Climate Change

Projections for New Zealand

NIWA
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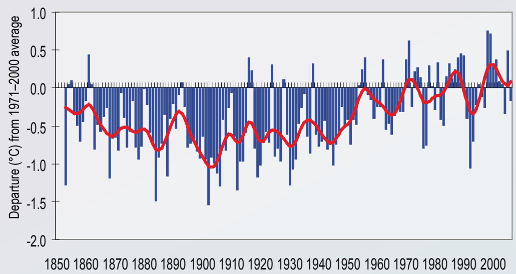
Climate change is here now

There is now good evidence that the climate is warming and the cause cannot simply be natural variation.

New Zealand changes include:

- An overall warming trend: nationally averaged temperatures have increased by about 0.9 °C over the past 100 years.



NZ temperatures: comparison through time. Average temperatures go up & down from year to year but there is an overall upward trend.

- Fewer frosts over most of the country: Canterbury and Marlborough, for example, experience about 20 fewer frosts per year now than in the early 1970s.
- Retreat of major South Island glaciers: the volume of ice in the Southern Alps reduced by almost 11% in the past 30 years. Twelve of the largest glaciers are unlikely to return to their earlier lengths without extraordinary cooling of the climate.
- Sea-level rise: 0.16 m during the 20th century averaged over the four main ports.

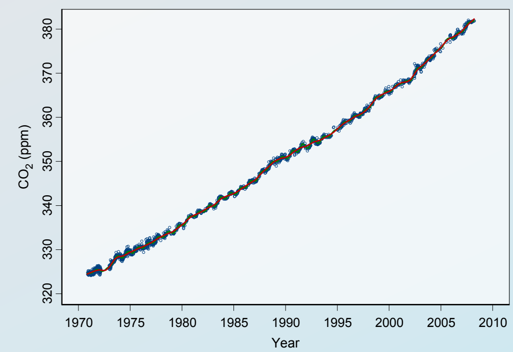
The effect of greenhouse gases

Ice core records show that in 1750 the concentration of atmospheric carbon dioxide (CO_2) was about 280 parts per million of air. Since then, the global average has risen by 100 parts per million, with half of this increase occurring in the last 30 years.

There are many other factors, such as solar activity, which affect the Earth's climate. But their effect is not big enough to fully explain the observed global warming since the mid-20th century. It is only when we add together all the natural factors and the effect of rising greenhouse gases from human activity that we get a complete explanation which fits the evidence. These greenhouse gas increases are very likely the cause of most of the observed global warming since the mid-20th century.

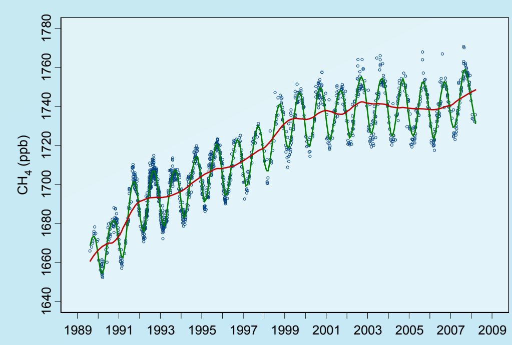
NZ measurements show greenhouse gas rise

NIWA has the longest-running continuous measurements of CO_2 in the southern hemisphere. Since our measurements began, the combustion of fossil fuels has roughly doubled. Not only has the concentration of CO_2 risen in that time, the growth rate has accelerated. The annual mean growth rate in atmospheric CO_2 measured by NIWA has reached over two parts per million seven times since records began; five of these peaks occurred in the past decade.



NIWA's carbon dioxide measurements from Baring Head, Wellington.

Methane is about 23 times more powerful than CO_2 as a greenhouse gas. Recently atmospheric methane concentrations flattened out at about 2.3 times pre-industrial levels. The causes remain unclear but could include global deforestation, fewer gas pipeline leaks in former Soviet countries, and drying wetlands (due to high temperatures and draining). However, methane concentrations increased in 2007, with a rise of 4.9 parts per billion.



NIWA's methane measurements from Baring Head, Wellington.

The projections

Future climate changes will be affected, amongst other things, by how much extra greenhouse gas goes into the atmosphere. For this reason, NIWA has looked at likely changes in New Zealand across six greenhouse gas emission scenarios from the Intergovernmental Panel on Climate Change (IPCC), but focusing on the mid-range. These scenarios do not include major efforts to reduce greenhouse gas emissions.

