

## 4.2. South American event

## 4.2.1. Wave heights and Arrival times

The incident wave from South America has a maximum elevation of about 0.15m in the open ocean. When a tsunami encounters the continental shelf slope, it is partially reflected and the wave speed decreases and wavelength shortens due to the decreased water depth. As the wavelength becomes shorter the wave height increases. When the wave encounters the Chatham Rise the wave amplitude increases abruptly around the Chatham Islands because of the rapid shoaling effect. After the Chatham Islands the tsunami then makes landfall along the east coast of the North Island due to the waves travelling faster in deep water. When the tsunami reaches East Cape, the crest is aligned roughly with the Kermadec Ridge. The wave front stretches and refracts into the Bay of Plenty and continues on to the Northland coast. Contour plots of the arrival times of the first wave and the maximum wave are given in Figures 4-7. As stated above the relative arrival times given can be relied upon but the exact arrival times may vary depending on where the epicentre of the earthquake is.

Approximate wave arrival times:

First wave: Between 900 and 1020 minutes after fault rupture

Largest wave: Considerably later than the first wave in most cases, 1020 - 1320 minutes after fault rupture in many cases.

Maximum wave heights for the remote tsunami for the three sea levels are shown in Figures 8, 10 and 12. Maximum water speeds are shown in Figures 9, 11 and 13. Wave height at the shoreline is typically 1 to 2m. There are mixed effects as the tsunami arrives along the eastern coastline of Northland and much of this depends on the resonance effects of the different bays. The wave heights at the shoreline are generally 1 to 2m with larger values of 3m or more in a few bays. Refraction around North Cape sees similar wave heights maintained in the upper part of the west coast and gradually diminishing southwards. With increasing sea levels there is a corresponding increase in wave heights as shown by maximum levels in Bream Bay exceeding 3m. Water velocities are highest where funnelling or focussing occurs in narrow embayments. Maximum water velocities are recorded around Whangarei Heads at around 2.5 m/s.

While inundation may not be extreme in places, tsunamis of this magnitude will cause significant scouring of dunes and estuary channels. This will affect river flows and beach dynamics. These effects are not taken into account in the model. It is the detailed coastal geometry and bathymetry that controls how a given wave affects the shoreline. A typical tsunami represents a superposition of waves of many frequencies



and amplitudes. Hence, a section of the coast amplifies parts that are in resonance and dampens others (e.g. Mercury Bay, Coromandel, will typically oscillate at about 45 minutes in response to the corresponding component of the tsunami, whereas there are 10-minute current surges in small bays and a characteristic 2 to 3 hour resonance in Pegasus Bay and the Port of Lyttelton. As a result there is a wide range of observed frequencies and amplitudes for a single tsunami as it interacts with the coast).



**Figure 4:** Full domain: 30 minutes interval arrival times for the first wave for the remote South American tsunami scenario.





**Figure 5:** Northland: 10 minutes interval arrival times for the first wave for the remote South American tsunami scenario.





**Figure 6:** Full domain: 30 minutes interval arrival times for the maximum wave for the remote South American tsunami scenario.





**Figure 7:** Northland: 10 minutes interval arrival times for the maximum wave for the remote South American tsunami scenario.





**Figure 8:** Maximum water surface elevations for the South American tsunami scenario at MHWS – New Zealand (upper) and Northland (lower).





## **Figure 9:** Maximum water velocities for the South American tsunami scenario at MHWS – New Zealand (upper) and Northland (lower).











**Figure 11:** Maximum water velocities for the South American tsunami scenario at MHWS + 30cm - New Zealand (upper) and Northland (lower).





**Figure 12:** Maximum water surface elevations for the South American tsunami scenario at MHWS + 50cm – New Zealand (upper) and Northland (lower).





**Figure 13:** Maximum water velocities for the South American tsunami scenario at MHWS + 50cm – New Zealand (upper) and Northland (lower).