South Island Monthly Fire Danger Outlook (2021/2022 season)
Issue: November 2021

Current fire danger situation

In general, monthly fire dangers and fire climate severity are low across much of the South Island (Figures 6-9). However, moderate to high conditions are located in coastal portions of Canterbury, and interior Otago. This is not uncommon for these areas, except parts of Canterbury do have higher than normal fire dangers.

Current fuel and soil moisture status

As of 17 November (Figure 2), soil moisture levels are near normal across most of the western and southern South Island. However, below normal soil moisture is located near Nelson, coastal Marlborough, northern and central Canterbury, and the eastern coast of Southland.

Much of the South Island is currently experiencing Low Fire danger due to low Fire Weather System Codes and indices (BUI, DC, DMC and FFMC refer appendix for definitions) that result from winter/spring precipitation. The Lower DC and DMC means moderate, heavy or subsurface fuels will generally not be available to burn. There are however areas shown in figure 1 around Otago and parts of Central and North Canterbury where the DMC and DC indicate drier conditions and moderate to high fuel availability (although these areas are dryer than others, only some parts of Canterbury are dryer than normal).

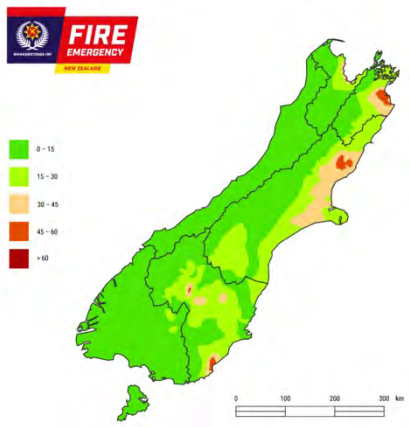


Figure 1: Map of Build-up index (an indicator of the amount of fuel available to burn in a forest based on their expected moisture content) for the South Island.

The South Island, particularly the eastern parts, has bad occasional windy periods generating elevated fire danger. Fine fuels are especially susceptible to these events, particularly on the lee side of the Southern Alps where the Fohn effect results in strong warm and dry winds. Figure 1 shows an example of the dramatic fluctuations in predicted grass fire spread rates from Hanmer that are associated with changes to wind speed and direction.

Figure 2: Graph of Hanmer predicted grass fire spread rate for the past month based on observed weather conditions.

Forecast climate and weather

Late November will likely feature a mix of high pressure with tranquil weather, and low pressure bringing rainfall. In December, easterly wind flows are expected to prevail, which would favour dry conditions for much of the South Island, particularly in the south and west. Overall wind speeds are expected to be below normal in December, with above average or well above average temperatures. Looking later into the summer, La Niña conditions are likely to continue, with generally easterly winds and above average temperatures. Drier than normal conditions will continue to be favoured, especially in the south and west. For more information, see pages 3 and 4.

What to watch for

Areas of Northern Otago and Canterbury that have received little spring precipitation, meaning fuel availability will be elevated for these areas.

Southern and Western areas which are likely to receive higher than normal fire dangers in the coming months.

Areas where winter grass growth has resulted in greater fuel loads heading into summer when they become cured (with increased dead and brown material).

When eastern parts of the island are subject to strong NW winds (expected to be less common this season).

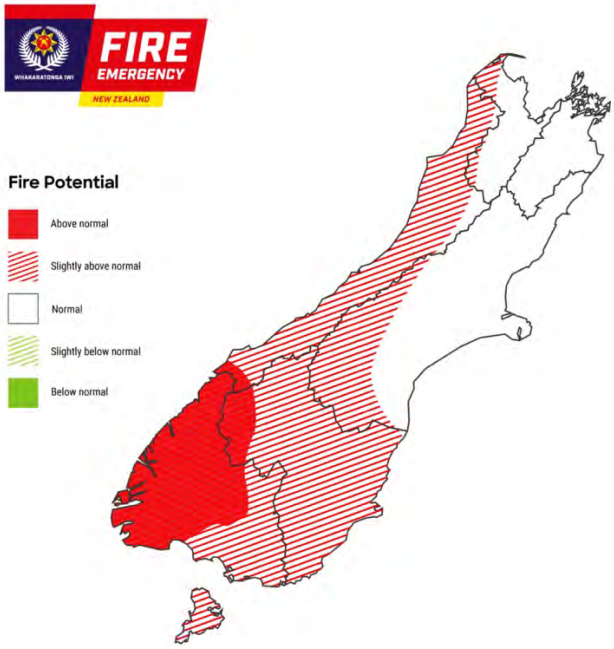


Figure 3: Locations identified as areas of interest that may develop an elevated risk of high to extreme fire danger over the next three months.

Fire such as this in light flash fuels like the scrub fire example do not require extended dry periods and are not uncommon in spring and early summer.

Current climate

October 2021 was New Zealand's 5th-warmest October on record. Temperatures were above average (0.51°C to 1.20°C above average) to well above average (>1.20°C above average) for the majority of the South Island. The exceptions were parts of Marlborough and coastal Canterbury where temperatures were near average (±0.50°C of average).

