### 4.3.3. $M_w$9.0 Tonga-Kermadec subduction zone scenario

The arrival times of the first and maximum waves (as calculated by the method outlined in section 4.1) for the tsunami generated by a $M_w$ 8.5 subduction zone earthquake in the Tonga-Kermadec trench are given in Figures 24-27. Because this tsunami originates in a very similar location to the tsunami generated by the $M_w$ 8.5 earthquake, and they travel at the same speed, the results are very similar, especially for the first wave arrival. The maximum wave arrival times are a little more different. This is because the different scales of the two tsunamis mean that there are different resonances when they interact with the coastline. A summary of these results follows
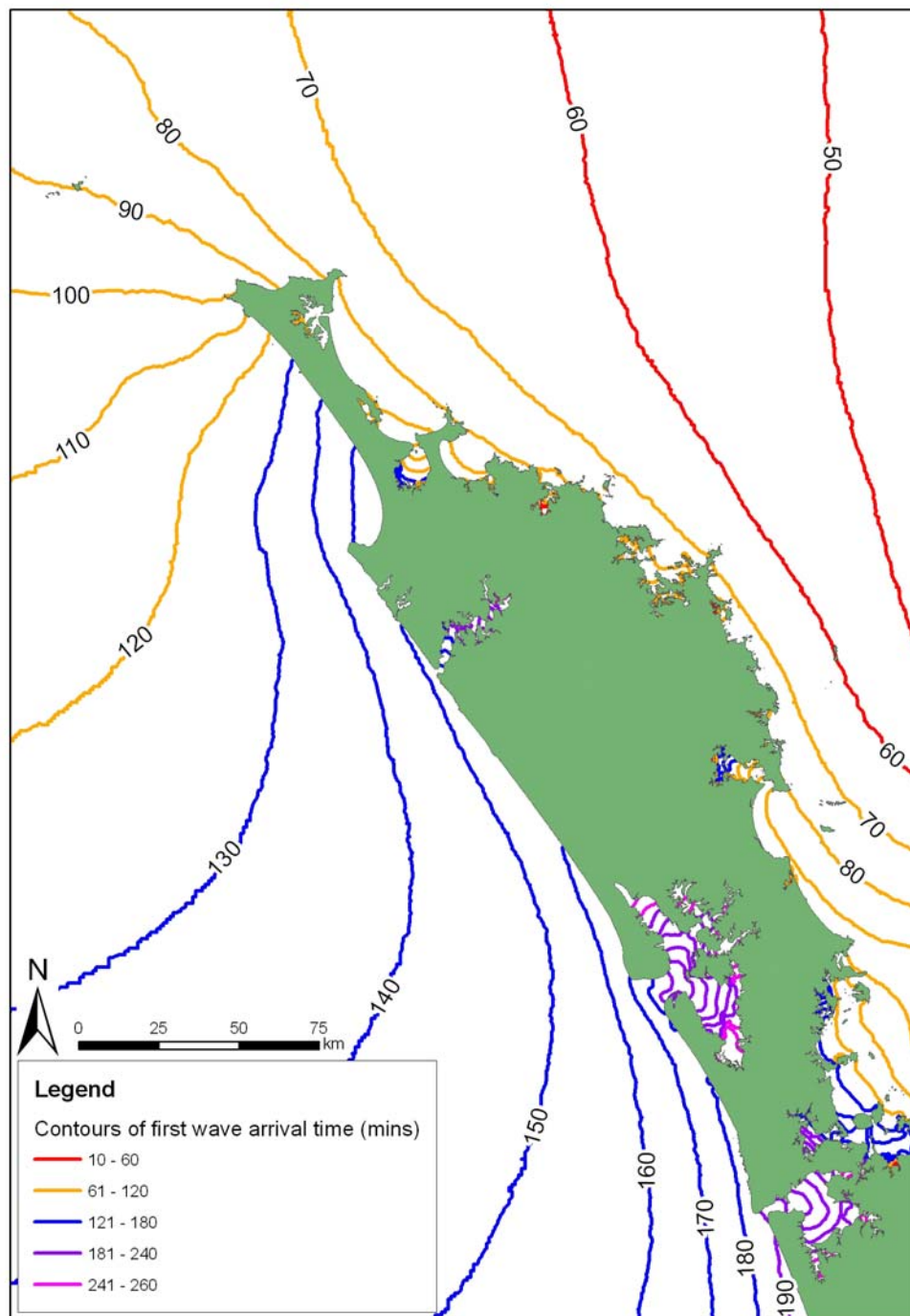
Wave arrival times:

First wave: Between 60-170 minutes after fault rupture at the outer coast. Up to 4 hours after fault rupture in the Hokianga and Kaipara harbours.

Largest wave: The first wave is the largest wave for some of the more exposed eastern coast. In enclosed bays and on the west coast the maximum wave may occur considerably after the first wave (up to 3 hours later).

Maximum wave heights for the Tonga-Kermadec $M_w$ 9.0 scenario for the three sea levels are shown in Figures 28, 30 and 32. Maximum water speeds are shown in Figures 29, 31 and 33. There is a marked increase in maximum wave heights. At MHWS wave heights of 8m or greater are recorded around much of the Northland coast. Unlike the $M_w$ 8.5 event though, there is a more ubiquitous impact on the coast with high levels recorded on the western coast as far south as Tauroa Head. 30 to 50cm increases in sea level lead to corresponding increases in wave heights around the coast, most noticeably extending the length of coastline affected by waves of 8m or more. Water velocities are generally in excess of 4 m/s from Ngunguru to Ahipara, with noticeable increases in northern and southern Bream Bay. In this instance there is a greater correlation between wave height and velocity.
