

Interactive comment on “Region-wide glacier mass balances over the Pamir-Karakoram-Himalaya during 1999–2011” by J. Gardelle et al.

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Review of: Region-wide glacier mass balances over the Pamir-Karakoram-Himalaya during 1999–2011

Summary: Reviewer 1 and 2 have already provided very thoughtful evaluations of this work so I will try to keep my comments as brief as possible. Firstly, I think this is excellent work that adds greatly to our knowledge of recent glacier changes in the PKH, a subject that is somewhat controversial. The authors are very knowledgeable in both the methods and the study region. The work directly builds on, and greatly compliments, their previous work and is of good quality and of significant interest to

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The Cryosphere readership.

I do, however, see some room for improvement. In particular I agree with many of the more substantive comments of Reviewer 2. Having skimmed the article a month ago before finally finding time to complete my review, I identified most of the same points of concern as identified by Reviewer 2. I also found the quality of the writing a bit lacking, which I attribute to the native language of the author not being English. I would recommend that the first author work closely with his co-authors to improve the writing, particularly the abstract and introduction.

General: See general comments by Reviewer 2.

I would only add that the calculation of uncertainties should be revisited.

Specific: Units: my personal preference is for SI units of $\text{kg m}^{-2} \text{yr}^{-1}$ over m yr^{-1} w.e. but it ultimately boils down to personal choice.

P976 – 15-17: Provide more context for this sentence. P976 - 4-7: The wording of this sentence could be improved P976 – 20-23: I bit difficult to follow with all the directional references P976 - 10-12: The wording of this sentence could be improved P976-16 to P979-1: Three numbered lists in a row. Try to rework some of the lists into full paragraphs. P977 –20: add “SLE” and provide area covered by study P977 – 26 “shrinking rates” -> “rates of retreat” P978 – 10: delete “obvious” P978 – 14: replace “point-wise elevation” and with altimetry P978 – (ii) provide a reason why the geodetic method is a good alternative.. It’s obvious to me but may not be for other readers P978 – i to iv: could better describe each method and their respective strengths and weaknesses P978 – What about repeat gravimetry (GRACE)? P978 – include assessment of inter-annual variability, probably the more valuable measure that you can get from the in situ records P980 – 6: How do you “extrapolate”? Linear interpolation? P980 – 23: “melt water” -> “meltwater”.. can change throughout P980 – 23: what about the basins on the northern sides of the mountain ranges? P982 – 12: In general, the writing for the intro could use some improving P982 – 17: “comes along with” -> “is provided with” P983

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- 1: what method was used to resample the SRTM? P983 - 5: delete "over the whole study site (Hengduan Shan, Everest and West Nepal), the" P983 - 13: Can you make these outlines publically available either through GLIMS or RGI? P983 - "(before the Scan Line Corrector failure in 2003, which used to compensate for the forward motion of the Landsat 7 satellite, and results in a ~20% data loss within a scene after 2003) -> "(prior to the failure of the Scan Line Corrector of the ETM+ sensor onboard Landsat 7 that resulted in image striping)" P984 - (ii) does this cause error in the "relative elevation" as the image geometry is incorrect when doing the bundle adjustment? P985 - 11: I would not use the word "value" as the "value" does change. . . maybe "does not impact the utility of validity of the correction. P985 - (iv): For reasons already articulated by Reviewer 2 this section could use some more work. P985 - (v): Why not use Kaab's estimates of seasonal elevation change? I agree with Reviewer 2, this correction could be improved or maybe just add it to the uncertainty. P986 -20-22: Why would they bias your results? You are binning by elevation. P986 - I don't know about the separation of surge type glaciers, as long as you have regionally proportional sampling then it should all average out. Do you anticipate surge-type glaciers to exhibit a regionally averaged dh/dt that differs from non-surge-type glaciers? P987 - 8: Flip figure order P988 - are all stated errors for a 90% confidence interval? Maybe I missed this. P989 - 13: Gardner et al. 2013 used a correlation length of 50 km. P989 - 14-17: This is a correlated bias. . . so should not be reduced with increasing study area. I believe this will substantially increase uncertainty bounds. P989 18-21: Again, maybe this can be better constrained using the Kaab et al dataset. P989 - 22-23: I can't quite follow what you've done here. P990 - 15% error seems way too large when I look at Table 1. Did you average % error or did you sum all regional areas then determine the % difference? I think the later is probably the best approach. P990 - what about the largest source of uncertainty, the uncertainty introduce from extrapolation of mass changes to regions without measurements? P990 - would you be able to show figure 2 with and without ice-free ground masked out? It would be valuable to see how much noise there is in the dh/dt over non-ice surfaces. P991 - 21: The uncertainty in the SRTM penetration is at

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best 1.1 m or 0.14m/yr so a total mass budget uncertainty 0.11 m/yr is much too small. I would revisit the estimation and propagation of errors. P992 - 12: mass change to discharge equivalent? Are these not the same. P992 - If you mention proglacial lakes then you should also mention evaporation, ground water storage, and lake expansion, all of which make the glacier mass balance a maximum estimate. P992-993 - I find the analysis of surge glaciers not all the helpful.. maybe just group all glaciers together. You'll get the same result. P993 - 5.1: should this be in results? Also see Reviewer 2's general comments P996 - 7: Your results are not significantly different. P996 - 16 "dynamically little active" -> " slow flowing"? P996 - 22: "took" -> "take" P997 - 4-6: maybe ref Nuth et al., 2010 and Gardner et al., 2013 P997 - 9: This provides no evidence for a gradual speed up.. P997 - 1-14: all much budgets are not significantly different from zero.. This supports that glaciers are near equilibrium not that they are gaining mass. P997 - 20: It would be better to assign an absolute error, unless you expect your error to scale with the measured mass budget. P997 - 23 "yr" -> "years" P998 - 23-29: See Graham's comment P989 - 5: "However, this" -> "The" P998 5-19: This discussion is a bit weak. P998 - 25: estimates are not significantly different.. This will become even more apparent if the calculation of uncertainties is revisited. P998 27 to P999 -2: This is speculation. Both gravimetry and altimetry have the strengths and weaknesses. Jacob et al. 2012 provide adequate error bounds to account for the limitations of their methods. P999 18: "On the opposite" -> "On the contrary" P999 - 24: "is negative" -> "is slightly negative" could also say "nearly in balance" P1001 5.5 See reviewer 2's comment.. I fully agree with his/her assessment.

Figure 1: Maybe change Study site outlines to red of green? I found it a little difficult to distinguish between all of the dark lines.

Figure 2-3, A1-6: Would be helpful if to include a hillshade or Landsat base image to provide spatial context for the glacier changes. Could also include drainage divides and lake. Can't see glacier outlines or surge/quiescent markers (maybe increase size and change color to green or magenta?)

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