October rainfall was above normal (120-149% of normal) in northern Tasman, an area near Christchurch, southern Canterbury, and northern Otago. Conversely, below normal (50-79% of normal) and well below normal (<50% of normal) rainfall was observed in northern and central Canterbury, Fiordland, and much of Southland.

Soil moisture levels are currently near normal across most of the western and southern South Island. However, below normal soil moisture is located near Nelson, coastal Marlborough, northern and central Canterbury, and the eastern coast of Southland.

Climate drivers

In October, the NINO3.4 Index anomaly (in the central Pacific) during October (through the 24th) was -0.54˚C. The Southern Oscillation Index (SOI) was +0.8 during October, on the La Niña side of neutral. The three-month average SOI was +0.7, also on the La Niña side of neutral.

During October, upper-oceanic heat content decreased substantially across the equatorial Pacific. Sub-surface ocean conditions during October were 3˚C to 4˚C colder than average around 100 m depth in the east-central Pacific, a marked trend from September.

This was driven by an upwelling Kelvin wave and stronger than normal trade winds across the equatorial Pacific Ocean, focused over the Niño 3.4 region. Stronger than normal trade winds are expected to continue during November, which will result in continued cooling of the sea surface in the equatorial Pacific.

NIWA has moved to "La Niña Alert". There is an 80% chance for the development of a formal La Niña event between November-January, based on international guidance.

La Niña will become a dominant climate driver during the upcoming fire season. La Niña is often associated with more north-easterlies during summer, but each La Niña event comes with unique characteristics.

La Niña events tend to bring warmer temperatures and more moisture/humidity to the northern and eastern parts of both islands, although last summer was an exception.

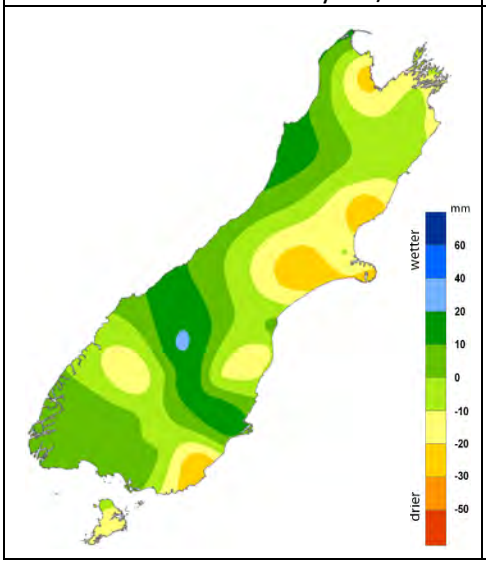
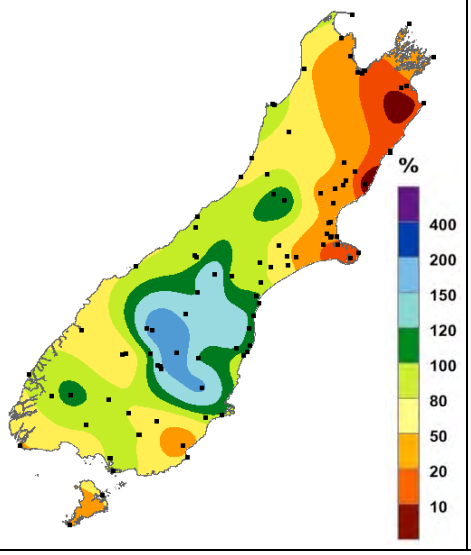
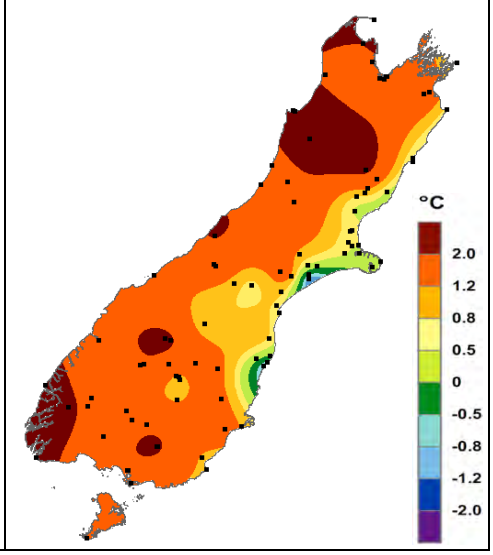
Soil moisture anomaly: 17/11	Rainfall anomaly: 01/11 – 17/11	Temperature anomaly: 01/11 – 17/11
		

