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

Current fire danger situation

In general, January's monthly fire danger and fire climate severity were moderate to high in the upper South Island along with southern Canterbury and interior Otago (Figures 8-11). However, many of these indices have temporarily improved in the upper South Island due to the heavy rainfall experienced during the first half of February.

Current fuel and soil moisture status

As of 16 February (Figure 4, left), soil moisture levels are above normal to well above normal in the upper South Island and most of Canterbury. Below normal soil moisture is located in Southland and Stewart Island. "Dry" to "Extremely Dry" conditions are currently found in interior Otago, all of Southland, and Stewart Island on the New Zealand Drought Index map.

The recent heavy rainfalls so far in February have resulted in significant reductions in Fire Weather System Codes and indices (BUI, DC, DMC and FFMC – refer to appendix for definitions) in many areas, especially across the northern and western parts of the South Island. However elevated values, especially of the DC (Figure 1), remain in the southern half of the island, indicating drier conditions and higher fuel availability (although these areas are drier than others, only some are drier than normal for this time of year).

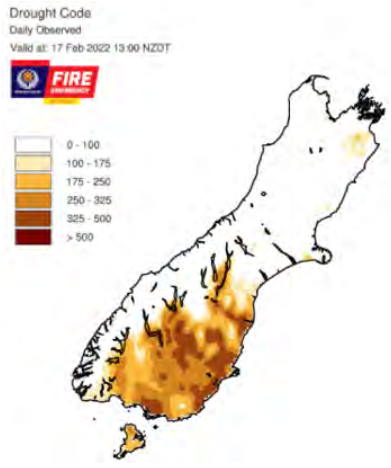


Figure 1: Map of Drought Code (an indicator of dryness of forest fuels and amount of smouldering in deep duff layers and large logs) for the South Island as at 17 February.

Dry spells and higher than normal temperatures over the next few months could see BUI and DC values quickly return to normal or above normal levels in many areas. However these increases may also be interspersed with drops in values caused by further occasional tropical storm activity. Figure 2 shows the current BUI trend for Nelson, where values have fallen from record high levels with the recent rain; however, these could rapidly increase again to normal or even above average levels.

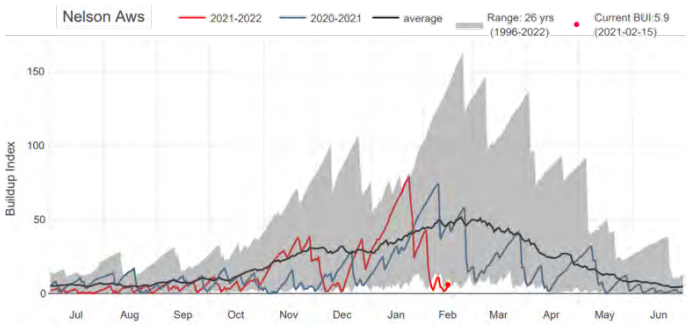


Figure 2: Trend in Buildup Index (BUI) code values for Nelson Aws comparing current values (2021/22, red line) with previous seasons (2020/21 (blue line), average (black line), and range (grey shading)).

Forecast climate and weather

A couple of fronts will move up the South Island during the next week with light to moderate rainfall, but a generally drier lean is expected through the rest of February overall. However, a return of the Madden-Julian Oscillation (MJO) to the western Pacific may result in wetter weather returning during early March. The chance for sub-tropical or tropical lows to form north of New Zealand will again increase during March, which will continue to bring an elevated risk for "binge rainfall" that can cause flooding.

The autumn season (March-May) is forecast to have more easterly winds than normal as the effect of La Niña continues, with near normal or above normal rainfall favoured in northern and eastern parts of the South Island, but below normal rainfall may continue in the southwest. This will come with a continued risk for ex-tropical cyclone activity, with a signal for such activity during March and early April in particular. However, long dry spells may continue between periods of activity in the tropics. For more information, see pages 3 and 4.

What to watch for

- Southern areas of Southland and Otago are most likely to experience above normal fire dangers in the coming months due to underlying dry or very dry soils, continuing warmer-than-normal temperatures and lower-than-normal rainfall.
- Areas of Southland and Otago (especially south coast) that have received lower rainfall over the past month compared to other parts, and have existing elevated DC and BUI levels.
- Long dry spells, causing soil and fuel moistures to increase rapidly from present levels to more normal or above normal levels.
- Elevated grass curing levels, combined with the high grass fuel loads present due to the warmer and wetter than normal summer growing conditions.
- Rapid fire spread potential in cured fine grass and scrub fuels, especially under strong winds.
- The possibility of further tropical storm activity, which could bring heavy rainfall but also possibly stronger winds to northern areas.
- Flare-ups or re-ignitions from burns, especially during periods with strong winds and now that Restricted fire seasons are back in place in many areas.

