

## ***Interactive comment on “A conceptual glacio-hydrological model for high mountainous catchments” by B. Schaeefli et al.***

**B. Schaeefli et al.**

Received and published: 8 April 2005

Response to R. Hock (referee)

Comment 1: Snow- / rainfall threshold temperature

We have discussed this question in the response to the referee comment of referee # 1 (refer to Hydrol. Earth Syst. Sci. Discuss., 2, S36-S42, 2005). As pointed out in this discussion, the determination of the snow- /rainfall threshold temperature could be based on aggregation state observations at automatic weather stations. (Rohrer et al., 1994) have determined the hourly thresholds for different Swiss stations (the so-called ANETZ stations); they have found values between 0 and 1.5°C depending on the station. These thresholds are point values for a given time step. Up to today, we could not find any useful indications about how to interpolate these results for another spatial and temporal resolution.

Comment 2: Modelling of firn area

We have in fact not considered firn as a separate snow type, modelling its melt with the same degree-day factor as for snow and routing its contribution to the discharge through the same linear reservoir as snow. This represents of course a rough approximation. We justify this simplification by the fact, that no better calibration results could be achieved by including a firn as a third aggregation state of accumulated water. Using a powerful global optimisation method, we have calibrated the model for different model structures including a structure that simulates firn separately (Schaeefli et al., 2004; Schaeefli, 2005). In this approach, at the end of each hydrological year (30th September), the snow that has fallen during the year but not melted is added to the firn pack. On a given spatial unit, firn melt only occurs if the snow pack has disappeared and ice melt appears if the snow and firn packs have disappeared. The firn melt is simulated using a degree-day factor for firn and the melt-discharge transformation is completed using a separate linear reservoir.

The calibration results obtained using only two aggregation states are generally slightly better than for models that use the additional firn type. We assume that this result is due to the over-parameterisation of the model with respect to the available data (note that this result is obtained if calibrating the model based only on discharge data or based on discharge and mass balance data).

### Comment 3: Error of mass balance simulation during mass balance year 1981/82

The important error is in fact not only due to the important overestimation of the melt in the lowest spatial units but also to a general overestimation of the ablation in the entire ablation area plus a slight underestimation of the accumulation above the equilibrium line. A further discussion will be included in the revised manuscript version.

### References:

Rohrer, M. B., Braun, L. N. and Lang, H.: Long-term records of snow cover water equivalent in the Swiss Alps. 2. Simulations. *Nordic Hydrology*, 25(1-2), 65-78, 1994.

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Schaefli, B.: Quantification of modelling uncertainties in climate change impact studies on water resources: Application to a glacier-fed hydropower production system in the Swiss Alps. Doctoral Thesis, Ecole Polytechnique Fédérale de Lausanne, pp. 204, 2005

Schaefli, B., Hingray, B. and Musy, A.: Improved calibration of hydrological models: use of a multi-objective evolutionary algorithm for parameter and model structure uncertainty estimation. In: B. Webb (Editor), *Hydrology: Science and Practice for the 21st Century*. British Hydrological Society, London, pp. 362-371, 2004.

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Interactive comment on *Hydrology and Earth System Sciences Discussions*, 2, 73, 2005.

HESSD

2, S109–S111, 2005

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