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Hydrology and Earth System Sciences Discussions

Interactive comment on "Aspects of seasonality and flood generating circulation patterns in a mountainous catchment in south-eastern Germany" *by* T. Petrow et al.

T. Petrow et al.

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We would like to thank you for your helpful and detailed suggestions and criticism how to improve the manuscript. Please find our response and how we tackled the criticism to all suggestions below. Your remarks are marked with "-", our response can be found directly below the remark.

Specific comments - In my opinion the title is not adequate as "Großwetterlagen" only play a minor role in the paper as provided.

The other reviewer and the editor also agreed with the title, which is why we didn't change it. We think that the analysis of the circulation patterns is an important part of the paper and should be reflected in the title.

- The abstract does not contain sufficient information. One or two introductory sentences as well as some more concrete conclusions should be provided.

We have revised the Abstract. We included more information about the Vb-weather pattern and more concrete conclusions.

- Some parts of the introduction should be moved from to the methods section (e.g. details on AMS, POT, distribution functions; p.590, l.24 to p.591, l.28).

We shortened the paragraph about the flood frequency analysis in the Introduction. However, we didn't move the entire paragraph to the methods section because we think that the Introduction Section is the right place to introduce the approach and to be more concrete in the Methodology Section.

- The catchment description is very detailed; a lot of information is provided which is not used for further analyses. I am not sure whether all information provided is really required. On the other hand information on soils and geology is not provided which is stated to be not important later on without performing further analyses?!

We agree in that point. We shortened the description about the study area and remove, where possible, sentences that do not directly provide information that is further used. More detailed information about the landscape analysis and the integrated information were written in the new Section 4.4 (Results - Landscape characteristics). There, you find more detailed information about what we included in the analysis (type of soil with information on soil depth, texture, conductivity, etc.), bedrock, groundwater flow and land-use).

- Most parts of the results section of the paper just describes figures but does not provide further interpretation of the results to develop a synthetic message and to draw some profound conclusions. This section needs to be rewritten. A continuous thread and a sound argumentation are required. Some interpretation of results should already be provided in this section as there is no additional discussion section.

HESSD
4, S467–S478, 2007

We revised the entire section and included more discussion and interpretations. Moreover, we included a new Section about the results of the landscape analysis to better show how we derived our findings.

- Not all statements in the conclusions' section are proven by the analyses performed in the study presented (precipitation may be the dominant influence on runoff generation, but it has not been proven by this paper that it is; not all other landscape characteristics have been analysed in detail!). Some conclusions are not consistent (supplementation of the FFA by analysing landscape characteristics while it was stated earlier that most of the landscape characteristics have no major influence on spatial patterns of flood statistics). Please check the conclusions sections carefully, and draw more substantial conclusions (Conclusions are not a summary!)!

We totally revised the second part of the Conclusions and integrated more concrete conclusions.

- Please, mention the date of access of cited www-addresses

We included the actual date of access.

Technical comments

- p. 590, l. 6,7: "from west to east" within the catchment of investigation?

Yes. We included it in the sentence.

- p. 590, l. 14-16: Why is it necessary the traditional flood frequency analysis? In which way? Please be somewhat more concrete in the abstract!

As mentioned above, we revised the abstract and included more concrete findings.

- p. 590, l. 22/23: "the focus is set on" instead of "will be".

We changed that.

- p. 591, l. 6: add "or" before the last element of the listing.

HESSD
4, S467–S478, 2007

We changed that.

- p. 591, l. 7: estimated “by”.

We changed that.

- p. 591, l. 10-13: Please split the sentence into two sentences.

For better readability we split the sentence into two..

- p. 591, l. 21: Jain and Lall, 2000 or 2001?

We corrected the reference to 2000.

- p. 591, l. 22-24: Independence is not always given when analysing annual maximum series (e.g. events on 31.10. / 1.11.); definition of criteria to avoid this dependence of events is necessary.

We included a short explanation of how to handle the problem. Usually, a threshold of up to 30 days is included in the routine. The threshold value is dependent on the catchment characteristics.

- p. 593, l. 20: The catchment is split into how many zones? Which soil and geology related properties are used to define the zones? Is the presence of groundwater reservoirs the only criterion? (that’s what the manuscript tells me) What about soil texture, soil depth, etc.?

The catchment is split into 3 zones, which are now also marked in the Figure 1. These correspond to the three large sub-catchments. As mentioned above, detailed information, which landscape components were analyzed, were included in the article. As you will read, there are more components that groundwater reservoirs important for our analysis.

- p. 594, l. 13: Both winter floods? They were not mention before. Two winter floods?

We deleted the word “both”. We didn’t mean two winter floods, but wanted to emphasis

HESSD

4, S467–S478, 2007

that winter floods as well as summer floods can cause damages in the catchment.

- p. 594, l. 14: How do you define high damages? Please be more specific!

Floods with high damages are those with damages or losses on private and/or public property, on infrastructure and agriculture, often in combination with fatalities.

