Impact of Climate Variability on Fire Danger

NIWA Client Report: AKL2007-061
August 2007

NIWA Project: FSS07101

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Prepared for

New Zealand Fire Service Commission

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August 2007

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Executive Summary

New Zealand experiences around 3000 vegetation wildfires each year that burn around 7000 hectares of rural lands. Strong winds, high temperatures, low humidity and seasonal drought can combine to produce dangerous fire weather situations. These features fluctuate seasonally, and from year to year.

Previous compilations of a comprehensive database of daily fire weather and fire danger information provide a better description of New Zealand's fire climate. This allows investigation of the effects of seasonal to decadal climate variability, through analysis of the El Niño-Southern Oscillation (ENSO) and Interdecadal Pacific Oscillation (IPO) on long-term fire weather records.

New Zealand climate varies with two key natural cycles that operate over time scales of seasons to years (El Niño-Southern Oscillation) and decades (Interdecadal Pacific Oscillation). The El Niño/Southern Oscillation (ENSO) is a natural feature of the global climate system. El Niño events occur irregularly, about 3 to 7 years apart, typically becoming established around April or May and persisting for about a year thereafter. In El Niño years, New Zealand tends to experience stronger and/or more frequent west to southwest winds. La Niña events bring roughly the opposite changes, with weaker westerly winds occuring in summer and more northerly quarter winds at other times. Characteristically, El Niño events norally develop prior to or early in the fire season (May-October) then diminish later in summer (February to April), whereas La Niña episodes usually intensify later in the season (October-January).

The Interdecadal Pacific Oscillation (IPO) is a Pacific-wide natural fluctuation in the climate, which causes abrupt "shifts" in Pacific circulation patterns that persist for decades. There are two phases, positive and negative. The positive phase produces more westerly quarter winds over the country, with generally wetter conditions in the west and south. In the negative phase, with weaker westerlies over the country, more easterlies and north easterlies occur over northern New Zealand, with increased tropical disturbances.

The main objective of the current research is to improve understanding of the potential effects of seasonal to decadal climate variability described by ENSO and IPO on fire climate and fire danger trends, and to determine likely differences in fire danger for the natural cycles of climate variability for New Zealand. The indications of possible future fire activity and increased suppression and management requirements associated with natural climate variability highlighted within this study will enable New Zealand rural fire authorities to make more informed fire management decisions on fire prevention and preparedness activities now and in the future.

The fire weather and fire danger database was updated from the NRFA's Fire Weather Monitoring network. From these, 40 weather station locations had sufficient length of record for analysis of ENSO effects. The IPO analysis required longer periods of record, and there were 16 stations with sufficient length of record for this analysis. These are used to compare rainfall, temperature, Fire Weather Index

(FWI) System components and fire danger between ENSO phases, IPO phases and various combinations of ENSO and IPO.

ENSO seasons are classified as neutral, El Niño or La Niña. Station records were composited into these three phases of ENSO. Similarly, datasets were separated into the periods for the two opposing phases of the IPO: the last negative phase to 1976, and positive phase from 1978-1998. Summary statistics of weather inputs, FWI System components and fire danger class frequencies were calculated for each station for the various ENSO and IPO phases. Average values of temperature, Fine Fuel Moisture Code (FFMC), Buildup Index (BUI) and Daily Severity Rating (DSR), along with rainfall totals and the number of days of Very High and Extreme (VH+E) forest fire danger classes were compared on an annual and seasonal basis.

The primary aim of the present study was to identify whether there was evidence of differences in fire dangers, as described using both FWI System components and fire season severity measures, between ENSO event types, IPO phases or combined ENSO/IPO phases. A non-parametric Kruskal-Wallis rank-sum test was used to determine whether the resulting mean or median values for each phase or phase combination were significantly different, and these statistical results and graphical comparisons were then used to qualitatively assess which of the phases it was that was different from the other(s). As such, comparisons of the averages for each event type with other individual phases were not conducted.

El Niño seasons bring enhanced rainfall in the south and west of the South Island, with reduced rainfall in the north and east of the North Island and Marlborough. Therefore in El Niño seasons, fire danger might be expected to increase from Northland to Hawke’s Bay, Marlborough and at times Canterbury, especially with dry westerly and southwesterly winds. Reduced fire danger is likely in southern New Zealand. In La Niña seasons there is usually enhanced rainfall in the north and east and reduced rainfall in the south and west. As La Niña springs are often wetter in many areas, higher fire danger is likely to develop later in the fire season. Increased fire danger is likely to become established in the southern North Island, and in parts of Canterbury and Otago during summer. Reduced fire danger is likely in the north and east of the North Island, and Nelson/Marlborough. Over New Zealand as a whole, La Niña events are expected to produce lower fire danger ratings in any season, compared with El Niños.

For the fire seasons considered, El Niño rainfall was found to be generally lower than La Niña rainfall in the north and east of the North Island. Rainfall was lower in both El Niño and La Niña seasons in parts of the central and south west North Island and Kaikoura. Kaitaia and Nelson showed decreases in El Niño and increases in La Niña rainfall. In the south of the South Island El Niño seasons were wetter. However, there were differences between the climatic seasons. Average fire season temperatures were generally lower in the west and south of both islands during El Niño events and, in some cases, higher in La Niña events.

The FWI components (FFMC, BUI) show differences in the phases expected from rainfall and temperature. FFMC was significantly higher during El Niño fire seasons in Bay of Plenty and the east of the North Island, and for both El Niño and La Niña seasons in western and central North Island areas and Christchurch. Fire season FFMC values were lower during El Niño events in the west of the South Island, and higher in La Niña episodes. Winter was the climatic season that showed the most significant differences. BUI was more distinct, with generally higher values during El Niño events in Northland, Coromandel, Bay of Plenty and the east of the North Island. La Niña events saw higher values in the south west of the North Island and the west and south of the South Island. Summer was the most significant climatic season of effects, with development of higher BUI values earlier during El Niño than La Niña events.

Fire season severity measures (DSR, VH+E forest fire danger) also varied according to ENSO phase. Average DSR values increased throughout the Bay of Plenty and eastern North Island with El Niño conditions. DSR was higher under La Niña and lower under El Niño conditions in the west and south of the South Island. The number of days of VH+E fire danger was significantly higher in El Niño in the Coromandel, Bay of Plenty and east of North Island. In many cases these were 2-3 times higher compared with neutral or La Niña conditions. Although not significant, the number of days was higher under La Niña conditions in the south of the South Island. In those areas where increases occurred, fire season severities were again higher by early summer under El Niño conditions, whereas increases in DSR and VH+E forest fire danger under La Niña conditions usually occurred during late summer.

For the last IPO change in 1977 to the positive phase from the previous negative phase, precipitation increases were found in the west of the South Island and Southland. Reduced precipitation has occurred in eastern Northland, Auckland, Bay of Plenty, the east of the North Island, Marlborough and Canterbury. However, fire season rainfall differences with IPO were generally small for the 16 station datasets examined. Decreases occurred at Rotorua, and also Kaitaia and Kaikoura, with increases at Hokitika, Dunedin and Invercargill with the change to the positive phase. For temperature, all stations (with the exception of Westport) showed an increase with the change to the positive phase. Therefore IPO changes to the positive phase are likely to reduce fire danger in the west of the South Island, and increase fire danger in parts of northern New Zealand, and the east of both islands.

For the FWI system components with the last change to the positive IPO phase, FFMC generally decreased in the far north and western areas of both islands, and increased in the east at Kaikoura, although differences are small. BUI values increased at Kaikoura for the positive phase of the IPO, but decreased at Westport, Hokitika and Dunedin. Although not significant, BUIs for other stations in the north of the North Island and east of both islands generally increased during the last positive phase of the IPO, whereas stations in the central and western North Island, and central and south of the South Island decreased.

The DSR and number of days of VH+E forest fire danger also showed positive IPO phase differences, In the majority of cases, these two severity measures were lower in the west during the positive phase of the IPO, with eastern stations showing large, if not always statistically significant, increases in the positive IPO phase. These results are consistent with the regional climate changes induced by the IPO: that of a higher fire risk regime in the east of both islands and parts of northern New Zealand, with a lower fire risk regime in the west of the South Island.

There is also some evidence of enhancement of ENSO fire dangers by the IPO, with fire dangers during El Niño being enhanced in the north and east during the positive phase of the IPO and reduced during La Niña conditions during the negative IPO phase, with the opposite occurring in western and southern areas. Several stations showed increases in fire season severity (of the order of 10-100+ times) in one phase combination compared with another.

However, in general it was apparent that effects on fire danger were driven more by ENSO than by the IPO. From the historical record of major fires in New Zealand, the effects of ENSO phase effects on fire danger do correlate with increased fire incidence. Since 1961/62, eleven major fires have occurred during El Niño seasons, thirteen during La Niña seasons, and eight during neutral seasons.

Results from this study indicate that climate variability cycles will both reinforce or offset the longer term trends to more severe fire weather and fire danger expected because of climate warming, especially in the Bay of Plenty and east of both islands. But while the analysis has identified some general trends for the various phases of both ENSO and IPO, each El Niño or La Niña event evolves differently no matter what phase of the IPO it occurs under, so that it is often better to track seasonal development against similar ENSO events rather than over generalising on the basis of average trends for each phase. It is also important to recognise that ENSO and IPO only account for some of the total climate variability over New Zealand, and other shorter duration factors will also have significant influences on seasonal fire danger.

1. Introduction

Although not having one of the most severe fire climates in the world, New Zealand still experiences around 3000 rural vegetation fires each year that burn some 7500 ha of rural lands[1]. Strong winds, often associated with high temperatures, low humidity and seasonal drought, can combine to produce dangerous fire weather situations. To effectively manage this risk, New Zealand fire managers require indications of likely trends in fire danger and fire season severity, and comparisons with previous seasons and long-term averages. This includes potential differences in seasonal fire danger as a result of natural climate variability.

The production of a comprehensive climatology of daily fire weather and fire danger in prior research (Pearce *et al*. 2003) has provided a better description of New Zealand's fire climate. In itself, this enables rural fire authorities and the National Rural Fire Authority (NRFA) to increase the focus of fire prevention and mitigation activities. However, the compilation of a database of current and historical fire climate data also allows investigation of the effects of natural climate variability caused by the El Niño-Southern Oscillation (ENSO) and Interdecadal Pacific Oscillation, through the analysis of the long-term weather records for individual stations contained within the fire danger climatology database. Armed with a knowledge of the impacts of natural climate variability on fire danger, fire authorities will then be better able to prepare for the risks associated with these seasonal to interannual climate cycles.

2. Scope of the Study

This report summarises research completed by NIWA and Ensis as part of the joint NIWA-Ensis project "Prediction of Fire Weather and Associated Fire Danger". The joint project aimed to investigate methods for forward prediction of severe fire weather. It combines the outcomes from previous NIWA research into the prediction of fire season severity and improved regional fire danger forecasts for New Zealand and complementary research undertaken by Ensis (then Forest Research) to develop a national fire climatology database and associated analytical tools.

This part of the joint project, aimed to investigate the "Impact of climate variability and change on long-term fire danger", by determining likely differences in fire danger as a result of annual to decadal climate variability in New Zealand. This is achieved by

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[1] From statistics for the period 1993/94-2002/03 produced by the National Rural Fire Authority, based on the Annual Return of Fires form completed by New Zealand fire authorities.

analysing the effects of the main factors of natural variability, the El Niño-Southern Oscillation (ENSO) and Interdecadal Pacific Oscillation (IPO), to the long-term weather records for individual stations contained in the fire danger climatology database developed previously (Pearce *et al*. 2003). The key steps in this study included:

- Defining the phases of ENSO and IPO to be applied to long-term weather records for individual stations;
- Updating long-term fire weather records to include data for recent fire seasons, and re-evaluating fire danger climatologies for as many as possible of the existing 123 weather stations, and any additional stations with sufficient length of record;
- Calculating Fire Weather Index (FWI) System components, severity ratings and fire danger class frequencies for each station for composites of El Niño/La Niña seasons, and before and after 1977 to determine IPO effects;
- Comparing fire danger climatologies produced under the various phases of natural climate variability to predict potential impacts of regional fire danger and seasonal severity; and
- Indicating possible future fire behaviour and suppression requirements to enable rural fire authorities to make more informed fire management decisions on fire prevention and preparedness activities.

3. Background

3.1 Fire danger rating in New Zealand

Assessment of the effect of fire weather (and other fire environment factors of fuels and topography) on potential fire occurrence and fire behaviour is assisted by the use of the New Zealand Fire Danger Rating System (NZFDRS) (Figure 1a), which is based on the Canadian Forest Fire Danger Rating System (CFFDRS) (see Stocks *et al*. 1987). The NZFDRS is used by New Zealand fire authorities to assess the probability of a fire starting, spreading and doing damage (Anderson 2005). New Zealand's adoption and continued adaptation of the CFFDRS has been described by Fogarty *et al*. (1998) and Anderson (2006).

The Fire Weather Index (FWI) subsystem (Van Wagner 1987) of the CFFDRS was adopted by the former New Zealand Forest Service in 1980 (Valentine 1978, Alexander 1994). Based solely on weather observations, the FWI System (Figure 1b) provides numerical ratings of relative ignition potential and fire behaviour which can be used as guides in a wide variety of fire management activities including (after Alexander 1992a):

- prevention planning (e.g., informing the public of pending fire danger, regulating access and risk associated with public and industrial use of forest and rural areas);
- preparedness planning (e.g., level of readiness and prepositioning of suppression resources);
- detection planning (e.g., lookout manning and aerial patrol routing);
- initial attack dispatching;
- suppression tactics and strategies on active wildfires; and
- prescribed fire planning and execution.

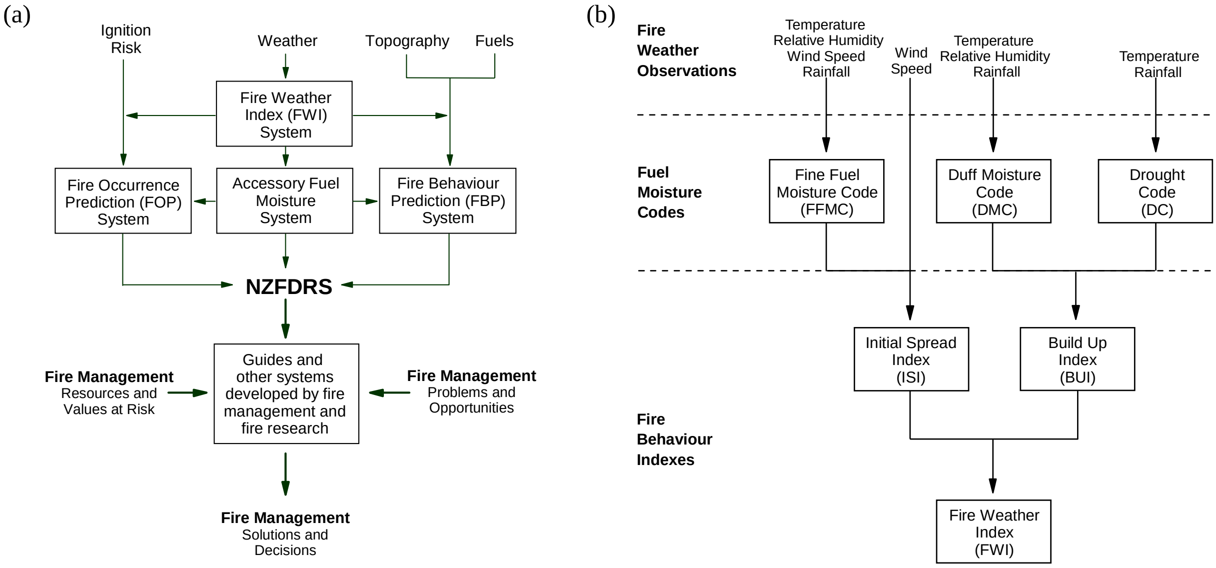

Figure 1. Simplified structure diagrams for (a) the New Zealand Fire Danger Rating System (NZFDRS), illustrating the linkage to fire management actions (after Fogarty *et al*. 1998); and (b) the Fire Weather Index (FWI) System (after Anon. 1993).

Daily observations made at noon local standard time of temperature, relative humidity, wind speed, and 24-hour accumulated rainfall recorded by a network of remote automatic weather stations located around the country (Figure 2) are used to compute values of the three fuel moisture codes and three fire behaviour indexes (Van Wagner 1987). Although these may be determined from tables (e.g., Anon. 1993), they are usually obtained by computer calculation (after Van Wagner and Pickett 1985). Within the NZFDRS, the FWI codes and indices are also used to determine fire danger classes for Forest and Grassland using the criteria defined by Alexander (1994), and further extended to Scrubland fuel types (Anderson 2006). The New Zealand Fire Weather Monitoring System (FWSYS) is described in more detail by Pearce and Majorhazi (2003).

The archiving of historical records of daily fire weather and FWI data make it possible to undertake climatological analyses of current, past, and even future, fire danger. While the production of climatologies for the standard weather elements are commonplace, analyses of fire danger are much less routine (Nikleva 1973, Tapper *et al*. 1993). Despite a clear need being expressed for such analyses (Valentine 1978, p. 35, Alexander 1992c), few New Zealand examples of fire climate studies exist. In trialling the FWI System prior to its introduction, Valentine (1978) compared fire season climatologies for British Columbia and New Zealand, and Cooper and Ashley-Jones (1987) used fire danger class frequencies to investigate the economics of fire prevention activities. Pearce (1996) produced a fire climatology for 20 weather stations (Figure 2) and, based on the example of Simard and Valenzuela (1972) from Canada, presented long-term average and extreme values for both weather inputs and fire danger components in a summary table for each station. This database was extended in 1998 to investigate the potential impact of the 1997/98 El Niño event on regional fire dangers (Anon. 1998, Pearce 1998), and in 2001 to further illustrate the use of severity ratings to compare and predict fire season conditions (Majorhazi and Pearce 2001).

