

## ***Interactive comment on “Glacier changes from 1966–2009 in the Gongga Mountains, on the south-eastern margin of the Qinghai-Tibetan Plateau and their climatic forcing” by B. Pan et al.***

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Received and published: 17 April 2012

### Overview

The manuscript "Glacier changes from 1966-2009 in the Gongga Mountains, on the south-eastern margin of the Qinghai-Tibetan Plateau and their climatic forcing" by Pan et al. presents changes in glaciers in the Gongga Mountains region where the Hailuoguo Glacier has been investigated intensively in previous studies. This study may contribute to understand the retreat and shrinkage of glaciers in regional scale. However, discussion with respect to climatic interpretation and topographical influence is too poor. Significant re-analyses / additional analyses and rewrite are required for the

C2155

publication.

### Major comments

In discussion (P3491-3494), the authors attempted to interpret their results derived from remotely sensed data with climatic records and topographical features. I basically agree their assertions such as (P3492L2) "the increasing amount of precipitation could not compensate for the mass loss due to the temperature increase" but these should be evaluated quantitatively within this study. Although Oerlemans (2001) demonstrated sensitivities of glacier mass balance, his conclusion (25% change in precipitation is equivalent to 1 degC change in temperature) could not be simply applied to real glaciers because the annual amount of precipitation (Oerlemans and Fortuin, 1992) and seasonality of precipitation affect the mass balance sensitivity (Fujita, 2008). In addition, dynamic response of glacier was totally NOT discussed with the climatic data (Figs 8 and 9) though the authors denoted its effect on glacier retreat with respect to topographical influence in the later part. Anyhow, changes in glacier extent (area and terminus) are basically resulted from mass balance as boundary condition via glacier dynamics. Therefore the authors have to interpret their results, temporal changes in areas and terminus of the glaciers, by discussing different sensitivities of mass balance and dynamics influenced by topography.

Although the authors described general influences of topographical features on fluctuations of glaciers, the descriptions are too general to understand the results analyzed by the authors. The readers cannot follow the authors' logic without topographical information.

Many assertions are described without evidence or references. I frequently miss the logic. For instance; [P3492L12-14] How did the authors know that small glaciers on the western slope are more sensitive to climate change than large glaciers on the eastern slope?

[P3492L14] Though the authors do NOT explain why small glaciers are more sensitive

C2156

to climate change than large glaciers, the authors describe "can be interpreted".

[P3492L20] The authors just mentioned orientations of the HLG and YZG Glaciers but did NOT explain why the HLG Glacier showed faster shrinkage.

[P3493L16] How did the authors guarantee "shorter time lag" of the targeted glaciers?

Though the authors mentioned that the lower parts of large glaciers were covered by debris-mantle, little discussion was made for the effect of debris-cover on the different retreats of glaciers. For instant, difference of debris thickness distribution may also affect the different shrinkage rates between the HLG and YZG Glaciers [P3492L19-20]. Different retreats associated with slope and size have to be re-analyzed by categorizing debris-covered or debris-free glaciers. Zhang et al. (2011) provide some suggestions to this issue.

[P3482L27] The authors emphasize that previous studies in this region have dealt a single "Hailuoguo" glacier and few systematic/comprehensive study has been made so far. I don't think this study show any systematic/comprehensive advances of knowledge for the glacier behavior in this region as I pointed out above.

English editing by native speakers or commercial services is appreciated to understanding the manuscript. I found lots of incomplete sentences though I don't point out one by one.

Minor comments

[P3480L11-15] Are specific values necessary?

[P3480L19] How do these warming trends affect the glacier retreats?

[P3481L9] It should be clarified what is "The response".

[P3481L13] Ohmura (2001) is a good reference here.

[P3481L16-17] Many of these references are remote sensing studies in the Euro-

C2157

American continents though the authors mentioned "by fieldwork investigation(s)". References dealing fieldworks in Asian glaciers are more appropriate here.

[P3481L22] References written in Chinese are not appropriate if alternatives are available. With respect to high sensitivity of "humid" glaciers was firstly shown by Oerlemans and Fortuin (1994). In terms of summer monsoon glaciers, Fujita and Ageta (2000) and Fujita (2008) have shown their high sensitivity. On the other hand, references such as Cui (1958) [P3482L8] are reasonable to be cited because of its own originality even if they are written in Chinese.

[P3482L4] Haeberli et al. (2000) has to be replaced by Kargel et al. (2005) as a reference for the GLIMS project.

[P3482L14] Aizen et al. (199x) is missed from the references of investigations in the 1990s.

[P3482L17] I don't understand "steady-state ELA". What is this? How is this derived or estimated? The authors also mention "the mean climatic ELA" later [P3487L5-7]. The definitions and methods to derive the ELAs have to be explained.

[P3482L26] "mainly influenced by climatic fluctuation": This is too unclear. More specific descriptions are necessary.

[P3484L11] Potential errors of the first Chinese glacier inventory have to be evaluated. D'Agata and Zanutta (2007) will be helpful.

[P3484L25] The CGI and DEM should have another coordinate system. The authors have to describe how they convert the coordinate system to the UTM WGS84 and the potential errors associated with the conversion. Zhang et al. (2010) and references therein (Guo et al., 2002).

[P3484L26] Errors from resampling have to be evaluated.

[P3484] No description is found for co-registration of different images. Tie-points for

C2158

the co-registration have to be depicted in figure.

