



**Earth Sciences**  
New Zealand

# A brief intro to weather & climate

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1. Weather Basics
2. Climate Basics
3. Climate Drivers
4. Resources

# Weather Basics

Officially, *weather* is defined as “the state of the atmosphere at a particular place and time”. But instead of learning a definition, it might be easier to think of the weather as what you see out your window every day. Is today sunny, cloudy, windy, rainy or stormy? All of those things are part of the weather.

Weather is what we see and feel in the short-term, meaning over the next few days or the next couple of weeks.

New Zealand's climate can be defined as 'temperate' meaning we experience mild weather conditions. However, every so often we experience extreme weather and climate events.

These events are unusual and don't happen very often – that's why we call them 'extreme'. The other reason we call these events extreme is because they can cause **impacts** that affect our daily lives, such as heavy rain that causes flooding.

These events may happen on a single day, or they may occur over a long period of time – for example droughts often develop when we have many weeks in a row without any rainfall.

## Low and high pressure

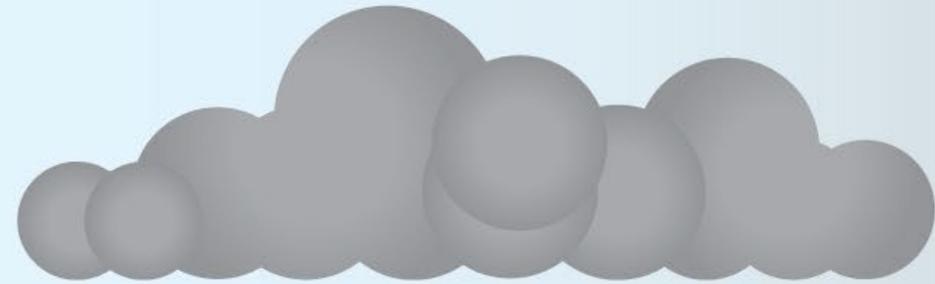
Areas with *low pressure* are usually associated with bad weather.

Areas with *high pressure* are usually associated with good weather.



**HIGH pressure:**  
air sinks, warms  
and dries out:  
few clouds, sunny

**H**



**LOW pressure:**  
air rises, cools  
and condenses:  
clouds and rain

**L**

# What makes wind blow?

Wind is caused by *pressure gradient*, or the difference between high and low pressure.

Think about high pressure like the top of a hill and low pressure as the bottom of the hill. If you roll a ball from the top it will quickly rush down to the bottom. The same thing is happening with wind.

The larger the pressure gradient is (the difference between the top and bottom of the hill), the stronger the wind will be.

# Warm and cold fronts



A front is a boundary between two different air masses (usually one warm and one cold), and along fronts there is often stormy weather, sharp temperature changes, and rapid shifts in wind direction.

A *cold front* divides warm air and cool air, moving so that the cooler air replaces the warmer air. A *warm front* works in the opposite way, with warmer air replacing the cooler air.

If you wake up and look out the window to see that it's sunny, cloudy, rainy or a little bit windy, you probably won't think too much about it.

However, occasionally the weather becomes much more dangerous – what meteorologists call severe weather.



# Drought

A drought refers to a lack of rainfall that results in a water shortage for some activity, group, or industry.

*Droughts* can last for months or even years!

In fact, from late 2019 through the first half of 2020, rainfall in the Upper North Island and Auckland was well below normal, causing councils to enact water use restrictions.

