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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Flood history of the Bavarian Alpine Foreland since the late Middle Ages in the context of internal and external climate forcing factors" *by* O. Böhm et al.

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Overall comment: This is interesting paper addressing a pertinent question, how have floods changed over a long timeframe. The application of the Alps Foreland to this study is appropriate and provides considerable insight into the challenges faced when using 'long' river flow series augmented by historical records, this represents a challenge though in the many and diverse factors that have influenced changes in the 'natural' flow to the river, though these are discussed. The paper provides a clear explanation of the value of long records, the importance of their consideration and the fact that few studies have identified trends in many of these long flood series and at-

tempts C2311 to link these to the generating mechanisms. The identification of the flood rich phases needs to be more clearly stated and explained (section 4), with more justification as to why methods are employed. The discussion would benefit from being expanded further to include a short section on how these results relate to those from previous studies, are similar or different flood rich periods being identified, this would provide a greater interest to readers from other regions beyond the Alps – a similar point can be made to the introduction, which could be made of wider appeal by including regions outside Central Europe.

Answer: The summarized main queries in the introduction of the referees comment will be answered on corresponding positions, see below.

The reference list included within this paper is good. An annotated copy of the manuscript is supplied containing a list of suggested amendments that the authors may wish to consider. These contain suggested re-phasing and minor queries.

Key points requiring attention:

p.4, l.12-16, you need to explain very careful what you mean by multiple river records being merged, as a single event can manifest in different ways on, between or along a river system, with the same event resulting in different magnitude floods at different places.

Answer: The aim of the current paper is a superordinate spatial unite based on recent administrative borders under consideration of climatic parameters. Only the flood events of the middle reaches and tail waters have been consulted. For example flash-floods due to convective events have not been considered.

Changes: . . . have been merged for one overall time series. The merging of the single time series should reveal the flood-vulnerability of a superordinate spatial unite based on recent administrative borders under consideration of climatic parameters. Single flood events as well as quantifications of flood events do not stand in the limelight of the current paper. The timeline of the flood history . . .

p.5, l.4, you need to be more specific about what you mean, ‘anthropogenic encroachments’.

Changes: . . .the riverbeds have deepened themselves. About 1850 Bavarian Administration started systematically riverbed corrections in order to prevent floods and protect infrastructure like railways and roads and to support agriculture in to the fertile plains and meadows due to growing population. In Fig. 2a one can see due to the results of gauge measurements the beginning of the anthropogenic encroachments, in the current figure starting around 1860. Gauges neutral points have not been changed, staff gauges have been prolonged into the negative measurement range. These circumstances affect hydrological interpretations concerning the EIP. . .

p.9, l. 20-, you need to explain why you have used the polynomial function rather than another function, a reference to past example would be easy solution, or a couple of lines of justification.

Changes: . . .as well as possible. The inhomogeneity of the number of cases could best be confronted by using a polynomial function. This method guaranties that all data despite different data density are considered. The fixing of the threshold based on a polynomial function of the fifth degree coincides with the fracture points of the t-test analyses (cf. Fig. 4), so the justification is confirmed by statistical measure. Different methodical approaches with the aid of quantiles as medians or percentiles couldn’t achieve satisfactory definitions for the generated time series and its comparability.

Fig.3 starts with a very low polynomial score which shows the early phase as flood rich (similarly the end as poor), but this line is being forced to fit through the data and may need careful consideration at the ends.

Answer: Regarding only the floods per annum (cf. grey columns) depicts accumulation of flood events. This period is provided by qualitative conclusions in different papers as

well. References on the climatic circumstances are given e.g.by Wanner et al. 2000, Lamb 1982. But due to bidden brevity the circumstances have been shortened and concentrated.

Changes: . . .in Figure 3. A further qualitative confirmation for particular climatic circumstances during that period is provided by Lamb (1982).

Why do you use 31years - justify?

Answer: 31year sliding frequencies’ have been chosen due to comparability to a multitude of other works using the same time step. The 31year time step is derived from the standard reference period of the World Meteorological Organization (WMO). It’s a proper tool to identify the linkage of climatic coherences out of time series.

Changes: . . .earlier studies (e. g. Glaser 2008). The 31year time step is derived from the standard reference period of the World Meteorological Organization. This time step is an established tool to identify the linkage of climatic coherences out of time series.

p.10, l1-5, I think you need to explain more clearly what the fractures are being used to indicate, as they reflect periods of change in a series, and not increased numbers C2312 of flood events, you might consider modifying the title of Fig. 4, to more clearly reflect this.

