Response to Referee #2 (Anonymous) comments on

Rapid simulation of wave runup on morphologically diverse, reef-lined coasts with the BEWARE-2 meta-process model

Robert McCall, Curt Storlazzi, Floortje Roelvink, Stuart Pearson, Roel de Goede, and José Antolínez

We would like to thank the anonymous referee for their suggestions and constructive comments on this manuscript. We have attempted to address the points made by the referee in the updated manuscript and/or have provided our rebuttal below. In the following, the referee's comments are given in **black** font and our response in **blue** font.

We have been advised that we are not able to upload the updated manuscript to the discussion portal at this time. In lieu of providing the referee with an updated copy of the manuscript, we have therefore included screenshots of changes to the manuscript, where appropriate, at the end of this document.

General comments:

This paper is concerned with the development and application of a meta-process modelling system to address the need for a fast, robust prediction of runup on reef-lined coasts. The scientific significance of the paper is substantial given that it addresses a very real problem associated with the need to better predict coastal flooding along reef-lined coasts. The use of large data sets which are validated against the results of a numerical model (XB-NH), and the incorporation of roughness variations make this an important contribution. The paper is generally well written and well presented. Progress towards an early warning system for such vulnerable areas would be highly beneficial.

We thank the referee for their support of the topic addressed in this manuscript.

Specific comments:

Though the paper is very thorough and uses large sets of data, as the authors suggest, there is a skewed focus on U.S. data, and testing the model with examples from other locations would be interesting to see.

We fully agree with the referee, as previously noted in our Section 4.1 (Next steps). Stating that, it is the range of morphologies of the reefs (fringing or atoll reefs versus barrier reefs, each of which have thousands of samples and extend over scales of meters to 10s of kilometers in the cross-shore) spread across two oceans that matter more than the nationality of those reefs, and we feel we have a good first pass at them. But as also noted previously, more reef morphologies can always be added to the database and new RRPs developed to expand the metaprocess model's database.

The validation against the XB-NH runup values is understandable given the complexity involved with obtaining field measurements, however it would be interesting to see a comparison with field data, even if only for a very limited number of scenarios. The use of a 1D model is certainly far more practical, however would validation against a small set of scenarios with field or physical model data help to reduce the uncertainty as to the extent of these effects on the runup values?

This comment is broadly in line with a comment made by Referee #1, and we partly refer back to our response to that comment regarding the availability of real-world observations of wave runup on coral reef-lined coasts with which to assess the skill of BEWARE-2. Our conclusion in our response to Referee #1 is that these data are simply not available; previous metamodel studies have instead mainly used the wave runup results of numerical models (primarily

XBeach) that have been validated for wave transformation as a proxy for true observations. In effect we are doing the same in this manuscript, as we start off by training the metamodel with the model validated for wave transformation in field conditions (XBeach-NH+), and subsequently compare BEWARE-2 wave runup predictions to runup predictions of the validated model (XBeach-NH+).

Specifically regarding the use of laboratory data: we know from previous research (listed in Section 2.1.2 of the manuscript) that XBeach-NH+ is well able to simulate laboratory scale wave transformation and even wave runup (Lashley et al. 2018). However, translation of these results to field cases is here also limited by the 1D (2DV) assumption of the wave flume: alongshore gradient effects, including large-scale reef platform circulation and its effect on setup, are unfortunately not captured in these physical model experiments. To assess the accuracy of the BEWARE-2 metamodel for these cases, we will still require field observations.

We would like to reiterate from our response to Referee #1 that we very much intend to assess the skill of BEWARE-2 once new observational data become available.

I agree with the comments made by RC1, that a slightly more detailed/clearer explanation of the differences in the methods used in BEWARE2 compared to BEWARE would be beneficial to the paper.

This suggestion was indeed also made by Referee #1 and we refer to our response to our response to Referee #1 on this point (Key Point 2).

Figure 2. I think this figure could be improved. I understand the use of the 195 RRPs but is there a deliberate order to the way they are presented? Could this be improved? Is yellow the best choice of colour for the low runup?

