Natural Hazards and Earth System Sciences Discussions

Nat. Hazards Earth Syst. Sci. Discuss., referee comment RC2
https://doi.org/10.5194/nhess-2022-95-RC2, 2022

Comment on nhess-2022-95

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Referee comment on "Nearshore Tsunami amplitudes across the Maldives archipelago due to worst case seismic scenarios in the Indian Ocean" by Shuaib Rasheed et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2022-95-RC2, 2022

The manuscript by Rasheed et al. describes the detailed modeling of tsunami hazard to the Maldives caused by credible worst case scenarios from various sourse locations. An emphasis is put to the ability to accurately model the wave behavior in the complex topography/bathymetry of the archipelago.

The work is significant, the presentation clear and well structured and the methods mostly up to date. I still recommend some major revisions, because I think the whole potential of this work has not been harvested. However, with relatively little effort, this work could in my view be of even more relevance, so I suggest considering the following.

General comments

1. A short discusion on why not a standard tsunami model was used, but a self built non-validated (at least not with the standard tsunami benchmarks according to Synolakis et al., 2008) based on Firedrake. What are the advantages compared to e.g. COMCOT or TsunaCLAW?

2. What kind of criteria were used for the diverse decisions made:

a. Mesh refinement - is it just proximity to coast?

b. removal of islands from the large scale simulation - is it size?

3. To me the local resolution mesh sizes seem still rather large. A 5000 m mesh size at the Maledives Atoll coast for the large-scale simulation yields an effective wave lenght

representation of 30 km or more (given the linear P1 elements of the DG discretization). Is this a reasonable scale? Additionally, the non-uniform mesh would allow for higher local resolution without much additional effort in terms of added unknowns, since the local area of refinement would cover only fractions of the domain. The same applies to the local simulations, where a 50 m mesh size allows to represent wave lengths of approx. 500 m or a little less that that. With island sizes of only meters in size, I doubt if this is high enough a resolution for quantitatively accurate results. Some sensitivity studies would be helpful in this.

4. Since you indicated in the text that you are only considering wave heights at the coast and no inundation, what are the boundary conditions at the coasts then? In Harig et al. (2008) it was found that inundation BC are necessary even if not used to realistically prepresent coastal reflection of waves.

5. In order to evaluate the wave build-up it would also be valuable to consider the different wave lengths/periods in comparison to the obstacle size (atoll diameter e.g.) to have a conceptual understanding of this phenomenon. I hypothesize that a singular atoll of a size less than - say - half the deep ocean wave length will be passed by the wave without major harm, given the extremely steep bathymetry. But this would be an interesting topic of diagnostics, analysis and discussion for the different locations and angles of attack.

6. You claim that such results are only possible by high resolution bathymetry data and go further to ask for even higher resolution in this respect. But you do not prove that this is really the case. It would be very instructive (and in your case probably easily possible) to actually demonstrate this claim by comparing the effect of diffraction, reflection and deflection in your large-scale and small-scale simulations. For example the results in figure 8, do they differ substantially for your large- and small-scale simulations? If so, I would buy your demand for ever higher resolution ;-) Here I assume that you use the same bathymetry data in your simulations, but that you interpolate to your unstructured mesh and therefore have different discrete bathymetries in your simulations.

Minor comments

1. **Lines 205-210**: I don't understand why 2500 m mesh sizes are used at continental shore lines, while only 5000-7500 m are used at the atoll boundaries - isn't this the area of interest, which should have the highest resolution? Additionally, given the capability of non-uniform meshing, a resolution of approx. 250 m along the atoll shore should be much more useful and feasible.

2. **Figure 4**: Can you explain why the wave patterns are so different in the two scenarios with respect to locality? It appears from the visuals that scenario a) produces much smoother results than scenario b), while the maximum values are somewhat similar. Have these simulations been run with different meshes?

3. **Figure 5**: These figures are very small and hardly distinguishable. Lagoon boundaries are invisible, and details are additionally blurred by the different scales used in the upper and lower row. I would suggest to improve by cropping the areas sideways and lining them besides each others increasing size. Also the same scale (maybe logarithmic) should be used for better comparison.

4. **Line 296**: Bengukulu -> Bengkulu.

5. **Section 3.2**: You mention several times that hazard levels with 1 m wave height increase with high tide levels. However, you don't mention how high high tide actually is. It would therefore be helpful to learn about the tidal elevation for those places, you mention.

6. **Line 340**: Calrseberg Ridge -> Carlsberg Ridge.

7. **Line 465**: Link does not work or is incomplete.

References

Synolakis et al. (2008): Validation and verification of tsunami numerical models, Pure appl. geophys. 165:2197-2228, doi:10.1007/s00024-004-0427-y.