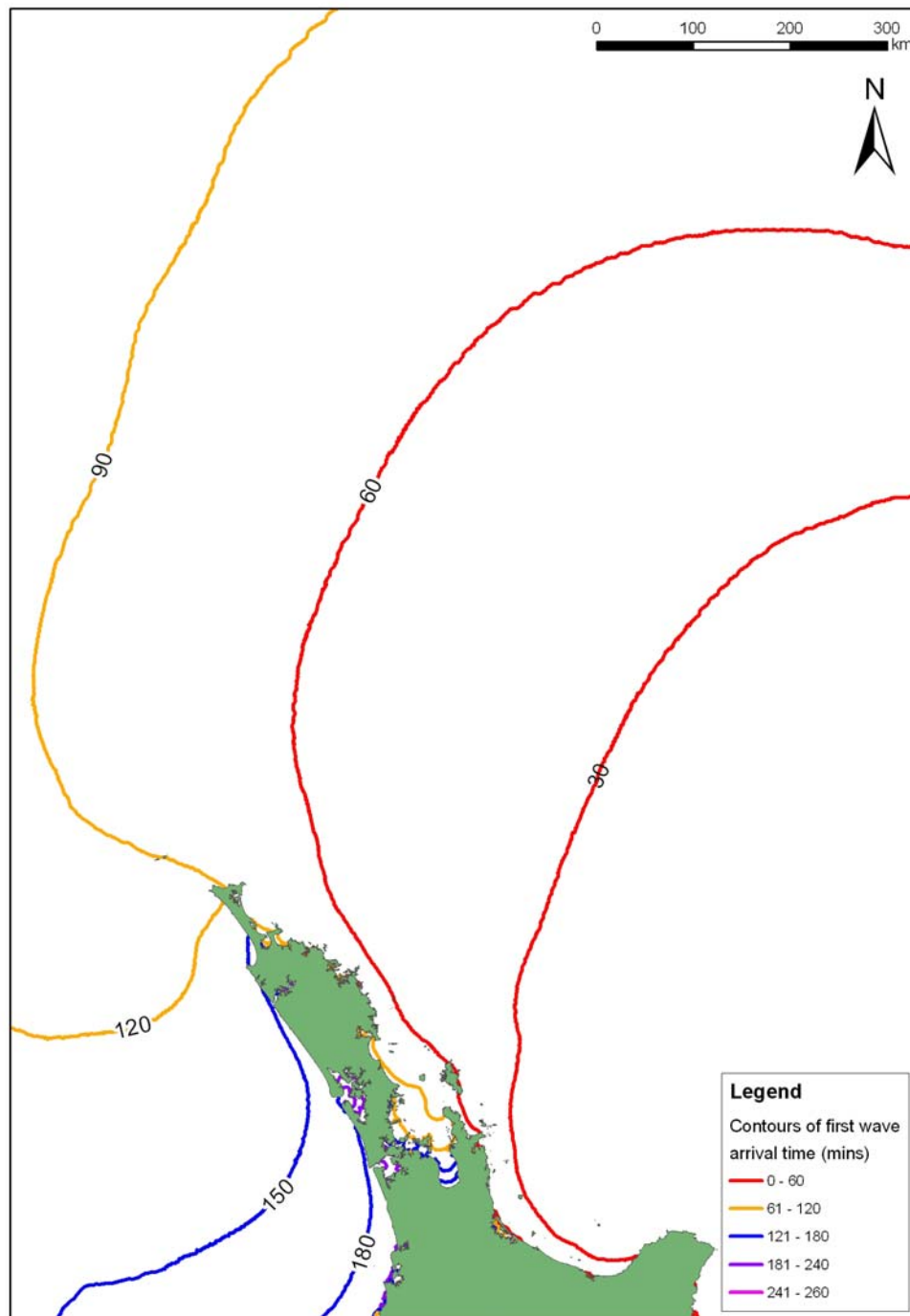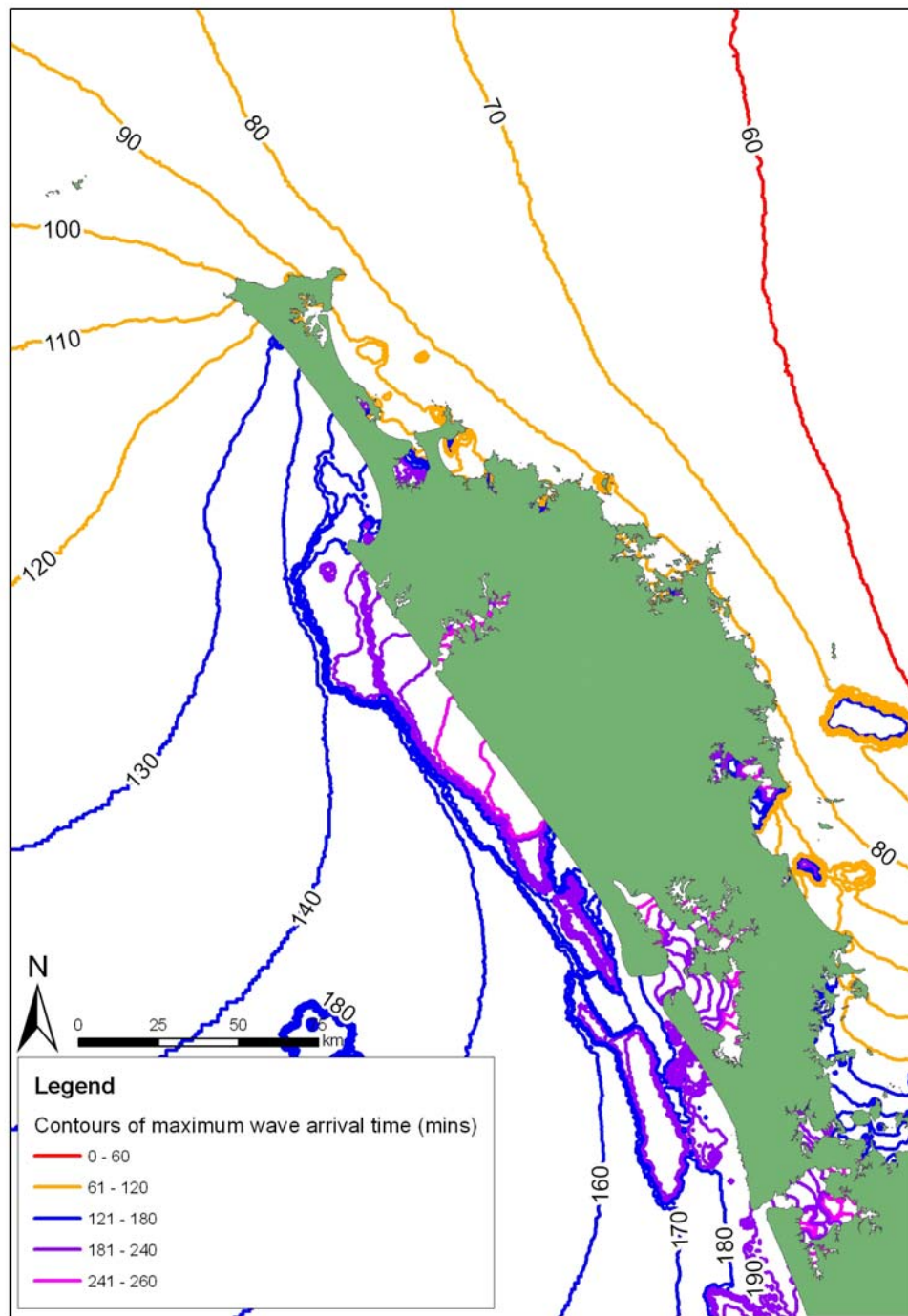
**Figure 24:** Full domain: 30 minutes interval arrival times for the first wave for the $M_w9.0$ Tonga-Kermadec subduction zone scenario.