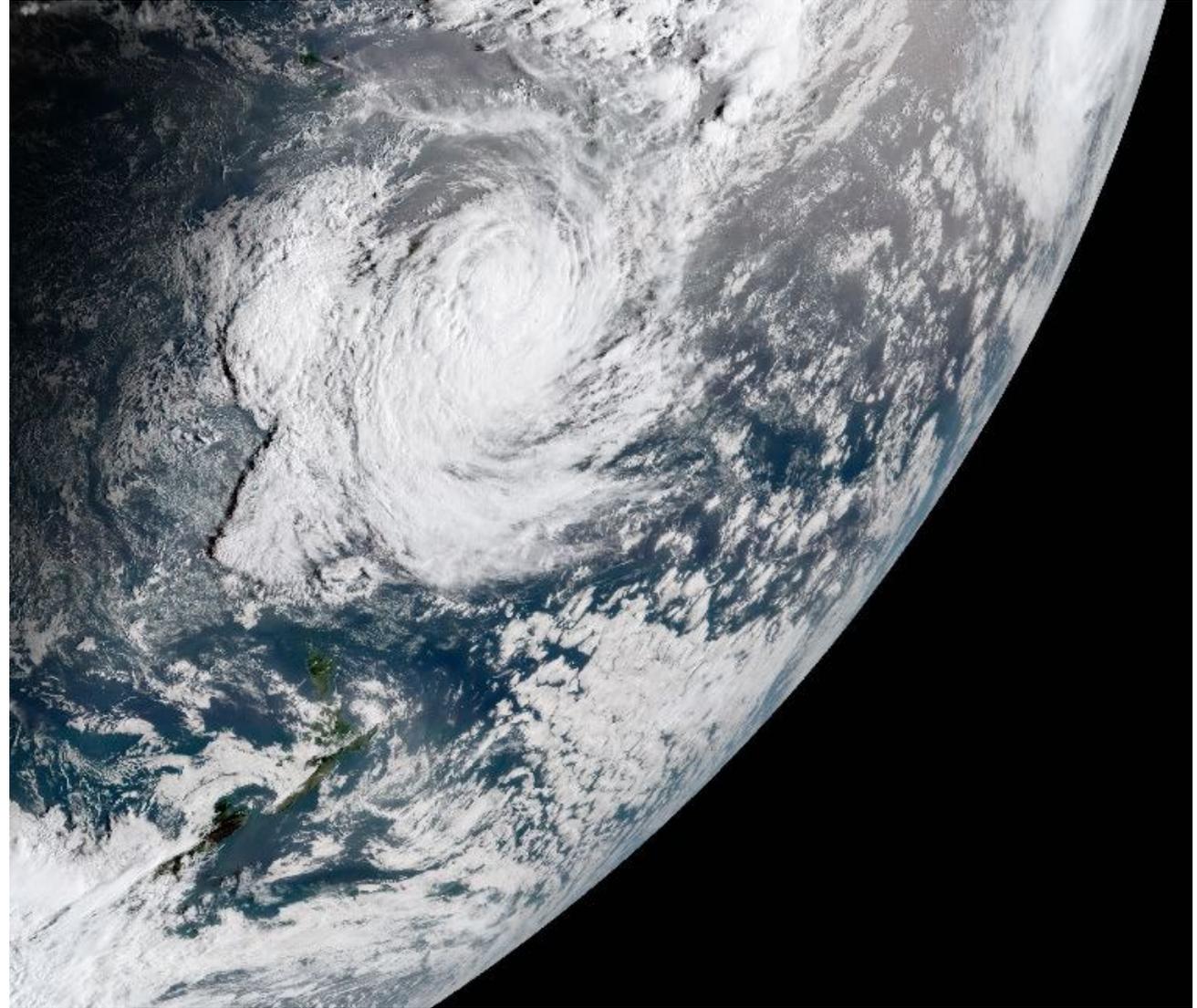


# Tropical cyclones

One of the most serious types of extreme weather to affect New Zealand are tropical cyclones. Cyclones require very warm ocean temperatures of 27°C or greater.

Tropical cyclones are also HUGE—the largest can measure up to 2,000 km in diameter with the strongest ones having wind gusts over 300 km/h!

Strong winds can easily destroy trees and buildings. However the most dangerous aspect of a tropical cyclone can be what's called storm surge. Storm surge causes flooding in coastal areas as the cyclone reaches land.



# Severe thunderstorms and tornadoes

Thunderstorms can form when the atmosphere is unstable, usually meaning that air near the ground is much warmer than air high in the atmosphere.

Here in New Zealand, thunderstorms must meet one or more of these specific criteria to be considered severe:

- Heavy rain of 25 mm per hour, or more
- Large hail of 20 mm diameter or more
- Wind gusts of 110 km/h or more
- Tornadoes with wind speeds of at least 116 km/h.





Tornadoes are violent rotating columns of air extending from severe thunderstorms to the ground or water. When they touchdown on water this is called a waterspout.

The strongest tornadoes are capable of producing incredible destruction with wind speeds of 450 km/h or more, and widths of up to 1.5 km!

Luckily, tornadoes in New Zealand are much rarer. The region most likely to see tornadoes is Taranaki, although they can occur anywhere in New Zealand.

# Climate

Weather is what you see out your window every day, whether it's cloudy, rainy, sunny or windy. Weather is what we see and feel in the short-term. It can change quickly, over minutes, hours or a couple of days.

*Climate* describes what the weather is like over a long period of time (years or decades) in a specific area.

In short, climate is what we expect, while weather is what we get.

To study the climate of a particular place, scientists look at *averages* of rainfall, temperature, sunshine, wind and other measures of weather over a long time, often over 30 years.

These long-term averages of weather observations are known as *climate normals*. Scientists study climate to look for trends and patterns and predict how the climate may change in future.



