

Comments on Mölg, N. et al., A consistent glacier inventory for the Karakoram and Pamir region derived from Landsat data: distribution of debris cover and mapping challenges, submitted to *Earth System Science Data Discussions*

Graham Cogley, May 2018

General Comments

This paper describes in detail the compilation of an inventory of all the glaciers in the Karakoram, Pamir and Pamir Alai in western High Mountain Asia. The authors emphasize (rightly) the consistency of their methods across the region, and note that the results are intended for incorporation into two global inventories, GLIMS and the Randolph Glacier Inventory. Careful treatment is given to the exclusion of cloud cover, the identification of debris-covered ice (assisted by the use of radar-interferometric imagery), and the digitization of drainage divides between glaciers. The authors note that they are unable to estimate “accuracies” in the absence of reference data representing “truth”, but I do not see this as a serious shortcoming. For one thing it is unavoidable, and for another I think they have done a very good job of estimating “uncertainties”. The only point on which their error analysis becomes unsatisfactory is the estimation of seasonal snow cover wrongly included within their glacier outlines, but this is a problem that is currently intractable and their attempts to exclude seasonal snow strike me as being equal to the best that I have seen in other studies.

This is an excellent paper, and could serve as a model for other glacier inventories, especially those which involve large numbers of glaciers. Having said that, the manuscript is not entirely free of ambiguity and some contradiction, but I would recommend acceptance if the authors consider carefully my substantive comments below. My stylistic comments are minor but fairly numerous; I think they will improve readability and therefore impact on readers.

Substantive Comments

- L43 “and related inventories” sounds odd. Perhaps expand to something like “, and their accompanying attributes as recorded in glacier inventories.”. But the real problem seems to be that this sentence sounds as though it is about outlines but is really about inventories.
- L57 Perhaps you could find a way to add a mention that version 6.0 of the RGI is unchanged in HMA.
- L121-145 Considering that this is a data paper, I suggest that this paragraph could be omitted as going beyond the scope of the manuscript. The only point that might be worth making in the paragraph above is that glacier climate is very poorly known because most weather stations are at lower elevation.
- L248 A remark should perhaps be added here to note that the coherence images do not allow the identification of stagnant ice. And do you regard stagnant ice as part of the glacier, or not? Apparently yes, to judge by L337-338. Of course little is known about the extent of glacier ice that has stopped moving, but it is by no means unknown.
- L298 Change “partly” to “sometimes”. But is this correct? The problem is not that the reflectivity of the surface is near zero, but that the incident irradiance is near zero. I think it would be correct to say that the reflected *radiance* is near zero.
- L351,L603 It sounds as though the automatic algorithms for drainage divides reduced the processing time by about a tenth. As one who has digitized rather a lot of glacier outlines manually, I agree that it is a time-consuming exercise, but I cannot but wonder whether the automatic aids were worth the trouble. At L603 you say they were, but then immediately contradict yourselves by saying that manual work gave the best results.
- L362 Surely the uncertainty also depends on pixel size (with the number of pixels becoming small as you look at smaller glaciers)?
- L386-387 At least when calculating rates of change, you can reduce the temporal uncertainty to zero if you use exact dates for calculating Δt , as explained by Cogley (2016, *Annals of Glaciology*, **57**(71),

- 41-49). I agree that if you do this then differences between t_{0s} or t_{1s} will not matter if they range over only a couple of years.
- L573 I know there is no satisfactory answer to the question of uncertainty due to seasonal snow, but can you suggest even a semi-quantitative estimate (like this one for a hypothetical small glacier) for the entire inventory?
- L580 Unless you clipped your inventory against the frontier of China, I do not think this comparison is of much value.
- L591 “still the largest challenge”: only because all the inventories have the same kind of trouble with seasonal snow.
- L625-627 I agree completely with the recommendation to include debris cover in inventories, but it will be a long time before the data approach global completeness.
- L686 Please clarify. This says that about 2744 glaciers had debris cover, but I suspect you mean that about 10% of the glacierised area is debris-covered (or is it 5%, as in the Abstract?).

