Authors response to comment on hess-2022-21

Anonymous Referee #1

Author comment on **A gridded multi-site precipitation generator for complex terrain: An evaluation in the Austrian Alps** by Hetal Dabhi et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-21-RC2, 2022

This article suggests a novel GLM-based space-time rainfall generator for Alpine region. While the suggested model shows the limitations in reproduction of reality, I think this is a meaningful attempt in our field given the extreme challenging nature of the space-time field generation. The model is original, and the article is well structured. Therefore, I believe that the article is suitable for publication in this journal after a few revisions.

We are thankful to Reviewer-1 for the time and positive feedback on our manuscript. In the following we provide our response comment by comment.

1) I suggest authors to compare extreme values too. E.g. extreme values by the model of this study vs. AGPD, both point values and areal values. This is because one of the primary reasons of developing weather generators is to analyze disaster (from a probabilistic viewpoints).

Response: We agree that one of the main purposes of developing weather generators is the analysis of extremes, but it is only one. This is the first time ever that such a model is used in complex topography to generate data at locations without historical observations. Therefore, we focused on testing our model in reproducing the basic statistical characteristics of precipitation over the complex topography. With respect to extremes, this at least includes the duration of wet and dry spells. We also have discussed the shortcoming of the model in reproducing some of the key statistics and concluded that further development is required in order to use it for a downscaling purpose. Therefore, including analysis of extremes will be a necessary next step, which is, however, out of scope for the present manuscript.

2) Please consider excluding trivial precipitation (e.g. less than 1mm) from your analysis to calculate occurrence-related values (Pww, Pdd, Pw, etc), and reanalyze your result. This is a common issue with all stochastic rainfall generator drawing rainfall depths from a modelled mathematical distribution. You may get better results.

Response: We adopted the standard definition of ‘wet day’ used by the data providers and hence, when comparing to observations we have to stick to it. Thus, we have decided to leave the threshold as in the original manuscript.

3) L181-184. I would like to see the map of the interpolated scale and shape parameter. Interpolating parameter, in many cases, causes problems. The map should look smooth and should show dependency to the terrain. In addition, I suggest authors to consider obtaining these parameter maps based on the AGPD data or the KED-based rainfall map from your point observations to exclude the process of spatial interpolation.

Response: We have shown the shape and scale parameters in Figure R1 and R2, respectively (see below). The shape parameter is presented in Figure R1, which is constant throughout the year and hence only one plot, while Figure R2 displays the scale parameter for each month. As mentioned by the reviewer, the figures do show the dependency on the terrain. The dependency is more prominent in the warmer months for the scale parameter and less prominent and displays smooth fields during the colder months. This is reflected in the simulated precipitation amounts also. We will explicitly add this information to the manuscript in the revised version. Due to the satisfying quality of the interpolated parameters we have refrained from also testing any alternative as suggested by the reviewer.