# Temperate climate



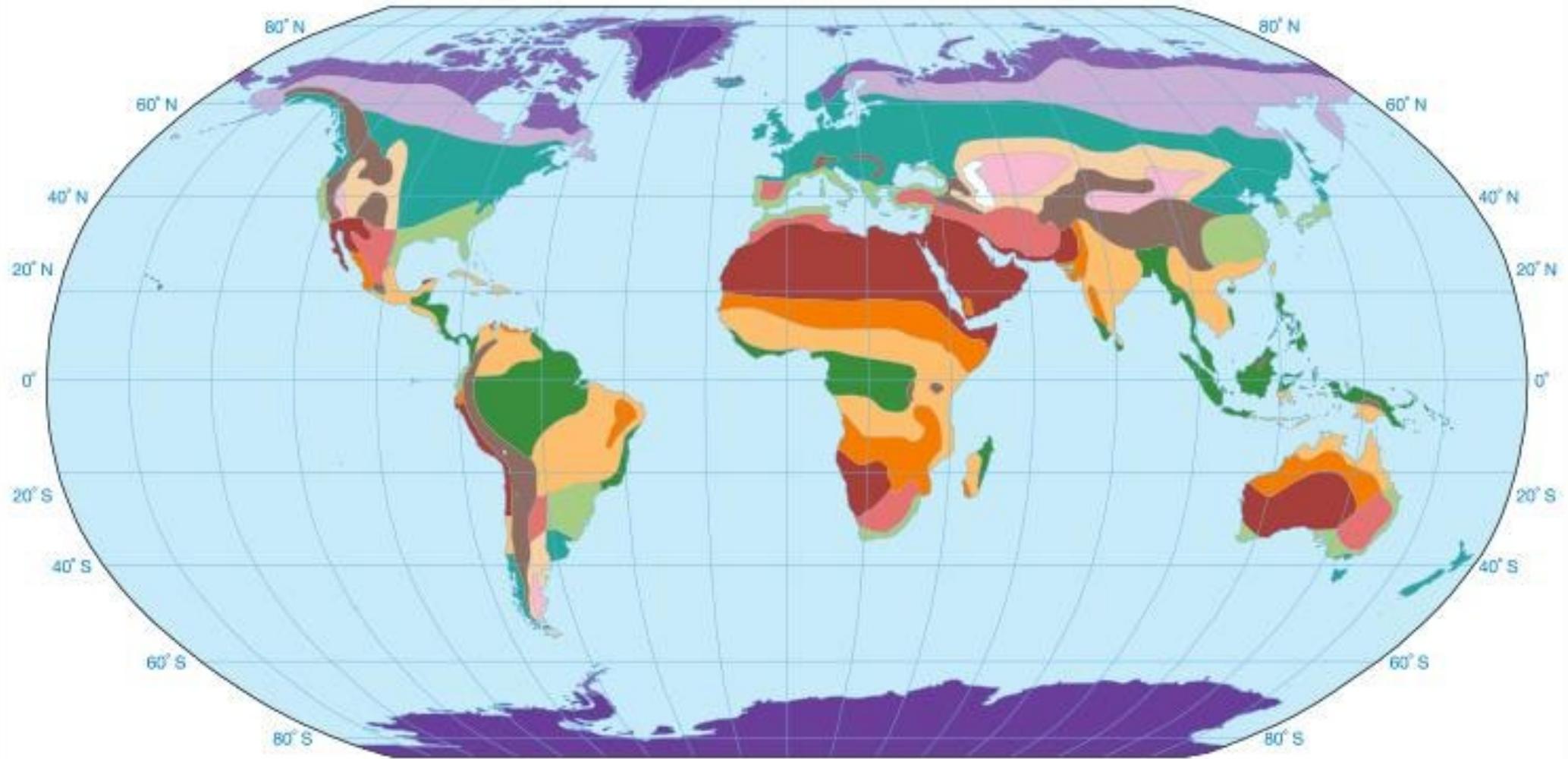
*Temperate climates* are considered to be those found between the polar climates and the tropical climates. In these regions , temperatures can change quite a bit during the year and there are usually four distinct seasons. This may mean that it's hot and humid during the summer, but in winter it can snow and be very cold. New Zealand has a temperate climate.



Aotearoa has a relatively wet, mild and windy climate. There are four pieces of the puzzle that are important for understanding New Zealand's climate:

- our temperate latitude,
- the influence of the ocean
- the prevailing westerly winds
- New Zealand's rugged topography (the shape of the land).

# WORLD CLIMATE REGIONS



## Tropical climates

- Rainforest
- Grasslands
- Semiarid
- Desert

## Subtropical climates

- Humid Subtropical
- Desert

## Temperate climates

- Temperate
- Subarctic
- Grasslands
- Desert

## Polar climates

- Polar Tundra
- Polar Ice Cap

## Highland climates

- Highland (varies with altitude)

# The influence of the ocean

The ocean surrounding New Zealand causes more moisture to be held in the air that travels across the country, bringing humid conditions and rainfall year-round. These oceanic air masses cause temperatures to generally be quite moderate (not extremely hot or cold).

Because New Zealand is surrounded by ocean, sea breezes ease temperatures and can cause cloudy weather to dominate.



## Prevailing westerly winds

In the Southern Hemisphere, there is not much land to slow down the westerly winds, compared with the Northern Hemisphere where there are large areas of land to slow down the winds.

