

Point by point reply to the Interactive comments of Referee #3

Dear Editors,

We thank the referees for their thorough reviews and for the numerous suggestions that greatly helped us to improve the manuscript.

Following the comments of Referee #3, we have:

- added to the discussion a sentence indicating that extreme snowfall has not yet been directly evaluated.
- corrected some notations in Table 1.
- added an Appendix section that illustrates the seasons when the annual maxima of daily snowfall occurred.

Following the recent publication of Blanchet et al. 2021:

- We added at the line L296 a reference to this article: “We also observe for the period 1958-2017 that 20-year return level of winter precipitation have decreased in the north of the French Alps and have slightly increased or remained the same in the south (Fig. 8 of Blanchet et al. 2021).”

We hope that our revised manuscript will be found suitable for publication in “The Cryosphere”

Yours sincerely,

On behalf of the co-authors

Erwan Le Roux

Suggestions from Referee #3

We thank Reviewer #3 for his/her useful questions and comments on our manuscript. Please find below detailed feedback to individual comments and questions.

Minor comments

1. As requested some sentences regarding the evaluation of SAFRAN reanalysis have been added to chapter 2. However, it should be explicitly mentioned (maybe in the Discussion chapter) that extreme snowfall from SAFRAN reanalysis has so far not been evaluated.

We added the following sentence to the Discussion section “For future works, we note that a direct evaluation of extreme snowfall could help better pinpointing the locations where return levels might be biased”.

2. Similarly, one or two sentences regarding the linear dependence of the location parameter (in contrast to Blanchet et al. 2009) should be added to the Discussion chapter. This maybe not only be “due to various differences in the data used” but also due to the fact that they analyzed the depth of snowfall (in cm) with corresponding settling and not water equivalent of snow fall (in mm).

The fact that they analyzed the depth of snowfall (in cm) while we focus on the snow water equivalent of daily snowfall (in mm) is included in the “various differences in the data used”. We believe that we cannot conclude anything from the comparison with Blanchet et al. (2009) due to the numerous differences in data used. Therefore, we think that adding additional sentences regarding the linear dependence of the location parameter (in contrast to Blanchet et al. 2009) will only be misleading for the reader.

3. I would suggest to add the already produced plot and corresponding text about the months when the annual maxima of snowfall occurred (part of answer to reviewer #2) in the appendix, since the information is definitely interesting for some applications.

In the Discussion section, we replaced “We observe that at 2500 m (and at all elevations) that changes of 100-year return levels of winter precipitation, which may generate heavy snowfall show the same contrasted pattern than 100-year return levels of snowfall” with “We focus on winter precipitation because winter is the season where most annual maxima of daily snowfall occur below 3000 m (Appendix E). We observe that at 2500 m (and at all elevations) that changes of 100-year return levels of winter precipitation show the same contrasted pattern than 100-year return levels of snowfall”.

In Appendix E, we illustrate the seasons when the annual maxima of daily snowfall occurred. We added the following text to this Appendix: “In Figure E1, we study the seasons when the annual maxima of daily snowfall occurred. For the elevation range 1 (below 1000 m) and for the elevation range 2 (between 1000 m and 2000 m), we observe that the annual maxima mainly occurred (>60%) between December and February, i.e. the coldest part of the snow season. For the elevation range 3 (between 2000 m and 3000 m) more than 40% of maxima occurred in winter, while slightly less than 30% occurred in autumn and in spring. For the elevation range 4 (above 3000 m) the seasons of occurrence are more spread, even if we observe that more than 40% of maxima occurred in autumn. In conclusion, we find that below 3000 m, most annual maxima of daily snowfall occur in winter, while above 3000 m they mostly occur in autumn. “

4. Table 1: “Mean of maximum” makes still no sense, because in contrast to the source of the term (Frei et al. (2018)) the authors analysis is not based on monthly values. Please just use “annual maximum snowfall in N consecutive days.

We replaced “mean of maximum” by “annual maximum”, and removed the word “annual” in the column “Indicator” of Table 1.

References

Blanchet, J., Marty, C., & Lehning, M. (2009). Extreme value statistics of snowfall in the Swiss Alpine region. *Water Resources Research*, 45(5). <https://doi.org/10.1029/2009WR007916>

Blanchet, J., Blanc, A., & Creutin, J.-D. (2021). Explaining recent trends in extreme precipitation in the Southwestern Alps by changes in atmospheric influences. *Weather and Climate Extremes*, 100356. <https://doi.org/10.1016/j.wace.2021.100356>

Frei, P., Kotlarski, S., Liniger, M. A., & Schar, C. (2018). Future snowfall in the Alps: projections based on the EURO-CORDEX regional climate models. *The Cryosphere*, 12(1), 1–24. <https://doi.org/10.3929/ETHZ-B-000233992>