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

Issue: September 2023

Current fire danger situation

August's various fire indices were generally all low (with the exception of scrub fire danger that was high to very high in eastern areas of both islands). See Figures 8-10 for more detail.

El Niño is expected to be classified in a New Zealand context around the end of September. A change to prevailing weather patterns is already bringing about drier conditions in many parts of the country, and confirmation of an El Niño event could bring a more significant shift to more normal or above normal fire dangers in many areas this fire season.

Current fuel and soil moisture status

As of 14 September (Figure 3, left), soil moisture levels are near normal across a majority of the country, with some drier conditions in the east of the North Island, Marlborough Sounds and Mackenzie Basin.

Current fire dangers across the North Island (Fig. 5-8) are low as a result of coming out of winter, and the carry-over effects of the below normal fire dangers last season which resulted from the wetter than normal summer and autumn in most parts of the country.

However, a change to drier conditions, in eastern and northern areas of both islands in particular, are seeing fire dangers begin to climb. This is most obvious in increasing values of the Duff Moisture Code (DMC) (Figure 1), which indicate the potential for greater involvement of medium and shallow subsurface fuels if fires were to occur. Values of the Fine Fuel Moisture Code (FFMC), which represent the dryness of fine fuels, have also been increasing over recent weeks. These indicate an 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.

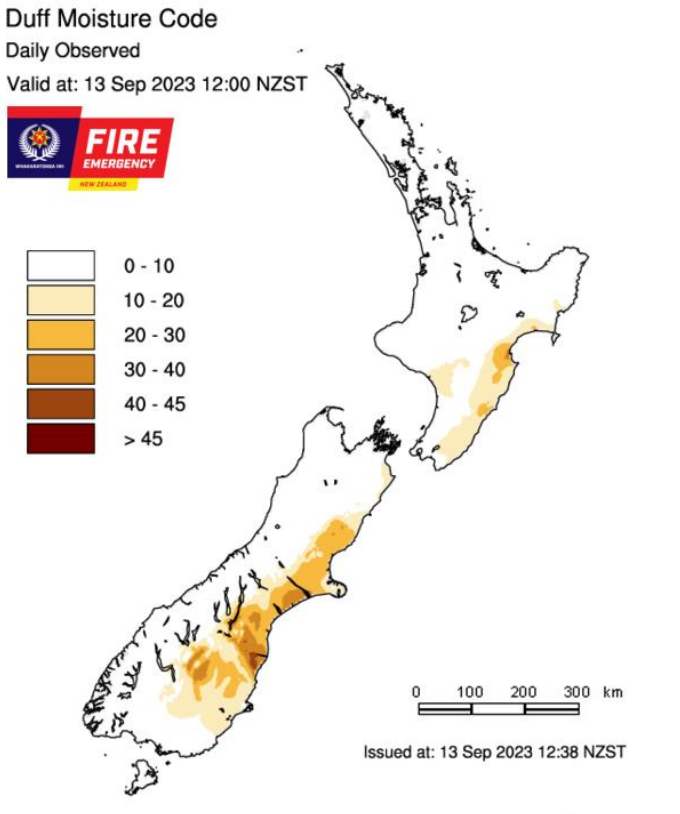


Figure 1: Map of Duff Moisture Code (DMC) values (an indicator of dryness in shallow organic soil layers and medium-sized woody material) as at 13th September.

Forecast climate and weather

The remainder of September looks to be variable. Windy, warm weather will remain for much of New Zealand, with the potential for very unseasonably warm and dry weather, particularly in eastern areas. Towards the end of September, cooler than average and more settled weather looks to dominate, before frequently westerlies kick in again, typical of an El Niño-like pattern.

For October as a whole, westerly winds will be favoured, indicative of the onset of El Niño conditions. This would result in above normal rainfall for the west of the South Island, but below normal rainfall in the east and north of both islands. During October, bursts of warmth in gusty westerlies could result in some unseasonably hot days, followed up by cooler southerlies lasting a few days.

October-December will likely exhibit more westerly winds than usual, as is typically the case during an El Niño. Drier than normal conditions are favoured in eastern and northern areas of both islands. Temperatures overall look to be near average to above average, especially in eastern regions.

For more information, see pages 4 and 5.

The El Niño climate pattern

The formation of a fully-fledged El Niño event requires the coupling of both the atmosphere and ocean, and currently only the oceanic indicators (such as sea surface temperatures) have reached the threshold required for El Niño. Predictions from all global climate models are that the atmospheric indicators (trade winds, pressure patterns) will reach required levels during spring.

But no two El Niño events are the same, and each event can produce different effects on weather conditions and therefore resulting 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. Previous El Niño seasons (and their strength) include 2015/16 (strong), 2009/10 (strong), 2002/03 (moderate) and 1997/98 (strong).

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

More frequent warm, drier W/NW wind conditions which contribute to easier ignition and fire spread. These may align to produce days with high temperatures and low humidity that escalate fire dangers significantly, especially in eastern areas.

The onset of drier conditions in many areas, especially eastern 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.

Winds stronger than normal could result in wind-driven fires, especially in light flashy cured grass and scrub fuels. Because these are made up of almost entirely fine fuels, these fuel types can 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 winter and early spring weather has contributed to very good growing conditions. This will result in high grass fuel loads that, once they begin to cure, 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).

More and larger burns this year as people clean up storm damage. Some of these fires may burn for many weeks if they have soil or silt with them these will have the potential to reignite as we progress through the coming months.

