Response to RC3

31st January 2022

Dear Reviewer,

We sincerely thank you for the constructive comments that greatly helped us to improve the manuscript. Here we present our point-by-point responses and revision to the comments.

Sincerely,

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General Review Comments

In the manuscript entitled 'Characteristics of two tsunamis generated by successive Mw 7.4 and Mw 8.1 earthquakes in Kermadec Islands on March 4, 2021', the authors have addressed a not trivial case capturing tsunami characteristics generated by two successive earthquakes. This study provides insights of the source spectrum based on the empirical Green's function (EGF) and tsunami/background ratio methods. The spectral analysis allows distinguishing the dominant wave periods and ranges. The paper is well written but the discussion and conclusions should be improved. I suggest further revision to the following comments.

Comment 1

While the selection of a second-order high-pass filter has been tested (e.g. Heiderzadeh and Satake, 2013; Heiderzadeh et al., 2015), the justification of the window or frequency corner is not clearly stated. This selection may affect results.

Response and Revision

Thank you. As the maximum tsunami period in our study is approximately 30 min, it is reasonable to apply a filter with a corner period of four times longer than that value.

Comment 2

Considering that this is a peculiar case where two tsunamis are generated from close sources, I've found that the Section 5 and the Conclusions are weak. These sections

could be enhanced by exploiting more the results, and providing a thorough discussion that is lacking. Also, consider to add limitations of this study (e.g. not using the DART records).

Response and Revision

Thank you very much. In response to this comment, we added a new paragraph at the end of Section 5.
In Line 246, we added:

"As limitations of this study, we could mention a few items: We are not using DART data due to the short duration of high-sampling records. In general, DART records are valuable type of sea level data in terms of tsunami source studies because they are less affected by local and regional bathymetry. In addition, the number of sea level records that we used for analyses of these tsunamis is not very large due to the limited number of available stations."

Comment 3

The authors are encouraged to provide further interpretation of the results higher frequencies, decaying processes and source characteristics, specially in light of one of the main observations of this study described in Line 195.

Response and Revision

We acknowledge. There are short-period (high-frequency) waves of approximately 5 min, which arrives at later stages due to dispersion. In Section 4, we added the following descriptions:
In Line 175:

"We note that the dispersive effects of tsunamis from the second event are evident on the wavelet plots as tsunami dominant period for the few initial waves is around ~20 min, whereas it linearly shifts towards ~10 min for the later waves, giving us the opportunity to plot the inverse dispersion lines (black dashed lines in Figure 4). We plotted the dispersion curve on these diagrams. We also observe short-period waves with period of 5–8 min at some sea-level stations (Table 1; Figures 3–4), which we attribute to various local bathymetric effects. In addition, we also note that wavelets and Fourier analyses give spectral results with varying degrees of accuracies, because wavelet analysis also incorporates the time evolution and thus its spectra are not usually as detailed as those obtained by Fourier analyses."

Comment 4

The overall structure of the paper is fine, but some elements of the Methods appear in the Section 5, where instead, discussion is expected. Also, the results of the subsection 2.3 'Earthquake Slip Models and Tsunami Numerical Simulation', where simulations

based on the USGS source models need further contextualization/discussion, for example, in Figure 5.

Response and Revision

(1) We agree. In response to this comment, we moved some content from Section 5 and created a new Section 2.4.

In Line 113, we added:

"2.4 Calculating Tsunami Source Period

In this study, we calculated tsunami source period from finite fault models to compare with the results of spectral analyses. Theoretically, the tsunami source period is related to earthquake rupture length and water depth (Rabinovich, 1997; 2010; Heidarzadeh and Satake, 2013; Wang et al., 2021). It can be estimated as:

$$T_n = \frac{2L}{n\sqrt{gh}} \quad n = 1,2,3,\ldots \ , \qquad (1)$$

where L is the typical size of tsunami source area (length or width), g is the gravity acceleration, and h is the average water depth in source area."

(2) We added more explanations on our simulations based on the USGS model.

In Line 204, we added:

"We simulated the propagation of two tsunamis using *JAGURS* code and plotted their maximum amplitude in our region of interest to investigate their propagation path (Figures 5a and 5b). ~~, and the~~ The tsunami amplitude in the NW-SE direction is larger than that in the NE-SW direction because it is parallel to the short axis of the fault. The propagation paths of two successive tsunamis are similar ~~(Figures 5a and 5b)~~."

Comment 5

Lines 83-84, articles needed.

Response and Revision

In response to this comment, we added some reference articles.

