South Island Monthly Fire Danger Outlook (2022/2023 season)
Issue: January 2023

Current fire danger situation

December's various indices mostly showed low to moderate values across the South Island, although some high to very high values were observed in parts of interior Canterbury and Otago. See Figures 7-10 for more detail.

Current fuel and soil moisture status

As of 19 January (Figure 3, left), soil moisture levels are below to well below normal across much of the western and southern parts of the South Island, along with parts of Canterbury. Soil moisture levels are near normal to slightly above normal in the top of the South Island. The New Zealand Drought Index is currently showing dry to very dry conditions in Banks Peninsula, coastal and interior Otago, the lower West Coast, and Stewart Island.

The South Island is currently experiencing variable conditions, with elevated Buildup Index (BUI) values (an indicator of fuel availability due to drying of medium and heavy fuels in forest) in Otago, Southland and Northern Canterbury, as well as Makenzie Basin, as reflected by Figure 1.

Areas such as Fiordland and Westport have recently experienced forest fires in areas where fires are not normally common due to the higher than normal fuel dryness. Conversely, North Eastern parts of the South Island and central Canterbury are experiencing lower than normal BUI values.

The areas with higher BUIs (Figure 1), and contributing Drought Code (DC) and Duff Moisture Code (DMC) values, will have greater fuel available to burn in forests. This greater fuel availability results in fires of greater intensities, as well as deeper burning into the ground which makes complete extinguishment of fires very difficult.

Although the BUI is up for a number of eastern and southern areas, the hot, dry fohn winds from the northwest have been less frequent, meaning less days where ignitions are easy and spread rates elevated. However, a fohn wind in reverse direction to normal has frequently been seen so far this summer, where the easterlies have been delivering warm dry conditions to western parts of the South Island.

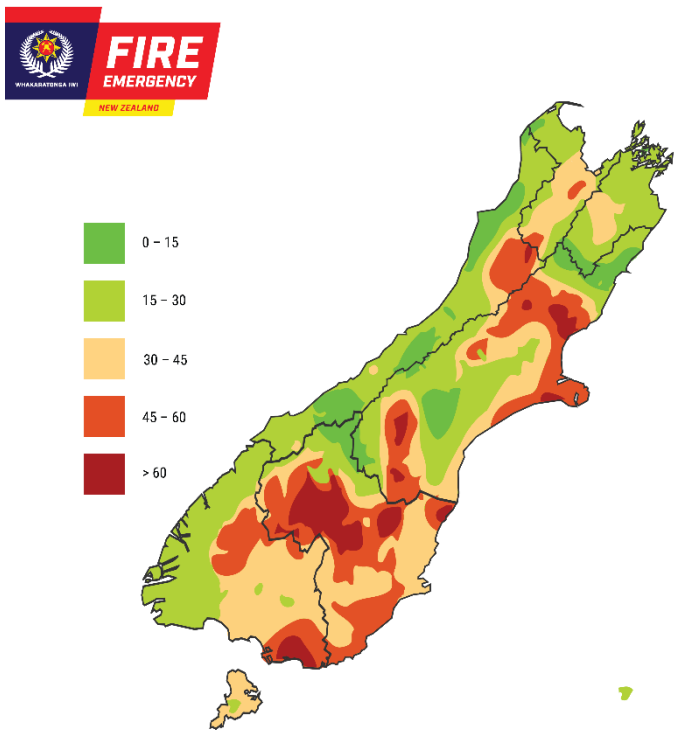


Figure 1: Map of Build Up Index (an indicator of fuel availability due to drying of medium and heavy fuels in forest) for the South Island as at 20th January.

Forecast climate and weather

Late January looks to be somewhat drier than normal as high pressure is generally favoured in the New Zealand region. Already dry soils will likely dry out even more in the next couple of weeks. For February as a whole, more easterly winds than normal are expected as La Niña

remains in place. This could result in continued dry conditions in the west and south, with many locations (especially in the west) seeing warmer than average temperatures.

February-April will exhibit more easterly winds than usual, although La Niña is expected to transition to ENSO-neutral later in the period, which may increase variability in air flows. There may be an increased chance for tropical cyclone activity from late February into March. Temperatures overall look to be warmer than average, especially in western regions.
For more information, see pages 3 and 4.

What to watch for

The areas of the South Island most likely to experience above normal or slightly above normal fire potential over the next few months are in the south and west (Southland, Fiordland and Westland). North eastern areas are most likely to see slightly below normal fire potential (see Figure 2).

- Parts of inland Canterbury and the east coast north of Kaikoura have had higher than normal soil moistures which have resulted in substantial grass growth, meaning the grass fuel loading is much higher than normal. Although the northwesterly winds are likely to continue to be less frequent, when they do occur there is potential for some very intense grass fires.

Fire of 19th January 2023 near Coronet Peak

- People undertaking burning may be complacent due to absence of "drought" conditions in some areas, so escapes may be more likely, especially under windy conditions.

- Fires in West Coast areas that do not typically get wildfires. Complacency again, this time from people burning, could be a problem because the conditions are such that fires may escape from burns in locations that they do not usually escape from.

- Crop stubble burns will be occurring over the coming months.

- Flare-ups or re-ignitions of old burns may also occur, especially during periods with strong winds.

