

## ***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.***

### **Anonymous Referee #2**

Received and published: 10 October 2017

#### General Comments:

This paper uses remote sensing imagery and digital elevation models to calculate the mass balance of glaciers in the southeast region of the Tibetan Plateau. Assessing the behavior of these glaciers is important to predict downstream impacts on water resources and the likelihood of glacier-related hazards. The region is of particular interest because the glaciers here receive significant monsoon precipitation and do not have a distinctly separated accumulation and ablation season. The authors present quite a wide range of interesting results, but I think they could go further in using these findings to advance our knowledge about the physical drivers of glacier change in the region.

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For example, the authors point to the possibility for glacier surging and/or increases in precipitation to explain their observations of advancing glacier (Page 11, Lines 20-21) and thickening at glacier termini (Page 12, Lines 27-28). This should be expanded: is there any evidence of glacier surging in the region, e.g. from glacier morphological features and patterns? Regarding precipitation, the authors analyze a gridded climate product that shows a mix of increase and decrease in precipitation across the region, but they do not link these results to the inferences about advancing/thickening glaciers. This could be explored further by looking at trends in the accumulation area stake mass balance datasets and exploring more precipitation station data, including a consideration of solid versus liquid precipitation. All of this analysis is particularly important because there seems to be a contradiction between the results presented here and those of Liu et al (2006), who observed 40% of glaciers were advancing during 1980 to 2001.

The authors make inferences about climate controls on the regional glacier mass loss on page 12-13 that are poorly supported. The authors show a trend analysis of a single gridded climate product over a time span that does not exactly match the period of the glacier change record. The spatial distribution of temperature and precipitation change is highly variable and shows both warming/cooling and increased/decreased precipitation across the study area. The authors go on to conclude that climate warming is the primary control on the regional mass balance. A more robust approach would be to subsample the gridded climate product to the glacier polygons, subsample the climate product over the time periods being examined in the glacier assessments, and possibly use degree-day or other methods to more directly relate climate to glacier mass balance. Finally, the authors should note that glaciers have a delayed response to climate forcings so that the changes observed in this study are a response to climate conditions both within and prior to the duration of the observations.

Specific Comments:

Page 1, Line 2 and throughout: Replace "Kangri Karpo Mountain" with "Kangri Karpo

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## Mountains"

Page 2, Line 5: This statement about a lack of previous studies seems to contradict what follows, which is a list of several studies exploring > 20 years of glacier area and mass change in the region.

Page 2, Line 6-9: List the range of years that these studies explored.

Page 2, Lines 16-22: This paragraph is confusing: how was mass deficit established? From the studies in the previous paragraph, or those referred to in this paragraph? The authors refer to the Nyainqentanglha Mountains, but the reader does not yet know that this is a larger mountain range associated with Kangri Karpo Mountains (we learn this on line 36). For the last sentence in the paragraph, also list the years to which these mass changes apply.

Page 3, Lines 1-8: Use the simple present tense to describe general conditions, unless you are referring to a specific year when the weather conditions had these specific characteristics.

Page 3, Lines 10-12: Suggest replacing this sentence with a statement that the mass turnover is large due to the large ablation and accumulation rates in this maritime region.

Page 3, Line 33: Generally, elevations derived from aerial photography over high elevation, snow covered regions have larger uncertainties due to poor contrast in the imagery. Do the authors have any additional information on this?

Page 5, Line 18: Is it problematic to rely on Google Earth imagery, since it is not possible to know the dates of the images?

Page 5, Line 31: I am unable to access the Yao et al reference: what is a "glacier axis concept"?

Page 6, Lines 1-27: This paragraph is very hard to decipher, especially for a non-expert

in SAR processing. Improvement of the grammar should help in this regard.

Page 7, line 12: Specify how this density uncertainty value was chosen.

Page 8, Line 4: Remove "about"

Page 8, Line 8-9: Replace "distribution in different elevation" with "hypsometry". Also, unless statistical tests for normality were carried out, remove "normal distribution".

Page 8, Line 36: Replace "terminal" with "termini".

Page 8, Lines 36-43: It is a bit difficult reading through all of these numbers. Could the authors condense this into a box plot or something similar?

Page 9, Lines 10-18: The authors report both total mass change over the measurement period, and rates of change (i.e. divided by the number of years). This mix of report is confusing. I recommend only reporting rates, especially when making comparisons between two time periods with different durations (1980-2000 and 2000-2014).

Page 9, Lines 18-26: It is not clear where "50282B" and "50291B" are located on the map. Be consistent in terminology: do not mix "mass deficit" with "mass loss".

Page 9, Lines 27-33: This paragraph appears to be referring to elevation changes at specific locations along the glacier? Should this be referencing Figure 7? Otherwise it is not clear where the data are to support these statements. Also, the terminology in this paragraph is confusing. By definition, the ablation area loses mass, and the accumulation area gains mass. In a particular year, there may be no accumulation area due to unfavorable climate conditions, but it is not possible for "ablation area and accumulation area [to] both experience[d] mass loss".

Page 9, Lines 34-37: more information on the percentage of debris cover on individual glaciers and over the entire region would be valuable.

Page 10, Line 29: "shrinkage" generally refers to thinning, but I think the authors intend to say a decrease in glacier area?

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Page 10, Lines 29-32: How do these results reconcile with the findings of Liu et al., 2006, who found 40% of glaciers were advancing in the region between 1980-2001?

Page 11, Lines 12-14: These are interesting ideas about what controls variations glacier advance and retreat, but they should be expanded and backed up with more firm evidence. The authors should cite sources for the velocity increase to explain the decrease in advance rate, otherwise this statement should be probably removed.

Page 11, Lines 15-21: I believe the authors intend to use the term "advancing" instead of "advanced"? If so, it was not clear until this paragraph that any glaciers in the study were advancing during the observation period. This should be clarified earlier in the text. Also, replace "terminals" with "termini" and explain what it means for a terminus to be "closed"?

Page 12, Lines 11-12: It is unclear how these different thinning rates for debris versus clean ice were calculated? Were entire glaciers classified as debris covered, or specific elevation bands? If so, what was the threshold of debris required to classify it in the debris-covered category?

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