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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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Author Explaining and replies to the comments and suggestions This response text includes the changes in the revised manuscript and our replies (Answer or Reply, AR Black) to the anonymous referee's comments (comments and suggestions, CS, Blue color) and references (red color).

1) CS: The manuscript "Glacier changes from 1966-2009 in the Gongga Mountains, on the south-eastern margin of the Qinghai-Tibetan Plateau and their climatic forcings" by Pan et al. contains useful and interesting measurements and observations of glacier retreat in this region covering a forty-year period. However, in its current form it is not

acceptable for publication in The Cryopshere and would recommend reconsideration after major revisions. Considerable work needs to be done on improving the presentation of the glacier retreat record – which is an important contribution and relevant to the journal's scope. In addition, more analysis of the meteorological records and areal changes within the region is required to provide more robust interpretation of the measured retreat, its climatic significance and how it relates to glaciers in a larger regional context. Overall I would rate the scientific significance good, the scientific and presentation quality fair. One of my major concerns with the manuscript in its current form is that considerable rewriting is necessary to improve its readability and make it easier for the audience to understand what is presented. The figures and graphs as presented are small and difficult to interpret as well. Improving the figures will also make the results easier to understand and interpret. I have made a number of corrections/suggestions on the manuscript itself that may help improve readability.

Reply: Thanks to the anonymous referee for giving us such valuable suggestions to help us to improve the manuscript. Referee's comments and suggestions are seriously consideredïijŻ and answered or replied them one by one, including the comments and suggestions in the attachment. According to the suggestion, several figures have been redrawn (Fig.1, Fig.2, Fig.3, Fig.5 and Fig.6) and figure (Fig.4) and one table (Table 7) have been added, and some sentences have been rephrased. Details about our responses and how to revise the manuscript are provided below.

2) CS: The methods need to be better presented. While the authors apply methods that are in common use in the field, their study site is impacted by debris cover which adds additional uncertainty in their computed glacier areas. The authors also note that at least in one case, perennial snow fields may be impacting their results. They also mention that manual editing of glacier extents was done in some cases. Because of these factors I would strongly encourage the authors to provide some evidence as to the accuracy of their estimated glacier areas which would help in the interpretation of the glacier retreat rates.

AR: we agree. The additional uncertainty in the computed glacier areas is unavoidable by remote sensing method, especially for the debris covered glaciers. For the thick debris cover, semi-automatic mapping methods have been developed, which emphasize terrain-based attributes such as slope and curvature, and object-based analysis (Bishop et al. 2001; Paul et al. 2004). These kind of methods were applied to the Obglerscher (23 km2 in area), Swiss Alps and the Nanga Parbat massif located south of the Karakoram range in Pakistan. The utilization of this method for glacier mapping from is, in general, quite robust; but the result should be verified by visual inspection (Paul et al. 2002). For a large number of glaciers (hundreds), the method is much faster than manual delineation, even if the final manual editing is considered. Song et al. (2007) improved Paul's semi-automatic mapping methods in 2007 and tested it in Gongba Glaciers (debris-covered glacier). Although he thought the actual classification result indicates that the method is more acceptable than that developed by Frank Paul in monsoonal temperate glacier regions of China, 2.5According to referee's suggestions, we have added the text about "accuracy analysis" on the revised manuscript, which would be helpful for the interpretation of the glacier retreat rates. Page 6 line 176-201

3) CS: The author's present air temperature and precipitation observations from nearby stations to demonstrate that air temperature increases, and not precipitation decreases are the cause of the observed glacier retreat. While I do not doubt the validity of their conclusions, I do have some concerns with the author's assessment of differences in temporal trends between stations. For example on page 9 lines 286-303 a number of statements are made about the strength (e.g. the mean annual precipitation to not exhibit a significant incremental trend) as well as magnitudes of changes (e.g. at the HLG station the air temperature warmed at 0.21 $_C perdecade. However, no information is provided how the temporal trends were calculated or hou$

AR: Agreed. This is a good comment and the referee gives us a valuable suggestion. In my manuscript, the mean annual precipitation increased by 1The meteorological

data is very important to interpret the glacier change. Fortunately, three meteorological stations were established in Gongga Mountains, one of which is near by HLG glacier (HLG station), even though the three weather stations have different record periods. These data was processed by Microsoft excel 2003, and the trend line was fitted by one-dimensional liner regression equation. At the same time, we redraw the Figure 6, and add the one-dimensional liner regression equation on the figure. We also reevaluate the HLG and Jiulong meteorological data in periods 1988-2009. The mean annual temperature of HLG and Jiulong stations has been increasing by 0.34 K /decade and 0.24 K /decade from 1988 to 2009, respectively.(Page 1 line 44, Page 10 line 337-339) Based on HLG station data, Liu et al. (2010) also interpreted the factor of glacier mass balance in the HLG catchment, which are probably controlled by the temperature changes rather than precipitation variability. Li et al. (2012) analyzed the change of daily climate extremes in southwestern China during 1961-2008 and suggested that the warming magnitudes were greater on the eastern Xizang Plateau and the Hengduan Mountains than on the Yunnan–Guizhou plateau and in the Sichuan basin, as confirmed by the decrease of the regional trend from west to east. Considering the difference of glacier changes between east and west slopes of Gongga Mountains, we could not show a logical illustration by the magnitudes of meteorological data changes on both sides. Hence, we think that the different retreat rates on both slopes can be probably interpreted by the difference of glacier size. Under the referee's comments, we will add the "The meteorological data processed by Microsoft excel 2003 and the trend line calculated by one-dimensional liner regression equation" in the manuscript.(Page 10 line 336-337)

4) CS: It is also doubtful to me whether the errors associated with determining glacier area as discussed above support some of the claims made regarding area loss presented. For example on lines 306 it is stated that the rate of area loss on the western slopes 5.89

