



Four Degrees of Global Warming:

Effects on the New Zealand Primary Sector
Summary

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4^o of warming

In 2007, the Intergovernmental Panel on Climate Change (IPCC) published 'best estimates' of global temperature rise by 2100 of between 1.8°C and 4.0°C compared to the 1990s, depending on how much greenhouse gas emissions and resulting atmospheric concentrations change over the rest of the century.

In 2012, the Ministry for Primary Industries asked climate researchers to consider what New Zealand might look like in 2100 – and the possible consequences for the country's primary producers – should we indeed see global warming of around 4°C compared to pre-industrial times (c. 1750). NIWA prepared a report, based on results from two global climate models, one from the Canadian Climate Centre (CCC) and one from Germany's Max Planck Institute (Planck).

The main findings of their report, *Four Degrees of Global Warming: Effects on the New Zealand Primary Sector*, are summarised here. It is important to realise that the report does not expressly predict four degrees of warming by the end of the century as the most likely global outcome. Rather, it explores the possible impacts for New Zealand if temperatures were to rise by that much.

Previously, similar New Zealand studies have focussed on low to mid-range temperature changes. While the direction and spatial patterns of the climate changes described here are generally consistent with those findings, their magnitude, effects and rate of change are significantly greater under the global four degrees scenario.

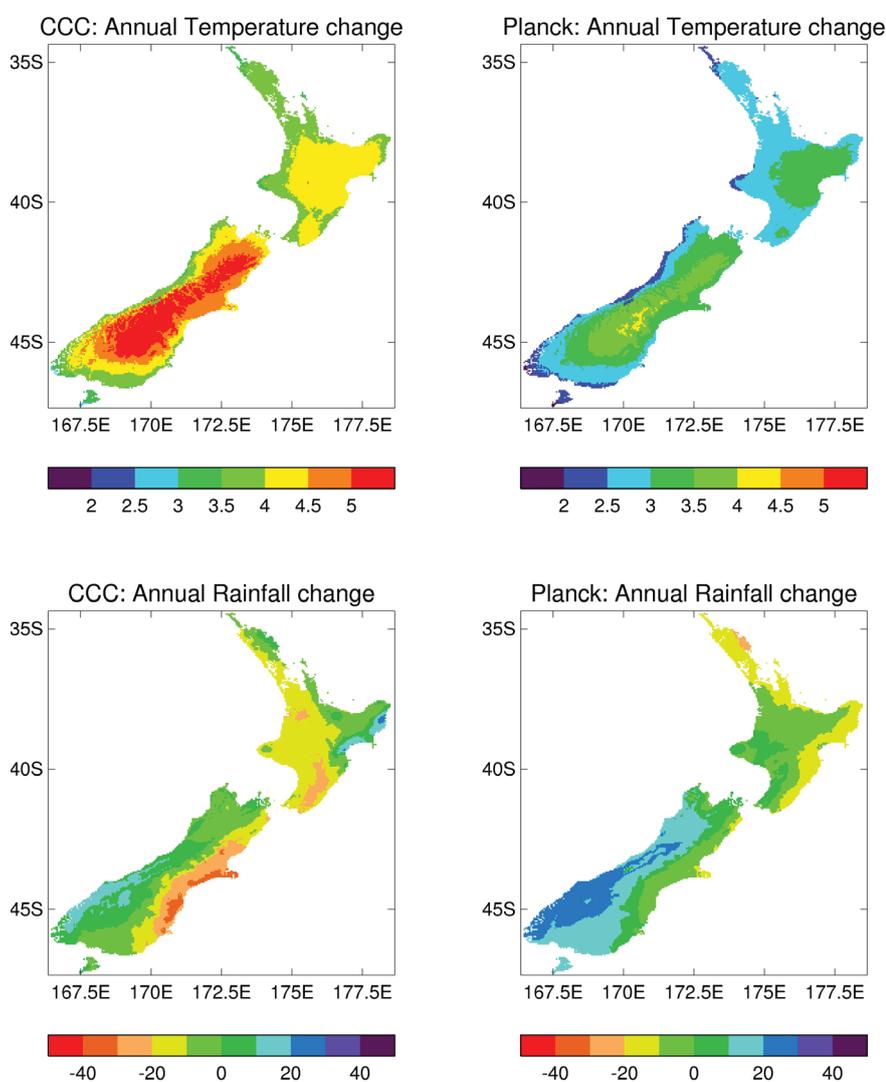
What might our climate look like?

