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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Regional frequency analysis of extreme storm surges using the extremogram approach" *by* Marc Andreevsky et al.

Anonymous Referee #2

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Recommendation

Accept with major revisions. (Mainly textual, presentation)

Synopsis

To design coastal protection structures one needs information on the likelihood of extreme water levels, typically in the form of the once-in-N-years event, with N being a large number (100, or 1000, or even higher). Ideally, this information would be obtained from measured time series of a length that is comparable to N. Unfortunately,

such long time series do not exist. The idea of the present paper is to pool time series together from locations that are somehow similar. If several locations are influenced by "the same kind of" surges, the time series from these locations can be combined to obtain a longer series, from which the extremes can be derived more easily. The paper describes the method to decide whether two stations are "similar", and how to combine the time series, and applies it to the western European coastline. As a result three similar regions are detected, one encompassing the whole French coast, a second one centred around the English Channel, and a third one consisting of the eastern (North Sea) coast of England. For these regions, the combination of stations leads to effective lengths of time series of up to 500 years, much longer than the typical 50 years of individual stations.

Discussion

The paper addresses a very important topic, namely the estimation of rare events. Pooling measurements from different locations makes it possible to extract more information from the existing short times series and allows to obtain a sharper estimate of the once-in-N-years event than it is possible from individual series. The paper is based on a sound mathematical concept. Therefore, it should be published. However, I found it hard to follow. Therefore, I recommend a partial re-writing to make the paper easier to understand for readers not fully familiar with the topic. Below I give some more detailed suggestions.

Detailed comments

p 2, l 51 You doubt that Boulonge-Sur-Mer and Calais belong to two different regions because they are so close together. However, is mere distance a good argument?

The two locations face different seas. Calais is oriented to the North Sea, while Boulonge faces the Channel and perhaps even the Atlantic. So I do not see an a priory reason why they could not belong to different regions in terms of surge heights.

eq. (1) How are the intervals A and B defined?

eq. (2) Comparing with (1), shouldn't it read $X(t+h) > q_X$, and $Y(t) > q_Y$?

eq. (2) Why is the upper bound of the summation in the nominator given by $D - h$? According to the explanation below the equation, D is the number of events, while h is a measure of time. $D - h$ then does not make much sense to me. In the denominator, the upper bound is N. How is N defined, and why are the upper bounds of summation different in nominator and denominator?

p 2, l 101 I guess $I_f = I\{f\}$ to conform with the notation in eq. (2). Please clarify.

p 2, l 101 D is the number of events that "occurred at the same time" - I think it should be "that occurred within a time of h" at the two sites.

p 2, l 103 Why does the fact that $\hat{\rho} \in (0, 1]$ indicate a dependency between X and Y? What would $\hat{\rho}$ be in case of no dependency?

together Please explain the the equations in more detail and make sure that the notation is consistent.

p 2, l 104 Start a new paragraph before "Let ρ_0 be ..."

p 3, l 108 What do you mean by "confusion"?

p 3, l 133-138 Please give the definitions of H and D_c, perhaps in an appendix.

p 4, l 141 "duration" - I guess you mean "length of time series"? I was confused because I associated duration with "duration of a storm". This applies for the whole paragraph.

sect. 2.3 General: As far as I understand there are two issues: First, to define "Neighbourhood", you need time series that overlap as much as possible. Second, to obtain as many independent events as possible, you would prefer non-overlapping time series. The effective length of overlapping series is shorter than their sum because some events are "extreme" in both locations and thus not independent. You should clarify these concepts and perhaps show a figure as an example (appendix?).

p 4, l 147 You introduce λ_r, but the explanation is given only after the equation. This is confusing. Define a symbol when you introduce it. But more important: What is φ? If you say that it was shown that $\varphi = \lambda_r/\lambda$, then you have to say first what φ stands for.

eq. (3) Try to interpret this equation. I cannot recover the results for the limiting cases "completely (in)dependent".

p 5, l 162 predicted tide - you mean astronomical tide? And please give a definition of SSS. Is it water level, residual surge, or skew surge, or something else?

p 5, l 167 How is "greatest majority" defined? Serious: I think "majority" suffices.

sect. 3.1 Again I would like to see a figure with an example.

p 7, l 211 Throughout the paper you refer a lot to Weiss (2014c), sometimes saying "confirming Weiss", sometime saying "different from Weiss". I have the impression (but I may be wrong) that one of the goals of the paper is to improve upon

the results of Weiss. If so, you should clearly state this at the beginning of the paper and explain how Weiss did his analysis, what he found, and what the present paper is improving.

p 7, l 221 duration → length of record?

p 7/8, l 210-254 Figure 6 → Figure 4 (everywhere)

p 8, l 258 add the station number (5) to the name. That makes it easier to fin the station on the maps (also for other stations when they are mentioned)

p 8, l 271 imply → implies

p 8, l 272 duration → length (?) (2×)

p 8 l, 275 show → shown

p 9, l 280 law → distribution

p 9, l 282/283 Define/explain Exp_{sin} and $\text{Gpd}_{\text{cos sin}}$.

p 9, l 292 Formulation: *The same conclusion is not the same* - sounds strange

p 9, l 300 Why *interesting*?

p 9, l 304 Again, which finding is interesting, and why?

p 9, l 306-308 See my remark about referring to Weiss above. - Why is the finding that that regions 1 and 2 are statistically homogeneous, a progress?

p 10, l 312 consider → considered

p 10, l 313 take → taken; remove → removing

p 10, l 313 removing a site - the criterion should be the D_c-value, shouldn't it?

p 10, l 314/315 please show Dieppe - otherwise the remark cannot be understood

p 10, l 315 *not centered enough on the target site* - what do you mean?

p 10, ll 326 duration → length

Fig. 2 Why do you reproduce a figure from Weiss? See my remark above.

Fig. 3 The black background makes the figure hard to read. Try a background that gives a higher contrast to the other elements (bars, red line, numbers) in the plot.

Fig. 3 Give value for red line - ~ 0.3, I guess.

Fig. 5 Units for the y-axis (Regional surge)?

Fig. 5, caption GPDcos sin → $\text{Gpd}_{\text{cos sin}}$; similarly for Expsin

Fig. 5, caption 70% = dashed line, 95% = dotted line.

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