The strongest westerly winds that occur in the middle latitudes of the globe are called the Roaring Forties. These winds affect New Zealand!

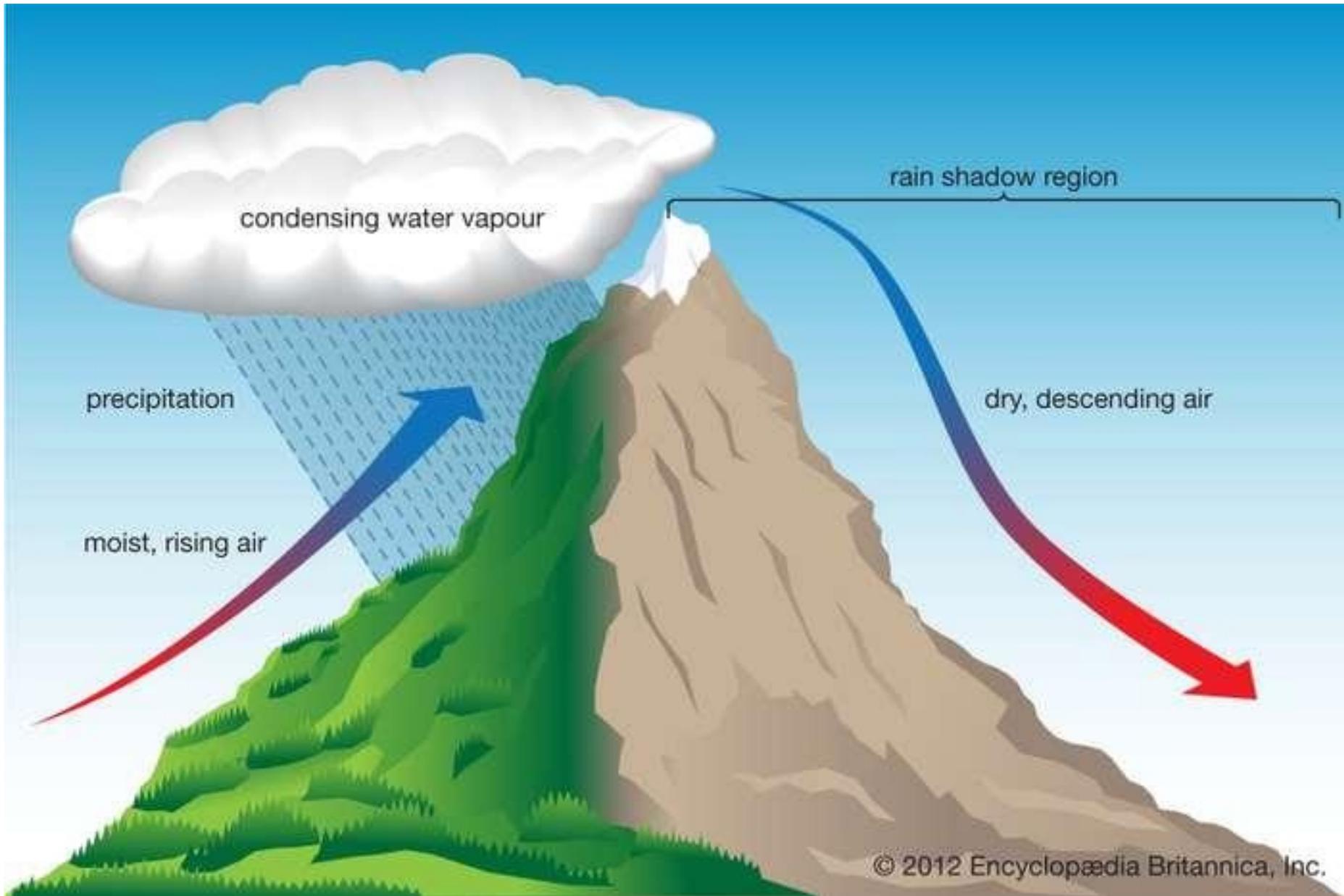
Westerly winds bring air full of moisture towards the west coast of New Zealand, partly explaining why western areas are usually wetter than eastern areas.

# NZ's varied topography

When the prevailing westerly winds, carrying lots of moisture, reach the west coast of New Zealand, they are forced to travel up the side of the mountains because the mountains are blocking their path.

