Aotearoa New Zealand National Monthly Fire Danger Outlook (2023/2024 season)

Issue: December 2023

Current fire danger situation

Most of November's fire indices were low to moderate across New Zealand, although some higher values were observed in Canterbury and Otago. In addition, scrub fire danger was high to very high across much of the country. See Figures 8-11 for more detail.

El Niño continued during November and has around a 100% chance of persisting through summer and an 85% chance of persisting through autumn. Although it will have an important influence on New Zealand's climate, unusual ocean heat in the western equatorial Pacific and on a global scale has contributed to circulation patterns that are not typically associated with a traditional El Niño.

Current fuel and soil moisture status

As of 12 December (Figure 4, left), soil moisture levels are near normal to above normal across the upper and eastern North Island and parts of the South Island. However, soil moisture is below normal from Waikato to Wellington, and in Nelson, Marlborough Sounds, and the lower South Island.

Current fire dangers across most of the country remain low to moderate due to the effects of regular rain events which have resulted in wetter than normal spring and early summer conditions, even with El Niño. Fire dangers have continued to "see-saw, with brief upward trends in codes and indices during periods of dry weather, but decreases again with the regular rainfalls.

A change to drier conditions, especially in eastern and northern areas of both islands over the next few months should see fire dangers begin to climb in many areas to more normal, or even above normal levels in some areas.

This will be shown in increasing values of the Duff Moisture Code (DMC) and Buildup Index (BUI) (Figure 1), which indicate the potential for greater involvement of medium and shallow subsurface fuels if fires were to occur. Values of the Drought Code (DC) are below normal to normal in most areas indicating little involvement of deeper or larger fuels, with the exception of inland South Canterbury and central Otago where values are more elevated and could reach above normal levels.

Values of the Fine Fuel Moisture Code (FFMC), which represent the dryness of fine fuels, have also increased. These indicate the increased potential for fires to ignite in fine fuels such as scrub and dead grass. In conjunction with periods of increased wind, these elevated FFMC values contribute to high Initial Spread index (ISI) values, indicating potential for any ignitions that do occur in these fine fuels to spread rapidly.

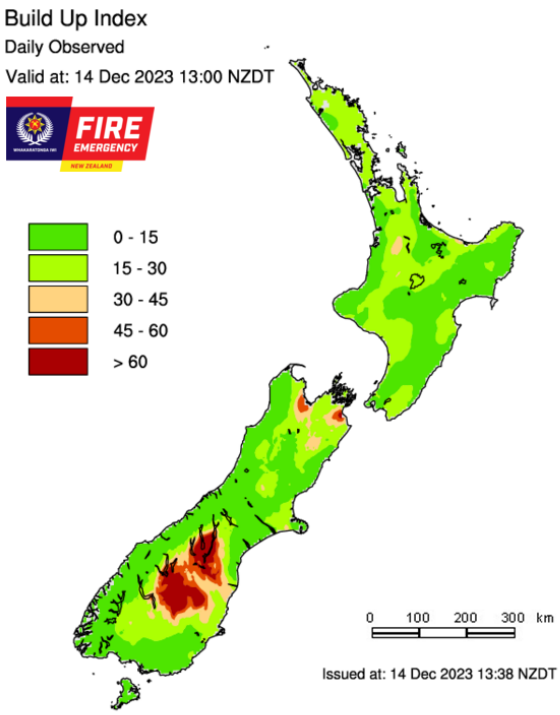


Figure 1: Map of Buildup Index (BUI) values (indicator the total amount of fuel available for combustion) as at 14th December.

Forecast climate and weather

The remainder of December is forecast to feature areas of high pressure, particularly across the North Island. However, low pressure forming in the Tasman Sea may increase the chance for rain in the western South Island, especially in the last 7-10 days of the month.

For January, a more north-westerly flow pattern is generally favoured. This would result in above normal rainfall for the western and lower South Island, and a chance for meaningful rainfall to spill over the Alps into the eastern South Island as well. The western North Island could see rainfall closer to normal, while areas farther north and east may be drier. This will also result in near average to above average temperatures and gusty to strong westerly winds at times, especially in the South Island.

January-March will likely exhibit more west-northwest winds than usual. These winds may be strong at times in the South Island especially. Drier than normal conditions are somewhat favoured in the north and east of the North Island, with wetter conditions possible in much of the South Island. Temperatures overall look to be near average to above average, with the warmest temperatures in the North Island and eastern South Island.

For more information, see pages 4 and 5.

The El Niño climate pattern

While El Niño has around a 100% chance of continuing over the next three months, periods that go against the grain of a typical El Niño will likely occur. The effect of a non-traditional El Niño will encourage increased variability in circulation patterns and air flows as compared to historical El Niño summers.

No two El Niño events are the same, and each event can produce different effects on weather conditions and therefore fire dangers across New Zealand depending on its timing, strength, and duration. In general, however, El Niño events bring a northward shift of the paths of the high and low pressure systems as they cross New Zealand and stronger westerly winds, which result in wetter conditions in the west and drier conditions in the east of both islands.

It is important to remember that ENSO events such as El Niño and La Niña only explain around 25% of the variability in New Zealand's weather. The last strong El Niño event in 2015/16 brought very mixed weather and fire danger conditions, due largely to the impact of other climate drivers which can also have significant effects. The strong 1997/98 El Niño event however did bring very dry conditions to eastern areas.

What to watch for

A high degree of uncertainty around weather conditions and resulting fire dangers in many areas of the country over the next few months, due to the non-typical El Niño.

In the short term, likely a continuation of the "see-sawing" of fire dangers through late December and early January as we get periods of drying interspersed with rain events.

But a change to drier conditions in many areas over the next few months, especially eastern and northern parts of both islands. This will result in increasing fire dangers, curing-off of grassland areas, and greater involvement of medium and potentially heavier fuels.

Wetter conditions, in the west of the South Island in particular, including spill-over rain over the Alps into inland areas with strong westerly wind events.

The likelihood of El Niño conditions continuing through summer and into autumn could mean an extended fire season. In some areas, the worst fire danger conditions may not occur until late February or March.

