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Title: Arctic glacier snowline altitudes rise 150 meters over the last four decades

Authors: Laura J. Larocca, James M. Lea, Michael P. Erb, Nicholas P. McKay, Megan Phillips, Kara A. Lamantia, Darrell S. Kaufman

Reviewed by: Dr. Antoine Rabatel (Univ. Grenoble Alpes)
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General comments

The work by Laura J. Larocca et al. focuses on satellite–based observations of the glacier end-of-summer snowline altitude (SLA) as a proxy of the equilibrium-line altitude (ELA) on glaciers in the Arctic.
The snowline was mapped on a subset of 269 land–terminating glaciers above 60 °N latitude from Landsat satellite images between 1984 and 2022. The mean elevation of the snowline is extracted from the ASTER-GDEM.
The remotely–observed SLAs are compared with available in situ measurements of ELA, and the spatio-temporal changes are analyzed with regard to ERA5–Land reanalysis climate data.
Overall, Arctic glacier SLAs have risen an average of ~150 m over the ~40-yr period. In parallel, a summer temperature shift of +1.2 °C at the glacier locations is quantified from the reanalysis data. This temperature increase goes hand-to-hand with an overall decrease in snowfall, an increase in rainfall and a decrease in the total number of freezing days.
Extrapolating the current rates of SLA rise, the authors finally show that half of the glaciers in the study regions could be below the ELA by 2100, and thus doomed to disappear.

All in all, I really enjoyed reading this article, whose theme and tools are particularly familiar to me. I think the work is very complete with figures (including the supplementary material) that are well done and used.
A large number of questions came to my mind during the reading (for example: the superimposed ice, the fact of considering only one DEM when the thickness of the glaciers has decreased over time, etc.), but the vast majority of them are dealt with in the discussion in an objective and clear manner, so I have few general comments on this work.

1) **Snowline *vs.* firn line. P4_L97-98**
   Apparently, no distinction was made between the snow line and the firn line.
   This is surprising at first sight, as for years with very negative mass balance it is often possible to distinguish between the two (including in optical data such as Landsat). Automatic algorithms have difficulty differentiating between the two, but for work based on manual digitization, and therefore on case-by-case visual expertise, experience shows that it is possible to differentiate between the two.
   It would be interesting to see, for example for the glaciers on which the ELA is measured in the field, whether distinguishing between the snow line and the firn line (in years when both are visible) changes the quality of the SLA *vs.* ELA relationships.

2) Selection of the glaciers. P4_L103-104

I was a bit surprised to see that in your sample you have kept glaciers whose maximum altitude is not high enough to allow you to have a snow line every year.

I can admit that when glacier data are aggregated by grid, the weight of missing data is potentially reduced, but I have the impression that this inhomogeneity in the data series can create biases, particularly in the analysis of spatial or interannual variability (less so in the long-term trend).

Of the 50,000 glaciers in the Arctic region, it would probably be fairly easy to find the same number as those you have used, but with maximum altitudes high enough to allow the SLA to be measured every year, as was done in the work by Davaze et al. 2020 in the European Alps.

At the very least, I think it is necessary to discuss the impact of this temporal heterogeneity in the available data (Fig. S1) on the analysis of the results.

3) Length of the snowline. P5_L109

The length over which the altitude of the snow line is measured can vary greatly from one year to the next depending on the glacier's hypsometry. And not systematically calculating the snow line elevation over the same length can create inhomogeneity in the data series. Furthermore, for a given year, the position of the snow line may be dependent on factors other than climatic factors, for example on the edges of the glaciers, in connection with local effects due to avalanche deposits or shading linked to surrounding walls. For these reasons, in Rabatel et al. 2005 (and following) as well as in the regional study by Davaze et al. 2020, we chose to measure the altitude of the snow line on the central part of the glacier: more or less X metres on both side of the central flow line of the glacier (X being related to the size of the glaciers in the study area). Without asking to recalculate everything, I think it would be relevant to test the sensitivity of the results to the method (for example on the 30 glaciers where ELA data are available). And discuss this in the "Discussion" section.

4) ELA vs. SLA. Section 3.1 P8-9.

In section 3.1, you indicate that the SLA observed on satellite images may underestimate the ELA measured in the field because the images do not necessarily date from the end of the hydrological year. According to Figure S5, a significant number of images date from the period July to mid-August, and therefore most likely have a low SLA, but do you have the exact dates of the field measurements, so that you can quantify the time difference with the date of the image used to measure the SLA? This would provide more precise quantitative information on the uncertainty associated with this point.

5) Uncertainty related to the glacier thinning. P19-20_L378-387

You quantify precisely the average (maximum bound) error in the rate of rise of the SLA due to the (not considered) glacier thinning (~1 m/year, *i.e.* 25% of the average rate).

I feel that this should appear both in the Abstract at the beginning of the article and in the synthesis presented in Section 5, because even if this is the upper limit of the error linked to thinning, given the way it is calculated, over a long period of time as is the case here, this source of error cannot be neglected.

Specific comments

- In many places (starting by the second sentence of the abstract or L60), you use the term "parameter" when the term "variable" should be preferred. Please check carefully.
- In a few cases, you use "glaciated" when "glacierized" have to be used (refer to Cogley et al., 2011, Glossary of glacier mass balance and related terms). Please check carefully.
- P1_L15: "equilibrium-line altitude" (the hyphen is missing). Check everywhere in the text.
- P1_L28: I think using SLA in the sentence "… entirely below the SLA by 2100" is ambiguous. I understand what you mean, but I think you should rather use "ELA" instead of "SLA" or at least mentioning something like "late summer SLA".
- P3_Fig1: You could add the RGI regions' limits on this map (like on FigS6) but cutting the polygons at 60°.
- P9_L205: you can add that the glaciers of the subset are also "higher for median and maximum elevation".
- P13_L266: the reference by Dowdeswell et al. is missing in the ref list.
- P15_L295-297: You mention: "Thus, although summer temperature generally controls glacier ablation, … annual PDD sum … are contributing to both increase ablation…". Well, overall, this is correct, but I wonder to what extent the "summer temperature" and "annual PDD sum" variables are not highly correlated (or even self-correlated) and therefore whether there is not a high degree of redundancy between them.
- P15_L304-309: You should add some discussion of the positive and significant correlation (for raw values and residuals) between SLA and spring rainfalls.
  In my view, more liquid precipitation in the spring, to the detriment of snow precipitation, generates a thinner snowpack, which will melt more quickly in late spring/early summer, resulting in an earlier snow/ice (or snow/firn) transition and, due to the albedo effect, greater mass loss in late summer (*i.e.* a higher ELA).
  I think it is important to mention this point. Especially as this point about spring precipitation has already been highlighted in several studies (*e.g.*, Réveillet et al., 2018, Bolibar et al., 2020).
- P22_L448-450: In line with my previous comment, you should here expand a bit the discussion related to the impact of rainfall in spring.
- The paper by Jiskoot et al. in the reference list is not quoted in the text. To be removed.

References quoted in the review (not already mentioned in the ref. list of the paper)

Bolibar, J., Rabatel, A., Gouttevin, I., Galiez, C., Condom, T., & Sauquet, E. (2020). Deep learning applied to glacier evolution modelling. The Cryosphere, 14(2), 565-584.

Réveillet, M., Six, D., Vincent, C., Rabatel, A., Dumont, M., Lafaysse, M., ... & Litt, M. (2018). Relative performance of empirical and physical models in assessing the seasonal and annual glacier surface mass balance of Saint-Sorlin Glacier (French Alps). The Cryosphere, 12(4), 1367-1386.