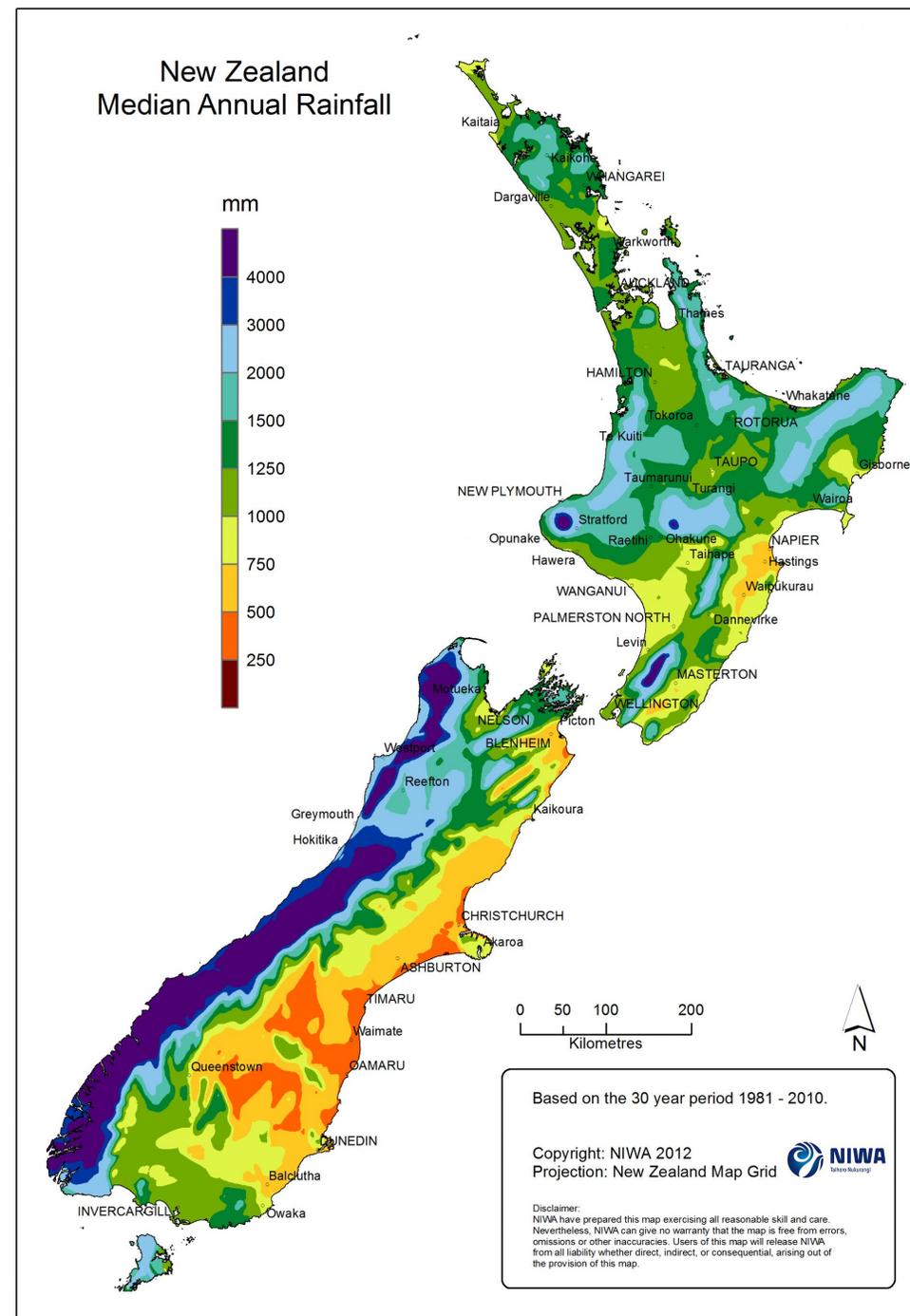
This is where we get an effect called 'orographic rainfall'. This means that as the air rises and cools, clouds form and rain (or snow if it's cold enough) falls.

Most of the rain falls upwind (on the western side) of the mountain range and the downwind side (eastern side) of the mountain range is in what's called the rain shadow where only small amounts of rain fall.



# Rainfall patterns in NZ

The orographic effect is why we get very high rainfall on the west coast of the South Island in places like Milford Sound (almost 7 metres of rainfall a year!) but only about 100 km away, places like Alexandra in Central Otago only get on average 30 cm of rainfall a year.



The summer of 2019-20 was the driest on record for much of Auckland. Summer 2017-18 and winter 2020 were the warmest on record for most of New Zealand. Autumn 2017 was one of the wettest, but spring 2014 was just average.

Have you ever wondered what makes the climate during one season more extreme than another? Such as why sometimes it rains, and rains and rains some more and other times it's non-stop sunshine and beach weather? We'll explore the reasons behind it in this lesson.

# Climate Drivers



Climate represents the weather trends and patterns that are experienced in a location over a long period of time, such as months to years.