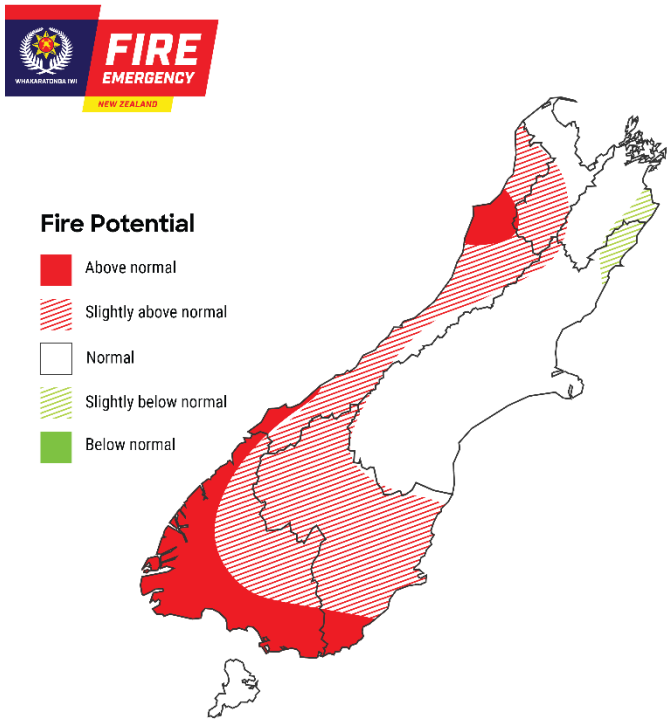


Figure 2: Locations identified as areas of interest that may develop an increased risk of above normal fire potential over the next three months.

Current climate

December temperatures were above average (0.51°C to 1.20°C above average) to well above average (>1.20°C above average) across much of the South Island, although near average (±0.50°C of average) temperatures were observed in eastern Marlborough, northern Canterbury, and pockets of interior Otago. So far in January, temperatures have been well above average in the west and south, with near average to slightly below average temperatures from Marlborough to central Canterbury (Figure 3, right).

December rainfall was above normal (120-149% of normal) or well above normal (>149% of normal) in eastern Marlborough, and parts of northern and southern Canterbury. Below normal (50-79% of normal) or well below normal (<50% of normal) rainfall was observed in Tasman, the West Coast, Banks Peninsula, along with most of Otago and Southland. So far in January, rainfall has been below normal to well below normal in most of the South Island, with above normal rainfall from Tasman east to Marlborough (Figure 3, middle).

Soil moisture levels are below to well below normal across the western and southern parts of the South Island and parts of Canterbury, but near normal to slightly above normal in the top of the South Island. The New Zealand Drought Index is currently showing dry to very dry conditions in Banks Peninsula, coastal and interior Otago, and the lower West Coast (Figure 3, left).

Climate drivers

The NINO3.4 Index anomaly (in the central equatorial Pacific) during December was -0.83˚C (climatology: 1991-2020), While this was within the La Niña range, it marked a warming trend as compared to November, indicating that the event is past its peak.

The December monthly Southern Oscillation Index (SOI) was +1.7 and +1.3 from October-December (climatology: 1991-2020), both in the La Niña range.

Trade winds across the equatorial Pacific were stronger than normal during December. Thus, La Niña continued, despite the slight weakening.

In the subsurface central equatorial Pacific, substantial changes took place between November and December as warmth associated with the West Pacific Warm Pool shifted eastward. Cooler than average waters contracted toward the central part of the basin while warmer than average waters at depth pushed from the central to the eastern equatorial Pacific. The setup was reflective of a decaying La Niña.

A sea surface temperature seesaw in the Indian Ocean called the Indian Ocean Dipole (IOD) eased during December, evidenced by an increase in the outgoing longwave radiation (a proxy for decreasing cloud) compared to November. During October-December, convective forcing was dominated by the low frequency signal of the negative Indian Ocean Dipole and La Niña, superimposed with pulses of the Madden-Julian Oscillation (MJO).

Tropical forcing favours the Indian Ocean and Maritime Continent during February, roughly corresponding to phases 2-5. This is historically associated with above average temperatures and mixed rainfall patterns. Phase 5 tends to be much wetter than normal during February.

New Zealand's coastal water temperatures became more unusually warm in all regions except the north of the North Island during December. Marine heatwave conditions were widespread, with local anomalies of more than 4˚C off the West Coast and greater than 3˚C near Waikato.