Fire dangers in some areas are already elevated, and could therefore increase to above normal levels. This includes areas such as Central Otago and inland South Canterbury in particular.

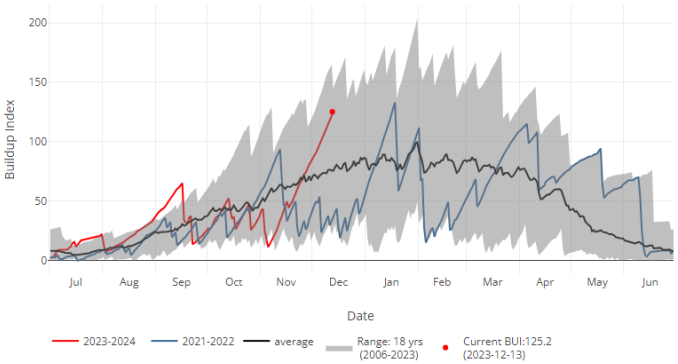


Figure 2: Trend in the Buildup Index (BUI) for Cromwell, indicating the potential for already elevated values to reach above normal levels if extended dry periods occur.

The more frequent warm, dry W/NW wind conditions are expected to continue. These often align to produce days with high temperatures and low humidity that escalate fire dangers significantly, especially in eastern areas, contributing to easier ignition and rapid fire spread.

Winds stronger than normal could result in large wind-driven fires, especially in light flashy cured grass and scrub fuels. As they are made up of mainly fine fuels, these fuel types dry out very quickly and become available to burn at high intensities after just a day or two without rain or in windy conditions.

The wet and warmer than normal spring weather have contributed to very good growing conditions. This has resulted in high grass fuel loads that, as they cure and die-off, will produce higher than normal fire intensities.

People rushing to burn before fire restrictions come into place may burn in weather conditions that are not suitable (especially windy conditions). People should be reminded to check the conditions before they light, and if a permit is required.

There has been a spate of fires in the past few weeks from burns either escaping or re-igniting in strong winds. People should therefore be encouraged to ensure their fires are fully extinguished, especially ahead of any forecast wind events.

Over the Xmas holiday period, fires may also occur from fireworks or other festive activities, such as bonfires or camp fires.

Even in the absence of a strong El Niño influence, a "normal fire season" in many areas will have much greater fire potential than the last few fire seasons. The occurrence of the predicted days when dry conditions align with strong winds, high temperatures and low humidity could mean that some areas see many more days of Very High and Extreme fire danger than average for this stage of the fire season. Be vigilant, as indices may change rapidly.

Watch for increasing fire potential as we head into summer. This continues to be the time to complete preparations for the fire season, especially in the north and eastern parts of both islands where the fire potential is likely to higher.

Ongoing fire season preparations should include:

- Regular monitoring of fire risk conditions through our weather station network and grass curing assessments.
- Watching for areas of increasing or already elevated grass curing. During windy conditions, these cured grasses can produce intense fast-moving fires.
- Districts to finalise roster arrangements, including IMT availability for the holiday period and over times of elevated fire danger.
- Planning for spike days when fire danger is especially elevated due to alignment of hot, dry, windy conditions. This could include actions such as awareness campaigns, cancellation of permits or standby arrangements.

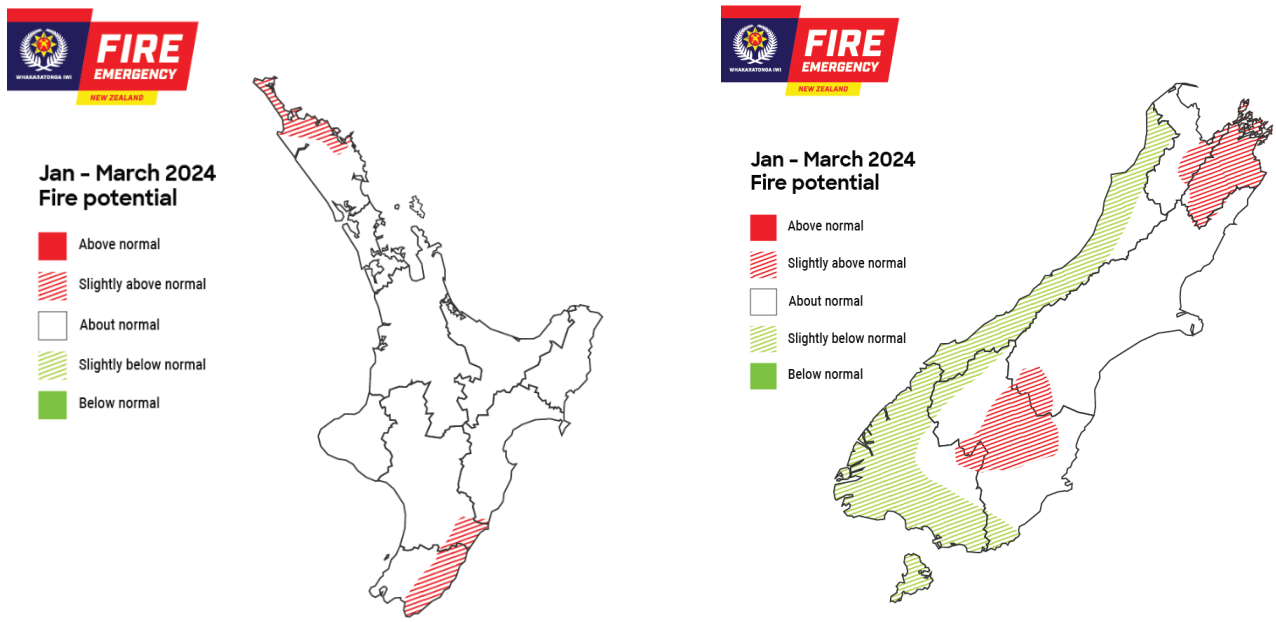


Figure 3: Locations identified as areas of interest that may develop an increased risk of above normal fire potential over the next three months.

