EGUsphere, referee comment RC2
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Comment on egusphere-2022-508

Anonymous Referee #2

Referee comment on "Impact of wave-water level non-linear interactions for the projections of mean and extreme wave conditions along the coasts of western Europe" by Alisée A. Chaigneau et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-508-RC2, 2022

Summary

This paper analyses the impact of nonlinear interactions between wind-waves and water level changes using numerical modelling projections. The study is focused on the IBI region, and the methods involve running different experiments accounting (or not) for water level variations, under different SLR scenarios. The focus is on the wave set up, which is calculated by deriving the wave setup scaling (without beach slope); the latter can then be scaled based on different empirical formulae or slopes. This allows calculation of the wave set-up over different potential beach slopes. Results show projected changes in significant wave height, peak periods, and wave set-up scaling. The inclusion of water level variation in the wave model has little (but some) impact over the mean sea state, however it does have an important impact during extreme event periods, particularly in high tidal range regions. Here, including the water-level changes can lead to an increase of significant wave height and wave setup.

General comments

The interaction between waves and ocean are bound by complex feedback effects, which are difficult to represent in models, yet increasingly important to consider in the light of future sea level rise predictions. This paper therefore tackles a very current issue, of interest to the scientific community and within the scope of the journal; that of the impact of water-level changes over wind-wave projections in regional climate models.

This work gives a new, good picture of changes induced by water-level changes to both the significant wave height and the wave period at the coast. The study also shows changes to the wave set up scaling, in a way which can be easily re-used and adapted to future studies considering specific beach slopes.

Details on the models used and methodology are thoroughly detailed. The paper is overall well written with strengths as well as weaknesses of the method explained clearly and objectively outlined. The limitation of the study however could be better explained in the discussion.

The discussion brings up important points to consider when analyzing results but could be better written by developing what the implications of the paper's findings are.

I thinks this paper brings an interesting contribution to the field, but before publication I would like the authors to clarify the following major point:

- The model used does not include shallow water processes such as wave breaking (line. 93), and cannot represent important interactions with the seabed in shallow regions, as the minimum depth is 6m (line. 206). These shallow water processes, as stated by the authors in the introduction, are important for wave setup and set down; yet this work estimates the setup from data that exclude them. Can the estimation of the setup, calculated excluding important shallow water processes, be trusted? Is it a reliable approximation?

Detailed comments

Section 2 Methods: model and simulations: I find this section hard to read. I appreciate that all information required on the models are provided in section 2, and figure 1 is helpful to understand the simulation used, however it is easy to get lost in the nomenclature of the multiple simulations, and in the mere amount of information laid out. It may be worth considering simplifying the reader's work by adding a table containing a list of all simulations ran, including which forcing were used and the main details (resolution, period etc.) for each. This would improve the readability.

Line 217-223: '*Therefore, at first order, wave setup and runup can be predicted via empirical formulations […] wave setup estimates are based on an empirical formulation (Stockdon et al., 2006)*.' This is the paragraph where you should convince the reader that runup estimation is reliable, despite the model's approximation. Please give more details on the parametrization limitations and how the empirical formulation you use affects results (i.e. what processes you are missing out). Explain why you think this first order approximation is good enough, even though you are not including sallow water processes.

Line 243: When referring to the wave setup scaling the author sometimes use (eg. Line 243) and sometimes don't use (eg. Figur10 description, Line 433) the delta sign. Please be consistent with it.

Line 259-261 '*The ability of IBI-CCS-WAV and IBI-CCS-WAV_ssh to reproduce observed distributions is assessed for the mean state and the 99th percentile of the significant wave height and peak period since these variables are then used to compute the wave setup scaling (Sect. 3.2, 4).'* Has the IBI_CCS_WAV_ssh been validated? The section title seems to imply it hasn't ('*Validation and projections of IBI-CCS-WAV, without waves-sea level interactions'*).

Section 5. Discussion: Important points are discussed, but I would strongly recommend adding a section on the implications of your results. For example:

The authors found an increase in the wave set up and a large impact on the wave-water level interaction in regions of extreme tidal range. In the introduction, the authors talk about coastal hazards and flooding during extreme water level to motivate the study. You cannot quantify hazards based on wave setup alone, but there is a lot to discuss. Considering that the tidal range will also be affected by sea level rise, are the regions where you predicted an increase in wave setup the same regions that are at risk from extreme wave events today? Are there other regions in the world that these finding could be relevant for (eg. Regions where the tidal range is expected to increase significantly)? The number of extreme events is also expected to increase in future, and your results show that these are periods in which the wave setup is particularly affected by the water-level changes; this could also be discussed. Which are the limitations of this study?

Line 587, Impact of waves on sea level. Please discuss what this means in relation to your results: how would you expect the impact of waves on sea level to affect your results?

Line 605: The new paragraph starts with '*However*', it would be better to remove and start the sentence with '*The*'.

Section 6. Conclusion. The main conclusion is not clear. I would rephrase it a way that answers your main aim reformulated as a question. For example, answer specifically: How is the sensitivity of historical and projected sea states for the IBI region coastlines affected by the non-linear interactions between wind-waves and water level changes, notably during extreme events?