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The Cryosphere Discussions

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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Pan et al (2011) provide a valuable comprehensive review of the response of glaciers in the Gongga Mountains, China to climate change. This paper builds on the strong research on one glacier in the region Hailuoguo Glacier, and extends the assessment to the 74 glaciers in the range. The value of this paper is the documentation of the size, distribution and change of all glaciers in the range. The following suggestions are aimed at strengthening the results of this paper.

In the Gongga Mountains some of the glaciers are impacted by extensive debris cover, others have very little, the extent of this debris cover as a percent of glacier area needs

to be documented. Better documentation of the GPS field campaigns sampling locations is essential. It is particularly important to not conflate glacier separation with adding additional glaciers to the sample. For the five focus glaciers it is important to better define their respective characteristics. Identification of the mean terminus elevation and mean glacier elevation is important, ideally for each size class.

More Specific Key Comments:

3483-19: There is an east to west gradient in precipitation and temperature. This is certainly evident in the degree of cloudcover. Also Su and Shi (2002) observed a change in precipitation from 3000 m to 4900 m of 1.89 to 3.0 m. This altitudinal gradient deserves some mention. It would also be useful to add to Figure 1 to place in a climate context better the Gongga Range, much like Figure 1 in He et al (2008). Is the main moisture source the southeast monsoon flow?

3484-26: How can you resample from the original 20 m contour interval DEM down to 15 m in DEM and maintain accuracy?

3486-1: Mention the visual characteristics utilized in manual identification of the glacier perimeter. Figure 3a and 3b indicate sector distribution not aspect. Make sure to be clear about aspect or orientation versus sector of the mountain range throughout.

3486-21: Where are these points, at least indicate those on the key glacier in Figure 4. Much like Figure 1 in Zhang et al (2011). What is the accuracy. In the 2008 GPS work on Hailuoguo Glacier it was noted by Zhang et al (2010) that GPS survey data define the 2008 outline of the Hailuogou glacier tongue, and were used to generate a DEM of the glacier surface with a pixel resolution of 15m.

3487-11: The climate gradient needs to be emphasized more in the lack of glaciers in the northern sector.

3488-5: That the number of glaciers has increased due to glacier separation is not a proper summary of the change. If a glacier disappears that is a reduction in number, if

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a glacier separates into multiple parts via disintegration that is not the same as glacier formation. Though it may be a separate glacier, it should not be considered an added glacier in the count total. As glaciers diminish they do separate into many parts that should not be counted separately, this is inconsistent practice to identify former tributaries as additional glaciers. For example as the Aral Sea shrinks and separates into different parts we do not say there are now more seas. Table 3 needs to be adjusted accordingly.

3489-7: At the start of each of these sections it is key to give a background paragraph as is done for Dagongba Glacier. It is crucial to note the terminus elevation, ELA if known, extent of debris cover and for each glacier. Hailuoguo Glacier has a much lower terminus elevation than the other glaciers. The debris cover importance is summarized by Zhang et al (2011) who note that 67% of the ablation zone has experienced enhanced ablation and 19% reduced ablation due to the debris cover. The main change in the lower ablation zone was noted as thinning and not ice retreat (Zhang et al 2011). There needs to be a measure of the debris covered extent as a percent or area on HLG, XGB DGB, MZG, and YZG much as Liu et al (2010) for the HLG basin. Given the crucial role in suppressing ablation as Figure 7 in Zhang et al (2011) indicates, this needs more emphasis though in this paper quantifying the impact is not the goal. .

3489-16: For Moziguo Glacier the terminus is much higher than Hailuguo Glacier. There is a significant difference in the distinct lack of debris cover compared to the other glaciers discussed in detail, this must be addressed. The terminus is also quite steep at present as indicated by Figure 5. Both the lack of debris cover and steepness of the terminus reach will lead to a different terminus response. This is important. The change in area for the MZG notes, “When the snowfields melted away in 2009 (Fig. 5a), the exact glacier outline exhibited a sudden shrinkage” . Is this change real or just suddenly well observed. Be careful in this determination.

3492-9: Should be percent of the loss for the east side and west side, not the fraction of the loss for the entire range.

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3493-10: Johannesson et al (1989) were examining the response time of a glacier to a step change in climate, where the response is the 2/3 adjustment of that glacier. The more immediate response time to a climate change or ongoing warming is faster. Porter (1986) is a good reference for that or Pelto and Hedlund (2001).

3493-21: How many small glaciers vanished this is important to note, what were there characteristics? Are there any others that now lack an accumulation zone that would indicate impending loss Pelto (2010).

Table 3: Revise glacier counts so a separated glacier does not count as two.

Table 4: It would be more useful for the last column to show the percent loss in area for that single size classification. Also mean terminus or mean elevation for the classes would be of great value going forward.

Table 5. It would be good to not repeat the numbers in the text, rates can be used in the text instead of interval distances.

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