

## ***Interactive comment on “Moderate mass loss of Kanchenjunga Glacier in the eastern Nepal Himalaya since 1975 revealed by Hexagon KH-9 and ALOS satellite Imageries” by Damodar Lamsal et al.***

### **Anonymous Referee #1**

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I believe that this is an important paper and makes a significant contribution to our knowledge of glaciology in the Himalayas. Most decadal scale change studies have focused on the Everest Region, the Indian Himalaya, or the Tian Shan, leaving a huge area of High Mountain Asia where we have relatively no idea of how the glaciers have responding to climatic perturbations.

General comments The English of the paper is very good although a few small typos exist. I have highlighted a couple but suggest a thorough read through. The paper is laid out well and the results are interesting, however I feel that before it is published

C1

there are some necessary changes. I have suggested these below, but I think additionally there are two problems: I think the justification and clarification of how you could create a geodetic mass balance from 62% of the glacier is needed. The interpolations and such that were necessary since so much of the accumulation areas were missing. It could be I have misunderstood this, in that case clarification is needed to make it more simple to understand. My second concern is the figures are rather cluttered, hard to interpret and not used to their potential in the rest of the text. There is a body of information in the figures that should be interpreted, and the conclusions that the viewer should draw from each should be stated in the text so the reader can judge for themselves. I recommend these small changes before publication.

L1 - “have been losing mass” and not “were losing mass” Take away the sentence “, and there are now several modern satellite datasets” and instead note the importance of the declassified datasets L30 The mapping camera Section 2.4 - I know this is not a paper on glacier mapping, but I feel you should briefly mention how you decided where to map the glacier boundary (what features did you look out for) since this is important in the final results Section 2.5 - I would have liked a little more on how the DEMs were cleaned - how much cleaning was necessary? How was it decided which points to remove? 2.6 - You should again focus more on DEM generation as many people will be interested in your methods. How was the affine transformation applied? Was it during the image matching to create the DEM? Instead of saying “validating the affine transformation” I suggest you rephrase to checking the elevation bias? I guess that is what was done? To compare the Z values for these 5 points? This way it is clearer for people who want to replicate your methods 2.7 - Am I to understand that these 9 points in the upper accumulation area were thickening less than the ice at the ELA? Is this due to the emergence velocity? I also think you need to further explain how you estimated the elevation change in the 38% of the glacier where there was no image matching, as these assumptions could wildly influence the geodetic mass balance derived. What interpolation method? Are these assumptions taken into account in the error assessment? Looking at the figures it seems that the debris-free

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areas where image matching was possible are rather steep and flow into the debris-covered area, are these areas really representative of the accumulation area? 2.8 - How was this 0.16 m/a uncertainty derived? Was it based on the standard deviation? Or on the standard error as other papers have used (Bolch et al 2011, TC, King et al 2016, TCD) 2.7 Glacier Velocity - there is a problem with the numbering here, it goes from 2.8 down to 2.7 Also my understanding of the Heid and Kaab paper was they compared different types of feature tracking methods, so the sentence that feature tracking is one of the most efficient methods is erroneous. The parameters you talk about - robustness and masks should at least be outlined

3.1 - I understand why you give the values in change per year, but two data points over a 35 year period is perhaps a little risky when it comes to estimating annual change. I suggest you acknowledge this somewhere in the text 3.2 - There has been some discussion about downwasting versus elevation lowering. I am not 100% sure which is appropriate in this context, but to some downwasting implies stagnant ice that is not flowing and only melting. Again, it could be wise to mention this in the text Again, how certain are you in the glacier wide mass balance when you are missing data for 38% of the glacier? 4.1 - Is an  $r^2$  of 3.5 a strong correlation? 4.5 - This is an important section but seems unfocused. The last sentence seems to contradict the study. If you need to understand regional changes then what is the justification for this study? Maybe a slightly more detailed comparison with High Mountain Asia glaciers could be useful to give the reader an idea of how your study fits into the larger picture

Other comments

I think that table 3 is very interesting and should be highlighted more

On figure 1, I do not see the glacier from 1975. Additionally this map could be cleaned up considerably. It's hard to even see the glacier on the image

Figure 2 - How did you assess the accuracy of the velocity measurements? It could be nice to see some off glacier displacements to give confidence. Additionally the vector

C3

arrows are very hard to see

Figure 5 - What would you like the reader to gain from this? Additionally, B is not straightforward - larger ponds control less mass loss? Is that because they are fewer? Is C also showing how the pond elevation has changed? Or am I reading it incorrectly?

Figure 7 is very hard to interpret, again what conclusions do you draw from this? I think you need to use the figures a lot more

Figure 9 is again hard to interpret.

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