Current climate

In November, temperatures were above average (0.51°C to 1.20°C above average) for western and inland parts of the South Island, and much of Auckland, Waikato, Bay of Plenty, East Cape, inland Whanganui, parts of Manawatū, Kāpiti Coast, and inland Wairarapa. Near average temperatures (±0.50°C of average) prevailed for most remaining areas of the country. So far in December, temperatures have been near average across large portions of both islands, with smaller areas of above average and below average temperatures (Figure 4, right).

November rainfall was below normal (50-79% of normal) or well below normal (<50% of normal) for much of the South Island, the southwestern North Island, western and northern parts of Waikato, and southern parts of Northland. Rainfall was above normal (120-149% of normal) or well above normal (>149% of normal) for in western and inland parts of Bay of Plenty, southeastern Waikato, Gisborne, Hawke's Bay, eastern Wairarapa, and parts of mid Canterbury. So far in December, rainfall has been below normal or well below normal across much of the country. However, areas of near normal to above normal rainfall have been observed in Northland, Auckland, coastal Waikato, Gisborne, and the West Coast (Figure 4, middle).

As of 12 December, soil moisture levels are near normal to above normal across the upper and eastern North Island and parts of the South Island. However, soil moisture is below normal from Waikato to Wellington, and in Nelson, Marlborough Sounds, and the lower South Island (Figure 4, left).

Climate drivers

The NINO3.4 Index sea surface temperature (SST) anomaly (which covers the west-central equatorial Pacific) over the last month (through 28 November 2023) was +1.90˚C, within the range of a strong El Niño (classified when the NINO3.4 Index is greater than +1.5˚C). In terms of 30-day anomalies ending 28 November, the NINO3.4 Index is exceeded only by 2015 and 1997 considering data back to 1981. Recent daily values of the NINO3.4 Index reached as high as 2.18˚C above average. From an oceanic perspective, this El Niño continues to rank with the most significant events in recent decades.

The Southern Oscillation Index (SOI) was in the El Niño range during November (-1.3) and September-November (-1.0) (climatology: 1991 – 2020).

Of the models monitored by NIWA, there's around a 100% chance of El Niño continuing through February 2024 and an 85% chance that the event persists through autumn 2024.

In the subsurface equatorial Pacific Ocean, temperature anomalies of +3˚C to +6˚C were occurring in the upper 100 metres in the central and east as of late November. Anomalies intensified at depth around the NINO3.4 region, resulting from a Westerly Wind Burst (WWB) during the second half of November. Peak oceanic El Niño strength is most likely in January, but sustained peak intensity into February cannot be ruled out.

Trade wind strength was below normal or well below normal in the Pacific during November, particularly just north of the equator and in the central and west. In parts of the region, this event qualified as a WWB. This WWB will be responsible for the eastward propagation of warm sea water through January.

In the Indian Ocean, a strongly positive IOD continued during November. The IOD event will continue to influence the region through the first half of summer, at times amplifying the circulation patterns of El Niño.

During November, convective forcing was focused in the western tropical Pacific and over Africa. Notably, activity was reduced over the eastern tropical Pacific, uncharacteristic of a strong oceanic El Niño. Forcing was greatly reduced over the eastern tropical Indian Ocean and Australia, in association with the strongly positive Indian Ocean Dipole (IOD).

In the Pacific Ocean, convective forcing has been commonly located west of what is typical during strong El Niño events, likely owing to the basin-wide signal of above average sea surface temperatures and anomalously high ocean heat on a global scale. This has contributed to atypical weather impacts in New Zealand during the El Niño event to-date. At some level, this is expected to continue into the summer season, likely contributing to variable weather patterns.

Overall, these climate drivers will favour high pressure near and north of the North Island and low pressure to the south of the South Island. The associated pressure gradient (difference in air pressure) is expected to drive stronger than normal and frequent westerly quarter winds and occasionally intense lows and fronts into the western and lower South Island. More frequent high

pressure to the north of the country will also reduce, but not eliminate, the chance for ex-tropical cyclones.

Seasonal wind strength is predicted to be above normal across the country, but especially in the South Island. This means there could be a higher than normal risk for damaging winds. These winds will also bring warm-to-hot and dry air from Australia at times, culminating in spells of well above average temperatures, particularly in eastern areas of both islands.

New Zealand's coastal water temperatures were slightly above average at the end of November. In the months ahead, the expectation for stronger winds, in association with a fully developed El Niño, means that the risk for the development of widespread marine heatwave conditions in New Zealand's coastal waters is low; however, during periods of unusually warm conditions, localised-to-regional marine heatwaves may continue or develop, particularly near the north and east of both islands.

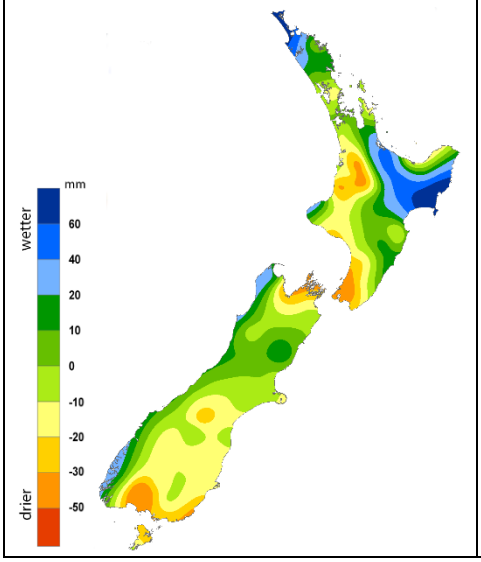
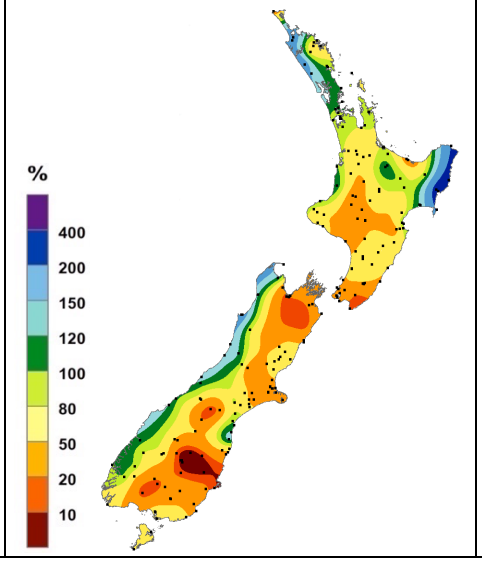
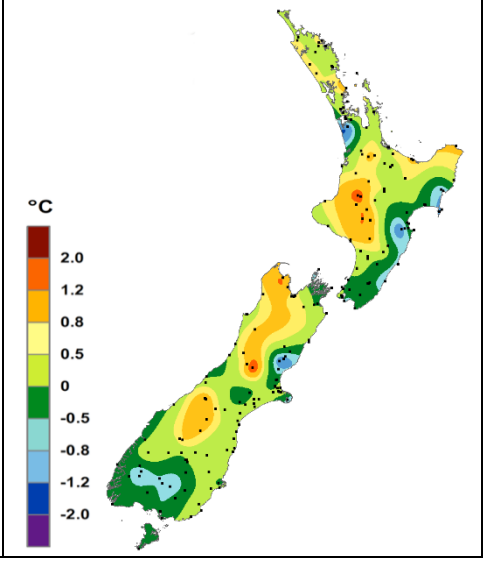
Soil moisture anomaly: 12/12	Rainfall anomaly: 1/12 – 12/12	Temperature anomaly: 1/12 – 12/12
		

