Geoscientific Model Development | Ms. Ref. No.: GMD-2023-151

Title: Development and performance of a high-resolution surface wave and storm surge forecast model: Application to a large lake

Author(s): Laura L. Swatridge et al.
MS type: Model experiment description paper
Iteration: Major revision

Response to Reviewers Comments

Public justification (visible to the public if the article is accepted and published):
Dear Ms. Swatridge & co-authors;

I have now received two referee reports. The first indicates a desire to publish your manuscript essentially as-is. The second suggests rejection of your manuscript. This latter referee notes several points which, at least to me, look more straightforward to address than would be suggested by the "reject" suggestion indicated here.

I would ask your team to address Referee #2's eight points by responding to them and updating your manuscript and/or supplementary products, as appropriate, accordingly. I believe that you can improve the quality and impact of the manuscript through this process. I look forward to seeing both these responses and the updates that you make to the text, figures, and additional information.

Best wishes,
Andy Wickert

> **Response:** We thank the editor and reviewers for their time in continuing to review this manuscript, and are optimistic that through addressing the comments, the manuscript has greatly improved in quality and clarity throughout this process. Please find below a response to all comment from the referee reports. These details are provided using indented blue text underneath each comment.

Report 1:

> **Response:** No comments to address. We thank the reviewer for carefully reviewing the manuscript.

Report 2:

Suggestions for revision or reasons for rejection (visible to the public if the article is accepted and published) Reviewing of the round 2 version of the manuscript ‘Development and performance of a high-resolution surface wave and storm surge forecast model: Application to a large lake’ by L.L. Swatridge et al. (2024).

Thanks for the authors of their responses to my comments. However, the revisions and comments are not substantial to improvement of the manuscript. My suggestion is Reject.

The following are specific comments.

1. For a research paper, I could not clearly find the research gap from previous studies and the novelty of this work. For example, what the new knowledge could we gain from this study? This should not just a case study and model application analysis.

    Response: This is not a research paper, it was submitted as a model experiment description paper. We believe the findings of this manuscript fit within this scope, and have demonstrated that the application of Delft3d-SWAN as a real-time forecast model in the Great Lakes is novel.

2. I was thinking the modeling results based on different model grids while the authors have not given. For example, how the grid changes of wave model influence the simulation results of water level, storm surge, and wave statistics?

    Response: we agree that model resolution is a fundamental aspect of model accuracy, as values for storm surge and wave statistics will change as more details of the coast and small scale hydrodynamic features are resolved, as has been shown in previous works (eg. McCombs et al. 2014; Bastidas et al. 2015).

    The model resolution is comparable to other studies that have achieved accurate results in the great lakes in hindcast studies (Mao and Xia, 2017; Lin et al. 2022). Therefore, the use of this grid in real-time capacity is justified. In addition, the results are compared to the GLCFS model, which has a higher resolution in coastal areas (up to 30 m), and it is shown that the results are comparable (Section 4.2).

Bastidas, L. A., Knighton, J., and Kline, S. W. (2016). Parameter sensitivity and uncertainty analysis for a storm surge and wave model. *Natural Hazards Earth System Science.* 16. 2195-2210.

Lin, S., Boegman, L., Shan, S., and Mulligan, R.P.: An automatic lake-model application using near real-time data forcing: Development of an operational forecast workflow (COASTLINES) for Lake Erie, Geosci. Model Dev, 15(3), 1331-1353, https://doi.org/10.5194/gmd-15-1331-2022, 2022.

Mao, M., and Xia, M.: Dynamics of wave-current-surge interactions in Lake Michigan: A model comparison, Ocean Modelling, 110, 1-20, https://doi.org/10.1016/j.ocemod.2016.12.007, 2007.

McCombs, M.P., Mulligan, R.P., Boegman, L., and Rao, Y.R.: Modelling surface waves and wind-driven circulation in eastern Lake Ontario during winter storms, J. Great Lakes Res., 40(3), 130-142, https://doi.org/10.1016/j.jglr.2014.02.009, 2014a.

3. Still, I would require the authors show the modeling results by including the river discharges, since they could be important to the lake hydrodynamics in a relatively shallow lake.

Response: We have already responded to this. It is not feasible to include inflows and maintain a water balance over long term simulations. This will not impact storm surge and surface waves, which we discussed in our last response. It will impact currents near the Niagara river inflow, but we do not seek to model/forecast currents. This lake is ~200 m deep, it is not shallow as the reviewer claims. This is beyond the scope of the present work.

4. For the storm event selection, it is ambiguous to me what are the differences between 'largest event' and 'strongest event'?

Response: The definitions of what is considered the 'Largest events' are explained in the text:

Line 282: This event was selected due to the large storm surge generated (η = 0.17 m), and it resulted in the largest significant wave height that occurred over the 20 month operational period with wave measurements available at all buoy locations for comparison.

Line 349: For further investigation into model performance during storm events, wave forecasts during the event that resulted in the largest observed wave heights (December 1, 2022, Fig. 3c) were examined

5. 50% relative error for the storm surge prediction is not satisfactory, it needs to be improved.

Response: As this is a real-time operation model, results cannot be calibrated for every possible event, therefore greater uncertainty is expected in these results compared to hindcast models.

As we have noted, this error (shown in Figure 5h) corresponds to an absolute error of 5 cm, which falls within acceptable performance ranges developed by NOAA (+/- 15 cm), as discussed in the previous response (Kelley et al. 2018). The is also compared to acceptable performance criteria for hydrodynamic models developed by Williams and Esteves (2017), which defines a maximum error in peak water level of 15 cm as acceptable.

We also note that as the forecast lead time decreases the error improves, with a minimum error between observation and modelled results at this location of 2 cm. This is updated in the text as:

Line 293: "A set down of about 0.10 m was recorded at the Burlington station, which was underpredicted by the model by up to 0.05 m for the initial forecast results, and improves as the forecast lead decreased to a prediction of 0.08 m."

Williams, J. J., and Esteves, L. S. Guidance on setup, calibration, and validation of hydrodynamic, wave, and sediment models for shelf seas and estuaries. *Advances in Civil Engineering*. 2017(1).

6. Figures 5,7,9,10 have so many solid lines, which is difficult to identify. The quality of this figure is not acceptable.

Response: This is a personal opinion. The other reviewer and the authors find this figure acceptable. We argue that the multiple overlapping lines are an important demonstration of evolving model forecast.

7. While my comments suggest authors to compare their forecast systems with GLFS, they select to ignore my comments.

    Response: See section 4.2 in the discussion where the model is compared to the Great Lakes Coastal Forecasting System (GLCFS)

8. Why the forecasting system (https://coastlines.engineering.queensu.ca/elementor-2122/) of wind speed is March 2024 not June 2024?

    Response: This is a bug in a website and has nothing to do with the submitted MS.