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Interactive comment on "High resolution numerical modeling of mesoscale island wakes and sensitivity to static topographic relief data" *by* C. G. Nunalee et al.

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We thank the reviewer's for their time and insightful comments. In light of the input from the reviewers, we have revised our original manuscript and are confident that we have thoroughly addressed all of their individual comments. Of particular note, the revised manuscript incorporates a third global terrain dataset (i.e., GMTED2010) which helps to reinforce the results gleaned from our GTOPO-based and SRTM-based model comparison. Furthermore, in the revised manuscript GMTED2010 and SRTM were both remapped from their native 7.5s and 3s resolutions to 30s resolution prior to ingestion into the WRF model's preprocessing system. The remapping was done by

the USGS interfaces used to download the data. These interfaces can be found at http://dds.cr.usgs.gov/srtm/version2_1/SRTM30 and http://earthexplorer.usgs.gov for SRTM and GMTED2010, respectively. Once the 30s SRTM and GMTED2010 data was downloaded (i.e., SRTM30 and GMTED30) we examined whether the differences in model results associated with each terrain dataset were explicitly due to source dataset resolution or instead differences at a deeper level. As is shown in the revised manuscript, the significant differences between the GTOPO30, SRTM30, and GMTED30-based simulations are found even when terrain remapping is invoked which indicates that the resolution of the dataset is not necessarily the root cause of the modeled flow field differences. Below we provide point-by-point responses to individual comments.

Reviewer #1, Comment 1: This paper is well written. i suggest it to be published after resolving these issues: Why the orography datasets are so different for this island? It is due to resolution and why?

Author response: As discussed above, this is an important question to address and what our new results show is that the differences in the orography between the different datasets is not necessarily due to resolution. This was determined because even with the use of terrain remapping from high resolution to 30s resolution the differences still remained. Given that spatial resolution is not the differentiating factor between GTOPO, SRTM, are GMTED, it is likely that the differences are due to the methods in which the different datasets were compiled.

Reviewer #1, Comment 2: What would be the larger scale influence of the orography difference?

Author response: This manuscript has focused on the implications of the orography difference on the atmospheric mesoscale. To understand the implications of these difference on a synoptic or global-climactic scale one would need to perform numerical simulations at those respective scales. Unfortunately, such experimentation is beyond the scope of the current work.

Reviewer #1, Comment 3: It is a good suggestion for future model studies to consider which dataset to use, however, I suggest to emphasize in both abstract and conclusion about what specific aspect to consider, resolution?

Author response: We have added a sentence to the end of the conclusion which essentially states that modelers could evaluate the uncertainty of their simulations to terrain dataset by comparing the agreement of available terrain datasets for the area of interest prior to performing numerical simulations.

Reviewer #2, Comment 1: This manuscript is well-written and the reviewer is delighted to see studies of the sensitivity to orographic height (which is usually not published by modeling groups or left as a detail not considered worthy of publication). That said, the reviewer is concerned about the way in which the orographic datasets are interpolated to the target resolution. As explained below, it seems likely that the differences in GTOPO30 and STRM are due to resolution differences and not the datasets per se.

Author response: We agree with the reviewer that the interpolation method could potentially play an important role in this study. That being said, we have re-run all of our simulations using terrain remapping of SRTM and GMTED to 30 second resolution before ingesting it into the WRF model's preprocessing system. This remapping was done by the USGS's web interface which allowed us to download the data at 30s resolution directly. As is shown in our new results, very little difference is observed compared to the previous results which indicates that the simulated differences between SRTM/GMTED and GTOPO are not explicitly due to source data spatial resolution.

Reviewer #2, Comment 2: The orographic height generated from GTOPO30 and SRTM as shown in Figure 3 look like two completely different mountains. In particular, the "GTOPO30 mountain" does not even look like a smoothed version of the "SRTM mountain. While this could be due to plotting cross sections that are not averaged along the other dimension, it could also be due to the interpolation method. If that is the case it

is not surprising that the two simulations are drastically different.

Author response: The new figure 3 illustrates terrain profiles of Gran Canaria after terrain remapping was applied. As can be seen, the significant differences between GTOPO30 and SRTM30/GMTED30 are still present yet the differences between SRTM30 and GMTED30 are marginal. As a side note, the terrain profiles shown in figure 3 are not dependent upon a plotting cross-section, instead they represent a southern (3D) view of the modeled island.

Reviewer #2, Comment 3: The authors state that they use the default interpolation method to map elevation data from GTOPO30(approx. 1km)/STRM(approx. 300m) to the model grid (1km). If interpolation and not remapping is used to map from a higher resolution grid to a lower resolution grid, one ends up effectively sampling the value closest to the target grid point in question instead of averaging source grid values over a control volume (as is done in remapping). If indeed linear interpolation is used to map STRM data to the model grid, such sampling is occurring which will inevitably lead to higher elevations than if remapping is used. This does not happen with GTOPO30 since it has approximately the same resolution as the model grid. The reviewer therefore speculates that the GTOPO and STRM differences are due to not using remapping. The authors are kindly asked to use remapping for the STRM mapping. If the authors show cross sections of the raw topographic data they will likely show that STRM has much higher elevations than GTOPO simply because it is higher resolution and therefore resolving the peaks better. In that case the authors should not attribute the differences to the orograhic source dataset per se but the resolution of the topographic data. In any case, the manuscript demonstrates that orography rougher than GTOPO is needed to accurately simulate flow downstream of the obstacle. This leads to questions about the smoothing procedure. There are several techniques (e.g. envelope orography) that attempt to raise peak heights without introducing spurious noise in the solutions. Maybe such techniques would render the GTOPO-based elevations rough enough for producing more accurate results. How and how much the orography is smoothed might be as important as the raw datasets. As mentioned above, the differences may be more due to differences in the resolution of the raw elevation dataset rather than which dataset is used (for this particular case). The above needs to be discussed in the manuscript. It would be very interesting if the authors would investigate different smoothing algorithms (such as envelope orography) if they are easily accessible/doable (from a software perspective).

Author response: As discussed above, the revised manuscript used high resolution terrain datasets remapped to 30s prior to ingesting it into the WRF model's preprocessing system. The remapping was done by the USGS and downloaded directly at the 30s resolution.

Reviewer #2, Comment 4: Many models also include effects of under-resolved orography in the parameterizations. These usually use the standard deviation of the under-resolved orography. Are such parameterizations used here? This should also be mentioned in the manuscript since such parameterizations could also lead to significantly different simulation results.

Author response: In the results presented here, no parametrization for under-resolved orography has been invoked. Conventionally, such parameterizations are used primarily for larger-scale numerical simulations when grid scales are significantly larger than the terrain dataset resolution. Such parameterizations are frequently used to account for the effect of gravity wave drag at the synoptic and/or global scale. Nonetheless, the revised manuscript has included a mention of under-resolved topography parameterizations in the conclusion.

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