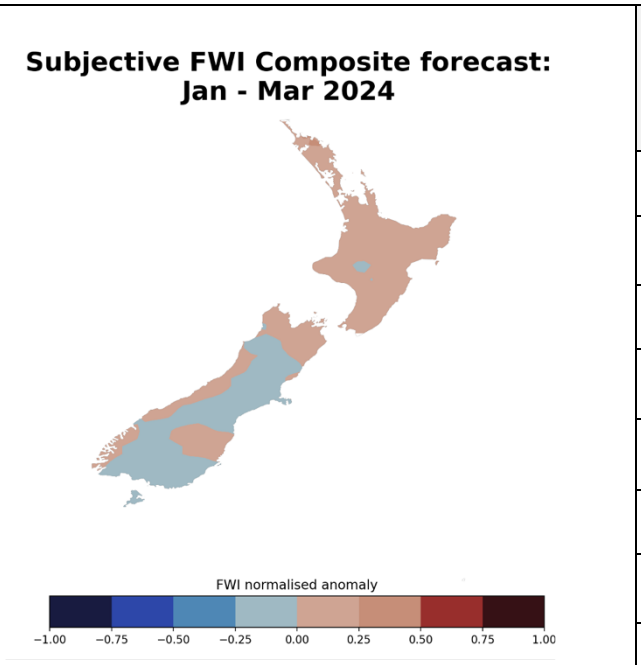
Figure 4: Maps showing the current soil moisture anomaly, as well as rainfall and temperature differences from normal since the start of the month.

Fire season analogues

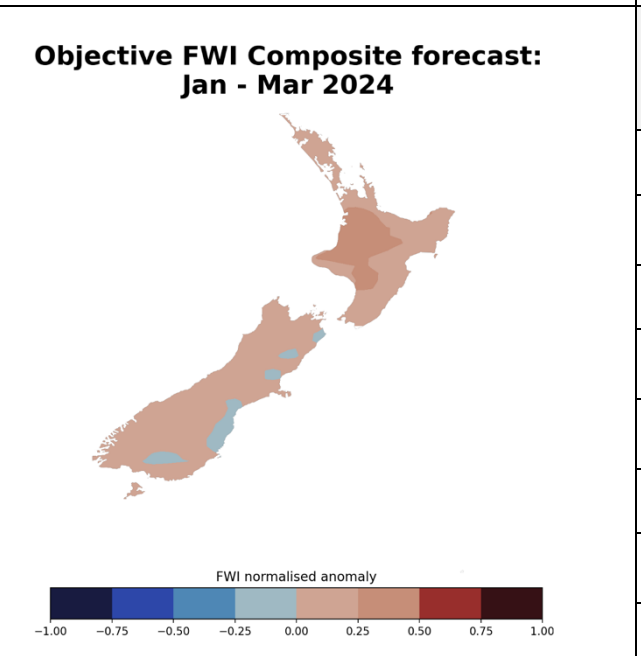
To help understand what fire weather conditions may be like this summer, we can look at analogues. Analogues are historical years with similar climatic conditions to the current year.

This season's analogue years featured historical years that had El Niño patterns in the ocean and/or atmosphere (Figure 5). The subjective analogue seasons are selected with expert interpretation from NIWA. The objective analogue seasons are automatically selected via a computer analysis. Where the two methods agree, confidence tends to be higher. The current situation favours a mix of the two analogue sets.

The upper and eastern North Island are expected to have higher fire danger than normal during the season, but western areas may see a reduced threat. Meanwhile, eastern parts of the South Island may have a slightly elevated fire danger risk from normal, while western and southern areas see a decreased risk.



Forecaster-selected analogue season - Jan to Mar
1993
2020
2016
2010
2002
1983
2003
1997



Machine-selected analogue season - Jan to Mar
2007
2012
2014
2020
2015
2003
1997
2008

Figure 5: Analogue fire seasons as selected with expert interpretation from NIWA (top) and automated computer analysis (bottom). The Fire Weather Index (FWI) is a combination of the Initial Spread Index and Buildup Index, and is a numerical rating of the potential frontal fire intensity. In effect, it indicates fire intensity by combining the rate of fire spread with the amount of fuel being consumed. Here, the Fire Weather Index anomaly is calculated by averaging historical analogue years together and comparing to the average FWI between 1991-2020 for the relevant season.

Climate outlook: January 2024

January's air flows are generally expected to be more north-westerly than normal. This would result in above normal rainfall for the western and lower South Island, and a chance for meaningful rainfall to spill over the Alps into the eastern South Island as well. The western North Island could see rainfall closer to normal, while areas farther north and east may be drier. Wind speeds are expected to be above normal across most of the country, but especially in the South Island. Near average to above average temperatures and lower than normal relative humidity are favoured in many regions (Figure 6).

