South Island Monthly Fire Danger Outlook (2020/21 Season)

ISSUE: January 2021

Current fire danger situation

In general, monthly fire dangers and fire climate severity are Low to Moderate across much of the West Coast and Southland regions (Figures 4, 5 & 9). In contrast, High to Very High conditions exist in the Marlborough, Canterbury and Otago regions.

Fuel and soil moisture status

This is reflected in the current FWI System codes and indices (FFMC, DMC, DC, and BUI). These codes indicate the ease of ignition, the amount of fuel available for combustion, and how deep-seated and prolonged mop-up could be. Fuel dryness across the South Island typically peaks either in January or February.

This summer, Low to Moderate monthly fuel moisture codes currently exist across much of the island (Figure 7). The exceptions being High to Extreme levels observed in parts of Marlborough, Canterbury and Otago. Rainfall (or lack of) has affected heavy and medium-sized fuels. Regions with BUI and DC values generally below the historical trend for this time of the year include: Otago and Southland. Those that have stations either on trend or below include: Nelson/Tasman, Marlborough, West Coast, Mid-South Canterbury. Remaining regions (Canterbury) have a mixture of locations with above and below averages. Graphs tracking individual station trends are available on the Scion website.

Soil moisture levels along the West Coast (Tasman to Fiordland) are at or near capacity, which is about normal for this time of the year (Figures 2 & 3). In contrast, soils are dry and below 50% storage for parts of Nelson, Marlborough, Canterbury (north and south) and Otago (Queenstown Lakes and Clutha), which are also about normal for this time of the year. It has been wetter than normal for Otago and Stewart Island.

Forecast climate and weather

La Niña conditions remain in the tropical Pacific but has likely reached its peak strength. Models indicate the strength of this La Niña event is likely to ease over the remainder of summer and return to Neutral conditions by autumn.

The climate outlook over the next three months (January – March 2021) suggests north-easterly wind flows will dominate as higher than normal air pressure is situated to the south-east of New Zealand and lower pressure to the north-west. Warmer than average sea temperatures are expected and will support warmer than average land air temperatures for all regions. However, there will be the occasional cool snap.

Extended dry spells will be interspersed with unsettled weather, driven by current non-traditional La Niña conditions and a positive Southern Annular Mode (see Expected Climate Outlook overleaf). Sub-tropical air flows may bring heavy rainfall that can cause flooding, like what was experienced in parts of the country during late December and early January. Rainfall is forecast to be near normal or below normal for the West Coast, and near normal or above normal for remaining regions. Soil moisture and river flow levels are expected to be below normal or near normal for the West Coast, and near normal for remaining locations.

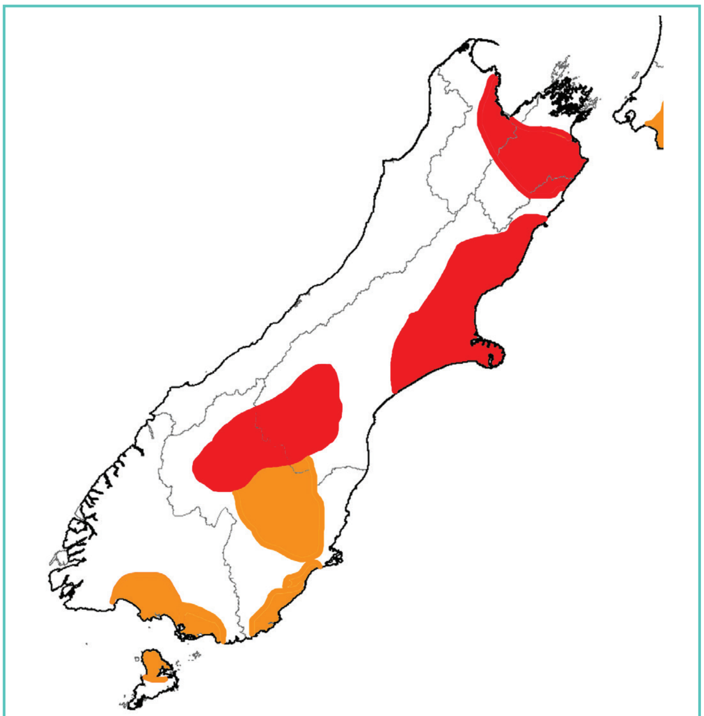
For the month of January, a wet start to the year will be followed by high pressure generally dominating the weather and resulting in more warmer and drier conditions overall. Coastal sea surface temperatures are forecast to increase along with air temperatures and higher humidity. With non-traditional moderate La Niña conditions more likely to continue, north-eastern locations are likely to experience further dryness. Near the second half of the month, large highs may form either side of New Zealand and will help encourage a few wetter and colder southerly days over the country.

Locations to watch

As we head into typically warmer and drier times of the year, vegetation and soil moisture levels over the coming months will be affected by forecasted warm weather and low rainfall. Consequently, this will elevate the fire risk and contribute to deeper burning and faster moving fires. During La Niña seasons, fire dangers and severity typically peak in January or February for the South Island.

The fire seasons coinciding with moderate strength La Niña conditions occurred in 2010/11, 2007/08, 1999/00, and 1998/99 and are potentially good indicators for what to expect this coming fire season (Figure 11). However, this fire season has not followed a traditional La Niña weather pattern. The South Island is currently tracking more like the 1998/99 and 2010/11 seasons that were moderate La Niña events.

Areas to keep an eye on for High to Extreme fire dangers during January and February are those that are more likely to experience a combination of warmer air temperatures, a lack of rainfall, and continued soil moisture deficits. These regions include: Nelson, Marlborough, Canterbury (North, Central and the southern lakes), Otago (Queenstown Lakes and Central) and parts of Southland (Tuatapere & Stewart Island). However, if January continues to experience substantial rainfall events (much like in December), this will improve soil and fuel moistures and consequently reduce the potential for wildfire outbreaks in highlighted regions.



Map 1. Locations identified as specific areas of interest that have or may develop an elevated risk of high fire danger over the next three months.

Background

The purpose of these monthly outlooks is to provide a heads up on current and potential fire danger as we transition from spring to summer and, later, into autumn. This is not a detailed fire seasonal outlook for specific localities, nor does it summarise fire potential (which depends on fuel conditions (i.e. grass curing), risks of ignitions, recent fire history and fire management resources available in an area, as well as weather and climate).

It aims to forewarn fire agencies of current and potential fire danger conditions that can be used as a prompt for local and regional discussions on fire potential. Continue your pre-planning (if you haven't done so already), by discussing where conditions are at, where they are heading, and how this can drive awareness about what this might mean for fire risk in your patch and for your neighbours.