The value of fire climatological information for fire management is evidenced by the vast number of studies and wide variety of applications illustrated in the literature. A significant number of these studies have attempted to use fire climatologies to describe fire activity (Cheney 1976, Haines *et al*. 1980, Harrington *et al*. 1983). However, fire danger climatologies have also been used to illustrate seasonal trends in fire danger (McAlpine 1990), to determine length of fire season (Wotton and Flannigan 1993), and to delineate fire climate zones (Simard 1973, Stocks 1978, Heydenrych and Salinger 2002). They have also been used to define impacts of El Niño-Southern Oscillation events (Williams 1998) and climate change (Wotton *et al*. 1998). Perhaps more importantly, fire climatologies have also been used to develop systems to assist with the full range of fire management activities, including prevention (OMNR 1989, Borger 1997), preparedness (Gray and Janz 1985, Fogarty and Smart 1994), fire suppression (Andrews *et al*. 1998, Fogarty and Slijepcevic 1998), and prescribed fire planning (Martell 1978, Furman 1979, Andrews and Bradshaw 1990).

To this end, a major effort was undertaken by Forest Research in 2002/03 to develop a more comprehensive fire climatological database for New Zealand as part of the preceding NZFSC-funded project “Fire danger climatology analyses and tools” (Pearce *et al*. 2003). This project resulted in the production of data sets of weather and fire danger components for 127 of the weather stations contained within the NRFA’s fire weather network (see Figure 2). As well as the 20 stations included in the original Pearce (1996) study, the analysis included all stations that had more than 5 years of record available. The principal output from the analysis was a summary table for each of the 127 stations containing the long-term average and extreme values of each of the weather and FWI System components and fire danger classes summarised by month, fire season and year (see Pearce *et al*. 2003). Summary statistics for each station were also used to identify the individual weather stations and geographic regions with the most severe fire climates. Stations in Marlborough and Canterbury demonstrated the highest values of the three fire climate severity measures contrasted.

The compilation of a comprehensive database of daily fire weather and fire danger information for 127 of the 179 weather stations for which data was available was the other major output from the analysis. In its own right, this database also provides an extremely useful tool for the NRFA and fire managers in making more informed fire management decisions on prevention, preparedness, and prescribed burning activities. The database has also been an essential component of associated research conducted by both NIWA and Ensis on links between climate and severe fire seasons, and prediction and forecasting of fire season severity. Based on the results of a pilot study (Salinger *et al*. 1999), the closely aligned research undertaken by NIWA as part of the NZFSC-funded “Climate and severe fire seasons” and “Prediction of fire season severity” projects identified large scale global and regional climate factors influencing fire season severity (Heydenrych *et al*. 2001, Heydenrych and Salinger 2002, Gosai *et al*. 2003, Gosai *et al*. 2004) as a basis for improving fire danger forecasts (Gosai and Salinger 2004, Renwick and Salinger 2003, Gosai and Griffiths 2004). As part of the joint NIWA-Ensis “Prediction of fire season severity” project, Ensis developed a methodology for predicting fire season severity based on past seasons (Pearce and Moore 2004), while the “Impact of climate variability and change on seasonal fire danger” project documented the impact of climate change on future fire danger (Pearce *et al*. 2005).

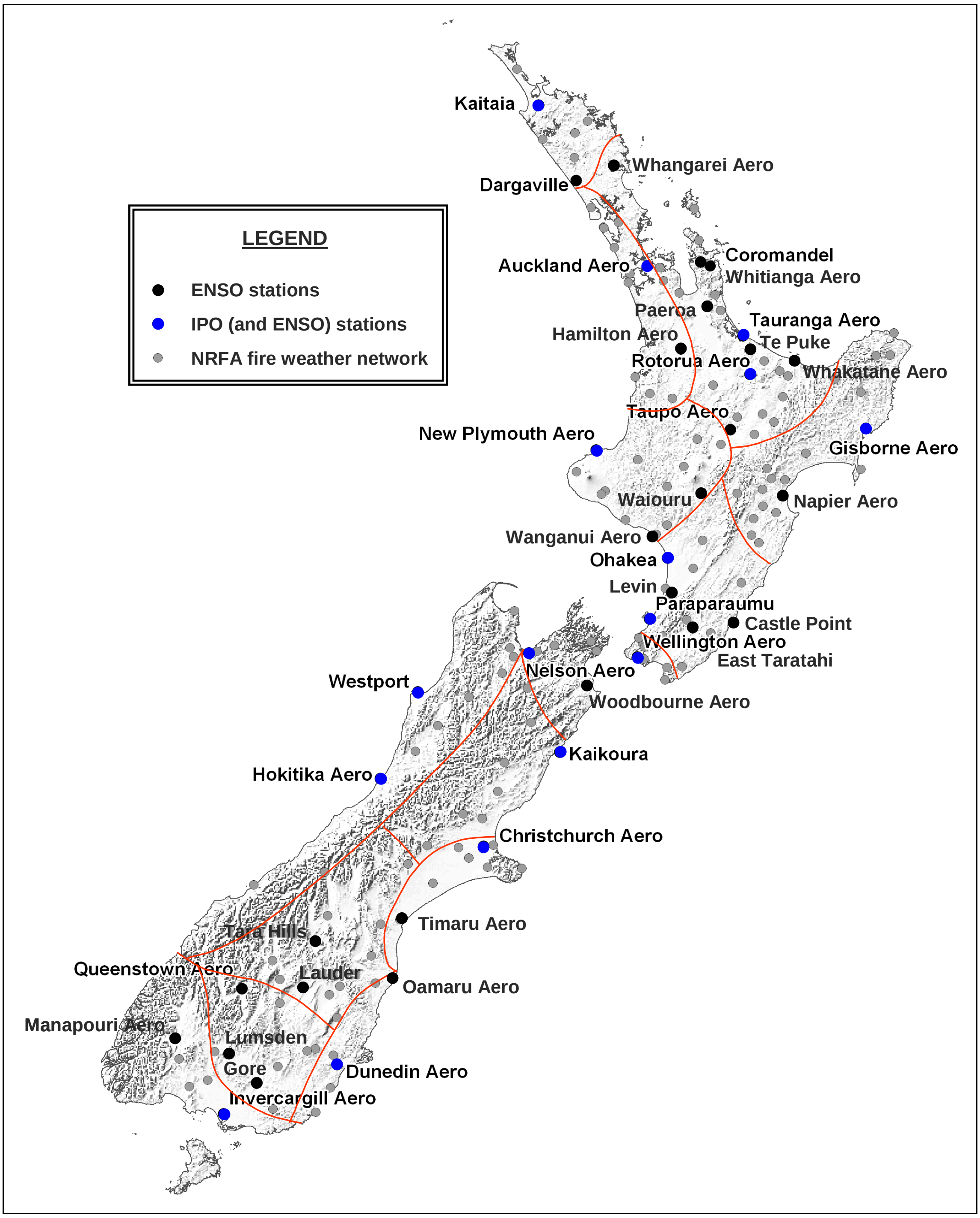

Figure 2. Current coverage of weather stations included on the National Rural Fire Authority's (NRFA) fire weather monitoring network. Stations used in the present study for determining ENSO (●) and IPO (●) effects on fire danger are highlighted in addition to those stations that had insufficient record (●) (see Table 1 for station details). © Ensis 2007

3.2 Climate variability

The impact of seasonal and year-to-year climate variability is drawing increasing attention from land managers, fire management agencies and the public in general. Natural climate variability can cause large fluctuations in regional climate, and give seasons of climate extremes. Natural cycles in the climate system are associated with interannual variability or other longer-term variations or shifts; i.e., El Niño-Southern Oscillation (ENSO) events (Gordon 1986, Nicholls 1992, Hay *et al*. 1993, Salinger *et al*. 1996) or decadal variability such as the Interdecadal Pacific Oscillation (IPO) (Salinger and Mullan 1999). This typically considers variability in climate from seasons to decades. The magnitude of current natural variations of the climate about the long-term mean is large.

3.3 The El Nino-Southern Oscillation

The El Niño is a natural feature of the climate system. The term was originally used by fishermen for the occasional warming of waters along the Peruvian coast, which typically happens around Christmas. The warming extends out along the Equator from the South American coast to the central Pacific. It is accompanied by large changes in the tropical atmosphere, lowering pressures in the east and raising them in the west, in what is known as the "Southern Oscillation". In the late 1960's and early 1970's, scientists realised that El Niño and the Southern Oscillation were linked, with one component in the ocean and the other in the atmosphere. This became known as the El Niño-Southern Oscillation, or ENSO (Troup 1965). A convenient way of measuring ENSO is in terms of the east-west pressure difference, the Southern Oscillation Index, or SOI, which is a scaled form of the difference in mean sea-level pressure between Tahiti and Darwin. A graph of the SOI over the past 30 years is shown in Figure 3.

ENSO may be thought of in terms of a slopping back and forth of warm surface water across the equatorial Pacific Ocean. The trade winds, blowing from the east towards the west, normally help to draw up cool water in the east and to keep the warmest water in the western Pacific. This encourages low air pressures in the west and high pressures in the east. An El Niño event is when the warm water "spills out" eastwards across the Pacific, the trade winds weaken, pressures rise in the west and fall in the east. Eventually, the warm water retreats to the west again and "normality" is restored. The movements of water can also swing too far the other way and waters become unusually cool near South America, resulting in what is termed a "La Niña", where the trade winds are unusually strong while pressures are unusually low over northern Australia.

Thus there are three recognised phases of ENSO – **El Niño**, with negative SOI values below -1; **La Niña**, with positive SOIs above +1; and **neutral**, or normal conditions with SOI values between -1 and +1 (see Figure 3). El Niño events occur irregularly, about 3 to 7 years apart, typically becoming established around April or May and persisting for about a year thereafter. The ENSO cycle is an example of a positive feedback system, where a small difference in the trade winds can change Equatorial sea temperatures to encourage a larger change in the trade winds that changes sea temperatures even more, and so on, into a full-blown El Niño or La Niña.

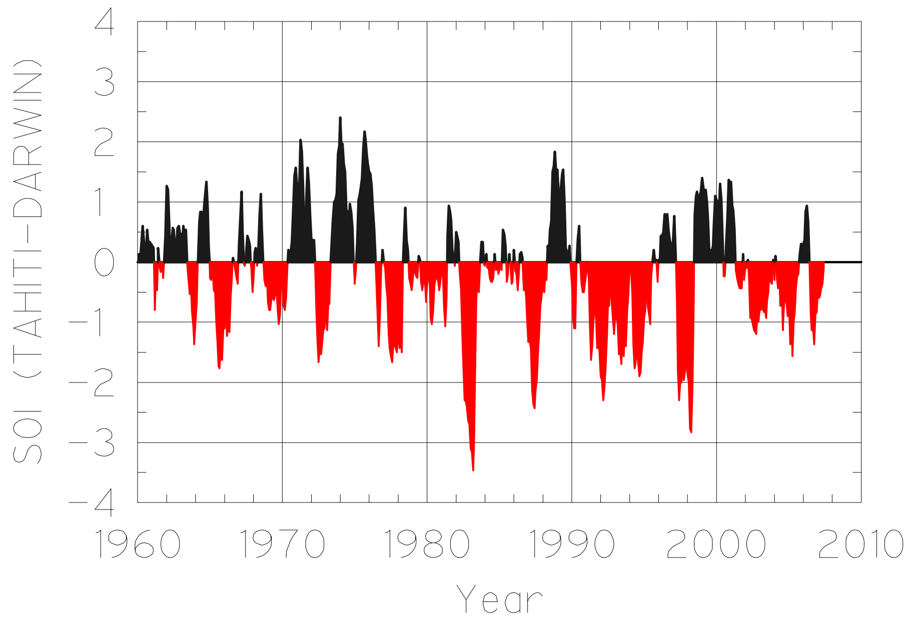

Figure 3. The Southern Oscillation Index (SOI) from 1960 - 2007. Negative excursions of -1 or below (red) indicate El Niño events, and positive excursions of +1 or above (black) indicate La Niña events. The irregular nature of ENSO events is evident in the time sequence. © NIWA 2007

New Zealand is not usually affected as strongly by El Niño conditions as are parts of Australia for example, but there is nevertheless a significant influence (Gordon 1986, Mullan 1995). In El Niño years, New Zealand tends to experience stronger or more frequent winds from the west in summer, leading to drought in East Coast areas and more rain in the west. In winter, the winds tend to be more from the south, bringing colder conditions to both the land and the surrounding ocean. In spring and autumn southwesterlies tend to be stronger or more frequent, providing a mix of the summer and winter effects. La Niña events generally have weaker impacts on New Zealand's climate. New Zealand tends to experience more northeasterly winds, which bring moister, rainy conditions to the northeast parts of the North Island. During winter, winds tend to be more from the north, bringing warmer conditions to both the land and sea surrounding the North Island. In spring and autumn more north easterly winds occur, and summer frequent easterly winds occur, particularly over northern New Zealand.

3.4 The Interdecadal Pacific Oscillation

The Interdecadal Pacific Oscillation, or IPO, is a Pacific-wide natural fluctuation in the climate, which causes abrupt “shifts” in Pacific circulation patterns that persist for decades (Mantua *et al*. 1997, Power *et al*. 1998, Folland *et al*. 1999).

The IPO also affects New Zealand’s climate, and affects temperature and rainfall averages in each phase (Salinger and Mullan 1999, Thompson 2006b). The IPO is strongest in the North Pacific, but sea temperatures in the eastern equatorial Pacific (“home” of El Niño) are also influenced. Current research in Australia and New Zealand is showing that when the IPO changes phase, there are differences in the way the El Nino-Southern Oscillation affects Australasia (Power *et al*. 1999, Salinger *et al*. 2001, Kiem *et al*. 2003). Thus, a “shift” can change not only the average climate, but can also mean that different forecasting relationships are needed to predict monthly and seasonal variations.

There are two phases, the **positive** and **negative** phases of the IPO. In the positive phase, westerly quarter winds over the country and anticyclones in the north Tasman are more prevalent, with generally drier conditions in the north and east. In the negative phase, with weaker westerlies over the country, more easterlies and north easterlies occur over northern New Zealand, with increased tropical disturbances.

Phase changes of the IPO are shown in Figure 4. The IPO exhibits phase reversals once every 20-30 years. Previous phase reversals of the IPO occurred around 1922, 1945, and 1977. Note that Figure 4 shows the IPO remaining positive after 1998. Because the IPO is a low frequency oscillation, values at the end of the series cannot be accurately estimated and might differ significantly with an extra year of data. The IPO returned to near zero in 2000, but has since remained slightly positive because of El Niño activity since 2000.

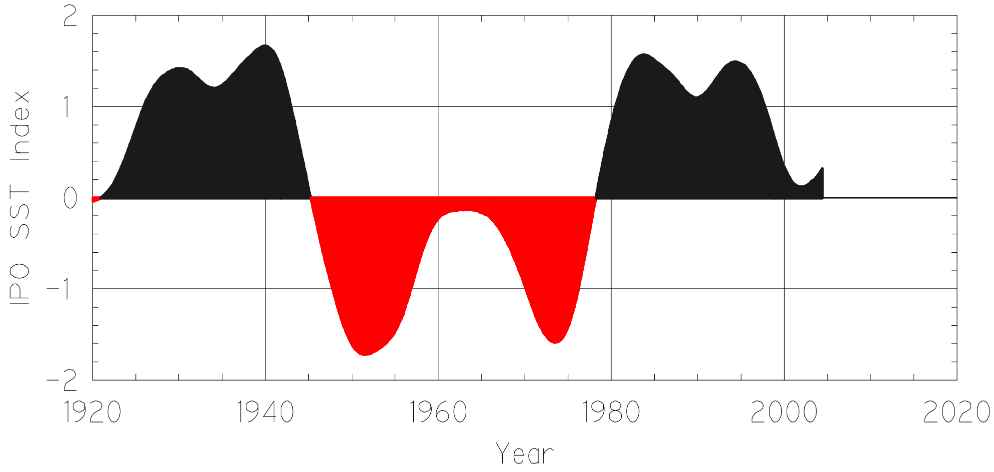

Figure 4. Phases of the Interdecadal Pacific Oscillation (IPO). Positive values indicate periods when stronger westerlies occur over New Zealand, and more anticyclones over northern New Zealand. Negative values indicate periods with more north-easterlies in northern regions. © NIWA 2007

3.5 Climate variability and fire risk

While research into large-scale atmospheric processes such as ENSO and IPO and their impact on New Zealand's climate is relatively well established (Gordon 1986, Salinger and Mullan 1999, Salinger *et al*. 2001, Thompson 2006a,b), links between fire and climate are known to exist but have been harder to describe due to limited availability of fire weather data and poor fire statistics. However, internationally it is widely recognised that fire risk and associated losses are closely linked to climate influences such as ENSO. The catastrophic losses resulting from bushfires in southeastern Australian during the severe 1982/83 El Niño generated significant interest in the ENSO phenomenon in Australia that continues to this day (Gill 1984, Skidmore 1987, Stern and Williams 1989, Krusel *et al*. 1993, Tapper *et al*. 1993, Williams 1998, Williams and Karoly 1999, Wright and Jones 2003a, Lucas 2005, 2006). Similar relationships have also been identified between fire and ENSO in the U.S. (Simard *et al*. 1985, Swetnam and Betancourt 1990, Brenner 1991, Alden 1994, Yaussy and Sutherland 1994, Harrison and Meindl 2001, Chu *et al*. 2002, Keeley 2004) and other parts of the world, such as Southeast Asia (Leighton and Wirawan 1986, Fuller and Murphy 2006) and South America (Villabla and Veblen 1998, Kitzberger 2002).

In New Zealand, the recent research undertaken under the NZFSC-funded project 'Integrated climate and fire season severity forecasting' identified definite links between weather, climate and fire season severity, with predictive relationships being established between global (e.g., Southern Oscillation Index) and regional climate elements (e.g., sea surface temperature, regional wind circulation and synoptic weather types) and monthly fire severity ratings (MSR) and seasonal fire severity ratings (SSR) for 21 locations (Heydenrych *et al*. 2001). This study built on the earlier work of Salinger *et al*. (1999), which investigated linkages for 10 station locations. The responses of severity ratings at individual station locations to these various climate predictors found in the Heydenrych *et al*. (2001) study were also used to define 15 fire climate regions (Heydenrych and Salinger 2002), which were then the focus of more detailed analyses of the factors contributing to high fire season severity in each region (Gosai *et al*. 2003, Gosai *et al*. 2004).

