Reply on RC2

We would like to thank the reviewer for his/her careful reading and constructive criticism. The suggested modifications have been a decisive help to revise and improve our manuscript.

This paper presents a global unstructured mesh configuration of the WW3 model tailored for capturing distant-source swells in the tropical ocean, especially around small volcanic islands. The authors implemented the spectral wave model WAVEWATCH III over a variable-resolution grid, with finer mesh around island shorelines (as low as 100m), allowing for a more detailed representation of tropical islands. The model, forced by ERA5 wind fields and corrected for biases via satellite data, seeks to address limitations in previous models that relied on coarse, regular grids with obstruction masks, which introduced negative biases. The new approach demonstrates improved predictive accuracy for sea states in tropical areas, and results are compared with in-situ data nearshore at depths between 10-30m. However, several aspects need refinement, such as clarifying resolution differences around validation sites, examining triad interactions and partition comparison in shallow water, and addressing wind field temporal resolution. The manuscript's clear and well-organized structure contributes valuable insights into the challenges and methodologies for wave modeling in complex island environments.

Major Comments:

1. **Clarification of Novelty:** The claim that this is the first study to directly compare with nearshore data in 10-30m depths is inaccurate; other global wave model studies have also achieved this. While this study is pioneering in certain aspects, the authors should revise the abstract and relevant sections to reflect this context accurately.

Here we only partly agree with this comment because the very few global wave model studies that made direct comparisons with nearshore data considered wave buoys actually moored by 20-30 m water depth but located several km away from the coast (Zheng et al., 2016; Alday et al., 2021). The novelty of our study is that, due to the volcanic island context, such water depth are found a few hundred meters from shore only. In the revised manuscript, we better explained the novelty of our study in abstract and in the discussion.

We agree with the reviewer's remark, the following modifications have been applied in the revised version of the manuscript in lines:

In lines 11 to 13 in the Abstract:

"Moreover, this new simulation allows for the first time direct comparisons with the in-situ data collected on volcanic islands at depths of water ranging from 10m to 30m, which corresponds to a few hundred meters from shore."

In lines 257 to 262 in the Discussion:

"However, the resolution employed in these studies also remains too coarse to allow for a direct validation in nearshore shallow depth. A few studies already compared global wave model with stations located by 10-30 m water depth, although these wave buoys were moored at gently sloping inner shelves or in big lakes (Zheng et al., 2016; Alday et al., 2021). The novelty here

is that, due to the steep slopes usually surrounding volcanic islands where our stations are located, such water depths are found very close to shore, typically a few hundred meters."

2. **Wind Field Temporal Resolution:** The choice of 3-hourly ERA5 data might be insufficient for fast-moving systems, such as hurricanes. Given that ERA5 offers hourly data, it would be valuable to understand why 3-hourly data was chosen. Further, suggestions on time interpolation techniques to better capture these conditions would be helpful.

Hourly wind field data were also considered but a sensitivity analysis revealed that it only improved model bias predictive skills by 0.62% and increased the normalized error by 0.04% (see Figure 1). In order to explain our choice we added in the revised version in lines 107 to 108 : "*. ERA5 also offers hourly data but sensitivity tests revealed similar results with 3 hourly wind fields.*"

