

Heavy Precipitation Events of Various Durations Across Germany: A Station-Based Assessment of Spatial and Temporal Variability Using the Block Maxima Method

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Contents

The study examines heavy precipitation events in Germany using spatially dense station-based high-resolution 5-minute rain-gauge data for durations from 5 minutes to 7 days. Results show that the variability of annual maximum precipitation strongly depends on event duration: short events are more evenly distributed and highly variable, while longer events are more influenced by topography and show more regional consistency. Positive trends are more common for events lasting 1 to 7 hours, whereas longer events (3 to 7 days) show mixed or slightly negative trends, though statistically significant trends are generally rare.

Recommendation

substantial revisions required

Justification

The topic of this paper is relevant as it analyses data that has not been available before which is potentially very interesting. In general I enjoyed reading the manuscript, it confirms and supports several things already found for surrounding regions. It is a pity that the interpretation of the very short durations is hampered by data problems. I am not sure if it is a good idea to show the trend results at all for these time granularities – you should motivate this a bit better, if you keep them. In addition, I think that the manuscript could be shortened in several places (esp. the introduction and see details below). I am also not sure if all multi-panel maps shown (Figs. 2, 4, 5, 8, 9 10) are necessary or some could probably be moved to an appendix or supplementary material file. The readability of some figures need to be improved (see details below). I think that the paper is suited for HESS after substantial improvements of the abstract, changes of several parts of the text and some improvements of the figures and their annotations. My comments below are intended to strengthen the paper.

Specific comments

Title. I would shorten the title by deleting “Using the Block Maxima Method”. This is a methodological detail not needed in my view.

Abstract. L16: Consider shortening to “~~Using the block maxima method, we confirmed that~~ The spatial and temporal variability of annual maximum precipitation totals (AMPTs) is strongly duration-dependent.” The usage of AMPTs is implying the method, or not? L21f: There is also no hint on the time periods used for the trend analyses. Please add, also esp. the end year.

1 Introduction. Is with almost 100 line too long in my view. Some details but could be easily shortened. It is not necessary to mention the project a paper was based on (L75). An important point is related to the super-CC scaling discussion (L79f). *Da Silva & Haerter (2025)* is mentioned a bit misleading here, because their main message is that “*the present data unambiguously show that there is no exceedence of the CC rate at the scale of individual convective cells. To the contrary, the CC rate is a robust predictor of the change in convective precipitation intensity with temperature. Super-CC changes with temperature are found only as a statistical superposition of distinct rainfall types*”. Also *Estermann et al. (2025)* doi:10.1029/2024JD040901 suggest that there is hardly any super-CC scaling. I would thus suggest to make more clear that super-CC-scaling is not necessarily a physical feature in some cases. I think it could also make sense to additionally consider mentioning the results by *Haslinger et al. (2025)* doi:10.1038/s41586-025-08647-2 as it studies a very similar topic in Austria.

2 Data and methods. Fig. 1: y-axis could be limited to 1000. Fig. 2: Readability should be improved. Maps should probably be bigger, legend in panels a)-c) is only needed once. Legend dot colours difficult to see. Test transparent of colours? L165f (LOESS smoother): probably add reference *Scherrer et al. (2024)* doi:10.1016/j.cliser.2023.100428.

3 Results. Fig. 3: Hard to read, especially combination of box plot and violin plot does visually not work (distribution not visible). Please improve. Also everywhere in text and figures: I suggest to change 60 Min to 1h, 180 Min to 3h, 420 Min to 7h, 720 Min to 12h, 1440 Min to 1d, 4320 Min to 3d. This would make things much more readable. Fig.5: Consider moving to Appendix or suppl. material. Units in Fig. 5 are wrong: [%] instead of [mm]. As for other maps, not all points are readable (transparency?, bigger maps). 3.2 Long-term variability and Fig. 6: The more than 50% of sign. positive trends for 5' values is really troubling. It is good that you made additional tests but I think there should be a bit more quantitative information about that or you should omit the trend analysis results for the very short time granulation in Fig. 6 and following. Additionally for Fig. 6: I see that there is no fixed period for the trends but you could at least give a statistic (min year, mean/median year, max year) or so to make things a bit more objective here Fig. 7: What is the min. number of years used to compute trends? Please mention. There is a strange behaviour in panel "420 min". Only 0, 50 or 100% is shown until 193X. Why is this the case? Please explain. Are there only 2 stations available? If yes, I would omit results based on less than X stations (e.g. X=10 or so). Legend: "Only stations with at least 90% data availability for AMPTs in the respective time periods are included." appears twice in legend. I would reduce the start year analysis to two periods (e.g. 1951-2020 and 1991-2020 or 1951-2020 and 1971-2020) to reduce the number of maps shown. 1991-2020 is very short for a trend analysis though. L314-315: How was this shown? Please give more details here. Legends of Fig. 8-10 are the same except for the period, shorten to "Same as Fig. X, but for period XXXX-YYYY". Fig. 11: some colours are hard to read or too dominant (station >1750 m), please ameliorate.

4 Conclusion. With ~60 lines too long for conclusions. It is also rather a discussion of the most important results (e.g. lines L395-406), so either rename to "Discussion and conclusions" or divide into a discussion chapter and add a conclusion of less than half a page.

References. Please check if all listed references are cited and if all citations are listed in the reference list. For example, I did not find an entry for *Papalexiou & Montanari (2019)* in the reference list. There might be more such cases.

Typos. L427: Scherer → Scherrer; L439: Scherer → Scherrer