This suggestion was also given by Referee #1 and we have followed the suggestion of Referee #2 to change the color scheme of this figure.

Could the font size be increased in Figure 3 and 5?

Where figure spacing allows, we have increased font size of these figures. We would like to note that for online readers of the manuscript, all figures are in vector format to support zooming in to any section of the figure. We have included a screenshot of the updated Figure 3 and 5 at the end of this document. Note that these screenshots are not in vector format, those in the manuscript are in vector format.

Figure 4: Is it necessary to include all profiles? The grey can barely be seen when printed.

We have included the grey lines to indicate the entire spread of observed profiles, but not with the intention for readers to study the individual profiles themselves. We have included a message to this effect in the figure caption.

I may have missed this, but what were the computer specifications used to run the XB-NH simulations?

For the purpose of the comparison of computation times between XBNH and BEWARE-2 (i.e., lines 448–449), is based on simulations on a 12th Gen Intel Core i5 laptop (referred to as a "standard desktop computer" in the manuscript) but should be fairly consistent for any "standard" computer. In the manuscript we do not specify the hardware used to develop the XBNH training dataset. Due to the 1D nature of the XBNH simulations, generating the training dataset is possible using separate or clusters of desktop PCs.

Technical corrections:

Ln 191 "…converted on…" should this be "…converted into…" ?

Thank you, we have corrected this in the manuscript.

Ln 472 “…”the influence reef health…” should this be “…the influence of reef health…”?

Thank you, we have corrected this in the manuscript.

Ln 474 “100s years…” should this be “…100s of years…”?

Thank you, we have corrected this in the manuscript.

Screenshots from updated manuscript (track-changes):