Overall temperature set to rise

Temperature is projected to increase by about 1 ºC by 2040 and by 2 ºC by 2090 for a mid-range scenario. The full range of projections across scenarios is 0.2–2.0 ºC by 2040 and 0.7–5.1 ºC by 2090.

A 2 ºC warming is about the difference in the annual median temperature between Wellington and Auckland.

There will still be warmer years and colder years. But an unusually warm year now could be the norm in 30–50 years, and might be considered a very cold year by the end of the century.

Temperature rise is expected to accelerate as the century goes on.

Fewer frosts

Initial simulations from NIWA's regional climate model suggest large decreases in the number of frost days in the central North Island and in the South Island.

Example: The number of frosts in the central plateau of the North Island, away from the alpine areas such as Mt Ruapehu, could more than halve. Currently the plateau gets about 30–40 frost days per year. Under a low-medium emission scenario, this could drop to 5–15 days per year, and even fewer with a medium-high emission scenario, by the end of the 21st century.

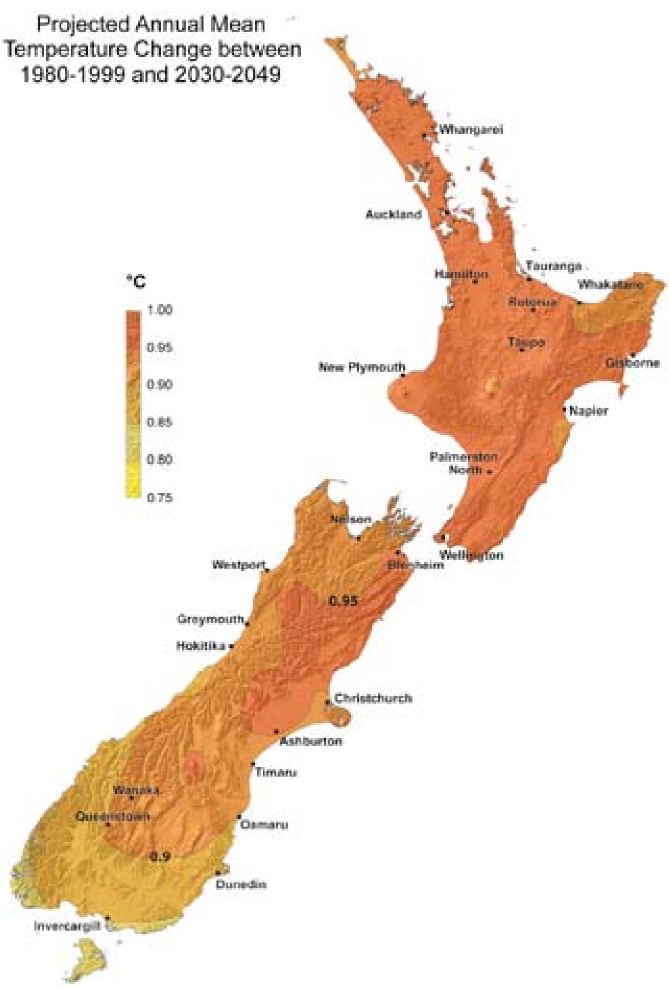
More hot days

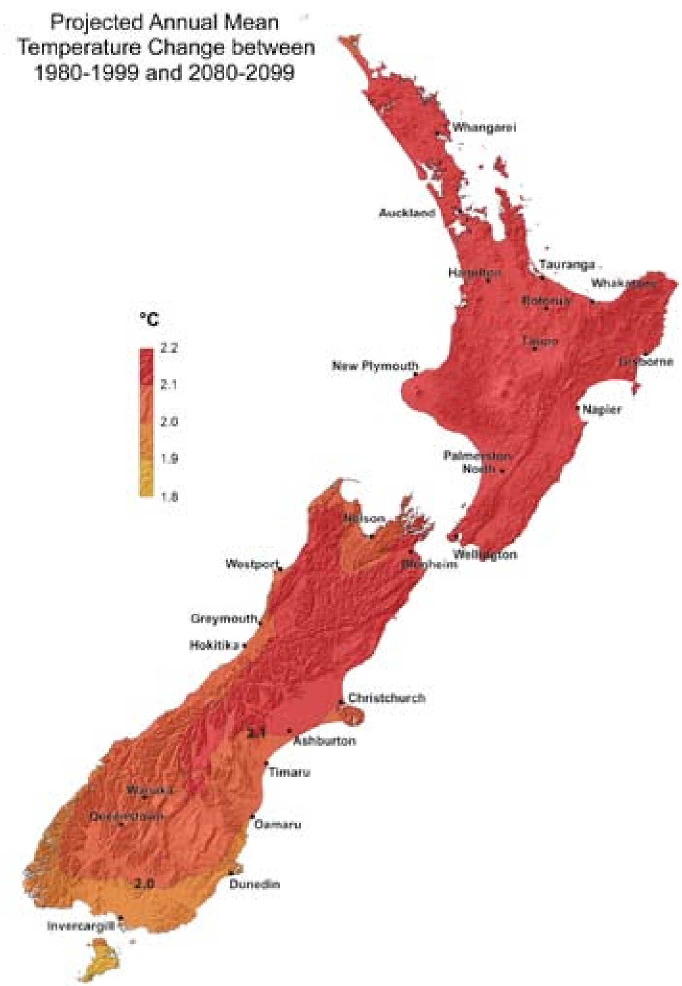
NIWA's first regional climate model runs also suggest substantial increases in the number of days above 25 °C, particularly at already warm northern sites.

