Point-by-point response to Reviewer #1

Florian Ehmele on behalf of the co-author

July 09, 2018

Thank you very much for your work and the useful and valuable comments that helped to improve the scientific quality of our manuscript. Please find below our reply to the individual points.

This study extended the previous models from Smith and Barstad (2004) and Barstad and Smith (2005) to stochastically generate extreme precipitation events. The model relates extreme precipitation to atmospheric conditions, kind of circulation-based model. This model is exclusively for extreme precipitation events, different from those models for long-term weather generation. The paper presented a lot of details to interpret the procedures about development, calibration and validation of the proposed model. The topic falls within the scope of HESS.

Although the manuscript gave enough information about the model, it is not so easy to follow in the current form. I strongly suggest adjustments of the paper structure. First, a flowchart should be given to show the development, calibration and validation of the model.

We understand the reviewer's point that the manuscript may be difficult to follow. In the revised version of the manuscript, we try to improve the readability by re-organizing the sections and by tightening / deleting details that are not that important. We follow the suggestion and included a flow chart with corresponding descriptions in the text that may help to better understand the links among the different components.

Second, it is better to first give the model description following by data description, which is the usual way for method development.

In the new version of the manuscript, we changed the order of Sections 2 and 3 as suggested. We also rearrange some Sections to improve the logical story line.

Third, it is necessary to simplify some sections, but focus on how to connect atmospheric conditions with extreme precipitation so that the modeled data can represent the regional condition instead of one site.

Ambient conditions directly feedback into the model equations that combine flow conditions with microphysics, thus representing the regional conditions. This is highlighted, for example, in Figures 7 and 9 (which will be Figs. 8 and 10 in the revised version). Furthermore, to highlight directly the relation between environment and ambient conditions, we will include a new Figure. Another critical point is that we used only data from one radiosounding (Stuttgart). As shown by Kunz (2011) for a comparison between Stuttgart and Nancy sounding, ambient conditions during large-scale heavy rainfall usually do not show large gradients (at least for the parameters considered in the model and without fronts that are, thus, treated separately). We will add a comment in the manuscript.

Fourth, usually, for model development, a comparison with a paralleled model is necessary. Please consider the possibility to add this part. Although it takes time to do additional comparison, it is persuasive to highlight the strength of your model. Further, people would wonder how your model's performance compare with the

models for long-term weather generation. With the above adjustments, the manuscript would be easier for readers to understand.

We agree with the reviewer that a comparison with other models would be appropriate to highlight the skill and characteristics of our model. However, we are not aware of any comparable large-scale two-dimensional stochastic precipitation model. Therefore, we will compare the full SPM2D using the basic setup (reduced SPM; rSPM) with COSMO-CLM (CCLM) reanalysis using the top200 events. For this, we split Figure 12 into two new Figures 13 and 14, one for the median and one for the 90th percentile, and add the corresponding statistics of the rSPM and CCLM simulations. The same will apply to Figure 13 (new Fig. 15).

Furthermore, the authors should state the potential extension of the proposed models to the other regions in the world, which would be helpful for readers to know how to use it. Otherwise, it is a model just applicable to a specific region, which is not necessary to publish it in an international journal.

The methodology is not limited to a specific region. The basic core of the model, the orographic rainfall model according to Smith and Barstadt (2004), has been applied successfully to several regions around the world (e.g., US, Norway, Iceland, Germany). Our extension, the stochastic approach, only requires precipitation totals to estimate background and frontal precipitation including calibration. We will add a comment about the potential transferability in the conclusion section.

References

Kunz, M.: Characterisitics of Large-Scale Orographic Precipitation in a Linear Perspective, *J. Hydrometeorol.,* **12**, 27–44, 2011.

Smith, R. B. and Barstad, I.: A Linear Theory of Orographic Precipitation, *J. Atmos. Sci.,* **61,** 1377–1391, 2004.