

Scientists say there is no longer any doubt that the Earth's climate is warming. Despite the cooling effects of a strong La Niña, 2011 was, globally, the ninth warmest year since 1880, reinforcing a trend which shows that nine of the 10 warmest years on modern record happened after 2000.

New Zealand temperature records show an increase of around one degree over the last 100 years. Sea level rise is another indicator of warming temperatures. Recordings from Moturiki Island, off Mt Maunganui, show sea levels there have risen 11 centimetres since 1950, an average rise of 1.9 millimetres a year, which matches the average global increase.

Why is our climate changing?

The Intergovernmental Panel on Climate Change (IPCC) confirms that changes in our climate are very likely caused by increased volumes of greenhouse gases, such as carbon dioxide, nitrous oxide and methane, in the atmosphere.

Ordinarily, solar energy from the sun passes through the Earth's atmosphere, and is absorbed at the surface. As it warms, the surface emits infra-red radiation. Most of that radiation is absorbed by greenhouse gases in the atmosphere, but enough escapes it to balance the net incoming solar energy. Over the long term, this equilibrium keeps temperatures relatively stable.

But when the concentration of greenhouse gases in the atmosphere increases, more radiation is trapped, and some of it is re-directed back to the lower atmosphere and surface. This drives the climate to a new, warmer balance.

The most abundant greenhouse gases are water vapour, carbon dioxide, nitrous oxide, methane and ozone. The increase in carbon dioxide is mainly the result of our burning more fossil fuels, such as petroleum and coal, even as we fell more and more forests, which would otherwise have helped absorb those gases.

In New Zealand, nearly half of our greenhouse gas emissions – mostly methane and nitrous oxides – come from livestock and fertiliser use.



Photo by Barb Lowthen

What does this mean for our weather?

As this century unfolds, the Bay of Plenty climate will change. As temperatures rise, scientists expect New Zealand's wind patterns to shift, which will also affect our future rainfall.

In 2011, Bay of Plenty Regional Council asked the National Institute of Water and Atmospheric Research (NIWA) to update a 2003 climate change report for the region, incorporating a wealth of new information from more accurate climate models and projections.

Temperatures	<ul style="list-style-type: none"> Bay of Plenty temperatures will rise over the rest of this century. By 2040, the region's annual mean temperature is expected to be around 1.2°C warmer than it was in 1990. By 2090, it is expected to warm by between 2.7°C under a mid-emissions scenario (see explanation of emissions scenarios, page 3) and 3.6°C under a high-emissions scenario. Hot days – 25°C or more – are tipped to become the summer norm by the end of the century. Whakatāne, for instance, currently gets about 22 hot days a year; by 2090, it may experience between 80 and 100. Rotorua currently gets about 12 hot days a year; under a high emissions scenario, it could expect to get between 50 and 60. Tauranga currently gets around 22 hot days annually. By 2040, under a mid-range emissions scenario, it could see twice that number, and more than 70 a year by the century's end. Warming will be fairly uniform across the region; Tauranga, for instance, will warm at much the same rate as Whakatāne. Not all seasons will warm at the same rate. Autumn and winter are projected to warm slightly more than summer and spring.
Rain	<ul style="list-style-type: none"> The warmer air gets, the more moisture it can hold – about seven or eight percent more for each degree of warming – so rain is likely to fall more heavily in future. The region will get roughly the same average annual rainfall in 2090 as it does now, but rain may fall at different times. For instance, winters are expected to get drier as the century unfolds; by 2090, coastal and south-eastern areas may receive 10 percent less rain than they do now. On the other hand, summer rainfall is projected to increase – particularly inland – and to become more variable. We may see a sharp year-to-year contrast of either very dry summers, or very wet ones.
Wind	<ul style="list-style-type: none"> The Bay of Plenty will get more easterly winds during summer, and more westerlies during winter. By analysing historical weather maps that have produced extreme winds in the past, and comparing them against the sort of maps we might expect in a warmer climate, scientists calculate that extreme winds may be less frequent during future summers, but more common during winters.
Frosts	<ul style="list-style-type: none"> By 2090, frosts will be a rare thing in the Bay of Plenty. At present, Ōpōtiki gets around five frosts a year, while Rotorua may get 20. By the end of the century, Rotorua is projected to experience frost just once or twice a year – none at all in some years. Other locations may get perhaps one frost every three years. There will be fewer cold nights.
Sea level rise	<ul style="list-style-type: none"> There is some uncertainty around the likely rate of sea-level rise this century, so scientists can only estimate a range of possible increases. Current predictions are for a sea-level rise of between 50 centimetres and 80 centimetres by the 2090s. However, scientists can't rule out still greater rises – of more than a metre – by 2100, which should at least be considered in planning and development. They expect sea levels to go on rising for at least a few centuries after 2100. That means new coastal development should factor in rises of between one and two metres to avoid future risks . The Intergovernmental Panel on Climate Change (IPCC) will release updated sea level rise projections in its next assessment report, due in late 2013.

