Response to reviewer #2 (anonymous)

The idea of the article is original (development of a space-time rainfall model that can accurately reproduce various rainfall statistics including extreme values) and is also very well organized.

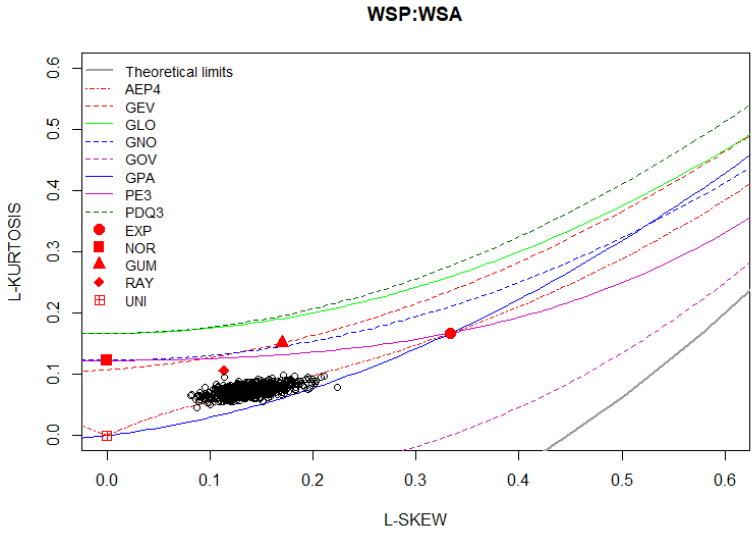
Response: I thank the reviewer for their supportive feedback.

L89: Is there any mechanism in your model to consider temporal autocorrelation of WSD, WSA, DSD while generating them? (Large rainfall is quickly followed by large rainfall, and vice versa) This mechanism will enable the model to reproduce long(er)-term rainfall variability (e.g. weekly, monthly) making it more versatile (Kim et al., 2020).

Response: At this stage there is no mechanism to consider event variable auto-correlation. As event variables are randomly sampled from fitted probability distributions, a possible method to model autocorrelation would be to include auto-correlation in the simulated annealing optimisation procedure, which is currently utilised to enforce spatial consistence. It must however by said, that observed event variable auto-correlation is relatively low. Median lag-1 auto-correlation across all 699 stations is 0.0269 for wet spell amount, 0.0822 for wet spell duration and 0.0482 for dry spell duration,

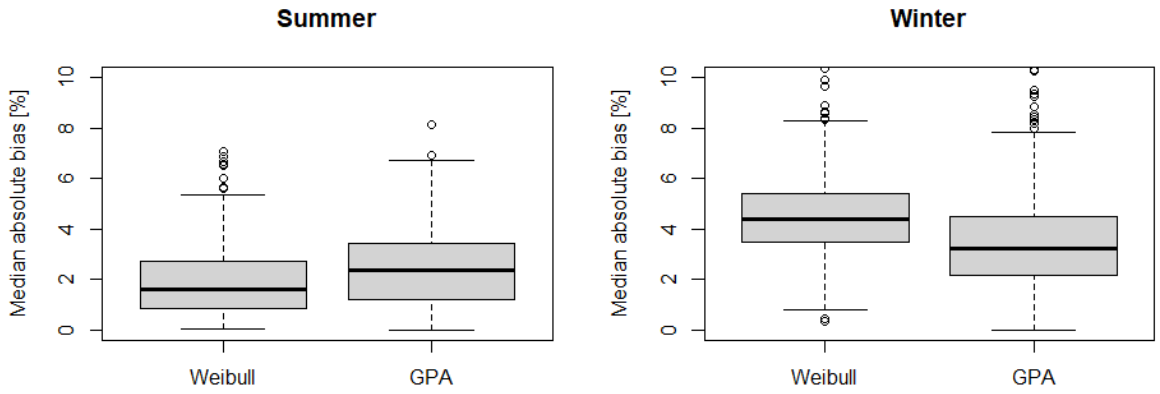
L147: Why Weibull? Generalized Pareto Distribution may be a better pdf for rainfall peak values. You may want to try the L-moment diagram method to figure out the most optimal distribution of WSP.

Response: We thank the reviewer for the comment and suggestion. The below diagram shows the L-moment diagram for all stations used for the study. It indicates that the Generalized Pareto Distribution may well be a good choice for the variable WSP:WSA.



To test its suitability, the WSP was modelled over 100 realisations of 15 years using both Weibull (as in the study) and GPA distributions (as suggested by the reviewer). Looking at the absolute relative bias, abs(mean(sim) – mean(obs) / mean(obs)), with the median taken over all realisations (below figure), a slight improvement can be observed in winter, however performance is slightly worse for summer. Other metrics (e.g. 98% percentile, standard

deviation etc) align with this finding, and as such it is not considered worth the effort to change the distribution at this late stage.



Section 2.2. Space-time rainfall synthesis via resampling: I have an impression that the model is too much oriented toward reproducing only spatial-correlation. Do you have any algorithm to ensure space-time correlation at all gauges? The algorithm does not seem to have a capacity to simulate continuous movement of storms. In other words, do the consecutive snapshot of rainfall fields resemble with each other?

Response: The current model is only able to reproduce spatial consistency dependent on inter-station distance alone. Direction is not considered, nor are any temporally lagged values incorporated into equations 9-11, which could aid in modelling moving storm fronts. The focus of this paper (and where most of the effort occurred) is its multi-scale performance to model both small and large rainfall gauge networks, as previous attempts had failed to do so. The nature of the simulated annealing optimisation procedure however allows for future revisions to incorporate additional characteristics such as storm front movement etc if the intended use of the output time series warrants it.

Figure 11. The systematic underestimation may be related to the first comment of this review.

Response: The k-NN resampling method, unlike the space-time rainfall model, aims to reproduce daily auto-correlation of the non-rainfall climate variables. The mechanism to achieve this is via the distance metric (equation 18) used for the selection of the k nearest neighbours. There is expected to be a systematic underestimation in auto-correlation, as the best ranked candidate day is not necessarily chosen due to the discrete probability distribution used (equation 19) and the conditioning on rainfall state further restricting possible candidates.

I suggest authors to add another figure that shows a diagram showing the space-time autocorrelation between Figure 8 and Figure 9.

Response: By space-time autocorrelation I assume that the reviewer is referring to lagged correlation between stations by station separation distance? As mentioned in R2C4 above, as lagged correlations were not a focus of the study, such a figure or discussion has not yet been included. Performance in this regard is unsurprisingly weak, due to not being included in the

objective function. The preliminary plot below shows the first 4 lagged correlations. Such a figure could be included in the work if requested, however I question the value in doing so.