Even a “normal fire season” will have much greater fire potential than last fire season. However, 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 early part of the fire season. Be vigilant, as indices may change rapidly.

Watch for increasing fire potential through the spring months. This continues to be the time to prepare for the fire season, especially in the north and eastern parts of both islands along where the spring fire potential will more than likely be above normal. Some areas may already be elevated, such as in Central Otago and inland Canterbury.

Fire season preparations should include:

- Monitoring risk conditions through our weather station network and grass curing assessments.
- Watch for areas of increasing or already elevated grass curing (e.g. due to frosts in high country areas). During windy conditions, these cured grasses can produce intense fast-moving fires in early spring, like the Pukaki and Ohau fires of 2020.
- Carrying out Fire Crew and Brigade readiness checks.
- Ensuring contract and FENZ resources are available for response.
- Raising awareness of defensible spaces around assets.
- Considering fire breaks in high-risk areas.
- 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.
- Have a plan with industries for additional risk management should the conditions escalate, such as management of spark hazardous activities and standby arrangements.

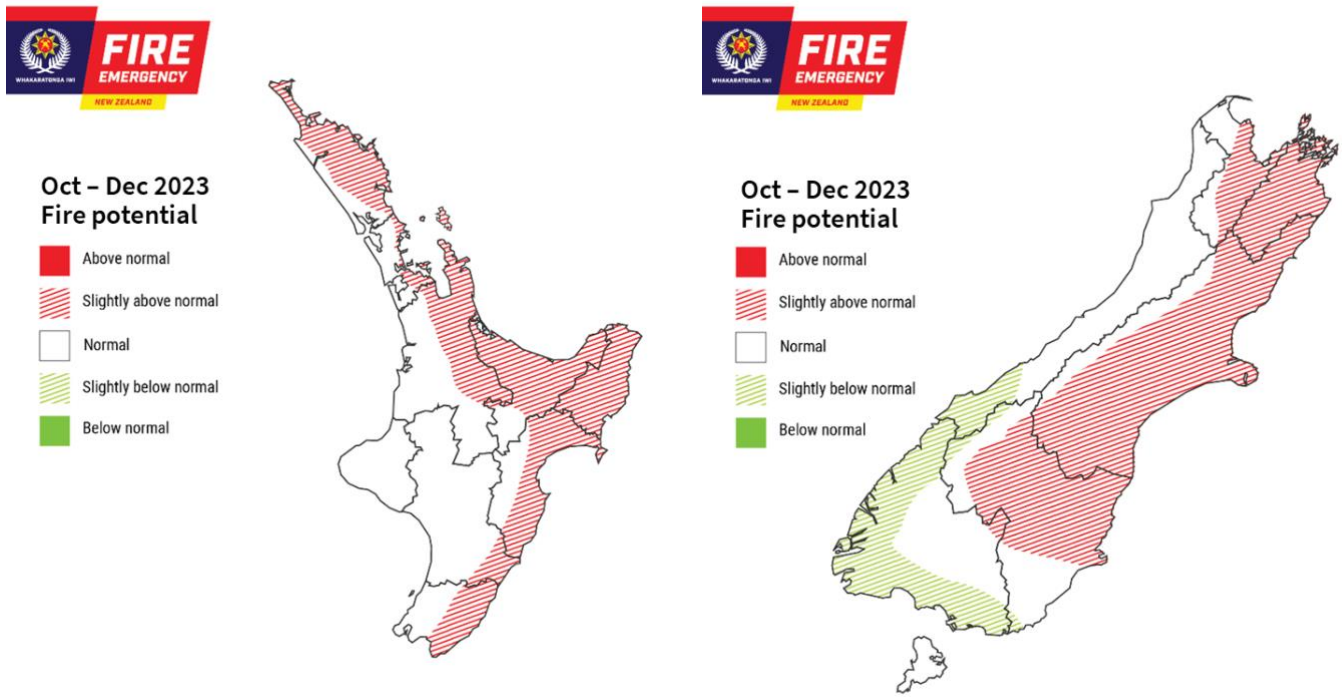


Figure 1: Locations identified as areas of interest that may develop an increased risk of above normal fire potential over the next three months.

Current climate

Temperatures were below average (0.51-1.20°C below average) across most of the North Island, and the top and west of the South Island during August. Some isolated areas also experienced well below average temperatures (<1.20°C below average) in the North Island and top of the South Island. The remainder of New Zealand experienced near average temperatures (±0.50°C of average). So far in September, temperatures have been near average for pockets of the central and eastern North Island and northern South Island, but warmer than average temperatures are dominating elsewhere, with well above average temperatures for parts of Northland, Waikato, Wellington, Tasman, West Coast, Canterbury, Otago, and Southland (Figure 3, right).

Rainfall was below normal (50-79% of normal) or well below normal (<50% of normal) for the eastern, central and northern parts of the North Island, as well as much of the South Island during August. A small area of above normal rainfall (120-149% of normal) was observed in the southern Wairarapa and the lower South Island. Near normal rainfall (80-119% of normal) was experienced in Manawatū-Whanganui, parts of Wellington, parts of Otago, and much of Southland. So far in September rainfall has seen a clear divide between eastern and western areas, with western areas near or below normal, and eastern areas below or well below normal. Small pockets of Nelson and Auckland have experienced above normal rainfall (Figure 3, middle).