While the relationship between annual or interannual climate variability (such as ENSO) and fire risk has received considerable attention, the influence of decadal or multi-decadal variability on fire danger has only recently come under investigation. Identification of the influences of decadal variability on rainfall and temperature distributions (Power *et al*. 1998, Salinger and Mullan 1999, Salinger *et al*. 2001, Wright and Jones 2003b), and the occurrence of droughts (Westerling and Swetnam 2003, Kiem and Franks 2004, Mullan *et al*. 2005, Thompson 2006b) have naturally lead to consideration of links with fire risk and occurrence. This has particularly been the case in the U.S. (Mote *et al*. 1999, Westerling and Swetnam 2003, Hessl *et al*. 2004, Schoennagel *et al*. 2005, Sibold and Veblen 2006) and Australia (Wright and Jones 2003a, Verdon *et al*. 2004), but also Alaska (Duffy *et al*. 2005), Europe (Baltzer *et al*. 2005) and Patagonia (Villabla and Veblen 1998).

Increasingly, these studies are considering the effects of interannual variability such as ENSO and longer-term decadal changes like the IPO together, due to the recent indications that the longer period variations can affect the strength and frequency of individual El Niño and La Niña events (Gershunov and Barnett 1998, Power *et al*. 1998, 1999, Kiem *et al*. 2003, Kiem and Franks 2004).

4. Methodology

The broad aim of the current research was to maximise the utility of the updated and extended fire climatology database (Pearce *et al*. 2003) by developing a number of analytical tools, including methods for comparing and predicting fire season severity (Pearce and Moore 2004) and investigating the effects of climate change on future fire danger (Pearce *et al*. 2005). Continuing this theme, the objective of this particular component of the study was to analyse the impact of climate variability on fire danger, in an effort to identify relationships between fire danger and measures of climate variability for use in improving forecasting of fire season severity.

As noted previously, the key steps in this study included:

1. Updating long-term fire weather records to include data for recent fire seasons, and re-evaluating the fire danger climatologies for as many as possible of the existing 123 weather stations, and any additional stations with sufficient length of record for this investigation (at least 15 or more unbroken calendar years of record);

2. Defining the phases of ENSO and IPO to be applied to long-term weather records for individual stations;

3. Calculating Fire Weather Index (FWI) System components, severity ratings and fire danger class frequencies for each station for composites of El Niño/La Niña seasons, and before and after 1977 to determine IPO effects;

4. Comparing fire danger climatologies produced under the various phases of natural climate variability to predict potential impacts of regional fire danger and seasonal severity; and

5. Indicating possible future fire behaviour and suppression requirements to enable rural fire authorities to make informed fire management decisions on fire prevention and preparedness activities.

4.1 Updating long-term fire weather records

As it was desirable to have the data sets for analysis as up-to-date as possible, the long-term data sets for as many as possible of the climate stations contained in the NRFA fire weather network were updated to include weather records to 31 December 2006. In some cases, this could be achieved by adding 1200 noon NZST weather inputs from the same or a nearby alternative station from NIWA’s nationally significant climate database (CLIDB). However, in many cases, periods of missing 1200 noon data were required to be substituted using the procedures outlined in Pearce *et al*. (2003), in particular using 1200 noon data from the closest substitute station on the NRFA station network or from the CLIDB. Where rainfall data were missing, and a suitable alternative station from the NRFA network was not available, 24-hour rainfall totals reported for 0900 NZST from the nearest rainfall station within the CLIDB were used as the best estimate of onsite rainfall (after Pearce *et al*. 2003).

In total, more than 120 (of the 179 available) station datasets were updated to 31 December 2006. From these, 40 stations were then selected for further analysis of the effects of climate variability based on their available length of record. For consistency, all selected stations (with the exception of OHA and Coromandel, COR) had complete, unbroken records to December 2006. The IPO analysis was limited to 16 stations.

4.2 Defining and analysing phases of ENSO

ENSO events have been identified most commonly using either the Southern Oscillation Index (SOI) or an index of the tropical Pacific Sea Surface Temperature (SST) anomaly in the central equatorial Pacific Ocean (120°W–170°W and 5°N–5°S), named the Niño 3.4 region. As it is a linked atmospheric/oceanic phenomena, ENSO climate seasons (3 month periods) have been classified by NIWA as being neutral, El Niño (Warm), or La Niña (cold) events (Appendix 1) by using both average SST departures from normal for the Niño 3.4 region in the central equatorial Pacific Ocean and the SOI (the normalised difference in mean pressure between Darwin and Tahiti).

Of the updated datasets of fire weather and fire danger from the NRFA’s Fire Weather Monitoring network, a decision was made to limit analyses to stations for the ENSO analysis with 15 or more unbroken calendar years of data (i.e., a minimum of 14 complete fire seasons), on the basis that this length of record is sufficient for fire climate studies (Simard 1973, Pearce and Hawke 1999) and captures the range of variability exhibited by the ENSO climate phenomena. The 40 selected stations (see Figure 2) also provide sufficient spatial coverage across the country, and the NRFA Regional Rural Fire Committee (RRFC) areas and fire climate regions identified by NIWA (Heydenrych and Salinger 2002). 40 station locations were identified with sufficient length of record for analysis of ENSO differences (see Table 1). Initially it was thought that it might have been possible to use a higher number of stations (~110) with over 10 years of record. However, it was decided to use only those stations with longer records that encompassed several (at least 4-5) individual El Niño or La Niña events rather than just 2-3 events of each that have occurred in the last 10 years to 2006 (see Appendix 1).

Station records for each of the 40 stations were separated into periods for the two opposing phases of ENSO using the two indices for event classification (Appendix 1), and El Niño, La Niña and neutral episodes composited for analysis. As ENSO events are usually of shorter duration than whole years or fire seasons, the effects of ENSO on fire danger at each station were assessed by calculating the average values of each of the variables of interest for each phase of ENSO over several different averaging periods. These included complete fire seasons (i.e., October to April), the 3-month climate seasons (i.e., winter = June/July/Aug (JJA), spring = Sept/Oct/Nov (SON), summer = Dec/Jan/Feb (DJF), and autumn = Mar/Apr/May (MAM)), and individual months (1 = July, 2 = Aug, … to 12 = June). Fire season averages for each ENSO phase were compared using the non-parametric Kruskal-Wallis rank-sum test, whereas climate seasons and individual months were compared using a slicing technique and ANOVA with repeated measures.

4.3 Defining and analysing phases of the IPO

The two most recent phases of the IPO occurred from 1946-77, and 1978-98. The IPO returned to zero at 2000, but has remained slightly positive since. The datasets for each station selected for analysis of IPO changes contained fire weather inputs and resulting fire danger ratings for:

1. The negative phase of the IPO, from first observations to 31 December 1976;

2. The positive phase of the IPO from 1 January 1978 to 31 December 1998.

Data for the year 1977 was omitted from the analysis as it included the IPO phase change, while data for the years 1999-2006 was excluded due to the IPO trending towards zero by 2000, then uncertainty in the trend subsequently (see Figure 4).

The IPO analysis was limited to 16 stations with at least 25 or more unbroken years of data spanning the two IPO phase periods. In all but one case (Ohakea, OHA), stations had complete records (21 years) for the positive phase of the IPO (1978-1998) (see Table 1), but locating stations with suitable lengths of record for the negative IPO phase proved more problematic. As a result, stations had variable lengths of record for the negative IPO phase (to 1976). All but two stations (Tauranga, TGA and Westport, WSA, with 6 years) had more than 10 years of record in the negative phase. The selected stations for the IPO analysis covered all of the fire climate regions in the North Island, and all but two in the South Island.

4.4 Comparison of ENSO and IPO fire dangers

The effects of ENSO and IPO classifications on fire dangers were compared using the following six variables - ‘average’ values of temperature, total rainfall, Fine Fuel Moisture Code (FFMC) and Buildup Index (BUI) (after Van Wagner 1987, Alexander 1992b), along with the Daily Severity Rating (DSR) (after Pearce 1996) and the number of days in the Very High and Extreme forest fire danger classes (VH+E FFDC) (after Alexander 1994). These were the same as those used in the previous study into the effects of climate change (Pearce *et al*. 2005). Average values were determined by calculating both mean and median values of each variable for each averaging period of interest. Due to the shorter duration of ENSO events compared to IPO, analyses were conducted over a range of averaging periods in an attempt to identify whether the effects of ENSO on fire danger were significant and, if so, how fire danger conditions vary at individual weather station locations under the different phases of ENSO. Comparisons of annual (i.e., full calendar years) and fire season (i.e., 1 October to 31 April) averages were conducted for both IPO and ENSO using both means and medians, while subsequent climate season (3-month periods JJA, SON, DJF and MAM) and individual monthly comparisons for ENSO used only the best estimate of central tendency in each case; i.e., means for temperature and rainfall, and VH+E FFDC; and medians for FFMC, BUI and DSR. In the latter case, despite being identified as the FWI System component most suitable for averaging (Van Wagner and Pickett 1985), median rather than mean values of the DSR were used because of the skewed nature of the DSR distribution resulting from the predominance of low values and infrequent high values. The BUI exhibited similar trends, while the FFMC showed a prevalence of higher values and fewer low values. As a result, mean and median values for these variables were significantly different, and the median was considered a more robust estimate of the ‘average’ or ‘mid-point’ of the distribution in each case.

Average or summed values of weather (Temp and Rainfall) and fire danger (FFMC, BUI, DSR and VH+E FFDC) were determined for each comparison period (i.e., fire seasons, climate seasons or months), and then overall averages were compared for each ENSO event type (i.e., El Nino vs. neutral vs. La Nina) or IPO phase (i.e., negative vs. positive) using an analysis of variance (ANOVA) to determine whether they were significantly different. Due to the skewed data distributions, a non-parametric Kruskal-Wallis rank-sum test (Kruskal and Wallis 1952) was used rather than a normal analysis of variance (ANOVA) to determine whether the resulting mean or median values for each event type were significantly different. Also known as the Mann-Whitney test when only two samples are being compared, this test had been used in similar analyses of the effect of IPO on drought occurrence (Thompson 2006b).

The primary aim of the current report was to identify whether there were differences in the FWI System components, and fire dangers between ENSO event types, IPO phases and combined ENSO/IPO phases. As such, statistical testing simply identified those stations and/or month/seasons where the average value for a particular ENSO or IPO phase was significantly different from the others (i.e., the null hypothesis that they were the same was rejected), and multiple comparisons comparing the averages for each event type with each other were not included due to the difficulty of conducting such an analysis as part of a non-parametric procedure. In the case of the ENSO event types, the statistical analysis did not therefore compare whether the pairs El Niño-La Niña, El Niño-Neutral or La Niña-Neutral were significantly different, but whether the averages (means or medians) for each phase were significantly different from each other. Where event phases were found to be statistically different, averages were qualitatively assessed based on the values themselves and graphical output (e.g., see Figures 8 and 9), including data variability estimates indicated by error bars, to determine which of the phases it was that was different from the other(s). The same methodology was also applied to comparison of the six possible ENSO/IPO outcomes.

In the case of shorter averaging periods, such as 3-month climate seasons or individual months, statistical comparisons between ENSO phases were made using a ‘slicing technique’ to break the station datasets into the particular periods for comparison. However, because of the correlation of fire danger in one period (i.e., climate season or month) with previous periods (especially BUI, and therefore DSR and VH+E FFDC), it was necessary to use a ‘repeated measures’ ANOVA analysis to account for this covariance in the data. Several covariance structures (unstructured, compound symmetry, first-order auto-regressive, and Toeplitz) were run to determine the appropriate structure to use, with the selected model being that which minimised the model fit statistics, the Akaike information criteria (AIC), the finite-population corrected Akaike information criteria (AICC) and the Bayesian information criteria (BIC) (Littell *et al*. 2006).

All statistical analyses were undertaken using the SAS statistical analysis package (SAS Institute 2004). In all resulting comparisons, the 90% level of statistical significance (i.e., probability, $p < 0.10$) was chosen instead of the more common 95% level ($p < 0.05$) so that instances where there were substantial evidence of a difference would not be excluded. For a phenomenon such as climate variability, where there is considerable spread in response to the respective climate phases, a 90% significance level is still a strong indicator of potential trends.

4.5 FWI System components

Two of the six components of the Fire Weather Index (FWI) System were used in this study to investigate the effects of climate variability on fire danger – the Fine Fuel Moisture Code (FFMC) and Buildup Index (BUI) components (see Figure 1b). The FFMC combines the influences of temperature, relative humidity, wind speed and rainfall on the fuel moisture content of fine fuels, and provides an indicator of the flammability of fine fuel and likelihood of ignition by fire (Van Wagner 1987). As such, the FFMC responds to day-to-day differences in weather conditions. Increases in temperature and/or decreases in rainfall due to ENSO (or IPO) changes should therefore result in increases in average FFMC values.

The BUI combines the influences of temperature and rainfall (through the Drought Code, DC) and relative humidity (as well as temperature and rainfall, through the Duff Moisture Content, DMC) on the moisture content of medium and large-sized woody material and soil organic layers, and therefore provides an indicator of the total amount of fuel available to burn (Van Wagner 1987). The BUI responds to medium to longer range drying trends, in the order of weeks to months and, through its combination of the DMC and DC in particular, also provides a useful indicator of seasonal drought and amount of smouldering fire that can be expected in deep duff layers and large logs. Again, increases in temperature or, more importantly, decreases in rainfall due to ENSO (or IPO) phases should also result in increases in average BUI values.

4.6 Fire season severity measures

In addition to the two FWI System components, two measures of fire season severity were also used to compare the effects of ENSO (and IPO) on fire danger. The Daily Severity Rating (DSR) is a numerical measure that rates the daily weather fire severity at a particular station based on the Fire Weather Index (FWI) value and, as such, integrates the effects of the weather inputs through calculation of the intermediate components of the FWI System that are used to determine the final FWI index itself (see Figure 1b). The DSR reflects fire intensity, and describes the amount of work required to suppress a fire as fire intensity increases (Van Wagner 1987). It can be averaged over any period to provide weekly (WSR), monthly (MSR) or seasonal (SSR) severity ratings (Harvey *et al*. 1986, Pearce and Moore 2004), although median rather than mean values were preferred in this study due to the skewed nature of the DSR distributions, with a prevalence of low values and few high values.

The number of days in the Very High and Extreme (VH+E) forest fire danger classes (FFDC) is a count of the total number of days in each of the Very High (VH) and Extreme (E) fire danger classes for Forest fuels defined by Alexander (1994). These fire danger classes are based on fire intensity, with the Very High class representing a transition zone between being able to achieve control and the upper limit for direct fire suppression using conventional firefighting resources, and the Extreme class describing levels of fire intensity where it is very difficult if not impossible to control a fire using conventional means. The Forest fire danger class criteria uses the Initial Spread Index (ISI) and Buildup Index (BUI) components of the FWI System, together with the Pine Plantation (C-6) model from the Canadian Forest Fire Behaviour Prediction (FBP) System, to estimate fire intensity and resulting fire danger class for pine plantation fuels (Alexander 1994, Anderson 2005). The combined number of days of VH+E forest fire danger therefore provides a measure of fire season severity that again integrates the effects of the weather inputs and contributory FWI System components that could be averaged for different ENSO and IPO phases to determine the effects of these on fire danger.

5. Results

5.1 Updated station datasets

In the first step of the analysis, a total of more than 120 of the 179 available station datasets from the NRFA fire weather network were updated to include data to 31 December 2006 using the methods outlined by Pearce *et al*. (2003).

Of these, 40 stations with available lengths of record exceeding 15 complete years (i.e., 14 full fire seasons) were then selected for analysis of the effects of ENSO on fire danger. These comprised 24 North Island and 16 South Island stations with data records ranging from 15 to 46 years (Table 1; also see Figure 2). The minimum length of record covered 8 ENSO seasons (4 El Niño and 4 La Niña), while the maximum record period covered 26 ENSO seasons (15 El Niño and 11 La Niña) and, on average, stations included in the ENSO analysis included 8 El Niño, 7 La Niña and 11 neutral seasons (see Table 1).

The 16 stations included in the analysis of the effects of IPO on fire danger included 9 from the North Island and 7 from the South Island. These had lengths of record ranging from 35 to 46 years (Table 1), and included 6 to 16 negative IPO seasons and, with the exception of Ohakea (OHA) with 18, 21 positive IPO seasons (see Table 1).