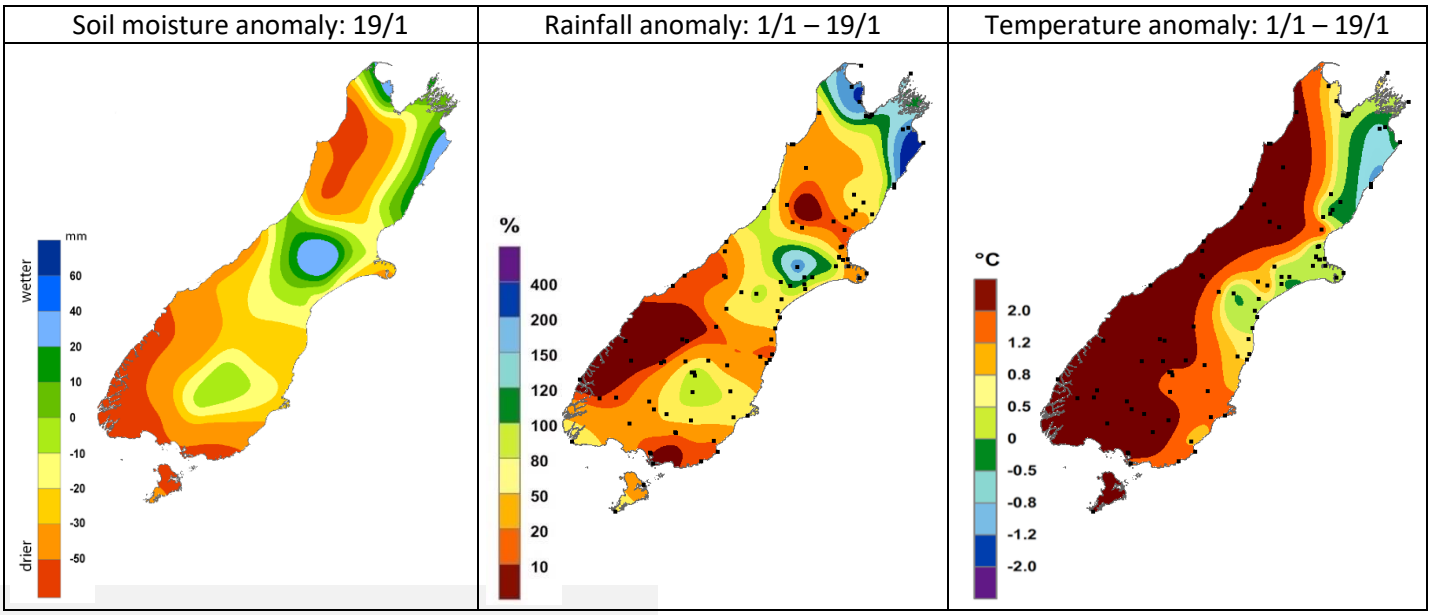


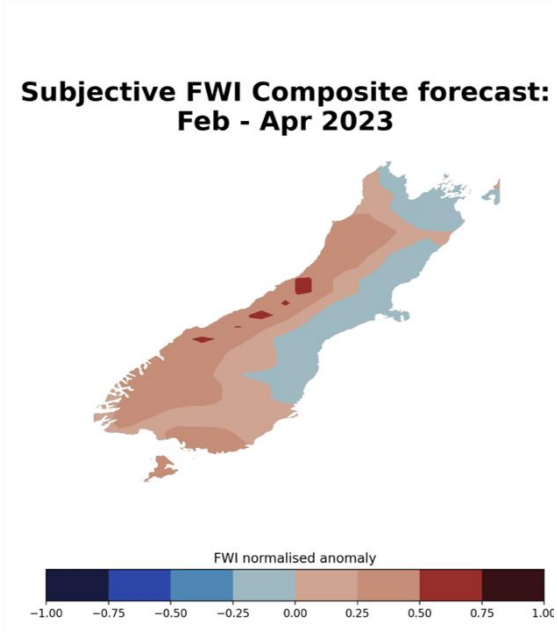
Figure 3: Maps showing the current soil moisture anomaly, as well as temperature and rainfall differences from normal since the start of the month.

Fire season analogues

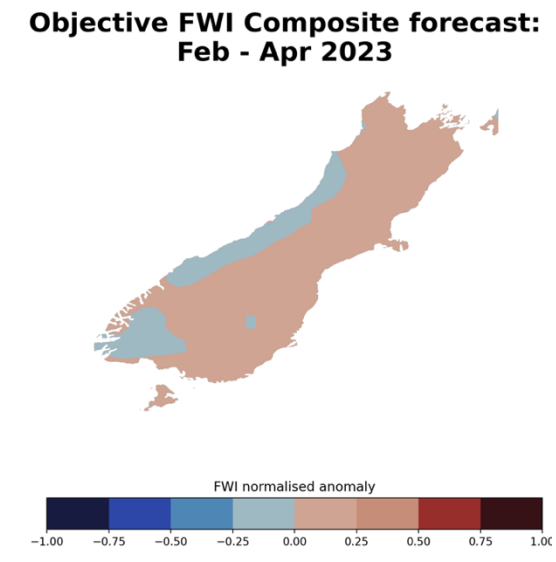
To help understand what fire weather conditions may be like this summer, we can look at analogues. Analogues are historical years with similar climatic conditions to the current year.

This season's analogue years featured historical years that had La Niña-like patterns in the ocean and/or atmosphere (Figure 4). The last two seasons (2020-21 and 2021-22) were both La Niñas. 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 favours the expert-selected years for late summer and early autumn 2023. Western and southern regions are expected to have higher fire danger than normal as the season progresses. The subjective expert-selected guidance agrees more with La Niña-like patterns and is therefore strongly favoured.