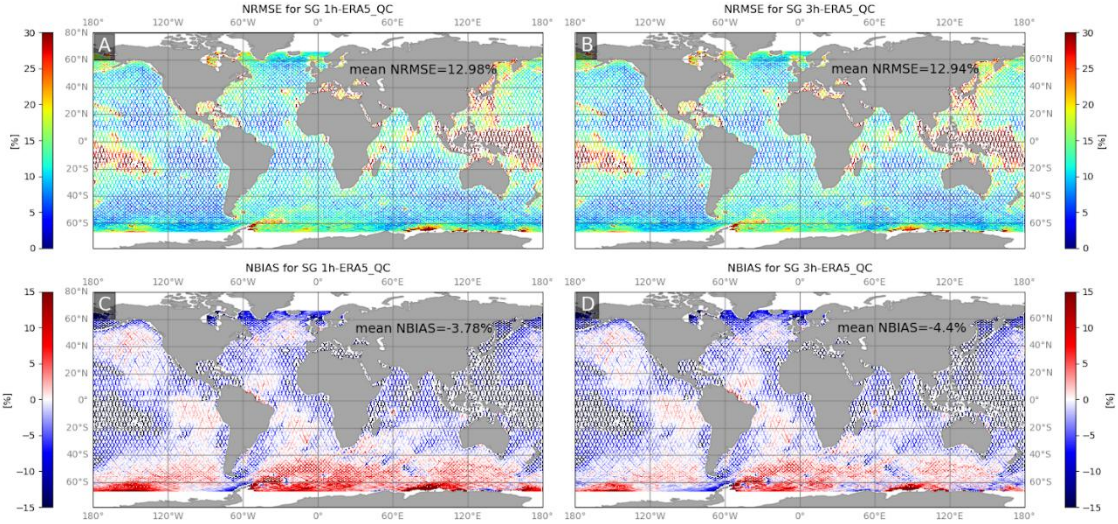

Figure 1 : Normalized RMS error (A) and bias (C) between Hm0 deduced from altimetry and simulated with the SG 1h-ERA5_QC configuration and normalized RMS error (B) and normalized bias (D) with the SG 3h-ERA5_QC configuration

Concerning hurricanes, we added complementary explanations in lines 275 to 276: "*Moreover, the spatial resolution and the representation of the strongest winds limit our ability to accurately model waves generated by hurricanes (Jullien et al., 2024).*"

3. **Triad Interaction in Shallow Waters:** While the study employs triad interactions, the impact on shallow water gauges isn't clearly demonstrated. It would be beneficial to include an analysis of triad effects on gauge results in these areas.

We propose to show the wave spectrum in La Réunion Island at the peak of the DDS event of June 2022, with and without triad interactions (see Figure 2). In the revised version of the manuscript, Fig. 14 was modified accordingly:

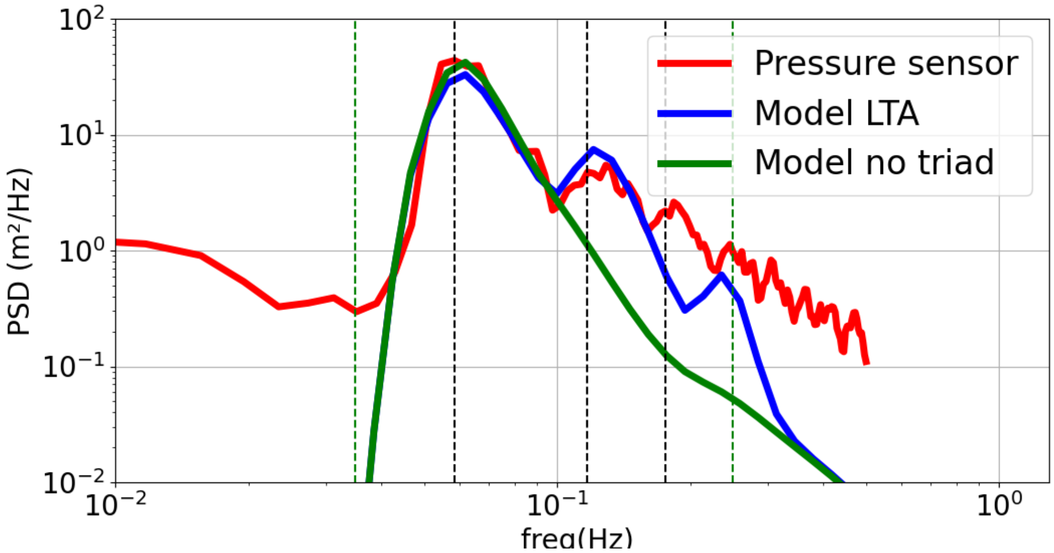

Figure 2 : : Comparison between measured power spectral density modelled and observed at 9:00 UTC on June 8th, 2022 (Hermitage, La Reunion Island). The green lines represent the cut-off frequencies. The black lines represent the peak frequency and the superharmonic frequencies.

