Author reply to RC2 (nhess-2022-96)

Major Comment

In my opinion, the most interesting parts of the paper are contained in Sections 3.2 (Lagrangian Moisture source analysis), 3.6.1 (Conditional event attribution) and 3.6.2 (Role of Aerosols). Therefore, I would give more space to these parts, that, in the present version of the paper. Therefore, I would give more space to these parts, that, in the present version of the paper, have a marginal role. Contrarily, I would shorten the other Sections, which basically contain a description of the event. For example, I would include Section 3.3 (Observed lightning activity and accumulated precipitation) and 3.5 (Probability of exceedance and severity) in a new Section 3.1, which would contain the complete description of the event, from the synoptic scale to the impacts at the local scale. This, in my opinion, would improve the readability of the paper. The analyses that go beyond the simple description of the event may be included in subsequent Subsections (or in a new Section 4).

We thank the reviewer for the valuable comments and suggestions to improve the manuscript. We acknowledge that the previous version of the manuscript needed more coherence and that some parts were too large. This was also pointed out in the second revision.

We have followed the reviewer's advice and the most relevant results have been given a separate subsection (within the results section). Moreover, former Section 2, has been split into two ("2. Data" and "3. Methods") ,and Sections 3, "Meteorological situation", 3.3 "Observed lightning and accumulated precipitation", 3.4 "Impacts during the 29 June 2017 case", and 3.5.2 "Severity" have been merged into one ("4.2 Case analysis and climate context"). Section 3.5.1 "Probability of exceedance" has been given a subsection within the results, as we believe the discussion presented here will also be of high interest to potential readers-

We expect these structural changes to have improved the readability and presentation of our results, as pointed out by the reviewer.

Minor and technical comments

Line 113: lightNings

Corrected.

Line 178: is the resolution of ERA5 25 x 25 km2 or 31 x 31 km2, as stated at line 150?

The resolution is 31 km. This has been corrected in the text.

Line 230: corresponding approximately TO the peak…

Corrected.

Line 480: I do not understand why the 29 June 2017 event is the 29th most severe event in the 1951-2021 period.

We agree that the writing of this sentence is misleading. The information we wanted to deliver here is that, the 29 June 2017 event showed the 29th highest PSI value.

The PSI is an index that assigns values typically between zero and 2, depending on how severe a record of daily precipitation was. The severity is calculated according to three magnitudes, a) grid-point daily precipitation intensity, b) extent of surface affected by precipitation larger than the percentile-80 of the climatology and 3) the persistence of precipitation over the same grid point.

In this sense, after obtaining a value of the PSI for every day in the period 1951-2021, the 29 June 2017 HPE, had showed the 29^{th} highest value compared to the all other days in the 70 -year climatology.

We have adapted this sentence. Now it reads:

"The unusual precipitation totals made the 29 June 2017 HPE one of the most extreme event in the climatology of the greater Berlin area. Based on the PSI method (Sect.3.1; Caldas-Alvarez et al., 2021; Piper et al., 2016), the 29 June 2017 event around Berlin was the 29th most severe event in the 1951-2021 period (Fig. 6). This event showed a PSI value (1.71), well above the 99th-percentile of the climatology indicating an extreme event. The PSI quantifies the severity of an event considering grid-point precipitation intensity, surface of affected area and persistence.

Line 486: The Ahr flooding in July-2021 (number 7 in Fig. 11). Should be number 9?

Corrected.

Line 488: due to the lack OF observations

Corrected.

Line 563: Rasmund II induced… Rasmund II or Rasmund?

It was Rasmund II.

The upper-level large-scale trough favoured a generalized cyclonic circulation over western Europe. However, it was Rasmund II, a surface low of relatively small-scale, the disturbance that deepened the penetration of warm and moist air from the south (Slovenia, northern Italy) up to the Berlin area. This is can be seen in Fig. 3 of the manuscript where the higher values of $\theta_e$occurred in the warm sector of Rasmund II.

Because Rasmund originated earlier (British Isles), it was given the principal name and Rasmund II (Central Europe) was given the ordinal suffix (II) as it originated several hours later.

We have added labels in Fig.3 to enhance the readability and comprehension of these results in the manuscript.

Line 565: triggered several thousand convective cells... is "several thousand" correct?

We corrected this to "over 11.000 convective cells, to be more precise

Line 568: Lightning activity was especially active…repetition

Corrected

Figure 2: what do the vertical lines in panel b represent?

The vertical lines in figure 2b indicate the standard error (SE) of the computed SEDI, with $SE = \sigma/\sqrt{n}$

Figure 12: Is this Figure referring only to the area surrounding Berlin, as written in the caption? If yes, what area? Panel b of Figure 1?

Yes, it is a squared area of 350 km x 350 km, covering the Berlin metropolitan area, reaching the polish border as shown in the following figure.

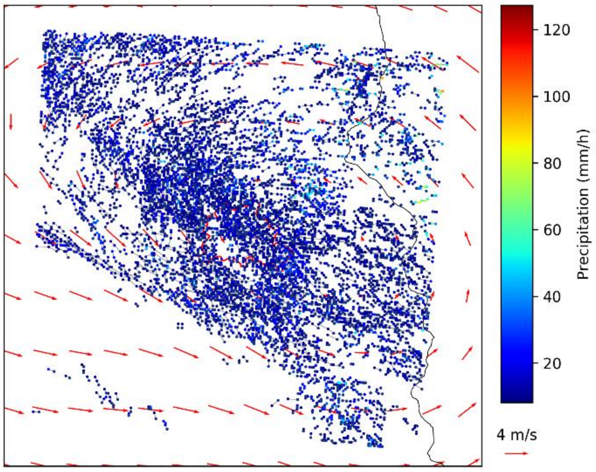

Figure 1. Isolated convective cells identified through the cell tracking algorithm over the Berlin metropolitan area. A surface of 350 km x 350 km is selected for identifying the cells

We have adapted the caption of Fig. 12 to better describe the extent of this area.

Moreover, can you give more information on how data are divided into the two groups?

The objective weather type classification of Bisolli and Dittmann (2001) has been derived for the focus region by centering the analysis domain over Berlin (the overall analysis region is much bigger covering huge parts of Central Europe). Input data have been ERA5 data for 12 UTC (except for the humidity classification with daily data). We used the same levels and the same reference period as described in Bisolli and Dittmann (2001). So, we end up with one weather type for each day in the period 2001 to 2020 (the period of the radar data). In the plot we distinguish days which belong to the weather type ‘no prevailing wind direction, cyclonic circulation in 950 and 500 hPa and above-average humidity content of the troposphere - XXCCW and days belonging to another weather type (the exact type is known but not plotted here).

References

Bissolli, P. and Dittmann, E.: The objective weather type classification of the German Weather Service and its possibilities of application to environmental and meteorological investigations, Meteorol. Z., pp. 253–260, https://doi.org/10.1127/0941-2948/2001/0010-0253, 200