

Review of the manuscript titled “Data-driven distinction between convective, frontal and mixed extreme rainfall events in radar data” submitted to HESS

**Paper overview / general comments:**

This manuscript developed a method to categorise extreme storm events using high-resolution radar images in Germany. The selected extreme storm events were characterised with a total of 17 storm features; and the PCA (Principle Component Analysis) technique was used to reduce the dimensions to 5 – 9. Finally, the k-mean clustering algorithm was used to classify storm types according to the PCA outcome.

The overall organisation of the manuscript is not great. In particular, the link is weak between the proposed sampling strategies for characterising spatial dependence of extreme events and the storm type classification. The section 3.2 does not make much sense to me, and the proposed strategies are not convincing. Especially, a well-established geostatistically-based method to quantify the spatial dependence of storm events has been developed in Ochoa-Rodriguez et al. (2015) (see Section 3.2.1). I would encourage the authors to have a detailed look at the method mentioned above.

In addition, in section 4.2, the authors looked into both spatial variation and spatial correlation. The former was investigated according to the proposed sampling strategies, whilst the latter was performed using all radar pixels. In my opinion, these two are very similar characteristics. I am not convinced why they have to be done over different domains.

Moreover, a lot of efforts were made to explain the sampling strategies and spatial structure of storms, but it seems no ‘spatial’ features were included in the PCA analysis. This is really strange to me. I wonder if the authors can explain the reason excluding spatial features in the PCA analysis and consequently storm classification.

Finally, it is pity that the authors did not cross compare the results obtained from the proposed classification method and those from some widely-used methods (such as Steiner et al., 1995; Biggerstaff and Listemaa, 2000). I believe this would provide more insights about the quality of the proposed classification method.

From my point of view, the authors have to address the above issues before it can be published. Given that these issues may be difficult / time consuming to address, I suggest either very major corrections or that the manuscript be rejected in its current form.

**Minor comments:**

- Page 3, Lines 29: were the radar reflectivity data of all selected extreme events converted into rainfall rates using the Z-R relationship specified here? What is the Z-R relationship used for frontal (or stratiform) events?
- Page 4, Line 10: Could you please explain why 39 extreme events?
- Page 4, Line 24: What do you mean by ‘grid cells registering each event’?
- Page 7, Line 7: In terms of tracking algorithm, I would recommend to include Muñoz et al., 2018.

## References

Biggerstaff, M. I. and Listemaa, S. A., 2000: An improved scheme for convective/stratiform echo classification using radar reflectivity, *Am. Meteorol. Soc.* 39, 2129-2131.

Muñoz, C., et al., 2018: Enhanced object-based tracking algorithm for convective rain storms and cells, *Atmos. Res.*, 201, 144-158.

Ochoa-Rodriguez, S., 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.

Steiner, M., et al., 1995: Climatological characterization of three-dimensional storm structure from operational radar and rain gauge data, *J. Appl. Meteorol.* 34: 1978-2007.