

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

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Dear reviewer, we thank you for the very nice and thorough review of our manuscript. In the following we have done our best to reply to your comments and suggestions as point to point answers. The review is copied and all our comments start with an asterics to ease reading.

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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

C1

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.

\* Thank you, we will rewrite the abstract and introduction with a clearer motivation and aim of the study.

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.

\* We will try to be clearer in why this discussion is necessary yet still condense the relevant information. We suggest to put most information into a table for a quicker and shorter overview. We hope these changes makes it clearer why we would like to keep the 4.1 result section (also see later comment about discussion on urban drainage).

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.

\* Thank you for the suggestion. We will add a figure with a typical event from each of the four clusters. We anticipate to use a layout corresponding to figure 2 in Ochoa-Rodríguez et al., 2015.

Sect 4.4.1 is interesting, but to my view it lacks some physical inferences. Can you

C2

please try to elaborate on the physical meaning of PC1-PC3?

\* We will elaborate on the physical understanding of PC1-PC3 and also try to relate it to a new section on validation of the classification against ERA5.

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?

\* Yes, we will make sure the urban drainage aspect is properly discussed together with the results of the sampling methods and the clustering results.

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

\* Thank you for suggesting this reference, we will refer to it in L19.

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

\* We will make sure the aim is clearer when we revise the abstract and introduction. As the aim of the manuscript is not dependent on the study area, we will not include the name here.

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.

\* Thank you for your suggestion, we will add that and make sure to clarify the ending of the sentence.

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).

### C3

\* Thank you for the suggested articles. We will consider these articles as examples of spatial sampling strategies.

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.

\* Thank you, we will change the sentence to "Extreme events from five different grid cells".

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.

\* The +900 events is the pool of events (after applying a drizzle threshold and 24 dry weather separation) from which the 39 extreme events are sampled from. We will make sure this is stated clearly.

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

\* Thank you, this will be checked.

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.

\* We see your point, the discussion on sampling strategies are started in section 4.1 and continued in 4.2.1, resulting in an overlap. We will shorten the discussion in section 4.1 and refer to the discussion in 4.2.1, to avoid repeating statements

Sect 4.2.3: Other comparable results are found also in (Armon et al., 2020) and in (Marra and Morin, 2018).

\* Thank you for pointing us towards these articles. We will add them to the discussion,

### C4

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.

\* We will add mean annual precipitation contours to the map and try to make the background image clearer, so the reader is able to see the Wupper River and city of Wuppertal on the map.

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

\* We guess this applies to Fig 3, instead of Fig 2. We will change the y-axis to make it more understandable.

Technical corrections

\* Thank you for the 8 technical corrections, we will make sure to implement those.

References

Armon M, Marra F, Enzel Y, et al (2020) Radar-based characterisation of heavy precipitation in the eastern Mediterranean and its representation in a convection-permitting model. *Hydrol Earth Syst Sci* 24:1227–1249. <https://doi.org/10.5194/hess-24-1227-2020>

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Ochoa-Rodriguez S, Wang LP, Gires A, et al. (2015) Impact of spatial and temporal resolution of rainfall inputs on urban hydrodynamic modelling outputs: A multi-catchment investigation. *J Hydrol* 531:389–407. <https://doi.org/10.1016/j.jhydrol.2015.05.035>

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Marra F, Morin E (2018) Autocorrelation structure of convective rainfall in semiarid-arid climate derived from high-resolution X-Band radar estimates. *Atmos Res* 200:126–138. <https://doi.org/10.1016/j.atmosres.2017.09.020>

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