Forecaster-selected analogue season - Feb to Apr
2022
2011
2008
1994
1989
2013
2000
1996



Machine-selected analogue season - Feb to Apr
2007
1989
2000
2014
2001
2019
2004
2006

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: February 2023

February's air flows are generally expected to be more easterly than normal, continuing the trend of recent months. The signal is for a wetter than normal lean for the top of the South Island, but dry conditions are favoured in the south and west. The risk for ex-tropical cyclones looks reduced until at least late February. Wind speeds are expected to be below normal for February. Above average temperatures appear likely, especially in the south and west. Relative humidity is forecast to be higher than normal in northeastern areas and below normal in western and southern areas (Figure 5).

Climate outlook: February – April 2023

Guidance suggests that Feb-Apr will exhibit more easterly winds than usual, although La Niña is expected to transition to ENSO-neutral later in the period, which may increase variability in air flows. Temperatures overall look to be warmer than average, especially in southwestern regions (Figure 6). Rainfall looks to be near normal or above normal in the northeast, but likely below normal in the west and south. Above normal relative humidity is possible in the east, but it is expected to be below normal in western and southern regions. Wind speeds continue to look lower than normal for most of the South Island.

The tropical cyclone season for the Southern Hemisphere runs through April. This season the risk is considered near normal to elevated. Tropical cyclone activity may increase from late February into March.

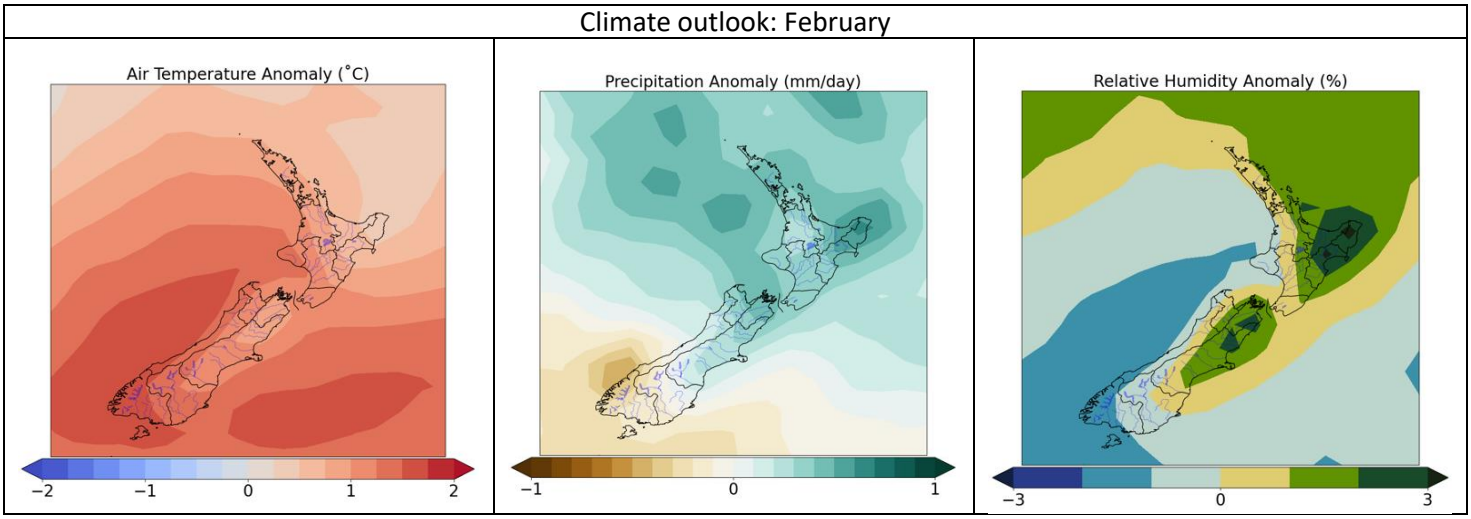


Figure 5: Climate outlook for February showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