Changes: . . . time series (cf. Glaser & Stangl 2003b). The fracture points reveal differences between the means of sliding flood frequencies. The differences, shown by estimators above the threshold are expected to detect significant coherences between superior framework conditions like variations of large-scale atmospheric circulation and consequential variability of flood-poor and –rich periods.

Modified title of fig. 4: Differences of sliding means by 31-year running t-test estimator of flood frequencies of the Bavarian Foreland, threshold value for the two-sided t-test is 2.00 (see red line). Grey bars label flood-rich periods #1 to #9.

p.10, l.14, you need to clearly show where the flood rich phases are on Fig.3, insert your grey boxes onto this figure – possibly above the curves/columns.

Changes: Flood rich periods according to the grey boxes in Fig. 4 supplemented, see below:

Fig. 3: 31-year running flood frequencies of the Bavarian Foreland. Right ordinate: black columns show the annual flood frequencies, grey bars label flood-rich periods #1 to #9

p.10, l. 12-14, you need to check the numbering of the figures and the discussion associated with them in the text, I think there are a couple of places for example where you discuss flood rich phases in relation to Fig. 3 – these can be deduced but are not clearly shown, see above point. There are a number of places where Fig. numbers need reviewing.

Answer: Relations have been fixed for final revised paper

p.10, l.17, The consideration given to increasing frequency of records and the potential implications on flood frequency needs further assessment, can you devise an approach which allows for the increasing frequency of accounts to be compensated into your estimation of frequency - I appreciate the polynomial has been used to identify the phases but then running meas of events are used in Fig. 5. I suspect this in part explains the increased frequencies post 1700.

Answer: Running means have been the fundament for the polynomial as well as for the curves in Fig. 5. To ensure the compatibility between the running mean of floods and sunspots depicted in Fig. 5, the values of both time series have been scaled and centered. p.13, l.5, you ask the reader to compare Fig.5 to Wanner et al., (2000), I think you need to be more explicit here, what do I need to compare in Wanner to Fig.5?

Answer: Wanner et al. reconstructed the movement of glacier tongues of selected Switzerland glaciers, i.a. of the Aletsch Glacier. Under consideration of the delay of glacier movement a correlation of mass balance and flood-rich period # 5 can be

derived. This coherence is already listed in chapter 5.6.

p.13, l.8, you may wish to have a look at the flood rich phase termination (phases 4 and 5), as at the end of phases the 31-yr flood frequency line is below 0, can this be reassessed?

Answer: Values below 0 are caused by scaled and centered values (z-scores) of the running means.

Discussion section: Can you link the findings of this work to those from other areas of Europe, UK, Spain, Scandinavia, Czech Republic, are the findings similar, are different patterns emerging? Why might that be?

Answer: Result Chapter will be expanded about a comparison in a central European context. A further comparison is interesting concern but can't be realized at the moment. In context of the current HESS special issue a paper by Kiss et al. regarding this concern is in preparation. The main-author contributes to that review article.

Changes: The flood frequencies of the Bavarian Foreland in confrontation with selected flood frequencies of Central Europe

This confrontation is limited to the period between 1500 and 1900. The limitation is founded due to weak data density in general before 1500 and due to a multitude of anthropogenic overprints of the river systems around the beginning of the 20th century. The comparison will be limited to the Lower Rhine and Middle Rhine (cf. Glaser 2008) and Vlatva (an Elbe tributary) and the Czech Elbe itself (cf. Brazdil 1998). The confrontation is depicted in table 4. Due to the decadal visualization beginnings and endings of the marked periods underlie a certain blur. Similarities for all time series can be particularly highlighted for the second half of the 16th century. In general an unexpected similarity can be stranded between the time series Bavarian Foreland and the Lower Rhine, except the years 1790 until 1819. Good accordance between the Bavarian Foreland can be revealed for the first and seventh and eighth decade of the

16th century. During the 17th century only the sixth decade shows good accordance. Again good accordance can be highlighted for the end of the 18th and beginning of the 19th century. Reasons for this variable behavior are founded in the variability of general synopsis and resulting weather conditions. In that context the above mentioned NAO is playing a vital role. For a further understanding of the variability between the confronted time series meteorological aspects must be consulted.

