Interaction of tsunamis generated by successive Mw 7.4 and Mw 8.1 earthquakes on Kermadec Islands on March 4, 2021

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On March 4, 2021, two earthquakes occurred successively on Kermadec Islands, New Zealand. The foreshock (Mw 7.4) happened at 17:41:23 (UTC) whose epicenter was at 29.58˚S, 177.03˚W with a depth of 41 km. It had a thrust mechanism and generated a small tsunami. The mainshock (Mw 8.1) happened at 19:28:33 (UTC), approximately two hour later after the foreshock. The epicenter was located at 29.11˚S, 176.77˚W with a depth of 37 km. It generated a moderate tsunami affecting New Zealand and other Polynesian countries. The epicenters of two earthquakes are very close (~55 km) and their focal mechanisms are similar. The occurrence of two successive tsunamigenic earthquakes provides us with a rare opportunity to study the tsunami interaction.
We collected sea surface elevation records at 15 tide gauges: North Cape, Great Barrier Island, Port of Tauranga, East Cape, Owenga, Nukualofa, Suva Viti Levu, Lautoka, Lenakel, Port Villa, Ouinne, Thio, Hienghene, Kingston Jetty Norfolk, and Raoul Island Fishing Roack. We conducted spectra analysis to these records. The spectra of Fourier analysis show that the dominant period ranges of the first and second tsunamis are 5–17 and 8–28 min, respectively. In addition, wavelet analysis show that two distinct oscillation patterns with different period ranges are visible on the wavelet plots of most stations. We observed that after the arrival of the second tsunami, the oscillation in the period range of the first tsunami still persists and becomes sometimes stronger at some tide gauges, indicating the interaction of the two tsunamis. We calculated the source spectrum of second tsunami by two different approaches: empirical Green’ s function (EGF) method (Heidarzadeh et al., 2016) and tsunami/background ratio method (Rabinovich, 1997). Using the first tsunami as the EGF, spectral deconvolution indicates that energy of the second tsunami is mainly distributed in the period range of 8–30 min, with spectral peaks at 25.6, 15.7, and 9.8 min. The method of tsunami/background ratio presents similar results: The period range of main energy of the second tsunami is 7–28 min, with spectral peaks at 25.7 min, 14.2 min and 9.1 min. These results are also consistent with the dimensions of USGS source models. It indicates that the short axis has stronger effects on tsunami source spectrum.

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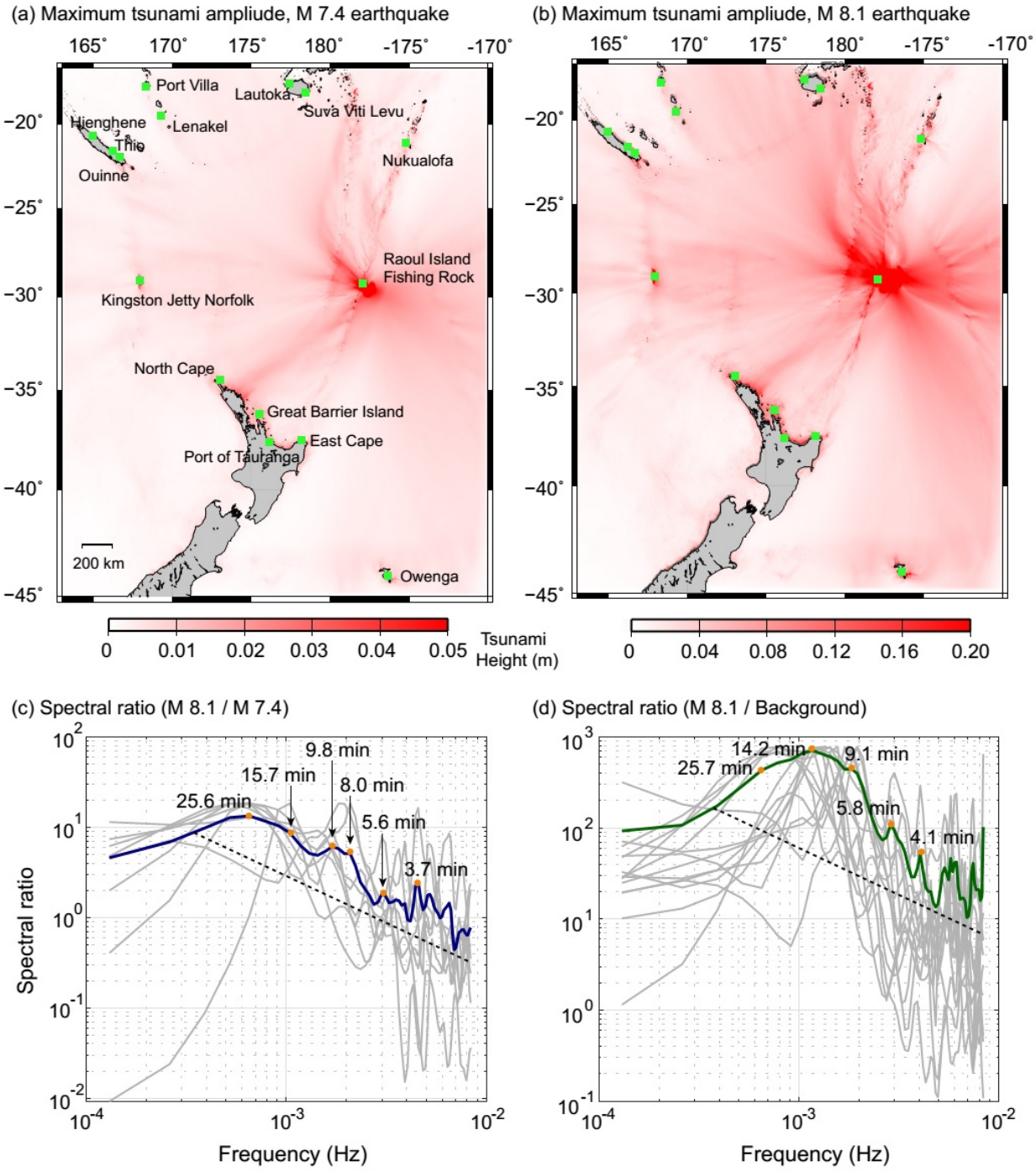

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