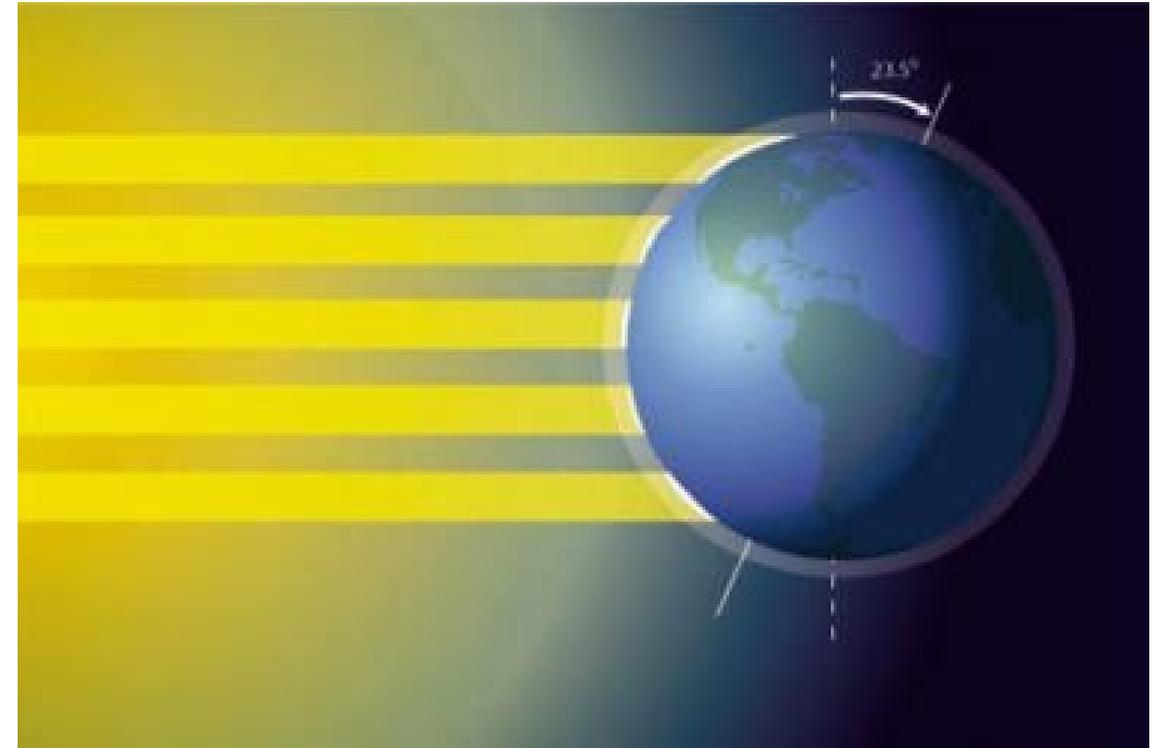
Global climate drivers influence weather patterns that occur over months and seasons.

You can think of climate drivers like pie. Each driver gets a piece of the pie, but depending on the season, a certain climate driver may get a bigger piece of the pie than other drivers. That driver would then have a bigger influence on the weather that occurs during that season.

# Climate driver 1: The Sun

The sun is the main driver of Earth's weather and climate patterns. The sun's energy (solar radiation) isn't equally distributed across the globe because of Earth's spherical shape. This "unequal heating" of solar radiation across our planet is effectively what causes weather and climate.

Differences in solar radiation lead to differences in temperature and differences in temperature ultimately lead to stormy weather – storms are Mother Nature's way of trying to minimise temperature differences.



# Climate driver 2: El Niño Southern Oscillation

El Niño Southern Oscillation (ENSO) is a climate pattern that influences rainfall, temperature, and wind patterns around the world. ENSO has three phases: El Niño, La Niña, and neutral. El Niño and La Niña events occur, on average, every few years and last up to around a year or two.

Watch this video to learn more about ENSO!



<https://www.youtube.com/watch?v=A1r8ymAoe2M>

# Climate driver 3: Madden Julian Oscillation

The Madden-Julian Oscillation (MJO) is an eastward moving zone of cloud and rain that circles the tropical areas of the globe. It is the biggest driver of changing weather in the tropics and lasts a few weeks.

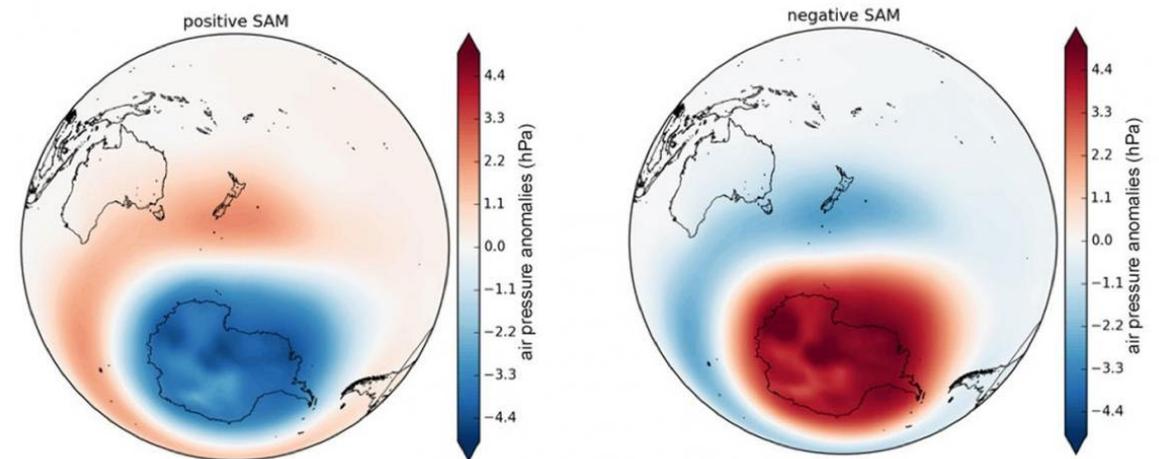
The MJO and its rain and thunderstorms are more likely to develop over an area that is experiencing warmer than usual ocean temperatures and less likely to affect an area with cooler than usual ocean temperatures.

