Hydrol. Earth Syst. Sci. Discuss., referee comment RC3
RC1 https://doi.org/10.5194/hess-2022-179-RC3, 2022

Comment on hess-2022-179

Anonymous Referee #2

Referee comment on "Characterizing four decades of accelerated glacial mass loss in the West Nyainqentanglha Range of the Tibetan Plateau" by Shuhong Wang et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-179-RC3, 2022

This study assessed 44 years of glacier area and volume changes in the major West Nyainqentanglha Range (WNT) using comprehensive remote-sensed dataset. The selected study area is a very typical and important glacial region on the TP, bounded by the Nam Co basin to the north and the Lhasa River basin to the south. In addition to the widely-studied climate factors, the effect of local modulators, such as debris cover, slope and aspect, on glacier thickness has also been investigated. Overall, this study is very interesting and would merit publication in HESS.

Response: Many thanks for the positive comments and suggestions. We have addressed your concerns and suggestions carefully. In the following, we provide point-by-point response to each comment (blue texts are our responses, while black texts are original comments). Note that we have also modified the color scales for some figures to meet the journal's requirement.

My comments are as following:

1. I am very interested in the impacts of elevation, slope, and aspect on the retreat rates and thinning rates. The elevation and slope may have correlations, so the contribution of each factor deserves further investigation. For example, one can do the partial correlation analysis or analyze the impact of slope in each elevation band.

Line 401: The following findings are interesting, and reasons need to be explained: "the retreat rate increased with slope while the thinning rate decreased."

Response: Many thanks for your suggestions. We have analyzed the impact of slope on glacier change in each elevation band (Figure 9). We found a positive correlation between areal retreat rates and slope (faster retreat with steeper slope) for most elevation bands and in both time periods (Figure 9 a and b). The only areas where this relationship differed were on flat or shallow slopes at lower altitudes (slopes below about 5° at elevations below about 5500 m, e.g., blue lines in Figure 9a) which also experienced relatively rapid retreat, and at the lowest elevations of <5200 m, with relatively few measurements available. We find a very similar but inverse relationship between slope and vertical thinning rates (dh in Figure 9 c and d). In this case, thinning rates were highest on shallow slopes and decreased over steeper slopes, except for flat or shallow slopes at lower altitudes where thinning rates were relatively low. We suspect that dominant pattern in which "the retreat rate increased with slope while the thinning rate decreased" occurred because:

a) steep slopes are associated with thinner ice (Linsbauer et al., 2012). This means that any given thinning rate will tend to drive more rapid areal retreat on steeper slopes as the thinner ice there is depleted first, explaining the broadly positive correlation between retreat and slope; and

b) steeper slopes are biased towards higher elevations, where the colder climate leads to slower thinning rates (dh), explaining the broadly negative correlation between slope and thinning rate.

The somewhat different behavior of the low-elevation flat areas (relatively rapid retreat, relatively slow thinning) may in part reflect the modulating effects of proglacial lakes (quicker retreat) and thicker debris cover (slower thinning) near the terminus.

