

The Cryosphere Discuss., referee comment RC3
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Comment on tc-2021-64

Anonymous Referee #3

Referee comment on "Elevation-dependent trends in extreme snowfall in the French Alps from 1959 to 2019" by Erwan Le Roux et al., The Cryosphere Discuss.,
<https://doi.org/10.5194/tc-2021-64-RC3>, 2021

The submitted manuscript describes how the 100-year return level of daily snowfall water equivalent from Safran reanalysis has changed in the French Alps between 1959 and 2019 based on non-stationary GEV distributions. The study demonstrates an elevation dependent result with mostly decreasing values below 2000 m and mostly increasing values above. However, the investigated regions and elevation ranges often show a high regional variability.

I liked reading the manuscript, which has a clear structure and illustrative figures. The language is with a few exceptions easy to read. The topic is definitely of high interest for readers of TC. I suggest to accept the manuscript as soon as the following points, have been addressed:

- Extreme snowfall or even snowfall in general from Safran reanalysis, at least to my knowledge, has so far never been evaluated with measurements as e.g. described in Gaume et al. (2013) or Nicolet et al. (2016). I believe it's necessary to show at least some comparisons with the available time series.
- Moreover, the following points are missing, which are both important in case of comparisons with measured snowfall water equivalents:
 - a) Is the reanalysis able to reproduce rain-on-snow-events within a 24 h time period?
 - b) Are the reanalysis data refer to the same 24h period as the measurements?
- The examples of extreme snowfall or roof collapses provided are used to justify the use of the 100-year level, although all these examples are not caused by one extreme snowfall alone. Most of the examples also concern elevations below 600 m, which are not analyzed in this study at all. Please elaborate. Furthermore, instead prominently mentioning avalanche defense structures, which are not impacted by one extreme daily snow fall; I'd suggest to mention snow breakage.
- The linear elevation dependence considered in L100 is in contradiction to doi.org/10.1029/2009WR007916. Please elaborate.

Minor:

Title: I'd suggest to extend the title with «based on reanalysis» as the used snowfall data are not measured.

L18: "power lines" instead of "electric systems"

L20: Rather cite : doi.org/10.5194/nhess-8-1-2008

L53: previous studies (see next sentence)

Table 1: Why is Faranda et al (2020) not listed?

S_{nd} : Why the mean of maximum? It's just the annual maximum snowfall in N consecutive days.

L61: Does 600 m elevation mean the 300 m elevation band between 450 and 750 m? Please clarify?

L66: Please explicitly mention that the reanalysis provides the daily snowfall amount in kg/m² in contrast to measured height of snowfall, which usually is given in cm.

Figure 1: Why is the m⁻² of kg m⁻² written italic?

L113: "Appendix A"

L118-119: Please rephrase.

L151: Fig. 3b

L156: I count 7 massifs?
Fig. 3c

L160: In Figure 2d..., while in Figure 3d...

L167: "Further" instead of "Then"
Xi instead of Zeta

L172: "at 500 m" instead of "at low elevations"

L173: "at 2500 m" instead of "between 2000 and 3000 m"

L179: "Appendix B"

L199: "with an increasing or decreasing trend"

L205: What means "short"?

L214: "we always have at least two time series..."

Figure 8: Could you please indicate the non-significant massifs with a white-dotted pattern.

Fig 9: "...illustrated with colors (elevation range dependent scale)..."

L234: "...literature (see next paragraph)..."

L242: I don't find the 1.5 kg m⁻²/100 m in Blanchet et al. (2009)?

L243ff: This study is about annual maximum snowfall, which is only at low elevation a concern in regard to infrastructure. Avalanche defense structures or settlements in the mountains are endangered by annual maximum snow depth and not one snowfall event. Please rephrase!

L244: What means red? Reddish, dark red?

L250: "combined with liquid precipitation, which is not considered in this study"

L251-252: Is there a specific reason you distinguish here below 1000 and above 3000 m, in contrast to the separation below and above 2000 m in the abstract and the conclusion?

L254-262: It seems strange that you write in these lines about increase in "extreme precipitation", "high latitude" and "moderate extreme snowfall", which all have so far not been analyzed in this study.

Please rephrase the last sentence and make clear to what elevation you refer.

L257: "1.4 billion Euro of damage"

L266-274: This might be true for moderate extreme snowfall but not for the annual maximum.

L283: "Faranda (2020)"

L295: "For the four investigated elevation ranges..."

L305-307: See my comments to lines to L243ff.

L325: How is a "good" fit defined in numbers?

What did you do for those cases, where no good fit could be obtained?