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The Cryosphere Discussions

Interactive comment on "Recent glacier mass balance and area changes in the Kangri Karpo Mountain derived from multi-sources of DEMs and glacier inventories" *by* Wu Kunpeng et al.

Wu Kunpeng et al.

wukunpeng2008@lzb.ac.cn

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Dear referee,

Thank you for your valuable suggestions and I have already revised the article according to your suggestions. The following are a few answers to some questions.

General comments: (1) "The study found that most glaciers show significant mass loss and shrinkage, while nine glaciers are in advance for the study period. The authors investigated the reason for advance of these glaciers in the section of 6.2, but this discussion is a little bit simple. The glaciers of this region belong to monsoonal tem-

perature type, where previous studies suggested accelerated mass loss (e.g., Yao et al., 2012) and no such phenomena. Hence, if possible, can the authors provide more discussion for this behavior in this region?"

Answer: I have already provided more discussion for advanced glaciers, and we found that advance of individual glaciers resulted from the increase of high precipitation. "For advanced glaciers, the mean glacier size is about 0.51 km2 and mean glacier surface slope is about 27.9 °, most glaciers have an S or SW aspect, and mean accumulation area ratio (AAR) is 51. Previous studies also found advanced glaciers in Kangri Karpo Mountains (Liu et al., 2006; Shi et al., 2006). Compared with the CGI2 and GAMDAM glacier inventory, the location of most glacier termini in 2000 are very close to that in 2014, indicated that glacier advanced mainly occurs before 2000. Due to the special geographic location and climate feature, the qualities of Landsat MSS/TM images are too low to identify glacier termini. Fortunately, two Landsat Thematic Mapper (TM) scenes (LT51340401994189BKT00 and LT51340401988301BJC00) with high quality can be employed in this study. Compared the glacier termini that acquired from Landsat scenes, such as Glacier 5O282B0111 (Fig. 3B), glacier advanced mainly occurs before 1988, and glacier retreated continuously after that (Fig. 7). Main reason for this phenomenon is probably that the increase of high precipitation (Shi et al., 2006). Annual precipitation dataset from 1980 to 2012, collected from the three nearest meteorological stations (Bomi, Zuogong and Zayu), indicated that maximum precipitation (1153 mm in 1988) is 1.6 times the minimum precipitation (714 mm in 1981) at Bomi (29°52âĂšN, 95°46âĂšE, 2736 m a.s.l.), maximum precipitation (683 mm in 1987) is 2.3 times the minimum precipitation (302 mm in 1983) at Zuogong (29°40âĂšN, 97°50âĂšE, 3780 m a.s.l.), and maximum precipitation (1091 mm in 1988) is 1.7 times the minimum precipitation (624 mm in 1982) at Zayu (28°39âĂšN, 97°28âĂšE, 2423 m a.s.l.). Supposing that the precipitation fluctuation in high elevation glacier area had been consistent with that at the three nearest meteorological stations, the change of precipitation or glacier accumulation certainly have significant influence on terminus fluctuation of glaciers. Due to the complicated terrains, the accumulation of glaciers

varies greatly, and the response of glacier movement is not quite the same, individual glaciers advanced during 1980 – 1988."

Figure 7. Terminus changes of Glacier 5O282B0111 from 1980 – 2015.

(2) "As discussed in the manuscript, debris-covered glaciers exist in this region. In particular, the authors found that debris-covered areas are much more thinning on average than clean-ice areas. The manuscript did not introduce how to separate the debris-free and debris-covered regions, Can the authors provide this process in the manuscript?"

Answer: Thank you for your suggestion. Actually, I have already introduced how to separate the debris-free and debris-covered regions in the section of 4.1. "A semi-automated approach using the TM3/TM5 band ratio was applied to delineate glacier outlines in 2015 using Landsat OLI images (Bolch et al., 2010b; Paul et al., 2009; Racoviteanu et al., 2009). To ensure that ice patches were larger than 0.01 km2, a 3 by 3 median filter was applied to eliminate isolated pixel (Bolch et al., 2010b; Wu et al., 2016b). Then, the derived glacier polygons are checked manually against images from adjacent years with less or no snow and cloud-free, to discriminate proglacial lakes, seasonal snow, boulders on the glacier and debris-covered ice." Due to a small proportion of debris-covered regions in Whole Mountain Range, the debris-free and debris-covered regions were separated manually using Landsat OLI images.

(3) & (4) "However, previous studies found that glacier ablation on debris-covered regions were greater than on the exposed ice regions" (Lines 16-17 of page 12). The authors should rewrite this sentence. As previous suggested, ice ablation on debris-covered regions is greater than that on the exposed ice regions, when debris thickness is less than critical thickness (Østrem, 1959; Nakawo and Young, 1981, 1982; Mattson et al., 1993; Kayastha et al., 2000). The English of the manuscript is not well. I strongly advise the authors to improve their English in the manuscript.

Answer: Thank you for your valuable suggestions and I have already revised this sen-

tence and improve English in the manuscript according to your suggestions.

Specific Comments: "Figure 1 and 2: Can two figures merger one?" Answer: At first figure 1 and 2 were drawn together, while a lot of information can't be clearly displayed, such as the locations of sample glaciers and drainage basins. Hence, it is better that there have two figures to show the information of whole study area and detailed study area, respectively.

"Figure 4: I cannot catch two figures difference." Answer: The two figures look similar, but there still have difference between before and after the co-registration, especially in off-glacier regions. Before the co-registration, elevation increase and decrease are both obvious in off-glacier regions, and these phenomena are caused by relative horizontal and vertical distortions between two data sets. After the co-registration, elevation changes are gentle in off-glacier regions, indicated that the pre-processed DEMs were acceptable and suitable for the estimation of changes in glacier mass balance.

Best Regards, Wu Kunpeng and other authors

Please also note the supplement to this comment:
https://www.the-cryosphere-discuss.net/tc-2017-153/tc-2017-153-AC1-supplement.pdf

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