PHYSICAL OCEANOGRAPHY

Ebb and flow: testing the tides

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Tides in the New Zealand region are accurately predicted by NIWA's computer model, but how well does the model predict tidal currents?

THE RHYTHMIC RISE AND FALL of the tide is very familiar. Less familiar are the currents generated by tides. These can be very strong – particularly in narrow waterways like Cook Strait. In fact, predicting tidal currents can be as important for safe shipping as predicting the tides themselves. Already the New Zealand Tide Tables provide tidal stream predictions for Tory Channel and French Pass, as well as the traditional tide-height predictions for the major ports. But how predictable are these currents in other areas?

We investigated whether NIWA's tide model (see panel below) could be used for predicting the currents generated by the tides, as well as the tides themselves.

Predicting tidal currents

Tidal currents in New Zealand's EEZ were calculated using data from the NIWA tide model. However, describing ocean currents is more complex than describing tides because we need to know both the strength (speed) of the current and the direction of flow.

In narrow passages – like Cook Strait – the direction of the tidal current is fixed and current speeds are usually greatest at mid-tide, and zero (called slack water) at high or low tide. On the other hand, in open waters tidal currents vary in both speed and direction. For each tidal cycle, the current can be traced around an ellipse. The shape and size of the ellipse depends on the strength of the flow at maximum flood (rising) tide compared with the flow at mid-tide. To get the direction we need to know the orientation of the ellipse relative to north. We also need the time (in GMT – Greenwich Mean Time) at which the flow is maximum.

These four pieces of information (minimum and maximum flow, direction and time) are all that is needed to predict the current arising from a particular tidal constituent.

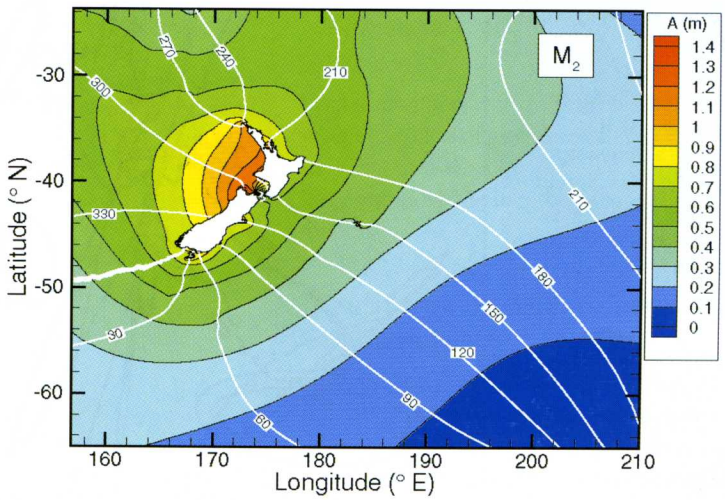
The NIWA tide model

NIWA's tide model (see *Water & Atmosphere* 5(1): 13–16) covers all of New Zealand's Exclusive Economic Zone. Comparisons with measured tidal heights have shown that it reproduces tidal elevations around the country very accurately.

In addition, the model illustrates a very striking feature of New Zealand's tides: the main tide – M_2 – moves continuously anti-clockwise around the country. This result of the interaction of the tide with the continental shelf means that at any time it will be high or low water somewhere on the New Zealand coast. At midday on days of new or full moon, the tide will always be high (and a spring tide) in Fiordland and low near Poverty Bay.

From the model we can also see that the central parts of the west coast have the highest tidal ranges, of 1–2 m.

Cook Strait's notoriously strong tidal currents occur because the twice-daily M_2 and S_2 tides are almost completely out of phase at either end of the strait. Hence, when it is high water at one end it is almost low water at the other. The significant difference in sea level drives the strong flows.



The model M_2 tide. The white lines (called co-tidal lines) join places where high water occurs simultaneously. These are traditionally shown in degrees of a full (360°) tidal cycle. The 30° interval between the lines represents approximately 1 hour, and the tide wave moves in the direction of increasing phase as shown by the arrows. The tidal amplitude (or half-range) in metres is shown by the colour fill.