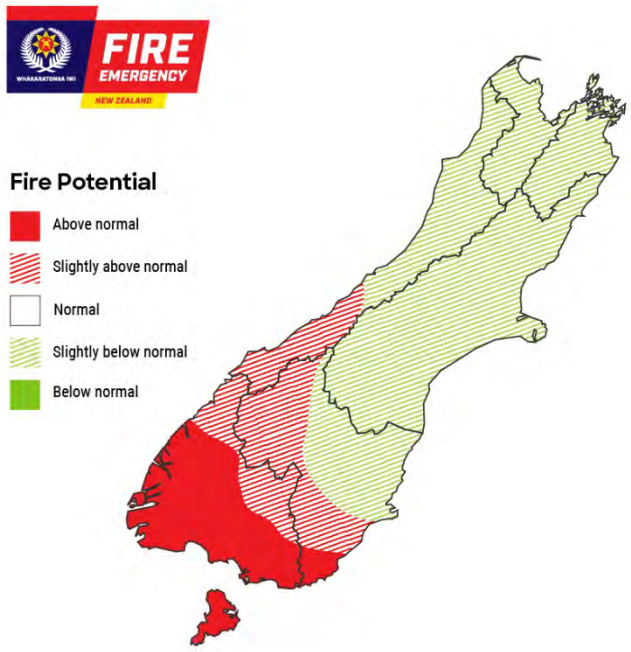


Figure 3: Locations identified as areas of interest that may develop an increased risk of above normal fire potential over the next three months.

Fires such as this in light flashy fuels like cured grass, scrub and wetland vegetation do not require extended dry periods and can spread rapidly under the influence of wind.

Current climate

January 2022 temperatures were above average (>0.50°C above average) or well above average (>1.20°C above average) across a majority of the South Island. However, generally near average (±0.50°C of average) temperatures were observed along the east coast, including Marlborough and Canterbury. The trend for above average temperatures has continued in the first half of February on the West Coast, while near average temperatures have been observed in the east (Figure 4, right).

January rainfall was below normal (50-79% of normal) or well below normal (<50% of normal) across the upper, western, and lower South Island. Isolated pockets of near normal rainfall (80-119% of normal) were observed in parts of central and southern Canterbury. In addition, a small area of above normal rainfall (120-149% of normal) was observed near Kaikōura. For the first half of February (Figure 4, middle), well above normal rainfall has been observed in most areas, although it remains quite dry in Southland and Stewart Island.

Soil moisture levels are above normal to well above normal in the upper South Island and most of Canterbury. Below normal soil moisture is located in Southland and Stewart Island (Figure 4, left).

Climate drivers

The NINO3.4 Index anomaly (in the central Pacific) for January was -0.70˚C, at the La Niña threshold. The monthly Southern Oscillation Index (SOI) was +0.3 and the three-month average SOI was +0.9, the latter near the La Niña threshold.

During January, upper-oceanic heat content increased in the western and central Pacific, signalling the gradual decay of La Niña. Meanwhile, conditions remained cooler than average in the eastern Pacific. In the subsurface, a substantial warm pool (+2˚C to +3˚C) at around 150 m depth continued to progress eastward from the western Pacific, which indicated an ongoing, gradual decay of La Niña, which will most likely give way to ENSO neutral conditions in the coming months.

During January, convective forcing focused over the Maritime Continent and central and western Pacific. This was influenced by several modes of variability. During the second half of February, the MJO is expected to focus over the eastern Indian Ocean and Maritime Continent.

Heading into March, there is an indication that the MJO will be more active in phases 5 and 6, which would imply an increased chance for wet weather, particularly in the North Island, and tropical cyclone activity in the Southwest Pacific.

La Niña remains the dominant climate driver for now, but it is expected to ease during autumn.

New Zealand's coastal waters continued to experience marine heatwave (MHW) conditions during January. Sea surface temperatures (SSTs) were above to well above average in all regions, ranging from +0.9˚C to 1.9˚C above average. Although daily maximum SST anomalies during January decreased slightly compared to December, MHW conditions will continue to have an upward influence on air temperatures and humidity during February and into March. Climate models indicate that marine heatwave conditions will ease during autumn.

