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Interactive comment on "Identifying robust bias adjustment methods for extreme precipitation in a pseudo-reality setting" *by* Torben Schmith et al.

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Authors' response to referee #1

* We will start by thanking the referee for a fair and thorough review. We will comment (marked with * . . . *) on each review items below. *

This is an interesting contribution involving a lot of work. I have a few general issues that the authors should address in their revisions, followed by some specific comments. Firstly - there needs to be a better discussion about the possible problems in using the pseudo-reality setting for assessment of precipitation extremes. Most models have a tendency to increase the probability of occurrence of rainfall, thereby increasing the size of the sample that could potentially constitute extremes. The authors have avoided this issue to some extent by performing a pseudo-reality assessment. I believe some discussion should be included as this could create difficulties in taking the findings from here to real applications.

* We will clarify the introduction by underlining that bias adjustment methods can be validated by two main methodologies: 1) training/validation split of observations (Themeßl et al. 2011; Li et al. 2017) and 2) inter-model cross-validation, which we use. Methodology 1) has the advantage of actually comparing the bias-adjusted model date with observations, which methodology 2) does not. This may be important, since models may have precipitation characteristics, e.g. the division between stratiform and convective precipitation, different from observations. Methodology 2), on the other hand, also has advantages. Firstly, the models are tested in in future climatic conditions, different from present-day conditions on which they are trained. Also, model and pseudo-reality have the same spatial scale, thus avoiding any interfering with scale issues present in methodology 1) where pointwise observations are compared with area-averaged model data.

We recognize that models do have a tendency to increased probability of rainfall. This is, however, in the form of continuous drizzling and therefore would not affect our extreme value analysis. *

Secondly, the paper is coming across as a bit of a report (and I sympathise with the authors as they do have a lot of information to present). Perhaps a more creative C1 discussion for differences in mountaineous areas versus not, coastal areas versus not,

* Our adoptation of the 'PRUDENCE regions' was motivated by the desire to illustrate results for different meteorological regimes. This we will formulate more explicitly. We will also consider using Figs. 5 and 7 (with a revised color scale) for relating the results to storm track, orography and coastlines. *

and daily durations versus hourly would be useful. I note the spatial resolution is 11km. Daily extremes should be simulated better at this resolution.

* We will extend the text in the results in Section 4.2. on daily vs. hourly. B.t.w., the issue is dealt with in more principal terms in Section 4.3. *

Also, no mention is made of the causative GCMs that are interpolated using the RCMs. There are different extent of biases in these. Some discussion should be included on this as well.

* We will include this discussion, based on the available literature on GCMs and their ability to reproduce large-scale features (storm tracks, blocking frequency and, duration) and RCMs and their ability to reproduce local details of precipitation due to e.g. orography. A priori, we regard the effect from the RCM to be important for extremes.

We note that only few pairs of pseudo-reality and model use the same GCM model and ensemble member. Counting in Tab. 1 shows that 40 pairs out of 342 are driven by the same GCM ensemble member, i.e. 11% of the pairs analyzed. A specific analysis of the relation between the two kinds of model pairs would be very interesting, but it is not easily included into the current study. *

Thirdly, the authors have missed with publications on this topic by Jingwan Li. Relevant papers are: Li, J., et al. (2017). "A comparison of methods for estimating climate change impact on design rainfall using a high-resolution RCM." Journal of Hydrology 547: 413-427. Li, J., et al. (2017). "A comparison of methods to estimate future sub-daily design rainfall." Advances in Water Resources 110: 215-227. Li, J., et al. (2018). "Addressing the mischaracterization of extreme rainfall in regional climate model simulations – A synoptic pattern based bias correction approach." Journal of Hydrology 556: 901-912. Li, J., et al. (2018). "Can Regional Climate Modeling Capture the Observed Changes in Spatial Organization of Extreme Storms at Higher Temperatures?" Geophysical Research Letters 45(9): 4475-4484. I am a co-author on these papers hence have a conflict here. But I think these are very relevant to what the authors are attempting to do here, as she used an even finer resolution RCM with a high density of observed gauges at the same time resolution (hourly). The bias correction approach she adopted acknowledged the bias in simulating convection within the RCMs as well as the quantile bias convective and non-convective rainfall were exhibiting.

* We were not aware of these papers. We foresee that the two papers “A comparison . . .” will be referenced in Section 5.1 and contribute to the discussion there.

Our manuscript evaluates basic adjustment methods only. We know that there is a myriad of special-designed adjust methods, including the one described in the paper “Addressing the mischaracterization . . . “.

The paper "Can Regional Climate Modeling Capture . . .” about the spatial extent of extreme precipitation events is not within the scope of our manuscript. *

Now to the specific comments:

line 142 - missing section marker

* Thanks, will be fixed. *

line 225 - there is another way to create the partial series sample. It is to acknowledge that there may be a bias in the proportion of events that are say convective. If this proportion is biased, one is forming a biased sample effectively by selecting the series the way adopted here. This issue is the focus of Li, J., et al. (2018). "Addressing the mischaracterization of extreme rainfall in regional climate model simulations – A synoptic pattern based bias correction approach." Journal of Hydrology 556: 901-912.

* In the manuscript we evaluate the standard POT procedure, as it is implemented by numerous hydrological authorities. The work described in the suggested paper is not within our scope (see also above). *

line497 - If the proportion of convective extreme events increases in the future (as it is expected to) then ignoring any bias in the representation of convection as discussed above, will create a non-stationary bias. This can be addressed though using the above mentioned approach.

* The aim of our work is to evaluate the simple bias adjustment methods for extremes, as also explained above. More sophisticated methods are not included in this study, but the suggested paper can go into the discussion on future work. *

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