AR: Agreed! According to Prof. M. S. Pelto comment "Should be percent of the loss

for the east side and west side, not the fraction of the loss for the entire range.", we recalculate the rate of area loss on the western slope (14.6(Page 11 line 353-358, Page 7 line 220-221, Page 8 line 243-250, Fig. 4)

Specific comments Page 5 line 126 – What is meant by the sentence "...aerial photographs taken at a scale of 1:60,000 taken during 1966, and corrected by aerial photographs..." It is not clear how one set of aerial photographs can be corrected by another. AR: I rewrite the sentences. "The glacier outlines from the CGI were corrected by aerial photographs and field investigation. The glacier outlines were corrected by aerial photographs..."ïijŇreplace "...aerial photographs taken at a scale of 1:60,000 taken during 1966, and corrected by aerial photographs..."(Page 5 line 127-130)

Page5 line 158 and 164. What are the wavelengths of the selected bands? AR: The wavelengths of the selected bands are 0.76 0.86 and 1.60 1.70μm for the third band and fourth band of ASTER image are, respectively. The wavelengths of the Landsat MSS3 and MSS4 image are 0.7 0.8 and 0.8 1.1μm, respectively.

Pag6 line 170 – What is meant by "great" percentage of area loss? A more quantified assessment should be provided? AR: Analysis of the corresponding change in glacier area consistently indicates about 11.3

Page 6 line 172 – Some indication of how water bodies can be confused with glaciers in satellite images should be provided as this is not obvious. AR: In this sentence, we do not say clear about water bodies. We want to express that the water bodies was refreezing which may be unavoidable factors affecting glacier mapping. (Page 6 line 179-182)

Page 6 lines 193 and 195. How was the "climatic" snowline determined? Some description of the technique should be provided. AR: "Climatic" snowline was defined that a multi-year average of ELA in a plane and bare surface (Shi Eds, 1988). We will add the definition about climatic snowline into the revised manuscript.(Page 7 line 210)

Page 7 line 203. The last portion of the sentence is a bit unclear. Do you mean to say the areas of most glaciers have slopes ranging between 25 and 40$_?AR$: $Yes.Irewritethesentences.$"$Adependenceofglacierareaandnumberonmeanslopeisobserveda$ (Page 7 line 220-221) We also added a new figure about relation between area and slope (Fig. 3d)

Page 10 lines 335-336. The authors state that monsoonal nature of the Goggna glaciers may make the time lag between mass balance changes and terminus fluctuations shorter than for other glaciers because of their characteristics. Could the reverse also be true? Some supporting information for this claim should be provided. AR: Observation of the terminus behavior of 38 glaciers, Washington, U.A.S., since 1890 shows three different type of glacier response (Pelto and Hedlund, 2001). Type 1 glaciers are notable for steeper slope, extensive crevassing and higher terminus region velocities(Pelto and Hedlund, 2001). Gongga glaciers are all type 1 glacier. The lag time of this type glacier should be 4 to 16 yr. We also have replied this question in Prof. M. S. Pelto's comments (3493-10). At the same time, we have provided some texts to support this claim.ïijĹPage 12 line 387-395ïijĽ

Table 1. What does the Quality number indicate? Is it from the USGS assessment of quality or is it your own. If so, some explanation is required or the column should be dropped. AR: The Quality number is from USGS assessment of quality, and we have dropped this column.(Table 1)

Figure 1. Figure 1 needs some improvement. For example, three meteorological stations are mentioned in the text. However, I could only located 1 on the map. I do not see any GPS survey data on the main map only the inset map (c), but the legend seems to indicate the points should be in the main map. AR: According to referee's suggestion, we have refined the Figure 1. We have to locate Jiulong and Xindu qiao Stations on the Figure 1.a, because the left of the main map has not enough space to label these two stations. We also add GPS survey data to the Figure 1.b and Figure 2

It might be useful to show enlargements of all the 6 studied glaciers in some figure as the glacier outlines are quite small as presented. It is stated on line 218 that Figure 2 illustrates a trend of decreasing glaciers size in the Gongga Mountains; however Figure 2 only illustrates the size number/area relationships of glaciers and does not illustrate temporal trends. AR: Agreed! The enlargements of all the 6 studied glaciers in figures have been done, however, we can't load them through the website, because they were too large. We have to show reduction figure on my manuscript. We have redrawn the Figure 2 and added a new figure about the size number/area relationships of glaciers (Fig.3).

Figure 3 is confusing. It is unclear to me how the aeral percentages in figure 3b sum to 100AR: We have redrawn this Figure 3 and put it together with Figure 2 (Fig. 3). The old Figure 3 was deleted.

Figure 4. The figure is so small it is difficult to see what is going on in terms of terminus changes. The lines in the subset images presumably represent the mapped terminus at different times. However, it is what times the outlines correspond to. These should be labeled. AR: Agreed! We have refined this figure. We added the times to the correspond outlines and also added GPS data onto the map (Fig 2).

Figures 5 6. It is difficult to figure out the intent of these figures. For example in Figure 5 it is difficult to see the relationship between b and c and the image in a concerning the separation of the glacier. In Figure 6 it appears the glaciers are still connected in the images but not in the satellite images? Is this the case? The size of the images makes it difficult to ascertain. AR: We have redrawn the Figure 5 according to the suggestions of the anonymous referee and Prof. M. S. Pelto and decided to delete the Figure 6, because the size of the images makes it difficult to ascertain. If we provide all the large and clear satellite images, it will take too much space of the manuscript.

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Please also note the supplement to this comment:
http://www.the-cryosphere-discuss.net/5/C2038/2012/tcd-5-C2038-2012-supplement.pdf

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