In Line 88, we added:

"We ensured that there were no storms or other atmospheric events at the time period of the background signals, so the background spectra could exclusively reflect the frequency response of local topography (Cortés et al., 2017; Aránguiz et al., 2019). Tidal components were removed by applying a high-pass filter in a similar way to preparation of the tsunami records (Heidarzadeh and Satake, 2013)."

Comment 6

Line 127, needs rephrasing: Similar patterns were also be observed at Ouinne…

Response and Revision

In response to this comment, we added more explanations.
In Line 140, we added:

"Similar patterns were also be observed at Ouinne: Short-period components existed in the few hours after the second tsunami's arrival, but the waveforms after 01:00 (+1) were dominated by long-period components (Figure 2)."

Comment 7

Line 133, modify 'at most stations. At most stations …'

Response and Revision

In response to this comment, we modified the language.
In Line 148, we changed:

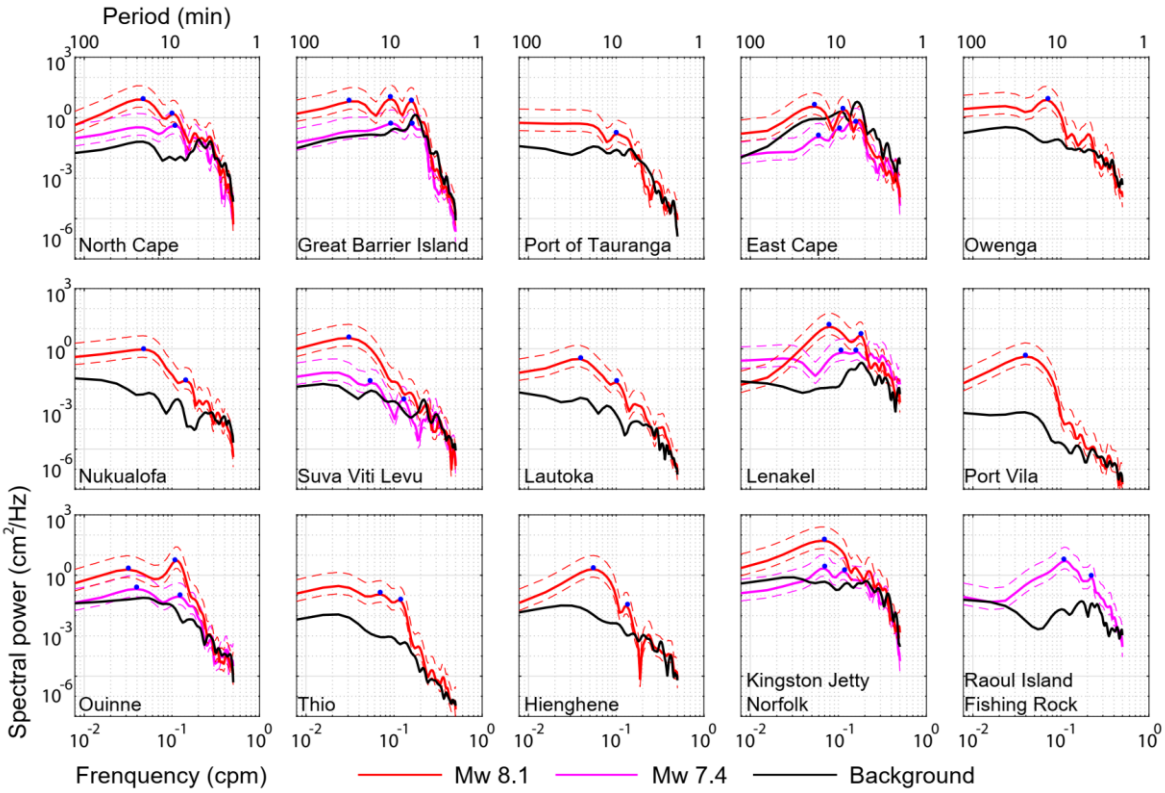
"~~At most stations, the~~ The peak periods of the first tsunami are mostly distributed in the range of 5–17 min…"

Comment 8

The figures of this manuscript have been greatly improved in the answers to previous comments, but I suggest to modify the green point that shows the spectral peaks in Figure 3. Instead, consider using a stronger color.

Response and Revision

In response to this comment, we changed the color of points showing the spectral peaks.


Period (min)
100
10
1
North Cape
Great Barrier Island
Port of Tauranga
East Cape
Owenga
Nukualofa
Suva Viti Levu
Lautoka
Lenakel
Port Vila
Ouinne
Thio
Hienghene
Kingston Jetty
Norfolk
Raoul Island
Fishing Rock
Spectral power (cm²/Hz)
Frenquency (cpm)
Mw 8.1
Mw 7.4
Background