Climate outlook: January – March 2024

El Niño will continue during the season, and this will favour a west-northwest air flow anomaly. Temperatures continue to look near average to above average overall, although occasional hot days will be likely (Figure 7). Rainfall is favoured to be somewhat below normal in the upper and eastern North Island, but wetter conditions are indicated for the western and lower South Island. Meaningful rainfall could also spill over the Alps into the eastern South Island at times. Slightly below normal relative humidity is expected in eastern regions. Wind speeds are expected to be higher than normal for most of the country.

The tropical cyclone season for the Southern Hemisphere runs from November through April. In this El Niño pattern, the tropical cyclone risk for New Zealand is forecast to be slightly below average.

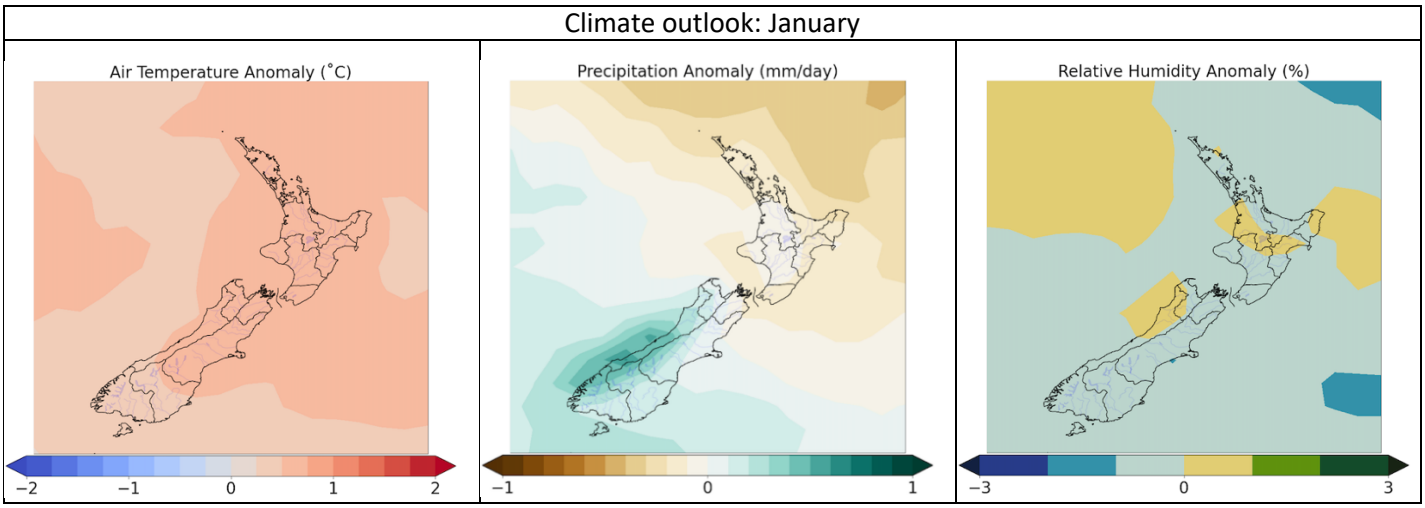


Figure 6: Climate outlook for January showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

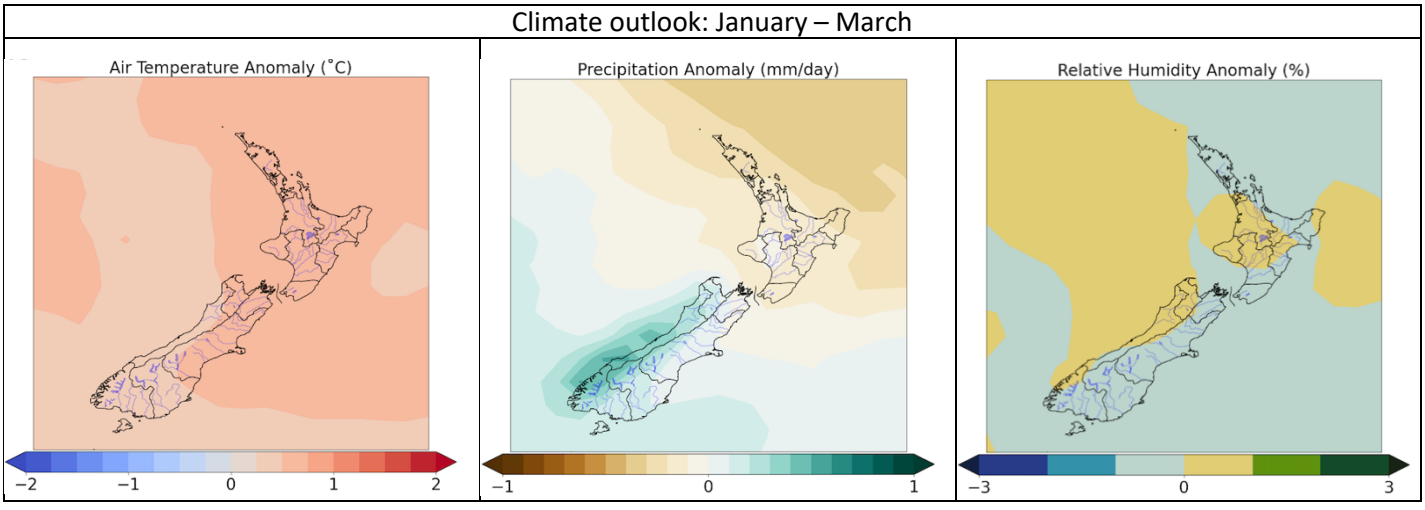


Figure 7: Climate outlook for January-March showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