Although below average soil moisture levels are present in Hawkes Bay, parts of Gisborne, the Tararua District, parts of Marlborough, and parts of South Canterbury, most of New Zealand is currently observing near normal soil moisture levels (Figure 3, left).

Climate drivers

The NINO3.4 Index anomaly (which covers the west-central equatorial Pacific) over the last month (through 31 August) was +1.35˚C, indicating sea surface temperatures were well above average (climatology: 1991-2020). The weekly value reached +1.5˚C at the end of August– the traditional threshold for a strong oceanic El Niño when maintained over several months. The NINO1.2 and NINO3 indices, comprising the east-central equatorial Pacific, are surpassed only by 1997, one of the strongest El Niño events on record, with data back to 1981.

The Southern Oscillation Index (SOI) was near the El Niño threshold (-0.9) during August, but the three-month (June-August) value was neutral on -0.3 (climatology: 1991-2020).

NIWA is closely monitoring the developing El Niño and may be in a position to classify El Niño conditions as having officially arrived in a New Zealand context over the next month. For now, an El Niño Alert continues.

In the subsurface equatorial Pacific Ocean, remarkable anomalies of +5 to +7˚C were occurring in the upper 100 m in the east as of late August. The distribution of the anomalously warm water is consistent with the development of an east-based canonical El Niño event. The abnormally warm waters are predicted to surface and expand westward over the course of the next six months, culminating in a strong or very strong El Niño event that rivals records.

During August, trade wind strength was below normal in the west-central Pacific and near or above normal farther east. There is the potential for a reduction or reversal in these trade winds during the late September and into October.

Based on this information, El Niño is expected to develop in the next month or two with a 95% chance of it continuing through summer 2023-2024. El Niño is favoured (55% chance) to continue through until autumn 2024.

Cooler than average seas north-west of Australia and warmer than average seas north of Madagascar in the western Indian Ocean signal a rapidly developing positive Indian Ocean Dipole (IOD) event. This pattern may have a strong influence on regional moisture availability and suppress the chance for tropical rainmakers. A strongly positive Indian Ocean Dipole helped kickstart a drier than normal summer for New Zealand in 2019-2020.

During August, convective forcing was focused in the Pacific Ocean, with subsidence in the Indian Ocean – a change from recent months and a pattern that is more consistent with an El Niño-like atmosphere. The eastward migration of the warmest ocean water in the equatorial Pacific is expected to facilitate a shifting convection regime in the months ahead, with a rising branch of the Walker Circulation becoming established in the east.

Even so, remnant warmth in the western Pacific will likely influence some level of variability in New Zealand's air pressure and wind flow patterns. Periods of intra-seasonal variability brought about by pulses of the Madden-Julian Oscillation will result in more

easterly-quarter winds for New Zealand with wetter conditions in the northern and eastern North Island. Such patterns are in contrast to typical El Niño features like increased westerlies, and will sporadically occur through the season.

The El Niño signal is forecast to become more firmly entrenched during October, with high pressure favoured near and north of the North Island and low pressure near and south of the South Island. The associated air pressure gradient (difference in air pressure) is expected to drive more westerly quarter winds and frequent lows and fronts into the western and lower South Island, owing to the influence of El Niño and the positive IOD.

Overall, this supports more frequent westerly-quarter winds for New Zealand, wetting up western areas of the South Island in particular. The combined effect of more frequent high pressure and developing westerly winds reduces the chances for above normal rainfall in several regions, namely across the eastern North Island and northern and eastern South Island.

The westerlies may be strong at times, advecting warm, dry air from Australia. Warm periods may be followed up by sharply colder southerlies.

The Southern Annular Mode (SAM) was positive for the first half of August, then negative during the second half. As El Niño strengthens during spring, the SAM may favour negative values.

New Zealand's coastal water temperatures became less unusually warm in all regions during August. Marine heatwave conditions eased in most regions, excluding coastal Wairarapa, Nelson-Tasman, Canterbury, and Otago. As El Niño becomes firmly entrenched in the climate system, the risk for the development of widespread marine heatwave conditions during spring in New Zealand's coastal waters is low.