**Figure 25:** Northland: 10 minutes interval arrival times for the first wave for the $M_w$9.0 Tonga-Kermadec subduction zone scenario.
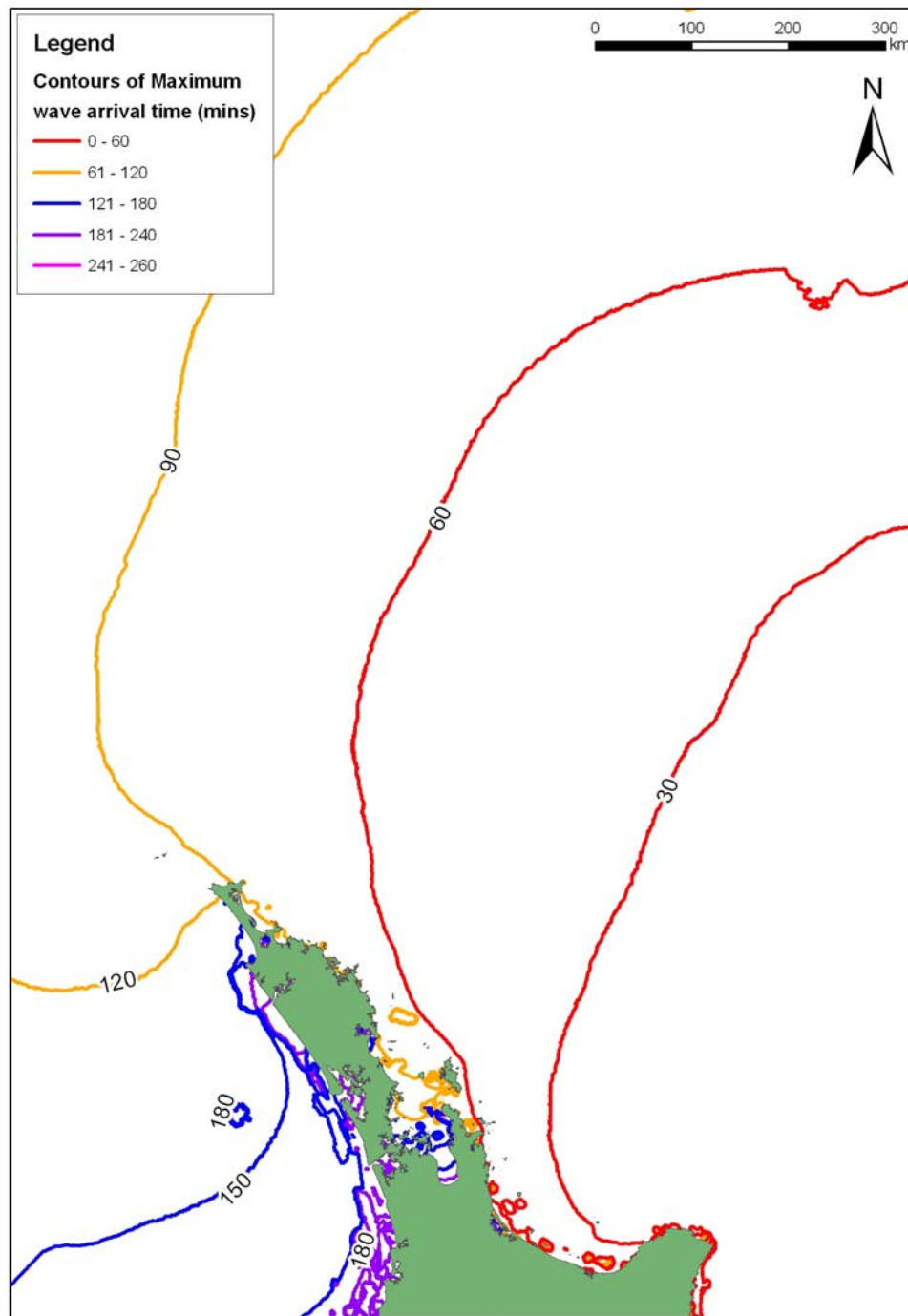
**Figure 26:** Full domain: 30 minutes interval arrival times for the maximum