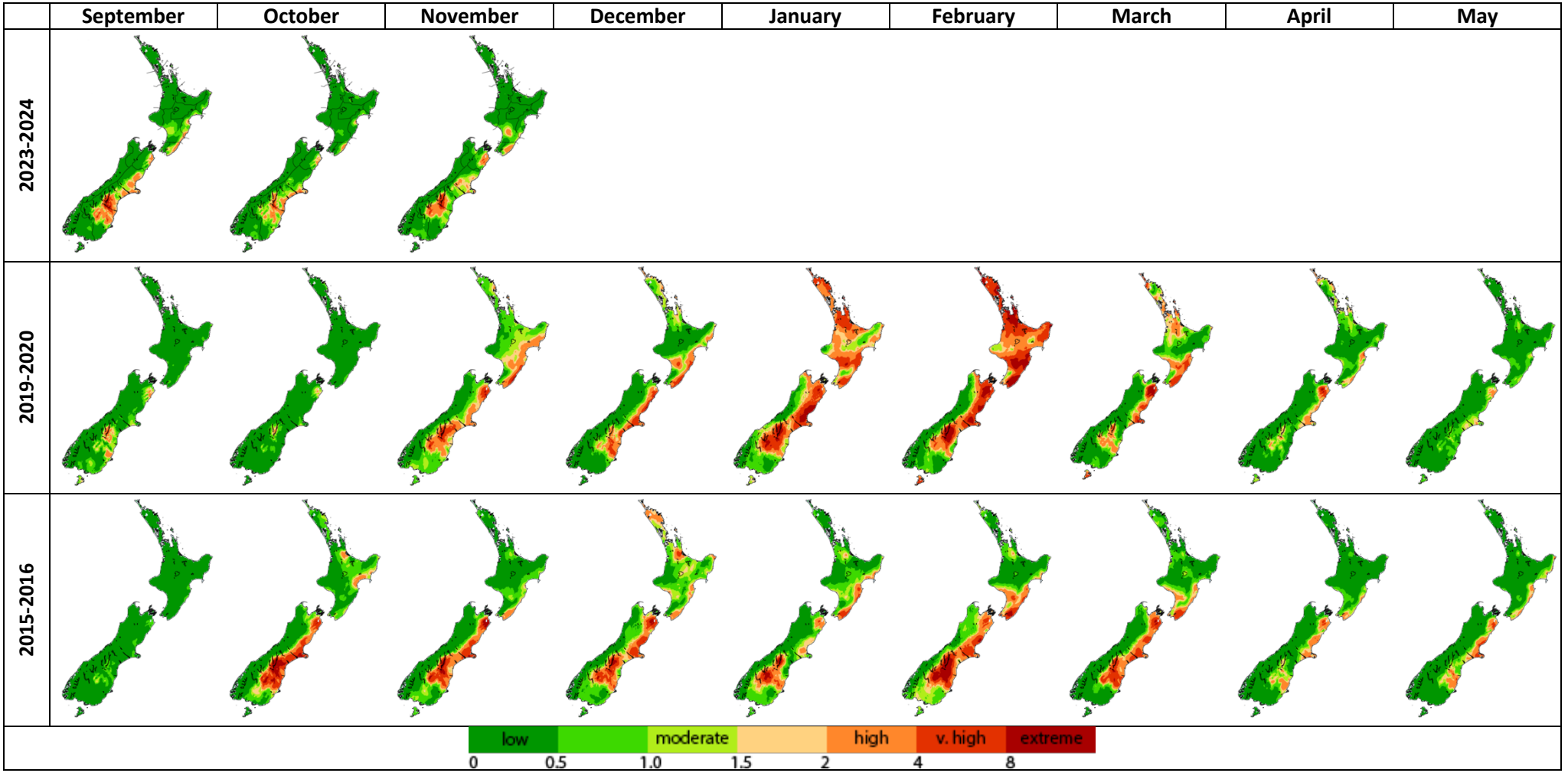


Figure 8: Monthly average severity rating for the current year 2023/2024 and the comparative years of 2019/2020 and 2015/2016. These are analogue years for the current season and give us an insight into what the upcoming season may be like.