The MJO can influence the formation of tropical cyclones. Typically, one cyclone per year affects New Zealand!

# Climate driver 4: Southern Annular Mode

The Southern Annular Mode (SAM) involves alternating windiness and storm activity between the mid-latitudes, where New Zealand is located, and higher latitudes, such as over the Southern Ocean and Antarctica.

There are two phases of the SAM: positive and negative. In short, when the SAM is positive, the weather is more likely to be nice across Aotearoa.



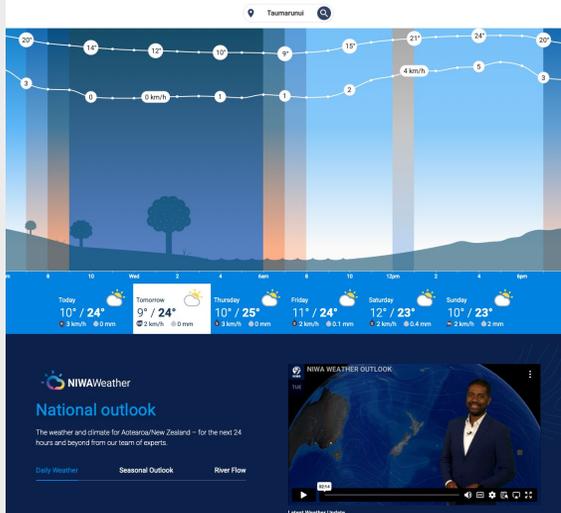
# Weather and Climate Resources

# Weather forecasts

Choose your local and favourite weather sources. Beware of social media pages with no background on who runs the pages.

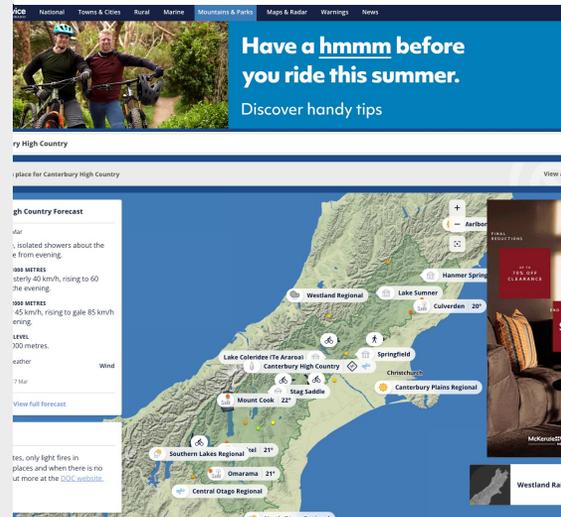
## NIWA weather page

Uses weather data from the optimal seamless forecast. Including local models like the NZCSM, NZENS, and other model data.



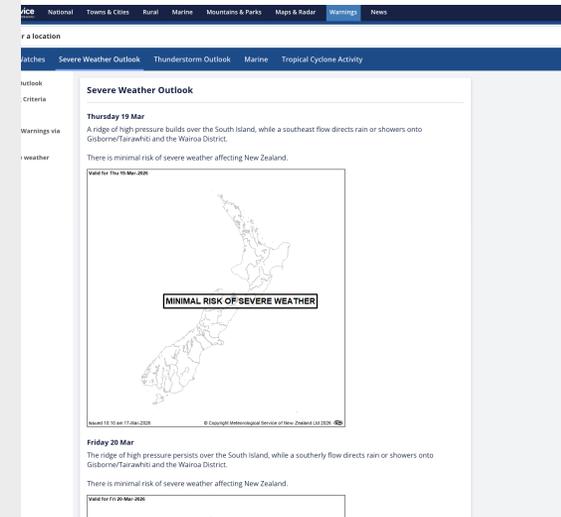
## Metservice

Global and locally run model data along with local meteorological data. Forecasters based in NZ.

