

Interactive comment on “Formulating and testing a method for perturbing precipitation time series to reflect anticipated climatic changes” by Hjalte Jomo Danielsen Sørup et al.

Hjalte Jomo Danielsen Sørup et al.

hjds@env.dtu.dk

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Reply to Anonymous Referee #1

We greatly appreciate the review and acknowledge that the comments and suggestions will lead to an improved paper.

Regarding the general comments

It is not assumed that extreme precipitation only occur in summer even though the majority of the events occur during this season. The summer season is particularly interesting because most extremes occur here and will increase further while in general the precipitation amounts are decreasing. In other seasons there is no such difference

C1

between average and extreme properties of the changes.

Regarding a discussion of alternative approaches we will add further discussion of the possibilities beyond the presented approach (also facilitated by the comments from Referee #2) that could also include alternative approaches to reach the same endpoint. We will focus on using Markov models for precipitation and the two downscaling approaches Delta Change and Distribution Based Scaling, which has inspired us in defining the framework.

Regarding specific comments

In 1. a point is raised that the semi-Markov system used to frame the approach is “rather formal” given that essentially the approach is very simple. However, the use of a somewhat extravagant terminology has advantages if the model should be extended into a stochastic formulation. The application of a semi-Markov system for setting up different numbers of classifications is straightforward and extending the system to a stochastic model on a more general level is possible.

As pointed out in 2. the difficulties in assigning a single event state is central to the approach and the section (Section 3.3) will be extended with an elaboration of the mathematical considerations as well as the importance of these.

Regarding 3. we thank the reviewer for pointing out the error in our manuscript and will correct it in the final version of the paper.

As stated in 4. there could be other ways to determine the return level of the individual events. We will try to make this section clearer, especially since both reviewers point out that the current manuscript is unclear here. We will focus on the need to test the approach in relation to how it will be used and that users can and should define suitable metrics depending on the actual use of the constructed series. The defined metrics was chosen because it is a basic requirement that the series should be able to fulfil these criteria before they are used in Denmark (which other approaches have

C2

failed).

The duration independence of the used change factors (as raised in 5.) is based on the official recommendations for Denmark. We agree that it is probably a bad assumption. One of the justifications for choosing this approach is that often climate change impacts are based on design storms which makes duration-specific change factors difficult to employ. It might be an option to identify duration specific change factors and use them within the presented framework. However, it would probably require some further analyses of the structure of events which goes beyond the current study.

The point raised in 6. about the A1B scenario's relative place in relation to RCP2.6 and RCP8.5 is much appreciated and really help demonstrate the difficulties of working with derived data based on different generations of climate model scenarios. The idea has not been to indicate that the A1B scenario was the midpoint between the two RCP scenarios, but merely to state that it was somewhere in between. Also, as illustrated by the results in Figure 4, we use the notion of "low", "middle" and "high" emission scenarios in an assessment effort towards documenting the sensitivity of the approach towards the absolute magnitude of the expectations to climate change. We will alter the relevant sections to make this clearer.

Regarding technical corrections

We will make the grammar corrections and add explanation for $||$ and z^* as asked for. As for the reference "Madsen et al. (2009, submitted)" we will rewrite the sentence to highlight that what is referred to is Madsen et al. (2009) and Madsen et al. (submitted) where the last one is an update of the model described in the first one.

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