EXPECTED CLIMATE OUTLOOK:

One of the major climate drivers for New Zealand is the El Niño–Southern Oscillation (ENSO). The ENSO outlook remains at La Niña conditions. Current model projections indicate that this event has reached its peak strength (in terms of seas surface temperatures), with a gradual easing towards neutral values. International models are forecasting La Niña to continue over the next three months (92% during January – March). ENSO neutral conditions are favoured during autumn (66% during April – June) and winter (52% during July – September). Despite this weakening pattern, La Niña is still likely to influence our climate for the remainder of summer.

To date, a non-traditional central Pacific-based La Niña event has occurred (sitting more westward as opposed to the traditional east-based event). This is a result of unusually cool Sea Surface Temperatures (SSTs) in the central Pacific. This non-traditional La Niña has produced uncharacteristically dry conditions across the upper North Island (Northland, Auckland and northern Waikato). However, the cooling has recently intensified deeper below the surface in the central Pacific Ocean, which is an indication of a shift towards more typical La Niña conditions.

In January, convective forces are expected to sit over the Indian Ocean, west of where a typical La Niña sits. This will result in high pressure systems sitting over New Zealand, mixed with brief unsettled periods. Over the next three months, convective activity could drift eastward, which is more typical of La Niña events. This will result in a much wetter North Island. Current sea surface temperatures around New Zealand and in the Tasman Sea were cool last month. The outlook is for warming of surrounding coastal waters during January. These abnormally warm ocean temperatures will likely impact land air temperatures and can fuel cyclones approaching from the north of the country.

To help understand what the fire season could look like during the next three months, recent past events (historical analogues) reminiscent of a moderate La Niña included 1998/99, 1999/00, 2007/08 and 2010/11. Weak La Niña seasons included 2000/01 and 2011/12. However, each historical La Niña event has resulted in different weather patterns for New Zealand. Our weather is very dependent on where the high-pressure systems sit (which determines the air flow over New Zealand).

Tropical Cyclone outlook

To date, two Tropical cyclones have developed in the south west Pacific (Yasa and Zazu). The risk for New Zealand to be affected by an ex-tropical cyclone this season remains elevated. The risk is considered above normal, with equal probabilities of an ex-tropical cyclone passing either to the east or west of the North Island. Significant rainfall, damaging winds, and coastal damage by waves are possible in the lead up to and during these events. These cyclone events can reduce the fire risk in affected areas, with effects often being spread over a large area, especially if a decaying storm system interacts with other existing weather systems. Past years like this current season suggest that at least 3 cyclones could reach category 3 strength (considered severe, with 118 km/h winds).

This month: January 2021

Following a wet start to the year, high pressure is expected to bring with it warm settled weather for most of January. High pressure out to the west of New Zealand will bring with it south-westerlies over the country, and cool showery weather. Some locations will receive heavy rainfall, while other areas will miss out entirely. As the system moves eastward, settled weather will prevail. By mid-January, the high is expected to sit over the east of the country and is likely to remain for the rest of the month. Drier than average conditions are likely for much of the South Island.

Further ahead:

Over the next three months (January – March 2021), patterns of higher than normal air pressure are expected over and to the south-east of New Zealand, and occasionally lower than normal pressures to the north-west. North-easterly quarter winds are expected as a result. There is an expectation for warmer than average sea temperatures that will support warmer than normal land air temperatures. Sub-tropical air flows are also expected that could bring with them heavy rainfall and flooding to parts of the country (like that experienced during December and early January). It's difficult to pinpoint which regions will experience these significant rainfall events in advance.

Extended dry spells will be interspersed with unsettled weather, as a by-product of the current non-traditional La Niña event and a positive Southern Annular Mode.

Coastal sea surface temperatures are expected to increase during January. Land air temperatures are forecast to be above average for all regions, with elevated humidity levels at times. This does not exclude the occasional cool snap. Warmer than average temperatures and drier than normal conditions are expected along the West Coast and for the hydro lakes (around South Canterbury and Queenstown).

Near normal or below normal rainfall is expected for the west of the South Island and near normal or above normal for remaining regions. Soil moisture and river flow levels are likely to be below normal in the west of the South Island and most likely to near normal for the remaining regions of the country.

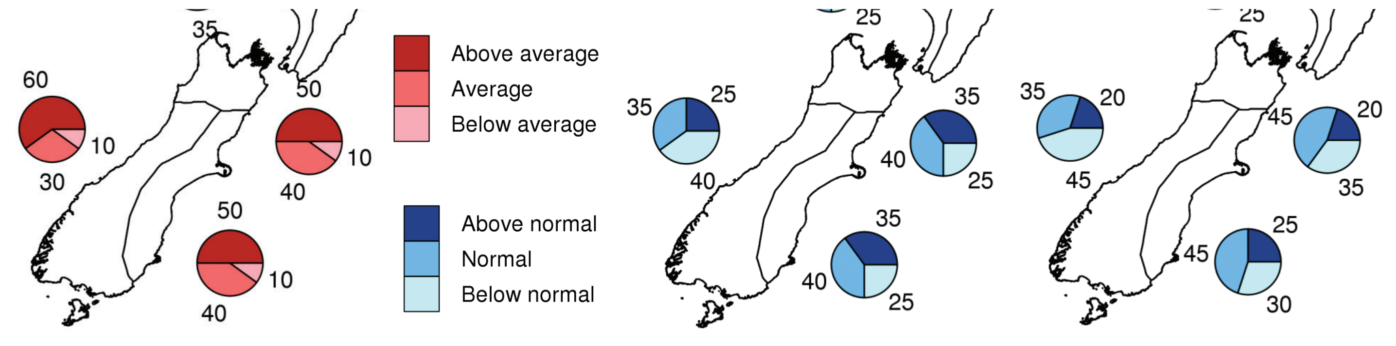


Figure 1. Outlook for January to March 2021: air temperature (left), rainfall (middle), available soil moisture (right). Source: NIWA.

Regional breakdown (Figure 1):
Temperatures are most likely to be:
- above average (50% chance) for Tasman, Nelson, Marlborough, Buller, coastal Canterbury and eastern Otago;
- above average (60% chance) for West Coast, Alps and foothills, inland Otago, and Southland.

Rainfall totals are most likely to be:
- near normal (40% chance) or above normal (35%) for Tasman, Nelson, Marlborough, Buller, coastal Canterbury and east Otago;
- below normal (40%) or near normal (35%) for the West Coast, Alps and foothills, inland Otago and Southland.

