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Interactive comment on "The role of flood wave superposition for the severity of large floods" *by* Björn Guse et al.

Anonymous Referee #2

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General comments:

The paper aims quantifying flood waves superposition and their implication on the severity of flood events. Mean daily discharge data from 37 triple points (around the main channel and the main tributary) in Germany were studied. The main conclusion is that the largest floods at the downstream gauge occur not because of a perfect temporal matching of a tributary and the main river, but a few confluences can bear strong flood magnifications. The topic is novel and of high interest for flood wave routing. The data are of good quality. The paper is well written, clear and easy to read.

The paper deals only with discharge data, defines indices to characterize flood waves superposition, and discusses the results obtained from statistical correlations and distribution of indices. The main conclusions (e.g. that the largest floods at the down-

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stream gauge occur not because of a perfect temporal matching of a tributary and the main) are not related to hydrological processes and the main hydrological reasons remains unclear to the reader (see for example lines 10-15 in the abstract). Only Figures 3 and 4 present the methodology, but remain schematic and no real-case examples are shown. The paper can be reinforced by given a discussion on the physical hydrological processes explaining the different cases shown in Figures 3 and 4, and later in the results. My main comments concern:

1. Main hydrological processes and real-case examples: The paper can be reinforced by adding a scheme showing all hydrological processes during flood events around a triple point: i) the two inlets and the outlet hydrographs extensively studied in this paper; ii) Rainfall/runoff on the three intermediate subcatchments, two subcatchments upstream the bifurcation node on the main channel and on the tributary, and one subcatchment downstream the junction between the bifurcation and the outlet; iii) contribution of baseflow ; iv) eventual overbank flow; v) role of initial conditions of soil moisture on runoff genesis and floods; vi) geometric and hydraulic characteristics of the channels: sections shape, slope, roughness, etc. This figure will help understanding why there are only four cases in Figure 3 and many combinations in Figure 4, and what is the corresponding processes inducing the superposition of waves (magnitude, time of peak). Then these hydrologic characteristics (rainfall, baseflow, initial soil moisture conditions, water balance, etc.) and hydraulic characteristics (peak magnitude, time of occurrence, etc.) can be shown on some real-case events on Figures 3 and 4. This needs the selection of some flood events (at least four corresponding to the four cases of Figure 3) and some particular triple points (in order to illustrate Figure 4). The hydrologic and hydraulic characteristics of these examples of “an event on a triple point” (noted for example A, B, C, etc.) can be studied showing the terms of the main processes (rainfall, runoff, baseflow, overbank, water balance, peak magnitude, characteristics of times, etc.). The different cases studied (A, B, C, etc.) can be indicated on Figures 5 to 8.

2. The characteristics of the intermediate catchment and the channel network: The rainfall/runoff on the intermediate catchment and the geometric and hydraulic properties of the channel network play an important role on wave superposition: impact on velocity/celerity, diffusivity, overbank flow. Also these characteristics can be studied on some real-case examples in order to help understanding what are the main processes inducing the different cases of Figures 3 and 4.

3. Overbank flow: This is a main process during extreme flood events. When overbank flow occurs, a volume of water may be lost from the water balance, and consequently impact peak magnitude. Overbank flow can occur on one, two or the three reaches (2 upstream and one downstream the junction). Please discuss this process for some real-cases. Is there any information on some of the studied events?

4. What is the impact of baseflow and of the initial condition of soil moisture on the different cases shown on Figures 3 and 4? And on results?

5. Uncertainties on data: What is the impact on results of uncertainty on data, especially the rating curve for extreme flood events? What is the sensitivity of results on the method used to define flood events?

6. Extension for cases with more than two inlets: Using the same datasets and similar approach, the discussion and analysis (Figures 3 and 4) can be extended to the cases of a channel with three or more inlets and one outlet.

7. Comparison to the international literature: the paper can also be reinforced by comparing the results to the large international literature presented in the introduction.

Minor comments:

- Page 2, L 10-29: Please explain what hydrological/hydraulic processes behind the results of the reference papers from the literature.

- Page 4, L14: Does the “daily time step” defined between 0h and midnight? What about historical data with daily time step from 6h GMT to next day 6h?

- Page 4, L19 and Figure 2: The paper says that “the ratio of tributary catchment size to downstream catchment sizes may reach 55%”. There are three points on Figure 2 which are above the 1:1 diagonal. Please give the definition of the tributary in comparison to the main channel: is it from the names on map or the channel with the highest discharge, the highest specific discharge (what time step: annual?) or other? Please also explain that the tributary may drain an area highest than the mainstream.

- Do the results depend on the distinction between “main” and “tributary”? or do we obtain similar results?

- Page 5, Line 4 – Page 6, Line 3, Section “3.1 Derivation of flood peaks”: It is not easy to follow how flood events were defined. Please add a figure showing real cases in order to illustrate the difficulties encountered.

- What is the sensitivity of the results on the method used to define flood events?

- Page 6, Line 24: The paper says that “Figure 4. ... shows the ten largest flood” while there is only 8 points and not 10 on Figure 4.

-Page7, Line 26 says that “both axes are scaled to the same specific discharge”. Please explain. It is not clear what are the units of Figure 4 Graphics “B”, and on Figure 6? Please add a 1:1 diagonal on Figure 4 Graphics “B” in order to homogenise with Figure 6, and explain what represents this diagonal. The legend of Figures must give all information to understand the figure.

- Figure 4: i) Graphics “A”: please explain what the vertical distance between two points is; is it arbitrarily in order to classify events? ii) Graphics “B”: please indicate on the figure or on the legend what represent the different colours (grey, blue, red, etc.). This information is given on Figure 6 with the results on the Weser. Iii) Graphics “B”: the legend says that the symbol indicates event severity: please give the definition of “severity”. Please add the units of x- and y-axes. What means “Discharge” is it Qx, a mean discharge during the flood event and hence depending on the definition of an

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event, specific maximum discharge or other? Please be clear; iv) Graphics “C”: please add a legend explaining the three curves on C1 to C4. Why points are indicated only on the two curves in “blue” and “yellow” and not on the “black” one? What represent the horizontal distance between points; is it arbitrarily to class events? v) There is only 8 points on the figure while in the text it is mentioned that there are 10.

- Figure 5: Does the time lag on the x-axis in day? Please add the unit.

- Figure 6: i) What represents the diagonal on figures? As the x-axis and the y-axis are not identical, the diagonal doesn’t represent 1:1. The text Page7, Line 26 says that “both axes are scaled to the same specific discharge”; it is not clear. Please explain on a rela-case and in the legend in order to help the interpretation. Ii) What are the units of the x- and y-axes? Iii) Please also add a legend explaining what represent the size of symbols, what units? It is difficult to distinguish the difference of the different size of symbols.

- Figure 7: Please add the units on the y-axis.

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