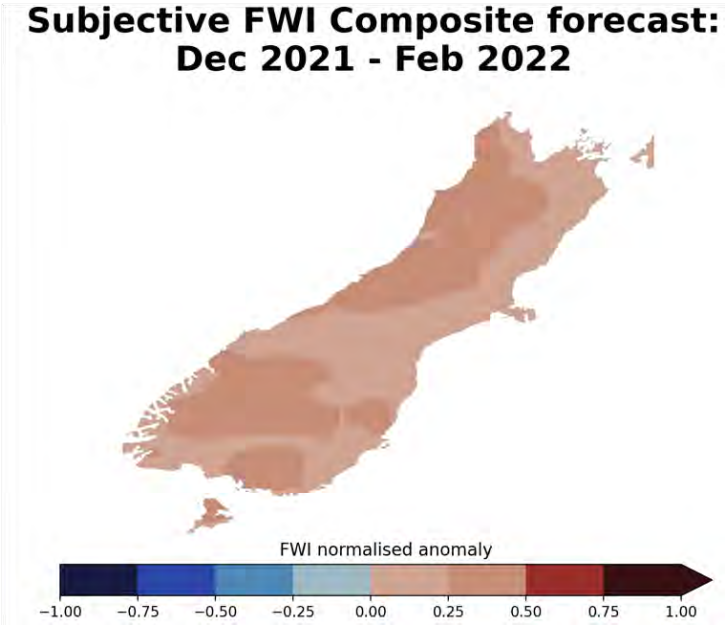
Figure 2: Maps showing the current soil moisture anomaly as well as temperature and rainfall as a difference from normal since the start of the month.

Fire season analogues

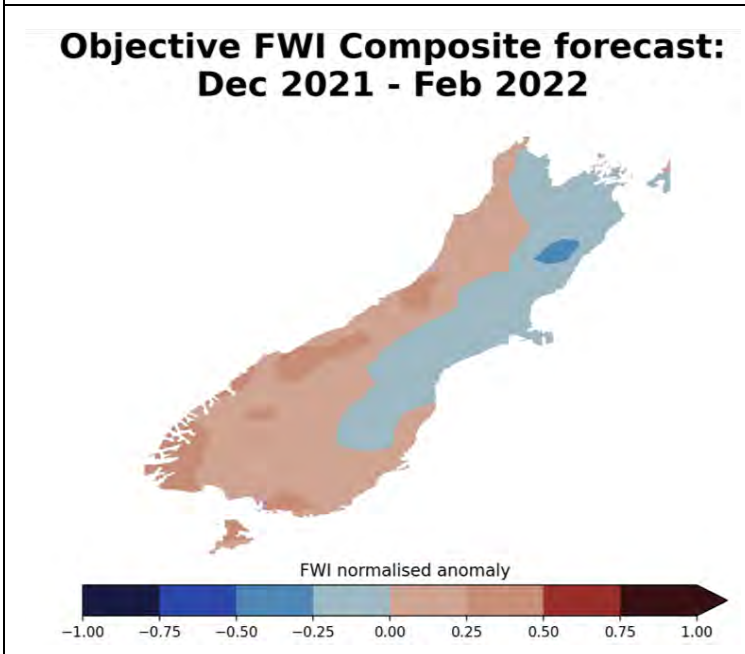
To help understand what fire weather conditions may be like this summer, we can look at analogues. Analogues are historical years with similar climatic conditions to the current year.

This summer's analogue years featured historical years that had La Niña-like patterns in the ocean and/or atmosphere (Figure 3). 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 signal is for a summer with higher fire weather indices relative to the long-term average, especially across the south and west of the South Island. Summer 2020-21 is one of the strongest analogues, placing 1st on the forecaster-selected analogue list (top) and 4th on the computer-selected analogue list (bottom). This season featured drought conditions in parts of the South Island. Overall, it's a sign that many regions across the island will need to be prepared for long dry periods that can enhance fire weather conditions.



Forecaster-selected analogue season - Dec to Feb
2020-2021
1999-2000
2017-2018
2008-2009
2000-2001
1998-1999
1995-1996
1988-1989



Machine-selected analogue season - Dec to Feb
1967-1968
2007-2008
1996-1997
2020-2021
2011-2012
2013-2014
1970-1971
2001-2002

Figure 3: Analogue fire seasons as selected with expert interpretation from NIWA (top) and automated computer analysis (bottom). The fire weather index is a combination of the initial spread index and build-up 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 fire weather index between 1991-2020 for relevant season.

Climate outlook: December

December's air flows are generally expected to be easterly, which would favour drier than normal conditions across much of the South Island (especially in the south and west). Overall, wind speeds are expected to be below normal in December, with above average temperatures very likely. Relative humidity is forecast to be higher than normal in northeastern areas, but below normal in the southwest.

Climate outlook: December - February

Summer is expected to have more easterly quarter winds than normal. Above average temperatures are likely, particularly in the western South Island. Rainfall looks to be below normal in most regions, with the driest relative to normal in the south and west. Hot conditions will be common, with relative humidity forecast to be below normal in western areas. Wind speeds continue to look lighter than normal. These climate anomalies are well-aligned with La Niña conditions.

