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Natural Hazards and Earth System Sciences
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Interactive comment on "Updating knowledge of cyclonic wave hazard for Tahiti and Moorea Islands (French Polynesia) through a probabilistic approach" *by* S. Lecacheux et al.

Anonymous Referee #2

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General comments (overall quality of the discussion paper) The probabilistic approach to the cyclone modelling is fundamentally flawed, and this compromises the results and conclusions of the study as presented. Thus the paper requires revision before publication in NHESS, and suggestions are made below as to how this might be achieved. Other aspects are novel approaches worthy of publication, such as the attempt to quantify spatial variability in extreme wave height, the mixed cyclone/swell wave model, and the account of both wave height and period. However, the swell wave analysis needs fleshing out to quantify northerly storms, and the use of a 10-year long wave hindcast is insufficient to robustly calculate a 100-year ARI wave height. Specific comments

(addressing individual scientific questions/issues) âĂć This paper attempts to quantify the spatially-variable extreme wave hazard for Tahiti and Moorea Islands, by modelling wave fields using dynamic wave models, then undertaking extreme-value modelling on the predicted wave heights. The use of highly-spatially resolved dynamic models with advanced physics enables the effects of wave sheltering and refraction to account for the spatial variability of the wave hazard around the islands. The cyclone wave modelling is driven using a parametric wind model while the swell wave model is driven using a 10-year long wave hindcast. âĂć The probabilistic approach to the cyclone modelling is fundamentally flawed, and this compromises the results and conclusions of the study. The problem occurs due to the bootstrap resampling and the re-modelling of cyclones along existing tracks, but restricted to ïĆś0–1ïĆř latitude offset. This effectively reproduces the cyclones with the largest impact on the islands multiple times, along similar track corridor. The method used is highly reliant on the fact that a single intense cyclone (Veena?) passed within ïĆś0–1ïĆř of the islands (as in RHS of Fig 7). The bootstrap technique then generates a corridor of Veena storms impacting the northern face of the islands. Had this cyclone been more than 1ïĆř away then calculated extreme wave climate would have been much different. Likewise, had this cyclone taken a different angle past the islands then the calculated spatial exposure of the coastline might have looked significantly different. This is discussed by the authors on p. 740. It is impossible to accurately calculate a frequency–magnitude relationship for extreme cyclone waves using the presented method. âĂć Accordingly, the authors recognise that the absolute values of the extreme wave heights are compromised, suggesting instead that the results be used to "nuance" the previously calculated 100-year ARI Hs = 12 m (Des Garets 2005). âĂć "Nuance" might have been achieved by simply simulating a design cyclone travelling past the islands on several justifiable pathways. The probabilistic cyclone modelling is overly complex and misleading and not justified for the "nuance" purpose to which it is applied, and should be omitted. The paper requires revision along these lines before publication in NHESS. âĂć The taking into account of both cyclone and distant swell wave-generation, and the account of wave approach direction, is a thorough and novel approach. âĂć The modelling approach and some of the manuscript text suggests that the authors ideas have been influenced by the 2011–12 Cook Islands study "Climate change impacts on coastal inundation at Oneroa village, Mangaia", which employed a similar mixed cyclone/swell wave modelling approach. If this is the case then the authors should reference that study appropriately. âĂć As presented, the swell wave analysis appears to be a tack-on to the original cyclone analysis. For example, the title and conclusions talk of cyclone waves, but should include cyclone and swell waves. âĂć The swell wave analysis is incomplete, and it is not clear why only southern swell waves have been included. Northern Hemisphere storms can generate significantly large swell also. For example the December 2008 northern hemisphere swell caused severe inundation in Kiribati, Marshall Islands, Micronesia (Federated States of), Papua New Guinea, Solomon Islands. In December 1969 two storms in the north Pacific 40–50ïĆř N generated swell of 4–6 m height that travelled over 7000 km to the south and impacted Tahiti. For completeness, the swell wave analysis should also consider waves approaching from the northern hemisphere. âĂć 10-years of wave hindcast data is insufficient to calculate a 100-year ARI Hs. This is not just due to statistical uncertainty in fitting the GPD model, but is caused by climate variability that has cycles longer than 10 years (e.g. the 10-year hindcast might be unusually benign or severe, e.g. the 1969 event). A usual extrapolation period is 3–5 times the record length (Coles 2001), leading to 50-year ARI. If more data are not available, then the authors should at least discuss this uncertainty and put it in context. Standard hindcast lengths are 30-40 years? âĂć The account of wave period and height is a sound approach that is pertinent to quantification of wave setup and runup. âĂć P. 743 line 1. Restricted number of cyclones does create uncertainty, but the largest source of uncertainty is due to the bootstrap sampling method, subsequent to which it is impossible to accurately calculate a frequency–magnitude relationship for extreme cyclone waves.

