

Authors' reply to interactive comment posted by Anonymous Referee #2 regarding the HESS Discussion paper "Simulating cold-region hydrology in an intensively drained agricultural watershed in Manitoba, Canada, using the Cold Regions Hydrological Model"

Dear Reviewer,

We appreciate your comments and suggestions to strengthen the manuscript. Please find below the answers to your comments.

Major comments

Reviewer: The significance of the research, the novelty of the result and analysis is not clearly stated. For example, the importance of Lake Winnipeg is not the reason for publication (first paragraph). That CRHM has not yet used to simulate hydrological processes in the specific intensively managed lowland agricultural watershed is not the reason for publication either. As a suggestion, I would like the authors to highlight: 1) few hydrological modelling exercises have been carried out in the complex terrain like Red River. The current work provides valuable insights. 2) The study area has global implications (not only for Lake Winnipeg). 3) The challenges identified (ice and backwater conditions) are important for further modelling practices. The possible future research/experimental efforts should be clearly stated, which can be useful for other researchers. 4) How can the non-calibration of CRHM give the reasonable results, especially internal variables like SWE, soil moisture, and evaporation? More explanation can provide valuable insights for the readers.

Authors: The rationale in the first paragraph has been shifted from Lake Winnipeg to the Red River Basin, as suggested. More emphasis was also put on global implications of the research in this landscape due to similarities with other cold regions globally. Suggestions for future research have also been included in the Summary and Conclusion section. Internal variables have been further discussed in the revised manuscript. Discussion of internal variables has been extended in the revised manuscript to emphasize that aspect of the analysis.

Specific comments

1. *Reviewer: The eutrophication is background of this paper. It should be presented in a concise manner. The present manuscript talked too much about that, for example, in Ln40, Ln82, Ln109, Ln526.*

Authors: The emphasis has changed from eutrophication of Lake Winnipeg to hydrological simulations in the Red River Basin, as suggested by the reviewer in the major comments.

2. Reviewer: *Ln 63: references are needed for ARHYTHM and VIC. Also, It is fair to mention some recently developed cold-region hydrological models like THREW model: * Liqin Mou, Fuqiang Tian, Heping Hu, Murugesu Sivapalan. Extension of the Representative Elementary Watershed approach for cold regions: constitutive relationships and an application. Hydrology and Earth System Science, 2008, 12:565-585. * Fuqiang Tian, Heping Hu, Zhidong Lei, Murugesu Sivapalan. Extension of the Representative Elementary Watershed Approach for cold regions via explicit treatment of energy related processes. Hydrology and Earth System Science, 2006, 10:619-644.*

Authors: References for ARHYTHM and VIC have been added, as well as the references suggested for THREW.

3. Reviewer: *Ln328 and other locations: is ice condition mentioned specific to ice cover condition? Please clarify.*

Authors: Ice conditions are flagged in the HYDAT daily records, but no further detail is provided. It was assumed that ice conditions meant complete or major ice cover at initial ice breakup. This information has been included in the revised manuscript.

4. Reviewer: *Ln393: soil moisture is not well reproduced as we can see from figure 9. Please be careful with the relevant statements.*

Authors: The intention was not to talk about soil moisture in absolute terms but to discuss it as a trend, since no soil moisture observations were available. This clarification has been made in the revised manuscript.

5. Reviewer: *Figure 4: simulated and observed discharge lines are not easily differentiated (also in figures 6, 7, and 9). The size of dots for WSC manual readings is too big.*

Authors: Several colour schemes and line weights/types were tried to improve the figures during the manuscript preparation. The best scheme was chosen taking into consideration some technical aspects such as creating contrast with uncertainty periods and a fixing the scale in the y-axis to facilitate comparison among years. That being said, the dot sizes in the WSC manual readings have been reduced in the revised Figure 4 to improve legibility. The other figures mentioned did not present dotted data. High resolution versions of each panel have also been included as supplementary files to allow for more detailed inspection by the reader.