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A second benchmarking exercise on estimating extreme environmental conditions

Offshore structural design requires estimates of the extreme environmental conditions that may occur during a structure's lifetime. Various methods have been proposed to estimate these extremes. The benchmarking exercise whose results were presented in this special issue (Haselsteiner et al., 2021) showed that state-of-the-art methods can lead to widely varying estimates of extremes. For example, in the case of a few contributions, the estimated 50-year extreme significant wave height differed by a factor of two. Clearly, such differences can make a design either unreliable or over-conservative.

The benchmark exercise allowed us to compare the methods of choice from nine groups of researchers. We quantified differences among the methods and laid out the reasons why estimates diverge from one another: they included different ways of treating serial correlation, different distribution models, different parameter estimation techniques and different definitions for multivariate extremes. Discussions of the results amongst contributors raised new questions and inspired additional research, some of it presented in this special issue. However, constrained by the methodology employed, the benchmarking exercise could not answer some of these questions. For instance, the use of data sources typical for offshore projects, buoy data and hindcasts, and their limited duration of 20 and 50 years, respectively, limited our ability to assess the accuracy of the various estimated extremes. Also, questions about the influence of a changing climate could not be assessed properly based upon the supplied datasets.

To address these questions – and to catalyze joint research among the groups in our field – we have conceived a second benchmarking exercise on estimating extreme environmental conditions. This new benchmarking exercise is described in detail in an OMAE 2021 conference paper by Mackay et al. (2021). This second exercise makes use of several very long datasets from a global climate model that was recently published (Bao et al., 2020; Song et al., 2020). One of the datasets spans 700 years and was generated by assuming a constant pre-industrial climate. Other datasets cover alternate future scenarios, assuming different CO2 levels in the atmosphere. Based upon these datasets, we propose two separate studies in the planned benchmark exercise: one focused on estimating extremes in a steady-state climate and another focused on extremes in a changing climate. The 700-year dataset will allow us to compare estimates of 50-year extremes with empirical long-term distributions. The datasets associated with a changing climate will be analyzed with the purpose of dissecting the role of climate variability and assessing how well different models can account for such changes.

Similar to the first benchmarking exercise, this second benchmarking exercise is open to all interested participants. One of the goals when conceiving the benchmark was that participation should be easy. Thus, we have divided the benchmark into two sub-exercises, with the option for individuals to participate in either one or in both. Additionally, we aim to make the benchmark's organization seamless and readily accessible; accordingly, we will use a dedicated GitHub repository[1] to share data and information.

The first exercise succeeded in bringing together many researchers working on estimating metocean extremes. It laid out the state of the art and helped identify new research questions. It is our hope that this second benchmarking exercise will be a vehicle to foster additional collaboration in our field and to further advance knowledge about estimating extremes. Great challenges of our time – including improving our understanding of climate change and developing next-generation offshore renewable energy devices – require better understanding of the methods that we use to estimate environmental extremes. Apply your method of choice and join the second benchmarking exercise on estimating extreme environmental conditions!

References

Bao, Y., Song, Z., Qiao, F., 2020. FIO-ESM version 2.0: model description and evaluation. J. Geophys. Res.: Oceans 125 (6), 1–21. https://doi.org/10.1029/2019JC016036.

Haselsteiner, A.F., Coe, R.G., Manuel, L., Chai, W., Leira, B., Clarindo, G., Guedes Soares, C., Dimitrov, N., Sander, A., Ohlendorf, J.-H., Thoben, K.-D., de Hauteclocque, G., Mackay, E., Jonathan, P., Qiao, C., Myers, A., Rode, A., Hildebrandt, A., Schmidt, B., Vanem, E., 2021. A Benchmarking Exercise for Environmental Contours preprint from January 2021. http://www.lancs.ac.uk/~jonathan/CntCmp21.pdf.

Mackay, E., Haselsteiner, A.F., Coe, R.G., Manuel, L., 2021. A Second Benchmarking Exercise on Estimating Extreme Environmental Conditions: Methodology & Baseline Results submitted for publication).

Song, Z., Bao, Y., Zhang, D., Shu, Q., Song, Y., Qiao, F., 2020. Centuries of monthly and 3-hourly global ocean wave data for past, present, and future climate research. Scientific Data 7 (1), 1–11. https://doi.org/10.1038/s41597-020-0566-8.

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[1] https://github.com/ec-benchmark-organizers/ec-benchmark-2

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