Nearshore Tsunami amplitudes across the Maldives archipelago due to worst case seismic scenarios in the Indian Ocean
Response to Reviewer One

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1 Introduction

The authors would to like to thank referee 2, for taking the time to review paper providing valuable feedback for improving the manuscript. We are glad that the referee found that providing access to the results via the interactive GEE page, "will be of great benefit to the wider community." Below we respond to each of the comments from the referee and provide a summary of the proposed corrections.

2 Response to comments

2.1 Response to Main Comments

2.1.1 Comment Number 01

Aside from the detailed feedback below my main critique of the work is related to the numerical modelling and would recommend some additional efforts in this regard. The main issue is the use of coarse (50m) fine-resolution' grids. The authors themselves repeatedly state the necessity of high resolution bathymetry/meshes to capture the complex wave patterns of tsunami waves around and within Atolls. They state that their high resolution mesh has a minimum mesh element size of 50m however in their referenced work [Rasheed, 2021 (a)] it appears that bathymetry data on a 10m resolution is available. If high resolution information is key to capturing the complex tsunami wave patterns, something which this reviewer agrees with, why have the authors not used a finer resolution mesh? Is there an issue with computational resources? Please expand on this.

1. *We appreciate that increasing the resolution of the mesh from 50m at the coastline as in the present study to approximately 10m might have implications on the results of the study. We chose 50m due to sensitivity studies done earlier in previous studies where we found that the representation of bathymetry at 50m and 10m did not have considerable difference albeit the increase in mesh elements and computational expense, and also because we are more interested in the wider atoll scale patterns rather than at the island scale. However, as the referee has suggested we understand that it is essential to*

include a sensitivity study of selecting the mesh resolution to understand the implications on the results of the study and we will include a section in the revised manuscript based on further simulations.

2.2 Comment Number 02

The authors state that the model Thetis can capture wetting/drying using the algorithm described in Eq. 3, however they have chosen a minimum water depth of 0.1m. From this reviewer's experience this minimum depth is overly conservative. If a higher resolution mesh is used than I would encourage the authors to reduce this value. Otherwise the over-topping of low-lying islands may not be captured accurately and thus the influence on the resultant wave pattern will be missed. Further comparisons to run-up and inundation measurements from the 2004 survey could also be made. It should be noted that despite the recognised absence of additional terms in the non-linear shallow water equations (NSWE) for capturing inundation, numerous NSWE solvers have been validated against inundation and runup tasks, [Macias 2017] is one such example.

1. *The authors completely agree with the referee in that avoiding a minimum depth and using wetting and drying to capture inundation would make the study comparable to field measurements. However, during the study we made a pragmatic choice to represent the islands as voids in the mesh, mainly due to the fact that no large scale topographical data is available in the public domain for any of the islands in the Maldives. Some present studies assume fixed heights of 1.5m to 2m for the islands, however from tsunami observational data as reported in the manuscript we find that despite the relative low lying nature of the islands, the relative differences in topographic profiles of the island play a major role in inundation levels across the island. Hence, we decided that due to the lack of data, we would focus on identifying high impact regions at the atoll scale which could be highlighted for further study which could be used to model individual island scale inundations with the availability of high resolution topography and bathymetry. In selecting 0.1m as the minimum depth we also considered the fact that, all most all of the inhabited and industrial islands of the Maldives now have sea walls and additional off shore coastal protection which also needs to be taken to account for island scale modelling.*

2.3 Comment Number 03

Has the Thetis model in this set up been validated against traditional tsunami benchmark problems? If not I would suggest taking a look at the problems outlined in [https://nctr.pmel.noaa.gov/benchmark/].

1. *The Thetis coastal ocean model has been benched marked and compared to similar models such as in Pan (2020), where results are presented for some of the standard bench mark cases also outlined in [https://nctr.pmel.noaa.gov/benchmark/]. However, it should be noted that here we used the 2d hydrostatic version of Thetis since we donot focus on inundation and rather on identifying the larger atoll scale patterns of tsunami flow. We appreciate that for more small scale simulations which includes topography and inundation, we would require the use of non-hydrostatic version of Thetis which has been benchmarked in Pan (2020) marked against standard tsunami inundation cases such as the Okushiri tsunami.*

2.4 Response to Minor Comments

1. *Since these are suggestions by the referee to make minor changes to the manuscript to fix figures and typing errors, we will make the changes as suggested in the revised manuscript.*

3 Conclusion

We have proposed to include a sensitivity test to address the main issue of the reviewer in selecting the mesh resolution. Further, we have tried to explain the choice of using a minimum depth and excluding inundation modelling for this study due to lack of data. We hope that these proposed changes are satisfactory to the referee.

References

Pan, W.: Development of a non-hydrostatic coastal ocean model using the discontinuous Galerkin method, 2020.