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Comment on esd-2021-79

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Referee comment on "A non-stationary extreme-value approach for climate projection ensembles: application to snow loads in the French Alps" by Erwan Le Roux et al., Earth Syst. Dynam. Discuss., <https://doi.org/10.5194/esd-2021-79-RC2>, 2021

General comments

In this paper the authors make use of a non-stationary extreme values probability estimation approach based on using both past observations and future projections (from explicit numerical models); the proposed analysis is addressed to evaluating 50 years return levels (for the time period 2019-2100) of annual maxima of snow load at 1500 m elevation for the 23 massifs of the French Alps: past observations and model (GCM-RCM pairs) projections are **simultaneously** submitted to extreme value probability estimation by means of GEV distributions with piecewise linear trend (in the GEV parameters) and adjustment coefficients suited to making GEV of past observation and future projections compatible.

The paper is, in my opinion, interesting as it addresses problems that are relevant from a both conceptual and applicative point of view:

- estimating extreme distributions of statistical processes embedded in background dynamics evolving on time scales comparable with those of recurrence of extremes themselves is a well known statistical problem and distinguishing "natural variability" of extremes from variability "forced" by background dynamics is a classical scientific-technical challenge;
- projecting in future time variables (temperature, precipitation, snow load, etc.) that are relevant for the management of social-economic activities is a clearly important operational task.

The methodological approach proposed in the paper, based on simultaneous use of observations and model projections, is stimulating in particular when facing problems (like the one addressed in the paper) in which numerical simulation models are characterized by heavy tuning-parameterization (fudge factors) changing in time. However, in order to make the estimation process tractable in the specific application considered in the paper, many ad hoc assumptions have to be introduced and the results are admittedly (Section 5.2) problematic, raising doubts concerning the **applicability** of the adopted working hypotheses. This situation often occurs in operational statistical estimation: thorough a posteriori analysis is almost invariably required; the authors should critically re-examine their assumptions.

The paper is neat and clean, but here and there not easily legible as it is very concise ("dense"): since the paper proposes issues of potential interest for a wide audience in which "non experienced" readers could find elements of interest I suggest a more "friendly" communication approach; but I leave to the authors deciding whether being concise is more important than being readily accessible for a wider audience.

Specific comments

Many acronyms and "technical slang" words appear in the paper: a glossary may help.

Line 3 "chain of MME": define in text or in glossary.

Line 7 "with a robust quantification of uncertainties.": this claim appears repeatedly in the paper; I found mathematical definition in Appendix A: Uncertainty estimation a technical quantification uncertainties, but not an analysis-discussion of the "robustness" of the estimation itself.

Line 11 "is of major interest for the structural design of roofs": not only (skying, avalanches, mobility, etc.); a few more words about applications could help.

Line 24 "EVT makes it possible to robustly estimate return levels": see Line 7 comment.

Line 29 "estimated separately on each chain of the MME": see Line 3 comment.

Line 32 "30-year time slices": perhaps it is worth mentioning that 30 years is the traditional (WMO) "time scale" of "climatological" analysis.

Line 52 "robustly quantify uncertainties": see above lines 7 and 24 comments.

Line 63 "adjustment coefficients": a few more words could help.

Line 80 "snow load" see Line 11 comment.

Line 92 "Quantile mapping method ADAMONT": a few words about it?

Line 98 "Crocus": ?

Line 204 "For a detailed analysis of the mean logarithmic scores of each parameterization for each massif, see Supplement, Part C.": what is Supplement, Part C? Where is it?

Fig.4 This figure plays a central role in the paper: some graphical features are too faint.

Line 220 "adjustment adjustment".

Line 255 "Figure 2.3 of IPCC (2019)": wouldn't it be possible to insert this figure or its direct internet link in the text?

Line 273 “because it sometimes leads to prediction failure, i.e. the predictive distribution gives a null probability to some future annual maxima.”: this is not clear to me!

Line 287 “The 90% uncertainty intervals of return levels (Fig. 4) account both for the sampling uncertainty (Appendix A) and the climate model uncertainty (distributions are fitted together from the past observations and all GCM-RCM pairs).”: not easy to distinguish in the figure (see comment to Fig.4 above).