The tropical cyclone season for the Southern Hemisphere runs from November to April, with the odd TC occurring outside this period. On average, at least one ex-tropical cyclone passes within 550 km of New Zealand each year. This season the risk is considered elevated compared to normal.

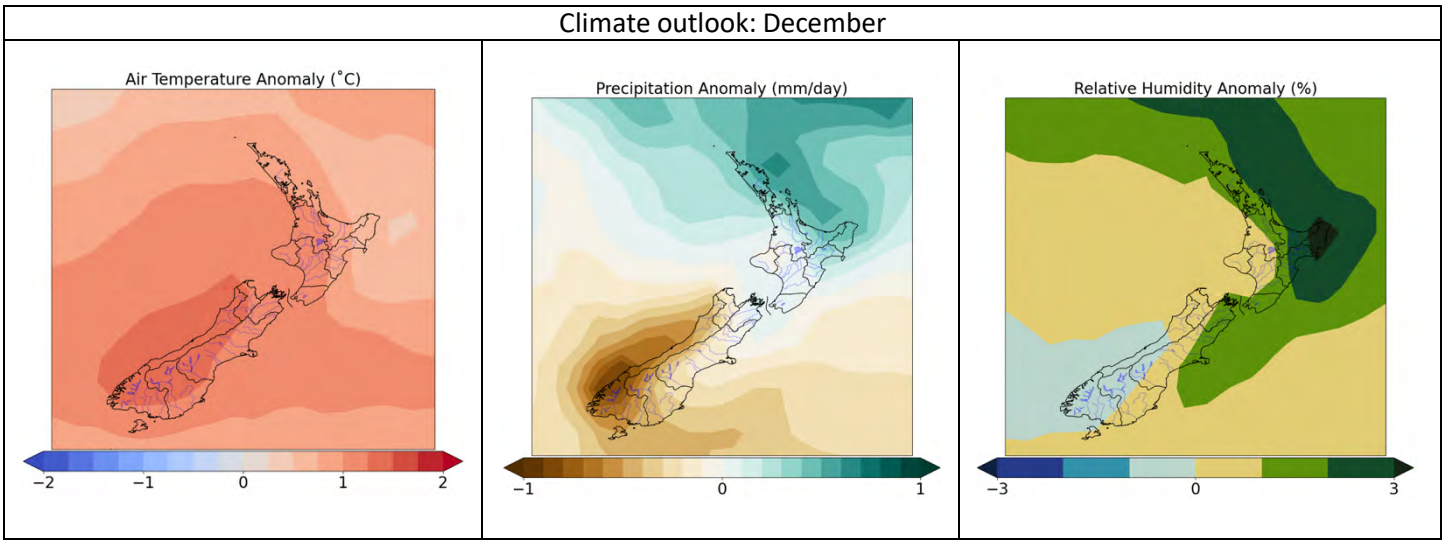


Figure 4: Climate outlook for December showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

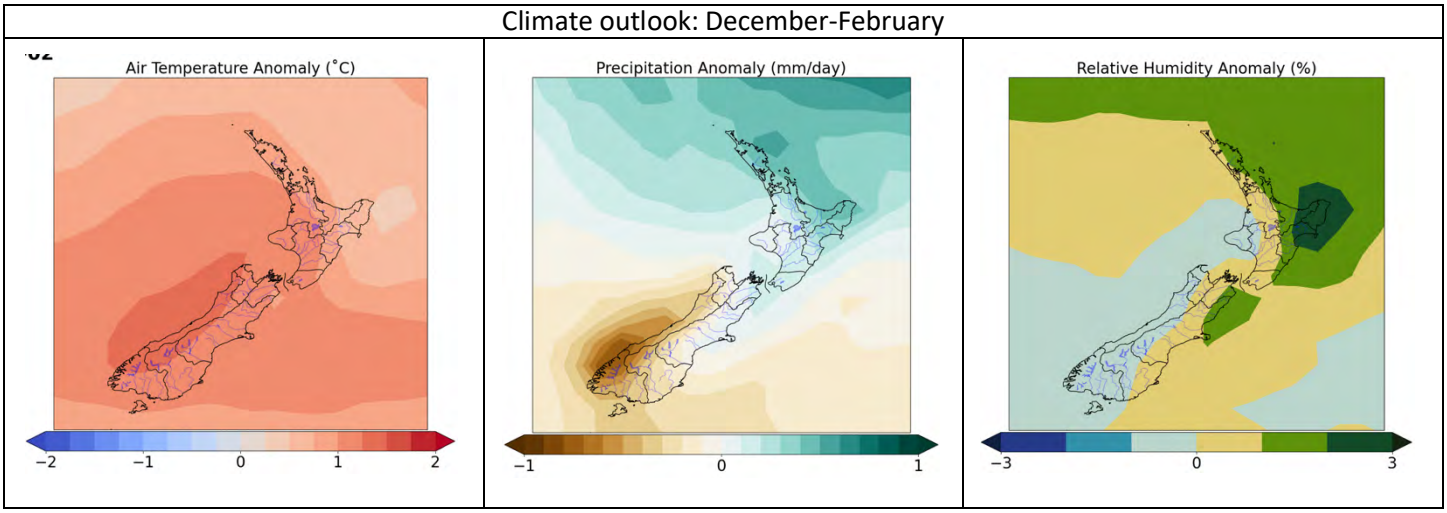


Figure 5: Climate outlook for December-February showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

