

Responses to the comments from Reviewer #2 for Fujita and Kayastha, submitted to TC

Dear Reviewer #2,

I'd like to thank you for your comments on our manuscript. My answers to each comment are indicated in blue below. Added descriptions are indicated with bold & underline.

Best regards,
Koji Fujita, on behalf of all authors of the manuscript

Reviewer #2

The manuscript used a set of recent and past data consisting of ice thickness observation, GNSS points, drone photogrammetry survey, and other datasets to update the mass balance record of two small glaciers in the Nepal Himalaya. Based on these observations, in combination with ERA5 reanalysis and nearby meteorological observations, the authors simulate the mass balance for a long period from 1940-2023 using their established glacier mass balance model. The main aim of the manuscript is to estimate and update the long-term mass balance record, understand how climate change has influenced glacier loss over the past decades, and how the glaciers will evolve in future decades. They conclude that both glaciers are losing mass at higher rates, particularly after the 1970s and in recent years, and that the glaciers may lose their remaining ice volume by 2050. The results support these conclusions.

Overall, the manuscript is well written, with good and informative figures and tables (including those in the supplementary material). Method-wise, the work employed all established methods with uncertainty/calibration analysis for reliability. I do not have any major concern about the method or content of the manuscript, except several minor issues regarding text phrasing, citation, etc., which I have highlighted below.

Thank you for your positive evaluation.

Introduction

The authors very nicely framed the introduction section touching almost every aspect that the title expresses, except for the role of climate change or warming in glacier shrinkage. In the second paragraph, the authors briefly review the existing records and understanding of glacier shrinkage of the Himalayan region and also particularly for the Nepal area, where the current work is conducted. In my understanding, at the end of this para, a brief sentence of **how climate has altered the mass loss / shrinkage of these glaciers over the past decades**, would make the paragraph/part complete, considering that 'climate change/warming' is the main reason of glacier shrinkage in the region, which the authors have also highlighted in their title.

Thank you for the suggestion. We added the sentence "**This acceleration in mass loss has**

been attributed primarily to regional atmospheric warming (Maurer et al., 2019).”, not at the end of the paragraph though.

Line 27: Please add ‘records’ (or similar word) after ‘mass balance’ as ‘..update the mass balance of an iconic glacier..’ sounds a bit incomplete.

Added.

Line 28-29: This sentence contains ‘mas balance’ word three times; the authors might want to take care of this in a different way.

I rephrased here as “**Using geodetic mass-balance estimates derived from aerial photogrammetry, we reconstruct long-term annual glacier-wide balances with the GLIMB model** (Fujita and Ageta, 2000; Fujita and Sakai, 2014).”

Line 45-46: Abbreviation of DEM is already done before in Line 23-24.

Corrected.

I would also expand GNSS term somewhere it appears first.

Corrected.

Line 65-66: This sentence is almost the same as it is in Line 47-48. Can be merged or removed from one place.

I rephrased here as “**For calculating the elevation difference between the 2008-DEM and the 2023-DEM,** the elevation change at the glacier boundary was assumed to be zero.”

Line 67-69: here, at the end of this sentence, I would cite a couple of studies who used similar methods for uncertainty analysis as error estimation is an important part of the mass balance calculation, so that readers can relate better or for their future reference. Within the authors existing reference list, Maurer et al., 2019; Shean et al., 2020 are also good examples of such studies.

I added the following sentence “**Uncertainty estimates in previous satellite-based studies primarily relied on elevation differences over off-glacier terrain. However, because the standard deviations of the elevation differences are too large to be used directly as errors, further processing, such as the normalized median absolute deviation (NMAD), is commonly applied (Shean et al., 2020; Hugonnet et al., 2021).**”

Line 130-131: Please cite the figure number (Fig. 1d) at the end of this sentence for reference. Also, instead of ‘show glacier changes...’, I would write it as ‘show mass loss/balance changes...’. In my understanding, mass balance/loss is more appropriate here compared to

'glacier change'.

Corrected.

Line 161: The authors may want to use 'glacier-wide' instead of glacier-scale.

Corrected.

Line 193-195: I do not see any figure or table reference to see the PDD changes. Table S8? Please add a figure/table reference at the end of the sentence.

I cited Table S8.

Line 238: Isn't here the ice thickness unit should be in just meter, not in m w.e.?

No. Here should be "m w.e." because this remaining "water equivalent" thickness is needed to estimate "vanishing year" by dividing by the annual mass balance in water equivalent. I describe "Assuming an ice density" and "corresponds to" to clarify that the ice thickness was converted to water equivalent. I did not change here.

Figure 1: Inside texts are very small to read, maybe increase the font size or the figure sizes. In B panel, legend markers are also very small to read. I do not see any elevation information of the glaciers here, which would have been helpful to identify the ablation/accumulation areas of the glaciers, thus, better interpreting the spatial mass loss patterns. Maybe adding elevation contours would be helpful. This came to my mind when I was wondering about the small size of the glaciers, if they have any distinguishable ablation or accumulation zones.

I enlarged the text size in the inset information as much as possible. I did not add contour lines because they should be so thick to be able to visible, and such thick lines would obscure the background image.