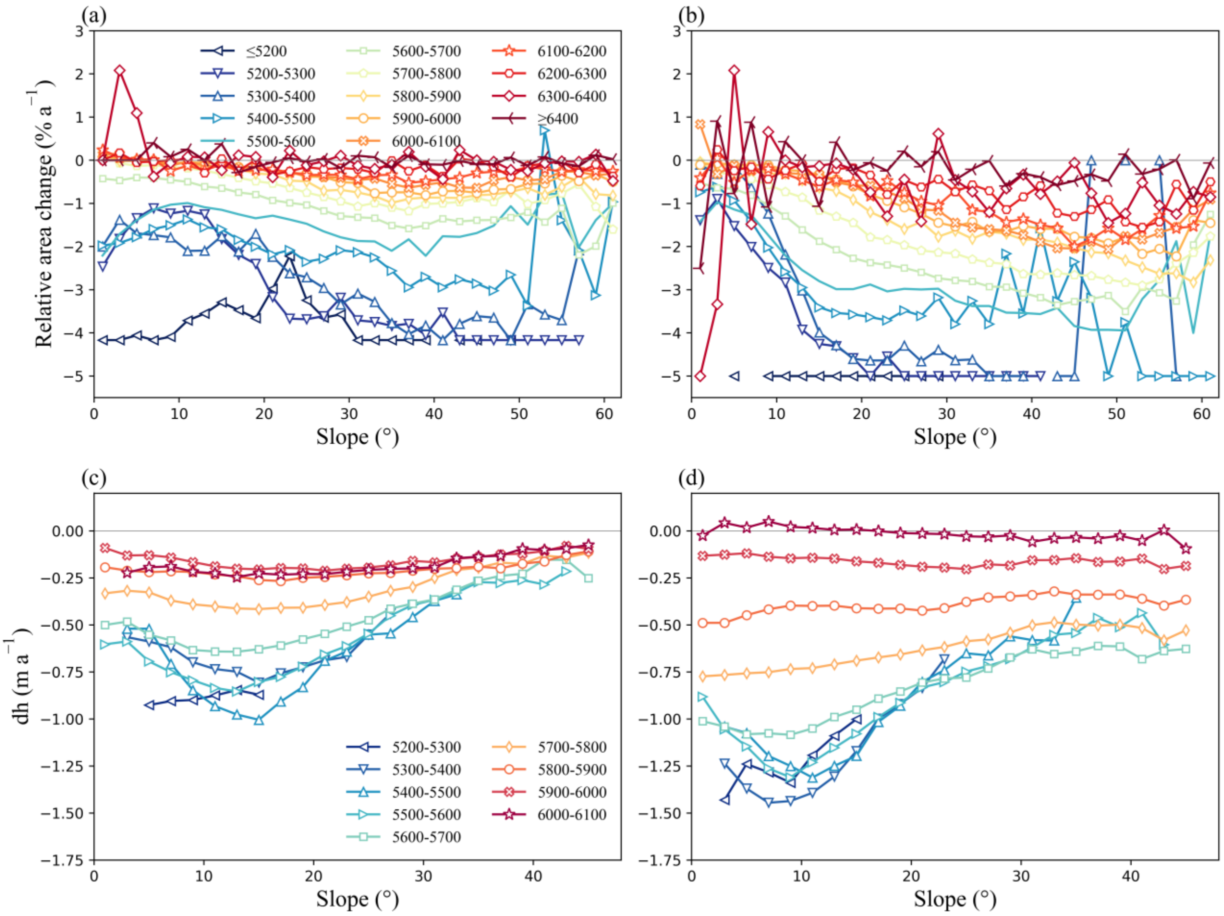

Figure 9 Glacier area changes with slope during 1976-2000 (a) and during 2000-2020 (b), and glacier elevation changes with slope during 1976-2000 (c) and during 2000-2020 (d).

Linsbauer, A., Paul, F., & Haeberli, W.: Modeling glacier thickness distribution and bed topography over entire mountain ranges with GlabTop: Application of a fast and robust approach, Journal of Geophysical Research: Earth Surface, 117(F3), 2012.

We have added these details to Section 3.1 Glacier area change, 3.2 Geodetic mass balance and 4.3 Topographic and climatic controls of varying glacier mass loss in the manuscript.

2. Figure 1: the extent of the study area should be marked in the map of TP (the upper left small figure).

Response:

We adjusted the Figure 1 when we responded the comments of the first referee and have marked the extent of the study area in the map of TP.