Example: The number of hot days in Auckland could double or treble. Currently, the city experiences about 21 days per year above 25 °C. By the end of the century, Aucklanders could face an extra 40 days or more of high temperatures under a low-medium scenario, and more than 60 extra hot days under a medium-high scenario.

Strong winds

A simulation using the regional climate model suggests an increase in the strongest winter winds over much of the country by 2100. The changes are fairly small for the most part (averaging out at a 2.3% increase over all land points in the model), but reach about 10% in some eastern locations.





All maps display projections for a mid-range scenario.

Overall rainfall: drier in the east; wetter in the west

The overall projection is for less rain in most of the east coast and north of the North Island, coastal Canterbury & coastal Marlborough, and for a wetter climate in the west and south of the South Island.

Different seasons could see different rainfall patterns

- **winter & spring:** more frequent, and possibly stronger, westerly winds appear likely, especially over the South Island. This would bring drier weather in the east & north, but more rain in the west of both islands.
- **summer & autumn:** the projected pattern is less clear-cut, but tentatively points to less frequent westerlies. This suggests drier summers and autumns in the west of North Island, and possibly wetter conditions in Gisborne & Hawkes Bay for those seasons.

Extreme rainfall

Heavy rainfall is likely to get heavier and/or more frequent. For a mid-range scenario, a 1-in-100 year event now could become a 1-in-50 year event by the end of the century.

Snow

Based on air temperature and precipitation projections, it is likely that average snowlines would rise as the temperature increases, but snowfall is influenced by complicated atmospheric processes. NIWA intends to use a specialised snow model to quantify likely changes at the small scale required for management purposes (eg, effects on skifields or the amount of water in a catchment).

Sea-level rise

Sea levels will continue to rise over the 21st century and beyond, primarily because of thermal expansion within the oceans and the loss of ice sheets and glaciers on land.

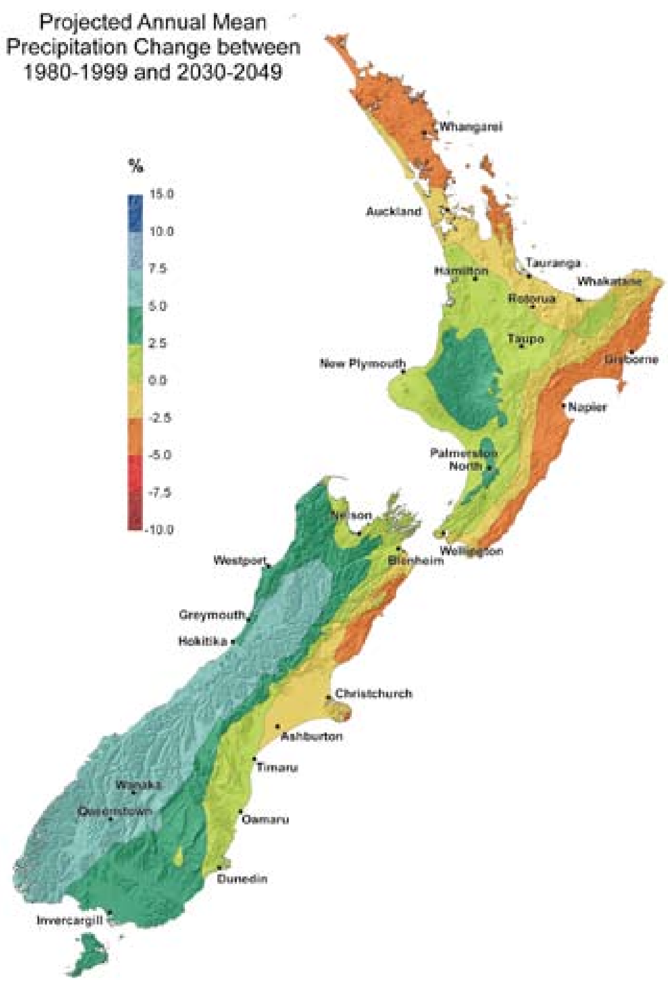
The basic range of projected sea-level rise in the IPCC's 4th Assessment, corresponding to the six scenarios, is 0.18–0.59 metres by 2090–2099 relative to the average sea level over 1980–1999. But it is possible that sea-level rise around New Zealand could be higher due to factors not included in current global climate models, such as the possibility of more rapid melting of the Greenland Ice Cap.