Station Code	Station Name	NIWA Fire Climate Region	Station Type	Period of Record	Length of Record (years)	No. Seasons/Years				
						ENSO			IPO	
						El	N	La	-ve	+ve
KX	**Kaitaia Observatory**	**Far North**	**NIWA**	**1963-2006**	**44**	**15**	**17**	**11**	**14**	**21**
WRA	Whangarei Aero	Far North	Met	1992-2006	15	4	6	4		
DAR	Dargaville	Far North	NRFA	1979-2006	28	8	12	7		
AKL	**Auckland Aero**	**Auckland West-Waikato**	**NIWA**	**1967-2006**	**40**	**13**	**16**	**10**	**10**	**21**
HNA	Hamilton Aero	Auckland West-Waikato	Met	1992-2006	15	4	6	4		
COR	Coromandel	Auckland East-Coromandel	NIWA	1979-1999	21	6	9	5		
WTA	Whitianga Aero	Auckland East-Coromandel	Met	1992-2006	15	4	6	4		
PAX	Paeroa	Auckland East-Coromandel	Met	1992-2006	15	4	6	4		
TGA	**Tauranga Aero**	**Bay of Plenty**	**Met**	**1971-2006**	**36**	**11**	**15**	**9**	**6**	**21**
TPE	Te Puke	Bay of Plenty	Met	1992-2006	15	4	6	4		
WKA	Whakatane Aero	Bay of Plenty	Met	1992-2006	15	4	6	4		
ROA	**Rotorua Aero**	**Bay of Plenty**	**Met**	**1965-2006**	**42**	**14**	**17**	**10**	**12**	**21**
APA	Taupo Aero	Bay of Plenty	Met	1979-2006	28	8	12	7		
GSA	**Gisborne Aero**	**East Coast**	**Met**	**1963-2006**	**44**	**15**	**17**	**11**	**14**	**21**
NRA	Napier Aero	East Coast	Met	1992-2006	15	4	6	4		
NPA	**New Plymouth Aero**	**Taranaki-Wanganui**	**Met**	**1976-2006**	**44**	**15**	**17**	**11**	**14**	**21**
RUX	Waiouru Aero	Taranaki-Wanganui	Met	1992-2006	15	4	6	4		
WUA	Wanganui Aero	Taranaki-wanganui	Met	1979-2006	28	8	12	7		
OHA	**Ohakea**	**Manawatu-Wairarapa**	**NIWA**	**1961-1995**	**35**	**12**	**15**	**7**	**16**	**18**
LNX	Levin	Manawatu-Wairarapa	Met	1992-2006	15	4	6	4		
CPX	Castle Point	Manawatu-Wairarapa	Met	1992-2006	15	4	6	4		
MSX	East Taratahi	Manawatu-Wairarapa	Met	1992-2006	15	4	6	4		
PPA	**Paraparaumu**	**Manawatu-Wairarapa**	**Met**	**1963-2006**	**44**	**15**	**17**	**11**	**14**	**21**
WNA	**Wellington Aero**	**Wellington-Nelson/Marlb.**	**Met**	**1961-2006**	**46**	**15**	**19**	**11**	**16**	**21**
NSA	**Nelson Aero**	**Wellington-Nelson/Marlb.**	**Met**	**1963-2006**	**44**	**15**	**17**	**11**	**14**	**21**
WBA	Woodbourne Aero	Wellington-Nelson/Marlb.	Met	1992-2006	15	4	6	4		
KIX	**Kaikoura**	**Northern Canterbury**	**Met**	**1965-2006**	**42**	**14**	**17**	**10**	**12**	**21**
WSA	**Westport**	**West Coast**	**Met**	**1971-2006**	**36**	**11**	**15**	**9**	**6**	**21**
HKA	**Hokitika Aero**	**West Coast**	**Met**	**1965-2006**	**42**	**14**	**17**	**10**	**12**	**21**
CHA	**Christchurch Aero**	**Coastal Mid/South Canty.**	**Met**	**1961-2006**	**46**	**15**	**19**	**11**	**16**	**21**
TUA	Timaru Aero	Coastal Mid/South Canty.	Met	1992-2006	15	4	6	4		
THE	Tara Hills	Mackenzie Basin	Met	1992-2006	15	4	6	4		
LAE	Lauder	Mackenzie Basin	NIWA	1992-2006	15	4	6	4		
OUA	Oamaru Aero	Coastal Otago	Met	1992-2006	15	4	6	4		
DNA	**Dunedin Aero**	**Coastal Otago**	**Met**	**1964-2006**	**43**	**14**	**17**	**11**	**13**	**21**
QNA	Queenstown Aero	Central Otago-Inland South.	Met	1979-2006	28	8	12	7		
LUX	Lumsden	Central Otago-Inland South.	Met	1992-2006	15	4	6	4		
GCE	Gore	Central Otago-Inland South.	Met	1992-2006	15	4	6	4		
MOA	Manapouri Aero	Southland-Fiordland	Met	1992-2006	15	4	6	4		
NVA	**Invercargill Aero**	**Southland-Fiordland**	**Met**	**1961-2006**	**46**	**15**	**19**	**11**	**16**	**21**

Table 1. Details of weather stations included in the analyses of ENSO effects on fire danger. Stations highlighted in bold were also included in the IPO analysis.

5.2 Comparisons of fire danger with ENSO and IPO

Comparisons between fire climate under each of the five phases of natural climate variability (three ENSO phases, two IPO phases) were made for weather inputs and resulting FWI System components and fire season severity measures.

Statistically significant differences (at the 90% level) were found at one or more stations for the different phases for all variables investigated, driven by the temperature and precipitation anomalies across New Zealand induced by ENSO and the IPO.

5.2.1 ENSO

Temperature and rainfall

In El Niño years, New Zealand tends to experience stronger and/or more frequent west to southwest winds, bringing relatively cool conditions, with below average land and sea surface temperatures. In spring and summer, increased westerlies lead to increased risk of drought in eastern areas, while in winter, increased southerlies often bring more cold stormy conditions, both to the land and the surrounding ocean (Figures 5 and 6, and see also Gordon 1986, Kidson and Renwick 2002a,b).

Thus for the fire season (October to April), reduced rainfall in spring occurs especially in eastern Northland, Bay of Plenty and Marlborough, evolving to much of the north and east of the North Island, Marlborough and Canterbury for summer. During autumn, reduced rainfall continues in the northeast from eastern Northland through to Hawke’s Bay, and Nelson/Marlborough. Therefore in El Niño seasons, fire danger risk might expect to be enhanced from Northland to Hawke’s Bay, and in Marlborough and at times Canterbury, especially with dry westerly and southwesterly winds. Increased spring rainfall occurs in Southland and South Otago, and similarly for autumn, extending into Dunedin. Summer rainfall is at least average in the west and south of the South Island. Thus fire danger risk in southern New Zealand is very likely to be reduced.

La Niña events bring roughly the opposite effects, with weaker westerlies in summer, and more northerly quarter winds, usually associated with enhanced rainfall in the north and east of the North Island, and dry conditions in some western regions, especially in the South Island (Figures 5 and 6). Land and ocean temperatures tend to be above average during a La Niña. There is a tendency for slow-moving anticyclones to position themselves just east of New Zealand, while depressions over the north

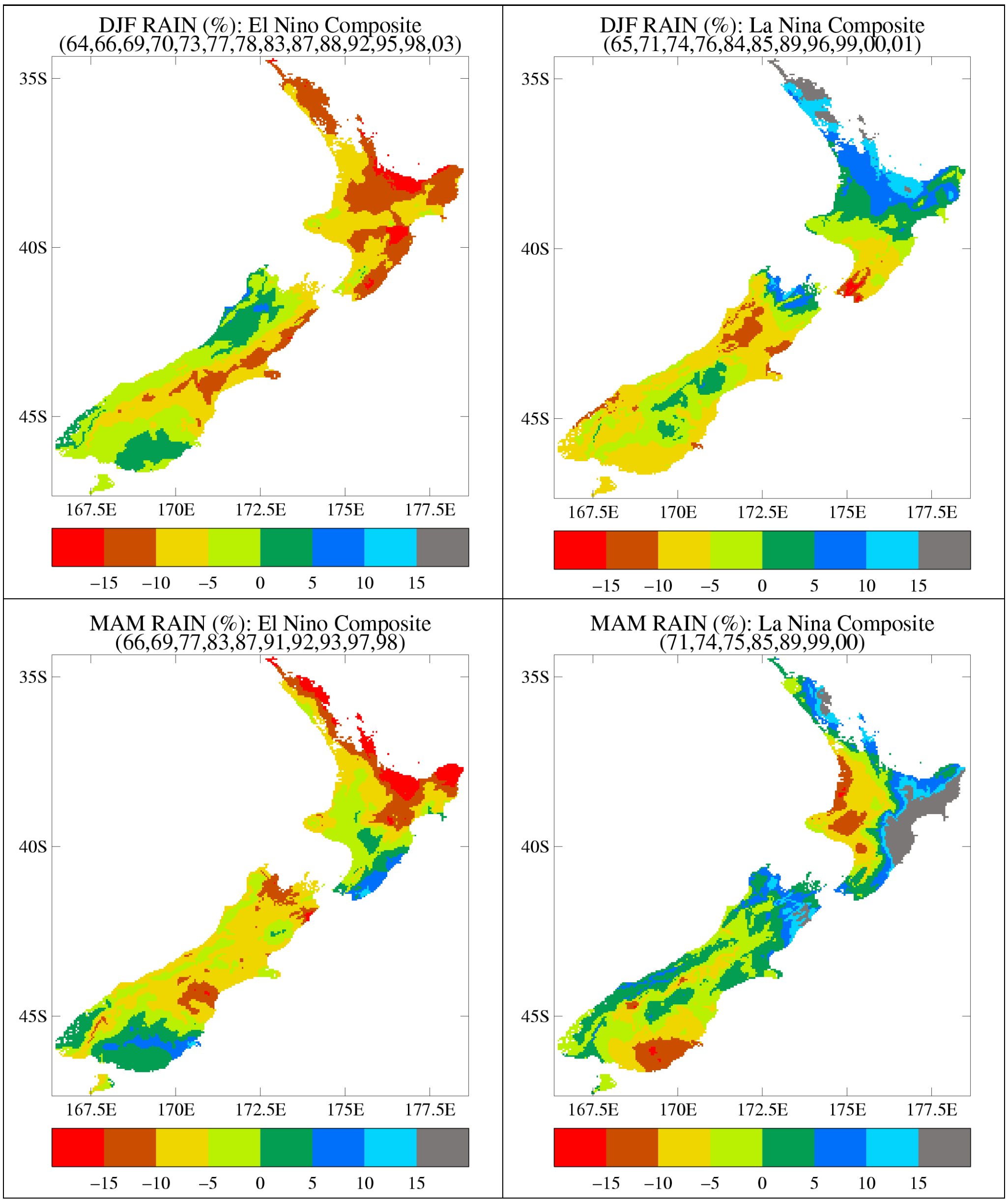

Figure 5. Average seasonal rainfall percentage of normal for El Niño and La Niña summer (DJF, top) and autumn (MAM, bottom). Rainfall is expressed as a % difference from the 1971-2000 normals. The figure legend indicates the years entering the composite (e.g., "64" in DJF is Dec 1963-Feb 1964). .© NIWA 2007

Tasman Sea can bring enhanced rainfall especially to the northern half of the North Island. Seasonally, spring rainfall is enhanced in many areas of New Zealand except Gisborne. Reduced summer rainfall occurs in Wellington, Wairarapa, north Canterbury and Otago. Autumn rainfall is often lower in the west of the North Island from Waikato to Manawatu, eastern Southland and Otago. Therefore increased fire danger risk is likely to develop later in La Niña seasons becoming established in the

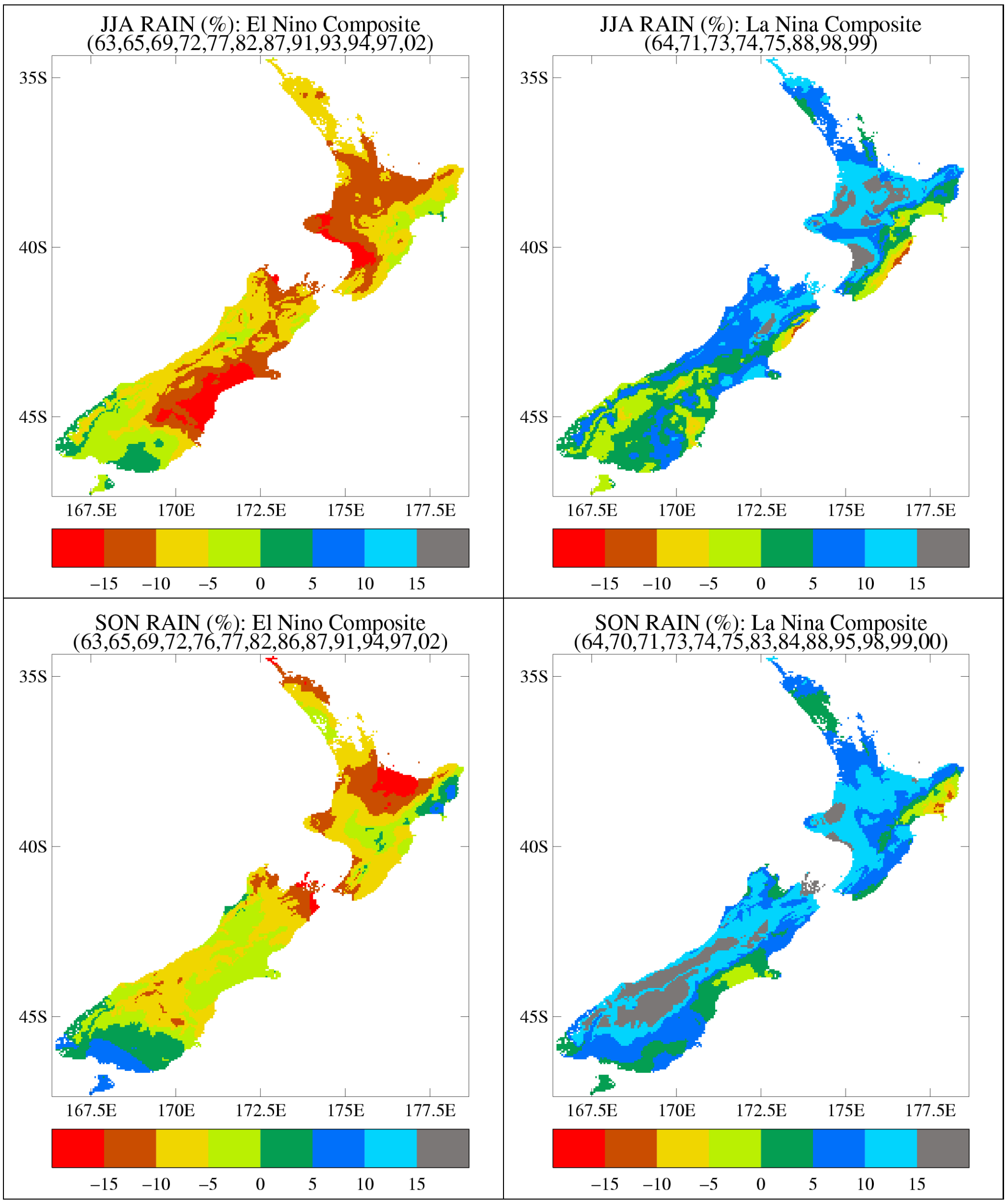

Figure 6. As Figure 5, but for winter (JJA, top) and spring (SON, bottom). © NIWA 2007

southern North Island, parts of Canterbury and Otago during summer, developing in parts of Southland and persisting in Otago during autumn. La Niña summers bring increased rainfall in the north and east of the North Island from Northland to Hawke’s Bay, and Nelson/Marlborough, with increased rainfall in autumn in eastern Northland, Bay of Plenty, and east of the North Island, and the north of the South Island. Thus reduced fire risk is likely in the north and east of the North Island, and in Nelson and Marlborough.

Figures 5 and 6 show the average picture for the composites. However, because each El Niño or La Niña event evolves differently, and because ENSO accounts for only part of the total climate variability over New Zealand, the average is not always a good guide to impacts on New Zealand. Instead, we must think about how ENSO events shift the odds of wet or dry, warm or cool conditions. For instance, the West Coast of the South Island is on average wetter than normal during El Niño and drier than normal during La Niña. On examination of individual cases, the West Coast is wet in two out of three El Niño events, and is dry in three out of four La Niña events.

Tables 2 and 4 compare averages for rainfall and temperature at each of the 40 stations included in the study under the three phases of ENSO over fire season months (i.e., Oct-Apr) only. Tables 3 and 5 include similar information averaged over each of the climate seasons. Appendix 2 contains comparisons of climate (and fire danger) variables at each station for each ENSO phase by individual month. The test statistic only identified those months/seasons where the average and/or the median value for a particular ENSO phase was significantly different from others.

Average fire season rainfalls (Table 2) were lower (-120 to -260 mm, or -18% to -35%) during El Niño seasons than during La Niña and neutral conditions in Auckland (AKL), the Bay of Plenty region (Tauranga (TGA), Whakatane (WKA), Rotorua (ROA) and New Plymouth (NPA). They were also lower during El Niño (-60 to -155 mm, or -12% to -24%) as well as during La Niña (-60 to -150 mm, or -10 to -24%) at Te Puke (TPE), Taupo (APA), Paraparaumu (PPA) and Wellington (WNA), Kaikoura (KIX) and Dunedin (DNA) (and Wanganui (WUA), Ohakea (OHA) and Castle Point (CPX) when medians were used). Two stations, Kaitaia (KX), and Nelson (NSA) when medians were considered, showed increases (+40 to +80 mm or +6% to +15%) during La Niña but decreases (-30 to -85 mm or -6% to -120%) during El Niño conditions. When medians (instead of means) were considered, Queenstown (QNA) showed a significant increase under both La Niña and El Niño conditions, and Invercargill (NVA) a decrease with La Niña but increase under El Niño.

In addition to significant differences over fire season months, many of the stations also showed significant differences in rainfall over winter months (June/July/August); in fact, many more stations showed significant differences in winter rainfall compared with other 3-month climate seasons (Table 3) (also see Figures 8 and 9).

Weather Station	No. Fire Seasons			Rainfall			
	El Niño	Neutral	La Niña	El Niño	Neutral	La Niña	Prob/Sig.
KX	15	17	11	593	678	717	**0.07**
WRA	4	6	4	597	620	757	0.37
DAR	8	12	7	515	583	595	0.46
AKL	13	16	10	477	593	596	**0.02**
HNA	4	6	4	578	755	714	0.27
COR	6	9	5	833	917	1164	0.13
WTA	4	6	4	870	876	860	1.00
PAX	4	6	4	631	651	663	0.96
TGA	11	15	9	542	717	720	**0.00**
TPE	4	6	4	781	925	772	0.79
WKA	4	6	4	490	752	741	**0.08**
ROA	14	17	10	648	824	821	**0.01**
APA	8	12	7	471	621	557	**0.03**
GSA	15	17	11	489	539	550	0.36
NRA	4	6	4	346	508	492	0.24
NPA	15	17	11	679	824	793	**0.07**
RUX	4	6	4	651	773	793	0.61
WUA	8	12	7	549	622	576	0.30
OHA	12	15	7	471	535	462	0.14
LNX	4	6	4	496	641	586	0.59
CPX	4	6	4	533	656	479	0.18
MSX	4	6	4	437	519	587	0.69
PPA	15	17	11	489	615	494	**0.05**
WNA	15	19	11	450	562	482	**0.06**
NSA	15	17	11	492	520	600	0.23
WBA	4	6	4	347	391	364	0.91
KIX	14	17	10	382	482	368	**0.06**
WSA	11	15	9	1177	1263	1207	0.31
HKA	14	17	10	1620	1702	1582	0.71
CHA	15	19	11	292	367	317	0.11
TUA	4	6	4	315	396	397	0.65
THE	4	6	4	260	321	310	0.47
OUA	4	6	4	377	530	397	0.28
DNA	14	17	11	413	470	392	**0.10**
LAE	4	6	4	303	329	366	0.77
QNA	8	12	7	477	426	488	0.31
LUX	4	6	4	676	846	627	0.58
GCE	4	6	4	591	589	511	0.29
MOA	4	6	4	708	627	697	0.96
NVA	15	19	11	682	662	622	0.32

Table 2. Average fire season (Oct-Apr) rainfall totals for 40 weather stations under the three ENSO phases (based on mean values). Values significant at the 90% level (i.e <0.10), using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when medians rather than means were compared.