4. **Handling of Singularities with Regular Grid:** If the regular grid configuration masked out the North Pole to avoid singularities, clarify at which latitude this masking was applied and what is the consequences on the results?

The regular grid extends up to 80.5° latitude, excluding the North Pole. Beyond 80° latitude, the ocean is predominantly covered by ice, so extending the grid to higher latitudes would not provide additional meaningful information.

5. **Quantifying Swells without Partitioning:** The paper does not describe a method for separating wind-sea and swell partitions, which is essential for accurately quantifying swells (this is the main argument of this paper). Swell partitioning would allow better comparison between modeled and observed swells and enhance understanding of the model's performance across different wave types. This would be beneficial, especially in coastal observations, to assess model accuracy across partitions.

In order to separate wind-sea and swell partitions, directional spectrum data exposed to wind sea and swell are required. As the sensors deployed in La Reunion and New Caledonia are located along the leeward coast of these islands, they were not exposed to wind waves generated by trade winds and hence were not considered for this analysis. We focused on the Guadeloupe wave buoy, which was exposed to trade wind sea and for which directional spectra were available. Because wind measurements required to compute the wave age were not available at this station, the spectral partitioning using a frequency cut (PTM5 in WW3) seems the most adapted in our case. Considering frequencies where both wind waves related to trade winds and DSS are present, a minimum can be observed at about 0.12 Hz (see figure 3), which we used to separate swells and wind waves. Integrating the wave spectrum with this frequency cutoff, one can see that the model reproduces DSS and wind waves with a similar accuracy (see figure 4). However, as satellite data from the missions used in this study and most wave buoys do not allow access to wave spectra, we do not think that this analysis should be integrated in manuscript.

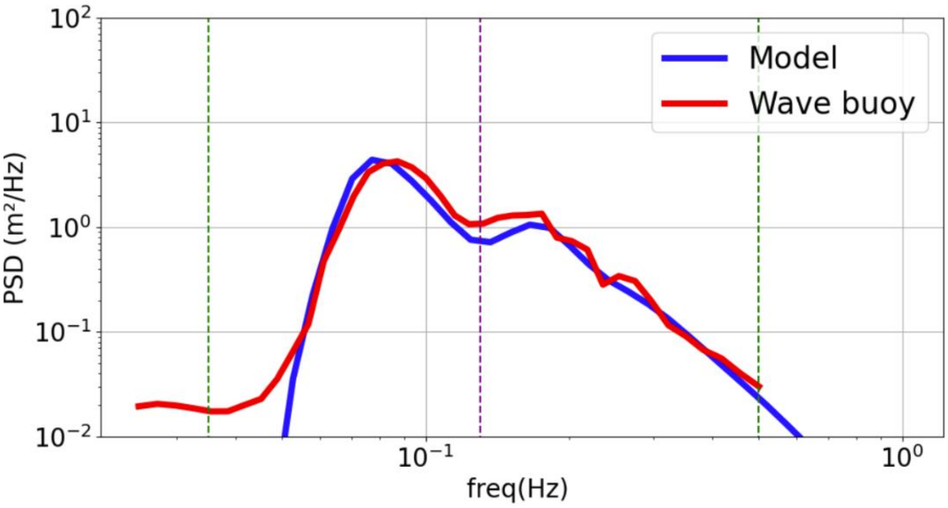

Figure 3 : Comparison between power spectral density modelled and observed at 21:00 UTC on March 22nd, 2008 (Pointe de la Grande Vigie, Guadeloupe). The purple line represents the frequency cut-off for the swell partitioning.

