Diagnosis of future changes in hydrology for a Canadian Rocky Mountain headwater basin

by Xing Fang and John W. Pomeroy

submitted to HESS

Referee comments:

The manuscript presents a climate change study for a small Canadian Rocky Mountain headwater basin. As process understanding has to be developed at the local scale, such regional/local studies are of a high value. The study is presented in a concise way and contributes well to current discussions. Small changes could improve the readability of the paper (see detailed comments).

However, I would strongly recommend to add a discussion on the uncertainty of the hydrological modelling results. The results chapter is full of numbers, partly with a high number of positions after the decimal point suggesting a high accuracy. Depending on the model design and the catchment characteristics, some results of hydrological modelling are more reliable than others. If, e.g., a model does not represent hydrophobic effects and if they play an important role in a catchment, then the model may simulate overall runoff with a satisfying efficiency but the calculated portion of Hortonian overland flow calculated by the model will be less reliable in this case. Thus, for readers not familiar with CRHM, a discussion on the strengths and especially weaknesses of the model concepts and the resulting reliability of the model results would be very valuable.

The comments in detail:

- The paper contains numerous abbreviations (WRF, MCRB, CRHM, CTRL, PGW, QDM, WY,…). A list of abbreviations would improve the readability.

- In the entire paper: please do not use "alpine" and "treeline" as single words, but always in combination with ecozone: "alpine ecozone", "treeline ecozone". This would improve the grammatical correctness of the sentences and the readability.

- I am no native speaker, but to my feeling sometimes articles are missing, e.g.
  Page 2, line 18: of <u>the</u> world,
  Page 2, line 23: two of <u>the</u> most
  Page 3, line 29: in the eastern slopes
  Page 5, line 5/6: <u>the</u> complex mountain terrain
  Page 9, line 23: had <u>a</u> very comparable … value (or had … values)
  Page 11, line 28: <u>the</u> entire basin
  Page 13, line 16: by <u>a</u> combination
  Page 14, line 15: <u>a</u> large elevational gradient
  Page 14, line 18: these changes were result of <u>the</u> interaction

- Page 3, line 19 and page 4, line 20: A model does not permit convective precipitation processes (they are permitted by the atmospheric conditions), but it permits the

representation/simulation/consideration of convective precipitation processes. Please adapt the formulation.

- Page 3, line 20/21: I would delete "to combine …. from CRHM to" as this is also said by "using a dynamically… model" (line 23-24).

- Page 5, line 29: I would include a citation (e.g. Pomeroy et al., 2007) at the first appearance of the model.

- Page 6, line 1: Please explain dynamic networks of HRUs (in the models I have worked with, HRUs are defined for a catchment and remain the same during the whole simulation).

- Page 6, line 12: please give some short information on the June 2013 flood.

- Page 6, line 26 to 28: Most of the content of this sentence is repeated in the next sentence, please streamline this text.

- Page 6/7, line 31/1: "do not appear to be linear distribution" does not sound to be formulated correctly (linearly distributed).

- Page 7: line 6/7: I would suggest to shorten the sentence, for example in this way: "… for the uncorrected WRF outputs, with two exceptions: Values of RMSD…"

- Page 8, line 22: unit is missing: 112 mm

- Page 8, line 26/27: "Sublimation is the total of blowing snow, surface snowpack and forest canopy interception sublimation." This sentence is either grammatically circular (sublimation is sublimation) or – if the last word does not belong to "blowing snow" - physically incorrect as the blowing of snow means a reduction of snow at the windward site, but by snow transport, not by sublimation in its physical sense.

- Page 9/10, line 31-32/1 and page 14, line 21: Regarding the uncertainty associated with hydrological modelling in general and climate projections, I would recommend to give only one position after the decimal point. Doing so means that you partly loose the differences between the CTRL and PGW values – but that means that they seem to be smaller than the uncertainty.

- Page 10, line 23-25: Please explain why the centre of flow volume shifts to an earlier period in PGW, but the peak basin discharge remains unchanged.

- Page 10, line 32: Please consistently use two positions after the decimal point for the discharge values.

- Page 11, line 26 and page 11, line 28: "close" instead of "closed"

- Page 12, line 3: "September" instead of "Septmeber"

- Page 12, line 28: sublimation losses from blowing snow → see comment above

- Figure 2c: Can you please explain the relative humidity values up to 300%?

- Figure 2e/g: The dotted line for "best linear fit" is misunderstanding. It is just the best linear fit for the lower values. For the whole data set, a best linear fit would look different. I would delete this line.

- Figure 4: I would recommend to show the simulation line in light blue instead of dark blue to get a stronger contrast to the black observation line.

- Figure 11 and 12: The differences between the ecozones would appear clearer if you would use a uniform scaling of the y-axis.