Soil moisture levels are most likely to be:
- near normal (45-50% chance) for Tasman, Nelson, Marlborough and Buller, coastal Canterbury and east Otago;
- below normal (40%) soil moistures and below normal to near normal river flows (45 - 40% respectively) for the West Coast, Alps and foothills, inland Otago and Southland.

Last month: December 2020

During the first half of December, high pressure sat in the Tasman Sea, resulting in warm dry conditions. Temperatures were well above average for eastern areas. This was interrupted with south-westerly air flows over the country, bringing cooler air masses from the Southern Ocean. This eased sea surface temperatures in surrounding coastal waters and prevented forecasted marine heatwave conditions from occurring. Cool wet weather also brought summer snow to parts of the South Island. The weather was also unsettled near the end of the calendar year, with thunderstorms, hail and heavy rain for many locations in the South.

Soil moisture (Figure 2 & 3)

Western and southern locations have experienced moderate to heavy rainfall during the early new year, resulting in significant soil moisture increases occurring for these areas. In contrast, the upper South Island received substantially less rainfall, resulting in only minor soil moisture gains.

This is somewhat reflected in the soil moisture deficit map (Figure 2), where eastern locations are still experiencing dry soils. This includes Marlborough, Canterbury (northern and southern), Queenstown Lakes district, and south-east Southland (between Tuatapere and Dunedin). In contrast, soil moisture levels are at or nearing water surplus along the West Coast (Grey district and Fiordland).

Soil moistures are about normal for many locations of the South Island for this time of the year (Figure 3). The exceptions being small pockets of slightly drier than normal soils found in Marlborough, Buller district, North Canterbury and south-east Southland. In contrast, wetter than normal soils are present in Otago (central and coastal) and Stewart Island.

NIWA's Drought Index (NZDI) indicates small pockets of dryness along the east coast (coastal Marlborough, Kaikoura and North Canterbury), Queenstown Lakes district (Otago), and Invercargill. There are currently no South Island locations in meteorological drought.

Fine Fuel Status:

Although BUIs may seem below levels considered extreme, fine fuels under forest canopies or scrublands, and grass pastures (as they brown off), can still contribute to fast fire spread and large fire sizes, even under moderate soil moisture dryness and wind strengths.

If a heat source is present in fine fuels with a FFMC of 86 or more, or grass curing over 80%, ignition will be easy, and a fire can still spread. Don't be surprised to observe incredible rates of spread and flame lengths, even with shorter grass. Light, flashy fuels are one of the common denominators of tragedy fires.

Grass growth & curing:

Depending on where you are in the country, grass curing could be patchy over a series of paddocks/area, especially during the 40-80% curing period, or more continuous in the dry bleaching phase of 70-100% curing.

Places that are experiencing a lack of rainfall or droughts will witness grasses develop into that typical golden brown or straw colour. Cured grass at this stage heightens the potential for a fire to ignite and spread in these fuels. The risk of grass fires starting and spreading in these areas is amplified further by high temperatures, low humidity and strong winds. For areas experiencing or nearing high curing values (above 80%), wildfires can produce large to very tall flame heights (2 m+), spread very quickly, be very intense and much more difficult to suppress.

However, climatic conditions for many locations this summer (mild temperatures and high soil moistures) have supported abundant

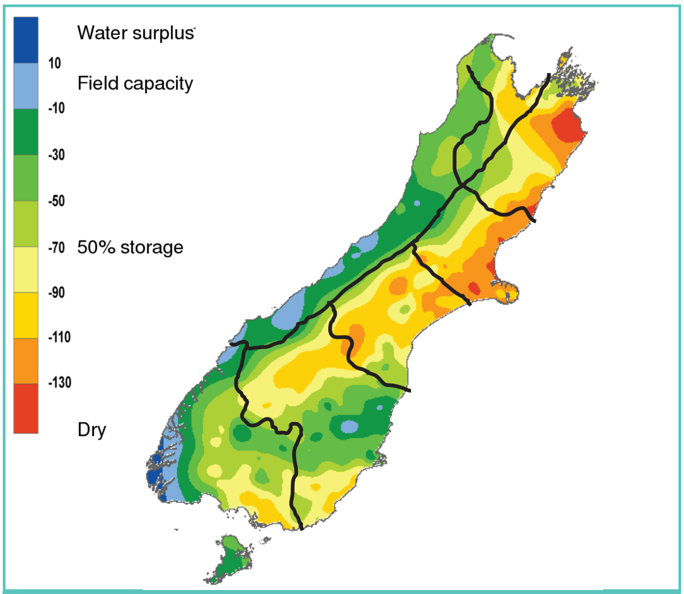


Figure 2. Soil moisture deficits as of 12/01/2021. Source: NIWA.

Note: Soil moisture deficit means the amount of water needed to bring the soil moisture content back to field capacity, which is the maximum amount of water the soil can hold.

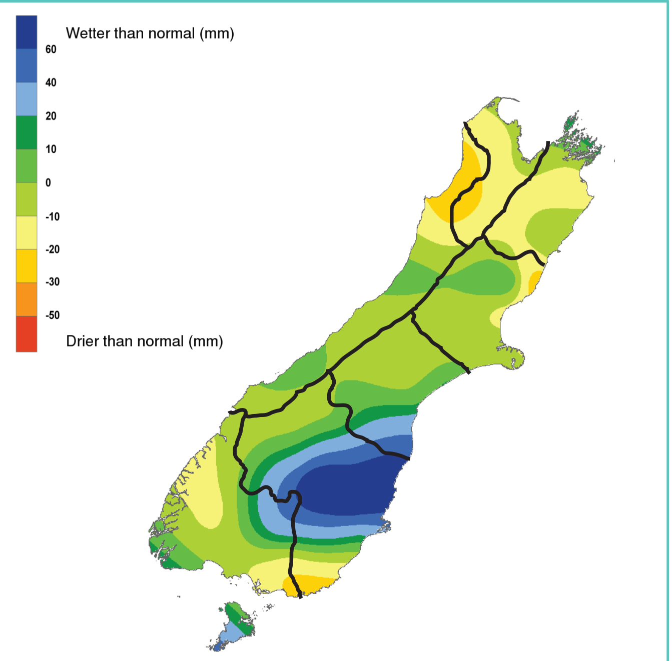


Figure 3. Soil moisture anomaly as of 12/01/2021. Source: NIWA.