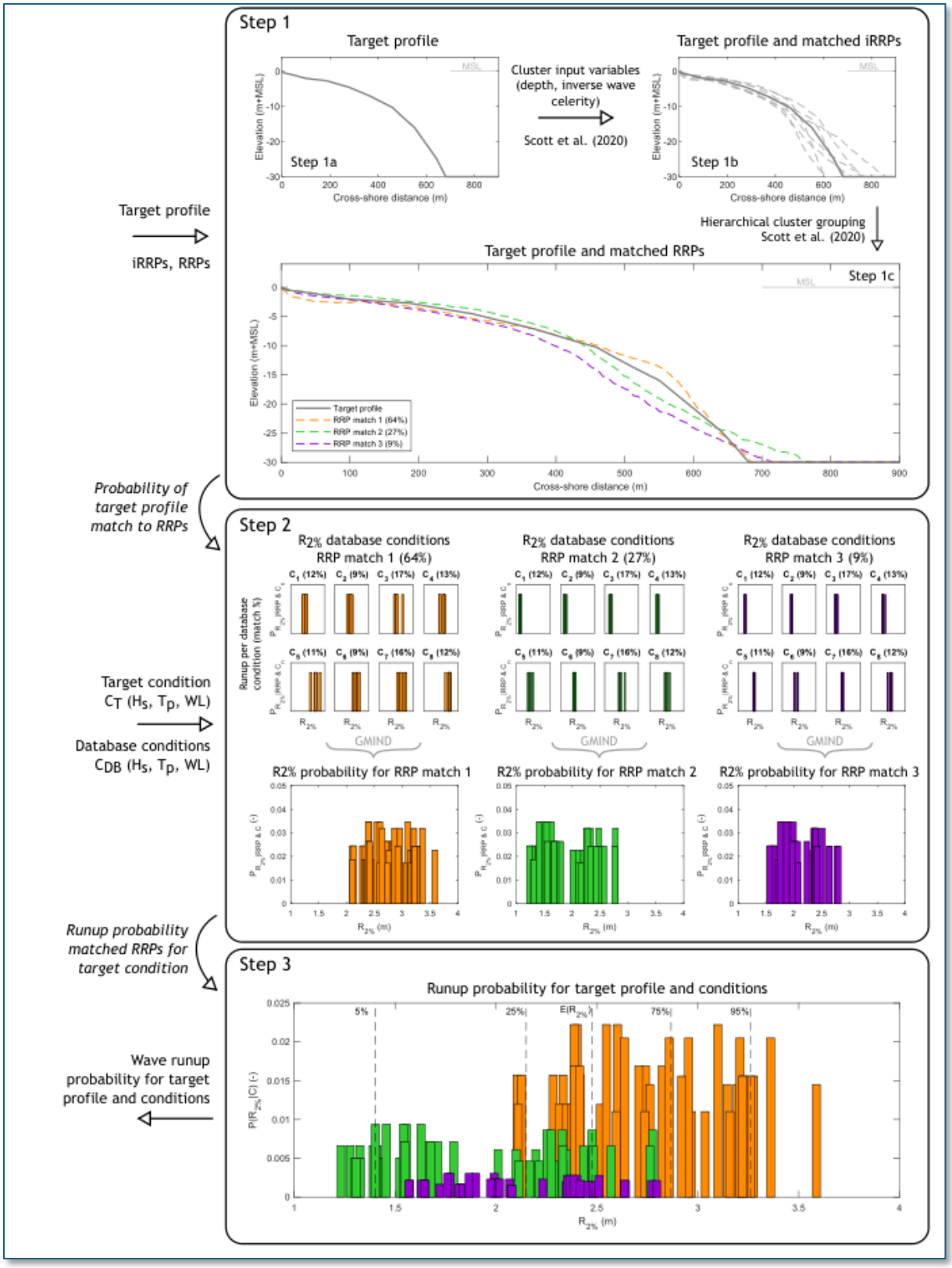

Figure 1: Screenshot of updated Figure 3.

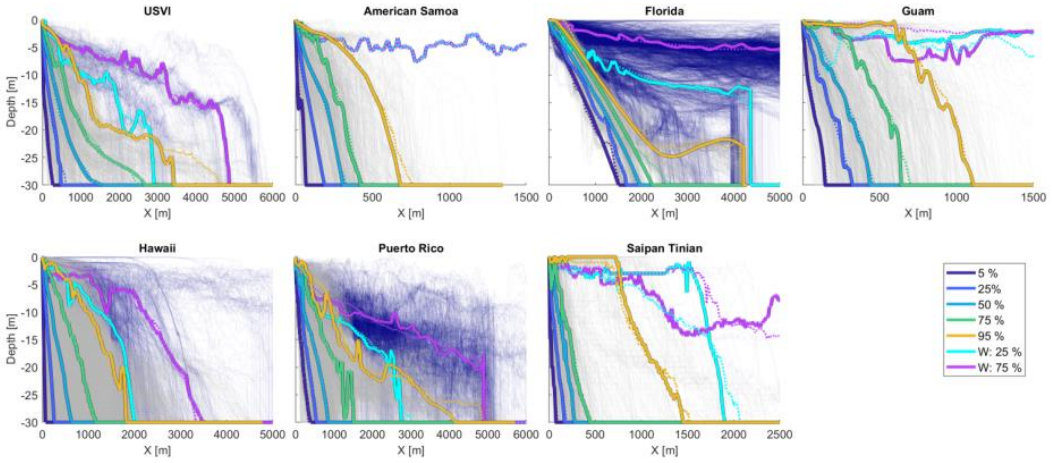

Figure 4. Observed, real-world, normal (gray) and wide (dark blue) cross-shore reef profiles for each of the seven geographic regions included in the dataset of Storlazzi et al. (2019), indicating the natural variability in reef morphologies. Colored dashed lines indicate the cross-shore varying, statistical 5, 25, 50, 75, and 95% depth exceedance ~~profiles and colored~~ values. Colored solid lines indicate ~~their nearest observed~~ the real-world profile ~~equivalent~~ most similar to each depth exceedence, which were used for model validation. For the wide reefs, only the 25 and 75% depth exceedance profiles were extracted for model validation.

Figure 2: Screenshot of updated caption for Figure 4.