Expected impact on fuels and fire danger

Fine fuel moisture is critically important to fire behavior with lower moistures resulting in easier ignitions and faster spread rates. Fine fuel moistures are affected by temperature, wind, humidity and precipitation. Based on the outlook above it is anticipated that drying rates will be increased by warmer temperatures in most parts of the South Island, but this is expected to be offset in the northeastern parts of the island by normal or above normal humidity and near normal precipitation.

Anticipated generally lower wind speeds are likely to see less frequent wind driven fires and generally reduced spread rates, although the reduction may be offset by lower than normal fine fuel moistures in the west and south as described above. It is also anticipated that the strong, hot, dry NW foehn winds that affect eastern areas of the South Island will be less frequent this season.

Looking to December and beyond the changing of the season will see increasing availability of medium, heavy and subsurface fuels as they dry out. The moisture of these fuels has less of an impact on fire spread rates, but as they dry the fuel availability increases, resulting in greater fire intensity, making suppression more difficult. The drying of these fuels is dependent on temperature, precipitation and to some degree humidity. The outlook above indicates that the medium and heavy fuel availability will likely be about normal in the north-east but are likely to be about or slightly above normal in the south and west and for a part of the highland between Otago and Southland may be significantly higher than normal.

The net effect of the climatic outlook is that much of the South Island is likely to have normal or slightly greater than normal fire danger except for the northeastern parts which are likely to be about normal and a highland area between Otago and Southland which is expected to have significantly greater than normal fire danger, Refer to figure 3 above.

It should also be noted that although north eastern parts are not expected to have higher than normal fire danger, their normal fire danger is relatively high. And these areas will still occasionally have elevated fire dangers when the NW winds occur.

Grass growth & curing

Winter/spring average or above average soil moisture for much of the South Island makes for good growing conditions, from which we can expect many areas will have increased fuel loads, especially where grazing has not kept up with the grass growth.

Grass fuels generally only burn in exceptional conditions (low humidity and high winds) if they are less than 50% cured i.e. less than 50% brown or dead material. Subject to weather and topography influences, grass fire ease of ignition, intensity and spread rates increase steadily as the curing percentage increases. At 50% cured, grass produces very slow moving fires and small flames, with >90% cured grass able to produce extreme flame lengths and intensities.

Curing for most pasture species occurs as a natural process with summer drying and seed set, the timing of this will vary between regions, seasons and grass types. Some areas will also be subject to frost curing where there is a build-up of dead material over winter. This is then replaced by a green spring flush but also some species, especially tussocks, have lower moisture levels in their live materials in order to survive severe winter frosts. This is why we often see tussock fires in the early spring. The temperatures will now be increasing but the winter frost cured material may still be present.

Many fires start in fine fuels such as grass which ignite easily and rapidly spread to other fuels. Grass fuel loads and curing rates should be monitored closely as a critical factor in assessing fire danger.

Examples of escaped burns in relatively mild conditions that could have been avoided with careful supervision and basic tools to control the spread of fire.