Note: Soil moisture anomaly means the difference between the historical normal soil moisture deficit (or surplus) for a given time of year and actual soil moisture deficits.

grass growth and continued green landscapes. Heavy and prolonged rains can delay the maturing process of grasslands until the onset of hot dry weather conditions, when curing will proceed rapidly. Rainfall before 60% curing will prolong grass life and slow the curing process. While rainfall after 60% will not delay the curing of mature grass. If a fire was to start in these fuels, fire spread would be difficult. Any burning will produce small flame heights and low intensities for easy suppression.

Areas with green landscapes and abundant growth will become more of a concern once prolonged warm dry conditions trigger the maturing process of grasses. Higher than normal grass fuel loads could contribute to increased fire intensities and faster rates of spread during the peak of summer. Some landscapes may already be a mixture of green and brown as grasses begin the curing phase (40-80% curing range). Any grass fires will be able to spread more easily in these locations.

The finer details:

The degree of grassland curing represents the proportion of dead material in a grassland fuel complex, expressed as a percentage. It is an important input for models to predict rate of fire spread and determine fire danger levels in grasslands.

Grassland curing will affect fire behaviour in several ways: it increases the amount of dead material present and affects fuel moisture content. The result is an increased chance of fire ignition, fire intensity and rates of spread. The moisture content of fine grass fuels (as well as pine litter and other fine fuels) also dramatically affects the ignition potential and ability of a wildfire to spread. High amounts of moisture increase the heat and thermal conductivity of fuel, so that more heat is required for the fuel to reach its ignition temperature. As grasses cure, and become drier, less heat is required to ignite and sustain a fire.

In partially cured grasslands, enough dead fuel needs to be present to ignite and sustain fire spread. Surrounding green grass with higher fuel moisture contents will require substantial heat input to burn off excess moisture and ignite. If there is not enough heat to ignite the greener sections of the grass, fire spread will either be very patchy or not spread at all. Burning under these conditions will produce very small flame heights, be low intensity and easily suppressible.

In some areas, the presence of dead matted material from the previous season's growth (thatch) can contribute to the ease of a fire starting and spreading. The material is often hidden underneath lush green grass that appears to have low curing (30 - 50%). However, thatch can increase a fires ability to carry and sustain a fire. These fires will typically produce small flame heights and spread in a patchy manner. It is often necessary to part the current season's grass to examine how much thatch is underneath. Even if a paddock has been harvested or grazed, there is often a couple centimetres of dead grass remaining.

What does La Niña mean for NZ?

New Zealand's climate is influenced by two key natural cycles: the El Niño-Southern Oscillation (ENSO) and the Interdecadal Pacific Oscillation (IPO). Both these operate over the Pacific Ocean and beyond, and cause fluctuations in the prevailing trade winds and in the strength of the subtropical high-pressure belt.

El Niño and La Niña are opposite phases of the global ENSO climate cycle. The two phases disrupt the typical wind and rainfall patterns for New Zealand. Neutral conditions encourage far more variability in weather patterns for New Zealand, whereas El Niño or La Niña tend to have more predictable patterns.

It's important to note that ENSO events have an important influence on New Zealand's climate, but account for less than 25% of seasonal rainfall and temperatures. La Niña is only an important climate driver for New Zealand over long durations (2-6 months) when a moderate or strong event is in force. If a weak La Niña occurs, it means our 'local' climate players (the Southern Ocean southerlies and Tasman Sea lows) will continue to take turns ruling our weather.

This is a good reminder that local climate patterns (blocking Highs over or near New Zealand, Lows over the Tasman Sea or to the north of the country, and the Southern Ocean storms) generally 'trump' climate patterns such as El Niño and La Niña

Effects on New Zealand

La Niña can encourage warmer than average sea temperatures, and fuel cyclones. The north can experience frequent lows and subtropical storms, occasionally stretching down as far as Canterbury. New Zealand is typically warmer than average during a La Niña, although there are regional and seasonal exceptions. During La Niña, more high-pressure systems than normal lie over the east of the country (South Island and Chatham Islands). This generally leads to more north-easterly and easterly winds (as opposed to westerlies).

La Niña effects on the South

For the South Island, under La Niña we tend to observe less wind and reduced rainfall in the south and south west in spring. Coastal Marlborough and Canterbury can be cloudier and cooler, with a chance of more rain than in non-La Niña years.

During a La Niña summer, anticyclones are more frequent over southern New Zealand, bringing dry weather and the West Coast, Southland and western parts of Otago tend to dry out. However, areas such as Central Otago and South Canterbury can experience drought in both El Niño and La Niña.

