

Response to Reviewers

Dear reviewers,

We would like to thank you for taking the time to review our manuscript and providing constructing and helpful feedback. Please find our responses in the tables below.

Reviewer 1

Reviewer comment	Our response
<p>The authors followed a method similar to Falaschi et al. (2019b?) to quantify glacier elevation change and mass balance errors. However, it is unclear how to compute the error of penetration depth (E_r) in equation (4). The accounting of penetration error as an independent source may be questionable in equation (4). Given that the error of penetration depth affects the calculation of elevation changes which are then propagated to the error of mass changes, E_r is not independent from $E_{\Delta v}$ in this case.</p>	<p>We have now clarified in L 188 – 191 that a linear correction was applied, where 0 m correction was applied at the firn line, increasing to 5 m correction at the top of the glacier. The reason we have E_r as a separate error term is that it is only included in the DEM pairs that involve the SRTM DEM. We recognise that there are various different corrections possible for radar penetration, and we have tried to list them in the text. The reason we chose this method is that it had been applied in other South American studies. We hope that by incorporating the radar correction into $E_{\Delta v}$ we can present our results and demonstrate their significance. We have also clarified now that we follow the approach of Falaschi et al 2019b.</p>
<p>The glacier mass change estimation in this study was compared to that of Braun et al., 2019 and Dussailant et al., 2019, which used different sources of DEMs. A new global estimation of glacier mass balance (and elevation change maps) is published in Hugonnet et al. (2021). It is necessary to update the comparisons with this dataset to see whether the disagreement persists.</p>	<p>Thank you for the update, we have now compared our study to that of Hugonnet et al, 2021 both in the text and the figure.</p>
<p>In line 350, the figure (Figure 8, comparison of glacier velocities) does not match the contents about comparing with in-situ glacier mass balance. Quantitative information from the field survey is therefore missing.</p>	<p>We have updated the text to refer to figure 7. We also calculated the median deviation, which is substantial, and as such validates our interpretation that the relation is weak.</p>
<p>Rock glaciers seem to be in an overall equilibrium (Table 5) between 2012 and 2020 in contrast to the noticeable thinning of Tapado Glacier with debris-covered and clean-ice sections (Table 4). In addition to velocities and evident elevation changes on different parts of rock glaciers, any extended comments or discussions regarding the overall state of rock glaciers? I.e., is the equilibrium state indicative of the insensitive response of glaciers to climate forcing?</p>	<p>This is a good point. We have expanded on this point in the discussion. It is hard to compare a glacier surface that is stable with a stable rock glacier surface. The former indicates a mass balance close to zero, but the latter can indicate either that the rock glacier is in equilibrium or conversely that there is little permafrost to thaw in the rock glacier. We have emphasis this point more in the manuscript and we now suggest that surface elevation changes combined with ice rock glacier deformation rates is the best</p>