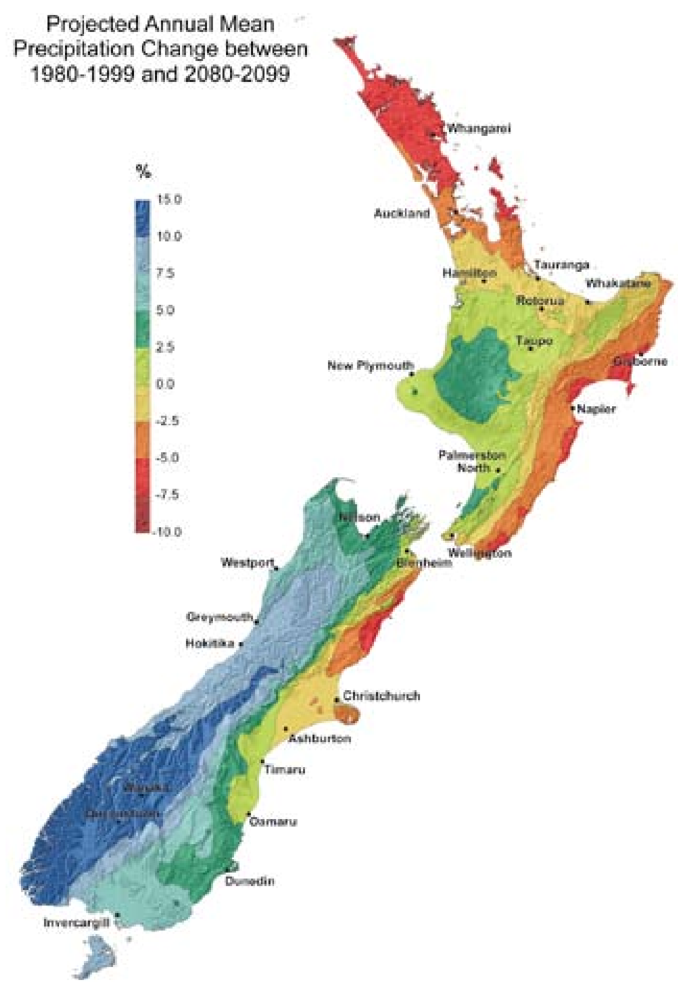
For planning and decision timeframes out to the 2090s, Ministry for the Environment guidance recommends:

a. assume a base value sea-level rise of 0.5 m relative to the 1980–1999 average, but also

b. assess the potential consequences from a range of possible higher sea-level rises (particularly where impacts are likely to have high consequence or where additional future adaptation options are limited). At the very least, all assessments should consider the consequences of a mean sea-level rise of at least 0.8 m relative to the 1980–1999 average.

For planning and decision timeframes beyond 2100 where, as a result of the particular decision, future adaptation options will be limited, an allowance for sea-level rise of an additional 10 mm per year beyond 2100 is recommended.





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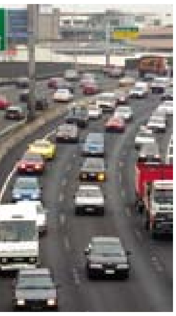
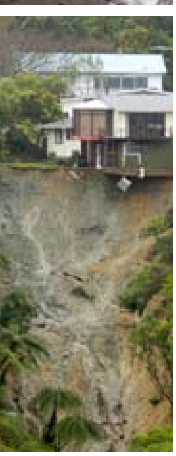



How the projections were made

These projections represent the most up-to-date scientific knowledge about likely effects of climate change in New Zealand. The new projections are based on the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), and the global climate modelling results produced for that report, run for a range of possible future greenhouse gas emission scenarios.