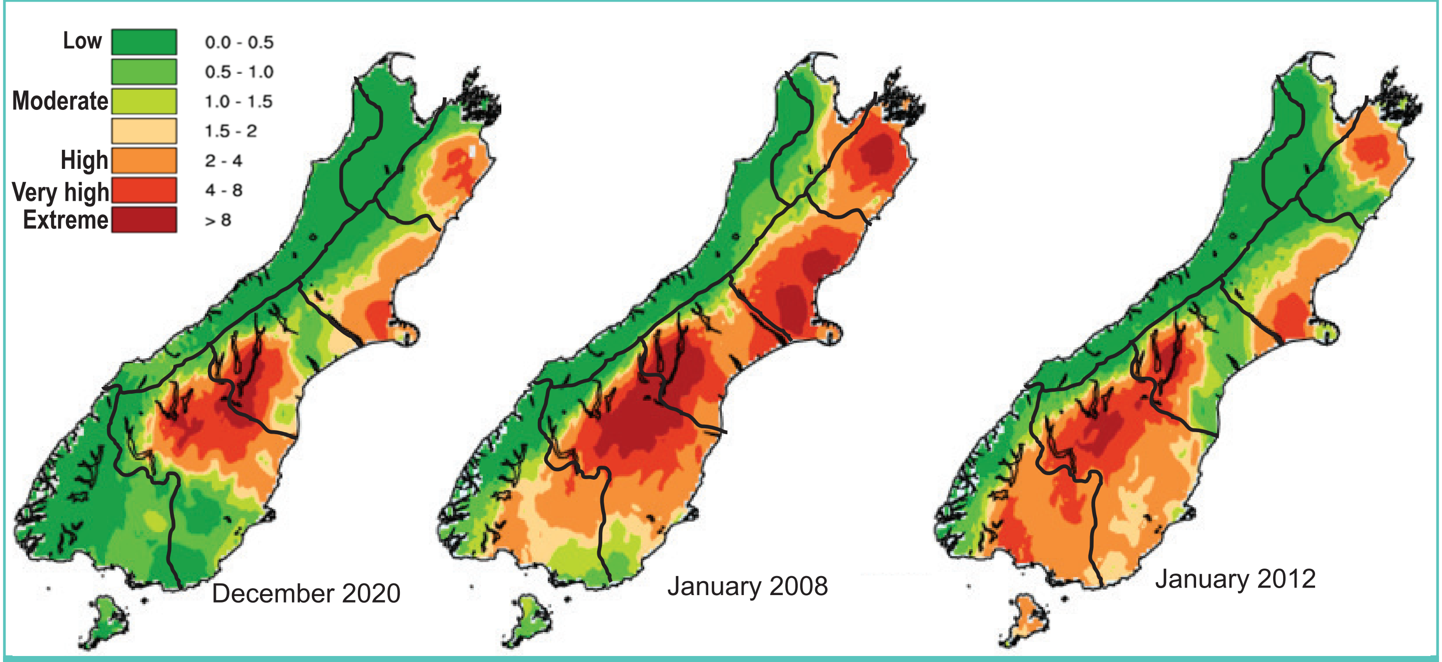


Figure 4. Monthly average Severity Rating for: the previous month (left), and expected average monthly values during the 2007/08 moderate strength La Niña (left) & 2011/12 (right) weak strength La Niña year

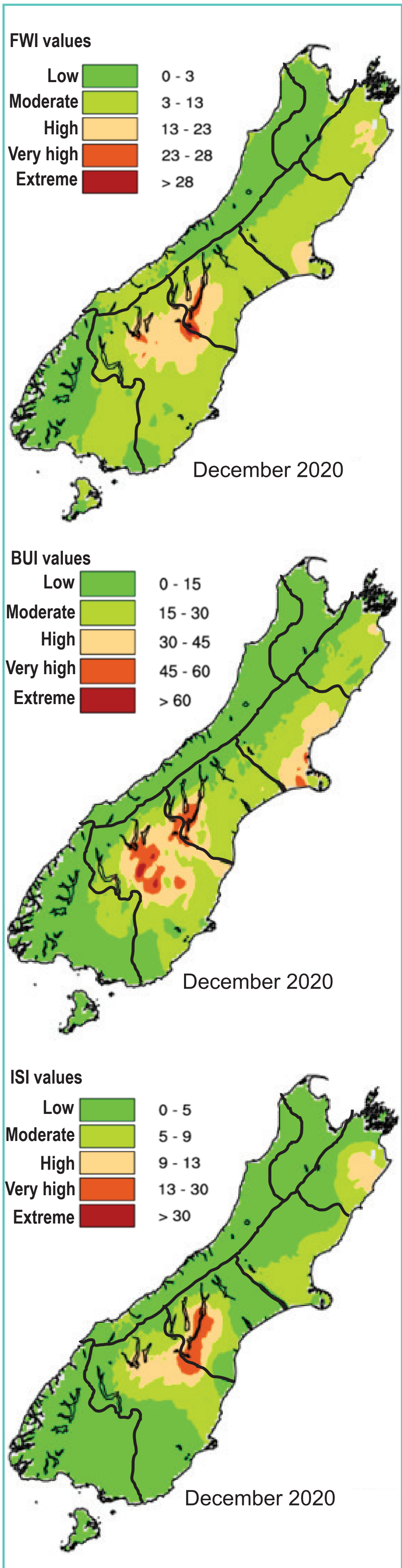


Figure 5. Previous Monthly Average for the: Fire Weather Index (top), Buildup Index (middle) and Initial Spread Index (below).

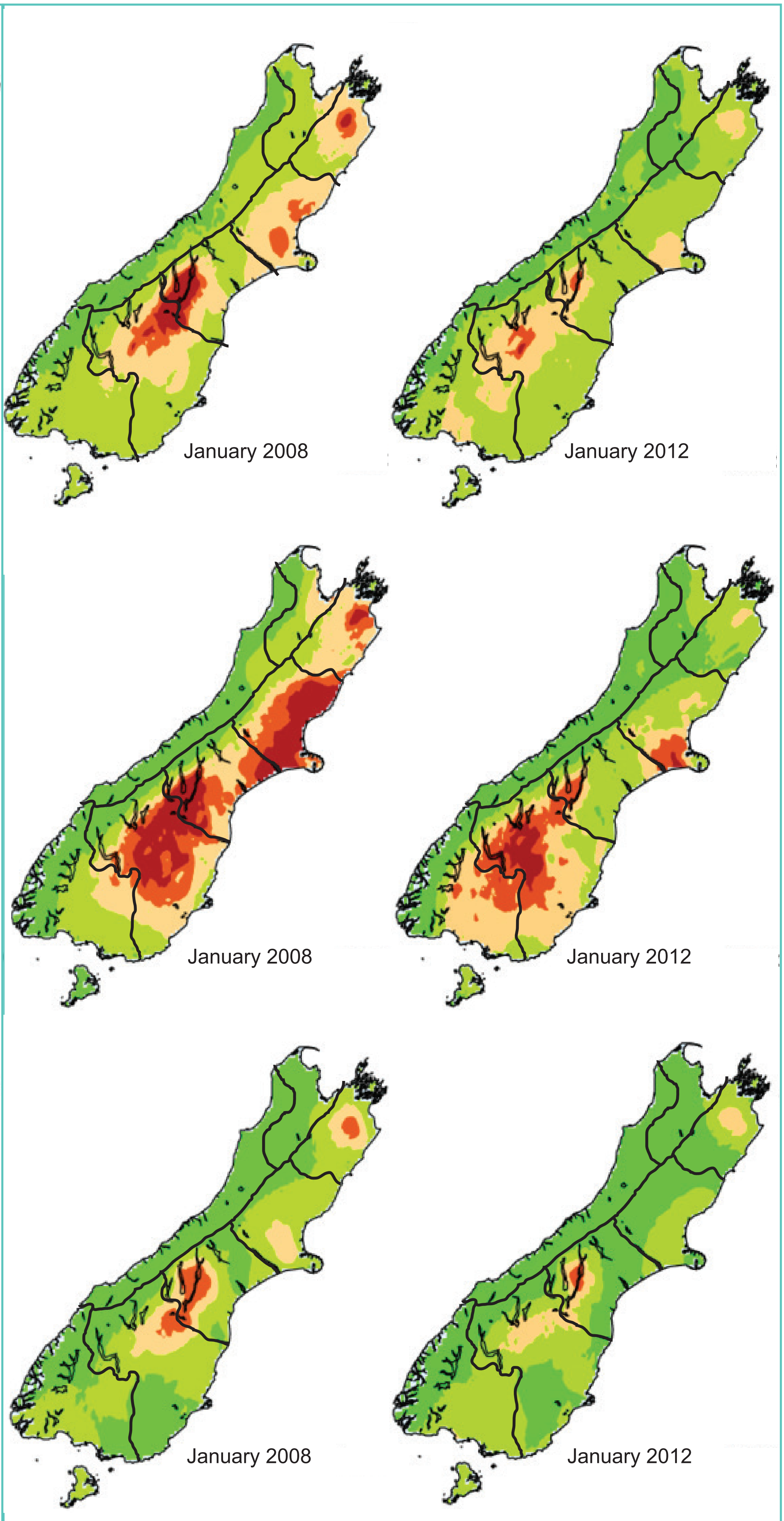


Figure 6. Expected average Monthly values of: Fire Weather Index (top), Buildup Index (middle) and Initial Spread Index (below); and during the 2007/08 moderate strength La Niña (left) & 2011/12 (right) weak strength La Niña year.

