Response to Reviewer 2

The manuscript outlines a methodology for defining habitability functions, which are purported to be a more accurate reflection of the impact of natural hazards and the ability of a community to recover than earlier work on damage or fragility functions. The authors focus on the impact of Hurricane Irma on locations on the Atlantic coast of Florida. The method couples information from a hurricane surge model (Delft3D-FM) with information from location based services and property data to deduce if residents of damaged buildings have resumed normal routines, linking this deduction to habitability of their homes. They indicated that the impact of water depth (flood depth) appears to be the major influence on habitability, greater than wave height or water velocities.

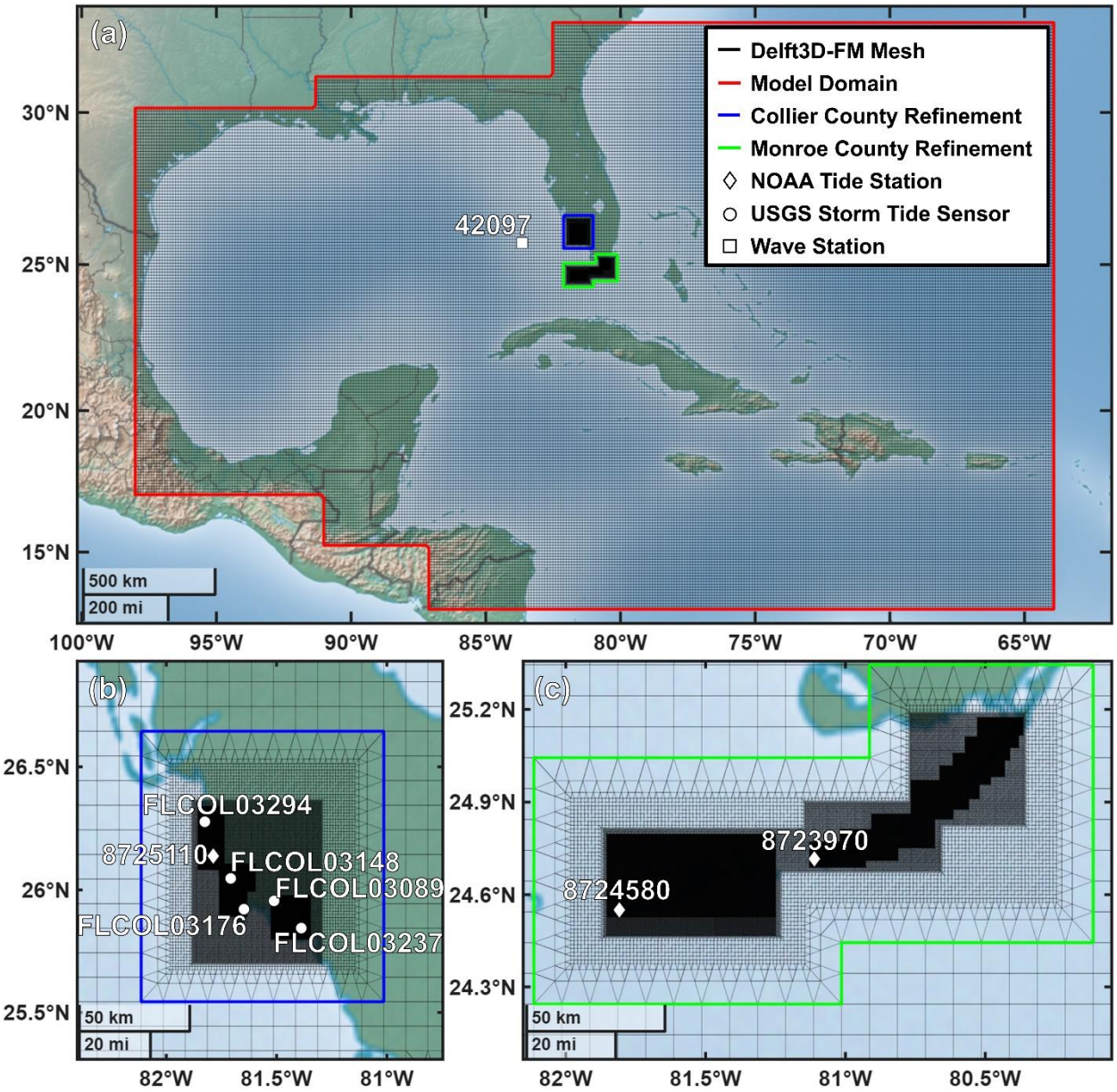
I think this is very interesting, perceptive work. I do have a few comments:

Thank you for the kind words regarding our work as well as the comments provided. We appreciate the time spent reviewing our study and have responded to each comment below, incorporating corresponding changes to our manuscript.

During our revisions, we have made some modifications/corrections to the flood model. Reviewer 1 asked about using an 80m SWAN grid and Reviewer 2 commented about increasing the model domain. These changes had minor impacts on our model and study. We also corrected two important details regarding the flood model during our revisions that resulted in more significant changes. Firstly, the original model used a uniform Manning's coefficient of roughness for the Monroe County portion of the model. After implementing a spatially varying Manning's coefficient, the maximum flow speeds modeled in Monroe County were reduced, which also resulted in better logistic regression fits for the models relying on flow speed. The second flood model detail we corrected is for the overland significant wave heights modeled in Collier County. We discovered a bug in the software that resulted in a lack of resulting wave data for Collier County. Our revised model now includes simulations that were not subject to this bug and therefore contain complete wave results for the full model domain.

