Geoscientific
Model Development
Discussions

Interactive comment on "The Canadian Hydrological Model (CHM): A multi-scale, multi-extent, variable-complexity hydrological model – Design and overview" *by* Christopher B. Marsh et al.

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Dear Reviewer #2, Thank you for your review.

>At the same time I think that the manuscript title, abstract, and Methods should be revised to be more specific on what CHM simulates at this point and what this manuscript is focusing on.

The following sentence "Although the CHM will eventually include the entirety of the hydrological cycle, snow accumulation and surface meteorology processes are currently

implemented." Has been added to the Design and Overview – Overview section to more explicitly acknowledge this limitation, and to ensure the reader is better prepared for the process representations described. The methodology already states this, so hopefully the addition to the Overview section is sufficient to make this point clearly. Regarding the title, we believe the title is sufficient and that describing the overall design goals of the framework with key cold region processes is a reasonable approach.

>I feel like an outlook section discussing how authors are planning to include "the entirety of the hydrological cycle" would be interesting.

A common question has been how to deal with the irregular geometry with overland and subsurface flows. A new section (Outlook) has been added that describes some other models' approaches to this, including some possible avenues for CHM.

>I also suggest authors to clearly define some of the wording in the manuscript. For example >Line 10 page 1: maybe "precipitation-runoff" would be better

I would like to keep rainfall-run off as I am referring specifically to the non-cold regions literature.

>Line 18 page 1: maybe introducing TINs here would be more informative

I've added "via variable resolution unstructured meshes" to this line

>Introduction: I think this Section could be revised for conciseness and to better streamline the story.

The introduction has been revised to improve the story. A new opening paragraph to more readily articulate the problem statement has been added, and the other paragraphs have been tweaked and reordered to follow a more logical progression.

>Line 6ff page 2: among these limitations,

The first line has been amended to "substantial heterogeneity and difficulty in observing surface and subsurface parameters and processes" which should better link the details

later in the paragraph.

>Line 30 page 3: could you provide examples of these "next-generation data products"?

I've added "such as unmanned aerial vehicle (UAV) imagery (Buhler, et al 2016; Harder, et al 2016; Spence, et al 2016]." To clarify. However, I do want the more detailed description in the paragraph following the list of features a next-gen model should have.

>Line 22 page 7: remove one "in" before Marsh et al. 2018.

This is fixed

>Section 4.4: I would expand this section to include details of the modules that are currently supported and their main parametrizations.

This has been added.

>Line 17 page 10: what does "embarrassingly" mean here?

This is a nomenclature common in computer science and means a type of parallel problem where no communication between the workers (threads, MPI processes, etc) is required. It's the simplest type of parallel problem. The text has been amended to include "– that is, a problem that does not require any communication between threads"

> Line 13 page 12: maybe remove "in the results"?

Agreed

>Also, how does the animation view specifically allow for immediate diagnosis of modeling errors? Maybe provide a couple of qualitative examples to make the point?

The following has been added: "It also allows for immediate diagnosis of modelling errors, especially if the spatial pattern of an output variable is clearly incorrect. For example, if a coding error resulted in: a patch-work of air temperatures instead of an expectedly smooth gradient with elevation, snowdrifts being formed in locations that

were known to be incorrect such as the top of a ridge instead of in the lee, or northern hemisphere north-facing slopes receiving the most shortwave irradiance."

>Line 3 page 14: I believe SNOWPACK is generally reported in all caps

This has been changed throughout

>Line 15 page 14: to my knowledge, SNOWPACK allows for many other turbulent-flux schemes

Yes, for example some Antarctica specific parameterizations. The one used herein is the default, wildly applicable scheme. The text has been amended with "The default Michlmayr, et al (2008) scheme was used herein." To clarify which was used.

>Line 26 page 14: maybe report reference to Figure 6 here?

Added, and the later reference was removed

>Line1&5&8page15: whydidyouchoose1000mand10stepshere? Maybe providing some of your experience here may guide future users.

The following has been added to the 2nd paragraph in the "Raster algorithm adaptation (shadowing)" section: "The guidelines for choosing these search values follows two criteria: 1) the radius should be large enough to cover the distance across a representative valley length distance, such that shadows from mountains across the valley are included; and 2) the step should be about half of a triangle length scale such that steps do not pass over triangles."

>Line 8 page 16: is 2007 actually 2008 here?

Yes, thankyou

> Line 22 page 16: I would include here more details on how the other parametrizations performed.

Although extensively detailed in Marsh 2012, an overview of the results was added to

this paragraph.

>Conclusion: I think the first two paragraphs could be summarized or removed

The first two paragraphs have been combined into 1 and a new paragraph summarizing the findings from sec 6 were added.

>Figure 11: maybe reports dots to highlight speedup values

added

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