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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "An analysis on temporal scaling behavior of extreme rainfall of Germany based on radar precipitation QPE data" *by* Judith Marie Pöschmann et al.

Anonymous Referee #1

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Introduction ————

Extreme rain events may cause severe damage and fatalities and they are of principle interest as they mark the physical limits. This manuscript describes the depth-duration relationship as observed in Germany by the DWD radars (RADOLAN product YW, adjusted by rain gauges) for the period from 2001 to 2016. Although neither the principle method nor the data are new, the application of this method to these data is. The manuscript offers a new sight to Germanys operational radar data and thus has a chance to be published. Nevertheless, it suffers from several drawbacks and misteks making it partly difficult to read and it contains several minor errors that should be

removed before publishing.

Major issues ————

Radar observations cover the complete area of Germany. This advantage is discussed in the paper. Rain gauges may miss the most intense events. Nevertheless, the data quality of radar measurements is spatially variable, depending on the orography and distance from the next radar. Furthermore, radar provides precipitation measurements at a different scale (here 5 min./1 kmˆ2) than rain gauges (commonly 1 min./200 cmˆ2 in Germany). The paper lacks a discussion on data quality. Especially the shorter extremes might be impacted by ground clutter (in case of 5 min. extremes even from wind turbines or airplanes). With increasing distance the area of each range bin increases, reducing the frequency of extreme values. For a self-contained publication the authors have to describe and discuss these effects. How do they impact the results? Is the spatial distribution of extreme rainfall caused by the precipitation process or by the method of observation?

It should be noted that the radar measurement consist of only one sweep at the lowest undisturbed elevation angle. Scan pattern were variable during the years. (So called precipitation scan.)

Additionally, the authors need to add a short description on the data processing from the measurement to offline quality control and the adjustment with RADOLAN.

Figure 3 shows the "total within-clusters sum of squares". This term is not defined in the paper. Please, describe the procedure to determine the shown curve so it can be comprehended and interpreted.

The authors explain (line 151f) "Between 25 min and 16 h, maximum values are calculated for the southeastern edge of Hesse state in May 29th 2016." This is not reproducible. From Figure 4 we can see, the 25 min extreme is already significantly above 100 mm. In the area between 8.96° and 9.37° east and 50.15° and 50.32° north (this

area should cover the location the maximum) rain amunt is below 32 mm. Maximum precipitation on that day is 123.67 mm at 50.54° N, 12.61° E in Ore mountains, Saxony. This maximum is followed by 122.98 mm at 49.22° N, 9.83° E, close to Braunsbach, Baden-Württemberg. That rain event caused estimated 100 million Euro damage and three fatalities, as newspapers reported a few days later. - I did not control the further maxima.

A table is missing, indicating duration, start time, rain amount, and location for each of the blue dots in Figure 4. Without these data no reproduction of the findings is possible.

The value of Figure 6 and its interpretation is not clear for me. What elevates the 3921st greatest event (shown) above the 3920th (not shown)? What is meant by "The lower the quantile, the sparser the location of the quantile rainfall occurence"? What is a sparse location? The location of the dots is totally random, as it is random if an event is the 3920th or 3921st.

I do not get the message, the authors want to transport here. If the focus is on the spatial distribution of extreme events, then show it for some durations (the locations of the strongest 10 (red), 100 (yellow), and 1000 (green) events for a duration of x minutes). If the focus is on the low impact of an individual event, then show the frequency distribution of rain amounts for a certain duration, focusing on the most intense 10000 events or so.

Figure 7 is hard to see, especially in a printed version. Figure 7 is in contradiction to section 3.1. The absolute maximum for 6 hours (Fig. 7d) occurs in the area between Ilmenau and Erfurt, roughly. The 1 hour maximum (Fig. 7c) is in the area of southeast Hesse.

Figure 8: I do not see that Wiesbaden is less fitting to a power law than Stuttgart. The authors do not provide a quantitative or at least objective way to describe the deviation from the power law.

I'm not convinced by the result of the clustering algorithm as shown in Figure 9. I cannot identify clearly distinct properties between the 6 categories. The authors have the same problem and propose to combine the categories into three new categories. The verbal description of the categories remains vague. Probably it was more helpful to state the properties and group the relations/pixels according to predefined criteria. (Cat 1: All relations with more then 40 mm @ 1 hour. Cat 2: less than 40 mm @ 1 hour but more than 100 mm @ 1 day ...) Without a clear description of the categories, Figure 9 lacks a message.