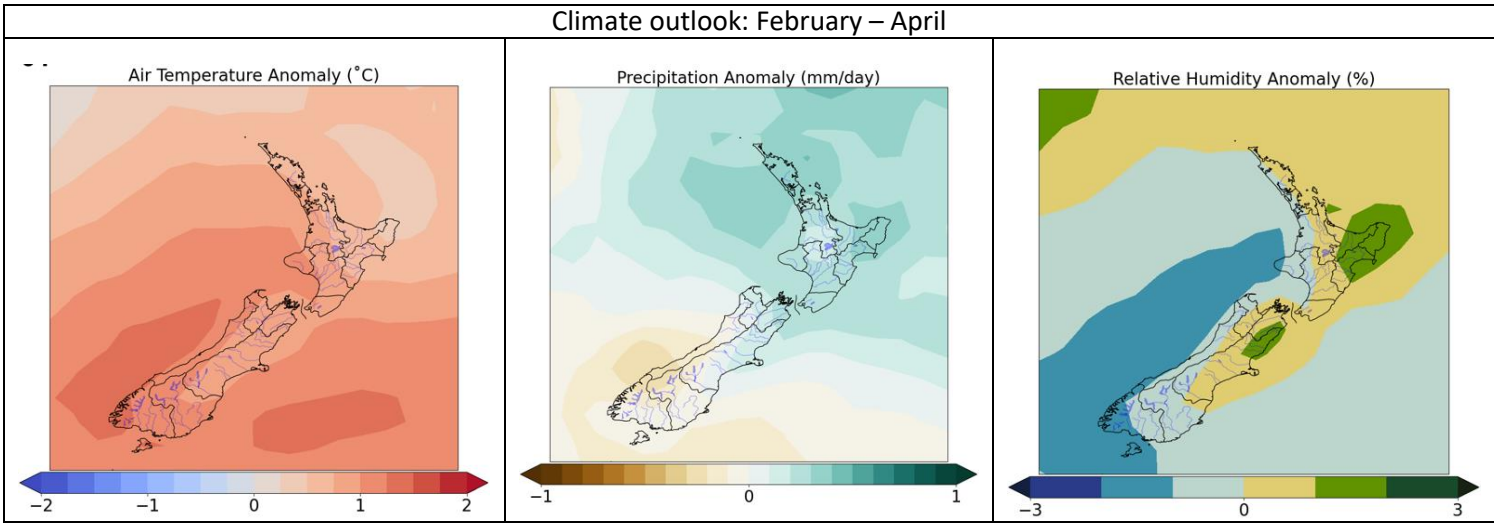


Figure 6: Climate outlook for February-April showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

Expected impact on fuels and fire danger

Looking to February and beyond, the availability of medium, heavy and subsurface fuels is likely to continue to be above normal for parts of Southland and the West Coast, and below normal for north eastern parts of the South Island with normal in other areas. The moisture of these medium and heavy fuels has a fairly small impact on fire spread rates, but as they dry the fuel availability increases resulting in greater fire intensity and making suppression more difficult. The drying of these fuels is dependent on temperature, precipitation and to some degree humidity.

Fine fuel moisture is critically important to fire behaviour, with lower moistures resulting in easier ignitions and faster spread, with wind speeds also contributing to spread rates. Fine fuel moistures are affected by temperature, wind, humidity and precipitation. Based on the outlook above, it is anticipated that fine fuel moistures will be lower than normal in the South West and higher than normal in the North East. Most notably, the spikes in fire danger in eastern parts due to the fohn wind creating drier fine fuels will be less frequent than normal, but will still occasionally occur. In the opposite direction to normal, the fohn effect of more frequent easterlies will however cause drier fine fuels on the west coast more often this summer.

Anticipated lower wind speeds are likely to see less frequent wind-driven fires and generally reduced spread rates, although the reduction may be offset by drier than normal fine fuels in the west and south of the South Island as described above.

The net effect of the climatic outlook is that Western and Southern parts of the South Island are likely to have higher than normal fire dangers, while the North Eastern parts experiencing increased easterly wind flows are expected to receive more humidity and precipitation and have slightly below normal fire danger.

There will however still be periods when the westerly flows return and, especially if they are strong and not accompanied by precipitation, they are likely to result in spikes in the fire danger (especially grass fire danger) in the east. It should also be noted that although eastern parts are not expected to have higher than normal fire danger, their usual summer fire dangers are still relatively high.

Grass growth & curing

Most fires start in fine fuels such as grass, which ignite easily and promote fire 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 South Island has experienced normal to good growing conditions over the past few months, with a relatively warm winter and abundant spring and early summer rainfall. Parts of Canterbury and the North East of the South Island have had particularly good grass growth which has resulted in higher than normal fuel loads. As a result, we can expect increased grass fuel loads in many areas, especially where grazing has not kept up with grass growth.

Curing for most grass species occurs as a natural process with summer drying and seed set, the timing of which will vary between regions and seasons. We are now seeing these grass fuels rapidly dyeing off and dry out in many areas.

If grasses are less than 50% cured (i.e. less than 50% brown or dead material), grass fuels will generally only burn in exceptional conditions (low humidity and high winds). But subject to weather and topography influences, grass fire ease of ignition, spread rates and fire intensity will increase steadily as the curing percentage increases. At 50% cured, grasslands produce slow-moving fires with small flames; but at 80-100% cured, grassfires are able to ignite easily, spread rapidly and produce extreme flame lengths and intensities.

FENZ staff accurately measuring grass curing in tussock to validate assessments from Satellite imagery

Grass curing is so important to fire danger and fire behaviour. FENZ currently has a project that will trial the use of satellite imagery to assess grass curing. If successful, not only will grass curing be updated automatically in the Fire Weather System but it will show the variation in curing across the landscape and research shows that it can be more accurate than current visual assessments in many situations.

