

## Peer Review

# Simulating cold-region hydrology in an intensively drained agricultural watershed in Manitoba, Canada, using the Cold Regions Hydrological Model

Marcos R.C. Cordeiro, Henry F. Wilson\*, Jason Vanrobaeys, John W. Pomeroy, and Xing Fang

The Basin of the River La Salle in the Canadian prairie is intensively managed for agriculture. 83% of the area is used to cultivate different types of crop. Nutrients are strongly evacuated by the La Salle river, especially during peak flows, which makes the ability of runoff prediction a crucial topic. As in the catchment snow and ice processes are major factors influencing discharge processes, the prediction suffers from uncertainties in discharge measurements and lacking knowledge of Snow and Ice related runoff processes. This paper aims to develop a runoff model capable to do predictions in intensively cultivated catchments considering the complexities of snow and ice related runoff processes. Therefore, the authors suggest the use of multiple models performing finally as one. As a basis the Cold Regions Hydrological Modelling platform is used, as there already existing knowledge is broadly included. An important character of the model is its physically based and un-calibrated nature, which is important to react on process and measurement uncertainties. To evaluate the model, several statistical measures as the NSE and RMSE, as well as a falsification assessment focusing on snow sublimation, snow transport and frozen soil infiltration have been conducted. Finally, the authors conclude by reflecting three points: First they figure out remaining model weaknesses and lack of knowledge, second they appraise their model regarding its accuracy and reliability as support of decision makers and thirdly they confirm falsifiability of their model.

### Main Assessment:

The Article is well structured and follows mainly the required contents of every chapter, which helps the reader to understand this quit complex development of the considered model. As far as noticed, the paragraphs are well written and use precise language. To develop the model, the authors use existing knowledge and software but try to address for unexplored difficulties in runoff modelling (i.e. Ice jams and backwater conditions). The literature review however shows, that mainly well-known as well as for national concerns developed concepts and models are applied which is not convincing regarding the actuality and importance of the paper. It is not clear how this topic is addressed on a global scale. Additionally, the paper is challenging to read, as it describes every step within its technical details and has no structural overview (process chart).

### Major Points:

Use of visualizations:

Process charts, graphs and tables: For a reader this paper is hard to follow; which step, which model-part is described where. Therefore, include a process chart and use same terms. Plus, insert graphs and tables, where they are mentioned.

Falsification:

The Falsification used in this research tries to assess model performance by removing modules and characterize the resulting model performance. This approach has in my opinion two weaknesses:

1. The time period falsification is conducted includes a period where no statistical measures for model performance have been done. This is critical regarding the informative value of the falsification.
2. Evidence of falsification is not given through this approach or it is at least not discussed. Discussing only the model performance differences, the proof of falsifiability is still not given.

Basis of Model development: Review gives a hint for incomplete investigation of existing research. Try to include as well international research and look for similar approaches.

Ch. 2 Material and Method: This chapter is too detailed and can be shortened. Find out which information is really considerable and important to understand your Model process. The rest can be shown in a process chart or can be described as an adaptation of existing concepts/models etc.

**Minor Points:**

Introduction: Research content and aims are mentioned, question and hypothesis are missing.

Implementation of land-use split method to define HRU's: Use of this approach has to be justified and evaluated. Both is done insufficient.

Assessment of the model: Besides the falsification the model assessment period for the statistic metrics (March to October) makes no sense without i.e. meteorological explanation of the catchment. It seems like the assessment for snow related runoff modelling is conducted in snow free periods.

Ch. 3.4: The model adaptation mentioned in this chapter is hidden and not explained in the method part. Implement it earlier and bring it into a context

Discussion Line 555ff.: Here it is mentioned that low flow conditions are important for land use management in Prairies. At the same time, it is mentioned, that low flow has only low impact on nutrient transport. Though, why are low flow conditions important? This explanation isn't clear enough.