

## ***Interactive comment on “Compound flood potential in Europe” by Dominik Paprotny et al.***

### **Anonymous Referee #1**

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This study offers a pan-European assessment of compound flood probability. The authors applied copulas to examine the statistical dependence between storm surge and precipitation/river discharge, using combinations of different observed and simulated sources. I find this paper quite interesting and it is important to discuss compound flood potential in Europe. The authors have strong expertise in this field and it is shown in the generally well-written paper especially in introduction and discussion. However, due to the large number of datasets and their combination, and the statistical analysis method (for readers unfamiliar with Copulas), it is not easy to follow some parts of the methodology and reproduce the reported results. Therefore, I would recommend the authors to significantly improve the clarity of their methodology before publication. Specifically, I have the following suggestions that should not be difficult to address:

1. It is not easy to keep track of the many different names of datasets used in the dependence analyses. While some of datasets are summarized in Table 1, the level of

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details provided could be improved. For example, for precipitation observation it would be nice to also provide the dataset name (E-OBS), and the names of models used (i.e., Delft3D) could also be provided here. Additionally, it would help the readers to summarize the combinations that are examined in the study (section 2.1), perhaps in table labeling with corresponding figures/tables to allow for quick crosschecking. Some more descriptions could also help with the occasional confusion of which table columns are observations and which are models.

2. While the analyses with copulas seem robust, improving the readability of the copula method description would help the readers to understand the results better. In general the readers should not need to read a lot of the cited literature in order to interpret results comprehensively in this study. For tail dependence the authors provided an example in P10L15-16 and elaborated a bit in conclusions (P14L11, “i.e. extreme events are not more likely to co-occur than more moderate events”), which should be mentioned much earlier in the text to motivate the analyses of finding best fit copula and the implication of having Gumbel vs Frank copulas. Figure 3 could also add theoretical probability density contours figures for the two copulas along with the actual data in display, which can also help with the explanation of copulas and tail dependence, concepts that are central for further understanding the results. Additionally, the “Blanket Test” score (equation 2) could be provided in the modified figure 3 along with the plots to provide readers a better sense in interpreting the scores shown in the figures. In which software is this score computed (is it R)? Will there be cases that two or three copulas have quite similar test scores for some stations? It would help to also include a supplementary figure of theoretical probability density contours figures for all 7 copulas.

3. In describing the equations for computing the composite indices of compound flood potential, it is better to explicitly provide the equation for transforming each variable “into decimal logarithm and standardized in the interval [0,1]” (P6L12). This will also help to understand why it is “1-S1” in Equation 4 (P6).

Minor comments/questions:

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1. Have you considered other precipitation indices such as 5-day precipitation, and the dependence of precipitation and river discharge?
2. Have you considered studying the compound flood potential under climate change? It may be beyond the scope of this paper but could probably be mentioned in discussion.
3. Most of the validations and analyses are performed with correlation. Have you also examined biases of the models?
4. Are all the computed correlations rank correlations? If so please make consistent reference in text.
5. Have you examined how different the three precipitation datasets are i.e. in terms of multi-year mean spatial pattern for overlapping period, extremes and trends?
6. Among the river gauges, what is the largest difference (%) in catchment area with your selection criteria (P4L19)?
7. In the results the performance of different model/forcing combinations are described, however I would like to see some more discussions on why certain combinations perform better, as not all notable performance differences are discussed.
8. A bit confused on the explanation regarding difference in correlation (P8L21-22), would you perhaps elaborate a bit more?
9. For figures showing rank correlation, would it be better to make grids with weak/insignificant rank correlation grey?
10. There are a few sentences/tipos that need to be corrected/clarified. For example, in P5L16 what do you mean by "rotated copula"? In P8L34 what does "78 or 43" mean? In P9L29 please explain "significant wave heights" for reader who may not be familiar with this variable. Also in L8L29 it should be R2 instead of R2. While already well-written in general, it would be nice for the authors to review the paper thoroughly once

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more to make some necessary corrections in the text.

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