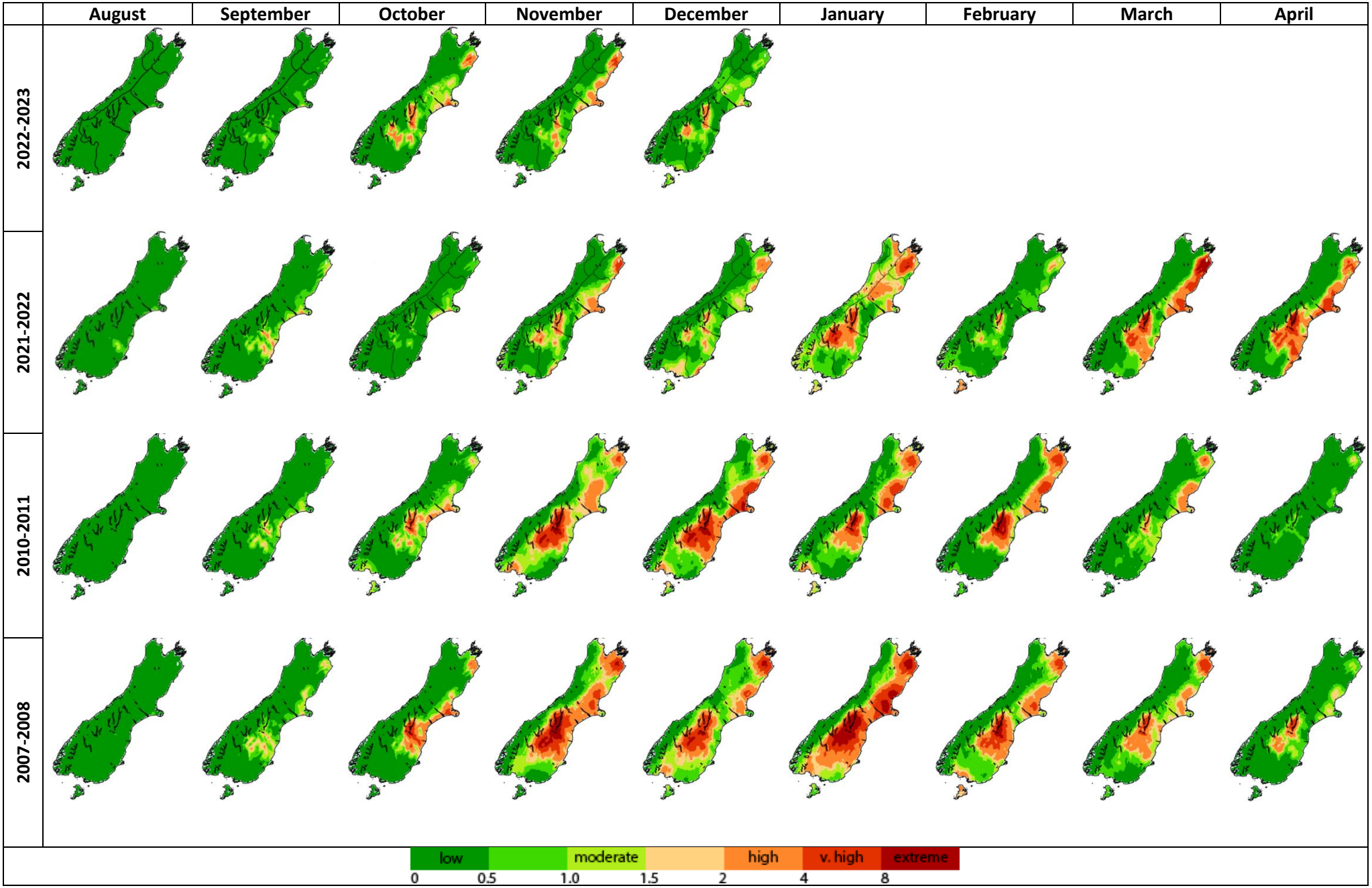


Figure 7: Monthly average severity rating for 2022-2023 up to and including December and the comparative years of 2021/2022, 2010/2011, and 2007/2008. These are analogue years for the current season and give us an insight into what the upcoming season may be like.