Stylistic Comments

- L15 Delete initial “The”.
- L22 Change “way” to “method”.
- L22-25 Break up this long sentence with semicolons after “information” (L24) and “GDEM2” (L25).
- L29 For some reason the comma separators in all numbers in the manuscript have come out as apostrophes.
- L31 I would begin a new sentence at “this”. But, more importantly, what is “this”? The range of median elevations? The range of all elevations? Clarify, e.g. by saying “The <whatever> is largely due ...”.
- L46 No space before “Sakai”.
- L47 Delete “also”.
- L50-52 “When glacier outlines are of poor quality, related ... have higher uncertainties.”. “Has improved significantly in recent years, during which ... have been published.”. “the second Chinese”.
- L54 “only partially considered ice cover on steep”.
- L55 Change “comprise” to “suffer from”.
- L60 I find “partly heavily” rather strange. “heavily” is probably not necessary.
- L72 “supraglacial” (no hyphen). “from that of clean ice”.
- L75-76 “higher and more extensively glacierised”. (I am not sure what a “large” mountain range is.)
- L81 Another instance in which semicolons are needed: after “main glacier” and “glacier ice”.
- L96 “with K2”.
- L97-98 Garbled sentence? I think it means “The central Karakoram and inner Pamir are two ... worldwide, and include some extremely large glaciers ...”.
- L100 Delete the repetitive sentence “The study region ...”.
- L102-103 Move “also” to before “present”.
- L146 “Glacier”.
- L148 “that was first identified by Hewitt”.
- L151 “1970s” (no apostrophe).
- L159 Change “like” to “as”.
- L163 Change “are” to “have been”.
- L179 Comma after “interference”.
- L193 “to work only with”. “many fewer data voids”.
- L207 “which is smoothed”.
- L254-257 Sentence not very clear. I think “the importance of” should be deleted, and “are considered” should be changed to “need to be considered”. But please clarify.
- L283 “In the case that”.
- L295 “(with less snow but possibly more cloud)”.

- L304 “contrast-enhanced”.
- L307 Delete “in this region”.
- L315 “were available for most of the study region”.
- L329 “by less”. “section 6”.
- L343 “be they”. Comma after “perennial”.
- L346 “two steps”.
- L350-351 “in general glaciers are divided by very steep ...”.
- L365 Delete “G.” (His initials are A.G. in any case.)
- L381-382 “substantial debris-covered parts; they also feature difficulties ...”. Change “confluences regions” to “confluences”.
- L390 Semicolon, not comma. “larger than”. Same at L399, L403, L403 (check throughout, in fact; there are very many instances).
- L400 “glacierised”.
- L404 “by only a few metres”.
- L413 I think “to the south” should be “from the south”.
- L425 Change “small-sized” to “small”.
- L465 Delete “by”.
- L485-486 Italicize *p* and change “R” to *r* (lower-case italic) *r*. *R* is usually reserved for correlations from multivariate regression.
- L518 Change “accuracies” to “uncertainties”. (You said earlier, at L358, that you do not calculate accuracies.)
- L538 “previously assumed”.
- L544 Should “regions” be “glaciers”?
- L546 Change “constitutes the case of” to “is”.
- L566 “high-“.
- L572 “from the perspective of”.
- L590 “needs”.
- L597 Move the comma to follow “decades”.
- L614 “shows”.
- L616 “sensitive”.
- L617 “of a much coarser”.
- L628 I do not understand the “large area ...” part of this sentence. Please clarify, or perhaps just delete the sentence, which sounds rather bland.
- L642 “criterion” (“criteria” is plural.)
- L645 “is difficult”.
- L652 “reflects”.
- L655 “decreases”.
- L661 “likely does not”.
- L668 “a rigorous error”. (I think you have done a pretty good job without reference data.)
- L670 “and some are higher”.
- L679 “, and have presented in detail”.
- L687 “superior to”.
- L688 “the latter”.
- L703 “on average”.
- L706 Delete the comma.
- L711 “with additional contributions”.
- L714 I have not checked the references exhaustively, but several need to have paper titles without initial capitals, and the abbreviation (or not) of journal titles needs to be checked.
- L751 Missing right parenthesis.
- L832 “ and Fountain, A.G.:”.