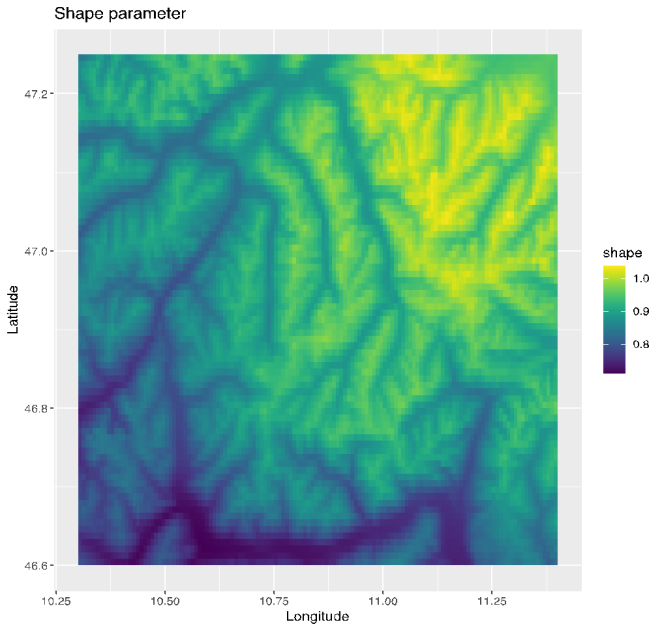

Figure R1: Interpolated shape parameter

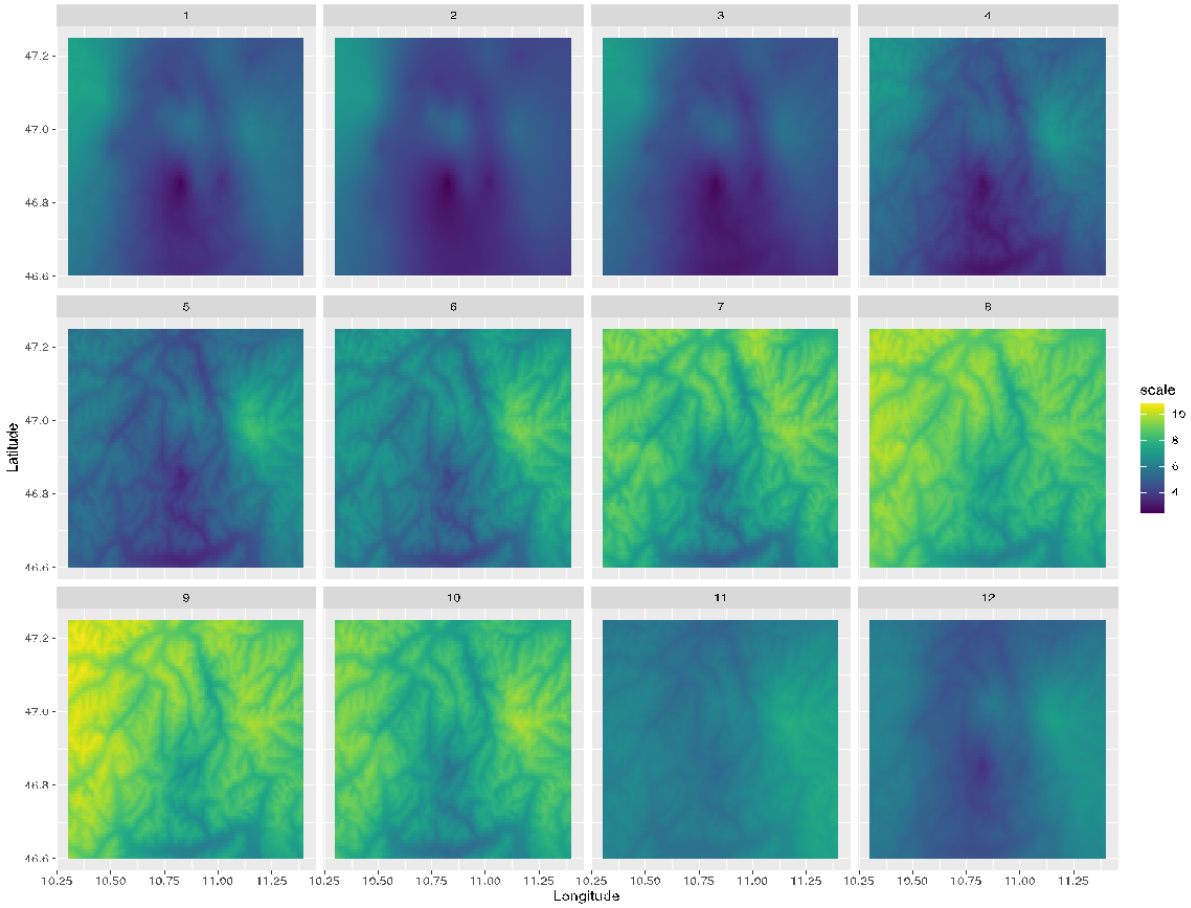

Figure R2: Interpolated scale parameter in each month

4) Figure 7 and Figure 18. I would also like to see the shades of the observed precipitations, which may be significantly greater than the current blue shades. This is not because I want to criticize, but because I would like you clearly show and mention the challenges of the stochastic rainfall generators (underestimation of large-scale variability) and to suggest potential remedies. Park et al. (2019) and Kim et al. (2020) discusses this issue in detail.

Response: This is indeed a relevant suggestion. However, the shaded region is the *tolerance interval* which cannot be determined for observed data. As opposed to confidence intervals, which would give expected bounds on the means of the simulated data, the tolerance interval gives bounds on the future individual observations. Here tolerance intervals are used to indicate the 99% range of the simulated values (with 95% confidence). In our view, tolerance intervals provide an appropriate visualization of the expected variability of the simulated data, as well as a means of comparison with the original data. We will consider adding this to the revised manuscript.

5) Figure 9. Why not show on the log-log axis? Too many small value pairs.

Response: In fact, we have started from the proposed representation as well. However, the advantages cannot compensate for the fact that the tolerance interval (the shaded region) on a log scale is hardly visible. We have therefore decided to stick to the linear scale.

6) Figure 12 and Figure 15 look like a collection of chessboards rather than a heat map. Would you remove the white squares?

Response: This is probably an issue of missed communication. We similarly noticed the 'chessboard-like' representation' of these figures *in certain browsers*. When we noticed this, we have added a comment regarding this on the HESS discussion page (https://doi.org/10.5194/hess-2022-21-AC1). We have corrected the issue with the figures now and it will be updated in the revised manuscript. We thank the reviewer for pointing this out.

7) Figure 11, 12, and 13 (Figure 14, 15, and 16 too): No need to show all the months. Please consider squeezing into one figure showing simulation (1^{st} row), AGPD (2^{nd} row), and differences (3^{rd} row) for 4 seasonal months (columns).

Response: This is a nice suggestion. This would increase the readability of the article. We thank the reviewer for this comment. In the revised manuscript, we will make the necessary changes.

8) L 300-302, Figure 17. I am not sure which of the two variables that the authors are precisely comparing. Would you let me know how, for example, correlation coefficients were derived (e.g. x and y values of the scatter plot)?

Response: We considered the synthetic spatial-series of monthly mean of precipitation (MMP), i.e. the values of MMP at each grid point and similarly the values of MMP at each grid point in the observed data. Thus, the correlation coefficient is considered between the grid to grid values of MMP in the synthetic and observed data. Similarly, other error metrics have been derived for the corresponding statistics in the synthetic and observed data. A necessary change will be made in the revised manuscript making this clear.