



New Zealand's changing climate & oceans: implications for the future

There is clear evidence that the Earth's climate is changing, and there is strong scientific agreement that this is largely as a result of greenhouse gas emissions.

For New Zealand, the impact of changes in wind patterns, rainfall, and the chemistry of our oceans can be expected to be at least as important as the changes in temperature itself. These changes are not expected to be the same across New Zealand; there may be differences between the North and South Island and between the East and West coasts, and there are also likely to be unequal effects on seasonal patterns of rainfall and extreme weather events.

Global context

- The scientific conclusions about climate change remain consistent with previous studies and reports
- Concentrations of CO² in the atmosphere have continued to rise. Ocean temperatures are rising.
- Climate change is happening now. A 0.8°C rise in global average temperatures has occurred since pre-industrial times.

Variability, lags and buffers

- Over short time periods, natural variability has a significant impact on the global warming trend
- Short periods of no change or even slight cooling are to be expected, despite a continued long-term warming trend
- At times natural variability may even increase warming
- Global surface temperatures are only part of the picture; the ocean is a much larger heat sink than the atmosphere
- The reported recent 'break' in the rate of rise of temperature does not signal that climate change has 'stopped' or is no longer a concern

New Zealand context

- What NZ is experiencing are generally in line with global observations of CO² concentrations in the atmosphere and temperature rise
- The combination of changing pH, ocean temperature, stratification, salinity and changing currents may have a major impact on the oceans surrounding NZ

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Table 1: Summary of projected changes (increases are relative to the 1980-2000 average)

Geographic zone	Temperature & extremes	Wind and circulation	Average rainfall	Seasonal & extreme rainfall & drought
All NZ	Average temperature increase of 0.9°C by 2040, 2.1°C by 2090	Increase in strongest winter winds by 2100	Little change in the average for all NZ but large variation throughout NZ	Heavier and more frequent extreme rainfalls, but also more droughts. On average, 2 or more extra weeks of drought annually by 2050 for much of North Island and eastern South Island.
North Island	Less than half the number of frosts by 2100 in the central plateau (less than 15 days per year) 40+ extra hot days (above 25°C) a year in Auckland by 2100	Less westerly wind and more easterly events	By 2040 overall rainfall decreased in the east by up to 5% (though seasonally variable), with smaller changes in the west	West – in summer and autumn rainfall decreases, in winter and spring rainfall increases by up to 5%. East (Gisborne/Hawkes Bay) decrease in rainfall in winter and spring by up to 5-10%
South Island (incl. Southern Ocean)	Frosts expected to be rare in coastal locations by 2050	More frequent and stronger westerly during winter and spring	By 2040, increases in the west by 5% and decreases in the east (smaller change)	In winter and spring rainfall in the west and south (10% or more increase) reduced rainfall in the east (north of Oamaru) Heavier and more frequent extreme rainfalls.

New Zealand temperatures

- Changes in the average temperature may appear to be small, but resulting changes at the extremes have a major potential impact
- NZ can expect new record highs for temperature
- There is already evidence of changes in frequency of extreme temperatures for NZ

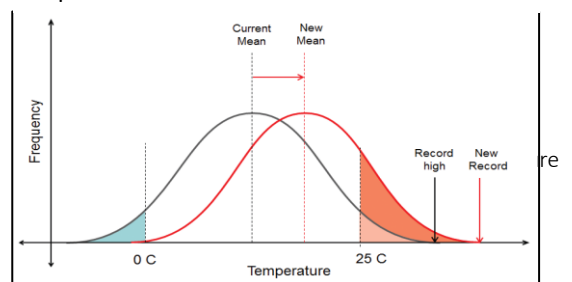
New Zealand atmospheric conditions

- NZ already experiences regional variation in rainfall due to its geography. This is likely to be greater, with even more rainfall in the west of South Island and less in the east
- Extreme weather events are likely to increase. Significant floods and droughts are expected to be more frequent
- An increase in extreme rainfall has already been seen

New Zealand region sea, snow and ice

- The rate of sea level rise has been increasing and is now about 3mm/year
- The rise is the result of a combination of thermal expansion of the oceans and the contribution of increased melting of land-based ice
- The rise in the NZ sea level is consistent with global change
- NZ can expect an increase in the number of extremes of high tides and their associated risks
- Changes in the Arctic sea ice are dramatic; there is more variable change in Antarctic due to the complexity of the system
- The size of NZ glaciers are expected to continue to decrease
- The snow line is expected to move upwards, although at the highest altitudes snowfall may increase

Figure 1. The effect on increasing mean temperature on the extremes



Impact on NZ industries

- Impacts are expected to be spread throughout NZ and vary depending on the season
- A general approach is needed because to consider changes individually may lead to wrong conclusions and incorrect action (or inaction)
- With some degree of change, increases in yield/profit may be possible in some farms
- The impact of extreme events and changing pest scenarios need to be taken into account

The future of land-based industries – a note of caution

The projections described here for the land-based primary industries are based on initial modelling that does not yet account for several issues. These factors need to be acknowledged to understand that there remains uncertainty about the full impact of climate change on NZ's primary industries as follows:

- Extreme temperature events
 - Projections do not usually account for stress on animals and/or crops posed by the increase in frequency the number of hot days (above 25°C) or by new record-high temperatures. The risk of wild fires also is expected to increase
- Flooding and high winds
 - Are expected to occur more often and with greater extremes and will impact on both yield and quality of produce
- Changes in pests and diseases
 - The decrease in frosts will increase survival rates of pest species. New exotic pests and diseases may become established with existing overseas pests becoming common.
- Temperature increases beyond 2°C
 - How to deal with anything more than a 2°C change world is less understood.
- Follow-on or spill-over effects (e.g. the effects of adaptation to climate change) appear to have the potential for similar if not greater impacts than the primary effects of climate change.

Further examination of these factors is required to assess potential adaptation decisions for arable, pastoral and horticultural farms.

Ecosystem biodiversity and human health

- Climate change can be expected to impact NZ's biodiversity
- NZ native species may be more vulnerable to climate change than those newly able to establish themselves due to changing environment
- Changes in timing of key seasonal events (such as flowering of crops) may disrupt ecosystems
- The occurrence and distribution of human disease carriers (e.g. mosquitoes) may shift as the climate warms

Energy and infrastructure

- The high and increasing percentage of people and buildings in coastal areas in NZ, results in high exposure to storm surges
- Existing physical defences are typically built to cope with past frequencies numbers of extreme events but may be at risk with more frequent future challenges.

NZ emissions

- Transportation is responsible for 19% of NZ's greenhouse gas emissions, and per capita road fuel consumption is high compared to other developed nations
- Agriculture remains the largest sector emitter for the country (47% of total emissions), and NZ has taken the initiative globally in seeking mitigation strategies for livestock systems
- The electricity grid is low-carbon compared to other countries globally, with over half of NZ's electricity supplied by hydro-electric power
- Forestation has significant impact, substantially reducing NZ's reported net emissions



Further information

The full technical report, *New Zealand's changing climate and oceans: The impact of human activity and implications for the future. An assessment of the Office of the Chief Science Advisor*, can be downloaded from www.climatecloud.co.nz/CloudLibrary/New-Zealands-Changing-Climate-and-Oceans-report.pdf

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