

Editor decision, 13 Nov 2020

Dear Leif and co-authors,

Thank you very much for the revised paper, which I am happy to accept for publication after technical corrections. I am happy to see that you considered almost all issues raised – and that you addressed some of the more major ones raised by reviewer 2. I agree with your choice of how to treat the assumptions you made and the sensitivity/uncertainty analysis (mostly moved to the SI).

I have few technical details for you to address, as I feel the English of the text could still be more polished. I have suggested a restructured version of the abstract below, which maintains all your content of course. I feel the order of the paragraphs was not entirely logical, and some of the wording could be improved. Feel free to use that or a modified, more fluent and tidier version of yours. I would encourage the authors to go through their text once more, and try to polish it some more and correct style/grammar, based on some of my comments below (in few instances the text contains still grammar errors). This is something that the co-authors could help with.

Finally, I hope the authors are satisfied with this final paper version, which I feel is substantially improved. I also hope that they appreciate the constructive and very thorough reviews of their paper, which remained all constructive all the time. There is no need for confrontational wording (e.g. lines 527-528: “From our view that is a presumptuous statement about the method we develop here”).

I really look forward to see this paper published.
All the best,

Francesca

REVISED SUGGESTED ABSTRACT:

Many glaciers are thinning rapidly beneath melt-reducing debris cover, including the Kennicott Glacier in Alaska. The zone of maximum thinning at Kennicott Glacier is located under debris. Scattered within the debris cover, melt hotspots, such as ice cliffs, locally increase melt rates. We explore the roles of debris and ice cliffs in controlling rapid thinning under thick debris at Kennicott Glacier.

We collected abundant in situ measurements of debris thickness, sub-debris melt, and ice cliff backwasting allowing for extrapolation across the debris-covered tongue (the study area and the lower 24.2 km² of the 387 km² glacier). A newly developed automatic method, the Adaptive Binary Threshold, uses for the first time only optical satellite imagery to delineate ice cliffs. We show that the method accurately estimates ice cliff coverage even where ice cliffs are small and debris color varies.

Kennicott Glacier exhibits the highest fractional area of ice cliffs (11.7 %) documented to date. Ice cliffs contribute 26% of total melt across the glacier tongue. Although the relative importance of ice cliffs to area-average melt is significant, the absolute area-averaged melt is dominated by debris. At Kennicott Glacier, glacier-wide melt rates are not maximized in the zone of maximum thinning, and we show that this rapid thinning is due to a decline in ice discharge through time. There is more debris-covered ice in Alaska than any other region on

Earth. Through our efforts, Kennicott Glacier is now the first in glacier in Alaska and the largest globally where melt across its debris-covered tongue has been rigorously quantified.

COMMENTS

COMMENTS RELATED TO THE REBUTTAL TEXT

_On line 265 of the document (in the authors' reply to reviewer 1): you show as original and new paragraph exactly the same text! Please clarify here if and how you made changes to that text.

_Text on line 590: there is a "in" missing I assume?

Original text:

"Expanding and thickening debris cover should reduce glacier thinning relative to glaciers without debris (Banerjee, 2017; Gibson et al., 2017), but the melt-suppressing effect of debris is not always apparent the observed thinning patterns of glaciers even when debris is thick and debris coverage is extensive (e.g., Kaab et al., 2012; Gardelle et al., 2013)".

It should be:

Expanding and thickening debris cover should reduce glacier thinning relative to glaciers without debris (Banerjee, 2017; Gibson et al., 2017), but the melt-suppressing effect of debris is not always apparent IN? the observed thinning patterns of glaciers even when debris is thick and debris coverage is extensive (e.g., Kaab et al., 2012; Gardelle et al., 2013)".

_Lines 765 and following: In response to a comment by Reviewer 2: Kraajeenbrink et al (2017) only consider ponds, not ice cliffs, in their melt estimates for HMA. I would also say that the evidence available until now suggests that the two do not melt at the same rate. So I suggest you rephrase the sentence you have added:

"While we do not explicitly document the melt rate of ponds and streams (i.e., melt hotspots) we follow Kraaijenbrink et al. (2017)' s approach and assume they melt at the same rate as ice cliffs. Using this logic, in order for ice cliffs (melt hotspots) in the ZMT to compensate for the insulating effects of debris, ice cliff (melt hotspot) area would need to increase from 11.7% to 90% of the glacier surface. Ice cliffs, ponds, and streams assuredly do not occupy 90% of the ZMT. This again suggests that ice cliff and other melt hotspots do not control the location of the ZMT."

I would recommend that in this paragraph you simply state that you do not address ponds and streams here, that you will do it in a follow up publication, but that, given current estimates of their contributions to ablation, their inclusion will not change your main conclusions.

_Line 802: provide the source of that 20% value (your own digitisation).

_Line 876 and following: on uncertainty of ablation measurements: how do you combine the uncertainty in the marking and the uncertainty due to the tilt of the stake? Can you please explain?

_Line 946: the reviewer suggested added reference: “*L231-2. Makes sense to reference (Steiner, Buri, Miles, Ragetti, & Pellicciotti, 2019) here*”. And I would agree with that, even if this is one of our studies.

_Line 970: I agree with the reviewer that you should provide units.

COMMENTS RELATED TO THE REVISED TEXT

The following comments and lines refer to lines of the revised paper (in track-changes):

_Line 1340:

«Greater surface elevation changes»: say if these are positive or negative, I assume you refer to thinning patterns here?

_Line 1434: I would remove this sentence

“leaving a detailed examination of other melt hotspots for another contribution.”, or rephrase it. The sentence as it is grants an explanation of why they are not included here, and does not add much to the paper. There will most likely be a second contribution, and readers will be aware of it.

_Line 1442

I would add, after (DEMs), “but showed that the method is sensitive to the DEMs resolution and its predictive skills diminish for coarser resolution”.

_Line 1448

Consider removing: “thereby addressing the questions outlined above»

_Line 1496: I would remove “better”

_Line 1566: I would rephrase as: We DEVELOP an automated algorithm to delineate ice cliffs from optical satellite imagery.

_Line 1567 and previous occurrences: WorldView (WV) satellite- check where you use WorldView as a word for the first time, provide the acronym there and be consistent in its use. You have used both acronym and extended word in the text before this occurrence.