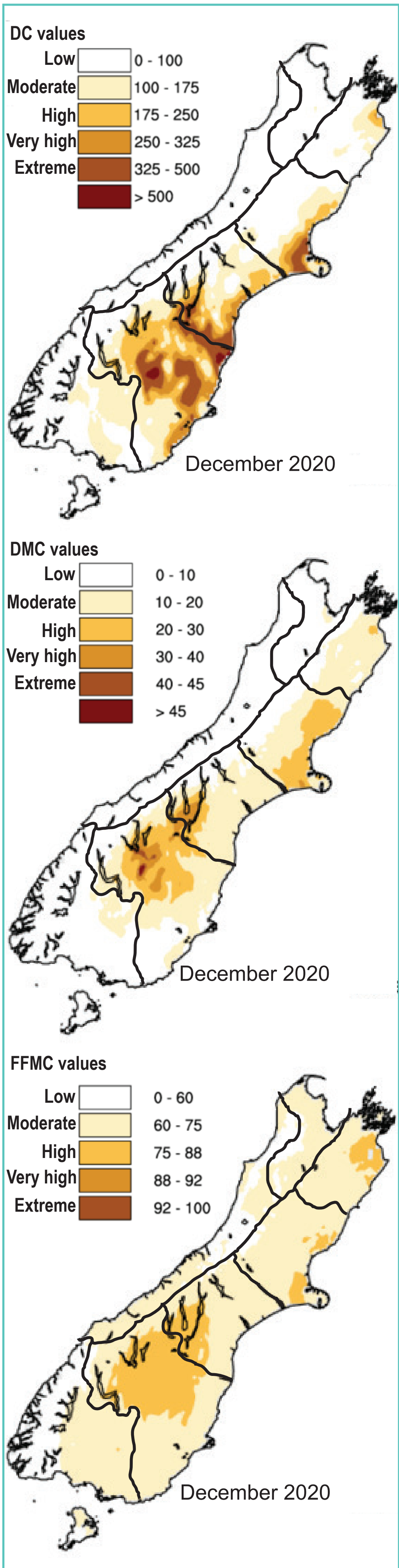


Figure 7. Previous monthly average for the: Drought Code (top), Duff Moisture Code (middle) and the Fine Fuel Moisture Code (below).

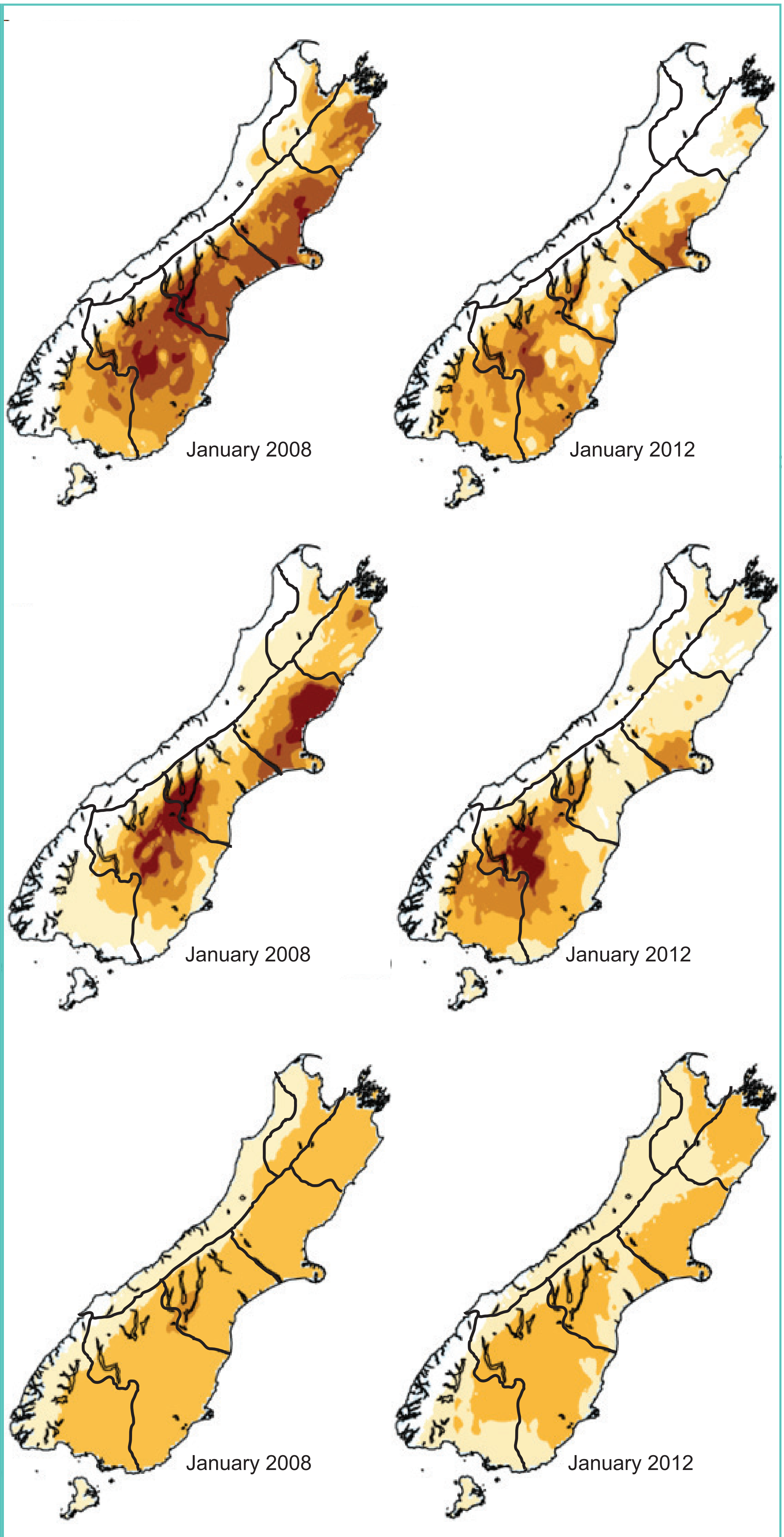


Figure 8. Average monthly values of: Drought Code (top), Duff Moisture Code (middle) and Fine Fuel Moisture Code (below); and during the 2007/08 moderate strength La Niña (left) & 2011/12 (right) weak strength La Niña year.

