Comments on "Comment on ... Huss et al. (2010)", P.W. Leclercq et al., *The Cryosphere Discussions*, 4, 2475-2481:

J. Graham Cogley, November 2010

Huss et al. (2010), relying on modelling constrained by relatively abundant data, 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 AMO signal, with a period of about 65 years, is extracted along with a secular trend towards more negative mass balance between 1908 and 2008.

Leclercq et al. draw attention to an apparent overestimate of the relative strength of the AMO signal identified by Huss et al. The latter calculated conventional mass balances, "conventional" being used in the sense of Elsberg et al. (2001) and referring to the balance as measured or modelled over the concurrent extent of the glacier. Leclercq et al. argue that the conventional balance is a response to both concurrent climatic forcing and the slower evolution of the glacier's hypsometry, and that to isolate the response to climate alone it is necessary to calculate the "reference-surface" mass balance of Elsberg et al., which is the balance the glacier would exhibit if its surface extent and hypsometry were to remain unchanged from some reference state.

The point made by Leclercq et al. is reasonable *prima facie*, and their comment ought therefore to be published. However, the model with which they seek to quantify the overestimate of the AMO signal is (understandably) very simple. It will be important to await the response of Huss et al. before judging the accuracy of the simple Leclercq et al. calculations and assessing their claim that the significance of the AMO is small with respect to gradual warming.

Leclercq et al. do not question the Huss estimate of the magnitude of the sinusoidal AMO signal. Rather, they assert that the magnitude of the "background" response of the glaciers to warming is larger than appears in Figure 3c of Huss et al. If that figure showed reference-surface and not conventional balance anomalies, its dash-dotted "sinusoidal fit" line would (presumably) be steeper but not less wavy. An acknowledgement of this point by Leclercq et al. would probably be helpful to readers. One of the notable contributions of Huss et al. was to show that the AMO is detectable *at all* in mass-balance records, and recalculating with reference-surface balances would (presumably) make that contribution more remarkable.

One difficulty in the text of Leclercq et al. will confuse readers if it is not corrected. They consistently misuse the adjective "specific", which means "per unit area" (or, in an alternative interpretation of Meier (1962) that I do not prefer, "at a point"). All of the balance numbers given by Leclercq et al. , including the reference-surface balances, are "specific", and all the instances of that adjective need to be changed to "conventional".

Cogley (2010), a popular-press article about Huss et al. and its context, may be of interest to some readers.

Some lesser points:

P2476

L6 Help readers to grasp the argument by saying, at this early stage, what *is* the appropriate measure if the conventional mass balance is not.

P2476

L9 The magnitude of the overestimate may itself be overestimated, so "significantly less important" might be better here than "far less important". Similarly at P2478 L27 "governed" might well be replaced by "dominated".

P2476

L12 Hyphenate "mass-balance" when it is an adjective, as here and at L15, L16, P2478 L2.

L20 Say whether this is an ice-equivalent or a water-equivalent volume.

P2477

L5 "do not reflect only".

L20 “for the state of glaciers” (not “on”).
L23 Hyphenate “present-day”.
P2478
L1 Delete apostrophe: “1970/80”.
L4 “Great Aletsch Glacier” (or “Grosser Aletschgletscher”).
L23 Move the comma: “AMO, such that”.
L21-24 I do not understand “the causal relation between the AMO and the mass balance anomaly is opposite at first sight”. It would be clearer to omit “the causal relation between” and to say “the AMO and the mass balance anomaly are out of phase”. But what is wrong with that? And how does this remark support the conclusion arrived at in the next sentence (“This further indicates ...”)?
P2479-2480
Delete the mysterious page numbers at the end of each reference.
P2480
L8 “50(50)”.

Supplement to the Comment of Leclercq et al.
Column 1
L3 Change “specific”’ to “conventional”.
L15 Delete the commas: “covering most of the”.
L22 Insert “conventional” between “average” and “mass balance”.
L26 Delete “specific” (it is correct, but distracting).
Column 2
L3 Delete the comma after Δb.
L4 Change “specific”’ to “conventional”.
Table 1
“Unterer Grindelwald”.
For Pizol, change Δb to “–3.00”.

Cogley, J.G., 2010, Glaciers and the Atlantic Multidecadal Oscillation, *In from the Cold*, environmentalresearchweb, 14 June 2010. [http://environmentalresearchweb.org/blog/2010/06/glaciers-and-the-atlantic-mult.html.]

Elsberg, D.H., W.D. Harrison, K.A. Echelmeyer and R.M. Krimmel, 2001, Quantifying the effects of climate and surface change on glacier mass balance, *Journal of Glaciology*, **47**(159), 649–658.

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.

Meier, M.F., 1962, Proposed definitions for glacier mass budget terms, *Journal of Glaciology*, **4**(33), 252–263.