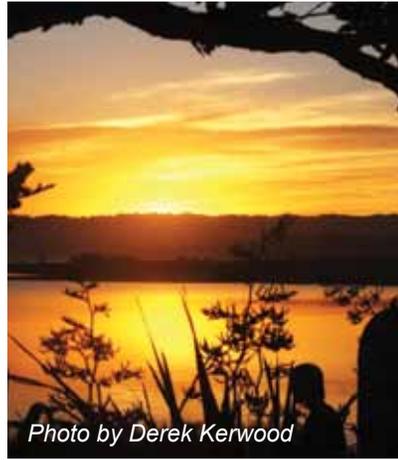


Photo by Derek Kerwood

Why can't scientists tell us exactly what will happen?

Humans are not responsible for all changes in the climate, but there has been a warming – by around 0.7°C globally – over the past 100 years. Much of that is likely due to greenhouse gases emitted into the atmosphere from human activity. Scientists expect concentrations of those gases to continue to rise well into the 21st century. Even though they can't predict precisely how these scenarios might play out, they nevertheless have to take them into account when they make climate projections.

To do that, they factor in a range of emissions scenarios. These are based on the various ways scientists think our economies, societies, population levels and energy use might look like in future. Different scenarios are based on whether greenhouse gases increase slightly, moderately or significantly.

When they made their climate projections for the Bay of Plenty report, National Institute of Water and Atmospheric research (NIWA) scientists applied mid-range and high-range emissions scenarios.

The mid-range scenario describes a future world of very rapid economic growth. It assumes that the global population will peak mid-century, then decline, and that we will rapidly adopt new, more efficient technologies. It also assumes that our future energy will come more or less equally from fossil and non-fossil sources.

In this scenario, carbon dioxide concentration doubles from pre-industrial levels by the 2060s, and is about 140 percent higher than pre-industrial (17th century) levels by 2100.

The high-range emissions scenario describes a more piecemeal response to climate change. Regions and nations adopt their own strategies and technologies, and their economies develop at differing rates. This slows the uptake of new technologies, while the global population goes on increasing. In this scenario, carbon dioxide concentration doubles from pre-industrial (17th century) levels by the 2060s and is almost 200 percent higher than pre-industrial by 2100.

Because scientists use a number of different climate models, which can deliver differing results, they issue their projections within possible ranges. For example, when NIWA scientists say the Bay of Plenty is projected to warm by about 1.2°C by 2040, 1.2°C is the annual *mean* temperature within a range of between 0.5 and 1.5°C.

By 2090, they expect that the region might warm, under the mid-range emissions scenario, by an annual mean of about 2.7°C, within a possible range of 1.7 to 3.2°C.

Under the high-range emissions scenario, they expect that the Bay of Plenty might warm by an annual mean of about 3.2°C, within a possible range of 2.5 to 3.6°C by 2090.



Natural variability

Apart from human influences on the climate, scientists also have to consider other, entirely natural, climate phenomena – such as La Niña and El Niño – that affect our climate.

In El Niño years, New Zealand tends to get stronger or more frequent winds from the west in summer, drying out east coast areas, but bringing more rain to the west. The 1997/98 El Niño drove one of

the country's worst droughts, that cost over a billion dollars in lost productivity.

La Niñas have a weaker impact on our climate, but tend to bring more frequent wet and warm northerly conditions to the Bay of Plenty. A La Niña brought record rain to the region over the first half of 2011.

It can be very difficult to tease apart the effects of climate change from

Nature's own variability. All these unknown quantities – human and natural – mean scientists cannot predict one definitive future scenario for the Bay of Plenty; they can only present a range of possible changes.

However, all those possibilities point to the same general warming trend, and researchers can say with some confidence which climate change scenarios are more likely, and which ones are less so.



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