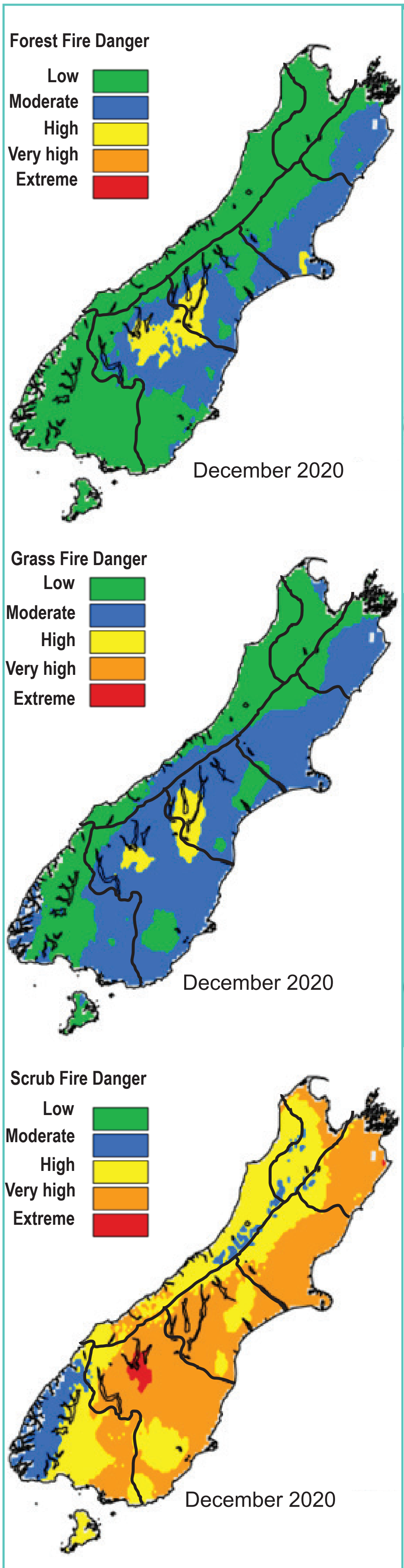


Figure 9. Previous Monthly Average for the: Forest Fire Danger (top), Grassland Fire Danger (middle) and Scrub Fire Danger (below)

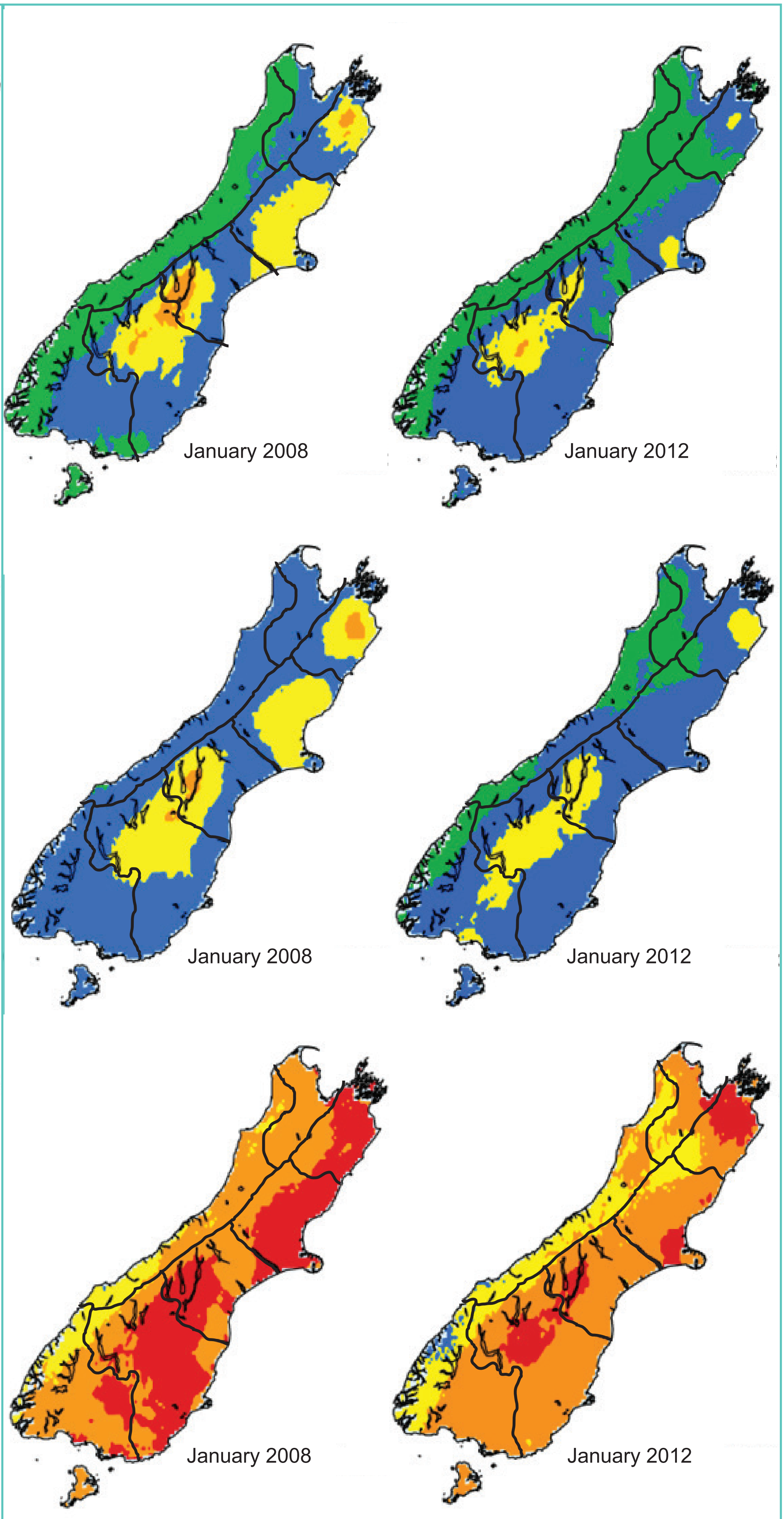


Figure 10. Expected average monthly values of: Forest Fire Danger (top), Grassland Fire Danger (middle) and Scrub Fire Danger (below), during the 2007/08 moderate strength La Niña (left) & 2011/12 (right) weak strength La Niña year.

