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Interactive comment on "Measuring compound flood potential from river discharge and storm surge extremes at the global scale and its implications for flood hazard" *by* Anaïs Couasnon et al.

Anonymous Referee #1

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General Comments:

Couasnon et al., present a global-scale analysis of compound flood hazard potential. Using modeled datasets of river discharge and storm surge, they highlight locations where the potential for compound flooding may have been overlooked using observational records alone, thus extending their analysis beyond that of Ward et al., 2018. They also incorporate new, creative metrics beyond conditional dependencies and copulas to describe the likelihood for co-occurrence of these variables. I feel that the research is an important contribution to the literature as it provides a global per-

spective on where compound flooding may matter for flood risk assessment and more detailed/localized studies. The manuscript is well written and describes the motivation, methods, and results very clearly, making it an overall pleasure to read. I have a few minor comments in which I believe the authors would benefit from addressing.

Specific Comments:

I appreciate that the authors consistently describe their results as "flood potential." Often the literature characterizes an extreme forcing (e.g., storm surge) as an extreme flood, without ever linking it to impacts. The authors make clear they are describing how the compounding forcing has the potential to drive flooding. On that note, I think that the title is slightly misleading/redundant, as there are really no implications for flood hazard and/or I'm not sure how that's different from "measuring compound flood potential." There are a few other locations in the text (noted in my comments below) that the authors could add "potential" to as well.

The majority of Central America, South America, and Southern Africa have a poor hit rate for storm surge (not quite as bad for discharge). Meanwhile, some of these locations have a very high number of modeled co-occurring annual maxima and correlation coefficients for (S_n, q_n) (e.g., Chile and South Africa). In Section 3.4, the authors do discuss some of the limitations of being able to represent the accuracy of the model in these locations, and also warn that the results of low compound flood potential in the northern latitudes is uncertain and should be interpreted with care. Should a similar warning be provided in other locations? Do the authors have any indication they may be overestimating flood hazard potential in areas where the models do not accurately depict observations, yet have a high amount of co-occurring events?

On that note, on Page 5-6: Line 34 – Line 1, the authors state, "As a result, the timing and correlation of extreme storm surge is generally well represented . . . and less well captured for the South African and South American coasts." This statement seems to be putting it lightly, as the hit rate is 0 for all these locations, and the correlation

C2

coefficient is negative, or relatively low. It more or less seems that it doesn't capture the South African and South American coasts.

Finally, the authors state in the conclusions (Page 18, Line 8) that, "Our study provides a first indication of locations where discharge and storm surge interactions are strong." Technically, the authors are not investigating "interactions" between these variables. Furthermore, Ward et al., 2018 provided the first indication of locations where these dependencies between variables are strong.

Comments on Specific Lines:

Page 5, Line 30: Hit rate is defined in the manuscript, but not here. Perhaps the authors could add it to the preceding sentence, "We calculate the percentage of annual maxima dates correctly predicted, termed hit rate . . ."

Page 6, Line 28: "We transform the annual maxima pairs to probability space using their respective empirical cumulative distribution functions" – I'm confused as to how this is done for 3 points (in this example at least). Am I missing something here?

Page 8, Line 19: I think simulated is sufficient when describing the datasets, and then can be removed from the rest of the text describing the datasets. The readers will know they're not observations. Anywhere else in the text makes me think there was a statistical simulation instead. "Simulated" is also used on Page 13, Line 10, caption Figure 5, and in a few other locations in the manuscript.

Page 10, Line 8: Similar to the above comment, how are the authors finding the dependence of (Q^*, S^*) pairs, when there may only be 1 or 2?

Page 17, Line 20: The authors state that some approaches, "may result in sampling events that are not extremes and underestimating the compound flood potential measure." At the same time, the definition of a compound event also includes events driven by extreme and non-extreme variables, so the authors could be underestimating the types of events that could drive extreme flooding.

Page 18, Line 26: "developed compound flood potential indicators" This is the first time the authors use the word indicators, so I'm not sure which metrics they're referring to. I suggest removing this, or defining it earlier on.

Figures and Tables: Figure 1: What is (Qn, Sn) on plot 1e? This hasn't seemed to be defined. Furthermore, is there a reason the authors choose to use Mexico (Section 2.2) as the example when Madagascar is the chosen example location later?

Figure 2b: The authors may want to consider adding a zoomed inset to show what is described in the text in Line 9-11 on this page.

Figure 5: I'm a bit confused about what the black line displays. Is it the empirical distribution of all AM occurrences across the globe? If so, how is this used to describe dependence at a particular location? I assumed that the red/black line could be applied to any location, e.g., if these two variables were independent over these time scales, here's the probability it would occur. But if the black line is generated for all locations, I don't understand how it can be applied to a specific location. Am I misinterpreting this?

Supplemental Table S3: Do these numbers denote averages across all locations?

Technical Corrections: Page 6, Line 5: Better stated as, "This leads to 3,979 stations of paired river discharge and storm surge..."

Page 8, Line 2: Compound Flood potential "from extremes" (since you're not including non-extreme forcing)

Page 9, title 2.2.3 "Quantification of the Compound Flood Hazard Potential" (add potential)

Page 17, Line 6: Add "potential" e.g., ..."we identify potential compound flooding hotspots..."

If the citation Eilander et al,. 2019 has been updated to a more final format, please update citation.

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