Technical corrections Abstract line 18 change "effects than" to "effects to" p. 727 line 2 " As many are low-lying islands, they are vulnerable to…" p. 727, line 10 – reference

needed to substantiate inverse barometer versus wind stress effect. p. 728 line 24, sp relationship. Line 25 change "figure out" to "calculate". p. 729 line 18, change "opened" to "open". Line 26 "… other from certain wave approach directions". p. 731 line 7 ch "carry out a" to "carry a". ch "be very impacting" to " heavily impact". p. 731 line 14 (and elsewhere in MS) ch "expertise" to "expert judgement". Line 23 "season season". p. 735 line 26 ch "although the limites…" to "Despite the uncertainty…". Ch "statistical analysis" to "extreme-value analysis". p. 735 line 27 (and elsewhere) ch "order of magnitude" to "estimate". The term "order of magnitude" has been used incorrectly throughout the text, and should be replaced with the term "approximation" (or similar). Orders of magnitude scale as exponentials of 10, e.g. 1, 10 100, 1000 are orders of magnitude apart. p. 735 line 28 ch "… all locations … until then." to "…at locations all around the islands to compare with the previously estimated 100-year ARI wave height of 12 m". p. 736 line 21 ch "…Martin and cyclone Oli extracted from the model along the satellite swath path". p. 737 line 9 ch "quite schematics" to "schematised". Line 19 "GPD law" to "GP model". Sp "Adjusted" p. 740 line 5 ch "To sum up, if" to "To sum up, although". Line 10 ch "… energetic waves." To "…energetic waves and thus have the largest extreme wave magnitudes". p. 740 line 6 The method also does not consider track variability. Line 12 & 14 sp "technique". Line 17 ch "much" to "many". Line 24 ch "be particularly impacting" to " have severe impacts", ch "southern waves" to "swell waves from the southern ocean". Line 27 ch "Thus we can wonder…coasts" to "For comparison, we calculated the significant wave height corresponding to a 100-year ARI for swell waves originating in the southern ocean". p. 743 line 11 ch "one can notice that the…" to "The…". Term "orders of magnitude" is used out of context throughout. p. 743 line 15 ch "In addition, the analysis of southern wave heights and periods pointed out that for the two return periods considered in the study, southern waves may be as impacting at the coast as cyclonic waves for a same return period" to "Swell waves originating in the southern ocean can have similar impacts cyclone waves on the southern coasts". Figure 4 caption: state the origin of the colour shading (satellite or model?). ch "…wave heights for cyclone…" to "wave heights along the satellite swath path for cyclone. . .” Figure 7 caption: ch “GPD laws” to “GPD model”. Figure 10: figure legend should be in English, not French. Caption: ch “SWH at PS” to “significant wave height at extraction point PS”.

1. Does the paper address relevant scientific and/or technical questions within the scope of NHESS? Yes 2. Does the paper present new data and/or novel concepts, ideas, tools, methods or results? Yes – the concept of cyclone wave shadowing effect, and merging of cyclone and wave datasets 3. Are these up to international standards? No – the cyclone probabilistic analysis is sub-standard. Yes – the joint wave height and period analysis, the cyclone wave shadowing 4. Are the scientific methods and assumptions valid and outlined clearly? Yes – the methods are outlined clearly No – the cyclone model is statistically compromised 5. Are the results sufficient to support the interpretations and the conclusions? Yes - 6. Does the author reach substantial conclusions? No – the “nuancing” of previously published extreme wave climate is not internationally substantial, especially given the uncertainty in the cyclone wave modelling method and probabilistic analysis. Yes – that the extreme wave climate is not uniform around the island; that wave sheltering is an important local consideration not always accounted for; that a mixed wave model is required to completely ascertain risk; that wave period is important. 7. Is the description of the data used, the methods used, the experiments and calculations made, and the results obtained sufficiently complete and accurate to allow their reproduction by fellow scientists (traceability of results)? Yes 8. Does the title clearly and unambiguously reflect the contents of the paper? Yes, except that the paper address cyclonic waves and swell 9. Does the abstract provide a concise, complete and unambiguous summary of the work done and the results obtained? Yes. 10. Are the title and the abstract pertinent, and easy to understand to a wide and diversified audience? Yes 11. Are mathematical formulae, symbols, abbreviations and units correctly defined and used? If the formulae, symbols or abbreviations are numerous, are there tables or appendixes listing them? N/A 12. Is the size, quality and readability of each figure adequate to the type and quantity of data presented? Yes 13. Does the author give proper credit to previous and/or

related work, and does he/she indicate clearly his/her own contribution? Mostly, apart possibly from Cook Islands study 14. Are the number and quality of the references appropriate? Yes 15. Are the references accessible by fellow scientists? Many of these are necessarily technical reports, because published literature on cyclone wave modelling is sparse in the Southern Hemisphere. 16. Is the overall presentation well structured, clear and easy to understand by a wide and general audience? Yes 17. Is the length of the paper adequate, too long or too short? Yes 18. Is there any part of the paper (title, abstract, main text, formulae, symbols, figures and their captions, tables, list of references, appendixes) that needs to be clarified, reduced, added, combined, or eliminated? No 19. Is the technical language precise and understandable by fellow scientists? Yes 20. Is the English language of good quality, fluent, simple and easy to read and understand by a wide and diversified audience? The quality of the English needs improving in places – see technical corrections 21. Is the amount and quality of supplementary material (if any) appropriate? Yes

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/2/C147/2014/nhessd-2-C147-2014-supplement.pdf

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 725, 2014.