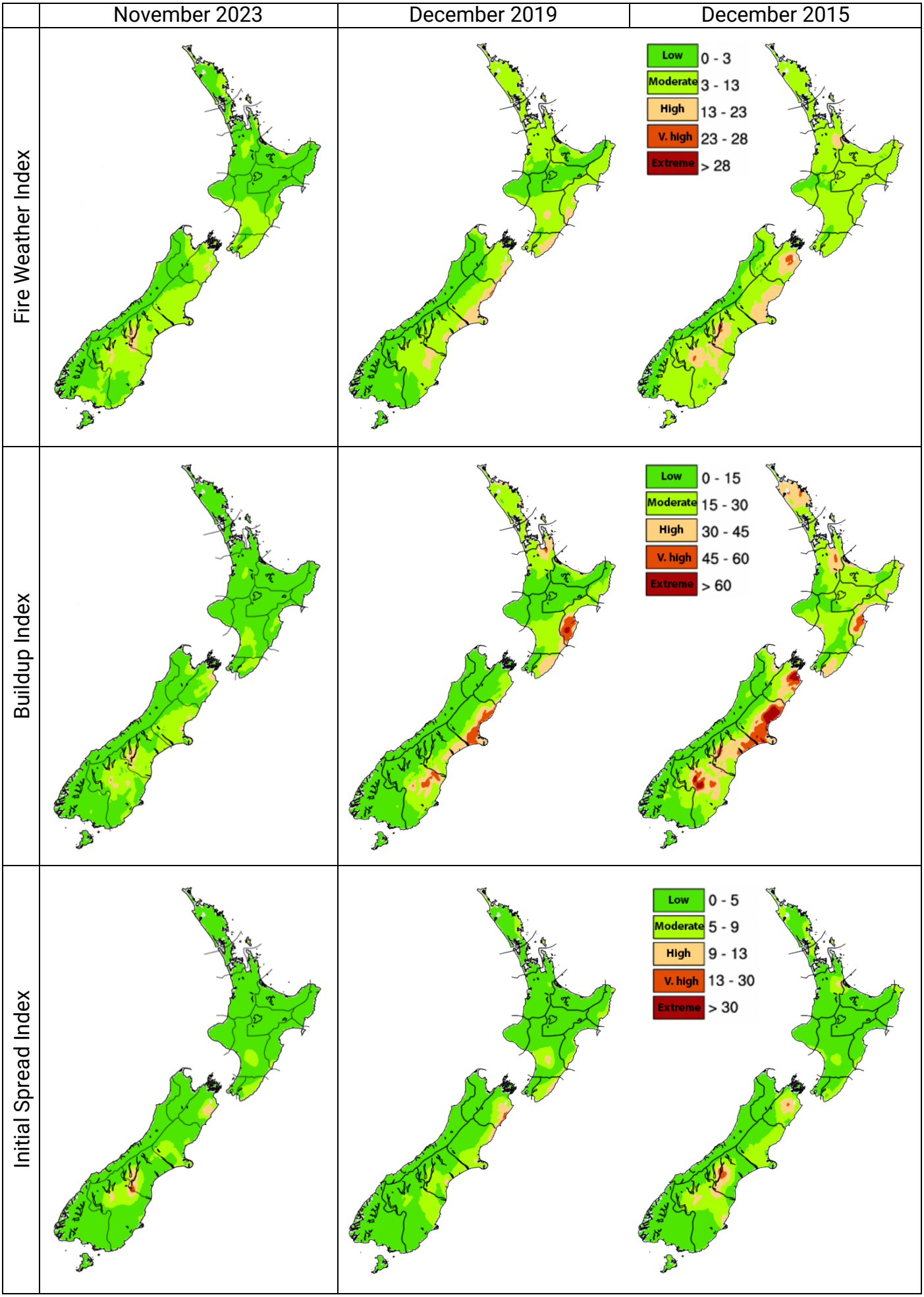


Figure 9: The most recent observed month (left column) and analogue months for December (middle and right columns); monthly average for the Fire Weather Index (top), Buildup Index (middle) and Initial Spread Index (bottom).

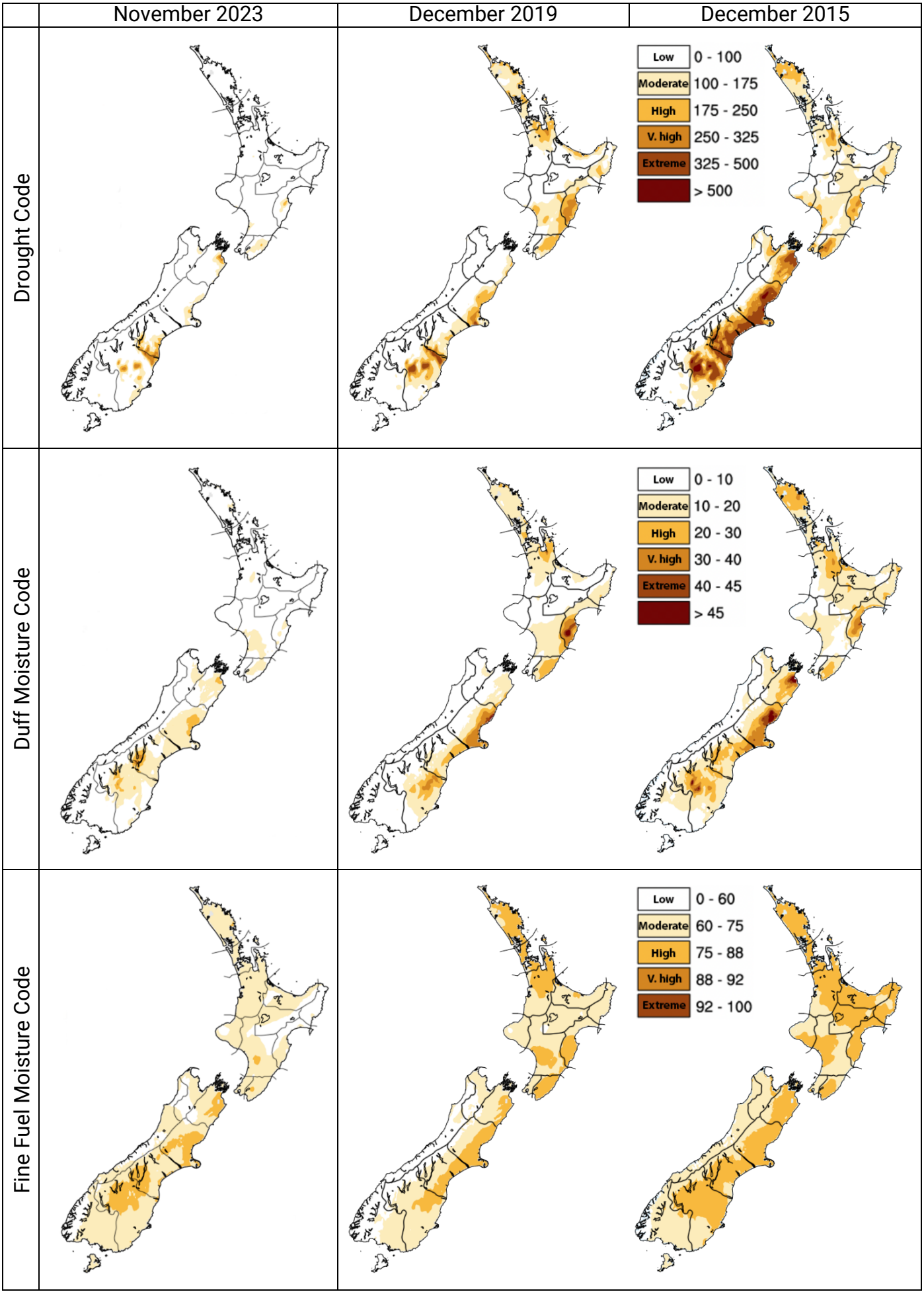


Figure 10: The most recent observed month (left column) and analogue months for December (middle and right columns); monthly average for the Drought Code (top), Duff Moisture Code (middle) and Fine Fuel Moisture Code (bottom).