wave for the $M_w9.0$ Tonga-Kermadec subduction zone scenario.
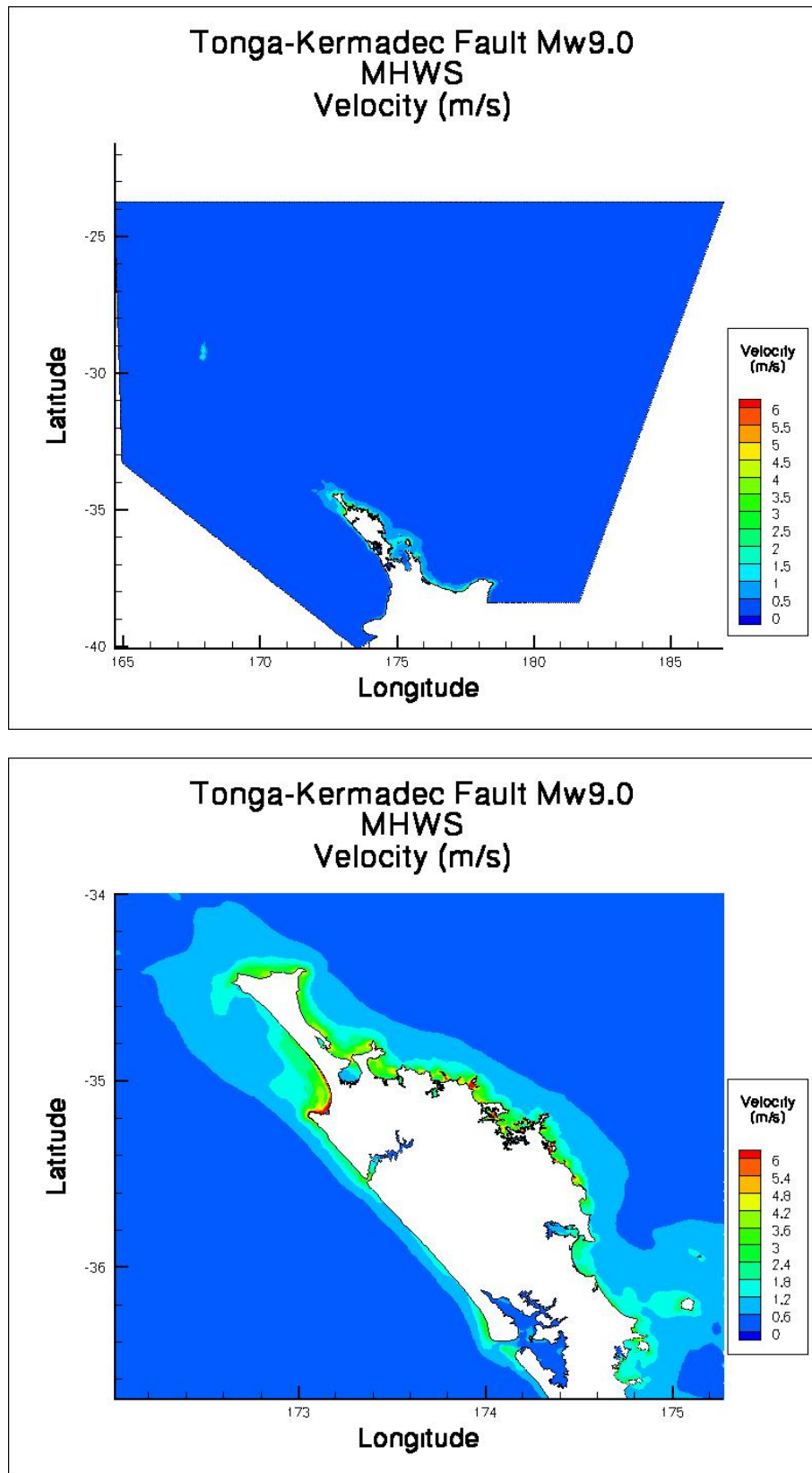
**Figure 27:** Northland: 10 minutes interval arrival times for the first wave for the $M_w$9.0 Tonga-Kermadec subduction zone scenario.