Weather Station	1 = Winter				2 = Spring				3 = Summer				4 = Autumn			
	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob
KX	213	313	313	**0.00**	273	333	328	0.20	226	268	307	0.20	279	324	327	0.55
WRA	213	271	319	0.32	226	324	328	0.34	186	270	252	0.49	262	348	365	0.48
DAR	204	268	252	**0.10**	263	281	235	0.57	179	238	255	0.23	279	288	300	0.99
AKL	164	241	229	**0.01**	243	274	261	0.59	182	242	238	0.14	234	291	262	0.25
HNA	204	262	326	0.62	287	339	303	0.83	193	322	282	0.29	397	345	226	0.19
COR	266	474	471	**0.02**	434	468	493	0.85	246	351	434	0.27	363	492	530	**0.05**
WTA	300	410	527	0.15	435	415	374	0.88	275	411	317	0.49	272	488	349	0.18
PAX	207	321	307	0.16	256	259	301	0.89	263	303	259	0.73	325	280	240	0.69
TGA	165	246	249	**0.02**	230	278	298	0.19	181	283	290	**0.04**	282	358	364	0.17
TPE	226	271	339	0.49	310	371	351	0.79	236	404	295	0.18	260	510	407	**0.01**
WKA	226	249	317	0.43	216	300	305	0.37	151	315	283	**0.07**	253	370	345	0.27
ROA	186	278	299	**0.01**	271	353	366	**0.08**	258	340	368	**0.03**	296	373	377	0.22
APA	135	174	193	0.23	226	260	242	0.64	173	270	284	**0.01**	220	238	176	0.38
GSA	169	219	200	0.19	198	233	195	0.71	182	196	210	0.78	285	271	327	0.37
NRA	148	177	326	**0.02**	145	211	150	0.40	105	273	174	**0.02**	197	247	242	0.66
NPA	186	297	278	**0.00**	299	347	425	**0.01**	278	326	316	0.43	340	373	319	0.49
RUX	205	284	479	**0.01**	363	365	349	0.78	218	323	331	0.73	415	345	271	0.41
WUA	143	200	279	**0.03**	270	263	312	0.58	202	253	227	0.50	287	246	220	0.25
OHA	103	182	181	**0.00**	208	212	243	0.46	192	221	193	0.46	216	237	174	0.24
LNX	144	197	127	0.35	302	329	344	0.76	206	290	208	0.18	318	221	218	0.16
CPX	184	212	166	0.66	209	297	193	0.21	169	291	185	0.14	243	267	286	0.82
MSX	146	224	163	0.49	232	286	235	0.78	170	231	226	0.63	291	260	206	0.76
PPA	138	207	219	**0.01**	244	273	285	0.42	194	240	194	0.23	219	240	235	0.88
WNA	155	214	218	**0.03**	214	252	268	0.28	168	220	167	0.21	257	237	255	0.81
NSA	112	220	184	**0.00**	224	253	254	0.73	190	179	245	0.21	248	267	257	0.71
WBA	111	147	190	0.39	160	191	212	0.71	135	177	113	0.49	155	142	142	0.94
KIX	112	178	137	**0.03**	153	197	177	0.48	129	171	135	0.54	215	227	272	0.49
WSA	288	381	425	**0.04**	573	551	584	0.90	484	562	446	**0.07**	446	547	556	0.37
HKA	315	478	456	**0.01**	729	775	827	0.44	671	710	618	0.37	633	712	653	0.59
CHA	86	133	139	**0.01**	131	142	136	0.94	116	143	119	0.51	154	166	171	0.89
TUA	50	173	86	**0.06**	120	226	157	0.16	152	170	139	0.78	160	168	149	0.99
THE	72	83	98	0.91	121	99	141	0.52	96	187	137	**0.04**	106	109	126	0.93
OUA	74	107	119	0.21	154	198	191	0.62	155	261	166	**0.07**	201	153	183	0.60
DNA	68	118	85	**0.01**	158	161	166	0.88	190	210	178	0.63	183	178	130	0.17
LAE	43	48	52	0.81	109	101	150	0.20	127	172	160	0.28	123	90	162	**0.03**
QNA	117	133	111	0.74	192	149	242	**0.03**	177	216	165	0.44	245	212	168	0.51
LUX	129	161	83	0.46	275	286	297	0.66	257	407	293	0.23	392	258	257	0.11
GCE	107	125	121	0.90	237	192	246	0.40	246	262	245	0.72	225	221	208	0.76
MOA	215	285	210	0.77	317	361	342	0.82	287	273	258	0.97	428	329	271	0.76
NVA	138	167	159	0.35	286	238	254	0.19	273	286	287	0.78	303	305	277	0.69

Table 3. Average 3-monthly climate season rainfall totals for 40 weather stations under the three ENSO phases (based on mean values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold.

Winter season (June/July/Aug) rainfall averages were lower during El Niño conditions at all stations to show significant differences (Table 3). Rainfalls were lower (-50 to -210 mm, or -28% to -44%) during El Niño only in the northern (Kaitaia (KX), Coromandel (COR) and Tauranga (TGA)) and lower western North Island (Ohakea (OHA), Paraparaumu (PPA) and Wellington (WNA)), and Christchurch (CHA). Winter rainfall was lower during both El Niño (-50 to -160 mm, or -24% to -71%) and La Niña (-12 to -87 mm, or -5% to -50%) events at Dargaville (DAR) and Auckland (AKL), New Plymouth (NPA), Nelson (NSA), Hokitika (HKA), Kaikoura (KIX) (see Figure 9), Timaru (TUA) and Dunedin (DNA). Average seasonal rainfall was also lower during El Niño (-90 to -95 mm, -24% to -33%) but higher during La Niña (+20 to +45 mm, or +8% to +12%) at Rotorua (ROA) (see Figure 8) and Westport (WSA), and also at Napier (NRA), Waiouru (RUX) and Wanganui (WUA) (-30 to -80 mm or -16% to -29%, and +80 to +195 mm or +40% to +85%, respectively). Frequently, these differences in winter season rainfalls were the result of significantly different July (month 1) rainfalls (Appendix 2).

Average spring (Sept/Oct/Nov) seasonal rainfalls were significantly lower (-82 mm or -23%) during El Niño at Rotorua (ROA) (see Figure 8), and also lower in El Niño (-48 mm or -14%) but higher in La Niña (+78 mm or +22%) at New Plymouth (NPA). Queenstown (QNA) had higher spring rainfall during both El Niño (+43 mm or + 29%) and La Niña (+90 mm or +62%) events compared with neutral springs. Several additional stations, particularly in the mid-north (Whangarei (WRA), Auckland (AKL), Whitianga (WTA) and Te Puke (TPE)) and lower North Island (Castle Point (CPX), Paraparaumu (PPA) and Wellington (WNA)) also showed evidence of significant differences in rainfall for at least one month (typically November, or October) of the spring season (see Appendix 2).

Summer (Dec/Jan/Feb) rainfalls were lower (-70 to -100 mm, or -24% to -36%) during El Niño seasons in the central North Island (Tauranga (TGA), Rotorua (ROA) (see Figure 8) and Taupo (APA)), and lower under both El Nino (-75 to -170 mm, or -14% to -62%) and La Niña (-30 to -120 mm, or -10% to -36%) conditions at Whakatane (WKA), Napier (NRA), Westport (WSA), Tara Hills (THE) and Oamaru (OUA). This was typically the result of significantly different December or January rainfall (see Appendix 2). Kaitaia (KX), Coromandel (COR) and Te Puke (TPE) in the north, Nelson (NSA), and Lauder (LAE) in the south also had at least one of the summer months where rainfall was significantly lower during El Niño, while Gore (GCE) tended to have lower rainfall under La Niña for two of the 3-month summer season.

Autumn (Mar/Apr/May) rainfalls (Table 3) were significantly lower at Te Puke (TPE) during both El Niño (-250 mm or -49%) and La Niña (-100 mm or -20%) conditions. They were also lower in El Niño (-130 mm or -26%) at Coromandel (COR), but slightly higher during La Niña (+40 mm or 8%). Lauder (LAE) was the only other station to show significant differences during autumn, with higher rainfalls under both La Niña (+70 mm or 80%) and El Niño (+30 mm or 37%) compared with neutral conditions. For individual autumn months (see Appendix 2), Whangarei (WRA), Whakatane (WKA) and Gisborne (GSA) had at least one month where rainfall was significantly lower with El Niño, whereas New Plymouth (NPA), Ohakea (OHA) and Paraparaumu (PPA) had months where rainfall was higher under both El Niño and la Niña. Westport (WSA) (higher in La Niña), Lumsden (LUX) (higher in El Niño) and Invercargill (NVA) (lower under both El Niño and La Niña) wre other stations to also show significant difference for at least one month during autumn.

Average fire season (Oct-Apr) temperatures (Table 4) were generally lower in the west and south of both islands during El Niño and, in some cases, also higher during La Niña conditions. Paraparaumu (PPA), for example, showed significantly lower temperatures (-0.3 ºC) under El Niño, but warmer conditions (+0.3 ºC) under La Niña. Wellington (WNA) and New Plymouth (NPA) (and Queenstown (QNA) when medians were considered) also showed lower temperatures (-0.4 ºC) under El Niño. Whakatane (WKA), Waiouru (RUX) and Levin (LNX) (plus Pearoa (PAX) and Timaru (TUA) when medians were used) showed higher average temperatures (+0.5 to 0.9 ºC) during La Niña and also (+0.4 to +0.7 ºC) under El Niño, compared with neutral conditions. On the South Island’s West Coast, both Westport (WSA) and Hokitika (HKA) had lower average temperatures (-0.6 ºC) during El Niño and warmer conditions during La Niña (+0.3/+0.4 ºC). Invercargill (NVA) also showed cooler conditions (-0.4 ºC) during El Niño.

For climate seasons (Table 5), average winter (June/July/Aug) temperatures were significantly different at a number of stations and, in most cases, were higher during La Niña. Kaitaia (KX), Coromandel (COR), Waiouru (RUX), Westport (WSA) and Christchurch (CHA) all showed increases (+0.5 to +3.2 ºC) during La Niña, as did Paraparaumu (PPA), Wellington (WNA) and Nelson (NSA) (+0.4 to +0.5 ºC). Winter temperatures at Rotorua (ROA), Gisborne (GSA) and Hokitika (HKA) also increased (+0.4 to +0.5 ºC) during La Niña and decreased (-0.3 ºC) during El Niño, whereas Manapouri (MOA) showed an increase during both La Niña and El Niño (+1.8 ºC/ +0.8 ºC). Winter conditions at Whitianga (WTA), Napier (NRA) and Levin (LNX) all decreased during La Niña (-1.4 to -2.0 ºC). In the majority of cases, these differences were the result of significant differences during a single month, typically June (month 12) or July (month 1) (see Appendix 2).

Weather Station	No. Fire Seasons			Temperature			
	El Niño	Neutral	La Niña	El Niño	Neutral	La Niña	Prob/Sig.
KX	15	17	11	20.0	20.1	20.4	0.21
WRA	4	6	4	20.5	20.1	20.5	0.47
DAR	8	12	7	20.0	20.2	19.9	0.80
AKL	13	16	10	19.5	19.9	20.0	0.13
HNA	4	6	4	19.6	19.3	20.0	0.21
COR	6	9	5	19.6	19.6	20.1	0.26
WTA	4	6	4	20.3	19.8	20.3	0.35
PAX	4	6	4	20.1	19.7	20.3	0.35
TGA	11	15	9	19.6	19.6	19.8	0.66
TPE	4	6	4	20.3	19.7	20.3	0.15
WKA	4	6	4	20.2	19.5	20.4	**0.05**
ROA	14	17	10	18.2	18.2	18.5	0.51
APA	8	12	7	16.4	16.5	17.0	0.21
GSA	15	17	11	20.4	20.3	20.4	0.93
NRA	4	6	4	20.0	19.2	19.5	0.20
NPA	15	17	11	17.8	18.2	18.4	**0.06**
RUX	4	6	4	14.9	14.4	15.4	**0.05**
WUA	8	12	7	18.0	18.3	18.7	0.22
OHA	12	15	7	18.2	18.7	18.9	0.15
LNX	4	6	4	18.1	17.8	18.7	**0.07**
CPX	4	6	4	17.0	16.7	16.9	0.85
MSX	4	6	4	19.3	18.5	19.2	0.24
PPA	15	17	11	17.3	17.6	17.9	**0.09**
WNA	15	19	11	17.1	17.5	17.5	**0.07**
NSA	15	17	11	18.1	18.3	18.4	0.33
WBA	4	6	4	19.5	19.0	19.3	0.74
KIX	14	17	10	15.8	15.9	15.9	0.75
WSA	11	15	9	16.2	16.8	17.1	**0.02**
HKA	14	17	10	15.9	16.4	16.8	**0.00**
CHA	15	19	11	17.7	17.7	17.8	0.77
TUA	4	6	4	16.8	16.3	16.8	0.38
THE	4	6	4	16.8	16.1	16.7	0.19
OUA	4	6	4	15.7	15.4	15.9	0.52
DNA	14	17	11	16.1	16.3	16.5	0.32
LAE	4	6	4	16.5	16.3	16.2	0.69
QNA	8	12	7	14.6	15.0	15.2	0.30
LUX	4	6	4	14.9	15.0	15.6	0.37
GCE	4	6	4	14.4	14.6	14.9	0.45
MOA	4	6	4	14.8	14.9	15.4	0.28
NVA	15	19	11	14.4	14.9	14.9	**0.02**

Table 4. Average fire season (Oct-Apr) temperatures for 40 weather stations under the three ENSO phases (based on mean values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when medians rather than means were compared.

Weather Station	1 = Winter				2 = Spring				3 = Summer				4 = Autumn			
	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob
KX	14.3	14.5	15.0	**0.01**	16.6	16.7	17.2	**0.06**	21.4	21.8	21.9	**0.08**	18.7	19.4	19.6	**0.00**
WRA	14.3	14.3	15.1	0.28	17.2	17.1	17.6	0.58	21.6	21.7	22.2	0.50	18.6	19.2	19.5	**0.00**
DAR	14.1	14.6	14.5	0.36	17.0	17.0	17.0	0.79	21.2	21.7	21.6	0.24	18.3	19.6	19.0	**0.00**
AKL	13.1	13.3	13.9	**0.02**	16.2	16.6	16.9	0.11	21.0	21.4	21.8	**0.05**	17.9	18.6	18.8	**0.00**
HNA	11.8	12.1	12.9	0.34	15.8	16.3	16.6	0.18	20.8	21.1	21.9	0.17	17.0	17.9	18.5	**0.00**
COR	13.6	13.7	14.6	**0.05**	16.4	16.6	17.1	0.14	21.2	21.2	21.3	0.94	18.2	18.8	19.2	**0.00**
WTA	14.0	13.8	12.4	**0.02**	16.8	16.9	17.2	0.75	21.3	21.3	21.9	0.44	18.4	19.0	19.6	**0.00**
PAX	13.0	12.9	13.1	0.94	16.3	16.6	17.0	0.56	21.3	21.5	22.3	0.22	17.6	18.5	19.1	**0.00**
TGA	13.1	13.1	13.7	**0.06**	16.4	16.5	16.8	0.26	21.1	21.2	21.6	0.16	17.9	18.5	18.8	**0.00**
TPE	13.5	13.5	14.4	0.22	16.8	16.8	17.3	0.67	21.4	21.2	22.2	0.11	18.0	18.7	19.5	**0.00**
WKA	13.1	13.0	13.3	0.79	16.6	16.6	17.1	0.51	21.5	21.1	22.2	**0.05**	17.8	18.5	19.3	**0.00**
ROA	10.6	10.9	11.4	**0.02**	14.7	14.8	15.3	**0.04**	19.9	20.0	20.3	0.39	15.9	16.4	16.7	**0.00**
APA	9.5	9.6	10.2	0.31	13.0	13.4	13.8	0.13	18.0	18.3	18.9	**0.06**	14.2	15.0	15.3	**0.00**
GSA	12.8	13.1	13.6	**0.06**	17.3	17.1	17.8	0.12	22.1	22.2	22.2	0.88	18.1	18.5	18.6	**0.00**
NRA	13.0	12.7	11.0	**0.01**	17.0	16.4	16.9	0.46	21.3	20.6	21.3	0.39	17.2	17.8	18.2	**0.00**
NPA	12.1	12.3	12.3	0.41	14.6	15.1	15.3	**0.06**	19.1	19.7	20.0	**0.01**	16.5	17.2	17.7	**0.00**
RUX	7.4	7.1	10.3	**0.00**	10.6	11.2	11.9	0.35	16.1	16.4	17.4	0.16	12.4	12.7	13.9	**0.00**
WUA	12.3	12.2	11.8	0.34	15.0	15.4	15.7	0.23	19.2	19.8	20.3	**0.03**	16.4	17.1	17.7	**0.00**
OHA	11.3	11.5	11.9	0.17	15.2	15.3	15.6	0.40	19.9	20.4	20.4	0.25	16.1	17.1	17.5	**0.00**
LNX	11.8	11.8	9.8	**0.01**	14.4	15.0	15.3	0.29	18.9	19.3	20.5	**0.04**	15.9	17.1	17.6	**0.00**
CPX	11.5	11.4	11.6	0.85	13.9	14.3	14.0	0.56	18.2	18.1	18.6	0.65	15.9	15.6	16.4	**0.00**
MSX	11.7	10.8	11.2	0.33	15.5	15.6	15.7	0.97	20.6	20.3	21.4	0.35	16.2	16.6	17.7	**0.00**
PPA	11.6	11.8	12.3	**0.02**	14.3	14.6	14.9	**0.09**	18.6	19.1	19.5	**0.00**	15.9	16.5	17.0	**0.00**
WNA	11.3	11.5	12.0	**0.03**	14.2	14.6	14.7	0.27	18.4	19.0	19.2	**0.03**	15.5	16.1	16.5	**0.00**
NSA	9.4	8.9	9.3	**0.37**	13.2	12.9	13.6	0.47	16.5	16.7	17.3	**0.32**	13.6	14.0	14.7	**0.00**
WBA	11.4	11.0	11.2	0.69	16.2	16.0	16.0	0.89	21.0	20.6	21.5	0.32	16.4	17.1	17.6	**0.00**
KIX	9.8	9.7	10.1	0.48	12.8	13.0	13.2	0.65	17.1	17.5	17.4	0.41	14.1	14.5	14.7	**0.00**
WSA	11.0	11.0	11.8	**0.03**	13.6	14.2	14.5	**0.01**	17.2	18.1	18.6	**0.00**	15.1	15.7	16.5	**0.00**
HKA	10.2	10.6	10.9	**0.04**	13.3	13.8	14.1	**0.02**	17.1	17.7	18.2	**0.00**	14.5	15.2	15.9	**0.00**
CHA	9.3	9.4	10.4	**0.01**	14.7	14.8	15.2	0.41	19.4	19.5	19.5	0.81	14.8	15.2	15.7	**0.00**
TUA	9.6	8.9	9.2	0.21	14.3	13.7	14.1	0.57	17.9	17.8	18.7	0.23	14.1	14.7	15.2	**0.00**
THE	6.1	5.6	5.8	0.61	13.2	13.4	13.3	0.98	18.8	18.1	19.5	0.16	12.3	13.0	13.6	**0.00**
OUA	9.4	8.9	9.3	0.37	13.2	12.9	13.6	0.47	16.5	16.7	17.3	0.32	13.6	14.0	14.7	**0.00**
DNA	8.2	8.1	8.2	0.94	13.7	13.9	14.1	0.33	17.5	17.8	18.3	**0.04**	13.3	13.8	14.2	**0.00**
LAE	6.2	5.8	4.8	0.19	13.1	13.6	12.8	0.59	18.4	18.3	19.1	0.51	12.2	13.1	13.4	**0.00**
QNA	5.8	5.7	6.3	0.60	11.8	12.4	12.2	0.41	16.5	16.9	17.4	0.16	11.7	12.1	12.8	**0.00**
LUX	7.4	7.2	7.2	0.90	11.1	12.2	12.9	0.20	16.2	16.7	17.8	0.26	11.9	13.0	14.4	**0.00**
GCE	7.0	6.6	7.4	0.32	11.7	12.4	12.3	0.34	15.7	16.3	16.9	**0.07**	11.7	12.1	13.4	**0.00**
MOA	6.9	6.1	8.0	**0.01**	11.7	12.5	12.3	0.37	16.5	16.8	17.7	**0.09**	11.7	12.2	13.6	**0.00**
NVA	7.6	7.8	7.9	0.64	12.2	12.7	12.6	**0.05**	15.7	16.3	16.5	**0.01**	12.3	12.8	13.4	**0.00**