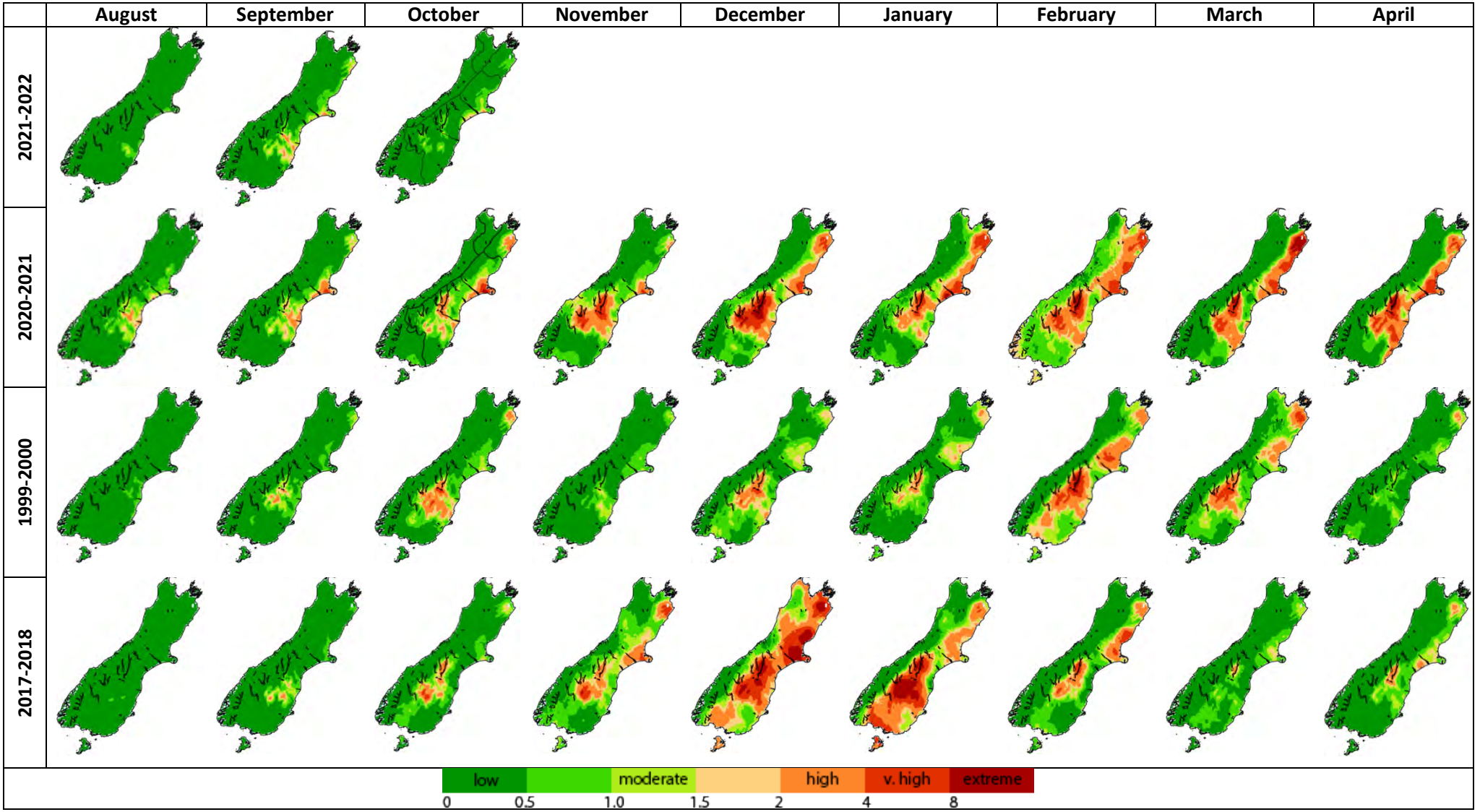


Figure 6: Monthly average severity rating for October 2021 and the years 2020/21, 1999/2000 and 2017/18. These are analogue years for the current season and give us an insight what the upcoming fire season may be like.