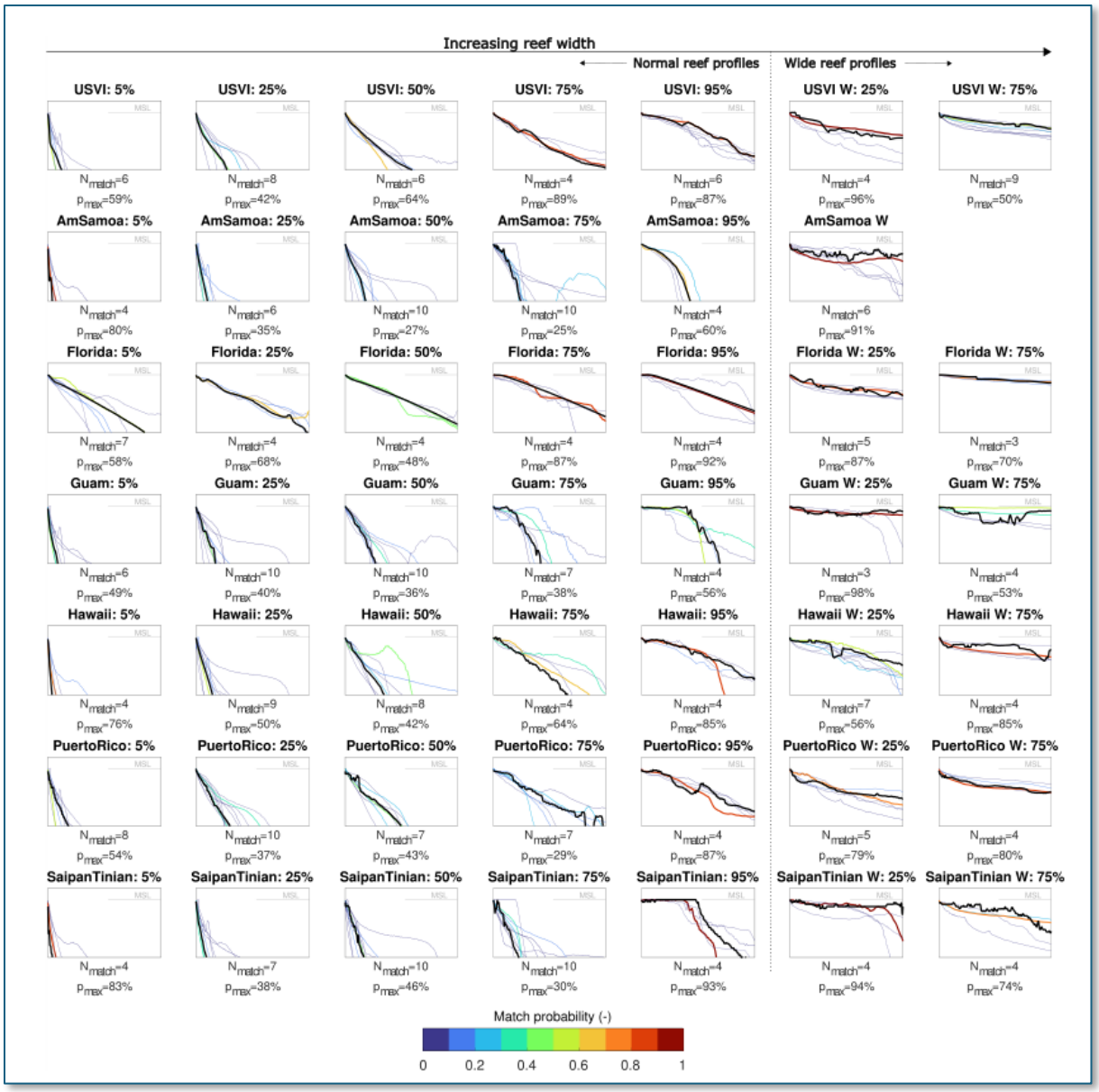

Figure 3: Screenshot of updated Figure 5.