Table 5. Average 3-monthly climate season temperatures for 40 weather stations under the three ENSO phases (based on mean values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold.

Fewer stations showed significant differences between ENSO event types during spring (Sept/Oct/Nov) (Table 5). Temperatures were higher (+0.6 ºC) at Rotorua (ROA) during La Niña, but lower (-0.5 to -0.6 ºC) at Westport (WSA), Hokitika (HKA) and Invercargill (NVA) during El Niño. Kaitaia (KX) and Paraparaumu (PPA) both showed evidence of increases (+0.3 to +0.4 ºC) during La Niña and decreases (-0.2 to -0.3 ºC) during El Niño. In almost all cases, these differences were due to significant differences in average temperatures during October and/or November (months 4 and 5) (see Appendix 2).

During summer (Dec/Jan/Feb), significant temperature differences occurred in the west and south of both islands, and tended to include both increases during La Niña and decreases during El Niño (Table 5). Stations showing both these trends included Auckland (AKL), Taupo (APA), Wanganui (WUA), Levin (LNX), Paraparaumu (PPA), Nelson (NSA), Westport (WSA) and Hokitika (HKA), Dunedin (DNA), Gore (GCE), Manapouri (MOA) and, to a lesser extent, Wellington (WNA) and Invercargill (WNA). In most cases, these differences were due to significant temperature differences for the month of December, although in a few instances February temperatures were also significantly different (see Appendix 2)

Autumn (Mar/Apr/May) temperatures were significantly different at all stations (Table 5), with cooler conditions (-0.3 to -1.2 ºC lower) during El Niño and higher temperatures (+0.1 to +1.5 ºC) during La Niña.

FWI System components

Average October-April fire season estimates of Fine Fuel Moisture Code (FFMC) used median values (Table 6), and generally followed the observed differences in temperature and rainfall for individual stations. However, effects were relatively small at just a few points (+/-5 points or +/-7%). Decreases in rainfall under El Niño (and, in some cases, also La Niña) conditions in the central and western North Island resulted in significantly higher (i.e., drier and more flammable) average fire season FFMC values at Tauranga (TGA), Rotorua (ROA), New Plymouth (NPA) and Wanganui (WUA) (plus Taupo (APA) and Christchurch (CHA) when mean values were used) under both El Niño and La Niña compared to neutral conditions. Average FFMC values at Napier (NRA) were also higher under El Niño conditions only, in response to a non-significant decrease in rainfall under this phase. Fire season FFMC values at Westport (WSA) and Hokitika (HKA) were lower (i.e., damper and less flammable) during El Niño compared to neutral conditions but were higher during La Niña, in the former case despite non-significant decreases in average fire season rainfall. Despite the greatest difference in average FFMC values (-8.6 points or 11%), which occurred from neutral to La Niña conditions, Te Puke (TPE) did not show a significant difference from FFMC values under other ENSO phases.

For climate seasons (Table 7), average winter (June/July/Aug) FFMC values were significantly different at a number of stations, and generally higher in the El Niño phase (by +3 to +8 points) for Kaitaia (KX), Whangarei (WRA), Coromandel (COR), most Bay of Plenty stations (Paeroa (PAX), Tauranga (TGA), Whakatane (WKA) and Rotorua (ROA)), New Plymouth (NPA), Ohakea (OHA) and the north of the South Island (Nelson (NSA) and Blenheim (WBA)). However, in several instances (Te Puke (TPE), Whakatane (WKA), Napier (NRA) and Kaikoura (KIX)), winter FFMC values were higher during both El Niño and neutral phases and significantly lower during La Niña (by -3 to -55 points); Te Puke (TPE) in particular, showed an average FFMC of less than 10 under La Niña conditions compared with values of 64 to 66 for neutral and El Niño conditions. In the east of the South Island (Oamaru (OUA) and Timaru (TUA), and at Masterton (MSX), FFMCs were higher in both El Niño and La Niña phases, and lowest during neutral conditions (by -7 to -8 points). The higher values of winter FFMC for the El Niño phase reflected the fairly widespread reduction in El Niño winter rainfall over many North Island areas and the north of the South Island compared with the neutral and La Niña phases. No winter month appeared to dominate, although at Te Puke (TPE), Napier (NRA), Ohakea (OHA) and Nelson (NSA), all winter months were significant (see Appendix 2).

In spring (Sep/Oct/Nov), only four locations showed significant differences (Table 7). At Te Puke (TPE), New Plymouth (NPA) and Ohakea (OHA), FFMC values were significantly lower in La Niña (by -2 to -25 points), and higher during El Niño and neutral phases, whereas at Invercargill (NVA) the neutral phase was higher and El Niño lowest (but only by -4 FFMC points). September was the important contributor month for North Island locations (see Appendix 2).

During summer (Dec/Jan/Feb), no significant differences occurred for the FFMC, whilst autumn (Mar/Apr/May) differences were only significant in the south of the South Island at Lumsden (LUX) and Invercargill (NVA) with higher values (by +7 to +20 points) in the La Niña phase and lowest values in El Niño (see Table 7). April and May were the contributing months.

Weather Station	FFMC				BUI			
	El Niño	Neutral	La Niña	Prob/Sig.	El Niño	Neutral	La Niña	Prob/Sig.
KX	82.7	82.0	82.7	0.72	20.1	17.6	18.4	0.72
WRA	83.9	82.8	81.8	0.40	24.5	22.2	17.9	0.46
DAR	81.1	77.9	77.7	0.81	20.0	17.3	17.7	0.95
AKL	82.2	82.3	82.1	0.71	20.3	19.9	19.6	0.98
HNA	81.9	81.3	82.4	0.11	17.0	14.8	18.8	0.11
COR	81.7	80.6	80.7	0.86	16.7	13.7	13.7	0.63
WTA	82.4	81.5	82.0	0.46	16.6	15.8	16.0	1.00
PAX	82.6	82.1	82.8	0.46	20.3	19.1	18.1	1.00
TGA	84.1	82.0	83.5	**0.01**	25.5	17.2	19.6	**0.00**
TPE	76.3	78.0	69.4	0.46	16.5	15.9	12.7	**0.07**
WKA	84.4	82.9	83.7	0.40	27.3	18.9	20.4	**0.07**
ROA	82.5	80.9	81.9	**0.07**	18.6	13.8	15.5	0.35
APA	81.7	80.7	81.9	0.39	18.4	14.5	17.6	0.39
GSA	85.2	84.5	84.4	0.23	35.3	26.6	31.8	0.23
NRA	85.6	83.9	84.1	**0.02**	44.0	28.3	28.6	0.40
NPA	78.6	78.0	79.2	**0.08**	12.0	10.2	12.0	0.91
RUX	71.5	69.6	73.1	0.46	10.8	8.5	10.5	0.46
WUA	80.5	79.8	81.8	**0.07**	15.2	13.4	19.0	**0.04**
OHA	82.8	82.8	83.9	0.44	21.4	20.6	23.6	0.77
LNX	79.3	78.5	80.4	0.40	22.2	14.1	19.3	0.46
CPX	82.1	79.1	82.4	0.11	22.3	14.0	19.5	0.46
MSX	83.6	82.0	82.8	1.00	31.0	20.8	22.6	1.00
PPA	81.4	81.1	82.2	0.32	19.3	15.6	21.2	0.32
WNA	82.4	81.9	82.6	0.34	21.6	17.5	22.8	0.74
NSA	83.2	82.9	83.1	0.32	25.8	21.4	23.4	0.72
WBA	86.5	85.4	85.7	0.46	45.0	32.7	51.4	0.46
KIX	79.8	79.6	80.5	0.23	23.8	18.6	25.5	0.64
WSA	67.4	68.7	72.6	**0.02**	5.0	5.2	6.4	0.45
HKA	65.1	66.1	70.9	**0.04**	4.2	4.6	5.4	0.31
CHA	84.9	84.2	84.6	0.57	41.8	36.5	44.0	0.22
TUA	82.6	81.3	81.5	0.46	33.8	23.5	29.2	0.46
THE	86.9	84.4	85.8	0.46	50.2	38.7	51.0	0.11
OUA	79.2	77.4	80.3	0.46	20.7	15.4	21.2	1.00
DNA	81.5	80.8	81.5	0.64	23.0	20.8	26.4	0.16
LAE	85.7	84.8	85.0	1.00	39.4	39.7	39.4	1.00
QNA	82.3	82.8	83.2	0.37	20.5	22.3	26.2	0.37
LUX	73.9	71.5	74.8	1.00	9.9	9.7	13.5	0.40
GCE	74.5	75.0	76.7	0.46	10.0	10.6	12.7	0.46
MOA	76.4	77.3	78.3	0.46	10.4	12.1	14.6	0.46
NVA	73.2	75.2	75.5	0.91	8.2	9.8	9.7	0.29

Table 6. Average fire season (Oct-Apr) Fine Fuel Moisture Code (FFMC) and Buildup Index (BUI) values for 40 weather stations under the three ENSO phases (based on median values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when means rather than medians were compared.

Weather Station	1 = Winter				2 = Spring				3 = Summer				4 = Autumn			
	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob
KX	67.8	64.6	63.8	**0.01**	77.7	77.0	76.7	0.59	84.1	83.6	84.3	0.95	79.4	80.4	82.0	0.63
WRA	69.8	65.1	65.3	**0.08**	81.4	78.6	81.0	0.58	85.5	84.3	84.8	0.92	81.9	76.0	80.3	0.12
DAR	58.5	57.1	59.8	0.53	74.9	73.7	75.9	0.68	83.1	79.5	77.2	0.67	76.5	75.4	79.3	0.27
AKL	66.0	63.7	64.3	0.19	77.9	78.4	76.3	0.51	83.9	83.4	83.8	0.95	79.3	78.5	80.9	0.35
HNA	58.6	62.1	58.6	0.38	76.7	75.7	78.2	0.83	83.9	82.0	84.6	0.76	76.2	76.4	80.8	0.29
COR	69.0	62.7	63.9	**0.00**	77.6	74.0	76.4	0.31	83.6	82.2	82.2	0.78	79.3	78.2	81.6	0.52
WTA	64.6	62.4	55.6	0.10	79.9	77.4	81.1	0.87	84.1	82.4	83.1	0.95	81.2	77.4	80.2	0.69
PAX	65.5	57.6	61.0	**0.01**	77.6	77.9	77.7	0.94	83.0	82.6	84.4	0.82	78.4	79.8	79.5	0.84
TGA	75.1	70.5	69.9	**0.02**	81.0	78.9	79.3	0.51	85.3	83.2	84.3	0.91	77.8	81.2	83.0	0.28
TPE	66.0	64.4	9.6	**0.00**	64.4	72.3	47.3	**0.03**	83.0	76.4	68.6	0.22	73.1	75.6	69.6	0.69
WKA	75.7	73.2	66.2	**0.00**	81.8	80.4	81.7	0.87	85.5	83.3	84.9	0.63	82.5	81.6	82.1	0.87
ROA	71.3	66.7	66.9	**0.00**	79.1	76.5	77.2	0.29	83.9	81.5	82.1	0.34	80.4	79.1	80.8	0.61
APA	69.6	68.2	66.7	0.46	77.6	76.7	76.9	0.92	83.4	81.6	83.0	0.67	80.0	79.3	81.1	0.81
GSA	75.0	73.9	72.4	0.24	83.6	82.7	83.9	0.77	86.4	85.4	85.4	0.78	82.5	81.8	80.5	0.65
NRA	80.2	78.6	58.3	**0.00**	84.9	82.4	84.3	0.33	85.6	83.4	84.9	0.40	83.5	82.8	82.9	0.89
NPA	65.8	62.8	61.4	**0.05**	72.1	73.7	67.6	**0.02**	79.2	79.5	81.0	0.72	77.4	76.9	80.1	0.46
RUX	43.4	40.1	52.9	0.18	57.3	61.0	65.9	0.41	74.9	72.9	79.0	0.70	57.7	59.3	67.4	0.47
WUA	67.3	66.4	64.5	0.77	76.8	76.4	76.3	0.97	81.6	80.8	83.3	0.78	76.9	78.3	81.9	0.69
OHA	75.5	70.1	69.8	**0.00**	80.2	80.0	76.6	**0.09**	84.0	83.8	83.8	0.84	80.5	80.9	83.3	0.65
LNX	65.6	62.8	66.2	0.71	70.5	74.0	71.7	0.69	78.6	77.1	83.2	0.50	78.1	78.7	78.9	0.98
CPX	72.2	69.3	74.5	0.32	81.5	77.5	79.3	0.58	82.8	79.5	83.0	0.71	74.1	79.7	81.5	0.17
MSX	69.3	61.3	65.7	**0.02**	81.4	77.5	78.4	0.50	84.6	83.5	85.2	0.93	78.0	78.0	79.7	0.87
PPA	71.9	71.0	69.9	0.40	77.2	78.0	77.5	0.79	82.0	82.0	83.4	0.63	81.0	80.3	82.0	0.61
WNA	69.9	69.5	70.0	0.95	79.7	79.1	78.8	0.74	83.1	82.9	84.0	0.91	80.2	79.9	81.0	0.90
NSA	76.5	70.0	72.0	**0.00**	80.6	79.9	79.6	0.78	83.5	83.7	84.0	0.81	82.2	81.6	83.0	0.64
WBA	80.7	77.9	74.8	**0.01**	84.7	82.5	82.4	0.54	86.6	86.3	87.4	0.87	84.2	85.0	84.9	0.97
KIX	76.7	76.1	73.4	**0.10**	78.6	77.8	79.4	0.53	80.3	80.6	80.9	0.96	79.0	78.4	78.2	0.94
WSA	51.1	55.0	57.5	0.21	56.7	62.8	60.0	0.35	69.7	69.6	76.5	0.16	67.6	63.1	71.9	0.11
HKA	53.2	52.5	51.2	0.90	55.7	59.0	58.3	0.68	67.2	67.5	72.6	0.44	63.2	60.5	67.2	0.38
CHA	74.3	72.7	74.2	0.41	83.6	83.1	83.5	0.83	85.3	85.1	85.4	0.94	82.3	81.7	81.3	0.93
TUA	80.7	73.0	79.2	**0.04**	82.8	79.1	80.1	0.36	82.6	81.9	81.3	0.88	81.6	81.0	80.7	1.00
THE	71.6	72.8	75.3	0.74	86.5	82.9	82.9	0.43	87.2	84.4	88.1	0.47	81.5	82.7	82.8	0.99
OUA	79.7	73.0	76.5	**0.10**	81.0	76.1	78.8	0.25	78.5	76.9	80.5	0.57	76.5	79.2	79.8	0.64
DNA	72.4	70.8	72.4	0.42	80.1	80.3	80.8	0.97	81.6	81.5	81.9	0.98	77.6	78.7	79.1	0.77
LAE	76.8	75.7	74.0	0.52	85.5	84.8	81.6	0.43	85.5	84.8	86.6	0.64	81.7	82.8	81.2	0.77
QNA	66.9	67.3	68.8	0.64	81.2	81.9	80.5	0.88	83.7	83.0	85.0	0.63	76.2	78.5	79.6	0.74
LUX	52.1	55.1	62.6	0.43	71.0	72.0	73.2	0.69	76.1	73.3	77.4	0.87	54.7	67.8	75.4	**0.04**
GCE	60.2	59.9	65.6	0.46	71.1	76.8	72.5	0.16	73.9	77.5	78.7	0.20	69.3	71.5	74.6	0.59
MOA	38.4	42.2	41.6	0.66	70.6	74.5	72.3	0.52	77.9	79.8	82.3	0.89	64.2	67.1	72.0	0.72
NVA	54.6	57.4	57.6	0.16	70.3	74.6	72.5	**0.08**	75.1	76.6	77.1	0.60	63.6	68.0	70.7	**0.06**

Table 7. Average 3-monthly climate season Fine Fuel Moisture Code (FFMC) values for 40 weather stations under the three ENSO phases (based on median values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold.