- p. 594, l. 22: “Ulbrich et al., 2003” instead of “Ulbrich, 2003”?

This reference was removed. For your information it is Ulbrich et al., 2003.

- p. 594, l. 23: “11.6 Billion EUR” instead of “11600 Million EUR”.

We changed that.

- p. 596, l. 4-7: Please use a structured list instead of the numbering in the text.

We changed that.

- p. 596, l. 17: Using a cubic interpolation scheme does not consider topographic effects in the rainfall interpolation. Are they not relevant?

Yes, they are relevant. However, we only calculated the areal precipitation to illustrate the distribution of the three extreme events. There is no further calculation with these data. Moreover, as you can see in Fig.2 (old Fig. 3) there exist many precipitation stations in and around the catchment. Information about the topography were already included in the measured data, since the stations are at different elevations. Therefore, we used a rather simple approach with the cubic interpolation.

- p. 597, l. 5-8: Which one of the 30 Großwetterlagen in Tab. 2 represents Vb?

The TM and TRM circulation patterns are representing the Vb-weather system.

- p. 597, l. 19: MQH = mean maximum annual flood discharge?

We changed the abbreviation into MAF.

- p. 598, l. 1: please add an “and” before the last element of the listing.

HESSD

4, S467–S478, 2007

We added it.

- p. 598, l. 4/5: Which hypothesis is tested by applying the Kolmogorov-Smirnov-Test?

We included the test hypothesis in brackets in the text.

- p. 599, l. 5-10: The results of such a statistical analysis could / should be proven by the application of a process based catchment model?! From such a model application one could learn a lot about flood generation mechanisms.

We agree with you. Unfortunately, we didn't have a process based catchments model, which we could run for the catchment.

- p. 599, l. 15: skip "manually"

OK

- p. 599, l. 15-17: Why do you analyse only data of one stream gauge? Is this gauge representative? Performing the analysis for several gauges would exclude the effects of measurement errors! (e.g. gauges Bad Düben, Erlin, and Wechselburg)

As the first gauge at the Vereinigte Mulde it represents the influence of the large sub-catchments Zwickauer Mulde and Freiberger Mulde (with the Zschopau). Moreover, it comprises 88% of the catchment area. The gauge in Golzern has a long time series (1911 - 2002) compared to nearby gauges such as Bad Düben or Erlln (both 43 years). Therefore, we only present results of this gauge.

- p. 599, l. 1/2: Repetition, was already mentioned before.

We merged to two first sentences into one.

- p. 600, l. 18: Skip the names of the 4 gauges, they were already mention figure 5. For what reasons these 4 gauges were selected out of the 15?

We deleted the first three sentences of this paragraph including Fig. 5 because of the redundant information with Fig. 6 (now Fig. 4 and Table 3).

HESSD
4, S467–S478, 2007

- p. 600, l. 22/23: Are the results representative for all gauges? Do the other gauges show the same systematics?

Yes, these results are representative for all gauges in the catchment. We updated the information in brackets about the percentages of the 20% largest events and now show the numbers / the range for all gauges.

- p. 600, l. 23/24: Figure 6 is mentioned, but there is no description of the results which are shown by that figure, and there is also no interpretation at all. - p. 600, l. 25/26: Final interpretation of this section is trivial.

We added a description of Fig. 6 (now Fig. 4) as well as an interpretation of the results shown in this chapter.

- p. 601, l. 2/3: Repetition, was already mentioned before.

We deleted the sentence.

- p. 601, l. 5: “In the beginning the assumption was made that ˇ E” instead of “the assumption could be made”?

We changed the word.

- p. 601, l. 8-13: Results presented in Figure 7 are described. Is an interpretation of the impact of rainfall or catchment characteristics on these statistical characteristics possible?

We think that this part is only a component in our analysis. Alone, it is too weak to conclude from this that rainfall is the main influencing factor. But it is part of the sum from which we draw this conclusion.

- p. 601, l. 16-19: The events affecting all subcatchments - are they summer events or winter events?

There are 9 summer events and 4 winter events.

HESSD

4, S467–S478, 2007

- p. 601, l. 21/22: How the 6 events analysed in Figure 9 were selected? The highest peaks in the time series? Or 6 of the 11 events affecting all subcatchments? Which criteria? - p. 601, l. 23-28: How this threshold of ten year peaks is determined? Arbitrarily? - p. 601, l. 25-28: Concerning Fig 9: Is there a real difference between 1938 and 1958? For both events, there is a factor 5 between the lowest and the highest return period?!

(Now Fig.5) We included the three largest flood events as well as three small flood events for comparison, which all generated catchment-wide the highest discharge of the respective year. Moreover, we included the standard deviations of the events to highlight the shift from relatively homogeneous small events to heterogeneous large events. Additionally, we checked and found that the findings also hold for the events not shown in the figure. This threshold of 10 years was determined based on the statistical calculations. We found that that the standard deviations of the return periods for the events abruptly change for events larger than 10 years. We see a difference between the flood events in 1938 and 1958. You are right that the factor of 5 is the same for both events. However, during the flood in 1958, there were regions with estimated return periods of 38 years which caused high damages. For the flood in 1938 this is not the case, where the largest return period was estimated to be 5 years. Moreover the range of return periods in 1958 is much higher which also highlights the heterogeneity.