1) Figure 1 shows the model grid. This seems very small for hurricanes. The grid implies the assumption that water level changes generated outside the grid due to the hurricane are negligible. This may or may not be the case for this specific storm event, but is not generally the case, as many hurricane researchers using ADCIRC use their standard grid, which covers half of the Atlantic Ocean. There has been work that suggests that a small grid might miss surge forerunners and other possible motions that can cause additional damage aside from the main surge event. This might explain why the model is incapable of simulating the long surge buildup (Figure 2d). If the emphasis is on peak surge, then perhaps it doesn't matter, as the model seems to be sufficiently tuned to get the max surge right. But to what degree does this impact the velocities (and, in turn, impact the finding that the habitability functions developed with velocities perform poorly)?

Thank you for the suggestions regarding the domain of our model. We have now expanded our domain to cover much more of the Gulf of Mexico and Atlantic Ocean (Reviewer Fig. 1). As stated above, this had only minor impacts to the model relative to other changes, but we have still revised our study using this expanded domain.



Reviewer Figure 1: Updated figure showing expanded domain.

2) Also regarding modeling: the tidal conditions from Egbert and Erofeeva can be less accurate in very shallow water, such as that near the Bahamas, where the offshore boundary is located. Was this accounted for?

We appreciate the additional comment regarding the model setup. We did not account for the influence of very shallow water on the accuracy of the tidal constituents. However, when we expanded our domain as in Reviewer Fig. 1, we did not see a noticeable change in the simulated tides, indicating the potentially less accurate boundary conditions in very shallow water did not significantly influence our results.

3) While I understand the presumed connection between habitability and the resumption of a normal routine originating from the same dwelling, the definition of "habitability" might be somewhat ambiguous. After Katrina, many residents lived in their homes while being compelled to return to their routines, yet many of these homes had no power or water. These homes served as functional shelters but that shouldn't be confused with recovery, since they were far from recovered. In many cases, these residents were out of options. This might actually bias the reliability of these habitability functions against those with lower incomes and fewer options. I guess I would like to either see a clearer definition of "habitability" (i.e. dwelling with sufficient cover from the elements), or these habitability functions placed in a more general context.

Thank you for the suggestion to clarify our exact meaning of building habitability. While we originally discussed some of the assumptions regarding our habitability functions in the Introduction in lines 45-47 and in the Discussion in lines 315-324, we agree that there is some ambiguity in our original definition of habitability that should be clarified. Firstly, we have added additional lines clarifying these assumptions by stating in the Methods that “This assumes that the reason a user did not return to a location is solely because that location was damaged by Irma beyond habitability. This assumption does not account for other socioeconomic factors that may influence if and when someone returns to a location.” Furthermore, in the Results we have added the sentence, “Another apparent detail of these functions is that some buildings are uninhabitable at relatively low hazard levels and others are habitable at relatively high hazard levels.” Regarding the specific example of Katrina, our methodology would need adjusting since we state that locations “are assumed to be uninhabitable due to damages caused by Irma since essential services such as power and schools were recovered by this point.” This goes beyond assuming a building is just a functional shelter, which we believe is appropriate for this study. However, this would be an issue for applying our methodology for an event such as Katrina, where the Reviewer points out many residents returned to homes without power or water. We have added the following to address this assumption: “Another important assumption for our definition of building habitability is that essential services such as power and schools are recovered 18 days after Irma’s landfall in Florida. While this assumption is appropriate for Irma (Hodge & Lee, 2017; Mitsova et al., 2018; Swanson & Guikema, 2024), flood events that cause longer recovery periods for essential services may create difficulties in estimating building habitability the same way.” We also included the Reviewer’s point about potential biases against people with fewer recovery options by adding that “For example, someone may not return to a completely undamaged building if they are able to stay with friends or family for an elongated period, and

for others, returning to a highly damaged building may be the best option, which may bias these functions against people with fewer recovery options."

4) The method relies on the availability and amount of LBS data. Collier and Monroe Counties have almost half a million residents between them. What would be possible in a place like the Louisiana coast? St Mary Parish, the largest coastal parish, has barely 50,000 residents. Is there a lower limit on data which would make the method meaningless?

This is a good observation and question. The amount of LBS data available for Collier and Monroe Counties is actually quite larger than the amount utilized to develop these habitability functions, largely due to the fact that we did not use locations with modeled maximum flood depths of zero. Specifically, in Collier County we have 16,769 identified locations but only use 348 for the habitability functions. In Monroe County, which had a population of approximately 77,000 in 2017, we have 1,736 locations and use 659 (~1% of the population) to develop these habitability functions. So even though there are almost half a million residents between Collier and Monroe Counties, we retained a significantly larger portion of locations in Monroe County. Therefore, in a place like St Mary Parish, one could estimate obtaining roughly 500 locations (1% of the population), assuming the majority of the area experienced flooding and a similar population to building ratio as in Monroe County. This would be sufficient for repeating our methodology. The company we obtained LBS data from, Veraset LLC, has also reported that it is increasing the quantity of LBS data collected, meaning that greater proportions of the population could be used for developing habitability functions for years after 2017.