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Interactive comment on "Data-driven distinction between convective, frontal and mixed extreme rainfall events in radar data" *by* Emma Dybro Thomassen et al.

Anonymous Referee #2

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Review of "Data-driven distinction between convective, frontal and mixed extreme rainfall events in radar data" by Emma Dybro Thomassen et al.

General comments

The manuscript "Data-driven distinction between convective, frontal and mixed extreme rainfall events in radar data" by Emma Dybro Thomassen et al. shows a thorough analysis of rainfall characteristics during extreme events in the Wupper River in Germany. The data and methodology are well exhibited and applied, and are very detailed. This is much needed, as the scientific literature lacks direct treatment of extreme events coming from both high-resolution data and long records. The combination of clustering

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analysis with PCA yields interesting results, which can be interpreted as the physical meaning of these statistical approaches, however, some physical understanding and a discussion of its implications are lacking from these analyses (as detailed later). Some general comments are detailed below, and more specific ones are in the other sections of this review.

I recon some minor revisions of this paper are needed before it can be published.

Abstract: To my perspective, the motivation of the study is missing from the abstract. It only appears seemingly as a part of the implications at the end of the abstract. Can you please add a short section in the abstract that describes the motivation or the knowledge gap that led you to perform this thorough analysis? The same holds for the introduction, in which there are some hints about why it is important to characterize extreme events, however to me this part seems lacking.

The discussion about sampling strategies, although interesting, is long, and if at the end of it only SS1 is chosen for the other analyses, I think it would be helpful to describe it more briefly. Similarly, sect. 4.1 can be easily moved to the methods, as the "result" is that SS1 is chosen.

Sect 4.3 can be much improved by showing some representative (or the largest) events. Namely, to my view, it will be better explained by showing one 15-min, one 1-h event and one 24-h event, and describing them shortly (convective / frontal activity, or possibly other kind of event). This could be supplemented by radar QPE maps for accumulated rainfall, or for the maximum precipitation rate of throughout the event. Doing so will also supplement the PC and clustering analyses as you could show where these events are situated with respect to the PC's, and thus in choosing such events you may also consider picking events from the different clusters.

Sect 4.4.1 is interesting, but to my view it lacks some physical inferences. Can you please try to elaborate on the physical meaning of PC1-PC3?

Finally, I am missing some discussion with regards to the motivation of this study, e.g., urban drainage response. Can you please add a small discussion relating the results of this study, especially the clustering part of it, to the motivation?

Specific comments

P2,L15 or L19: consider referring also to Marra and Morin (2015).

P2,L26-30: Please be more specific in your aims. For example, consider adding the study area name to the aims.

P3,L8: "The Bergisches Land is the first major barrier", where do you start counting? Consider adding e.g., "The Bergisches Land is the first major barrier downwind from the North Sea", or something similar. The ending of the sentence is also not clear to me – "Western side" of what? Please write it explicitly.

P4,L20: Please note that some studies typify extremes from spatial measurements based on a large enough amount of pixel passing a threshold (Armon et al., 2020), or based on spatial IDF curves (Rinat et al., 2020).

P5,L28: What do you mean by "independent"? Did you apply some statistical analysis of independence? If not, it is better to say "different", since those cells are probably dependent, at least on an hourly or 24-h timescale.

P9,L3: I am struggling to understand the difference between the fixed number of 39 events that was mentioned earlier, and the number of events cited in Table 2 and in the results section. Please clarify this, and elaborate on the number of events, their definition, and the difference between the 39 and >900 events you mention.

P10,L1: "It is believed" – This could be easily checked. Isn't it?

P10,L9-21: I have the feeling this statement is repeating things that was already mentioned earlier in the paper. It could possibly be better to move these parts together.

Sect 4.2.3: Other comparable results are found also in (Armon et al., 2020) and in

(Marra and Morin, 2018). Fig. 1: Could you please add mean annual precipitation contours to the map? They are described in the text but could be more easily be understood using graphics. To my opinion it would also be beneficial to add the Bergisches Land, the Wuppel River, and the city of Wuppertal to the map.

Fig 2: Consider changing the y-axis to “occurrence frequency”.

Technical corrections

P2,L1: “Inferences. . . two types of data” – These are not the only two types that can be used. Please either add “accurately” (since other products give less accurate data), or “e.g.”.

P2,L22: “A improved” should be “An improved”.

P2,L27: “A principal component analysis and clustering. . .”, should be “A principal component analysis and a clustering. . .”.

P3,L1, L2 and onward: consider changing “case area” to “study area”.

P5,L3: “extend” should be “extent”?

P7,L1: Please change “analysis” to “analyses”.

P12,L2: “Ten events is” – please correct to “are”.

Table 3: Please add units to the “Similar X” rows. E.g., “[of events]”.

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