Warming and precipitation

The report projected the greatest temperature rises for inland and eastern areas of New Zealand. Seasonally, temperature rises would be greater in winter and smaller in summer. The greatest increase came under the CCC model, in which the eastern South Island would warm in winter by 5.3°C.

The Planck model delivered the smallest increase of 2.3 degrees for the western North Island in summer.

Stronger westerlies would help drive a shift in precipitation, which was projected to increase in western regions, and decrease in the east, especially in winter and spring. Under the CCC model, summer saw a marked drying everywhere, but the Planck model projected little change (see full report, pp 10 – 22).

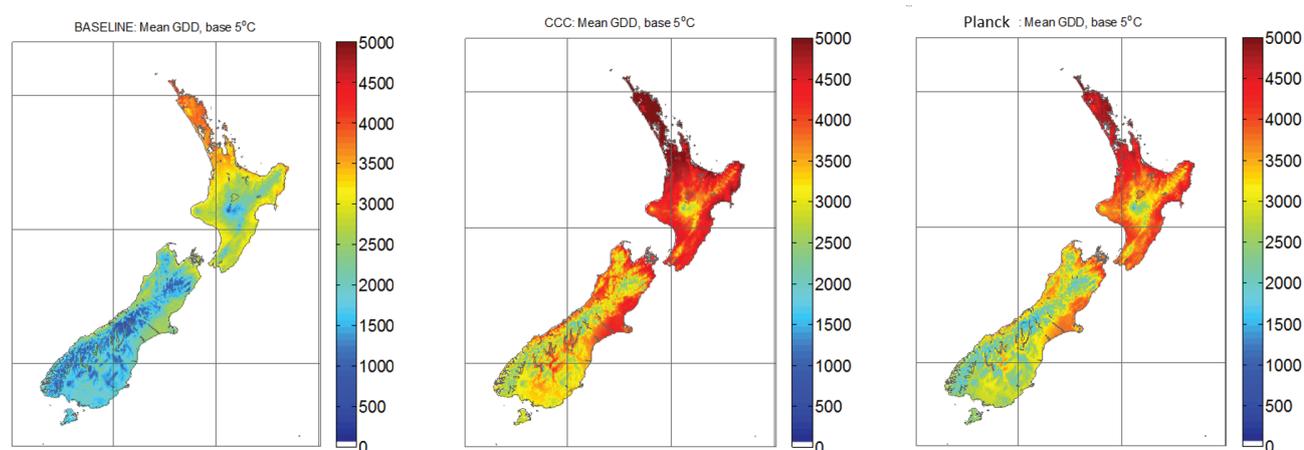


Projected annual changes under the 4-degree global warming scenario in New Zealand temperature (top, in °C) and rainfall (bottom, in %), according to the CCC model (left) and the Planck model (right).

Growing-degree days and frosts

Growing-degree days – above thresholds of 5°C and 10°C – are projected to increase markedly: by between 50 and 100 per cent in most localities. The mean length of the frost ‘season’ decreases dramatically, and frosts become very rare or stop altogether at most lowland sites in the North Island. In the South Island, frosts no longer occur in coastal regions of Marlborough, Canterbury, and Southland.

This would lengthen some growing seasons considerably, and ease temperature limitations for some crops. However, it would also reduce winter chilling for crops such as pip- and stone-fruit, and may allow some pest species to survive through winter (see full report, pp 23 – 26).



Growing-degree days above a base temperature of 5°C, for the current climate (left), and under the 4-degree global warming scenario according to the CCC model (centre) and Planck model (right).

Extreme rainfall and floods

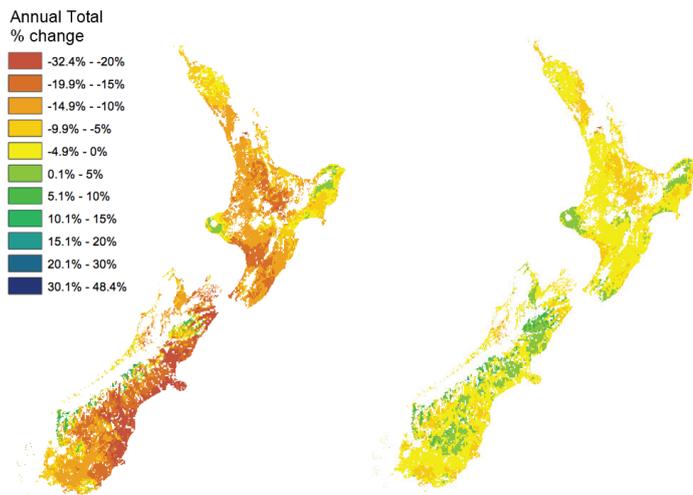
With each degree of warming, the atmosphere can hold eight per cent more moisture. That will affect rainfall intensity, and under the 4°C scenario extreme rainfalls are projected to increase by 32 per cent across the country, with extreme daily rainfall increases of between 50 mm and 150 mm expected in many locations. If expected stronger westerlies increase uplift and rainfall over the Southern Alps, these changes could be even larger.