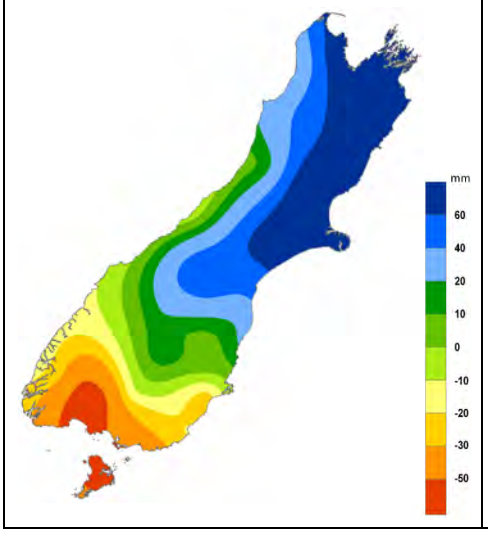
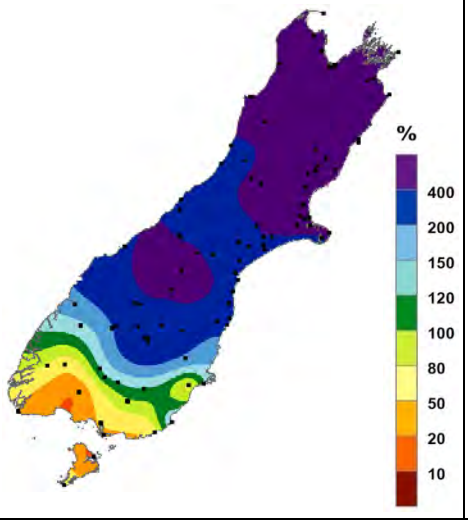
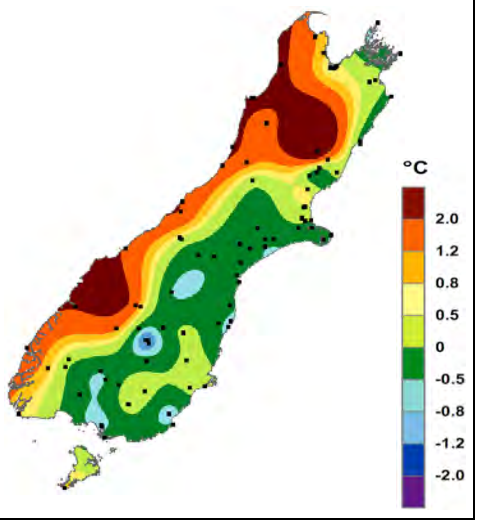
Soil moisture anomaly: 16/2	Rainfall anomaly: 1/2 – 16/2	Temperature anomaly: 1/2 – 16/2
		

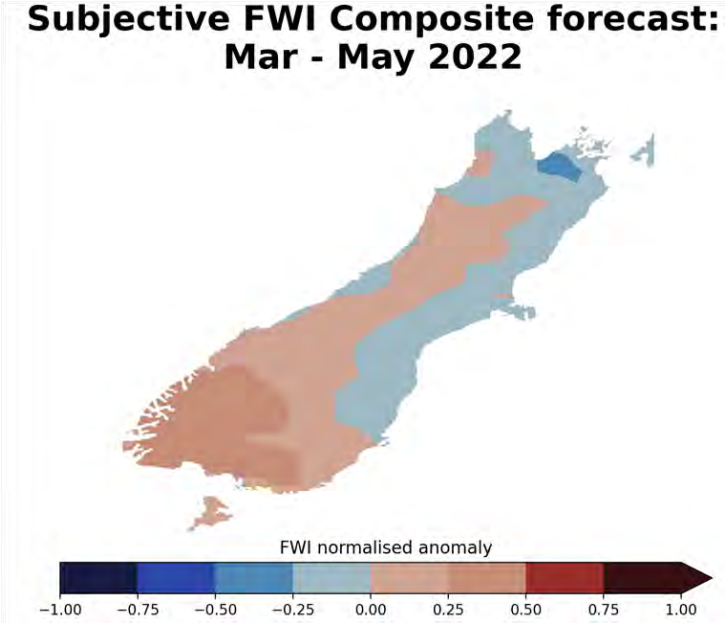
Figure 4: Maps showing the current soil moisture anomaly as well as temperature and rainfall differences from normal since the start of the month.

Fire season analogues

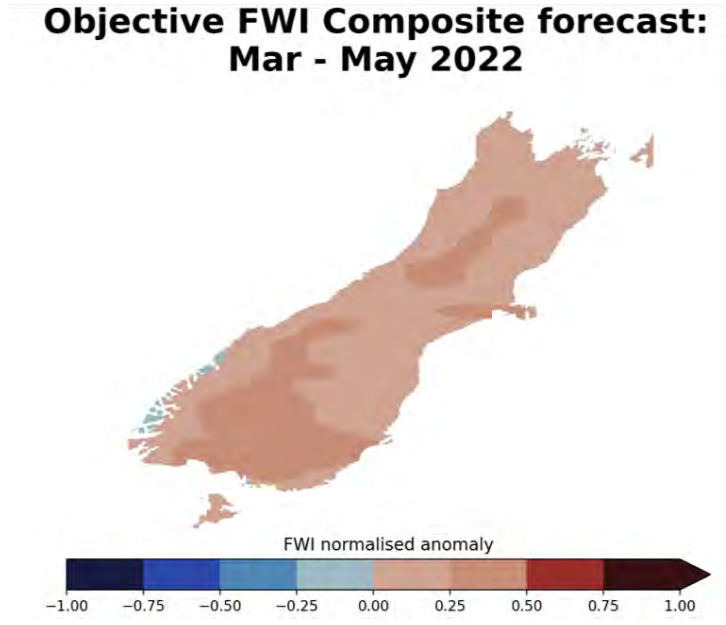
To help understand what fire weather conditions may be like this summer, we can look at analogues. Analogues are historical years with similar climatic conditions to the current year.

This season's analogue years featured historical years that had La Niña-like 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 signal is for a season with higher fire weather indices relative to the long-term average across the western and southern South Island. However, indices may be slightly lower than average in the north and east, partly due to the prevalence of onshore easterly winds. Overall, this indicates that some regions across the island (especially in the southwest) will need to be prepared for long dry periods that can enhance fire weather conditions.