- p. 602, l. 10-12: The correlation between precipitation fields and flood return periods could be expected.

Yes. This is what we wanted to show.

- p. 602, l. 14/15: If there is no influence of catchment characteristics on statistical flood characteristics - what is the reason for the flood? Why is precipitation distributed unequally? May be the reason of missing correlation also lies in the interpolation of precipitation; id topography would have been considered, it could be expected that topography would be correlated with precipitation and therefore with flood generation.

HESSD

4, S467–S478, 2007

(What about soils and geology? Has that been investigated?)

In our findings, the spatial and temporal distribution of the precipitation fields is the most influencing factor for the discharge in the Mulde. Precipitation is always unequally distributed in an area of 6000 km^2 during large events. As you can see in Fig.2 (old Fig. 3) there exist many precipitation stations in and around the catchment. Information about the topography are already inherent in the measured data, since the stations are at different elevations. We also used other simple approaches and found the same distribution, which can also be found in the literature about the flood events. Therefore, we have seen no reason for our purpose to use a more sophisticated methodology to derive areal precipitation.

- p. 602, l. 24-28: Is snow the only reason? What about antecedent soil moisture, frozen soils, etc.?

We don't think that frozen soils play such an important role in the catchment and therefore didn't mention it.

- p. 603, l. 7-9: Please relate this analysis to Table 2!

We added information about the respective circulation patterns to the percentages.

- p. 603, l. 11-13: Please indicate the presence of the Großwetterlagen in the Mulde catchment in Table 2!

We marked all circulation patterns with a * in Table 2, which are relevant for AMS discharges in the Mulde catchment.

- p. 604, l. 3: Why "although"?

We modified the sentence to improve the message.

- p. 605, l. 1/2: This statement has not been proven by the analyses performed in this study (although it is probable). The contributing factors could be analysed by modelling exercises.

HESSD

4, S467–S478, 2007

As already mentioned, we revised the article in that way that the analysis of the landscape characteristics is more detailed. Unfortunately, we didn't have a process based model available with which such an analysis is certainly very useful.

- p. 605, l. 10-12: Why should the FFA be supplemented by the analysis of landscape characteristics if they show only minor influence? Precipitation seems to be the only influencing factor?

We revised the entire second part of the conclusions.

- p. 606, l. 29-31: Jain and Lull, 2000 or 2001?

2000

- p. 609, Table 1: What is "Mean flood discharge"? Mean annual maximum? If not, which threshold is chosen and how defined?

Mean maximum annual discharge

- p. 610, Table 2: Please add information on the probability of occurrence in the Mulde catchment.

We have information in the article about the mean percentage of occurrence of the most important circulation patterns (westerly wind, Vb and high pressure systems). Moreover we indicated with a * in Table 2 these patterns which are relevant for AMS discharges. We hope this information is sufficient.

- p. 611, Table 3: Why do you present absolute values? Relative values could be easily compared between the gauge stations.

We changed the values into relative ones.

- p. 612, Table 4: Why these 4 stations were selected (see comments in the text)?

These stations were exemplarily selected because Wechselburg, Lichtenwalde and Nossen are more or less all on the same degree of latitude, but in different sub-

HESSD

4, S467–S478, 2007

catchments. Golzern is on the Vereinigte Mulde.

- p. 614, Figure 2: For which analysis has the land use map been used? Skip the figure.

The old Figure 2 was removed from the article.

- p. 616, Figure 4: Please remove grey colour from the figure background; please mention the equation of the regression line.

We removed the grey background color and added the regression equation.

- p. 618, Figure 6: For which reason the 20% threshold was determined?

(Now Fig. 4) The reason was that a large number of processes have a distribution of 20/80% as it is also described in the Pareto distribution. For flood events this distribution is also common with respect to damages as a small number of extreme events causes most damages whereas the large number of small events cause only a small part of the damages. Moreover, the 20% threshold also provided a good split-up of the data in order to have enough data in both groups for the comparison.

- p. 619, Figure 7: Please use gradients in colour and size of the symbols to better distinguish the gauges.

We changed the symbols in the figure.

- p. 620, Figure 8: What can we learn from this figure? No interpretation is included in the text. Skip the figure.

The figure was removed from the article.

- p. 622, Figure 10: Symbols in the upper 3 pictures are difficult to distinguish; lower 3 pictures are distorted.

(Now Fig. 6) We changed the symbols in the upper part of the figure. The lower three pictures are distorted because of a different geographical projection in another

HESSD
4, S467–S478, 2007

software program, which couldn't be transformed easily. We hope this is ok because the main information is not influenced by this distortion.

- p. 623, Figure 11: Please use different symbols and colours to better distinguish between the Großwetterlagen.

We changed the symbols in the figure.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 589, 2007.