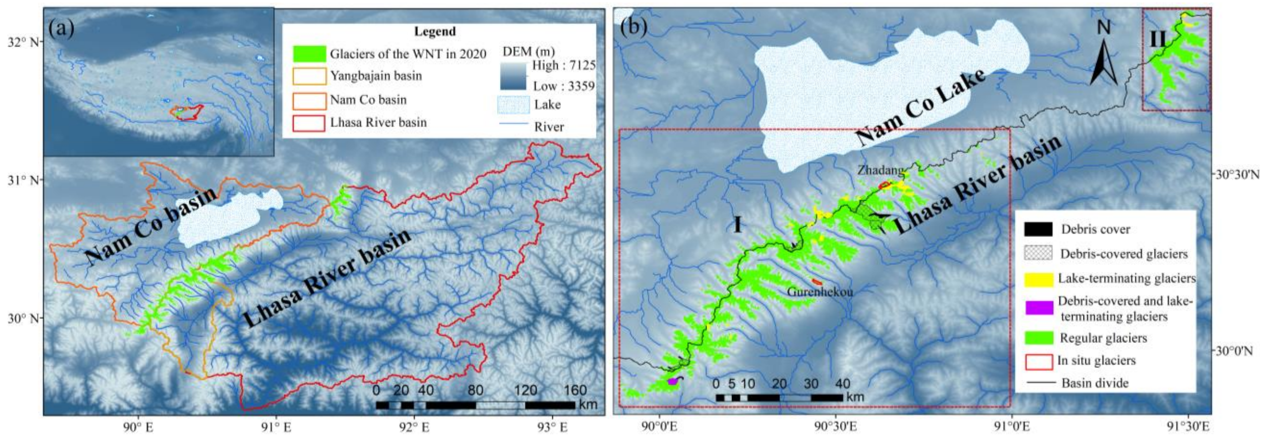

Figure 1 (a) Overview of study area. (b) Glacier distribution. Label I in the large, red dotted rectangle represents the SW section of the WNT and Label II in the small, dark red dotted rectangle represents the NE section.

3. Figure 5 is not easy to read. The legend of elevation changes and the boundaries of glaciers need to be adjusted.

Response:

Thanks, we also adjusted the Figure 5 when we responded the comments of the first referee.