Forecaster-selected analogue season – Mar to May
2020
2018
2017
2008
2007
1995
2021
2012



Machine-selected analogue season - Mar to May
2004
2012
2001
2000
2007
2013
1999
1990

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: March

March's air flows are generally expected to be easterly, similar to recent months. The signal is for a wetter than normal month in the top of the South Island and in Canterbury, but this may occur as irregular "binge rainfall" that can cause flooding. However, southwestern areas continue to look drier than normal. The tropics may again be active during March. Wind speeds are expected to be below normal across the South Island. Above average temperatures again appear very likely in the West Coast. Relative humidity is forecast to be higher than normal in eastern areas and lower than normal in western areas (Figure 6).

Climate outlook: March - May

The autumn season is expected to yet again have more easterly winds than normal. Above average temperatures remain likely, particularly in the western South Island. Rainfall may again be below normal in the southwest, but perhaps near normal to above normal in the north and east, driven by occasional sub-tropical depressions, and an elevated risk for ex-tropical cyclones (particularly in March and early April) (Figure 7). However, dry spells may occur between periods of rainfall. Above average temperatures will be likely, with relative humidity forecast to be below normal in western areas, and higher than normal in the east. Below normal wind speeds continue to be favoured. These climate anomalies are well-aligned with La Niña conditions.

The tropical cyclone season for the Southern Hemisphere runs through to April, with the odd tropical cyclone 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.

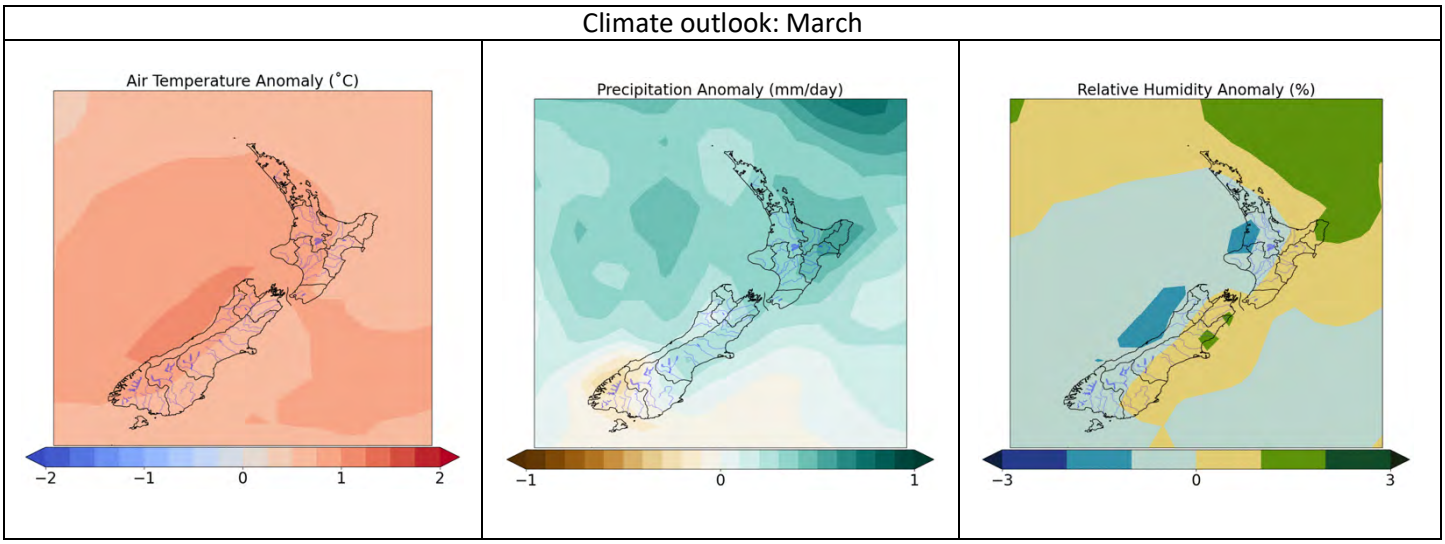


Figure 6: Climate outlook for March showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

