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The Cryosphere Discussions

Interactive comment on "A glacier inventory for the western Nyainqentanglha Range and Nam Co Basin, Tibet, and glacier changes 1976–2009" *by* T. Bolch et al.

Anonymous Referee #1

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General comments

This paper deals with glacier area change assessment using multi-temporal remote sensing analyses. This methodology is especially well suited to make a glacier inventory and to study area changes of glaciers located in remote regions like Nyainqentanglha Range. These days while everybody speaks about a general retreat of glaciers everywhere in the world, this kind of study, corresponding to a significant work, can be acknowledged.

Although a little too long, the paper is clearly written and organised, the methodology is well described and discussed, the state of the art is exhaustive but according to me, the

paper is missing a thorough description of the regional climate (including figures – air temperature, precipitation, humidity...) to reach significant conclusions to be published like this in The Cryosphere. Indeed, the objectives of the paper (to generate a glacier inventory, and to analyse glacier changes from 1976 to 2001 or 2009) are by themselves too light, and would largely benefit from a climatic interpretation. This paper gives a qualitative climatic explanation (temperature rise) of the general glacier retreat observed in the range, but no climatic study can support this statement. In general this paper is lacking climatological data to better describe the regional climate affecting the region, in order to relate that to glaciers.

Moreover, I guess that there is a large precipitation gradient between the leeward side (NW) of the mountain range compared to the SE side (Indian monsoon effect). I believe that this gradient is probably responsible for a different behaviour of northern and southern glaciers as well as for the distribution of polythermal and temperate glaciers. A short qualitative discussion (p 434, lines 10-14) on this last point is provided but not supported by data. A comparison (regarding glaciers and climate) between both sides of the range should be included.

Finally, this paper deals with area changes, but for climatic purposes, volume changes are much more valuable. The authors say that volume changes could be assessed (p 442, lines 2 to 4), which could be a great contribution in this paper.

I would therefore suggest to improve this paper by including climatic analysis of the region, and also, for selected glaciers, a volume change estimate.

Specific comments

- P 430 line 4 : I agree that the region is probably of "special interest for glacio-climatological research" but at the stage of your study, there is no evidence of that. That is why reading your paper gives the impression of a study lacking a second step analysis concerning climate, and not only glaciers, as suggested above.

- P 430 line 13 : provide the refering year corresponding to the total ice coverage of 795.6 km2

- P 430, line 14 : remove “a” after ∼5800 m or add a.s.l.

- P 430 : line 21 : in general and along the paper, you should not talk about relative values for length or area vartations of glaciers since it depends mainly on glacier size.

- P 431 line 17 : How far is Amdo met station from Nyainqentanglha Range?

- Introduction : the introduction could be shortened. It gives a general overview of the interest of glaciers as climatic proxies, water reservoirs, or potential natural hazards although the study mainly focuses on glacier area variations.

- P432 line 24 : where → were

- P433 line 12 : SW-NE instead of SW-NW

- P434 regional climate data : the paper would need a figure with meteorological data (T, precipitation, other available variables) recorded at Nam Co station, and around the range (Amdo? Lhassa?), if available. Also, when giving meteorological data, provide the kind of instruments used to collect temperature data as well as precipitation data (which is kind of tricky when measuring snow falls..)

- P437 lines 5 to 10 : As said in this part, I believe that debris-covered glaciers are sometimes hard to identify. I understand that different kinds of imagery may help to identify covered glaciers (like in Fig 3), but is it possible all the time? Which error regarding covered glaciers can you expect? And what is the total debris-covered area compared to the total glacier area of the whole range? This should be discussed in more details and text should be included in the error section.

- P438 lines 1-7: the error due to seasonal snow cover can be large, and how about the error on the upper part of the glaciers, where contrast can be low on images?

- Table 2 : I agree that the total number of glaciers is not a very valuable result, since

it depends on how glaciers are delineated (therefore, all comments and considerations concerning the number of glaciers can be shortened). The area coverage is more interesting, but it must refer to years, which is not systematically made. And may be I missed something, but the exact delineation of “Area around Mt N.” Or “Nam Co Drainage basin” is not obvious, and perfectly located on Fig 1.

- Fig 5B. Is the aspect given as a function of the number of glaciers? It would be more interesting to give the aspect as a function of the area.

- P440 lines 4-5 : Do you have any reference to support the statement that the median elevation is the best estimate for long-term ELA?

- P440, lines 23-25 : any consideration regarding the change of the number of glaciers is useless (since it depends on how to count them!), and should be removed

- P440 lines 26-27 or P441 lines 12-15 or p 443 lines 14 to 16: same comment regarding the relative area change. This relative area change depends on the size of each glacier, and is consequently not significant. Remove Fig 7a and 7b. Remove % in table 5. Remove all comments regarding rates of area loss in the section.

- Fig 9 : not so useful, this fig could be removed.

- P442, lines 4 to 17: some considerations here have already been discussed in the methodology (data and methods), earlier in the paper. This section 5.1 should not be included in the discussion section.

- P 443 line 3. Does the ELA estimation (5800 m) come from the median glacier altitude, or from other sources? Actually, what is the ELA of Zhadang glacier where mass balance measurements are conducted?

- P 443 lines 11-15 : The qualitative comparison here between glacier covered area changes (or length variations) and mass balance data is not relevant since length variations depend not only on mass balance variations but also on the own dynamics of the considered glacier. Mass balance measurements (2005-09) are moreover very inter-

esting and could be compared to volume variations obtained from your satellite image data.

- P 444, lines 21-24 : it is somehow dangerous and questionable to relate glacier area changes of five glaciers to long-term regional climate variability because length variations depend on the own dynamics of each glacier (see previous comment). That's why studies concerning volume variations (and then mass balance) are required to use glaciers as climatic indicators. This issue could rise the relevance of this paper.

- P445 lines 1 to 21 : I fully agree that unfortunately, you "are not able to attribute observed glacier changes to specific climate elements". However, the discussion just before qualitatively suggests that the glacier change is related to observed temperature trends. This study would gain a lot if a thorough comparison between climate data and glacier changes was conducted in this paper. Many questions arise regarding the importance of precipitation regimes, the intensity of sublimation, etc. but I am aware that you cannot deal with all these questions.

Interactive comment on The Cryosphere Discuss., 4, 429, 2010.