Average annual water discharge is projected to increase in all six catchments analysed: the Clutha, Ahuriri, Waimakariri, Rangitata, Ashley and Rangitaiki. Extreme maximum rainfall volumes will prompt higher flood flows, while more and longer dry spells will see lower low flows. That means less water will be available during times of highest irrigation demand. River flows are expected to alter seasonally as less snow accumulates on the ranges in winter, and consequently, less melts over summer and spring (see full report, pp 30 – 55).

Pasture productivity (non-irrigated pasture only)

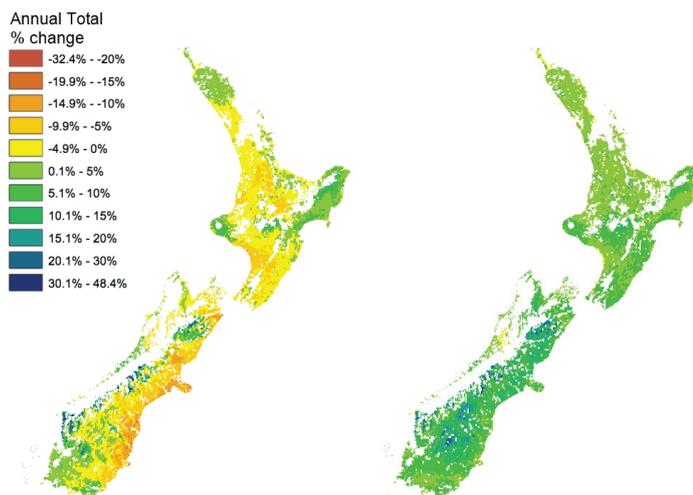
Grass growth can be stimulated by the CO₂ fertilisation effect. However, projections of pasture production must also accommodate a complex range of other variables, including fertiliser application and pasture use efficiency by animals.

Even when it included the CO₂ fertilisation effect, the CCC scenario projected a marked decline in both sheep/beef and dairy pasture production. The Planck scenario produced milder changes, with a slight decrease in sheep/beef pasture production, and an increase in dairy pasture production. Pasture production in the Biome-BGC model seems to rely heavily on the degree of warming: under a milder warming scenario, results suggest that pasture production would not change much. But more extreme warming would see New Zealand pasture growth significantly hampered (see full report, pp 76-87).



Sheep/beef sector

Change (in %) in annual pasture production (including the CO₂ fertilisation effect) for the sheep/beef sector, under the 4-degree global warming scenario, according to the CCC model (left) and Planck model (right).

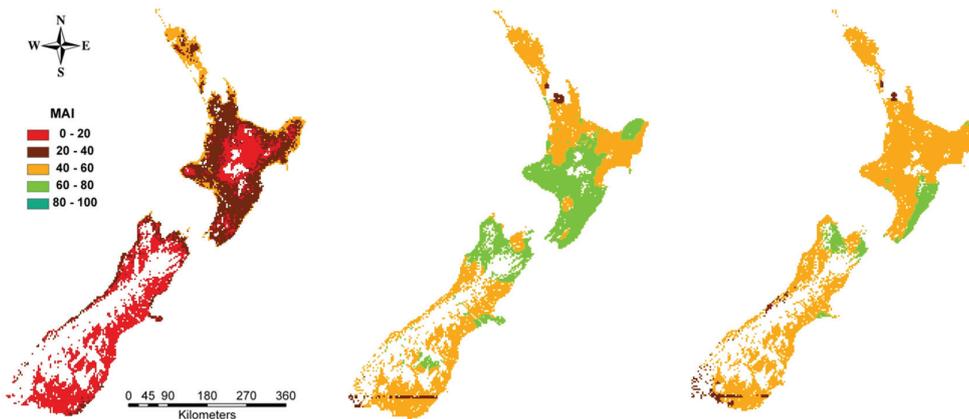


Dairy sector

Change (in %) in annual pasture production (including the CO₂ fertilisation effect) for the dairy sector, under the 4-degree global warming scenario, according to the CCC model (left) and Planck model (right).

