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# Comment on nhess-2021-181

Anonymous Referee #1

Referee comment on "Generating reliable estimates of tropical-cyclone-induced coastal hazards along the Bay of Bengal for current and future climates using synthetic tracks" by Tim Willem Bart Leijnse et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-181-RC1, 2021

This article provides an assessment for storm surge and wave hazards along the coast in the North Indian Ocean based on synthetic events. The method is based on synthetic tropical cyclones to provide more robust statistics compared to using only the short observational record on tropical cyclones in the area. I consider that the study is well structured, well presented and the science is sound, as such I recommend accepting the article after some minor revisions and one major are done.

Major comment:
The approximation for the future climate is based on Knutson et al. (2015), but in their work, they show a 200% increase in categories 4 and 5, which is not included in this work. The inclusion of the 200% increase for the most extreme events will likely change the results for the future climate, and I think this is a very important issue to discuss. Also, there is a new paper by Knutson et al. (2020), showing more details about the projections of TC into the future climate. While I do not suggest doing another assessment with the new projections, I do suggest a discussion of the selected projections in this work, with those reported in the latest work. I also suggest highlighting that the results presented for the future climate correspond to an RCP 4.5 scenario, although partially representing such scenario (as the 200% increase in cats 4-5 is not included), and also commenting that the results should be considered with caution as I believe this is more a proof of concept than an actual assessment for the motives explained above.

Minor comments:
Lines 51-53: Please revise the sentence as it is not clear (...value analysis on than otherwise...)
Lines 56-58: I would suggest including the reference of Emanuel et al. (2008) and Lee et al. (2018) as they are those synthetic events are different in the sense that they are not prescribed with historical events climatology.
Lines 59: The works by Meza et al. (2015) and Appendini et al. (2017) do consider the use of synthetic events to derive waves.
Line 72: Knutson et al. (2015) find an increase of 200% for category 4-5 storms, I think it

is worth noticing such high value, which I do not think is reproduced by the synthetic events presented in this study. I think this is something to discuss later in the text.
Line 76: Please note that even without an increase in TC intensity, sea-level rise will lead to an increase of flood risk by TC.
Line 85: "This data can be used as boundary conditions", please clarify which is "this data"
Line 112: Please provide a brief explanation of the DIVA data for readers not familiar with it.
Lines 115-116: It is explained that the DIVA segments are translated to deepwater for waves, but what about storm surge? Storm surge is highly dependent on the bathymetry and slope so that it is relevant to provide the information related to the depth for the storm surge extraction, as well as a discussion of the accuracy.
Lines 171-176:The text is a bit confusing. As I understand, first the PDFs for the different variables is calculated based on historical, then a new PDF is calculated for maximum winds and increased by 1.6% to generate the future climate events, and then a subset of those events is selected for the present climate, for which the wind speeds are reduced by 1.6%. Please make the text clearer. Also, the work by Knutson et al. (2015) specifies an increase of 200% for category 4-5 storms, while this is not included, it would be good to discuss the implications it may have to omit this important value.
Lines 214-215: The sentence is incomplete, please correct.
Lines 360-362: It is not very clear this sentence. Why HTC are not considered "true values"?
Lines 379-380: Please specify which patterns and then include the section parenthesis so that the reader does not need to go back in the text.
Section 3.3.3. Some of the subplots in Figure 10 and most of them in Figure 11 show that both the STCC and STCF are embedded into the CI for HTC. I understand it is because the CI is too large for CI, but such a large CI for return periods below 50 years draws my attention. Could you please expand on this and its implications?
Section 3.4. As I noted above, I think it is needed to highlight that Knutson et al. (2015) found an increase of 200% for categories 4-5, which is not considered in this study. Also, it needs to be noted that such results are based on an RCP 4.5, so the results in this work also represent that scenario.
Section 4.1. I suggest that you discuss the last three sentences in relation to physics-based synthetic events, such as the ones from Emanuel (2008).
Section 4.2. There is no discussion on the effect of bathymetry, which also has a large repercussion on storm surges. Please also discuss those limitations. I would suggest that at some point in the paper it is specified that the values obtained, at least for storm surge, need to be considered as indicative to provide a comparison between historical and synthetic (present and future climates), but the values per se need to be handled with care, as there is no validation or calibration of the wave and storm surge results.
Lines 514-516: This is not clear in the study as an overall increase frequency was applied, as well as increased intensity, based on Kuntson (2015). As such, the increase in 3-5 categories such as found in Sugi et al. (2017) (and 200% increase found by Knutson et al. 2015) is not really incorporated in this study.
Line 537-538: "The use of synthetic tracks allows to better sample the full parameter space describing the tropical cyclones and to more accurately capture modelled extreme values". The "better sample" part is related to lower CI, right? I think it should be put into that context. Maybe it is better to use the word robust instead of better.
Lines 560-562: It could be added that as an alternative to reducing the number of synthetic events, the application of fast algorithms to determine storm surges and waves could be another possibility.

Table 2: While the information is relevant, it would be easier to see the graphically with bar plots. For instance a figure with subplots, where each is a return period. On each subplot, all the locations are shown with bars for each dataset. The bars could even show

the CI as error bars. I think this would allow the reader to see more clearly the data.

Figure 4: Considering that this figure corresponds to the methodology for generating the synthetic events, I would consider that a time series of wind speed would be more adequate. Also, I suggest showing a plot with the PDFs for each database. While the CDF is presented for particular locations, comparing historical vs synthetic PDFs or CDFs for the entire basin would provide a measure of the method robustness, which is not necessarily shown for a particular location (that is discussed later as an area not experiencing yet a specific track, such randomness is diffused when considering the entire basin)
Figures 10 and 11: Why do the values start on different return periods for each location? Is it a result of the threshold used in POT? For instance, Port Blair in Figure 10 starts with a 40 years return period for STCC, could that be a result of too few data points from the POT to perform the EVA? It makes me wonder if the POT criteria is correct for some stations.

References:

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