Minor ——

Please be more precise in your wording. A "sample" can be a subset of radar pixels, i.e. only locally restricted. It might also be a temporal subset. A "cell" and a "pixel" refer, as far as I got it, to the same thing: An area of 1 kmˆ2 for which the RADOLAN product provides one rain intensity every 5 minutes. If this is right, please omit one of the two terms. Otherwise define a "cell". You are not talking of storm cells.

There are several issues with the figures: - The y-axis is never precipitation intensity but precipitation sum or precip depth and the unit is mm, not mm/Duration. - Figure 1 does not show the fit for the Spanish measurements and not the individual measurements for the Eastern German measurements. The caption denotes "regional extremes for Germany", the legend "Eastern Germany". Shall this be the same? - Scaling of the x-axes is difficult. In Figure 1 the structure seems to be clear (minutes, hours, days...) but minor tags are missing (they occur as small gaps in the horizontal grid). In Figure 4 the minor tags are too bright to be seen on a printout. In Figure 5 some minor tags have vanished. Could this be unified in a clear visible way?

Line 60f: Lower values of maximum rainfall values on a coarse grid of 400 kmˆ2 gird cells is no underestimation but a known impact of averaging, as Brena-naranjo et al. already mentioned. Whereas "underestimation" indicates a deficit of the measurement or procedure the reduction is physically reasonable.

Line 104: How do you calculate the "imputation bridge"? Radar data are missing so how do you get a rain intensity for these periods?

The description of the methodology is inconsistent and unnecessarily hard to read. E.g. tau is a duration (see line 115), so it might be given in minutes. np is a number, counting the observations at each location. np thus is unitless. What is np-tau+1 (line 124)? What is min? What is h? (line 117). How did you get results for 3-day-extremes when your analyses is limited to 3 hours (line 116)? Line 130 and following do not indicate how you determine B and b. Equation 7 does not fit to equation 6 (somehow tau is lost). Equation 6 might be meant as log(M)=B+b*log(tau), as the figures show log-log axes. Equation 7 then is M=10^B*tau^b in compliance with Eqn. 1. Besides the mathematical errors there should be more text. E.g.: M^(tau)_max,cell (Eqn. 4) are the individual duration-depth relationships for each pixel. This needs to be mentioned.

Figure 4: The publication of WMO, 1994 indicates the value for 3 days should be at 3130 mm (not roughly 4000 mm) and the points at 30 min./200 mm and 3 h/>700 mm are not given there (Table II.5.6). The study of DWD, 2002, cites "Ertel and Schmidt, 1999", as source for their records (without giving a findable reference). DWD 2016 is not accessible. The caption cites a Spanish study but the figure does not show the data.

Figure 7: There are inconsistent color scales, showing 150 mm twice in (c) and (d). The unit should always be mm.

Figure 8, section 3.4: How did you choose the pixels for the cities? All of them are larger than 1 km^2. Please consider to draw all 15 lines of Figure 8 into one pair of axes (different colors, different line style), making it possible to compare the curves.

Line 193: Did you only cluster the 15 depth-duration relations from Figure 8 or from all pixels?

Technical ———

Line 3 and 65: 1 km^2 (it's an area, not a distance)

Line 7: A smooth scaling behavior was (not were).

Line 20/22: If probable maximum precipitation is abbreviated by PMP you should introduce this abbreviation: Probable maximum precipitation (PMP)...

Line 35ff: Bad deal with units! (1) is a numerical value equation, thus you need to indicate units of all variables.

Line 37: In (1) duration is d not D.

Line 37: Are the values 425 and 0.47 found by Jennings (1950)? If so how did that curve change during the last 70 years? Shouldn't it be "alpha and beta had the values", as climate change might have changed these values?

Line 77: DWD is running (not has been running) a radar network. They still do.

Line 85: There is no need to mention RW product. There are more RADOLAN products but RW and YW.

Line 114: What is a radar cell? If a pixel is meant, call it a pixel. Are you aware of the difference of a pixel (beam volume element) within the basis data (sphere coordinates, growing size with distance) and a RADOLAN grid element?

Line 135: Please, add "Eqn. (4)" to the first sentence.

Line 143: There is no blue solid line in Figure 4. There is no red dotted line in Figure 4.

Line 146: As well as for one (not some) sub-daily values. Only for 1 h radar has a higher value than rain gauges.

Figure 5: Please consider to add the curves of this figure into Figure 4 and to remove the inlay with the map of Germany into a new figure.

Line 169: Which curve? There is no reference.

Line 185: Stuttgart, not Stuttugart

Line 193: depth-duration (not dept-duration)

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