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Hydrology and Earth System Sciences Discussions

Interactive comment on "Future changes in extreme precipitation in the Rhine basin based on global and regional climate model simulations" *by* S. C. van Pelt et al.

Anonymous Referee #1

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General comments —————-

The authors address a question of high importance for flood risk management in the Rhine basin. They face two challenging problems: (1) estimating rare heavy multi-day precipitation events (i.e. return periods up to 1000 years) based on a comparative short observational precipitation record and (2) projecting these into a far future (2081-2100).

The paper under review focuses on the second problem. An advanced (non-linear) delta change approach is developed, defining transformations between observed and projected precipitation data from an extended ensemble of climate change scenarios (compared to earlier studies). These transformations are subsequently applied to a time series of 3000 years of precipitation data representative for todays precipitation regime. The latter has been derived by resampling from the (short) observational record using a method described in the literature (and which is only briefly summarised in the present paper). The statistical analysis of the transformed time series yields bandwidth' of 10 day precipitation sums over the Rhine basin for different return periods up to 1000 years.

The current study is a valuable contribution towards an advanced understanding of possibilities and limitations of predicting future precipitation regimes. As it is rightly pointed out in the discussions and conclusions the delta method as applied here has its limitations and relies on a number of assumptions (in fact: as all methods trying to look into the future...). The single most important information lacking to me is an estimate of the impact of all these assumptions on the bandwidth determined and thus on its reliability. How sensitive is the bandwidth to various assumptions? The authors rightly cite Klemes (2000a, b) in the context of difficulties in the extrapolation of distributions fitted to observed flood peaks (p. 6536, l. 9). However, neither uncertainties in determining the parameters of the weather generator used nor in scaling the excess above P_90 are examined, though both in a sense correspond to extrapolating distributions towards extreme events. When exploring these (together with in addition the impact of "some subjective choices" regarding temporal and spatial smoothing) my basic (nil) hypotheses were, that the uncertainty in determining a climate signal on extreme precipitation events is much higher than the conclusions suggest (see specific comments below).

Overall, I had some difficulties to always keep oriented about temporal and spatial scales and intervals (1, 5, 10 days, overlapping, non-overlapping means, 20, 35 years) used and compared including rational behind choices, though Fig. 3 helped a bit. I suggest to add an overview (e.g. by extension of Fig. 3 or a separate table) and rational at one position (e.g. in an introductory paragraph).

Specific comments ——————

(1) Generation of 3000 years of "observation-like" data is based on 1961-1995? How sensitive is the generation method to choosing e.g. 1966-1995 or 1961-1990 or leaving out the most extreme event from the "seed"-data set? How does the bandwidth from this sensitivity compare to the bandwidth of the ensemble of climate change projections?

(2) Parameters of the advanced delta change approach are based on statistical analysis of periods 1961-1995 and 2081-2100 (i.e. 35 and 20 years periods)? Statistics on e.g. P_60 and P_90 or the excess thus are based on time series of different length for past and future. This is not nice (imagine to base the analysis on an even shorter future period, in extreme on just one single year, e.g. a very extreme or very moderate one. . .). Periods should be as long as possible and of equal length. At least it should be explored how sensitive the parameter estimation method is to the choice of periods and again, how does the bandwidth from this sensitivity compare to the bandwidth of the ensemble of climate change projections?

A number of additional remarks in consecutive order:

p.6535 l.20: "is believed": please choose another expression, science is not about believes but about hypotheses and their confirmation or rejection. E.g. use"it has been shown" or "several studies prove that under conditions" or something else. . .

p.6536 l.25: according to http://www.chr-khr.org/de/node/432 the length of the Rhine is only 1.238,8 km (older literature states 1230 km, only recently 1320 km has been used instead)

p.6537 l.23: "with a high resolution precipitation and temperature data set": Which set? Cite. Which period? Which bias correction method?

p.6538 l.10: "but this was not used in this study": ". . .could not be used. . ."?

p.6539 l.19: "non-overlapping": may miss more extreme 5-day sums. Sensitivity, if start of non-overlapping 5-day periods is shifted 1,2,3,4 days?

l.22ff: A definition sketch of both (present and future) probability functions indicating shifts of P_60, P_90 and Excess would be helpful

p.6541 l.13: and p.6542 l.7 “unrealistic high precipitation”: “unrealistic” in regard to what measure? Probable maximum precipitation (PMP)? The problem with events featuring return periods of 1000 and more years is that they always are very close to “unrealistic” as they hardly ever occur! It is not even clear, whether they belong to the same statistical basis, as their generation mechanism may be completely different. How sensible is the result of this paper to the exact scaling of the excess? This relates to my earlier (general) comments. p.6541 l.14/15 “adequately”: again, in view of my previous comment, what is adequate?

p.6543 l.25: “unrealistically”: In view of my previous and general comments: Why? Why subjective smoothing? Why not even more smoothing? It’s a rather arbitrary choice and its bandwidth needs to be explored.

p.6546 l.1-26: This paragraph very briefly describes the nearest-neighbour resampling used in the present paper which has been developed, applied and described elsewhere in the literature. Unfortunately there are no comments or estimates about the sensibility of the parameters of this resampling method to the results of the current paper. Some few suggestions to enhance readability: l.2: add “nearest neighbour” before “resampling” already here. l.5: New paragraph after 3.1.3. l.6: After “Rhine basin“ add “applied in this study”

p.6550 l.13: “Most. . .was tested carefully.” does not sound like Science. In fact, as explained earlier, I miss the evaluation of the impact of all choices (at least an estimate, how other reasonable choices could influence the bandwidth of the results). l.14: I missed estimates of “sampling uncertainty”, as mentioned before e.g. by sampling form shifted 30 year and 20 year time series (from the 35 year record).

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Interactive Comment

p.6562 l.3 in caption of Table 2: “changes”: add “between climate of 1961-1995 and 2081-2100” or similar

Technical corrections —————————

p.6537 l.15: “a” hydrological model (instead of “the”)

p.6540 l.13ff: the superscripts “C”, “F” and “O” are not explained here (initial use), but two of them at p.6541, l.2, there misleadingly using the word “again”. Also in Appendix A these superscripts are used from p.6553, l.4ff without explanation.

p.6541 l.8-11: This note could be moved into a footnote (or separated by a blank line)

l.12 A small caption “Excess > 90%” would improve readability and overview (or separation by a blank line)

p.6542 l.14: “smoothed”: add “over time”

p.6543 l.2:“...of the sub-basins...”: change to “...of all sub-basins”.

p.6565 l.5 in caption of Fig. 2: “Note the difference...”: No comma after “Note”

p.6567 l.2, 3 and 7 in caption of Fig. 4: change “upper” to “left” and “lower” to “right” panel readability of Fig. 4: - Indicate extension of left panel in right panel - Add tics and labels for 50, 500 and 5000 in right panel - Add tics and labels for lower and upper bounds of plot

p.6568 readability of Fig. 5: - Add tics and labels for lower and upper bound of plot

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 6533, 2012.