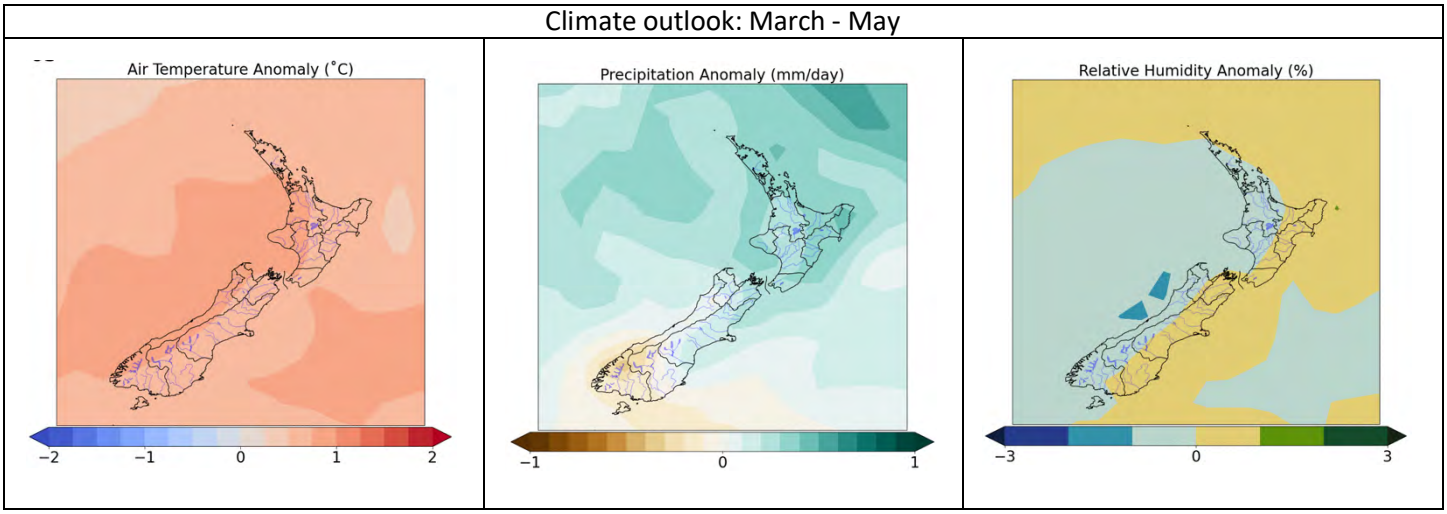


Figure 7: Climate outlook for March-May showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

Expected impact on fuels and fire danger

Fine fuel moisture is critically important to fire behaviour 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 higher in the west and south of the South Island due to the warmer temperatures and lower humidity, but lower in the east due to higher humidity and more onshore easterly winds. Fine fuel moistures will also be affected by any passing fronts and intermittent tropical storm activity, although will dry out again rapidly during dry periods that follow.

Grassland curing levels are also increasing as grass fuels dry and die off, so fires can ignite and spread more easily. Similarly, scrub fuels respond very quickly and can produce extreme fire behaviour within relatively short periods since recent rain. Vigilance therefore needs to be maintained around communities and high value sites where the prevailing surrounding fuel are scrub or grasses with higher than normal fuel loads.

Despite significant reductions to FWI codes and indices following the recent heavy rainfalls in most areas, the ongoing warmer than normal temperatures will see DC and BUI values continuing to increase over the next few months to more normal levels. Areas that missed much of the recent rain, such as Southland, Otago and parts of South Canterbury, have not seen the same reductions in DC and BUI values, and in the absence of further heavy rain will quickly return to normal or above normal levels.

Elevated BUI values in particular are indicative of greater availability of medium, heavy and subsurface fuels as they dry out. These fuels have 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 net effect of the climatic outlook is that southern areas of the South Island are likely to have normal to slightly above normal fire danger. Regions with currently elevated values that missed most of the recent heavy rainfall, such as Southland and coastal South Otago, will quickly return to above normal levels in the absence of further heavy rain events. Areas slightly further north in Otago and even South Canterbury may see slightly above normal fire potential. Remaining areas across the northern half of the South Island are likely to see more normal or slightly below fire danger levels. However, even these areas will still experience periods of elevated fire danger, associated with stronger winds or dry periods between heavy rainfall events, when wildfire ignition and spread potential will be high.

Grass growth & curing

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

Most of the North Island has continued to experience good growing conditions as a result of the above average temperatures, and higher than normal summer rainfall. This has resulted in increased grass fuel loads in many areas, especially where grazing has not kept up with the grass growth. As summer has progressed, these grass fuels are now dying-off and drying out in many areas.

Subject to weather and topography influences, grass fire ease of ignition, intensity and spread rates increase steadily as the curing percentage increases. Whereas a fire in <50% cured grass (with less than 50% brown or dead material present) will be slow-moving fires and produce small flames, a fire in >90% cured grass is able to spread much faster and produce extreme flame lengths and fire intensities.

Curing for most pasture species occurs as a natural process with seed set and summer drying. The timing of this varies between regions, seasons and grass types, but by mid-summer this will now be well advanced in many parts of the country. In areas with perennial (vs annual) grasses, there may have been some green-up following recent rainfalls. However, seasonal curing will continue over the next couple of months, especially during extended dry periods.

