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Hydrology and Earth System Sciences Discussions

Interactive comment on "Simulation of high mountainous discharge: how much information do we need?" *by* B. Schaefli and M. Huss

Anonymous Referee #2

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General assessment

This ms focuses on the problem of calibrating a hydrologic model for application in glacier-fed catchments, for which interactions between the parameters governing snow processes and ice melt introduce substantial equifinality. This problem has been recognized since at least 1990, when Braun and Aellen (1990) used glacier mass balance information to assist in model calibration. Several studies since then have used glacier mass balance information, mostly in a relatively informal manner, to assist with model calibration. In parallel to these studies, many studies (including those cited by Schaefli and Huss) have developed and applied formal methods for multi-criterial calibration in unglacierized catchments.

Within this context of previous studies, the ms by Schaefli and Huss involves three novel contributions: (1) the use of mass balance observations to calibrate a runoff model using a relatively formal procedure that draws upon both Bayesian and rejectionist approaches; (2) the use of mass balance observations to assist in evaluating alternative model structures; and (3) the use of state variables that are sparsely distributed in time as criteria for calibration. While these are incremental, rather than fundamental, contributions, they are sufficiently significant to warrant publication in an international journal such as HESS. I provide below some specific comments the authors should consider in revising the ms.

Specific comments

1. In the introduction, the authors should consider providing a more specific review of the ways in which previous studies used mass balance information to assist in calibrating a hydrologic model. This review would help set the context for and highlight the specific contributions of the current study.

2. The GSM-SOCONT model is "stripped down" relative to many other conceptual models that have been applied in glacierized catchments. For example, the authors had to add snowpack water retention to address overestimation of streamflow in early spring. How might adding further complexity to the model (e.g., accounting for the aspect-dependence of melt rates) influence the conclusions regarding how much information is required to calibrate the model? That is, how specific are the conclusions to the specific model structures tested in this study?

3. The authors indicate that the model does not account for the transition of firn to ice. Can the authors comment on what effect this might have on the results? How much firn cover existed on the glacier at the beginning of the simulation period and how did it change through time? For example, Braun and Escher-Vetter (1996) showed how the depletion of firn at Vernagtferner, beginning in the early 1980s, influenced both meltwater production and runoff routing. If such transient responses are not explicitly

accounted for, to what extent might the apparently optimal parameter distributions and model structures be distorted?

4. The authors indicate that the source of the overestimation of discharge in early spring (as illustrated in Figure 6b) is related to problems with modelling water retention, especially early in the spin-up period when the modelled firn layer is not sufficiently thick. However, an alternative interpretation is that the problem lies in not representing the thermal state of the snowpack (i.e., the "cold content"). Can the authors justify their inclusion of water retention rather than cold content? Could a case be made for including both processes?

5. Is all of the catchment above tree-line? If not, what is the effect of not accounting for processes such as interception loss?

Technical comments

6. A map of the catchment would be useful for readers not familiar with the geography of the study region.

References

Braun, L.N. and M. Aellen. 1990. Modelling discharge of glacierized basins assisted by direct measurements of glacier mass balance. In: Hydrology in Mountainous Regions. I – Hydrological Measurements; the Water Cycle, Proc. of two Lausanne Symp., August 1991. IAHS Publ. No. 193, IAHS, pp. 99-106.

Braun, L.N. and H. Escher-Vetter. 1996. Glacial discharge as affected by climate change, in Interpraevent 1996: Protection of Habitat against Floods, Debris Flows and Avalanches, 24– 28 June 1996, Garmisch-Partenkirchen, Germany, pp. 65 – 74, Int. Forschungsgemeinschaft, Klagenfurt, Germany.

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