Forest productivity

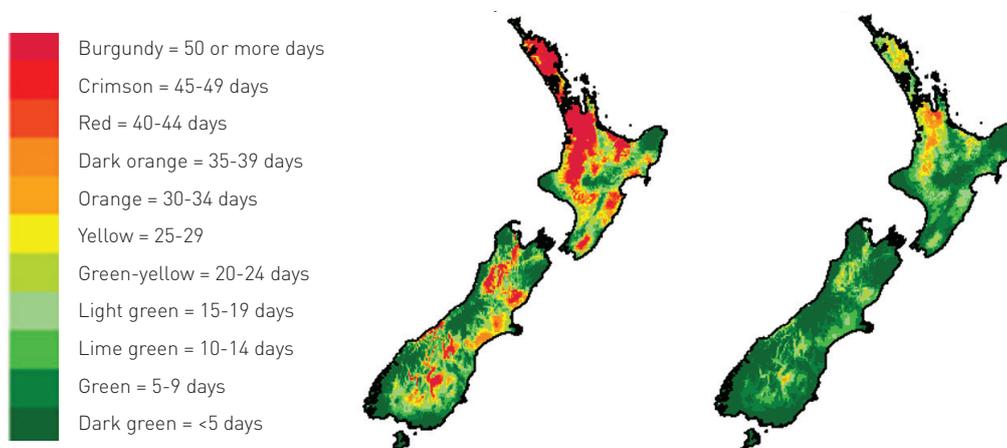
Any loss in *Pinus radiata* productivity from warming is more than offset by the enhanced fertilisation effect of increased atmospheric carbon dioxide, which would actually boost productivity by an estimated 30 to 40 per cent on average, depending on the climate change scenario. *Eucalyptus fastigata* (a fast-growing eucalypt tree species) productivity increases under both model scenarios, even when the enhanced fertilisation effect is ignored. When it is included, *Eucalyptus* productivity is projected to approximately double in many locations, due to fewer frosts and warmer temperatures. Note that the analysis took no account of the increased risk of forest fires, nor the possible impacts from changes in the distribution, survivorship or mortality of forestry pests (see full report, pp 87 – 116).



Eucalyptus fastigata productivity (mean annual volume increment in m³ ha⁻¹ yr⁻¹), for the current climate (left), and without a CO₂ fertilisation effect under the 4-degree global warming scenario according to the CCC model (centre) and Planck model (right).

Animal heat stress

Summers with 20 or more days above the heat stress threshold of dairy cattle are projected to become more common. Under both models, Northland and northern Waikato consistently experience more heat load, while the CCC model predicted the effect to extend further still – over most of the country. Without adaptation, heat stress could undermine production, reproduction and animal welfare. Adaptive measures might include a shift to more heat-tolerant breeds, milking only during the cooler months and providing more shade and cooling (see full report, pp 116 – 126).



Frequency (days) of Heat Load Index exceedance in summer under the 4-degree global warming scenario according to the CCC model (centre) and Planck model (right).

Where to go for more information

The full technical report, Four Degrees of Global Warming: Effects on the New Zealand Primary Sector, can be downloaded from www.niwa.co.nz, and www.mpi.govt.nz

Impacts of climate change on land-based sectors and adaptation options: Stakeholder/ Summary report

<http://www.mpi.govt.nz/Default.aspx?TabId=126&id=1581>

www.mpi.govt.nz/news-resources/publications.aspx. MPI has a range of reports, fact sheets and case studies here to help you plan for climate change. They cover a wide range of sectors and farm types.

<http://www.mpi.govt.nz/environment-natural-resources/climate-change/resources-and-tools/adaptation-toolbox.aspx> – a practical online adaptation toolbox to help guide you through key decisions.

A sector-by sector guide to adaptation can be found at <http://www.mpi.govt.nz/environment-natural-resources/climate-change/resources-and-tools/climate-change-resources-by-sector>

At <http://www.niwa.co.nz/our-science/climate/publications> you can find seasonal climate summaries, outlooks and updates, plus NIWA's State of the Climate report, published every two to three years.