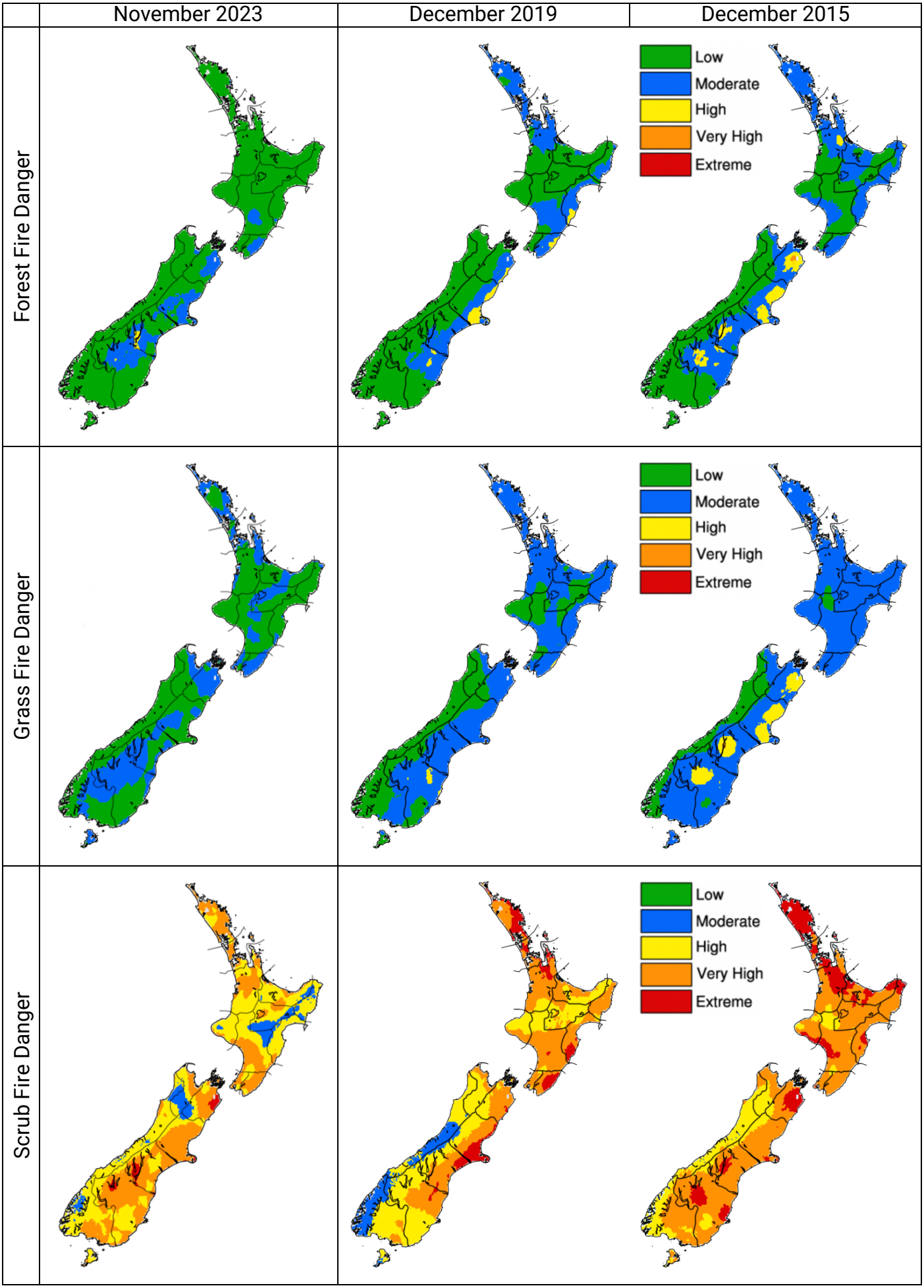


Figure 11: The most recent observed month (left column) and analogue months for December (middle and right columns); monthly average for the Forest Fire Danger (top), Grass Fire Danger (middle) and Scrub Fire Danger (bottom).

Background information on fire weather indices and codes

Fine Fuel Moisture Code: An indicator of the relevant ease of ignition and flammability of fine fuels.

0-74	Difficult
75-84	Moderately easy
85-88	Easy
89-91	Very Easy
92+	Extreme Easy

Initial Spread Index: Combines the effect of wind speed and the FFMC, providing a numerical rating of potential fire spread rate.

0-3	Slow rate of spread
4-7	Moderate fast
8-12	Fast
13-15	Very fast
16+	Extremely fast

Duff Moisture Code: A rating of the average moisture content of loosely compacted organic soil layers (duff/ humus) of moderate depth, and medium-sized woody material.

0-10	Little mop-up needs
11-20	Moderate
21-30	Difficult
31-40	Difficult & extended
41+	Extreme & extensive

Fire Weather Index: Combines the ISI and BUI to indicate the potential head fire intensity of a spreading fire (on level terrain).

0-5	Low fire intensity
6-12	Moderate
13-20	High
21-29	Very high
30+	Extreme

Drought Code: A rating of the average moisture content of deep, compact, organic soil layers, and a useful indicator of seasonal drought effects on forest fuels and amount of smouldering in deep duff layers and large logs.

0-100	Little mop-up needs
101-175	Moderate
176-250	Difficult
251-300	Difficult & extended
301+	Extreme & extensive

Daily Severity Rating: A numerical rating of the daily fire weather severity at a particular station, based on the FWI. It indicates the increasing amount of work and difficulty of controlling a fire as fire intensity increases. The DSR can be averaged over any period to provide monthly or seasonal severity ratings.

Buildup Index: Combines the DMC and DC, and represents the total amount of fuel available for combustion.

0-15	Easy control
16-30	Not difficult
31-45	Difficult
46-59	Very difficult
60+	Extremely difficult

Monthly Severity Rating: is the average of the DSR values over the month. DSR and MSR captures the effects of both wind and fuel dryness on potential fire intensity, and therefore control difficulty and the amount of work required to suppress a fire. It allows for comparison of the severity of fire weather from one year to another.

0-1	Low fire behaviour potential
1-3	Moderate fire potential
3-7	High to very high fire potential
7+	Extreme fire behaviour potential

This document was prepared by NIWA in collaboration with Fire and Emergency NZ