Hydrology and
Earth System
Sciences
Discussions

Interactive comment on "**Storm surge and extreme river discharge: a compound event analysis using ensemble impact modelling**" *by* **Sonu Khanal et al.**

Anonymous Referee #2

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Thank you for the opportunity to review this manuscript. This study deals with an important issue on compound flooding. It is very interesting to read. But there are a number of points that need to be clarified.

Detailed comments:

1. The authors presented a modeling framework involving a few different modeling platforms and an integration of them to examine the dependence between large riverine discharge and high sea level due to tide/surge. It will be good if the authors could illustrate the different modelling components, how they connect to each other, the flow of data/information in and out of them in a figure/chart. This will help the readers to underhand the entire modeling framework.

2. The authors mentioned that "For the Rhine catchment and the Dutch coastal area, existing studies suggest that no such relation is present at time lags shorter than six days." However, the outcomes of this current study contradict the previous findings. What are the mechanisms that have changed the outcomes of this current study?

3. As the authors noted that timing is important in dependence analysis. Both hydrological models "have errors in estimating the timings of flood waves" and "Both models have difficulties in reproducing flood timing". How these errors in timing actually contributed to the dependence estimated in this study compared to previous studies using observed data? Is it possible that the increased dependence found in this study is actually due to these errors in timing, rather than being genuine increased dependence?

4. Figure 6 and Figure 7 are important for this study. It seems the dependence between the total water level and river discharge is not very strong if there is any dependence at all. As shown in Figure 6, in the majority of the cases, the large values of the two processes occur independent of each other. It is not immediately clear to me how the authors arrived at the conclusions that "the probability for finding a co-occurrence of extreme river discharge at Lobith and storm surge conditions at Hoek van Holland are up to four times higher . . . ". This conclusion is only mentioned once in the abstract and cannot be found (and not explained) anywhere else in the paper.

5. By looking at Figure 6, the two processes seem to be asymptotically independent. Does this mean the driving forces of the two processes may change? For example, the extreme sea level may be driven by storm surge however, the very extreme sea levels maybe driven by astronomical tide, which is not correlated to river discharge? How will this impact the total dependence between the two processes?

6. How does the method used in this study compare to those ones commonly used in previous studies to assess the dependence between two variables, e.g. correlation-based (Wahl et al. 2015) or copula-based methods (Bevacqua et al. 2017), or the bivariate logistic threshold excess model (Wu et al. 2018)? Will there be simi-

lar/weaker/stronger dependence between the two processes?

7. Dependence between storm surge and other flood contributing processes have been studies previously (Svensson and Jones 2004; Wahl et al. 2015; Wu et al. 2018). However, this paper does not directly deal with storm surge; rather total water level was used. The title and heading of section 4 should be changed to reflect what was done in this study. In addition, Line 10, page 3: "We believe that the use of a large sample of data obtained from a fine resolution climate model ensemble provides a better insight into the statistical connections …". Similar recommendations were made/demonstrated in previous studies(Wahl et al. 2015; Wu et al. 2018)

Bevacqua, E., Maraun, D., Hobæk Haff, I., Widmann, M., and Vrac, M. (2017). "Multivariate statistical modelling of compound events via pair-copula constructions: analysis of floods in Ravenna (Italy)." Hydrol. Earth Syst. Sci., 21(6), 2701-2723. Svensson, C., and Jones, D. A. (2004). "Dependence between sea surge, river flow and precipitation in south and west Britain." Hydrol. Earth Syst. Sci., 8(5), 973-992. Wahl, T., Jain, S., Bender, J., Meyers, S. D., and Luther, M. E. (2015). "Increasing risk of compound flooding from storm surge and rainfall for major US cities." Nature Climate Change, 5, 1093. Wu, W., McInnes, K., O'Grady, J., Hoeke, R., Leonard, M., and Westra, S. (2018). "Mapping Dependence Between Extreme Rainfall and Storm Surge." Journal of Geophysical Research: Oceans, 123(4), 2461-2474.

Technical corrections

1. Line 27 page 2: country of US and Italy should swap as the first study by Bevacqua et al. (2017) is on Italy.

2. Line 29, page 7: "we chose it to use ± 5 days here" should be "we chose to use ± 5 days here".

3. Line 12 page 9. Pleas reword the last sentence.

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