[P3484L27] How many "verification points" the authors have? The points have to be depicted in figure.

[P3485L10] How did the authors confirm "more accurate"?

[P3486L1] Methods and thresholds to determine "debris-covered area" have to be described in detail.

[P3486L17] Ground survey is helpful to verify the ASTER images. But how do the authors verify the accuracies of the other images? Need more explanation in detail.

[P3486L19] What does it mean "dual"? Dual frequency?

[P3486L19] What does it mean "single-level"? If it means "single receiver measurement", it is unbelievable.

[P3486L20] Depict the 100 survey points. Figure 1 contains only 11 points.

[P3486L27/Fig. 2b] I don't understand what "distribution of number of glacier" means though I understand histogram for glacier number in Fig. 2a. Did the author count one glacier as "one" at a certain altitude band if the median altitude (how to get this?) of the glacier is within the altitude band? If my understanding is correct, what does this index mean?

[P3487L3] Is this one glacier reaching higher than 6000 m the same glacier reaching lower than 4000 m? Glacier name(s) and location(s) in figure are appreciated.

[P3487L5-7] How did the authors obtain "the mean climatic ELA"? The definition and method to derive the ELA have to be explained in detail.

[P3487L5-7] What is "sector"? How did the authors define it?

[P3488L2] Definition of slope orientation and showing in figure is appreciated. Is this shown in Figure 1 by black line along the main ridge?

C2159

[P3488L7] Figure 2 did not show any trends. And I don't understand what is remarkable with Table 3 and Figure 4.

[P3488L17] Figure 2a did not show shrinkage of glaciers in size class.

[P3488L17-18] What does "all glaciers" mean?

[P3488L20-21] Discussion in terms of slope seems important. More detailed descriptions are appreciated. How the mean slopes are calculated? Figure is helpful to understand the relation between slope and shrinkage.

[P3489L17] How did the authors get the accumulation area ratio? This part is related to how the authors derived the climatic ELAs.

[P3489L21] Why did the authors use "might" here while the glacier boundaries had been delineated by the authors themselves? These kinds of "quality check" had to be done in advance. How did the authors guarantee that the other glaciers were delineated precisely?

[P3490L24] It is difficult to follow changes in retreat rate from the retreat distances in different periods. Retreat rate is better expression here (other glaciers too).

[P3491L2-3] Need references for thick debris layer of the DGB Glacier.

[P3493L1] I don't understand "a significant negative correlation". Is this really "statistically significant" with five samples?

[P3495L8-9] The authors did not evaluate the warming as the main cause of glacier retreat throughout the manuscript. They just showed retreat and temperature in parallel.

[Tables 4 and 6] Left part (area change) for "each period" is unnecessary because of no discussion in the main text.

[Table 5] Retreat "rates" is more informative, isn't it?

[Figure 1] Black and white map of (a) is appreciated. Figure 1b should be enlarged.

C2160

Black and white back image of (b) is appreciated. It is difficult to see the boundary of east/west slopes, large glaciers and met-stations. Define east/west slopes in the main text. Only 11 GPS points are depicted in (c) while the authors mentioned they performed 100 measurements. Show all points. I see debris-covered surface outside of red boundary in (c). Is this real boundary?

[Figure 2] Vertical axis caption should be "Fraction of total number "and" area (%)" instead of "of". I cannot understand meaning of number distribution with altitude in (b). Altitudinal bin should be finer than 200 m. In addition, more analysis of this area-altitude profile will be fruitful, for instance, features of profile in terms of glacier size or orientation.

[Figure 3] I cannot understand this figure. For instance no northeastward glacier is in this figure, whereas the MZG (No. 2 in Figure 1b) Glacier seems northeastward oriented glacier. How did the authors define the orientation of glaciers? In addition, it is probably meaningful to discuss climatic causes of the orientation biases.

[Figure 4] Figure alphabets do not match those of the caption and text. Shading maps are difficult to see. I think the oldest (1966) and the latest (2009) are good enough. For terminus lines, colored lines are appreciated. Anyhow, year notations are required.

[Figure 5] Three rock walls in the left-bank upstream from the uncertain area discussed here are shaded in Figure 4b. I don't think that these parts have been covered by glacier even in the 1990s or earlier. Quality control/check should be carefully made. In addition, I could not follow the logic in the text which part the authors discussed, uncertain area or box b?

[Figure 6] I could not follow the descriptions in the text on the figure, where and when the tributary glaciers have detached from the main glacier. Glacier in red circle seems to contact the main glacier in the satellite images in 2005 and 2009. Glacier in yellow circle seems to contact the main glacier in the 2005 image.

C2161

[Figures 7-9] Few discussion is made for these climatic data. Anyhow, "Year" should be depicted in the horizontal axis.

Misc

[P3482L4] Two Paul et al. (2004) are found in the reference list.

[P3482L22] Probably Zhang et al. (2010)?

[P3484L16/Table 1] Show years for "two ASTER".

[P3488L24] Locations of large glaciers are difficult to see in Fig. 1.

[P3480L1] All abbreviated names should be spelled out in the subtitles.

[P3489L10/15L/P3490L5/L21] Figure notations are incorrect.

[P3494L1] "pre" is replaced by "per".

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C2162

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Interactive comment on *The Cryosphere Discuss.*, 5, 3479, 2011.