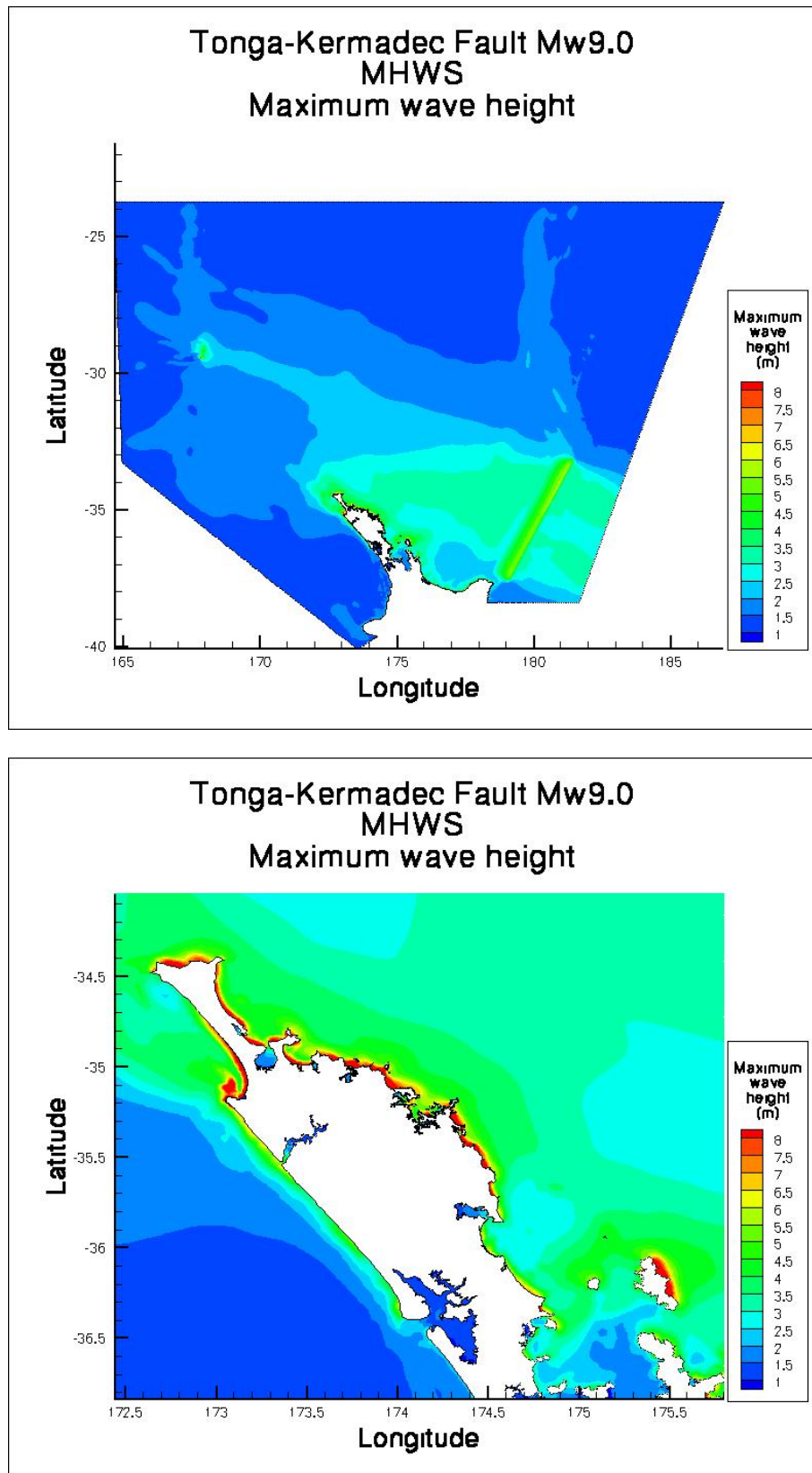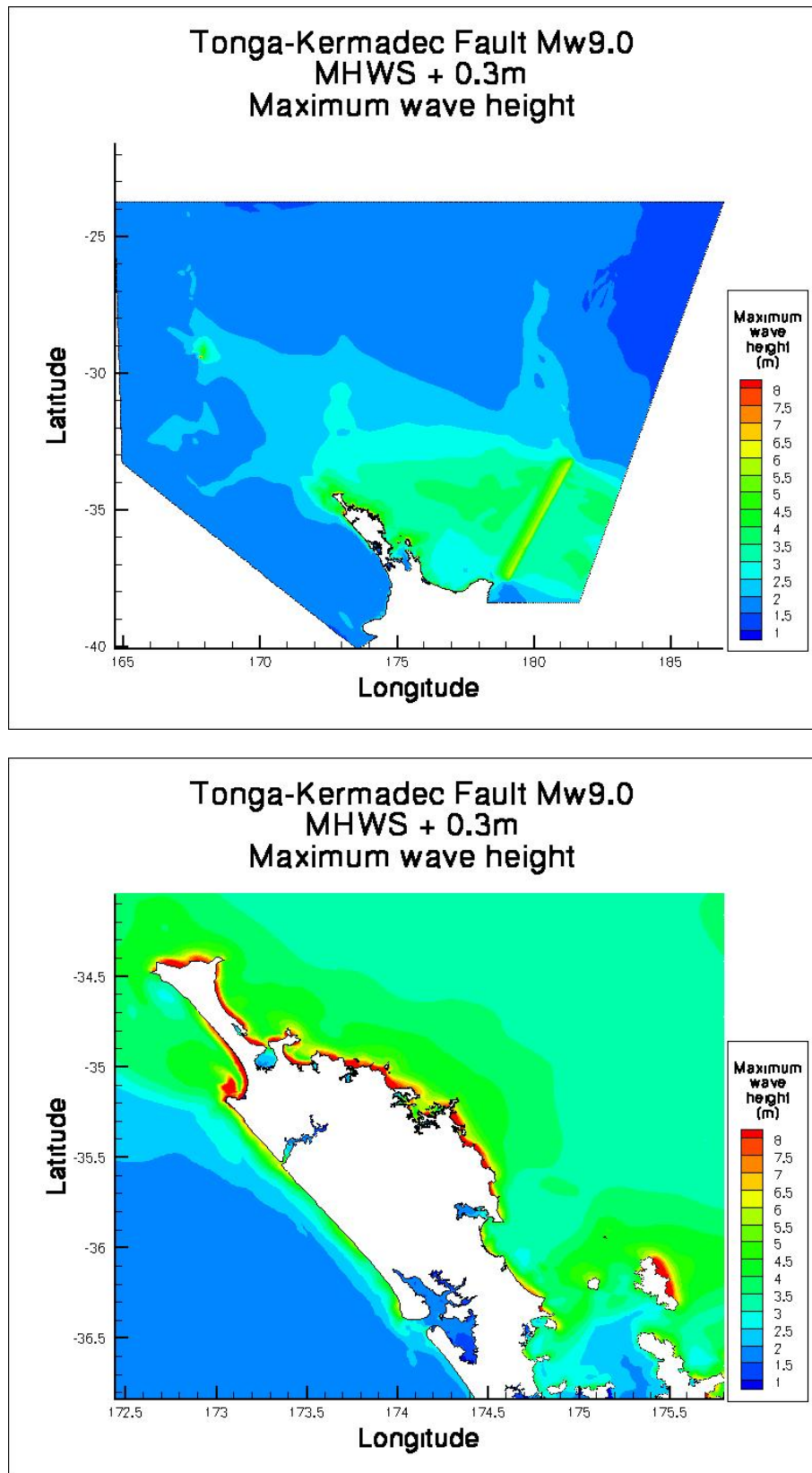
**Figure 28:** Maximum water surface elevations for the $M_w9.0$ Tonga-Kermadec subduction zone scenario at MHWS – New Zealand (upper) and