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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Modelling dependence and coincidence of storm surges and high tide: Methodology and simplified case study in Le Havre (France)" *by* Amine Ben Daoued et al.

Anonymous Referee #3

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The manuscript by Amine Ben Daoued and co-authors addresses an important issue for the modeling of exceedance probability of extreme sea-levels namely accounting for the dependence between storm surges and high tide. The authors present a new method that is compared to two existing ones (direct sampling of extreme sea-levels, and indirect construction of extreme sea-level distribution via a convolution between the astronomic high tide within a 12h window around high tide by using either the skew surge SSS or the maximum storm surge MSS). The methods are applied and compared on the Le Havre tide gauge.

Main comment.

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Discussion paper

The manuscript is well organized and the presentation is clear. Yet, several aspects should be clarified and further elaborated before publication (state of the art, details of the implementation, application to alternative real cases). Therefore, I recommend additional corrections by incorporating, if possible, the following recommendations.

Specific comments

1. State of the art.

I agree with the authors that most studies assume that “Tide and extreme SSs are considered as independent” (as stated in the abstract). Yet, this is not so systematic: I would reformulate by highlighting: “Most existing studies are generally based on the assumption that tide and extreme SSs are independent.” Some studies (not cited by the authors) have addressed this problem with different approaches. These should be underlined in the introduction and further discussed by the authors.

In particular, - Coles, S., & Tawn, J. (2005). Seasonal effects of extreme surges. Stochastic Environmental Research and Risk Assessment, 19(6), 417-427; - Gouldby, B., Méndez, F. J., Guanche, Y., Rueda, A., & Mínguez, R. (2014). A methodology for deriving extreme nearshore sea conditions for structural design and flood risk analysis. Coastal Engineering, 88, 15-26. – see section 3.2; - Pirazzoli, P. A., & Tomasin, A. (2007). Estimation of return periods for extreme sea levels: a simplified empirical correction of the joint probabilities method with examples from the French Atlantic coast and three ports in the southwest of the UK. Ocean Dynamics, 57(2), 91-107;

Note that a more recent overview on the interaction with tides is provided by Idier et al. (2019): Idier, D., Bertin, X., Thompson, P., & Pickering, M. D. (2019). Interactions between mean sea level, tide, surge, waves and flooding: mechanisms and contributions to sea level variations at the coast. Surveys in Geophysics, 40(6), 1603-1630.

Finally, the beginning of the introduction is mainly focused on the problem of NPPs though the problem of tide-surge dependence is of interest in all applications of the

domain of coastal engineering. The authors should maybe either reformulate the introduction to be more general, or reflect the focus on NPPs directly in the title.

2. Details on the implementation.

The manuscript would benefit from additional implementation details (and figures) on the different steps of the proposed method. In particular, - Figure on the time-series of Le Havre with examples of MSS (SSS) and High tide sampling; - An empirical bivariate scatterplot High Tide versus MSS (or SSS); - Consider the possibility of statistical methods to estimate tideâĂŘsurge interaction like the analysis by Feng et al. (2015): Figure 6 or the chiâĂŘsquare test described by Haigh et al., (2010); - Stability graphs for the choice of the threshold values; - Error estimates on the GPD parameters (line 206); - Further details on the delta method (page 6, line 197).

Besides, the authors refer to R packages: these references should be preferably located in the method section, together with additional formal details on the corresponding methods.

At the end of the discussion (page 7, from lines 340), the authors highlight some interesting alternative methods. These are very relevant and I must admit that after reading them, I wonder why the authors did not consider them in the frist place. Could the authors clarify this aspect?

References Feng, J., von Storch, H., Jiang, W., & Weisse, R. (2015). Assessing changes in extreme sea levels along the coast of C hina. Journal of Geophysical Research: Oceans, 120(12), 8039-8051. Haigh, I., N. Robert, and W. Neil (2010), Assessing changes in extreme sea levels: Application to the English Channel, 1900–2006, Cont. Shelf Res., 30, 1042–1055, doi:10.1016/j.csr.2010.02.002.

3. Application.

The application cases consists of one tide gauge, where the interaction between tide and surge is known to be high. Though the results on this site is useful to highlight

the possible pitfalls of neglecting the dependence as well as the differences between the three methods, the study would benefit from adding a new test case to discuss the influence of: - the strength of interactions for instance by choosing a site with less or no interaction (this location may done based on Idier et al., 2012 for instance); - the length of the time series.

4. Typo.

- Page 2 (line 65): “SSS” has not been introduced before.

- Page 2 (line 71): “Salvadori and De Mechele” should be “Salvadori and De Michele”

- Page 6 (line 193): “storm surge RLs”: sea level RLs?

- Page 7 (line 255): the symbol after “this temporal difference” is not depicted properly in the manuscript pdf. The problem also appears in line 258 and 260.

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