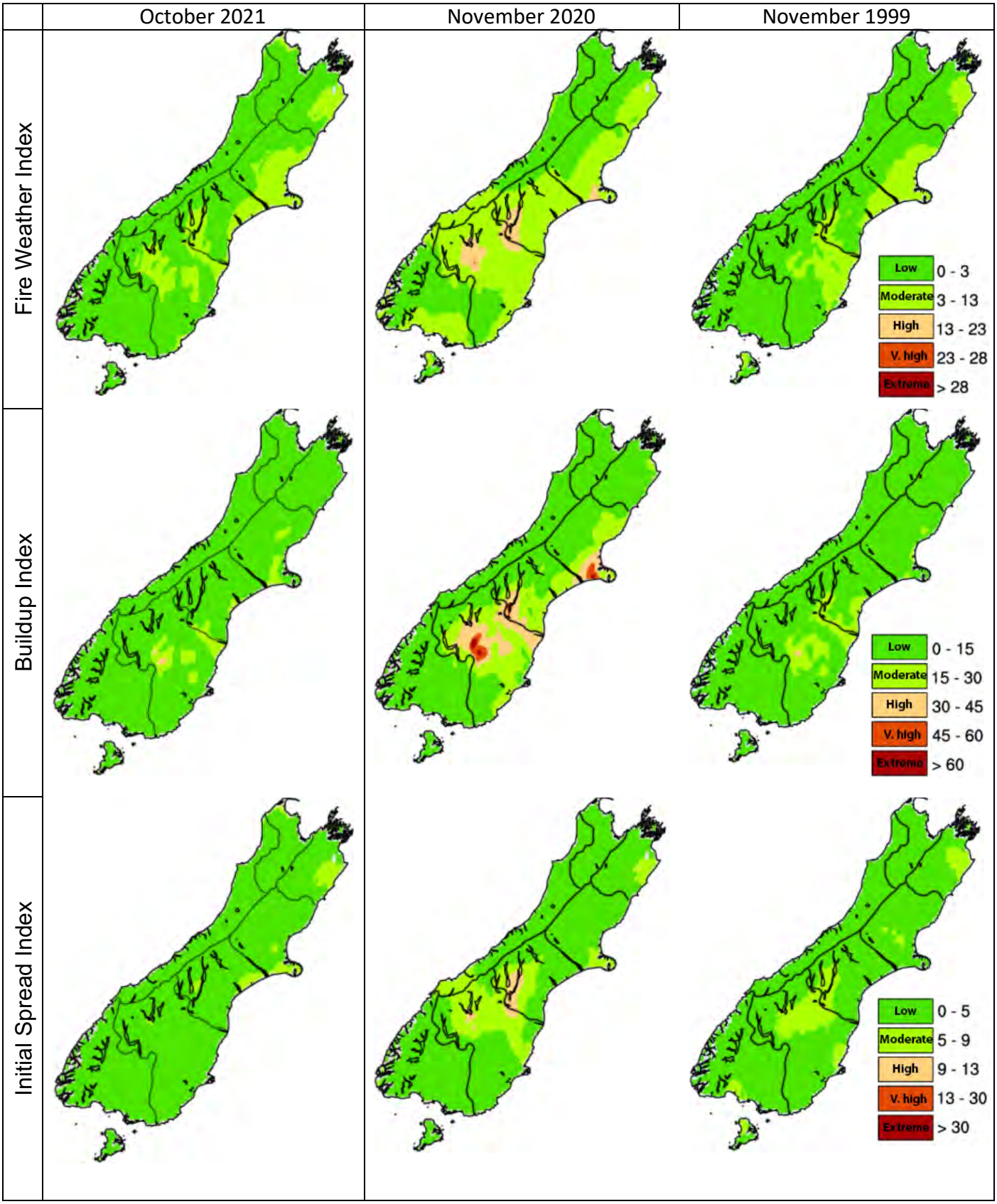


Figure 7: The most recent observed month (left column) and analogue months for November (middle and right columns); monthly average for the Fire Weather Index (top), Buildup Index (middle) and Initial Spread Index (bottom).