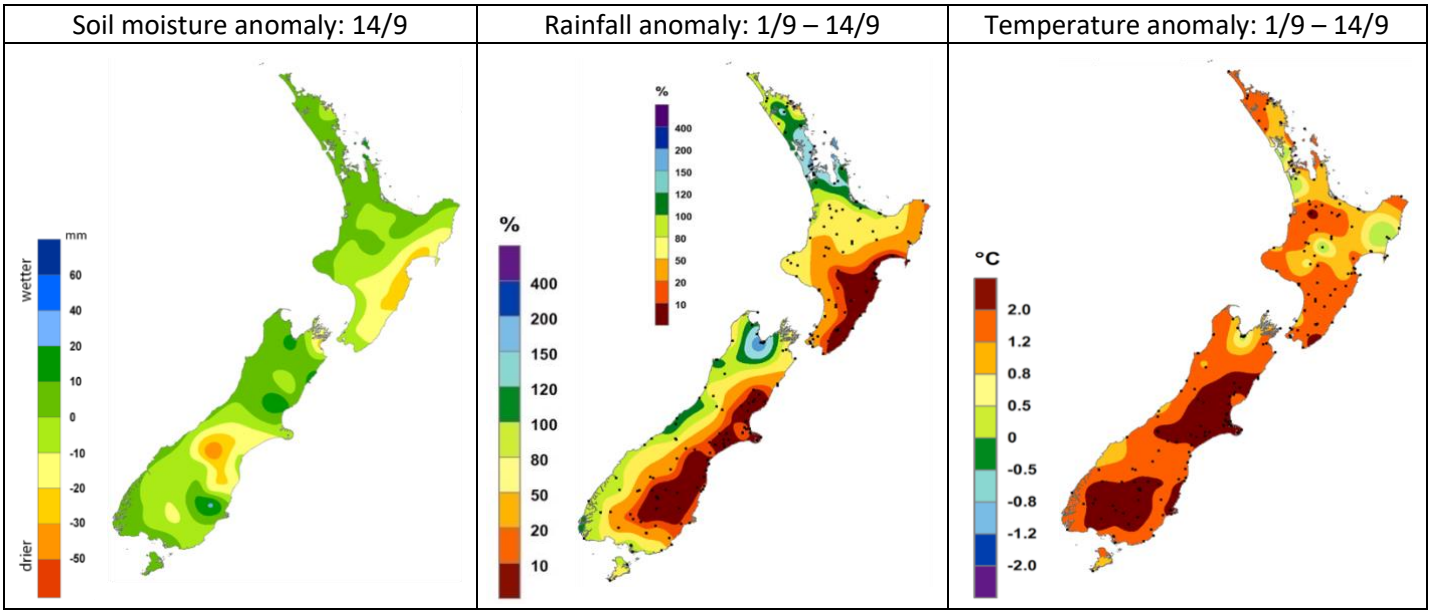


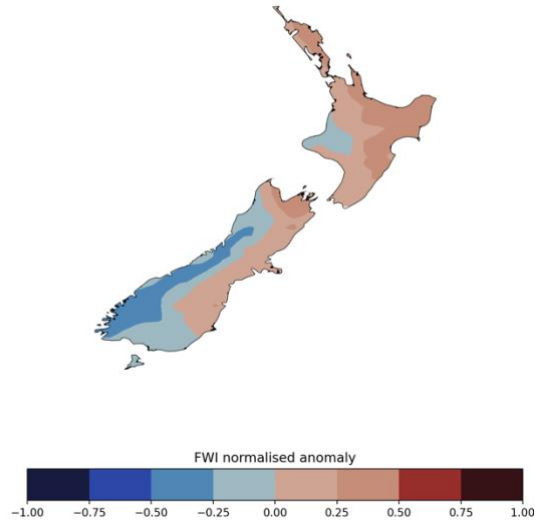
Figure 3: Maps showing the current soil moisture anomaly, as well as rainfall and temperature differences from normal since the start of the month.

Fire season analogues

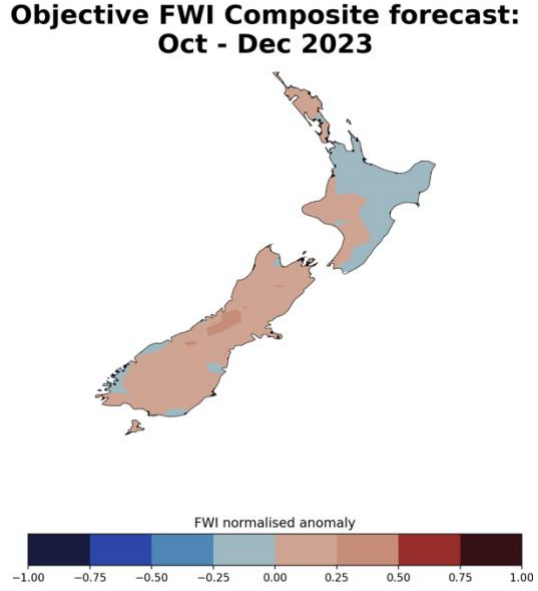
To help understand what fire weather conditions may be like this summer, we can look at analogues. Analogues are historical years with similar climatic conditions to the current year.

This season's analogue years featured historical years that had El Niño patterns in the ocean and/or atmosphere (Figure 4). 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 strongly favours the expert-selected years for October-December.

Most areas of the North Island are expected to have higher fire danger than normal during the season, although some western areas could see a decreased risk; meanwhile eastern and northern areas of the South Island are expected to have higher fire danger than normal, while western areas see a decreased risk (see Figure 7). This agrees with the expected westerlies commonplace with an El Niño pattern.



Forecaster-selected analogue season - Oct to Dec
2019
2006
1997
1994
1982
2015
2009
2002



Machine-selected analogue season - Oct to Dec
2020
2017
2001
2019
2013
2007
1996
2003

Figure 4: 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: October 2023

October's air flows are generally expected to be more westerly than normal as an El Niño-like pattern continues. The signal is for a generally drier than normal lean for the North Island, especially in the north and east. In the South Island, there is a drier lean in the east and north. Wind speeds are expected to be above normal for nearly all the North Island and South Island. Above average temperatures and lower than normal relative humidity are favoured in the east of both Islands (Figure 5).

Climate outlook: October – December 2023

As El Niño will likely develop during spring, this will continue to favour a westerly wind anomaly through the season. Temperatures overall look to be warmer than average, especially in eastern regions (Figure 6). Rainfall is favoured to be below normal, especially in northern and eastern regions. Slightly below normal relative humidity is expected in most regions. Wind speeds are favoured to be higher than normal for most of the North Island and South Island.