Estimates of average fire season (Oct-Apr) Buildup Index (BUI), again described using median values (Table 6), also generally followed rainfall trends for the different ENSO phases (see Figures 8 and 9). Differences were typically in the order of +/-8 points (+/-50%), although were as high as +/-19 points (+/-60%). Fire season BUI values were generally higher under El Niño conditions in the Waikato (Coromandel, COR), Bay of Plenty (Tauranga (TGA), Te Puke (TPE), Whakatane (WKA) and, using means, also Rotorua (ROA) (see Figure 8)), and under both El Niño and La Niña in the eastern (Gisborne, GSA), central (Taupo, APA) and western (Wanganui, WUA) North Island, central region (Paraparaumu, PPA) and eastern South Island. Fire season BUI values were higher under La Niño and lower in El Niño conditions in the west (Westport (WSA) and Hokitika (HKA)) and south of the South Island. Napier (NRA), Masterton (MSX) and Timaru (TUA) showed large (10 to 16 points, or 29% to 56%) but non-significant increases in BUI under El Niño conditions, as did Woodbourne (WBA) and Tara Hills (THE) under both El Niño and La Niña events (+11 to +19 points, or 29% to 57%) compared to neutral conditions.

For climate seasons (Table 8), no significant differences occurred in BUI for winter months (Jun/Jul/Aug), and in spring (Sep/Oct/Nov) only at Invercargill (NVA) were neutral and La Niña phase values higher (by +1 to +2 points). Similarly, individual winter and spring months (Appendix 2) did not display any significant relationships.

However, in summer (Dec/Jan/Feb) there were significant differences in BUI between the northeast and southwest of New Zealand (see Table 8). El Niño phase BUI was +6 to +20 points higher in the Waikato, Coromandel, Bay of Plenty (Hamilton (HNA), Coromandel (COR), Tauranga (TGA), Te Puke (TPE), Whakatane (WKA), Rotorua (ROA) (see Figure 8) and Taupo (APA)) and east (Gisborne (GSA) and Napier (NRA)) of the North Island. For the southwest of the North Island (Levin (LNX) and Paraparumu (PPA)), and west (Westport (WSA) and Hokitika (HKA)) and south (Tara Hills (THE), Queenstown (QNA), Gore (GCE) and Invercargill (NVA)) of the South Island, La Niña phase BUI was between +3 and +10 points higher. The significant differences in the north and east of the North Island were spread over all summer months; for the west of the South Island, these were confined to January, and Jan/Feb in the south of the South Island (see Appendix 2).

In autumn (Mar/Apr/May) (see Table 8), significant differences in BUI values were confined to the southwest of the North Island (Wanganui (WUA) and Ohakea (OHA)) and south and west of the South Island (Hokitika (HKA), Lauder (LAE), Queenstown (QNA), Lumsden (LUX) and Invercargill (NVA)). BUI values were several points higher for the La Niña phase (+8 to +10 points) in the southern North Island, with

Weather Station	1 = Winter				2 = Spring				3 = Summer				4 = Autumn			
	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob
KX	2.2	1.6	1.7	0.96	8.1	7.0	6.8	0.86	28.0	27.4	28.4	0.93	14.5	16.0	15.0	0.83
WRA	4.3	2.0	2.4	0.90	11.0	8.6	11.6	0.97	40.8	29.9	27.3	**0.07**	22.1	19.7	13.7	0.42
DAR	1.7	1.3	1.6	0.97	7.9	8.1	10.3	0.70	30.1	26.0	24.4	0.20	12.2	15.2	11.2	0.40
AKL	1.8	1.6	1.6	0.99	8.3	8.5	6.7	0.77	28.5	27.0	31.8	0.21	14.5	14.8	16.0	0.89
HNA	1.4	2.1	1.1	0.95	6.6	8.0	8.0	0.92	30.4	19.8	24.7	**0.02**	9.8	12.2	18.1	0.27
COR	2.8	1.6	1.6	0.71	6.6	5.5	6.7	0.80	28.6	20.8	17.0	**0.00**	11.1	9.2	10.2	0.58
WTA	1.6	1.8	1.4	0.95	8.2	8.1	12.0	0.37	22.2	20.5	22.0	0.86	17.2	12.3	11.4	0.24
PAX	2.1	1.4	2.0	0.98	9.0	9.0	8.5	0.99	32.5	24.1	25.9	0.18	13.2	19.1	13.3	0.40
TGA	4.4	3.1	2.8	0.71	11.8	9.3	9.2	0.52	37.9	24.6	28.0	**0.00**	15.1	14.6	16.5	0.74
TPE	3.4	3.1	0.2	0.71	8.8	9.3	4.8	0.36	28.7	19.0	17.7	**0.00**	16.2	12.4	8.8	0.27
WKA	3.5	3.3	2.0	0.97	12.3	10.1	10.0	0.76	43.1	21.5	28.2	**0.00**	20.3	16.7	13.0	0.53
ROA	2.8	1.9	1.7	0.83	8.6	6.5	6.8	0.54	28.0	20.3	20.5	**0.00**	13.3	11.1	11.4	0.55
APA	2.0	4.7	1.6	0.34	6.7	8.3	7.3	0.82	25.8	19.2	20.3	**0.05**	13.5	14.0	17.5	0.56
GSA	6.0	4.7	5.8	0.93	19.5	14.7	20.5	0.46	52.6	40.0	42.4	**0.02**	21.0	19.7	27.4	0.44
NRA	9.6	7.2	2.5	0.66	21.1	20.5	25.3	0.80	59.1	26.9	39.4	**0.00**	26.1	23.8	15.5	0.59
NPA	1.6	1.3	1.2	0.96	4.8	5.0	3.4	0.50	16.1	15.7	16.9	0.75	8.1	8.6	10.9	0.39
RUX	0.4	0.6	1.0	0.99	2.2	4.8	4.5	0.49	14.3	11.3	14.6	0.51	2.7	7.2	8.5	0.31
WUA	3.3	3.2	1.6	0.82	7.8	8.1	7.6	0.96	21.2	18.3	23.5	0.11	9.6	12.3	22.2	**0.00**
OHA	4.6	3.2	2.6	0.65	10.8	10.2	7.8	0.44	27.5	27.3	28.2	0.95	16.4	17.8	26.8	**0.01**
LNX	3.3	2.4	3.8	0.95	5.4	7.8	5.6	0.75	21.9	14.4	28.0	**0.02**	13.4	19.8	17.7	0.46
CPX	3.1	2.4	2.9	0.98	9.9	8.0	10.0	0.95	29.5	18.9	28.2	0.10	16.6	12.4	12.3	0.74
MSX	3.4	2.5	3.0	0.99	10.9	12.0	10.4	0.81	37.1	27.3	33.1	0.35	18.8	20.1	19.7	0.99
PPA	3.6	3.1	2.8	0.93	7.8	7.7	7.2	0.88	23.4	21.4	28.6	**0.02**	15.3	18.1	20.1	0.36
WNA	3.1	2.4	2.7	0.94	8.9	8.5	7.4	0.82	28.8	25.0	30.3	0.11	16.0	15.6	16.8	0.92
NSA	6.2	3.8	4.4	0.58	12.3	9.4	9.5	0.54	33.5	33.1	28.6	0.34	18.7	22.6	18.5	0.25
WBA	11.2	8.9	5.9	0.93	23.4	17.7	14.9	0.80	57.8	40.3	65.1	0.13	34.6	46.1	33.6	0.55
KIX	10.3	6.2	6.2	0.26	15.1	11.3	15.3	0.40	32.4	26.4	30.8	0.28	21.1	18.5	15.0	0.54
WSA	1.0	1.3	1.3	0.78	2.0	3.2	2.5	0.39	6.1	7.0	9.6	**0.00**	4.3	3.8	5.1	0.20
HKA	1.3	1.4	1.2	0.98	2.3	2.6	2.2	0.88	5.7	6.7	7.2	**0.04**	3.0	3.1	4.4	**0.09**
CHA	8.9	7.0	7.4	0.87	23.5	22.6	24.9	0.90	52.0	49.5	55.1	0.64	34.4	29.7	32.9	0.62
TUA	19.2	11.4	14.8	0.53	27.1	16.5	19.7	0.52	39.0	26.7	34.4	0.46	35.7	36.3	21.8	0.48
THE	9.9	7.7	7.0	0.95	33.1	27.9	22.8	0.74	53.9	37.2	68.2	**0.08**	29.0	45.7	29.3	0.26
OUA	10.1	10.2	7.2	0.81	22.9	11.7	14.4	0.25	20.1	17.9	23.1	0.82	12.6	25.9	12.6	0.19
DNA	5.2	5.6	6.7	0.91	16.7	16.2	18.5	0.73	25.1	25.4	28.0	0.65	17.5	21.1	21.4	0.54
LAE	13.0	11.4	6.3	0.81	37.1	32.8	24.1	0.57	45.4	47.3	55.6	0.64	26.5	49.4	22.8	**0.05**
QNA	2.6	2.1	2.7	0.98	10.8	14.5	8.7	0.17	26.6	27.6	35.7	**0.01**	11.9	18.0	20.0	**0.08**
LUX	0.8	1.9	1.7	0.94	5.3	6.2	8.0	0.77	12.2	14.0	15.4	0.58	2.0	8.6	12.9	**0.10**
GCE	0.8	1.1	1.7	0.93	5.5	7.9	5.7	0.46	12.1	16.9	17.8	**0.03**	4.5	8.0	9.6	0.15
MOA	0.3	0.5	0.5	0.98	4.3	6.7	5.6	0.64	14.2	17.8	23.0	**0.00**	4.7	6.1	10.0	0.22
NVA	0.6	0.8	0.7	0.95	4.5	6.6	5.7	**0.09**	11.7	13.7	14.6	**0.02**	2.8	5.4	5.4	**0.03**

Table 8. Average 3-monthly climate season Buildup Index (BUI) values for 40 weather stations under the three ENSO phases (based on median values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold.

neutral and/or La Niña phase BUI higher (+1 to +8 points) in the south of the South Island. April was the key month of signifcant differences in the south west of the North Island and some southern New Zealand locations (see Appendix 2).

Fire season severity measures

Average fire season (Oct-Apr) values for the Daily Severity Rating (DSR) (Table 9), described using median values, also varied under different ENSO phases, and generally reflected differences seen in rainfall and temperature as well as the FFMC and BUI components (see Figures 8 and 9). Fire season DSR values were generally higher (i.e., more severe fire weather conditions) under both El Niño and La Niña conditions in the Bay of Plenty region (Tauranga (TGA), Rotorua (ROA), Taupo (APA), and also Whakatane (WKA) when means were compared) and, to a lesser extent, the eastern North Island (Napier (NRA, plus Gisborne (GSA), Castle Point (CPX) and Masterton (MSX) using means). Increases in average DSR tended to highest under El Niño at these locations, with values frequently 2-3 times those under neutral conditions due to a greater number of days having higher DSR values. Although not statistically significant, fire season DSR values were also higher in the lower North Island, central region and eastern South Island under both El Niño and La Niña. Average values of the DSR were higher under La Niña and, in many cases lower under El Niño in the west (Hokitika (HKA) and, although not significant, also at Westport (WSA)) and south of the South Island.

No significant climate seasonal differences occur for DSR (Table 10) in winter and spring. For the summer (Dec/Jan/Feb) season, significant differences are reasonably widespread. Fire season DSR values were generally higher under El Niño (and lowest in neutral) conditions in Whangarei (WRA), Waikato, Bay of Plenty and the east of the North Island (Hamilton (HNA), Coromandel (COR), Whitianga (WTA), Tauranga (TGA), Whakatane (WKA), Rotorua (ROA) (see Figure 8), Taupo (APA), Gisborne (GSA), Napier (NRA), Castlepoint (CPX) and Masterton (MSX)), with El Niño values averaging about twice that during neutral and/or the La Niña phase. In Kapiti (Levin (LNX) and Paraparaumu (PPA)) and the west and south of the South Island (Westport (WSA), Hokotika (HKA), Tara Hills (THE), Dunedin (DNA), Queenstown (QNA) and Manapouri (MOA)), the reverse occurred with La Niña phase DSR values about 2 times those of El Niño and neutral conditions (see Table 10). For Kaitaia (KX), February was the key month (Appendix 2). For Waikato, Coromandel, Bay of Plenty and the east of the North Island (Hamilton (HNA), Coromandel (COR), Whitianga (WTA), Tauranga (TGA), Whakatane (WKA), Rotorua (ROA) (again, see Figure 8), Taupo (APA), Gisborne (GSA), Napier (NRA) and Castlepoint (CPX)), generally all summer months showed significant increases under the El Niño phase. In contrast the La Niña phase DSR increases were in January and February for the west of the South

Weather Station	**DSR**				**VH+E FFDC**			
	El Niño	**Neutral**	**La Niña**	**Prob/Sig.**	**El Niño**	**Neutral**	**La Niña**	**Prob/Sig.**
KX	0.92	0.64	0.78	0.21	10.3	6.6	9.8	0.45
WRA	0.95	0.62	0.49	0.40	9.5	5.0	0	**0.02**
DAR	0.35	0.30	0.36	0.64	2.6	2.1	0.4	0.58
AKL	0.85	0.83	0.74	0.33	6.7	8.1	8.2	0.79
HNA	0.41	0.23	0.50	0.11	3.8	0.8	3.5	0.11
COR	0.44	0.30	0.30	0.41	3.2	1.0	0.4	0.30
WTA	0.54	0.37	0.42	0.46	5.5	1.5	0.8	**0.05**
PAX	0.43	0.36	0.40	1.00	7.0	0.7	0.5	**0.04**
TGA	1.18	0.51	0.72	**0.00**	14.3	4.2	6.2	**0.00**
TPE	0.04	0.24	0.01	0.46	0	0.7	0	0.51
WKA	1.19	0.68	0.75	0.40	26.8	5.8	5.5	**0.02**
ROA	0.49	0.24	0.35	**0.02**	3.1	1.3	1.7	**0.03**
APA	0.43	0.24	0.37	**0.09**	3.6	1.6	1.9	0.12
GSA	2.36	1.37	1.83	0.23	38.5	21.2	26.5	**0.07**
NRA	3.09	1.36	1.30	**0.07**	58.0	20.2	19.8	**0.03**
NPA	0.28	0.16	0.29	0.32	2.1	1.4	1.4	0.32
RUX	0.03	0.03	0.06	0.11	0	0.5	1.3	0.26
WUA	0.52	0.38	0.66	0.10	3.9	2.9	4.9	0.34
OHA	1.24	0.93	1.41	0.59	15.1	10.9	18.3	0.33
LNX	0.41	0.13	0.34	0.11	3.3	0	1.8	0.19
CPX	1.77	0.67	1.13	0.46	33.5	9.2	16.8	**0.04**
MSX	1.28	0.53	0.62	0.46	29.3	8.7	11.8	**0.02**
PPA	0.68	0.45	0.76	0.12	4.2	2.4	3.8	0.84
WNA	1.78	1.20	1.55	0.22	21.3	12.8	18.5	0.20
NSA	1.18	0.84	1.01	0.72	12.0	10.6	7.2	0.24
WBA	4.03	2.02	3.49	0.46	59.3	37.2	46.8	0.37
KIX	0.49	0.29	0.62	0.98	6.0	3.3	5.6	0.63
WSA	0.01	0.01	0.03	0.13	0	0	0.1	0.24
HKA	0.01	0.01	0.02	**0.07**	0	0	0	1.00
CHA	2.83	1.84	2.40	0.38	44.7	34.1	38.6	0.29
TUA	1.01	0.39	0.73	0.46	17.5	8.8	9.0	0.42
THE	2.54	1.22	2.89	0.11	47.5	29.2	46.8	0.47
OUA	0.44	0.24	0.55	0.46	5.0	3.0	5.8	0.32
DNA	0.68	0.50	0.80	0.18	6.4	5.2	10.1	0.12
LAE	2.15	1.56	1.58	1.00	38.3	31.3	32.8	0.74
QNA	0.43	0.53	0.66	0.75	4.3	6.8	7.9	0.84
LUX	0.08	0.10	0.30	0.40	4.5	2.5	4.8	0.51
GCE	0.07	0.05	0.09	1.00	1.0	1.2	3.0	0.41
MOA	0.05	0.06	0.14	0.46	1.8	1.0	1.8	0.40
NVA	0.09	0.13	0.10	0.49	0.3	0.3	0.7	0.90

Table 9. Average fire season (Oct-Apr) Daily Severity Rating (DSR) values and number of days of Very High and Extreme (VH+E) Forest fire danger classes for 40 weather stations under the three ENSO phases (based on median and mean values, respectively). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when means or medians were compared, respectively.

