Review of the manuscript Egusphere-2022-334 "Effects of topographic and meteorological parameters on the surface area loss of ice aprons in the Mont Blanc massif (European Alps)" by Kaushik et al.

General comments

The paper from Kaushik et al. presents a study on ice aprons (IAs), very small ice bodies located on the steep slopes of the Mont Blanc massif. They inventoried 200 of these ice bodies at different time intervals (from 1952 to 2019), assessing the changes in their surface area in relation to various topographic parameters and to accumulation and ablation proxies constructed using air temperature and precipitation data.

The paper presents new data and is a valuable contribution to the knowledge of a still unknown component of the Alpine cryosphere.

The main findings of the work are the greater surface loss observed in the last two decades compared to previous periods, the impact of climate forcings on this loss, and the strong correlation between surface loss and parameters such as direct solar radiation and elevation.

The introduction is adequate and well supported by references, also considering that there are no previous studies on this type of ice features.

The used data and methods are well described, and accuracy and uncertainty are properly evaluated.

Results are mostly well presented and sufficient to support the interpretations. However, to improve clarity and linearity, the authors should consider separating the results and discussion into two distinct sections. In some cases, the discussion could be more thorough, considering more adequately alternative hypotheses such as the role of avalanching in the dynamics of the investigated ice bodies (see "specific comments").

I also emphasised the need to carefully separate the results concerning this study from those concerning previous studies conducted by the same authors (see "minor comments").

Figures are adequate in number and generally well made. However, some figures need improvements (see "minor comments").

The two main issues that arose from reading the paper are reported below (specific comments), whereas a number of minor/technical issues are listed in the last section (minor comments/technical corrections).

As an overall assessment, in my opinion the article is suitable for the scope of The Cryosphere and can be considered for publication after making minor revisions.

Specific comments

1) Accumulation and ablation processes on IAs can be very complex and, among the factors that determine their existence and evolution, the avalanche contribution has not, in my opinion, been adequately considered and discussed by the authors. The role of avalanches in the dynamics of these very small ice bodies can be crucial, as these processes can accumulate or remove large amount of snow from their surface in a way that is partially decoupled from the regional climatic conditions (i.e., air temperature and precipitation), and strongly related to the local topography and wind.
I'm aware that is rather hard to estimate/model the avalanche activity on IAs, however, the authors can evaluate the use of a simple approach like that proposed by Hughes (2008) and adopted also in Carturan et al., 2013.

2) It seems that in the abstract and along the manuscript the terms "climate forcing parameters", "meteorological parameters" and "climatic factors" are used interchangeably. In my opinion, these terms should be used more properly, because they do not have the same meaning. I suggest the authors to justify why they use these different definitions or, alternatively, be consistent in using only one of them.

References

Hughes, P. D. (2008). Response of a Montenegro glacier to extreme summer heatwaves in 2003 and 2007. *Geografiska Annaler: Series A, Physical Geography*, *90*(4), 259-267.

Carturan, L., Filippi, R., Seppi, R., Gabrielli, P., Notarnicola, C., Bertoldi, L., ... & Dalla Fontana, G. (2013). Area and volume loss of the glaciers in the Ortles-Cevedale group (Eastern Italian Alps): controls and imbalance of the remaining glaciers. *The Cryosphere*, 7(5), 1339-1359.

Minor comments/technical corrections

L 47: The terms "advance" and "retreat" are usually referred to the glacier snout; when speaking about glacier volume and area, it is better to use more appropriate terms.

L 55: It seems that the subject here is "variable responses" and not "variable". Please check.

L 112: Use "hosts" or "includes" instead of "displays"; remove "some of".

L 125: Check the elevation of Chamonix, which is not consistent with L 114.

L 131-134: Add a citation here to support these data and quantify the reported threshold.

L 139 – 154: This part could be summarized.

L 157 (section 3): check consistency in the use of verb tenses along this section (present vs past tense); I would prefer the use of past tense.

L 161 (section 3.1): this section could be shortened, as the procedure followed to create and co-register the 2019 DEM from Pleiades images has already been thoroughly described in Kaushik et al. 2021; here, it would be adequate to cite this paper and summarize the description.

L 180-181: could you give here more information on the 2m DEM used for co-registration? (e.g., spatial extent and location of the area used to perform the procedure).

L 182: *outlines* instead of *contours.*

L 188: check whether acronyms were written out in full the first time they were used (e.g., MARST).

L 191 (section 3.2): after reading this section, it is not clear which images were actually used in the study; please, try to be clearer and check consistency with table 1.

L 195: check the consistency of the resolution of 1952 and 2001 images with that reported in table 1.

L 216 (section 3.3): In my opinion, this important section should be clarified, because there is some confusion between what was done in a previous study (i.e., Guillet and Ravanel, 2020) and what was done in this study.