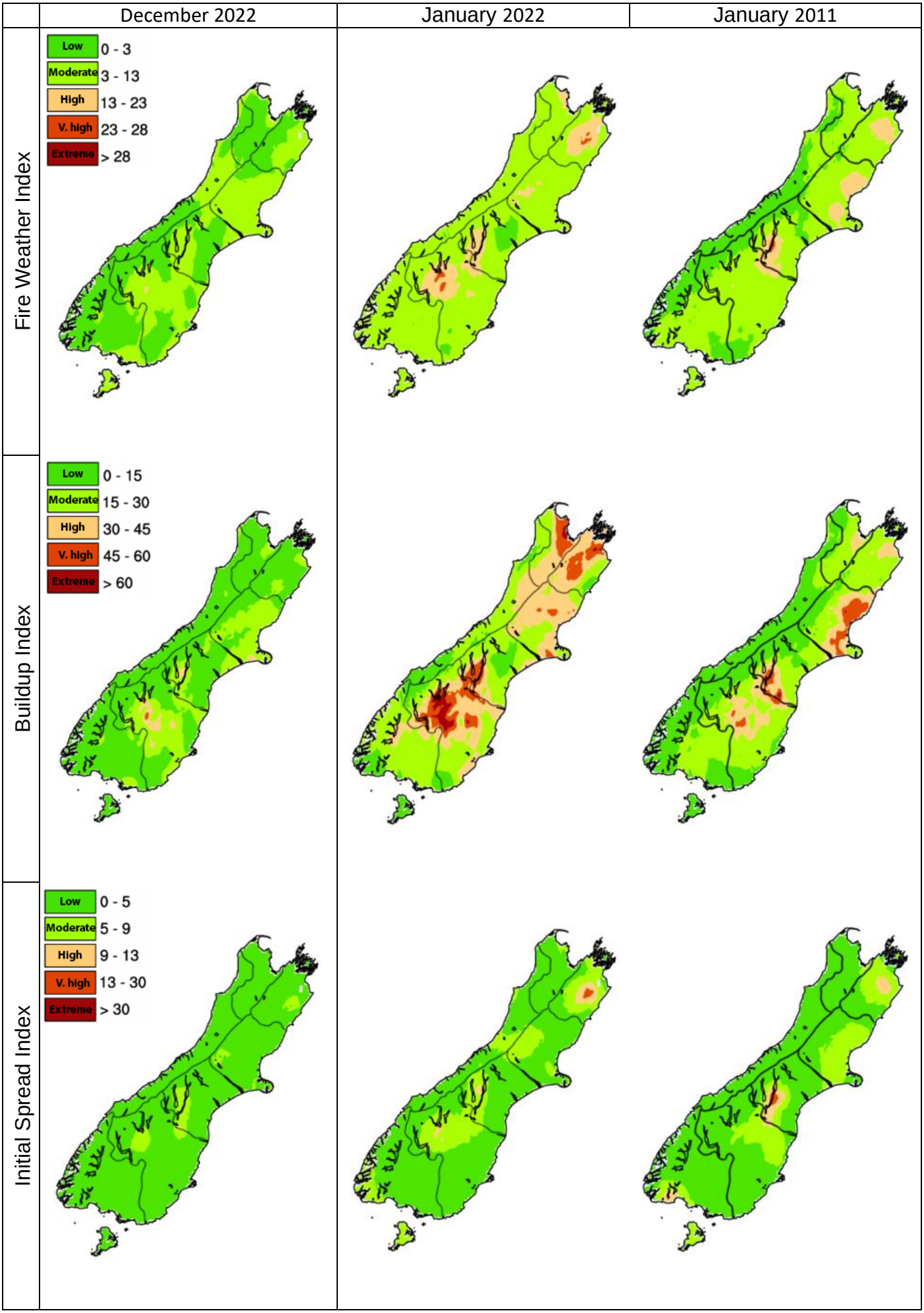


Figure 8: The most recent observed month (left column) and analogue months for January (middle and right columns); monthly average for the Fire Weather Index (top), Buildup Index (middle) and Initial Spread Index (bottom).

