

Interactive comment on “Coastal flooding: impact of waves on storm surge during extremes. A case study for the German Bight” by Joanna Staneva et al.

Anonymous Referee #1

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— General Comments

As a detailed assessment of a coupled high resolution wave-ocean modelling system's sensitivities in an extreme case, this paper provides a useful addition to existing published evidence regarding coupled systems and is a valid extension of the work in Staneva et al, 2016. I would therefore recommend this paper for publication, but with some additions/corrections related to the points below.

— Specific Comments

Section 2.1 Whilst this information may well be published in the authors' previous papers, it would be useful to those reading this paper in isolation if some extra details on

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the update frequencies of atmosphere and river forcing data were provided.

Section 2.2 This is an extreme case in shallow water, so please could the source term parameterizations for bottom friction and depth induced breaking dissipation that were used in the wave model be stated?

Section 2.3 I found the statements that " $\langle u \rangle$ is the sum of the Eulerian current and the Stokes drift" and "Thus the divergence of the radiation stress is the only (to second order) force related to waves in the momentum equations." somewhat contradictory. In the equations, Mellor (2011) has been followed correctly and I see the basic point about radiation stress being the difference between coupled and uncoupled systems, so just wondering if the authors can review the text in this section for clarity.

Section 2.5 As per the comment for section 2.1, can the frequency of coupling fields exchange be added please? Also, please note in Table 1 whether the NORIV wave model is one or two way coupled for consistency with the rest of the table.

Section 4.1 It's not clear whether the wave model discussed in this section and associated figures is the two way coupled version or the stand alone wave model. Can this be made more explicit?

Section 4.1, p9, line 9, Looking at the figure I get the impression that the peak of the storm is simply mis-timed rather than over predicted, unless the authors are discounting the measured peak for some reason. Please check.

Section 4.2 and later discussions. If I understand this correctly, the surge residual is defined by subtracting the same predicted tidal residual (generated via the T_TIDE package) from observations and model alike. The model residual is therefore a combination of both the model error in background tide prediction plus error in the surge prediction. In that case, I think it is important that any known systematic error in the model tide is stated in order to contextualise the benefits of the wave coupling. If these errors are not well understood, then I would recommend that the potential errors asso-

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ciated with the model tide are acknowledged and caveated in the discussion.

Section 5.1 Please comment on whether the coupling improved results at all individual stations, or just most of them...

Section 5.2 Regards the comparison with the barotropic model:

1) One of the arguments presented by the authors relates to large scale inter-annual effects on background water level, which a barotropic model will not deal with; this is correct, but can be mitigated to some extent if the predictive system for water level comprises an astronomic prediction of water level based on observations (which will include these long term effects) plus the barotropic model's estimate of the surge residual - this approach is adopted operationally in the UK for example. In terms of this paper one question for the authors to address is whether they believe that these effects are not present in the T_TIDE data used to calculate the residuals they show?

2) Of more importance, the barotropic model presented does not include any barotropic coupled effects (which might be included due to both waves radiation stresses and also water volumes associated with river inputs?) - however, the text implies that the main difference is baroclinicity. In order to make this argument better it would be good if the authors could present why they believe that introducing some coupled processes to the barotropic model would not close the gap between this model and the FULL run?

3) Finally, please check Figure 14, where the surge line for station ST3 does not look consistent with that in Figure 10.

Section 6 Items to consider for addition to the discussion:

1) the wave model, via the atmosphere model I expect, has over-predicted during period T2 and then been about right for period T3. In support of the comments regarding atmospheric uncertainties, how did the comparisons of modelled and observed surge vary during these periods for the FULL run?

2) in these simulations, there is no feedback to the atmospheric model from the waves,

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so the coupled system is not fully closed. In terms of the argument being presented here, where the waves are strongly affecting the ocean model in a shallow water region, I'd imagine that the sensitivity to the atmosphere-wave-ocean coupling is not too big a consideration at these scales; however, it might be useful to acknowledge this point more than has been presently done on line 9,p15.

3) Is it possible for the authors to discuss/speculate further on the role and potential uncertainties of the shallow water terms in the wave model?. My impression in this case is that the region with strongest wave-ocean interactions will see strong contributions from these terms in such a large storm and shallow depths.

— Technical Comments/Proposed text corrections

Page 2, para 2 There are a number of typos and the grammar could be improved significantly in this paragraph and, if kept, the authors need to review this carefully. However, in the context of the paper I think that the arguments being made about climate changes effects and other reasons for improving model accuracy can be taken as read (or just briefly expanded upon in the first paragraph); so I'd suggest removing this paragraph altogether.

p2, line 2, "predictions of the sea" -> "predictions of sea"

p2, line 6, "demand of improving" -> "demand for improving"

p2, line 8, "role at shallow area" -> "role in enhancing sea-surface elevation in shallow water areas"

p2, line 12 "mixing to circulation model." -> "mixing to a circulation model."

p2, line 17 "of biogeochemical" -> "biogeochemical"

p2, line 18, "radiation stress that accounts" -> "radiation stress accounts"

p2, line 20, "by number of studies like" -> "by a number of studies, such as"

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p2, line 30, "distributions s" -> "distributions is"
p3, line 30, "area are substantial hazard" -> "area are a substantial hazard,"
p3, line 31, "The coastal" -> "Coastal"
p4, line 22, "in details" -> "in detail"
p4, line 24, "are-sea" -> "air-sea"
p6, line 10, "equation of motions" -> "equation of motion"
p8, line 1, "The effects on using" -> "The effects of using"
p8, line 6, "rive" -> "river"
p8, line 11, "regions available" -> "regions are available"
p10, line 4 "in good consistency" -> "are consistent"
p10, line 10, "analyses on model" -> "analyses of model"
p10, line 13, "new examples on" -> "new examples of"
p10, line 28, "on Tables 2" -> "in Table 2"
p11, line 14 "reached reaching" -> "reached"
p12, line 16, "comparissons" -> "comparisons"
p13, line 11, "in direction to" -> "directed toward"
p13, line 31, "Even more" -> "Furthermore"
p14, line 7, "the three dimensional model" -> "three dimensional models"
p14, line 30, "hazard is" -> "hazards are"
p15, line 1, "has been gradually mature" -> "has gradually matured"
p15, line 2, "defective to satisfy the" -> "unable to fully satisfy these"

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p15, line 3, "the real time storm forecasting" -> "atmospheric storm forecasting"
p15, line 3, "is not perfect in practical use." -> "is not perfect."
p15, line 4, "It always" -> "This"
p15, line 5, "is depended" -> "depends"
p15, line 5, "accurate landfall position" -> "accurate prediction of landfall position"
p15, line 6, "tide may has a huge tide range" -> "tide may have a huge range"
p15, line 7, "forecasting cause" -> "forecasting can cause"
p15, line 9, "increasing the knowledge on" -> "increasing knowledge of"
p15, line 10, "weather forecast" -> "weather forecasts"
p15, line 13, "that wave-dependent approach yields to 25% larger surge at" -> "that the wave-dependent approach yields a 25% larger surge over"
p15, line 14, "German Bight reaching a contribution of about 40% is some coastal area" -> "German Bight and reaching a contribution of about 40% in some coastal areas"
p15, line 15, "The contribution of the fully 3-D model in comparison with a 2D barotropic one yield to" -> "The contribution of a fully coupled 3-D model in comparison with an uncoupled 2-D barotropic one yielded up to"
p15, line 23, "demand of disaster relief" -> "demands of disaster relief"

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