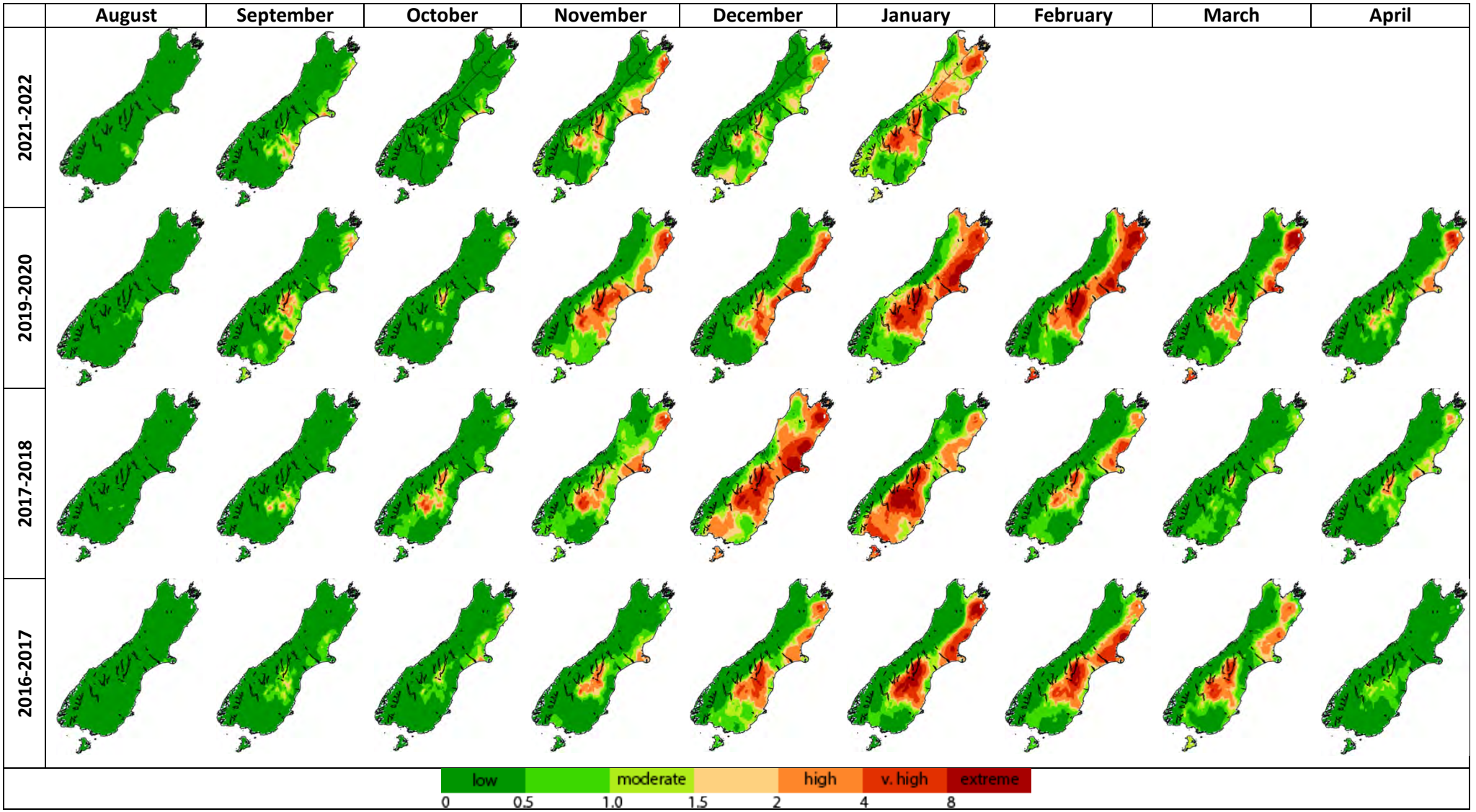


Figure 8: Monthly average severity rating for 2021-2022 up to and including January and the comparative years of 2019/2020, 2017/2018 and 2016/2017. These are analogue years for the current season and give us an insight into what the upcoming season may be like.

