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Hydrology and Earth System Sciences Discussions

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

M. Huss et al.

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We would like to thank B. Schaefli for her comments that were very helpful to improve the initial manuscript.

Below, all comments are given (in italic), and discussed (normal type style), and, where applicable, we suggest a new version of the text (in quotation marks).

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Since such a a parameterization approach will be particularly useful for hydrologic prediction, it would be interesting to evaluate the performance of the approach in terms of "water", i.e. what is the water equivalent of the differences between the results obtained of the ice-flow model and the deltah parametrization?

As the ice volume changes obtained from the ice flow model and the parameterization agree well over the entire study period and different scenarios (see Figs 7 and 8, Table 2) the differences in terms of water provided by long-term glacier storage change are rather small. An estimate of the difference in annual runoff is now provided.

"The application of the ice flow model leads to a slightly different glacier evolution relative to the Δh-parameterization (see e.g. Fig. 8). We evaluate the resulting differences in annual runoff from the catchment of Rhonegletscher in decadal intervals by comparing simulated glacier ice volume. Averaged over the century, the misfits are negligible (0.1% of annual runoff). Higher differences with both positive and negative sign occur for individual decades. The rms error of annual runoff obtained using the Δh-parameterization or based on the ice flow model over all scenarios and the entire study period is 3.2%."

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The relationships derived for three different glacier size types seems promising for ungauged catchments; however, it would be nice to have more information about the data behind these relationships (ideally, it would be nice to see all the 34 lines): how many glaciers per class, what is the spread around the mean relationships? Are the signatures really significantly different or do the underlying individual signatures for glaciers from different classes overlap?

This issue was addressed in detail. See comment in the response to Reviewer #1.

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Since the authors are specialists in the field, it would be nice to have a discussion of these signatures, which would make them even more relevant for prediction in ungauged basins; is it possible to explain the different signatures? what is their relationship to the typical features of the altitudinal distribution of mass balance? For Rhone and Silvretta, in general? If you were to work in a really ungauged area, what strategy

would you adopt to come up with a parametrization? Do you think the approach also works for very different climates (Himalaya...); could the ice-flow model not be used to better understand the sensitivity of these relationships to climate / physical environment?

A paragraph in the Discussion section is added (see below).

"The exponent γ, prescribing the curvature of the Δh-function, decreases with glacier size (see numerical values in Fig. 3b). This is explained with the higher importance of ice flow on large glaciers, as well as their wider elevation range."

"The general form of the elevation change signatures is assumed to prevail for all mountain glaciers, also including climate conditions different from Europe (e.g. Himalayas), as they are determined by the universal factors of some altitude dependence of mass balance, and gravitational ice flow. Therefore, the applicability of the Δh-parameterization outside of the European Alps is given, however, requires a recalibration based on repeated DEMs for very different glacier types (e.g. debris-covered glaciers, ice caps with outlet glaciers)."

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And finally, a small detail: since this paper is in a hydrology journal, I would like to have an idea of the main hydrological model parameters (degree-day factors etc).

The mass balance model / hydrological model applied in this study is already described in several papers (e.g. Huss et al., 2008b), including all relevant equations and parameters. The calibration to the same glaciers (Rhonegletscher / Silvrettagletscher) is outlined in Huss et al. (2008a). For the present study, we use the calibrated parameter set from that paper. For these reasons, the mass balance model is not described in detail here; the reference is given. Adding an additional table with parameter values would require a more extensive model description including equations and parameters, which would be a duplication of previously published work. Therefore, we prefer not to

elaborate on the calibrated parameter values, as this is not the focus of this paper.

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