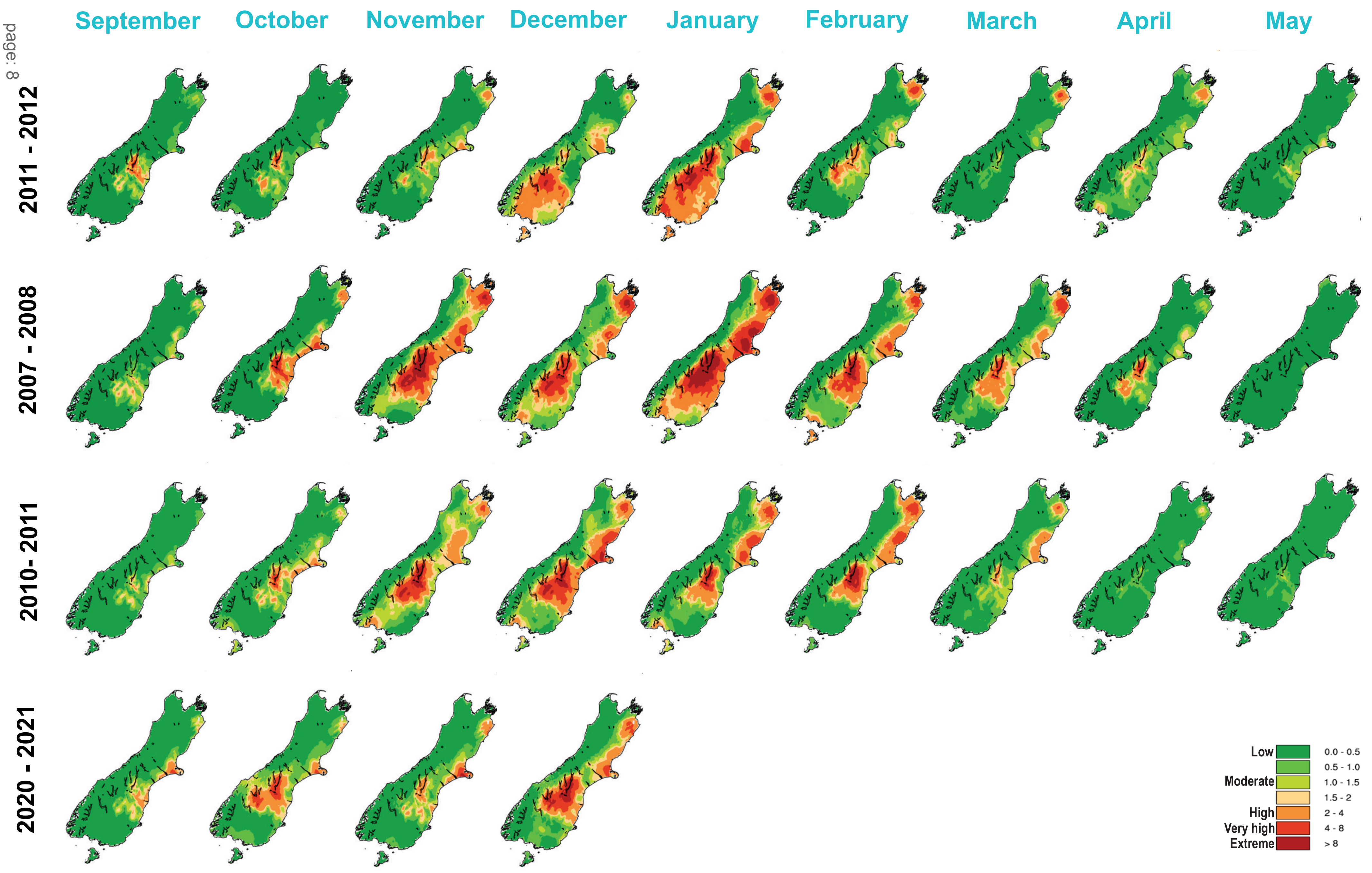


Figure 11. New Zealand Fire Season Severity (monthly)
The years of 2007/08, 2010/11, 1999/00, and 1998/99 and are ideal comparisons for what the North Island might experience over the next few months. These years were moderate strength La Niña years, 2011/12 was a weak La Niña event. DSR values of less than one equates to low fire behaviour potential, 1-3 moderate fire potential, 3-7 high to very high fire potential, and above 7 extreme fire behaviour potential.

Note:

Tracking trends
Comparisons of fire dangers for individual indicator stations for different regions are not shown in this outlook due to the low fire danger and severity across the country. As fire dangers increase, more detailed regional outlooks will recommence highlighting where Buildup Index (BUI), Drought Code (DC) and Cumulative Daily Severity Rating (CDSR) values sit in comparison with previous fire seasons.

For fire managers who are interested in tracking fire season trends for all your weather stations, the graphs are available monthly on the Scion Rural Fire Research website. If tracking is required on a more frequent basis (as opposed to the monthly analysis done here), please contact Scion for the data.

Background info on FWI codes and indicies:

Fine Fuel Moisture Code (FFMC)
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

Duff Moisture Code (DMC) 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 +	Difficult & extensive

Drought Code (DC) 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 +	Difficult & extensive

Buildup Index (BUI)
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

Initial Spread Index (ISI) 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

Fire Weather Index (FWI)
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

Daily Severity Rating (DSR) 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.

Monthly Severity Rating (MSR) 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

Acknowledgements:
Fire Danger interpretation was from information gathered from the Average Monthly Maps for: Severity Rating, FWI, BUI, ISI, DC, DMC, FFMC, Grassland FDC, Scrub FDC & Forest FDC. These maps were obtained from the Fire and Emergency New Zealand's Fire Weather System powered by Eco Connect.

Information on the Expected Climate Outlook was gathered from:
- MetService, Rural Monthly outlooks:
  www.metservice.com/rural/monthly-outlook
- NIWA, Seasonal Climate outlook:
  www.niwa.co.nz/climate/sco
- Australian Bureau of Meteorology Climate outlooks
  http://www.bom.gov.au/climate/ahead/?ref=ftr

Front Cover Image: 2020 Research Burns (V Clifford, Scion).