Moana PROJECT

Moana Project ocean models

Aotearoa New Zealand's oceanic Exclusive Economic Zone is about 15 times larger than its land area. Home to diverse habitat and species, our ocean supports fisheries, aquaculture, energy generation, and tourism – the blue economy. The ocean is also an important regulator of our climate, absorbing and redistributing heat via ocean currents, and influence weather systems that impact the country such as ex-tropical cyclones.

However, we know relatively little about our seas. The Moana Project set out to change this, to support our blue economy by providing accurate ocean observations, models and data products to better understand and predict ocean processes.

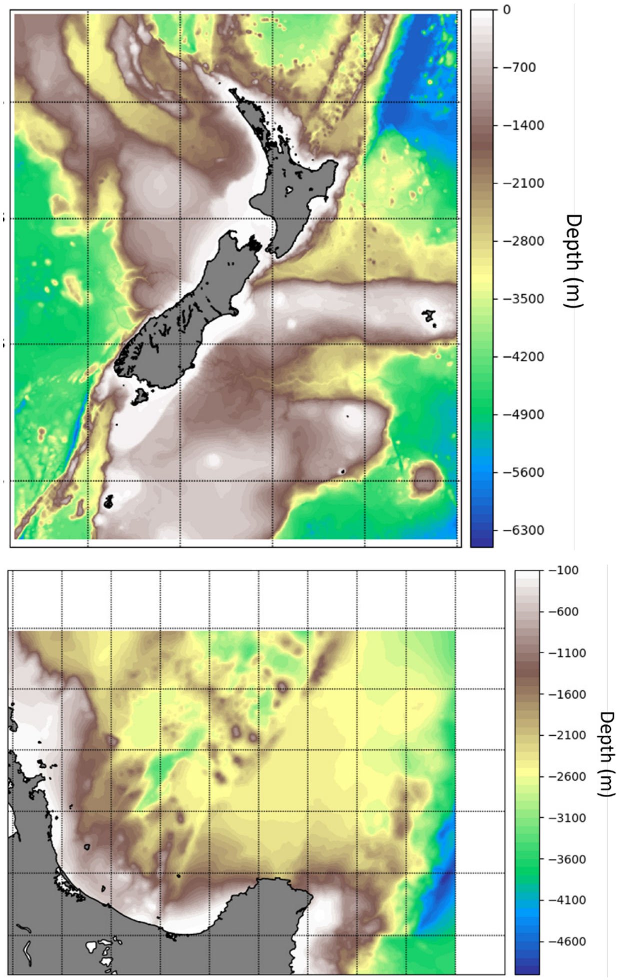
Why model the ocean?

The ocean is a complex three-dimensional environment with ocean currents driven by physical forces. Water temperature and current speed and direction affect our blue economy, and being able to forecast these, or discern values from the past, are important for sustainable management. Good ocean models work much like a weather forecast does for the atmosphere; they help us manage our oceans better, by allowing us to look at past conditions and predict what will happen in the future.

Of course, we can't observe everything, everywhere, all the time. Instead we use ocean models which provide a consistent and continuous representation of the ocean that is consistent with the physical processes we know drive ocean behaviour.

National and local scale ocean models

The Moana Project set up Aotearoa's first open nation-wide ocean modelling system, a fully three-dimensional model that covers the entire New Zealand exclusive economic zone at 5 km resolution. The model provides sea level, as well as temperature, salinity, current speed and direction for any depth. The project also set up higher-resolution models for the local areas around Te Moana-a-Toi / the Bay of Plenty, Kaikōura, Cook Strait, and Tikapa Moana / the Hauraki Gulf.



The Moana Project models include the entire New Zealand exclusive economic zone (Top), and an example of a high-resolution model for Te Moana-a-Toi / the Bay of Plenty (Bottom).

Hindcasting and forecasting ocean conditions

The ocean models allowed us to create datasets for the past – called hindcasts. Available at 5 km resolution nationally, and at finer scale for the local domains, the hindcasts represent our best knowledge of the ocean state for any location at any time over the last 28 years.

This provides an important baseline for ocean-based industries, and a good starting point against which we can monitor changes in e.g. ocean temperatures. The national hindcast data can be accessed here.

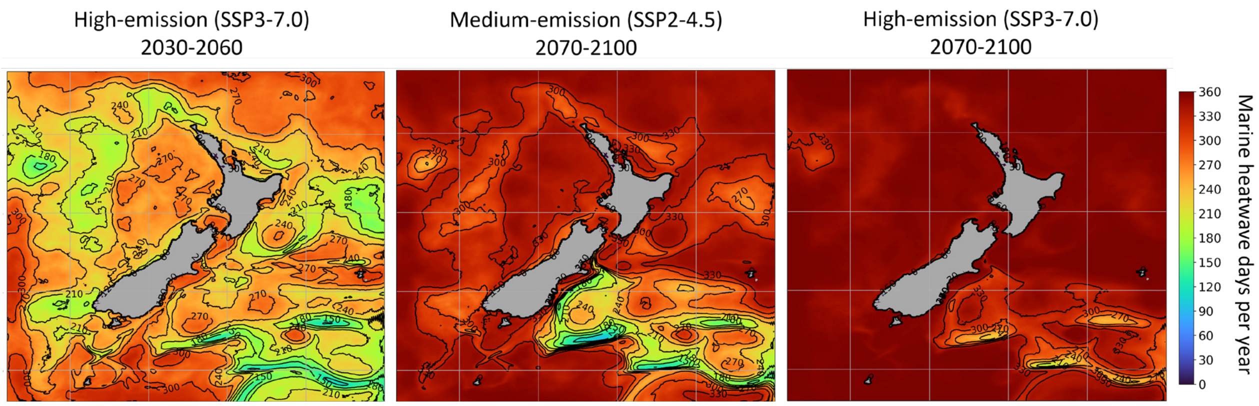
After evaluating that the model contains all the right processes and represents the ocean in a realistic fashion it is also used for forecasting, predicting the ocean behaviour up to seven days ahead. These forecasts are available via the MetService website, SwellMap, and the MetOceanView app.

Combining model and observations – data assimilation

Once we have a model that we are confident contains all the physical processes important to drive the ocean's behaviour, we can combine it with available observations to have a representation that is better than the model or the observations alone. For this, we use a technique called Data Assimilation. In the Moana Project we combine our national ocean model with all the available observations, including satellite, international datasets, and the unprecedent coverage provided by the Mangōpare sensor system. With this, we can provide the best possible representation of the past ocean (reanalysis) and improved forecasts.

Modelling how our seas will change with warming climate

Ocean models also allow us to predict how our seas will change as the climate warms. Using scenarios from the Intergovernmental Panel on Climate Change, we can map how warm our oceans will become, and the impacts on sealevel and ocean currents. In the Moana Project we explored three different scenarios: A mid-emission (SSP2 4.5) scenario for the years 2070-2100, and a high-emission (SSP 3 7.0) scenario for the years 2030-2060 and 2070-2100. The results are used to estimate ocean warming, changes in connectivity and the impacts on kaimoana.



Number of days per year above the marine heatwave threshold for the different climate change scenarios, showing that most of New Zealand will be under almost constant marine heatwave by the end of the century.