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

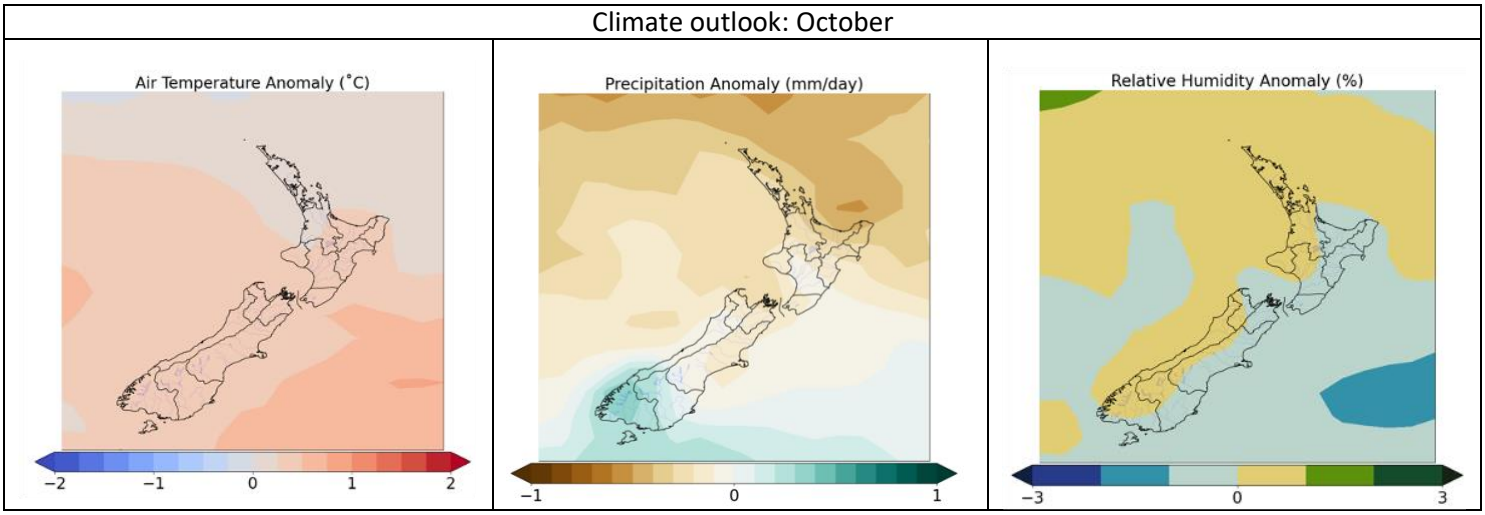


Figure 5: Climate outlook for Oct showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

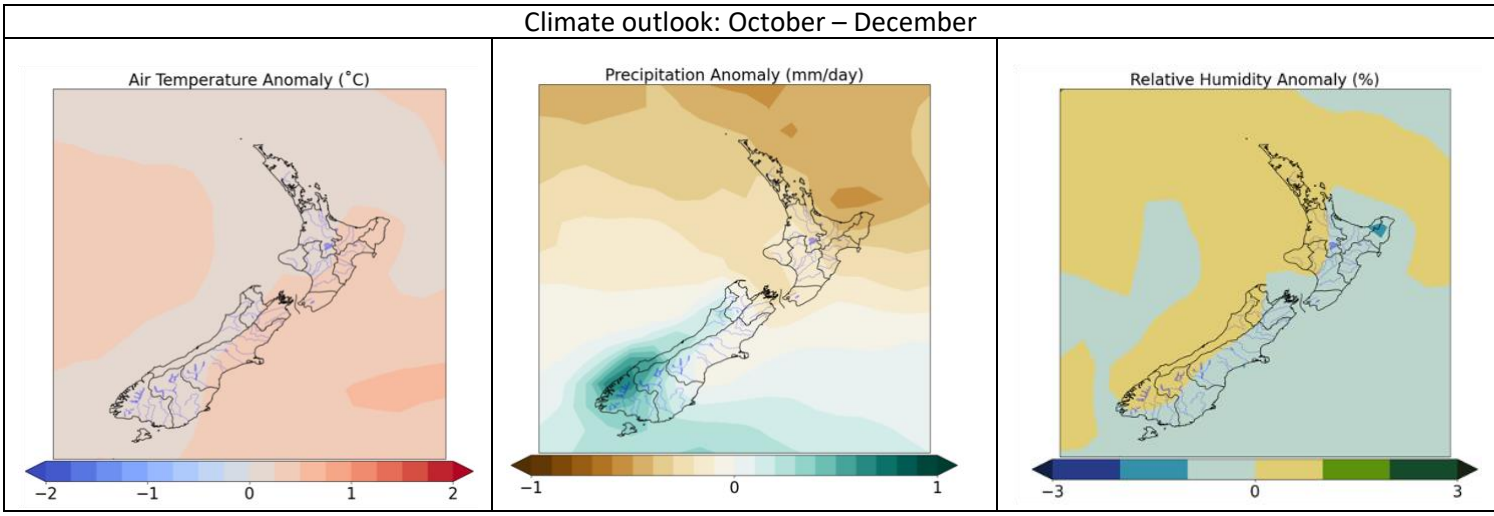


Figure 6: Climate outlook for Oct-Dec showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

