

**Referee Comment on “Reply to the comment of Leclercq et al. ...”, M. Huss et al., *The Cryosphere Discussions*, 4, 2588-2592:  
J. Graham Cogley, December 2010**

This Reply addresses a comment by Leclercq et al. (2010) on the findings of Huss et al. (2010), who had reported the detection of a signal due to the Atlantic Multidecadal Oscillation (AMO) in a century-long record of mass balance for 30 glaciers in the Swiss Alps. The authors of the Reply acknowledge the basis of the Leclercq criticism, namely that reference-surface mass balances are more relevant to the interpretation of glacier-climate relationships than are conventional balances. (Reference-surface balances are calculated with the glacier extent and hypsometry held fixed, while conventional balances are calculated with the observed values of these attributes.) However the authors also re-run their original simulations and find that the impact of substituting reference-surface balances for conventional balances is relatively slight. The effect of surface lowering, which Leclercq et al. were not able to model, is opposite to the effect of retreat of the terminus to higher elevations, and the two effects tend to cancel out.

The reference-surface calculations make it clear that some of the response of the glaciers to climatic forcing is indeed “hidden” in their geometric adjustment, and cannot be found in series of conventional mass balances. But the original detection of an AMO signal by Huss et al. (2010) is little affected by this re-calculation. The exchange between Leclercq et al. and Huss et al. has nevertheless been a valuable exploration of how the two kinds of mass balance are related in a practical context, and I recommend that both the Comment and the Reply be published.

Some points of detail related specifically to the text of the Reply are noted below.

P2588

L17 Needs to be conditional: “were fixed in time”.

P2589

L3 I do not understand “even if”, and the logic of the sentence in general. The glacier is *always* approaching equilibrium with the climatic forcing, but if the forcing is not constant the search may be doomed to failure.

L5 “on mass loss”.

L17 “most recent DEM”. A more suitable place to cite Huss et al. 2010 would be right after “model”.

P2590

L1 Change “with” to “as being due to”.

L15 “principle”, not “principal”.

L24 Insert “the corresponding” before “reference-surface balance”, and a comma after it.

P2591

L3 “online supplement”.

References Delete the mysterious page numbers at the end of each reference.

Figure 1 It is interesting that the conventional and reference-surface balances diverge almost linearly with time on the century time scale.

*Online Supplement*

Section 1.1

General

The supplementary figures are all interesting, but I am puzzled by what the text says about some of them. Paragraphs 2 and 3 of this section say that the difference between conventional and reference-surface balances is relatively small both for small or steeply-sloping glaciers and for large and gently-sloping glaciers. It is not clear to me that the dimensions of variability (size/length and surface gradient) can be assumed to be equivalent, as suggested by these generalizations, nor is it clear that the elevation range of the glacier and/or its mass-balance gradient are not variables of at least equal potential significance. Finally it is not clear to me how this discussion, interesting as it is, bears on the correspondence with Leclercq et al.

Para1 L5 “increase”.  
Para1 L6 “Fig. S2a”, not “S1a”. All of the references to lettered parts of “Fig. S1” should actually be to “Fig. S2”.  
Para2 L7 Delete “elevation of the”.  
Para3 L1 “flat” is short but inaccurate. Say “gently-sloping” instead. Make same change in caption of Figure S1.  
Para3 L5 Delete “timely”, which is an adjective, not an adverb. You cannot use it to qualify a verb (and in any case ought not to split the infinitive “to reach”). Insert “in a timely way” after “balanced conditions”.  
Para4 L1 Change “strongly” to “heavily” or “extensively”.  
Para4 L2 Given “throughout”, “entire” is redundant.  
Section 1.2  
Para1 L3 Figure S3 is cited only in the body of the reply. Try to find a way of citing it in the Online Supplement before this citation of Figure S4.

Table S1  
Caption L3-4 “would have had if retreat, but no surface lowering, had occurred ...”.  
Caption L5 “similar to the estimate”.  
Caption L6 “due to”. Delete comma after “shows”.  
Caption L7 Delete “that would occur” and “the effect of”.  
Right-justify the  $R_{\text{comp}}$  column.

Figure S1 Cases 1 and 2 would be more accessible to the reader, and the message of the graph would be clearer, if the lines were labelled in the legend as “Case 1: Pure retreat” and “Case 2: Pure thinning”.  
Caption L4 Delete “loss of”.  
Caption L8 “gently-sloping”, not “flat”. Put “widely” after “been observed”.

Huss, M., R. Hock, A. Bauder and M. Funk, 2010, 100-year mass changes in the Swiss Alps linked to the Atlantic Multidecadal Oscillation, *Geophysical Research Letters*, **37**, L10501, doi:10.1029/2010GL042616.  
Leclercq, P.W., R.S.W. van de Wal and J. Oerlemans, 2010, Comment on “100-year mass changes in the Swiss Alps linked to the Atlantic Multidecadal Oscillation” by Matthias Huss et al. (2010), *The Cryosphere Discussions*, 4, 2475-2481.