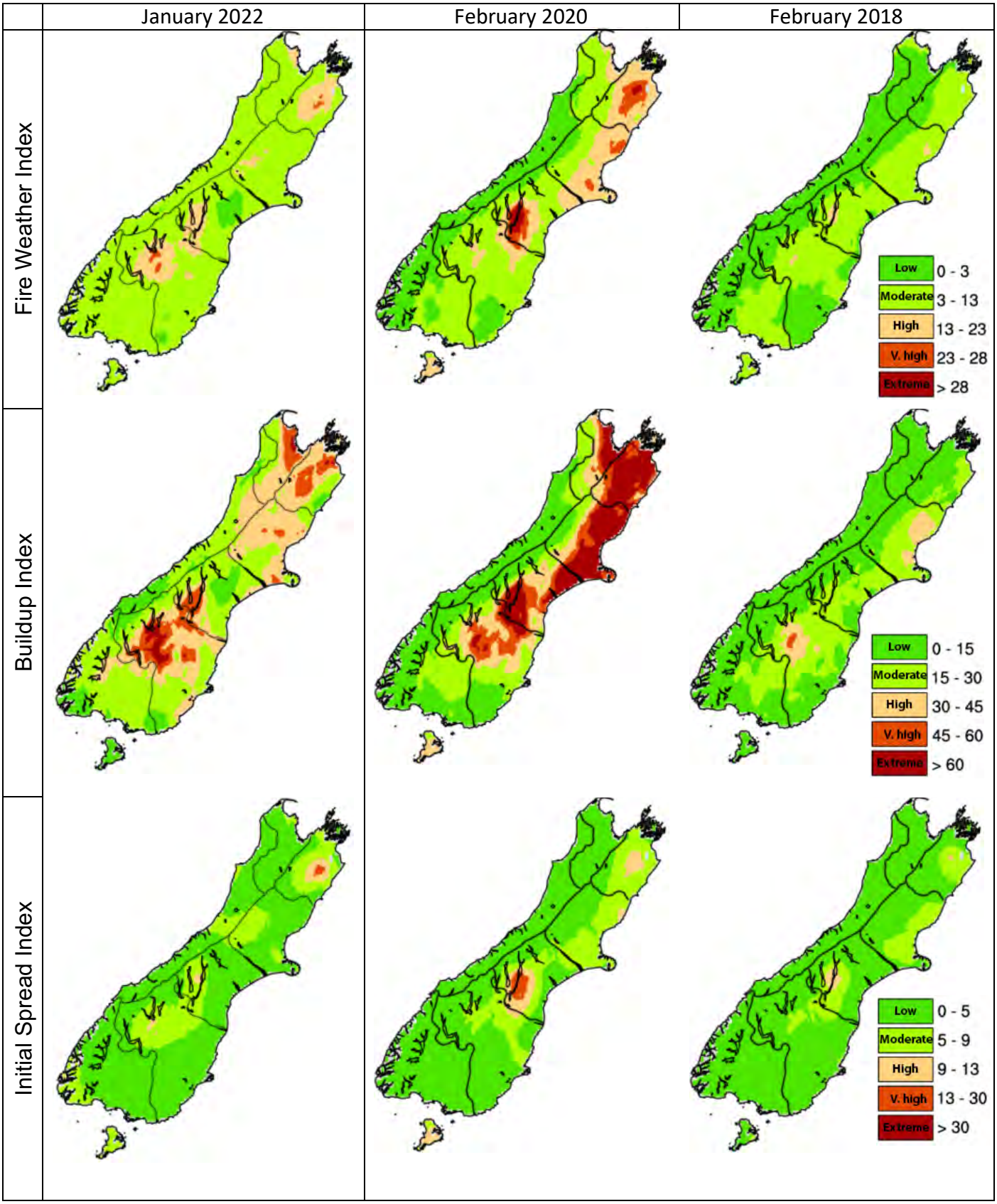


Figure 9: The most recent observed month (left column) and analogue months for February (middle and right columns); monthly average for the Fire Weather Index (top), Buildup Index (middle) and Initial Spread Index (bottom).

