

Review of: **Atmospheric conditions favouring extreme precipitation and flash floods in temperate regions of Europe** by Judith Meyer et al.

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Summary

I would like to thank the authors for their extensive responses to the received reviews and the considerable effort they have made to improve the manuscript. The manuscript has improved considerably, and I think the authors present a more balanced story that is well supported by their results now. Below, I have a few additional comments and suggestions, but these are rather minor.

General comments

Flash flood database (lines 171 – 179)

In the response to my earlier comment, the authors wrote: “Before the choice of using a database that was collected through various sources, we analysed discharge data in the region (entire Moselle catchment). Therefore, we collected data for time series as long as possible. Long time series are, however, mainly available for large rivers, such as the Moselle or other bigger stream gauges, but not for catchments, in which flash floods occur. Moreover, data is often only available on a daily resolution. We have conducted several analyses of specific discharge using 79 stations within the region with catchments < 300 km² and found it hard to extract flash floods or high floods from these data. High flows in the past (1980s) were often caused by zonal precipitation in the Vosges mountains. Some regional flash floods that were of major importance and that we know well (i.e. Ernzt Blanche 2016 & 2018), were to some extent detected by discharge data, but the overall time series are too short for any long-term analysis. Other events were so small and even outside streams, that they were not even captured by any stream gauge. We concluded that the inconsistencies in this type of streamflow-based dataset would be even bigger than the one presented in the manuscript. Apart from actual flash floods we have also made analyses about the number of scientific reports on the topic, which also started to increase around that time period (beginning 2000), when the topic received more attention. While a better database would be desirable, flash floods rely on site inspections.”

I think this information is actually very relevant for the reader. Can I ask the authors to put parts of their answer above in the text (either here or in the discussion section)?

Specific comments

Lines 146 – 147 “Unfortunately, the south-western part of the study area is not covered by the RADOLAN data”: Perhaps add a reference to Figure 1b here.

Lines 294 – 296 “Often, soil moisture within the upper and lower soil layer (Swvl10-7 cm, Swvl37-100 cm) is higher during flash flood events compared to general extreme P events (Figure 295 5k, m). The mid-level soil layer (Swvl27-28 cm) shows lower soil moisture before flash flood events (Figure 5l).”: These lines still lack some interpretation in my opinion, i.e. do you expect to see these differences between upper/lower and mid layers?

Lines 301 – 303 “Moreover, sufficient CAPE, high q and weak WS10m-500hPa were identified as the most clearly distinguishing parameters per category to characterize extreme precipitation events, including 75% of all extreme precipitation events and excluding around 75% of all generally occurring parameters values”: What about the K-index? No need to change the top three parameters in my opinion, but good to mention the strong signal in this parameter (as the authors already do in their conclusion).

Lines 416 – 417 “In recent years they have been increasingly observed, especially in summer (Detring et al., 2021; Lupo, 2020)”: You could also add a reference to the July 2021 floods here, for instance Kreienkamp et al. (2021).

Figure 5 and lines 291 – 293: I think I haven’t mentioned this in my previous review, but I can imagine that the difference between the P and FF classes and non-extreme rainfall events might even be larger than the current comparison with “all” classes, as this also included many no-rain time steps (which may also have relatively low wind speeds and shear levels). It is just an idea, but perhaps worth the try if it makes the conclusions stronger.

Technical corrections

Line 35 “.Flash flood”: Seems like you have forgotten a space between the dot and “flash”.

Line 371 “Moselle catchment”: for the non-European readers, perhaps briefly mention the location of this catchment.

Line 406 “US American studies”: Just American studies would suffice.

Conclusion section: it may help readers that quickly scan through the paper, to write out the abbreviations once again in the conclusions.

Figure 1: The caption still only contains subfigures (a) – (c), while there are four subpanels now.

Figure 2: Very useful addition to the text!

References

Kreienkamp, F., Philip, S. Y., Tradowsky, J. S., Kew, S. F., Lorenz, P., Arrighi, J., Belleflamme, A., Bettmann, T., Caluwaerts, S., Chan, S. C., Ciavarella, A., De Cruz, L., de Vries, H., Demuth, N., Ferrone, A., Fischer, r. M., Fowler, H. J., Goergen, K., Heinrich, D., Henrichs, Y., Lenderink, G., Kaspar, F., Nilson, E., Otto, F. E. L., Ragone, F., Seneviratne, S. I., Singh, R. K., Skålevåg, A., Termonia, P., Thalheimer, L., van Aalst, M., Van den Bergh, J., Van de Vyver, H., Vannitsem, S., vanOldenborgh, G. J., Van Schaeybroeck, B., Vautard, R., Vonk, D. and Wanders, N. (2021) Rapid attribution of heavy rainfall events leading to the severe flooding in Western Europe during July 2021. WorldWeather Attribution. URL: <http://hdl.handle.net/1854/LU-8732135>.