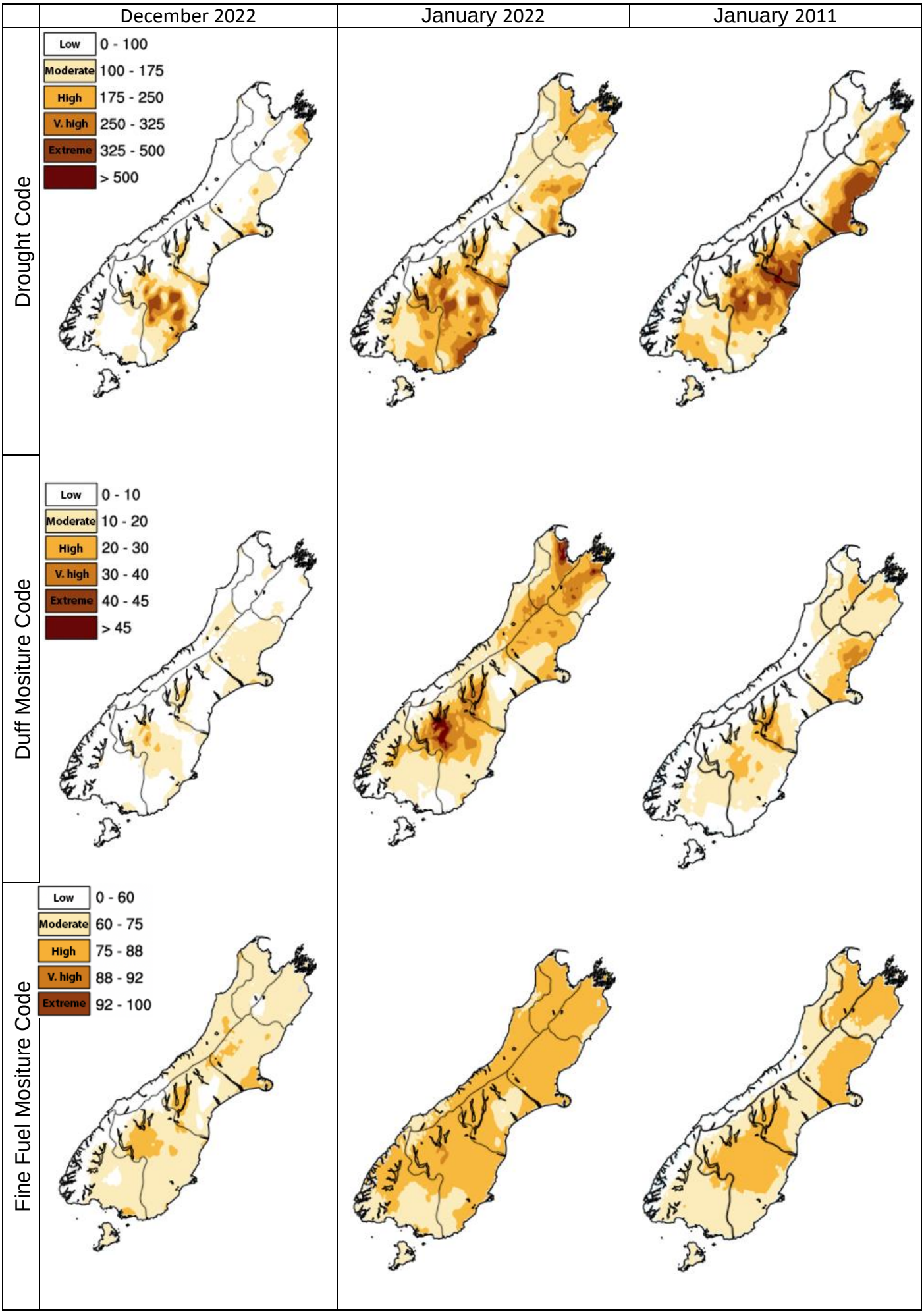


Figure 9: The most recent observed month (left column) and analogue months for January (middle and right columns); monthly average for the Drought Code (top), Duff Moisture Code (middle) and Fine Fuel Moisture Code (bottom).

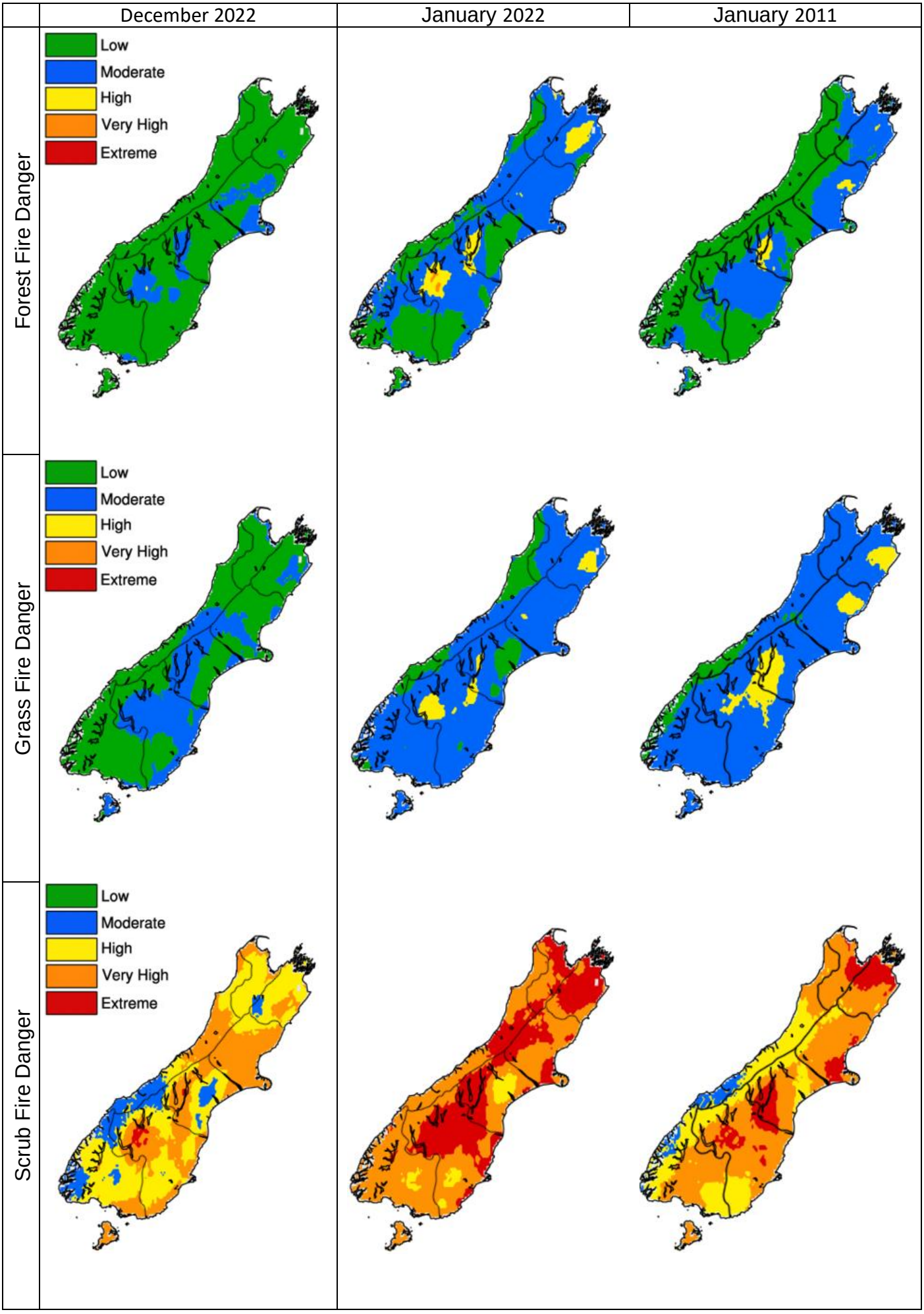


Figure 10: The most recent observed month (left column) and analogue months for January (middle and right columns); monthly average for the Forest Fire Danger (top), Grass Fire Danger (middle) and Scrub Fire Danger (bottom).

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