Northland (lower). Note change in scale.
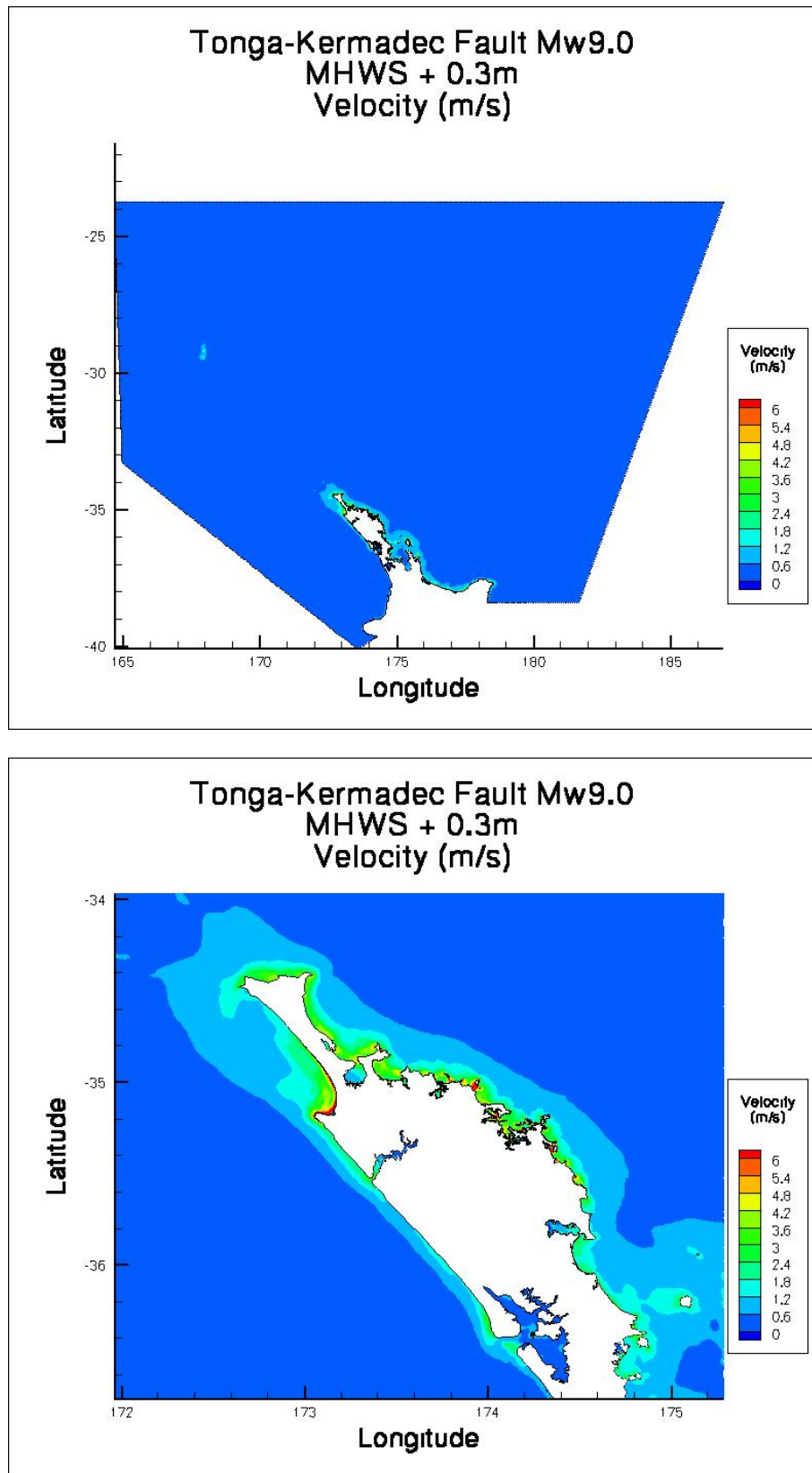
**Figure 29:** Maximum water velocities for the $M_w9.0$ Tonga-Kermadec subduction zone scenario at MHWS – New Zealand (upper) and Northland (lower).
