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Interactive comment on “Parameter sensitivity and uncertainty analysis for a storm surge and wave model” by L. A. Bastidas et al.

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Response to Comments by Anonymous Referee # 1 – p 6493 line 1 - A paragraph describing scientific questions and the aim of the paper could be added.

The following text has been added:

We present a parameter sensitivity analysis of the Delft3D computer model under extreme storm conditions using Hurricane Bob (1993) as the underlying event. The analysis allows for an evaluation of the model's ability to reproduce observed values of water surface elevation and wave height which are relevant for storm surge hazard predictions. In addition, because publically available wind observations do not provide sufficient information to drive the model, we evaluate the influence on the model per-

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[Interactive Discussion](#)

[Discussion Paper](#)



formance of three widely used formulations to derive wind fields: NWS23, Holland, and Rankine. Finally, an evaluation of the impact of the model grid resolution is also presented. Specifically, this paper aims to 1) demonstrate the importance of model parameter selection in storm surge and wave modeling; and 2) reduce the computational demand for producing surge and wave model parameter-related uncertainty estimates.

â€” p 6493 line 7 - It is specified that tide gauges records are generally shorter than return periods, making [. . .] this methodology unreliable, but some statistics methods exist allowing to compute return periods longer than records, and confidence levels are also computed.

We are aware that statistical fitting to extreme value methods are possible. However, sometimes the length of the record is too short for statistical fitting and any statistical extrapolation, based on those fittings, is extremely unreliable. That is one of the purposes of the present research, to overcome this type of issues by means as stated in the

â€” p 6498 line 11 - “This paper aims to . . .” objectives appear late in the paper (page 5).

See response to first comment above.

â€” p 6499 line 23 - Boundary conditions is not a part of numerical settings, but an input.

The reviewer is right, the words ‘boundary conditions’ have been removed.

â€” p 6500 line 25 - The wind drag formulation (U_b , C_b , C_c) is not clear enough, and could be specified.

If we were to describe in detail every single formulation, the paper will be extremely large and somewhat tedious. The following text has been added at the beginning of the last paragraph of section 2.2.1: “Hereinafter, we consider the wind drag formulation to be a three-point function of the wind velocity, as described in Deltares, 2014b.”

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[Interactive Discussion](#)

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âĀĀ p 6500 line 25 - Drag coefficient dependence of sea state have been demonstrated (Janssen 1989, 1992, Oost et al. 2002, Drennan et al. 2003) and is here also mentioned, but the choice to take a formulation only wind-dependant could be justified.

Delft3D only uses the wind-speed based drag coefficient. Even if we were interested in having the wind-drag as a function of sea state we believe any current models (Delft3D or ADCIRC) do not provide that opportunity. Research is ongoing, but the models have not yet caught up to include this complexity. In the present case: first, our calibration using only a wind-speed based drag looked reasonable. Neglecting sea state as a variable affecting wind drag did not prevent our model from producing reasonable estimates. Second, we are predicting coastal surge, so the perturbation of the sea state (i.e. wave heights) may be somewhat limited by the shallow depth of the water in coastal areas, which in turn limits the ability of the sea state to affect the drag.

âĀĀ p 6508 line 1 - Figures are not really introduced, it could be explained how is computed sensitivity indice for example.

The introduction of the methods to compute the sensitivity indices is not part of the objectives of the paper, as they are well established. A general description of the methods is presented in section 2.5. Again, the description of every single method in detail is beyond the scope of the paper. The relevant references were provided, i.e. Morris, 1991, Campolongo et al., 2007, Saltelli et al., 2001, etc.

âĀĀ p 6510 line 25 - Model is of high precision because “the bounds of simulations are quite tight” is not fully exact, it means that model is not so sensitive to selected parameters. Outputs are probably also very sensitive to other parameters, which are not mentioned here (bathymetry for example). Criteria to say if a model is of high precision would be more a low RMSE and bias (based on model/observations comparisons).

We use the standard definition for model precision which is related to the width of the uncertainty bounds. The standard definition of precision establishes that the measured or modeled values tend to be the same or similar all the time. A model may be of

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high precision without being accurate, i.e. even without bracketing the observations. It may have high values of RMSE and bias. The concept of accuracy is related to the bracketing of the observations. Again, low values of RMSE are not required for accuracy.

We did not consider necessary the inclusion of the definition of precision as it is well established.

â& p 6511 line 12 - Better performance is found for the Rankine model, this is really not surprising because figure 2 shows that Rankine wind model is the best match with observations, it could be mentioned.

That is not entirely accurate. In figure 8, we can see that the performance depends on the measure used. For example, at location 44008 the Holland model has the best performance in terms of Maxdiff. However, a statement is added just before the last paragraph of section 3.4: “This is most likely related to the best fitting of the wind fields using the Rankine model (Figure 2).”

Also, there is a conclusion (the second) indicating that the choice of the appropriate theoretical wind field is a significant consideration.

â& p 6511 line 27 - Increasing resolution leads at some locations to deterioration in the precision of the model, this is quite amazing, and these surprising results could be explained. The results could be presented in a more synthetic way (results for 5km is on figure 9, and “multiple” resolution on figure 10, is multiple resolution equivalent to 500 m resolution?).

We understand that the use of the concept of precision is different between our intended use and the idea of the reviewer. We have justified above that our implied use is more akin to the standard definition for the concept. That aside, yes, there are some locations at which the increased resolution does not lead to better simulations.

We do not agree with the suggested change in the order of the figures as it affects the

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Interactive Discussion

Discussion Paper



overall flow of the paper.

The second paragraph of section 3.5 already describes the results and the fact that the increase in resolution does not imply an improvement in the quality of the simulations, at least in terms of the error measures used here.

â– p 6513 line 10 - Model reproduces the observations with “reasonable precision and accuracy”, but we notice that even taking into account 95% uncertainties, model is in some locations still quite far from observations, particularly for waves. This shows that it is probably not just a question of parameters – or that all sensitive parameters haven’t been explored. Results could be analysed more deeply.

The somewhat positive statement about the particular computer code used seems to have drawn the attention of both reviewers. The conclusion has been modified to say:

“Overall, Delft3D shows an ability to reproduce the water surface observations with reasonable precision and accuracy at most of the locations considered. However, the performance in terms of the wave height is of a lesser accuracy with the precision significantly decreasing at the tail of the simulated event. As expected, the simulations are dependent on the wind fields driving the model.”

Technical corrections

â– p 6497 line 18 - New York appear twice

It is customary in the USA to refer to the location and the state because several cities share the same name but in different states. The text has been changed to ‘New York City’.

â– All the figures are very small, and medium quality doesn’t allow reading it easily. Moreover, legends are really not enough precise (colours and markers should be detailed). For example, for figure 1 the area (US North Atlantic Coast) could be added.

The figures provided to the publishers were of sufficient size. The original idea was

that they will have a one page size to guarantee clarity and quality for all the details. They were downsized during the typesetting process. A request will be made to the typesetters to keep the size.

The suggestion of the reviewer regarding Figure 1 was included in the caption. As to the other figures, the captions have been changed to include the details of colors and markers and the type of indices shown, e.g. Figure 3 – Campolongo sensitivity indices for water surface elevations at tidal gage locations for different wind model and error function: blue upward pointed triangle – Maxdiff, brick left pointed triangle – RMSE, mustard right pointed triangle – MAE

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