Global climate models are 'coarse' in scale. Often they have only three or four grid squares for the whole of New Zealand, and our climate is much more varied than that. NIWA scientists developed the detailed projections outlined in this leaflet using two techniques. Both are well documented in peer-reviewed scientific literature.

Statistical downscaling
Scientists use statistical relationships between the regional circulation and aspects of the local climate (eg, temperature, rainfall, wind) to apply global climate model results to a particular place.

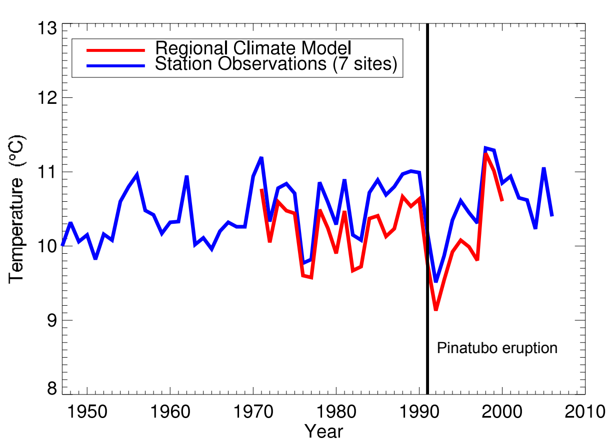
Regional climate modelling
A regional climate model uses output from a global climate model but simulates processes at much higher resolution over the particular region. NIWA's regional model has a 30 km grid spacing over New Zealand, compared with 100–300 km for a global model.

Reliability of climate models

Climate models are the best tool available for making climate change projections.

Modern climate models are extremely sophisticated. Models replicate the complicated factors and feedback loops that affect the climate, including atmosphere, ocean, sea ice, land surface, aerosol (tiny particles in the air), and carbon cycle components.

This graph compares the annual temperature from seven very long-running climate stations with the temperature simulated by NIWA's regional climate model at those same locations. We fed information into the model about large-scale patterns of sea surface temperature and weather (such as high pressure systems) over the oceans around New Zealand. The graph shows that the model successfully downscales the temperature variation at the chosen sites.

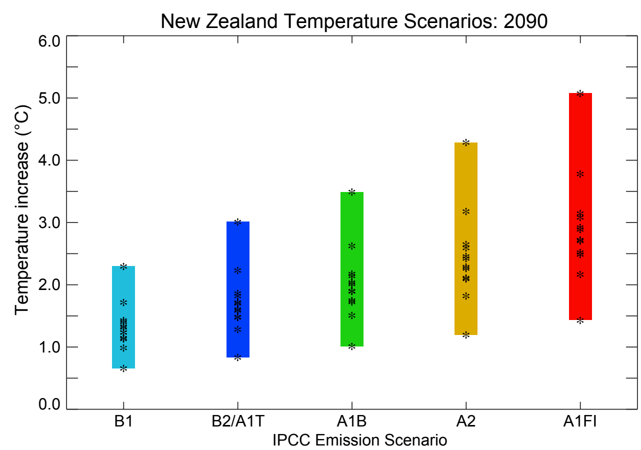


Why do we get a range of results?

Our future climate depends crucially on how much greenhouse gas we emit. Emissions, in turn, depend on trends in economic growth, global population, and technological change. For this reason, we use a range of scenarios (developed by the IPCC) which paint different pictures of the future.

The graph below shows NIWA's full range of projections for New Zealand's annual average temperature by 2090. Our results are based on 12 climate models across six emissions scenarios.

Each asterisk shows a climate model result. The bars show the full range of results for each emissions scenario. This demonstrates that different climate models give different results although many 'cluster' together. We have ordered the scenarios left to right from lowest greenhouse gas emissions (B1) to highest emissions (A1F1). The scenarios with higher greenhouse gas emissions produce higher temperatures.



This leaflet was produced by the NIWA National Climate Centre. It is based on scientific research funded by the NZ Foundation for Research, Science & Technology, and work for the 2nd editions of *Climate Change Effects and Impacts Assessment* and *Coastal Hazards and Climate Change*, guidance manuals for local government in New Zealand funded by the NZ Ministry for the Environment.

Further copies are available from:
NIWA National Climate Centre
Tel: 0800 RING NIWA (0800 746 464)
Email: climate-enquiries@niwa.co.nz
Also available online at: www.niwascience.co.nz/ncc

The guidance manuals are available at:
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Reports of the Intergovernmental Panel on Climate Change are available at: www.ipcc.ch

NIWA climate change maps are available at:
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August 2008