	way of assessing if rock glaciers have lost ice.
Line 95: Please simply describe the annual temperature level and precipitation amount in the study region in this paragraph.	We have now added in this information
Line 160: 'Third order polynomials were fitted to elevation biases...'. According to Figure 2, six-order polynomials was used for across-track correction?	Thanks for spotting this. You are right, sixth-order polynomials were useds for along-track, and third order for across track and elevation dependent. This has now been fixed.
Line 195: 'We opted to follow the same methods as Falaschi et al. (2019) who utilized...' The reference is unclear, Falaschi et al. (2019a) or Falaschi et al. (2019b)?	This has now been fixed.
Line 251: When describing glacier area changes, keep the number (positive/negative) consistent to avoid confusion. The sentence can be revised to '...the glacier area decreased at a rate of $5910 \pm 1060 \text{ m}^2 \text{ a}^{-1}$ ($0.35 \pm 0.30 \% \text{ a}^{-1}$), which increased to $6818 \pm 24202 \text{ m}^2 \text{ a}^{-1}$ ($0.60 \pm 2.28 \% \text{ a}^{-1}$)...'.	This has been revised
Line 251 Page 12: '-5910 $\pm 1060 \text{ m}^2 \text{ a}^{-1}$ ($-0.35 \pm 0.30 \% \text{ a}^{-1}$)', missing space between units ($\% \text{ a}^{-1}$). This kind of error is widely found throughout the manuscript (i.e., line 256, 315, 316). Do proofreading and correct the missing or surplus spaces.	Thanks, we have now fixed this
Line 265: '()' missing references?	Thanks, we have now fixed this
Line 278: '...between 2012 to 2015' revise to 'from 2012 to 2015'	This has now been fixed
Tables: The format of tables (number format, border lines, etc.) needs to be revised to improve the reading and be in line with the journal's requirements	This has now been fixed
Table 5: The table is long, moving to the appendix or supplementary?	This has now been fixed
Figure 1: It is not clear about the extent of debris-covered sections in (b). This information is necessary for a better interpretation of Figure 5. Try set the shade of rock glacier extent more contrasted in (a). The location of the (c) is not described in the figure caption. For a concise presentation, (b) and (c) can be aligned horizontally rather than vertically with (a). This organization also applies to Figure 3.	Thank you for the feedback. We have now altered the symbology for the rock glaciers, debris-covered section, and clean ice. We have changed the orientation of Figure 1 and Figure 3.
Figure 4: The legend covers up (blurs) part of the line drawings.	This has now been fixed
Figure 8: The figure does not match the contents discussed. It is about the validation of glacier velocities rather than glacier	We will move the figure up so that it fits better in the text

surface elevation changes from the field survey	
Figure 11: To improve visual geolocation, set the scale of the same place consistent across different panels (a, b, c)	We have now made the scale consistent

Reviewer 2

Reviewer comment	Our response
line 14: consider 'rapidly' instead of 'strongly'	This has now been changed
line 15: 'less investigated' is comparative please add to this sentence to complete it.	This has now been changed
Line 19: it is unclear which glacier you are referring to at this point.	We now make it clear that we are referring to Tapado Glacier
Line 21: suggest that 'strong' not be used as a modifier as it is a bit loose.	We have changed 'strong' to 'increased'
Line 23: remove 'in the region' as it is repetitive from the last sentence.	This has now been changed
Line 35: Better if this paragraph was a bit longer.	Thanks for the suggestion, we have added a sentence
Line 40-42: It is not clear why this needs to be an either or situation.	We agree that a combination of both theories for rock glacier formation is most likely, but here we just present both schools of thought from the literature.
Line 45: would add an e.g, here as the citation list is not exhaustive	This has now been changed
Line 55: The citations are not in the correct order starting with oldest and progressing to youngest. Correction should be applied throughout.	Thanks for pointing this out. We have corrected it
Line 82. maybe use 'agricultural production' 'worth' instead of 'of'. Also correct typo associated with	This has now been changed
Figure 1. The blue stars are hard to read in this figure and the red stars overlap. Consider a white outline of the markers? Caption: Correct typos 'Location of the La Laguna catchment and of landforms studies in this paper. Three landforms that will be discussed' in the text are highlighted in (A).	We have substantially edited the symbology of this figure so hope it is more readable now. Unfortunately at this scale the red markers do overlap, this is because the location of the mass balance data is approximately the same from year to year, but has a slight shift.
Table 1: 'For the imagery that were used to produce DEMs, the RMSE values for the Ground Control Points and Tie Points are shown.' You can remove 'that were'	This has now been changed
Line 109: 'The data were'	This has now been changed
Line 127: 'over' to 'on'	This has now been changed
Line 132: can cut 'for this area'	This has now been changed
Table 2. Would be helpful to signify in the figure by the bottom row is in italics.	We have removed the italics
Figure 3. It is difficult to read these lines.	This has now been changed
Figure 4. y-axis needs a label.	Thanks for spotting this, this has now been fixed
Line 351. Remove 'as'	This has now been changed
Figure 8. A-A' (etc.) should be labeled in Figure 1.	We have added these labels
Line 398. need a '.' here.	This has now been changed
Line 448. remove 'as'	This has now been changed
Line 467. Additionally Anderson et al., 2018 point simply to climate warming as a cause	We have adapted this sentence and added this reference

of the transition between debris-covered and rock glaciers	
Line 496. would be helpful to cite who has used this approach in the past.	We have added in some references here