More specifically, L 227 to L 247 refer to the previous study (conducted on 6 IAs), and in particular to the correlation between GSB and AdM, which was used to extend the Adm record over time. In this study (L 248 – L 264), the SAFRAN dataset was used, and a similar correlation with GSB was used to extend this dataset back in time (from 1958 to 1952). Then, the full SAFRAN dataset was extrapolated to the elevation belts considered in this study.

Try to clarify these points by clearly separating what was done in Guillet and Ravanel, 2020 and what was done for this study.

L 231: *located* instead of *present.*

L 278 – 279: the 2001 image is from July, not exactly the end of the ablation season; could a possible overestimation of the IAs extent for that year be considered?

L 312: a parenthesis is missed after the exponent of the second term (θ).

L 299-302: this introductive part could be shortened or omitted.

L 345-346: this sentence is not clear, try to rephrase.

L 393-394: are 'erosion' and 'deposition' here referring to snow or to the avalanche activity? Please clarify.

L 405: why is AdM weather record cited here? From section 3.3 one can understand that GSB record was used along with SAFRAN dataset, at least in this work. See comments for section 3.3 and try to clarify.

L 406: Sect. 3.3?

L 418: please, clarify what does it mean "annual temperature cycle".

L 449: equation (8).

L 465: check the consistency of the section numbers (e.g., DEM generation is described in sec. 3.1).

L 469: …better to use "of the same *surface"* instead of *"area".*

L 473-475: check for some repetitions here. (e.g., L 470).

L 485 (section 5.1): as with the comments in section 3.1, the text could also be summarized here, referring to what is reported in Kaushik et al. 2021, where the procedure is adequately described. In my opinion, the figures referring to this section (Fig. 6 and 7) should also be somewhat differentiated from those of Kaushik et al. 2021; perhaps the comment to the Fig. 6 might help (see below).

Alternatively, this part (section 5.1) could be summarized and included in a section of chapter 4 where an overall estimation of errors and uncertainties are provided, e.g. merged with the section 4.5.

L 535: add reference to Guillet and Ravanel (2020) instead of reference to the section 3.3.

L 538: *located* instead of *present.*

L 548: add a citation for this estimate.

L 550: exist *at…*

L 550: The reader remains a bit confused here. These numbers refer to the whole inventory of IAs (n=423), which is provided in Kaushik et al., 2021. However, only 200 IAs were considered in this work, i.e., a sub-sample of the complete inventory.
I would suggest being clearer, carefully distinguishing here and in the following part of the paragraph what refers to the previous work (with the full inventory) and what refers to the present work.
Are the correlations similar when considering the full inventory and the sub-sample? Are there differences?

L 559: the reference is to Fig. 10d; in general, check the consistency between the text and the sequence of plots in Fig. 10.

L 600-602: I do not find in section 4.2 what is stated here.

L 604: Lopez et al., 2009 not reported in the reference list.

L 609: not consistent with introduction (IAs area smaller than 0.1 km^2).

L 610: Lopez et al., 2010 not reported in the reference list.

L 618: show the trends in Fig. 11.

L 665: *in order to* instead of *better to*?

L 680: IA*s.*

L 683: IA*s.*

L 680-682 and 683-685: rephrase these sentences avoiding repetitions.

References (already included in the manuscript)

Kaushik, S., Ravanel, L., Magnin, F., Yan, Y., Trouve, E., and Cusicanqui, D.: DISTRIBUTION AND EVOLUTION OF ICE APRONS IN A CHANGING CLIMATE IN THE MONT-BLANC MASSIF (WESTERN EUROPEAN ALPS), Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLIII-B3-2021, 469–475, https://doi.org/10.5194/isprs-archives-XLIII-B3-2021-469-2021, 2021.

Guillet, G., & Ravanel, L. (2020). Variations in surface area of six ice aprons in the Mont-Blanc massif since the Little Ice Age. Journal of Glaciology, 66(259), 777-789. doi:10.1017/jog.2020.46

Comments to figures and captions

General comment to figures: check consistency between the figures regarding the font used for labels, numbers, and letters, etc.

Fig. 1

I suggest using black squares to indicate the correct location of the two towns shown on the map. (i.e. Chamonix and Courmayeur).

The blue labels are not clearly visible, try changing the colour.

For scale and north arrow: leave some space between the frame and the graphic item.

Fig. 3 and Fig. 4

Some labels should be enlarged to improve readability.

Fig. 5

I suggest combining the four figures into a composite one, using the north arrow and legend only once.

The scale and coordinate labels should be enlarged.

Be consistent with Fig. 1 in the type of north arrow used.

The year of the orthophotos used as background should be reported.

Fig. 6

The same suggestion as Fig. 5: should be combined into a composite figure.

Add north arrow.

Fig. 10

The seven plots should be of the same size.

Some labels should be enlarged, and the size should be the same among the plots.

The legend could only be used once if the graphs were combined in a composite figure.

Fig. 11

Check the label: Temperature (°C).

Some labels should be enlarged.

Fig. 12

The two plots could be combined in a composite figure, using the legend once, the same size of the frames and the same scale for the x-axis.

Figure caption: "Correlation between the mean normalized measured and modelled surface areas".