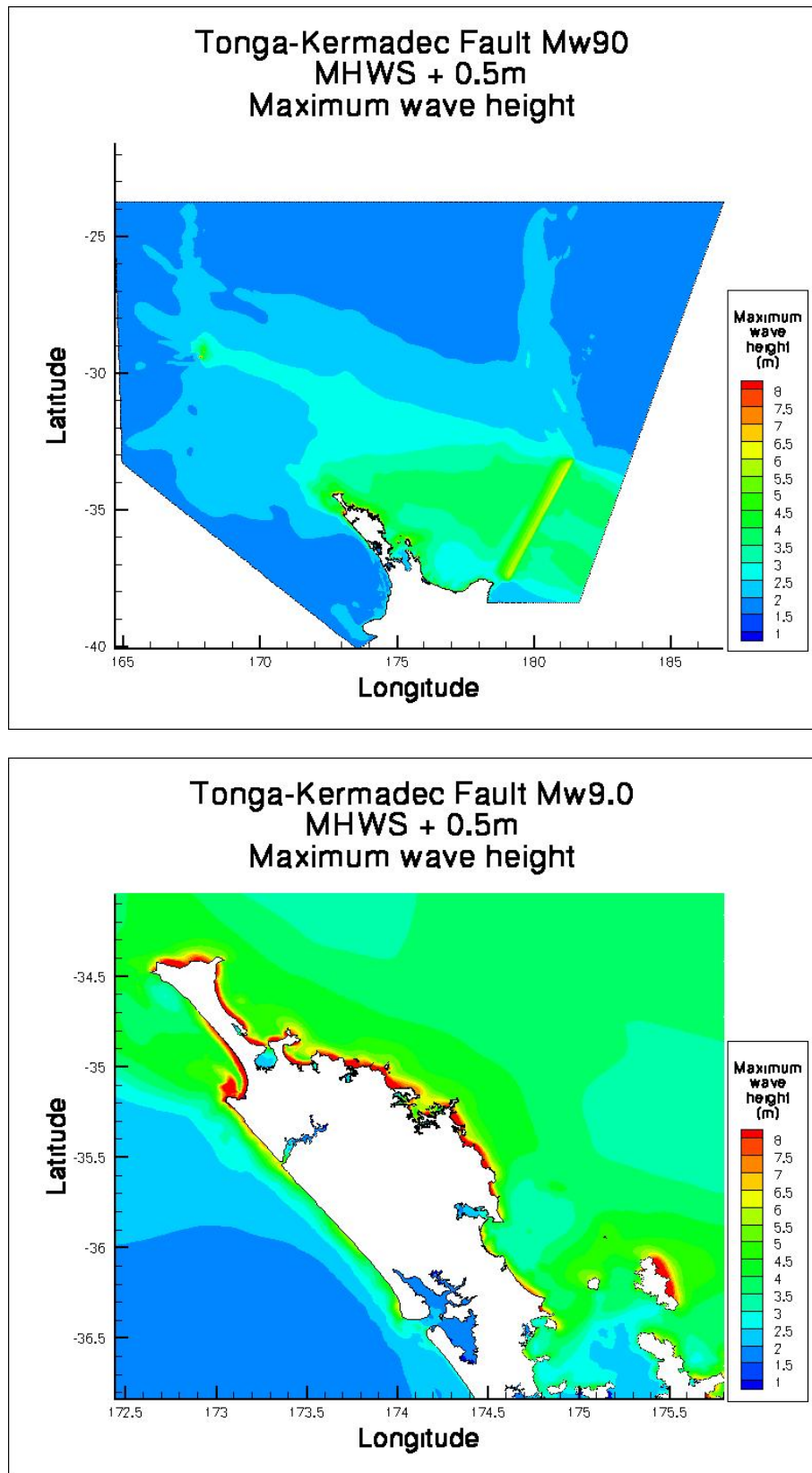
**Figure 30:** Maximum water surface elevations for the $M_w9.0$ Tonga-Kermadec subduction zone scenario at MHWS + 30cm – New Zealand (upper) and Northland (lower).