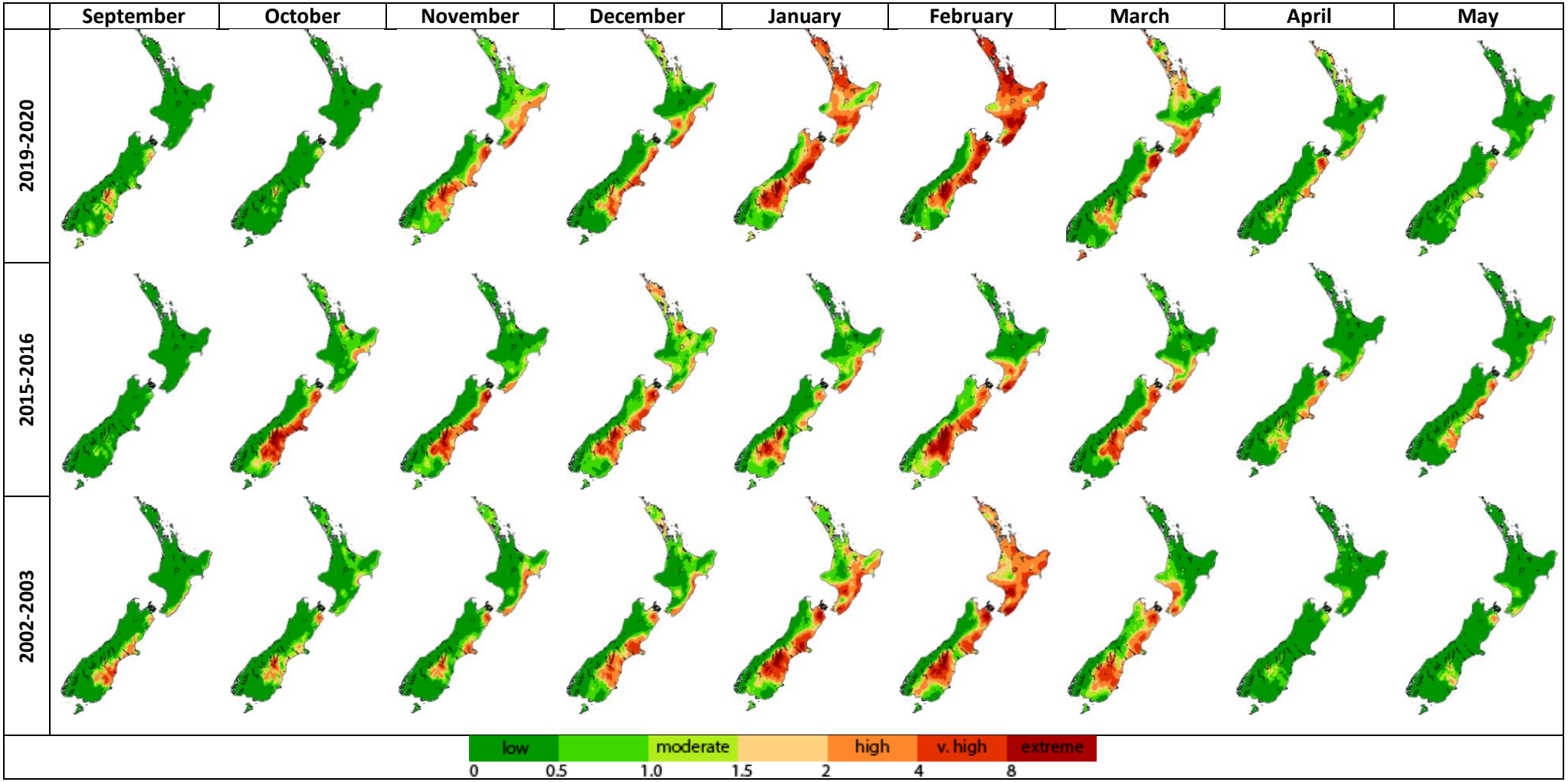


Figure 7: Monthly average severity rating for the comparative years of 2019/2020 (neutral), 2015/2016 (strong El Niño), and 2002/2003 (moderate El Niño). These are analogue years for the current season and give us an insight into what the upcoming season may be like.