Table 4. Confrontation of selected flood frequencies. Lower Rhine (RHl), Middle Rhine (RHm), Czech Elbe (ELBcz), Vlatava (VLA) and Bavarian Foreland (BF). Due to the decadal visualization beginnings and endings of the marked periods underlie a certain blur. Data altered according to Glaser (2008) and Brazdil (1998).

Fig. 1 – rephrase text beneath caption

Modification:

Fig. 1: Investigation area “Bavarian Foreland” is bordered by the rivers Iller, Danube, Inn/Salzach and the Alpine border (dashed line). Red spots are locating outstanding historical locations and gauges.

Figures 5,6 and 7: can one of these lines be dashed and ticks provided on x-axis so we can see where the years relate too as the grey blocks obscure the lines on the C2313 figure.

Answer: Figures have been fixed for final revised paper, see Fig. 3 above.

Please also note the supplement to this comment: http://www.hydrol-earth-syst-sci-discuss.net/11/C2311/2014/hessd-11-C2311-2014- supplement.pdf

Answer: Supplements have been fixed for final revised paper

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 7409, 2014.

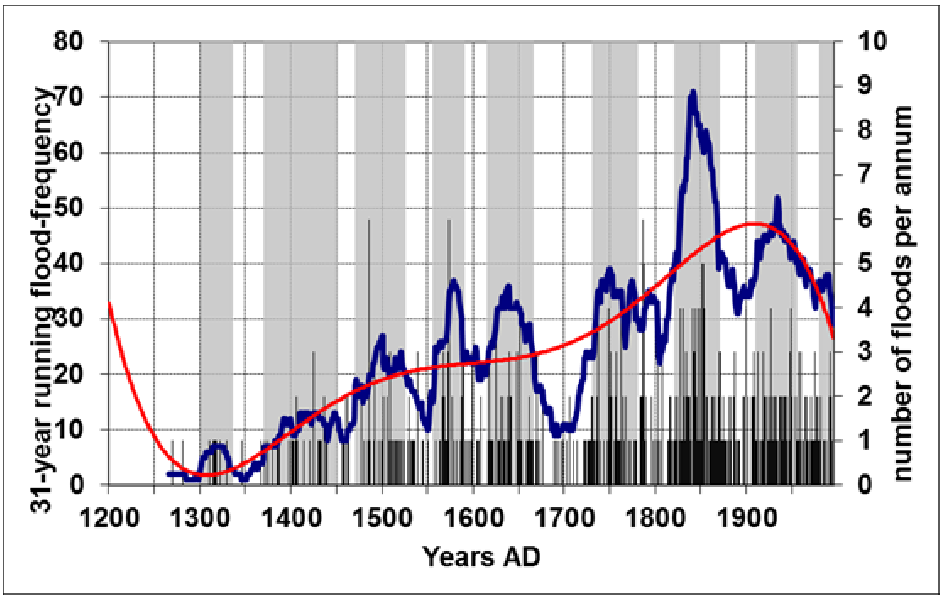

Fig. 1. Fig. 3

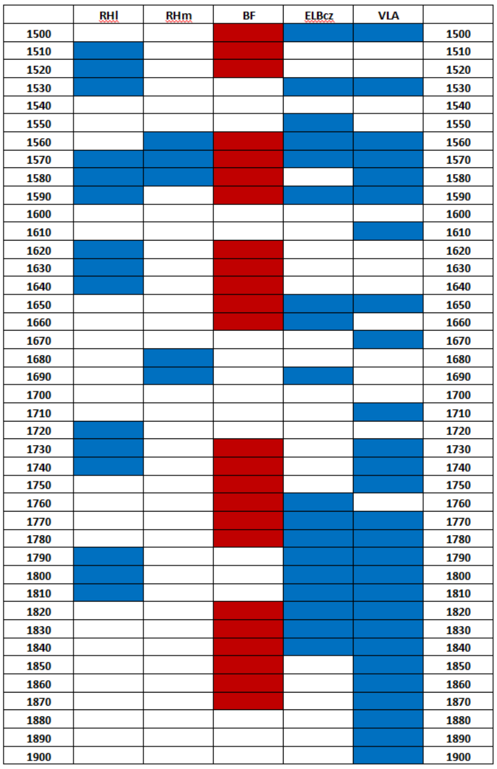
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Fig. 2. Tab. 4