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Interactive comment on "Unstructured global to coastal wave modeling for the Energy Exascale Earth System Model using WAVEWATCHIII version 6.07" *by* Steven R. Brus et al.

Anonymous Referee #2

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Review:

This is a groundbreaking and well-written study. The authors demonstrate how an unstructured WAVEWATCH III (WW3) spectral wave model setup can be used to conduct variable-resolution global simulations, with purposes of coupling with an earth system model. Like the two-way nested structured mesh approach, the unstructured model resolves coastal areas with similar accuracy of a higher resolution uniform-structured-mesh model but with lower computational costs. The study uses a consistent method to determine global mesh refinement. The unstructured approach is straight-forward to integrate with earth system models, and is an ideal choice for coupling with variable-

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resolution earth system models such as the E3SM.

General comments:

A1. The first half of Section 2.1 (L91-98) seems to imply that using a two-way nested structured mesh setup in WW3 is more computationally expensive than a variable resolution unstructured mesh (in terms of achieving similar accuracy). Is this a correct interpretation of the text? And if so, is it more of an opinion or is it based on previous studies or work by the authors?

I ask because regional wave climate studies often use WW3 with a nested structured mesh setup to resolve coastal regions and readers might be curious how this approach compares with the unstructured mesh setup.

My understanding is that there is a higher computational overhead (or at least was initially) when using an unstructured mesh (as well as differences in accuracy). Depending on the setup, it seems highly plausible that a two-way nested model could be more accurate or faster than using the unstructured approach (despite calculating potentially overlapping cells).

While a comparison of these two approaches is likely outside the scope of this study, it seems like a potentially missing component to make any definitive statements on accuracy or cost.

A2. As a follow up, I am wondering if this manuscript has overlooked situations where a nested structured mesh setup with WW3 might be preferable to an unstructured mesh for global simulations. Of course, it seems quite natural and desirable to use WW3 with an unstructured mesh with variable resolution earth system models such as the E3SM. However, there are some earth system models that do not use variable resolutions (e.g., ocean circulation model with a fixed horizontal spatial resolution) but do employ high-resolution atmospheric models (e.g., 0.2 degree spectral grid). In such situations, it seems like the nested structured mesh approach might be better since

communication with the atmospheric component would require limited field remapping (assuming near-coincident mesh placement).

In light of this, it might be worthwhile to review a few statements, such as those found in L47, L109, and L424-426, to see if any minor clarifications are necessary.

A3. One of the strengths of using the unstructured approach in global simulations is highlighted nicely by the sentence on L413-414.

Could the authors elaborate on why 4000 m was chosen for the refinement? In this wave model setup, the largest wave length resolved is around 1200 m, and depth effects are not likely to become important until around 600 m or shallower. I imagine the choice has to do with ensuring smooth transitions but it would be nice to know more details.

A4. In the comparisons with buoy data, there seems to be a negative bias at many of the stations when using the unstructured mesh model. I can see why the 2 degree structured mesh model might have a positive bias but the former case is not so clear to me. This may be more of an open question but do the authors have an idea of why this might be occurring (e.g., differences in numerical scheme)? Is this just a feature for this particular setup or does the negative bias persist for different resolution refinements (e.g., unstructured mesh with a 2 degree to a 1 degree transition)?

As a potential follow up, what is the beta parameter value used for the ST4 physics? In Rascle and Ardhuin (Ocean Modelling, 2013), the beta value is tuned for use with NCEP CFSR winds using a structured mesh setup. It seems plausible that similar improvements could be made tuning the same parameter with an unstructured mesh setup.

A5. L418-420 & Table 3: Can you clarify the following statements in L418-420?

"Overall, the ... have larger errors for the unstructured case."

Is this referring to the buoy validation results or global comparisons with the 0.5 degree

structured mesh? In the latter case, it does appear that the biggest improvements in agreement coincide with the Gulf of Mexico and the U.S. East Coast. However, in Table 3, there are dramatic performance increases in coastal regions of the Gulf of Maine, Alaska, and S. CA Coast when using the unstructured WW3. Aside from the N. CA and Pacific N. W. Coast, this improvement tends to be in regions with significant swell.

Specific comments:

B1. L188-189: How much does the use of the PR1 propagation switch affect accuracy for the structured meshes? This seems like important information to include since most structured mesh setups would not likely use this setting.

B2. Section 4.1: What model values are being used for the buoy station comparisons? Is a nearest neighbor approach being used (i.e., using the cell average computed by WW3 that the station falls within)? And if not, how sensitive are the results to interpolation method?

B3. L265-266: Is buoy station 44025 relatively far from the coast compared with other the buoy stations?

B4. L269: I recommend changing "The representation" to "Better representation", or similar.

B5. Table 3: It's a little odd that the 2 degree structured WW3 model performs slightly better in deep water than the 0.5 degree model for the S. CA Coast. Do the authors have any ideas why this might be?

Minor comments:

C1. I believe the proper nomenclature for the model (in the title and manuscript) should be 'WAVEWATCH III'.

C2. L151-152: Please add 'degree' to both instances of "1/2 structured mesh/es".

C3. L295: Station should be '46215' and not '36215'.

C4. Table 3: Please state that table values are percentages.

References:

N. Rascle, F. Ardhuin, A global wave parameter database for geophysical applications. Part 2: model validation with improved source term parameteri- zation, Ocean Model. 70 (2013) 174-188

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