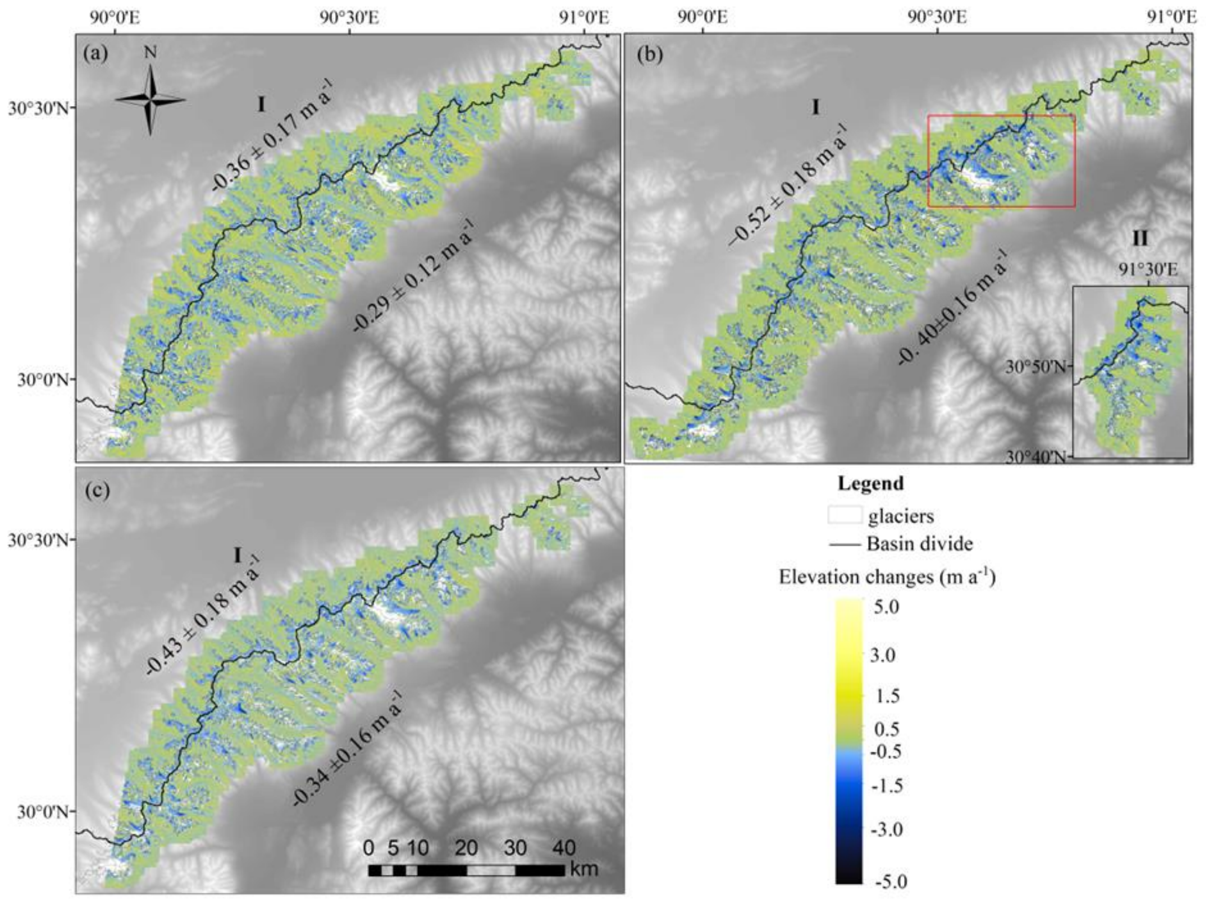

Figure 5 Mean annual glacier surface elevation changes in the WNT from (a) 1976 to 2000, (b) 2000 to 2020, and (c) 1976-2020. Label I in (a, b, c) represents the SW section and label II in (b) represents the NE section of the WNT (on the same scale). The red rectangular box in (b) shows an area of the centra WNT referred to in the paper.

4. It is difficult for me to understand the following sentences:

Line 309: "Compared to the glacier-area change between1970-2000 and 2000-2014 of Wu et al. (2016), and between1977-2000 and 2000-2010 of Wang et al. (2012), our results agree within the uncertainties over the whole

WNT, and the southeast WNT respectively"

Line 323: "suggesting that the more strongly negative average for the longer 2000 to 2020 period (-0.37±0.12 m w.e. a−1) is the result of particularly strong negative mass balance after 2014"

Response:

For line 309, what we are trying to say is that the deviation between our results and those from Wu et al. (2016) and Wang et al. (2012) over the whole WNT and the southeast WNT is within the margin of uncertainties.

For line323, we mean that the significantly more negative glacier mass balance from 2000 to 2020 is mainly due to the intensified glacier ablation after 2014. Because our glacier mass balance during 2000-2020 (-0.37±0.12 m w.e. a^{-1}) is more negative compared with the results during 2003-2009, 2000-2013/2014 from Li & Lin (2017), Neckel et al. (2014), Ren et al. (2020) and Zhang & Zhang (2017).We also calculated the change for the 2000-2014 period from ASTER DEMs (Figure 10) and found our estimated mass balance in this area (-0.28±0.15 m w.e. a^{-1}) is very similar to the other studies (Table S5). Therefore, we conclude that the significantly more negative glacier mass balance from 2000 to 2020 is mainly due to the intensified glacier ablation after 2014.This interpretation is supported by Ren et al. (2020) who also calculated a higher 2013-2020 thinning rate (-0.43±0.06 m w.e. a^{-1}) twice as negative as in 2000-2013.

We have made the corresponding supplementary description in the manuscript.

5. Some grammar and typo errors should be corrected, such as:

Line 101: WNT range mountain range

Line 311: our result. 4.1.2 Glacier mass balance.

Line 364 and 367: I cannot find Figure 3c and Figure 3d

Response:

We are sorry for the mistake we made. We have corrected Line 101 and Line 311 in the manuscript. Figure 3c and Figure 3d should be Figure 4c and Figure 4d and we have checked all figure numbers in the manuscript.