

Interactive comment on “Multi-variable evaluation of hydrological model predictions for a headwater basin in the Canadian Rocky Mountains” by X. Fang et al.

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General comments

This study evaluates hydrological predictions of non-calibrated physically based CRHM model for a small catchment in the Canadian Rocky Mountains. Hydrological simulations are compared with field observations of snow, soil moisture, groundwater levels and streamflow at several sites in the period 2005-2011. The results indicate relatively well simulation of snow accumulation and melt and unfrozen soil moisture fluctuations, but rather poor simulation of streamflow, particularly at sub-basin scale. The authors

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conclude that model results are encouraging and indicate future research priorities.

The study is interesting and within the scope of the journal. Manuscript is clearly written and has a good structure. The application of physically based hydrologic model, which does not require the calibration, is interesting and relevant to the problem of PUB (predicting streamflow at ungauged sites) and in changing climate conditions. The paper aims to assess the understanding of hydrological processes in cold regions by using a flexible physically based modeling platform. As it is discussed in Parajka et al. 2013, the choice and cross-validation of appropriate model structure is still a big challenge, particularly in PUB context. The objective of the paper is to examine this question, however, in the current form, the results need to be more clearly linked and discussed with respect to the choice and parameterization of particular model structure. The authors describe in detail the modeling of different processes, but it is not always clear how they relate to the observations used in evaluation. For example, authors conclude that the major snow-related processes (e.g. snow interception, sublimation, unloading, snow redistribution, etc) were well represented by selected model structure, but from presented results (e.g. figure showing total snow water equivalent) it is not clear whether and why it is the case? (How much are particular processes contributing to the overall snow mass balance at particular places? Does the particular parameterization of snow interception and/or redistribution dynamics contribute to the overall agreement between model simulations and observations? What is the role of different landscape and vegetation characteristics and their parameterization?) I would strongly suggest that authors carefully redesign the figures, in order to clearly demonstrate and justify the interpretations made about the choice and parameterization of selected processes. Secondly, I would suggest to discuss in more detail the reasons for relatively poor streamflow predictions. Particularly, it would be interesting to know the reasons for "unexplained spikes" in simulated hydrographs and why was the model unable to adequately reproduce the hydrographs at sub-basin scale?

Specific comments

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- 1) Constant environmental lapse rate: Please justify the value (0.75) and consider to discuss the effect of model input(s) uncertainty on the results (model structure complexity versus data availability).
- 2) Hillslope module parameters: This section is rather long in comparison to other parts. How relevant is the level of detail with respect to the overall objectives?
- 3) Snow evaluation- "the timing of snowmelt was excellent ..": Please provide more details on why it is the case? What parameters/process representation are important?
- 4) Figures: Please consider to demonstrate more clearly how selected model structure improves process representation. Please consider also to show shorter periods, when necessary (the entire time series are difficult to read). Figures showing the variability along some interesting transects (e.g. showing snow redistribution) might also be an alternative.
- 5) Fig.6, 7: Please consider to show snow simulation as a line.

References:

Parajka et al.(2013) Comparative assessment of predictions in ungauged basins; Part 1: Runoff hydrograph studies. Manuscript submitted to HESSD.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 12825, 2012.