Hydrol. Earth Syst. Sci. Discuss., 7, C204–C208, 2010
www.hydrol-earth-syst-sci-discuss.net/7/C204/2010/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Future high-mountain hydrology: a new parameterization of glacier retreat" *by* M. Huss et al.

T. V. Schuler (Referee)

t.v.schuler@geo.uio.no

Received and published: 16 March 2010

Review Huss et al: Future high-mountain hydrology: a new parameterization of glacier retreat Submitted to HESSD

General: The manuscript (MS) presents and discusses a novel method to parameterize the evolution of glacier volume and area. The method combines both, low data demands and computational cheapness. Unlike many other parameterizations available, this one conserves mass and is therefore well suited for hydrological modelling. As pointed out in the text, this procedure has previously been applied by the author, but the present MS analyses the method in detail, with special focus on the validity and limitations, making the MS a good contribution for both, hydrologists and glaciologists (and those somewhere inbetween. . .). The parameterization function is empirically derived

from observations and for validation, the predicted glacier volume/ area evolutions are compared to results from a Full-Stokes model. I found the results and their discussion convincing and the illustrations clear and helpful.

However, before publication, a few minor changes should be included to answer the following questions and thereby increasing the clearity of the MS.

Criticism: As mentioned in the Abstract, the (empirical) Δh-function is site specific, but the authors generalize the observations from 34 glaciers and use three size classes to transfer the function to other glaciers. A couple of questions is related to this approach:

1) The second question raised by B. Schaefli (http://www.hydrol-earth-syst-sci-discuss.net/7/345/2010/hessd-7-345-2010-discussion.html) deserves definitely more attention: how different are the Δh-functions for the 34 glaciers? Are they clustered such that the subdivision into three size classes is evident?

2) The validation against predictions made by full-Stokes modelling is testing the temporal transferability of the Δh-function. How about the spatial transferability? How transferable is the Δh-function to other glaciers? This could have been investigated by dividing the data set of 34 glaciers into a training and a validation subset.

3) During retreat of a large or medium sized glacier, it will at some point shrink into a different size class. How is this transition handled? From the MS it seems that each glacier maintains its size class until disappearance, still giving acceptable results. One may wonder whether the division into three size classes is necessary and one single mean Δh-function would have performed equally well.

4) Establishing the Δh-function: in Sec 3.1 it is stated that "the quality . . .increases with time span covered and the magnitude of changes occuring". This is only true if there is a monotonic trend in the changes. If the period covers an entire cycle of glacier fluctuation, the quality of the corresponding Δh-function would be lower than that derived from a shorter period that covered only advance or retreat.

5) As mentioned on P 363, L 16-25, the approach is used for glacier retreat only, but the argument why it would not work for glacier advance is not very convincing. Of course, the Δh-functions have been derived for periods of persistent retreat, and are therefore not necessarily applicable for advances. However, the main problem seems to me the question of how and where to distribute the ice volume in case of glacier advance. This is not straightforward, and treating the retreat is much simpler (unfortunately this is also the case that mostly applies).

In addition, I list also a couple of technical corrections and suggestions that would help to improve the readability of the MS (P=page, L=line):

P346, L2 (and further throughout the MS): "Climate warming" is awkward. Climate encompasses statistics of temperature, precipitation etc and cannot warm. Use "global warming" or "climate change" instead.

P346 L 4: change "...to efficiently project economic impacts..." into " to reliably asses..." (it is not the efficiency that is the crucial question here)

P346, L24: remove "management". Climate change has direct impacts on the water resources, whether the management is affected is mainly an adaptation problem.

P 347, L3: replace "disappearance" by "reduction" (less drastic wording) I think there is no consensus about the complete disappearance of all mountain glaciers.

P347 L13/14: you may want to add a reference to e.g. Hock, 1999 which describes the method that is used here.

P348, L3: remove "could be".

P 348, L26: "...generated using an interpolation..." (remove "on" and "advanced")

P349,L 5, L7 and L10: Acronyms VAW-ETHZ, BAFU and MeteoSwiss are probably unknown to non-swiss readers. In my view they are not necessary at all, so just skip them.

P349, L12 and throughout the MS: change the style for in-text-citations: e.g., "Huss et al.(2008a)" instead of "(Huss et al., 2008a)".

P349, L15: change into "...in response to a change in mass balance"

P349, L20-22: reword this sentence, it is hard to understand.

P353, L3: change to " ... in these regions, thickness changes due to ice dynamics..." (thickness changes is more general than thinning, comprising also thickening)

P353, L16: remove "types".

P353, L24: "The model thus reasonably simulates the hydrological cycle"...you probably mean "discharge seasonality", "hydrological cycle" is something different (see for instance http://en.wikipedia.org/wiki/Water_cycle).

P354, L4: remove "...has a high level of physical sophistication" (this is implicite in "solves the nonlinear Stokes equations").

P354, L23: change to "...using identical..." (remove "the").

P354, L27: change to "...the first glacier surface DEM available for 1874..." (remove "accurate", "for" instead of "in")

P355, L23: change "adversary" to "unfavourable"

P357, L17/18: "comparison between... and..." or "comparison of ... to ..." (do not mix).

P357, L20: "...change along the central flowline"

P358, L13: subsection head: "Future runoff", "stream-flow runoff" is redundant.

P359, L6-9: reword this sentence, it is hard to understand.

P359, L10/11: change to "After complete disappearance of the glacier, low-flow conditions...will be intensified..." (ice cover –> glacier, "enhanced" low-flow sounds

odd if you want to say that there is less water).

P359, L14/15: change to: “The glacier discharge peak is shifted. . .”.

P360, L11: remove “dynamically” (“dynamically changing” is redundant).

P360, L28: I do not understand how surface elevations are derived using the AAR-method, which only describes the adjustment of the glacier area.

P364, L12: “stream-flow runoff” is redundant, use “runoff”.

P365, L1-11: this part is very general and should be included in the introduction rather than in the conclusions.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 345, 2010.