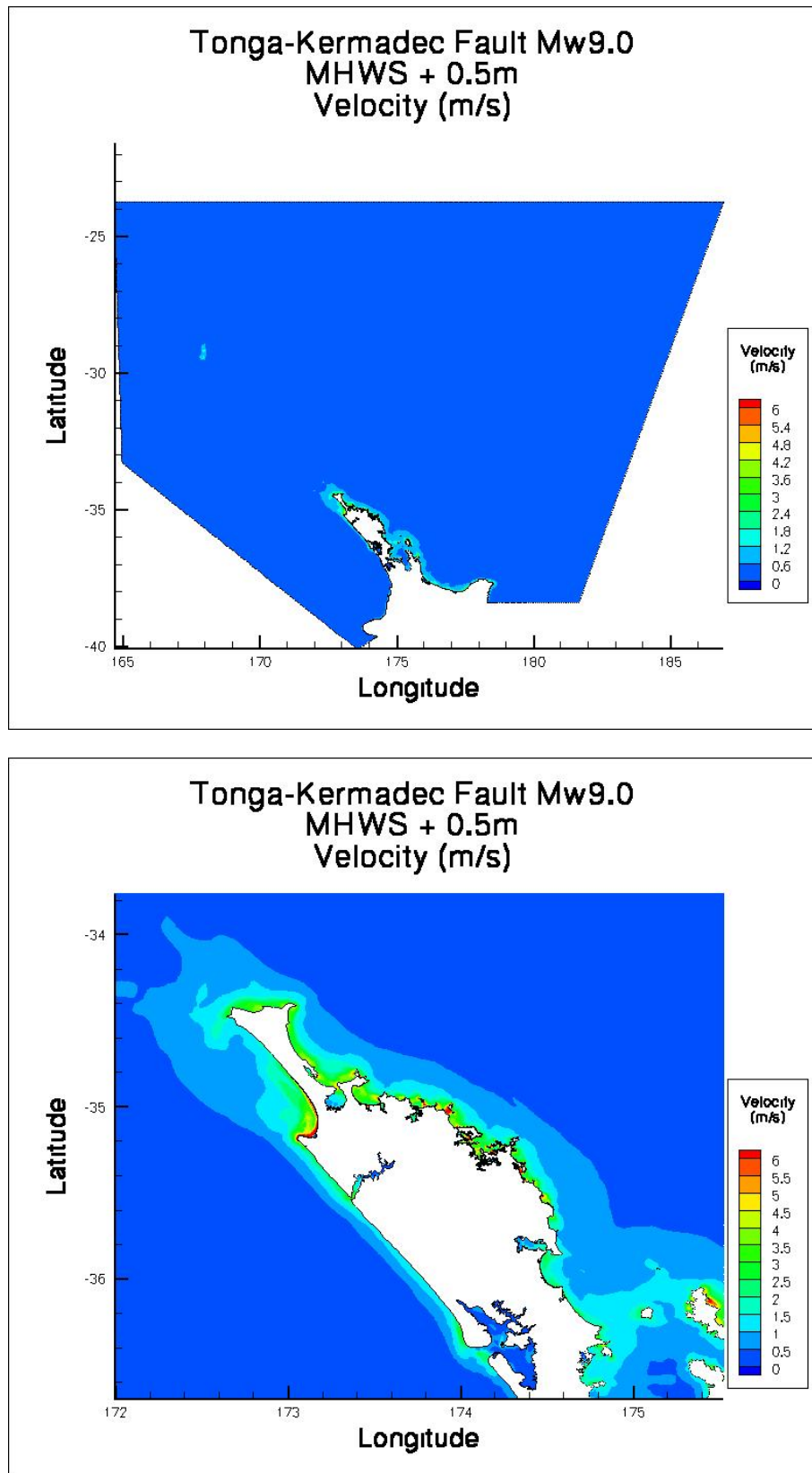
**Figure 31:** Maximum water velocities for the $M_w9.0$ Tonga-Kermadec subduction zone scenario at MHWS + 30cm – New Zealand (upper) and Northland (lower).

**Figure 32:** Maximum water surface elevations for the $M_w9.0$ Tonga-Kermadec subduction zone scenario at MHWS + 50cm – New Zealand (upper) and Northland (lower).

**Figure 33:** Maximum water velocities for the $M_w9.0$ Tonga-Kermadec subduction zone scenario at MHWS + 50cm – New Zealand (upper) and Northland (lower).