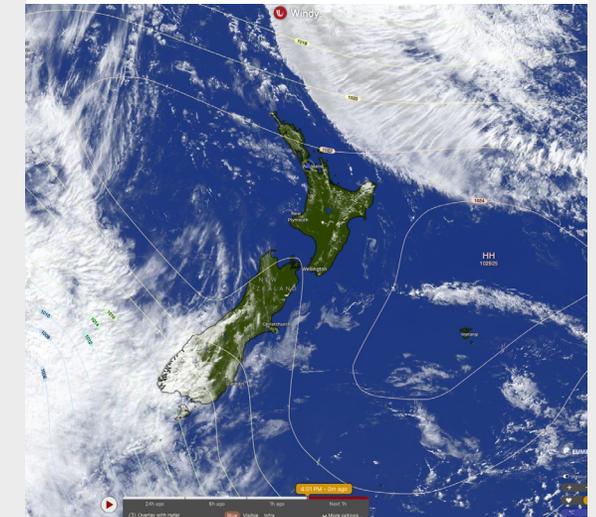


## Severe weather outlook

Metservice forecasters look ahead several days.



Other sources, choose your favourites:  
Accuweather  
WX Watch  
Phone Apps  
Yr.no  
Windy



# Climate information and forecasts

Longer range forecasts

<https://niwa.co.nz/climate-and-weather>

## Seasonal Climate Outlook

Air temperature, rainfall, soil moisture and river flow predictions for the coming season.

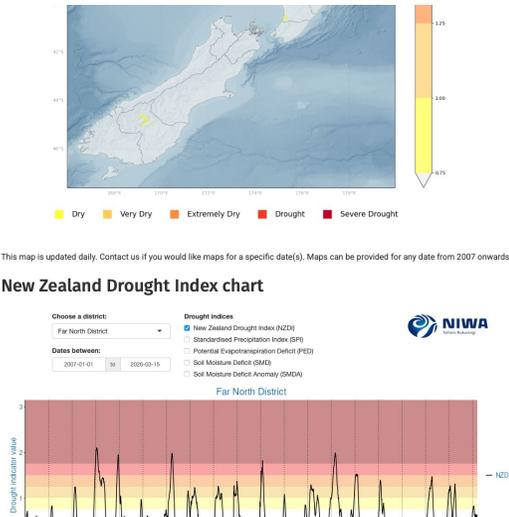


## Seasonal Climate Outlook March - May 2026

Despite the seasonal predictability barrier, the development of El Niño by winter is looking

## New Zealand Drought Monitor

The New Zealand Drought Monitor is a system for keeping track of drought conditions across New Zealand based on a standardised climate index.

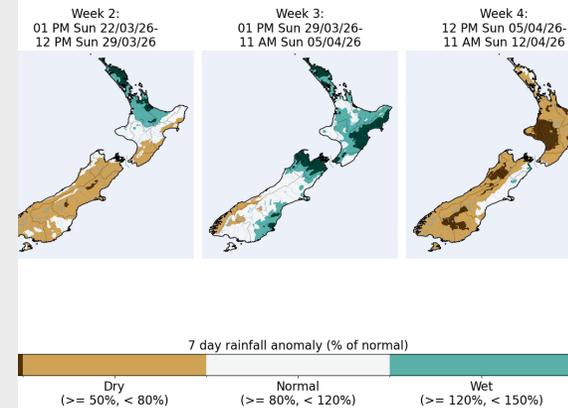


## NIWA35 Drought Forecasting Dashboard

The NIWA35 is a model that uses the latest advancements in artificial intelligence to take a coarse resolution forecast and increase its resolution. This results in a more skilful forecast at longer lead times. It's the first climate outlook in New Zealand to be updated on a daily basis, allowing for a real-time assessment of the risk for weather hazards and extremes, like droughts and floods, over the next five weeks.

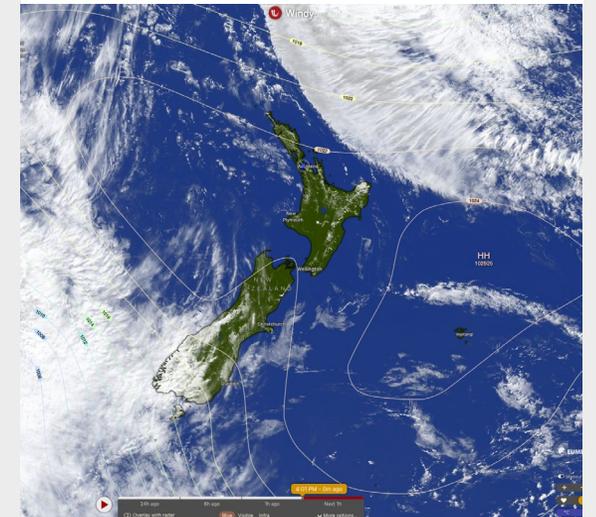
### Rainfall anomalies (% of normal)

on 15/03/2026



## Regional climatologies

A regional climatology is a summary of the typical weather and climate of a region, based on historical data observations made at climate stations located within the region.





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