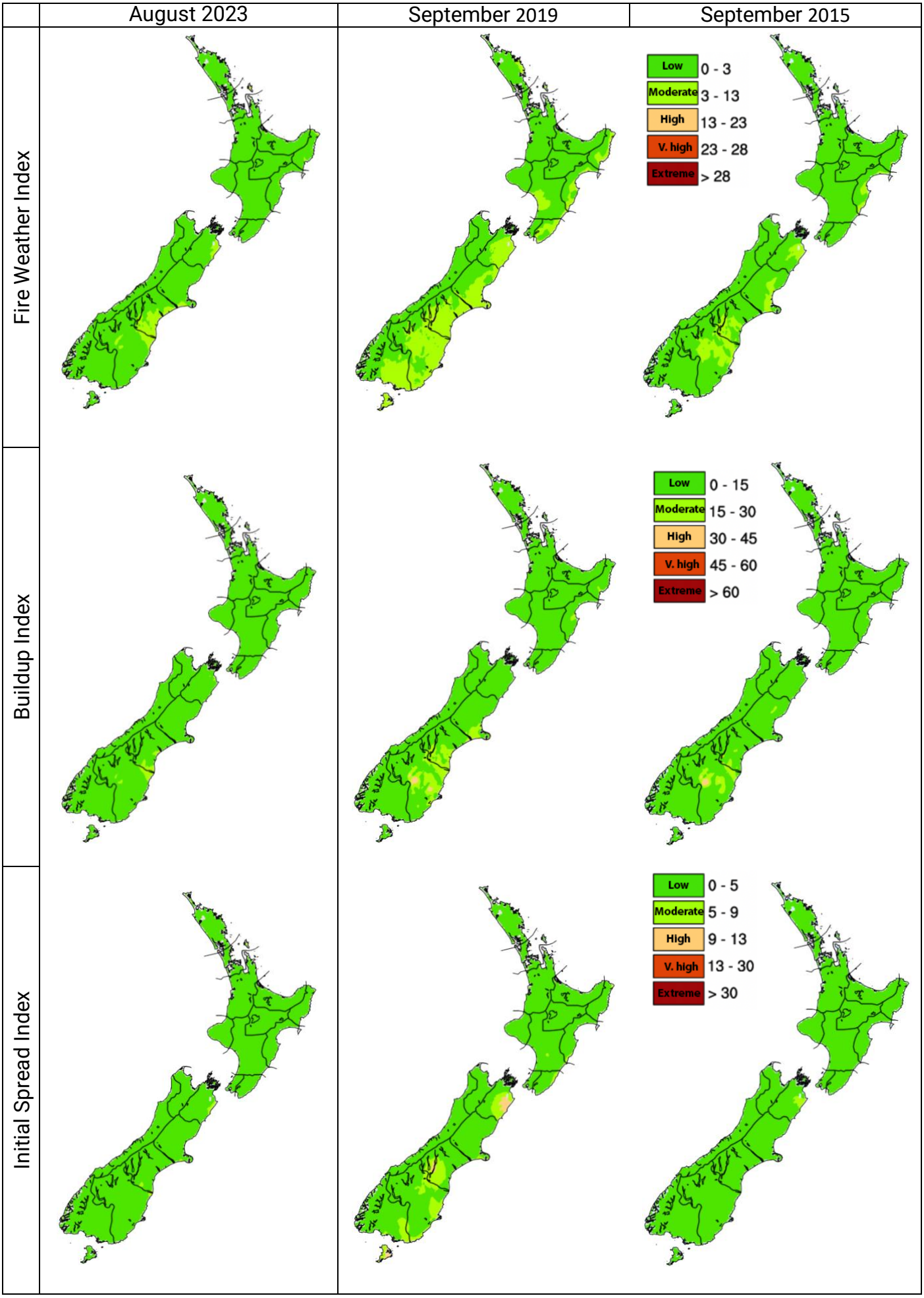


Figure 8: The most recent observed month (left column) and analogue months for August (middle and right columns); monthly average for the Fire Weather Index (top), Buildup Index (middle) and Initial Spread Index (bottom).