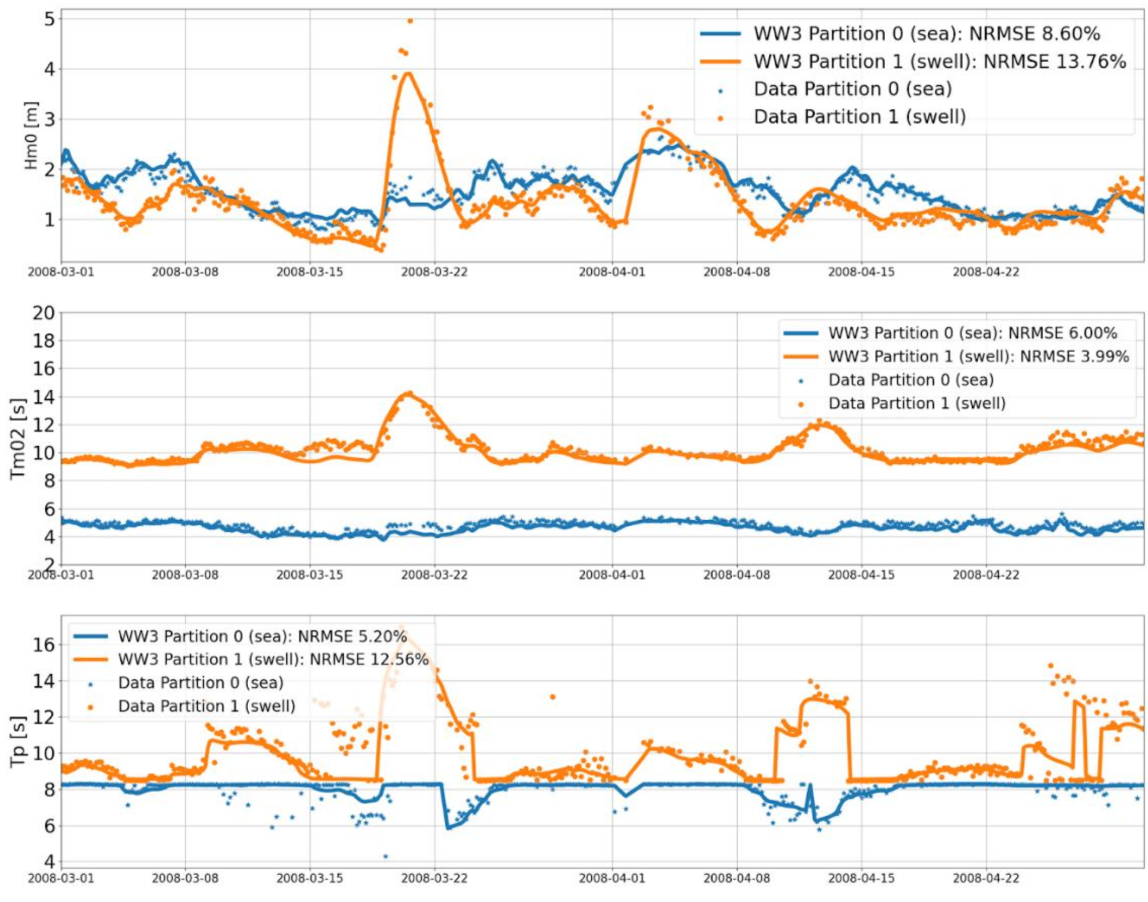

Figure 4 : Wave bulk parameters derived from partitioned wave buoy data against model for March to July 2008 at La Pointe de la Grande Vigie (Guadeloupe) for a) Hm0 b) Tm02 and c) Tp.

Minor Comments:

1. **Figure 5 Labeling Issue:** Ensure the y-axis label in Figure 5 is fully visible.

We thank the reviewer for pointing that out, we have modified the figure in the revised version of the paper so the y-axis label is now fully visible.