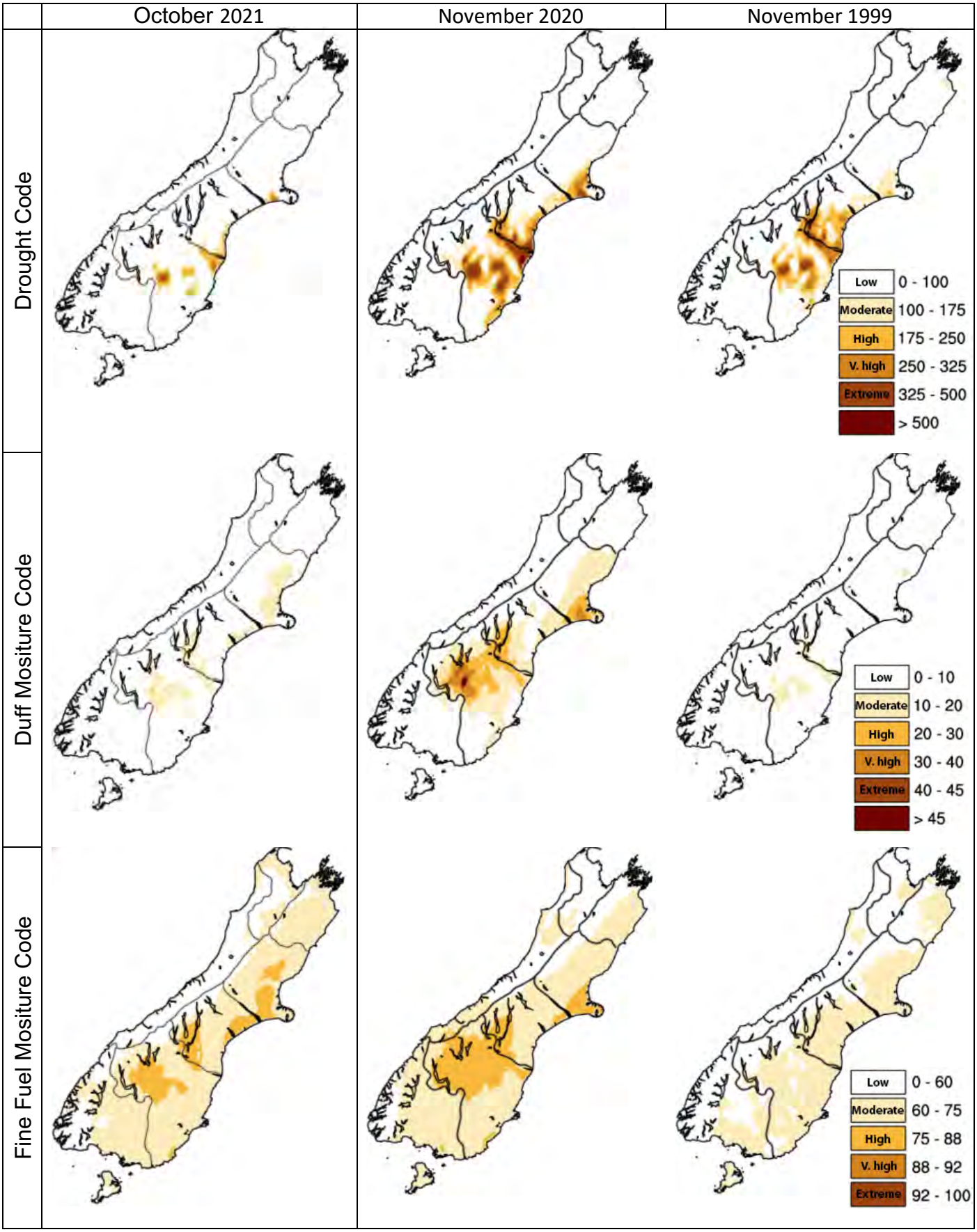


Figure 8: The most recent observed month (left column) and analogue months for November (middle and right columns); monthly average for the Drought Code (top), Duff Moisture Code (middle) and Fine Fuel Moisture Code (bottom).

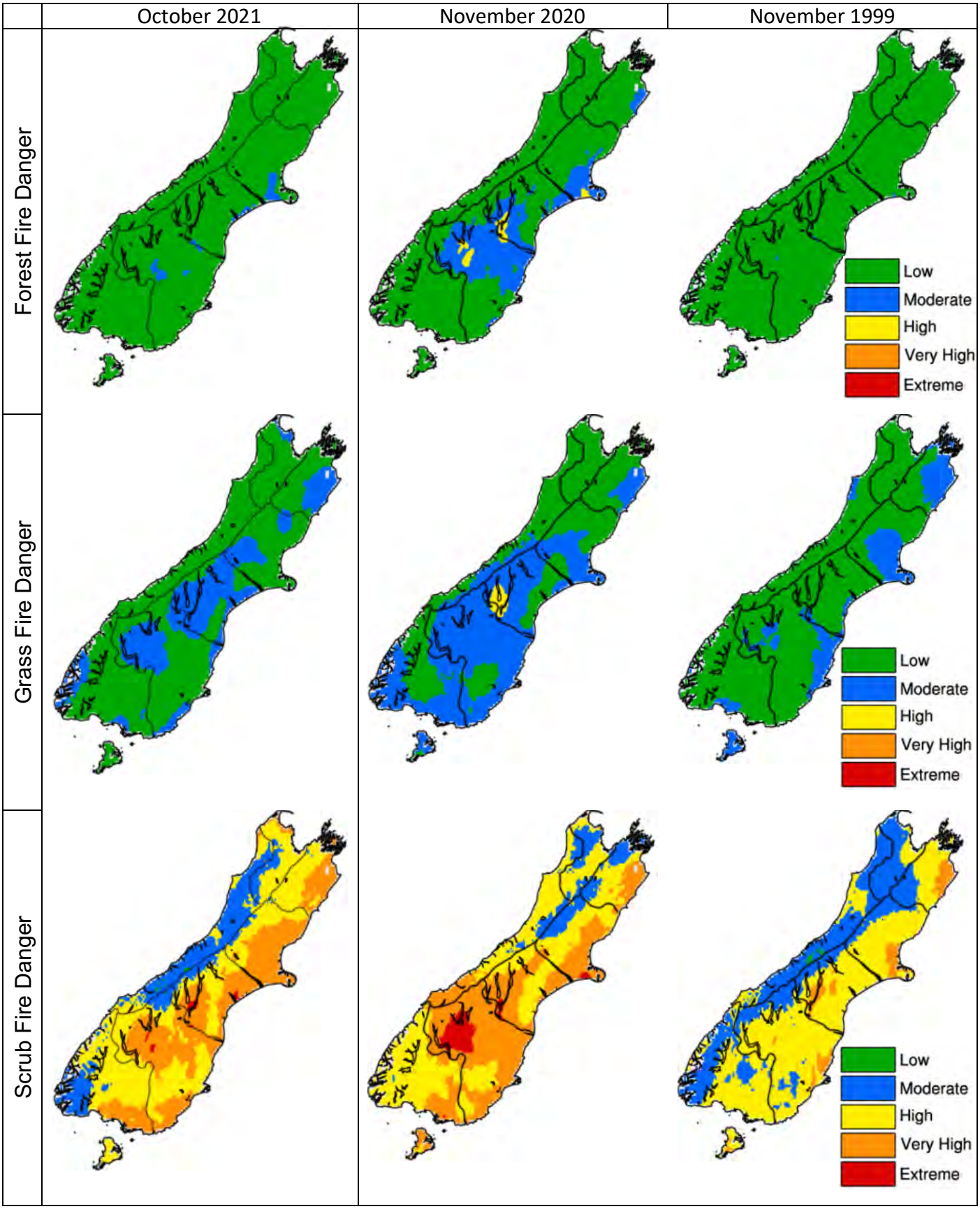


Figure 9: The most recent observed month (left column) and analogue months for November (middle and right columns); monthly average for the Forest Fire Danger (top), Grass Fire Danger (middle) and Scrub Fire Danger (bottom).

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 mopup 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 mopup 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