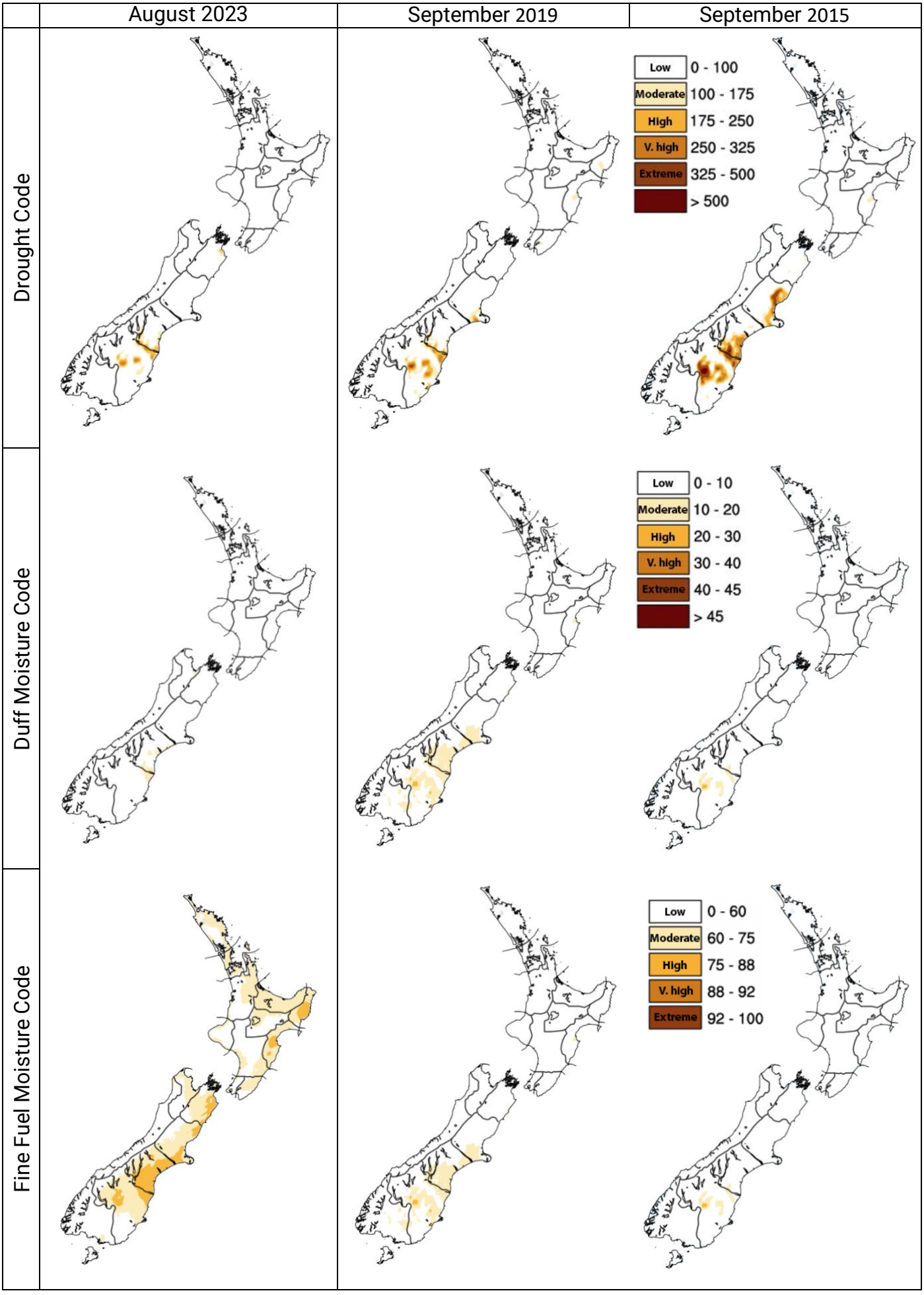


Figure 9: The most recent observed month (left column) and analogue months for August (middle and right columns); monthly average for the Drought Code (top), Duff Moisture Code (middle) and Fine Fuel Moisture Code (bottom).

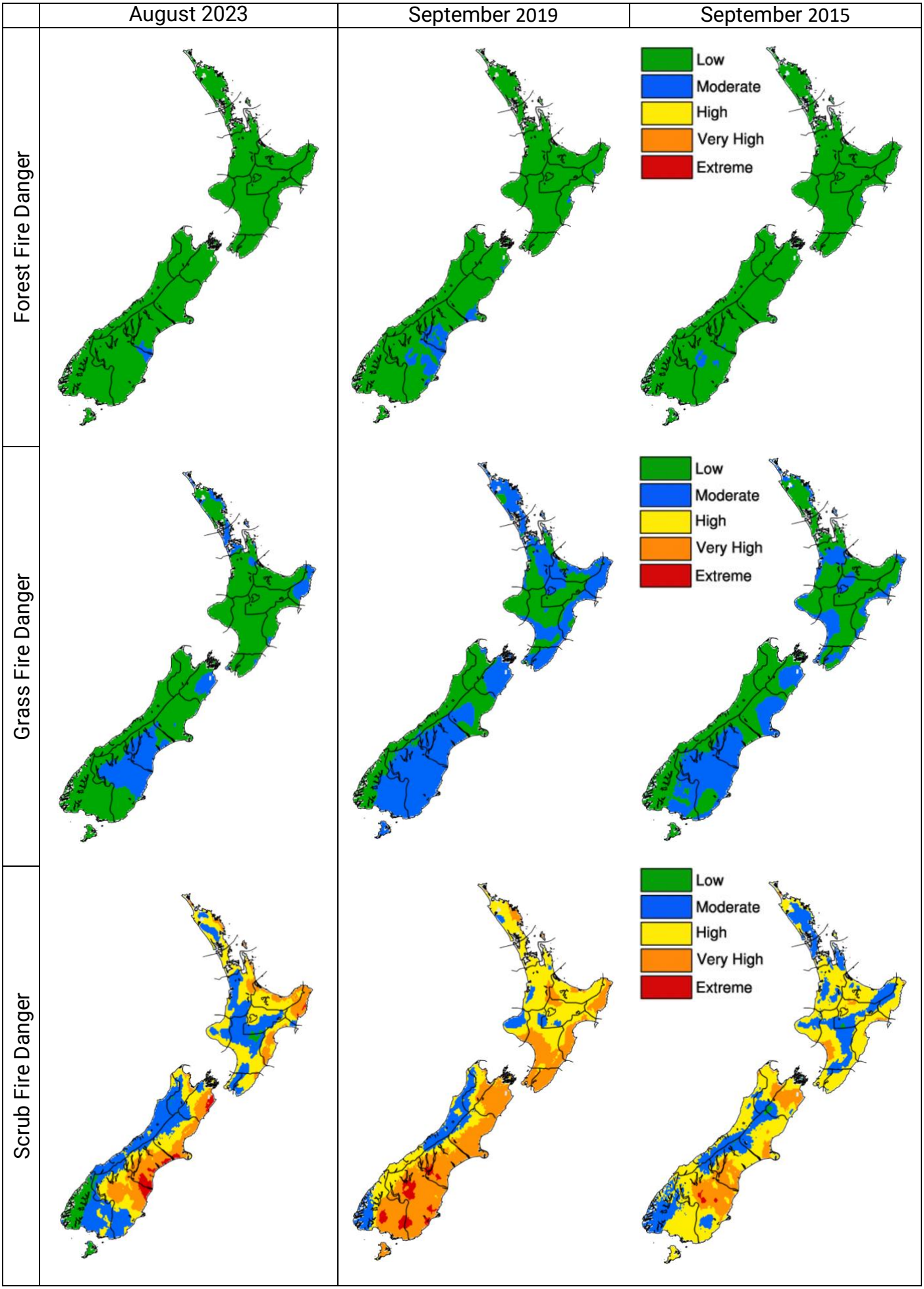


Figure 10: The most recent observed month (left column) and analogue months for August (middle and right columns); monthly average for the Forest Fire Danger (top), Grass Fire Danger (middle) and Scrub Fire Danger (bottom).

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