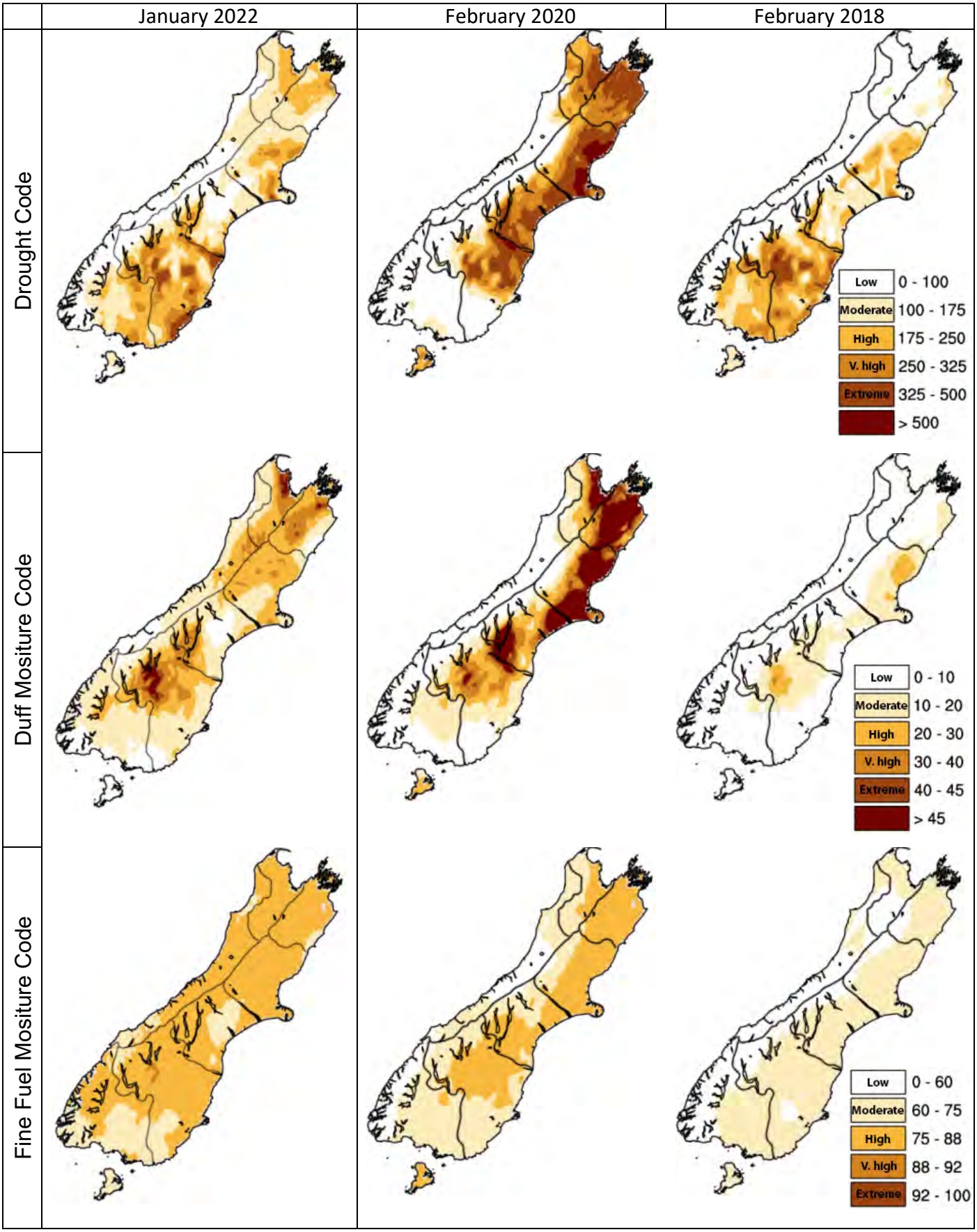


Figure 10: The most recent observed month (left column) and analogue months for February (middle and right columns); monthly average for the Drought Code (top), Duff Moisture Code (middle) and Fine Fuel Moisture Code (bottom).

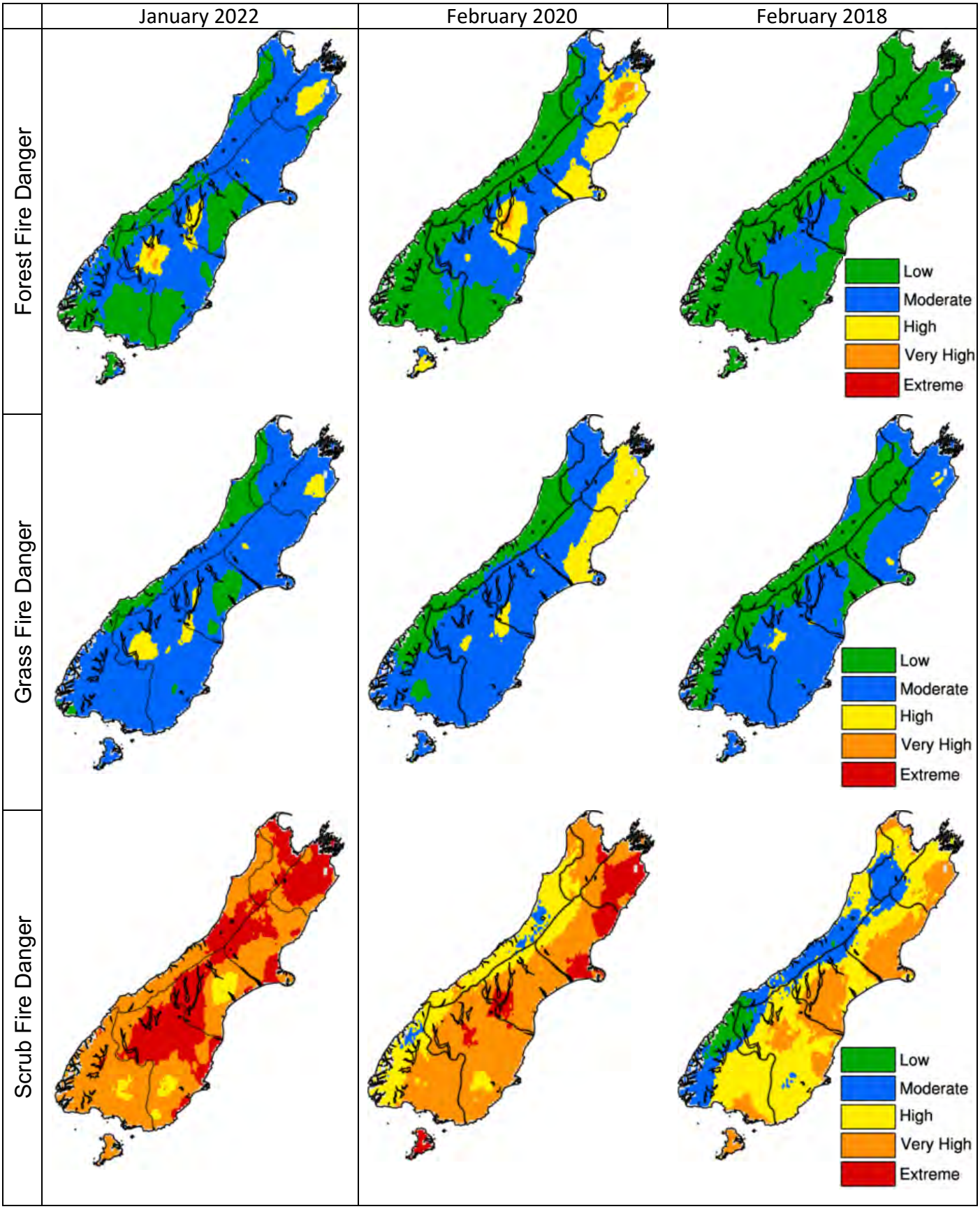


Figure 11: The most recent observed month (left column) and analogue months for February (middle and right columns); monthly average for the Forest Fire Danger (top), Grass Fire Danger (middle) and Scrub Fire Danger (bottom).

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