to? the absolute maximum, or a period of maximum?

L6 these are more than a few exceptions

L16 what statistical analysis this needs to be in the methods

L23-25 this isn't your results

L28 if you intend to discuss to AAR, include some relevant information in your introduction or methods – how did you measure the change in AAR? Is this from the model? In general, I find myself confused about where the results in 3.2 are derived from, are AAR, slope, snowline, etc. output in CRHM or do these come from satellite and DEM?

P7 L13 what does a decrease in mean annual snowmelt mean? Is there less melt or less snow to begin with?

L26 be precise in language, you are not accounting for mass change, only area change

L31 this is the most interesting finding you are reporting but it reads like an afterthought. Lead the paragraph with this and then justify it

Figures and tables:

F1 – this map needs more context. The border and the basin outlines are too similar, the red box has more visual weight than the important aspects of the map.

All figure captions need more detail

F3 – give Each panel a letter label, move labels outside of graphs. Y-axis scales should be the same across all panels. These are monthly means of daily max/min/mean, not "seasonal daily"

F4 – panel labels moved outside of graph boundaries, and A-D not A1, A2. Text the same size for all panels, colors consistent between panels, why say "past and present" in one and data period int eh other?

F5 should be combined with F4 as it presents another set of precip data, clarify modelled output vs raw reanalysis data (in F4 I believe)

F6 omit this figure and include snow/firn and ice in F7

F8 is not adding anything

F10 This would be easier to interpret as 4 panels, both past climate scenarios and both present climate scenarios

T1 this isn't adding anything, include information in text and omit table

T5-10 this is supplementary information, these tests are not described or the results addressed in detail so the detailed tables are not warranted

T11 highlight the cell rather than the text in the cell to draw the readers eye to the significant information, the more important values are the mass balance numbers, rather than the p-values