Weather Station	1 = Winter				2 = Spring				3 = Summer				4 = Autumn			
	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob
KX	0.01	0.01	0.01	1.00	0.26	0.14	0.12	0.81	1.64	1.34	1.81	0.11	0.31	0.51	0.42	0.66
WRA	0.05	0.00	0.01	0.98	0.28	0.16	0.25	0.93	1.92	1.11	1.32	**0.03**	0.48	0.43	0.20	0.74
DAR	0.00	0.00	0.00	0.99	0.07	0.07	0.14	0.84	0.88	0.58	0.72	**0.06**	0.07	0.14	0.15	0.79
AKL	0.01	0.00	0.00	1.00	0.24	0.23	0.12	0.87	1.67	1.41	1.80	0.22	0.32	0.29	0.35	0.98
HNA	0.00	0.00	0.00	1.00	0.08	0.05	0.08	0.99	1.08	0.43	0.95	**0.01**	0.05	0.12	0.34	0.59
COR	0.01	0.00	0.00	1.00	0.10	0.05	0.10	0.91	1.12	0.67	0.52	**0.00**	0.13	0.14	0.11	0.99
WTA	0.00	0.01	0.00	0.99	0.24	0.11	0.36	0.33	0.97	0.61	0.97	**0.06**	0.34	0.22	0.18	0.72
PAX	0.00	0.00	0.00	0.91	0.12	0.08	0.07	0.98	1.06	0.59	0.84	0.19	0.08	0.29	0.11	0.66
TGA	0.03	0.01	0.01	0.98	0.41	0.24	0.23	0.62	2.57	0.87	1.53	**0.00**	0.42	0.37	0.44	0.90
TPE	0.01	0.00	0.00	0.99	0.03	0.14	0.00	0.50	0.35	0.36	0.19	0.32	0.26	0.05	0.01	0.27
WKA	0.02	0.02	0.00	0.99	0.45	0.31	0.30	0.87	3.55	0.96	1.76	**0.00**	0.46	0.38	0.20	0.89
ROA	0.02	0.01	0.01	0.99	0.12	0.06	0.07	0.82	1.00	0.51	0.65	**0.00**	0.22	0.13	0.15	0.56
APA	0.01	0.04	0.00	0.90	0.07	0.09	0.09	0.97	0.91	0.45	0.68	**0.00**	0.17	0.18	0.27	0.63
GSA	0.09	0.04	0.07	0.98	1.15	0.65	1.21	0.50	4.73	2.85	2.62	**0.00**	0.76	0.55	1.14	0.67
NRA	0.27	0.18	0.00	0.98	1.52	0.79	1.31	0.52	5.27	1.32	2.24	**0.00**	0.91	0.72	0.29	0.82
NPA	0.01	0.01	0.01	0.81	0.04	0.04	0.01	0.92	0.47	0.45	0.56	0.44	0.09	0.13	0.35	**0.03**
RUX	0.00	0.00	0.00	1.00	0.00	0.01	0.01	0.97	0.12	0.06	0.19	0.14	0.00	0.02	0.01	0.90
WUA	0.03	0.02	0.00	0.74	0.24	0.16	0.17	0.85	1.01	0.62	1.02	**0.01**	0.14	0.22	0.64	**0.02**
OHA	0.05	0.02	0.01	0.99	0.48	0.37	0.30	0.76	2.08	1.69	1.98	0.21	0.49	0.48	1.15	**0.03**
LNX	0.01	0.00	0.01	1.00	0.03	0.06	0.02	0.97	0.54	0.08	0.86	**0.00**	0.13	0.25	0.16	0.80
CPX	0.13	0.08	0.04	0.99	0.85	0.33	0.65	0.89	3.35	0.82	1.72	**0.02**	0.57	0.50	0.53	0.98
MSX	0.01	0.01	0.01	0.98	0.24	0.16	0.12	0.97	2.01	1.06	1.50	**0.09**	0.35	0.34	0.15	0.98
PPA	0.04	0.02	0.01	0.97	0.17	0.16	0.13	0.95	1.00	0.97	1.36	**0.01**	0.36	0.45	0.50	0.74
WNA	0.06	0.03	0.02	0.98	0.63	0.49	0.43	0.75	2.90	2.32	2.67	**0.07**	0.66	0.76	0.88	0.86
NSA	0.03	0.01	0.01	0.98	0.36	0.20	0.21	0.71	1.97	1.98	1.61	0.34	0.43	0.43	0.38	0.98
WBA	0.17	0.09	0.01	0.99	1.36	0.72	0.55	0.85	5.28	3.52	6.64	0.11	1.21	1.84	1.26	0.88
KIX	0.15	0.06	0.07	0.66	0.27	0.18	0.26	0.80	0.82	0.61	0.83	0.32	0.39	0.31	0.23	0.88
WSA	0.00	0.00	0.00	0.85	0.00	0.01	0.00	0.97	0.03	0.06	0.10	**0.00**	0.01	0.01	0.03	0.71
HKA	0.00	0.00	0.00	0.64	0.00	0.01	0.00	0.97	0.01	0.04	0.04	**0.02**	0.00	0.00	0.02	0.69
CHA	0.08	0.07	0.05	0.95	1.13	1.07	1.56	0.58	4.31	3.65	4.08	0.37	0.93	0.84	0.80	0.95
TUA	0.15	0.08	0.05	0.96	0.71	0.21	0.26	0.42	1.48	0.59	0.89	**0.09**	0.53	0.61	0.27	0.81
THE	0.03	0.01	0.01	1.00	1.46	0.67	0.72	0.66	3.43	1.16	5.29	**0.00**	0.37	1.16	0.42	0.54
OUA	0.07	0.05	0.03	0.99	0.49	0.14	0.26	0.33	0.52	0.46	0.54	0.95	0.13	0.42	0.08	0.33
DNA	0.02	0.02	0.03	0.99	0.43	0.36	0.57	0.38	0.78	0.79	1.10	**0.08**	0.13	0.38	0.26	0.25
LAE	0.03	0.05	0.01	1.00	1.64	1.22	0.54	0.55	2.93	2.03	3.36	0.35	0.24	1.20	0.17	0.43
QNA	0.00	0.00	0.00	1.00	0.15	0.31	0.13	0.64	1.02	1.02	1.65	**0.01**	0.05	0.17	0.11	0.73
LUX	0.00	0.00	0.00	1.00	0.03	0.04	0.07	0.99	0.11	0.43	0.43	0.12	0.00	0.05	0.12	0.82
GCE	0.00	0.00	0.00	1.00	0.02	0.05	0.02	0.82	0.14	0.23	0.25	0.24	0.01	0.03	0.05	0.84
MOA	0.00	0.00	0.00	1.00	0.01	0.02	0.01	0.87	0.19	0.23	0.53	**0.00**	0.01	0.01	0.01	0.97
NVA	0.00	0.00	0.00	1.00	0.03	0.07	0.07	0.57	0.21	0.26	0.29	0.22	0.01	0.02	0.02	0.93

Table 10. Average 3-monthly climate season Daily Severity Rating (DSR) values for 40 weather stations under the three ENSO phases (based on median values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold.

Island (Westport (WSA), Hokitika (HKA)) and in February for the west of the North Island (Wanganui (WUA), New Plymouth (NPA) and Ohakea (OHA)) and southern New Zealand (Tara Hills (THE), Queenstown (QNA), Dunedin (DNA), Gore (GCE), Manapouri (MOA) and Invercargill (NVA)).

In autumn months (Mar/Apr/May) (see Table 10), significant differences only occur in the west of the North Island at New Plymouth (NPA), Wanganui (WUA) and Ohakea (OHA), with La Niña phase DSR values averaging 2-3 times those of El Niño phase DSR. April was the key month (see Appendix 2).

Average fire season (Oct-Apr) values of the number of days of Very High and Extreme (VH+E) forest fire danger (Table 9) also showed considerable variation under different ENSO phases, in response to differences seen in rainfall (and temperature) as well as the FFMC and BUI components, the latter a key factor in determining the Forest fire danger class (FFDC). Fire season severity was significantly higher under El Niño conditions in the Waikato (Whitianga WTA), Paeroa (PAX) and, with medians as opposed to means, also Hamilton (HNA)), Bay of Plenty (Tauranga (TGA), Whakatane (WKA), Rotorua (ROA), and also Taupo (APA)), eastern North Island (Gisborne (GSA), Napier (NRA), Castle Point (CPX) and Masterton (MSX)). In many cases, the number of days of VH+E fire danger was 2-3 times higher (or an additional 20-40 days) at these locations under El Niño compared to neutral or La Niña conditions. Although not statistically significant, the number of days of VH+E forest fire danger was also higher under both El Niño and La Niña events in the lower west of the North Island and Canterbury, but higher (in the order of 1-2 times, or 2-5 additional days of VH+E) under La Niña in the south of the South Island.

Climate season values for the number of days of Very High and Extreme (VH+E) forest fire danger (Table 11) do not show significant effects in winter (Jun/Jul/Aug) and spring (Sep/Oct/Nov). Only in the latter season are there significant differences, with 6 more danger days at Timaru (TUA). However, significant differences are reasonably widespread for summer (Dec/Jan/Feb) throughout Bay of Plenty, the east of the North Island, and parts of the west of the South Island and Otago. The number of days of VH+E forest fire danger increased by between 1 and 12 days during El Niño events at Whangarei (WRA), Dargaville (DAR), Whitianga (WTA), Paeroa (PAX), Tauranga (TGA), Whakatane (WKA), Rotorua (ROA), Taupo (APA), Gisborne (GSA), Napier (NRA), Castlepoint (CPX), Masterton (MSX) and Nelson (NSA). These increased during La Niña episodes by between 2 and 20 days in Otago at Tara Hills (THE), Dunedin (DNA) and Queenstown (QNA).

Weather Station	1 = Winter				2 = Spring				3 = Summer				4 = Autumn			
	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob	El N	Neut	La N	Prob
KX	0	0	0	1.00	0	0	0	1.00	7.7	6.2	6.7	0.64	1.0	2.3	0.9	0.62
WRA	0	0	0	1.00	0.2	0.2	0	0.99	5.2	3.0	1.4	**0.05**	0.8	1.7	0	0.62
DAR	0	0	0	1.00	0.4	0	0	0.67	1.9	1.4	0.5	**0.07**	0	0.4	0	0.67
AKL	0	0	0	1.00	0.3	0.1	0.3	0.98	5.1	5.4	6.2	0.72	0.8	1.8	1.7	0.62
HNA	0	0	0	1.00	0	0	0	0.99	2.5	0.8	1.8	0.11	0	0.2	2.5	0.15
COR	0	0	0	1.00	0	0	0	1.00	3.2	1.0	0.3	**0.00**	0	0.1	0	0.97
WTA	0	0	0	1.00	0	0	0.5	0.84	3.3	1.2	0.4	**0.01**	0	0.4	0	0.85
PAX	0	0	0	1.00	0	0	0	1.00	4.7	0.6	0.4	**0.00**	0	0.1	0	0.99
TGA	0	0	0	1.00	0.8	0.4	0	0.82	11.1	2.7	4.9	**0.00**	1.1	1.3	0.7	0.89
TPE	0	0	0	1.00	0	0.7	0	**0.04**	0	0	0	1.00	0	0	0	1.00
WKA	0	0	0	1.00	1.0	1.3	0	0.92	14.7	4.2	4.0	**0.00**	0.8	2.2	1.0	0.85
ROA	0	0	0	1.00	0	0	0	1.00	2.5	1.3	1.2	**0.01**	0.3	0.2	0.3	0.99
APA	0	0	0	0.95	0	0	0	1.00	2.8	1.6	1.3	**0.03**	0.3	0.3	0.8	0.62
GSA	0	0	0	1.00	6.9	3.1	5.2	0.44	23.3	16.4	15.8	**0.04**	6.7	3.9	5.9	0.74
NRA	0	0	0	1.00	8.2	5.2	4.8	0.88	27.8	4.8	14.6	**0.00**	10.0	7.3	2.5	0.58
NPA	0	0	0	1.00	0	0	0	1.00	1.4	1.2	0.5	0.12	0.2	0.4	1.1	0.24
RUX	0	0	0	1.00	0	0	0	0.99	0	0.6	0.6	**0.05**	0	0	1.0	**0.01**
WUA	0	0	0	1.00	0	0	0	1.00	3.3	1.9	3.4	0.20	0.1	0.6	2.5	0.19
OHA	0	0	0	1.00	0.7	0.3	0.6	0.97	10.4	7.7	9.6	0.24	2.3	3.6	9.2	**0.02**
LNX	0	0	0	1.00	0	0	0	1.00	1.5	0	0.6	0.16	0.3	0.3	2.0	0.26
CPX	0	0	0	1.00	1.4	0.2	0.3	1.00	16.8	6.4	12.0	**0.04**	5.5	3.6	2.0	0.95
MSX	0	0	0	1.00	0.6	0	0	0.95	15.0	6.0	8.8	**0.01**	4.3	2.8	4.0	0.74
PPA	0	0	0	1.00	0.1	0.1	0.1	0.96	2.3	1.9	2.3	0.96	0.2	1.1	1.7	0.56
WNA	0	0	0	1.00	1.6	0.7	0.8	0.89	13.3	9.4	12.2	0.10	5.8	3.6	3.9	0.51
NSA	0	0	0	1.00	1.4	0.1	0.4	0.64	7.9	8.2	5.0	**0.07**	2.3	2.4	1.3	0.81
WBA	0.1	0.2	0	1.00	11.8	6.5	2.0	0.48	28.0	18.6	33.2	0.15	7.8	14.3	7.5	0.58
KIX	0	0.1	0	0.99	1.1	0.5	0.7	0.81	3.3	2.9	2.2	0.42	1.8	1.4	0.4	0.57
WSA	0	0	0	1.00	0	0	0	1.00	0	0	0.1	**0.01**	0	0	0	1.00
HKA	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00
CHA	0	0	0	1.00	6.7	7.5	9.2	0.70	24.9	21.3	23.0	0.47	10.3	7.9	4.4	0.35
TUA	0.1	0.1	0	1.00	7.2	1.2	0.8	**0.05**	7.5	5.2	4.4	0.52	5.3	4.2	2.0	0.74
THE	0.2	0	0	1.00	13.8	7.7	7.3	0.46	20.2	10.0	30.0	**0.00**	5.0	10.3	15.5	0.38
OUA	0.1	0.2	0	1.00	3.6	0	0.5	0.12	2.2	2.4	0.8	0.64	3.0	2.7	0	0.45
DNA	0	0	0	1.00	1.0	1.4	2.0	0.65	2.6	3.1	5.3	**0.04**	0.9	2.6	1.3	0.21
LAE	0.1	0.2	0	1.00	12.6	10.8	8.3	0.80	18.0	13.6	19.4	0.54	4.8	9.2	9.0	0.64
QNA	0	0	0	0.97	0	0.7	0.3	0.90	3.0	4.3	7.9	**0.01**	0.4	0.7	2.0	0.55
LUX	0	0	0	1.00	0	0.3	0.5	0.95	0.5	2.4	2.4	0.38	0	2.2	0.5	0.26
GCE	0	0	0	1.00	0	0	0	1.00	0.7	1.4	1.4	0.46	0	0.4	0.5	0.75
MOA	0	0	0	1.00	0	0	0	1.00	0.8	1.2	1.0	0.84	0	0.2	1.0	0.49
NVA	0	0	0	1.00	0	0.1	0	0.94	0.2	0.3	0.6	0.10	0.1	0.0	0	0.85

Table 11. Average 3-monthly climate season number of days of Very High and Extreme (VH+E) Forest fire danger classes for 40 weather stations under the three ENSO phases (based on mean values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold.

For autumn, only Waiouru (RUX) and Ohakea (OHA) show significant increases in days of VH+E fire danger for the La Niña phase when compared with neutral and El Niño phases, although there are non significant increases in Otago. The key month was generally March.

Monthly values (Appendix 2) showed significant increases in the number of days of VH+E forest fire danger for El Niño episodes for all summer months in the Bay of Plenty (Tauranga (TGA), Whakatane (WKA), Rotorua (ROA), Taupo (APA)) and east of the North Island (Gisborne (GSA), Napier (NRA), Castlepoint (CPX) and Masterton (MSX)). Stations in the west of the North Island (New Plymouth (NPA), Wanganui (WUA), Ohakea (OHA) and Levin (LNX)) as well as Nelson (NSA) and Christchurch (CHA) showed significant differences in February. Increases associated with La Niña events also showed significant differences later in the season in February in the south of the South Island (Tara Hills, (THE), Dunedin (DNA), Lauder (LAE), Queenstown (QNA) and Invercargill (NVA)).

5.2.2 IPO

The effect of IPO on fire danger at each station was assessed by calculating the average values of each of the variables of interest for each complete calendar year or fire season of record within each phase of the IPO, and then comparing the overall means and medians for the positive and negative phases of the IPO using the non-parametric Kruskal-Wallis rank-sum test. Also known as the Mann-Whitney test, this test was used in similar analyses of the effect of IPO on drought occurrence (Thompson 2006b).

Again, this non-parametric test (*cf*. the normal parametric ANOVA or T-test) was used because several of the variables (especially the number of days of VH+E forest fire danger) had previously been found to have skewed distributions (Pearce *et al*. 2005). As noted previously, the ‘average” measure deemed most appropriate for each variable is used in summarising results of the analyses; that is, mean values for temperature, rainfall and the number of days of VH+E forest fire danger, and median values for FFMC, BUI and DSR. Use of medians rather than means in all cases resulted in generally fewer statistically significant differences with the IPO phase for the latter three variables, although in a few cases did result in additional variables for some stations becoming significantly different.

Temperature and rainfall

During the early 1950s following a shift of the IPO to the negative phase, the New Zealand climate warmed abruptly, with temperatures increasing by an average of 0.5 °C, and the prevailing westerly and south westerly winds weakened. Another shift, around 1977, was characterised by a strengthening of westerlies on to central and southern New Zealand. More frequent El Niño events have also occurred since then. The west and south of the South Island became wetter and cloudier, and the north and east of the North Island became drier and sunnier, with more anticyclones than usual occurring over the north of the country.

Figure 7 shows the precipitation differences between the negative IPO phase (1946-1977) and the following positive phase (1978-1998) for the incomplete period, similar to the longest fire climatologies. Precipitation increases are seen in the west of the South Island and Southland. Reduced precipitation occurred in eastern Northland, Auckland, Bay of Plenty, the east of the North Island, Marlborough and Canterbury. Therefore IPO changes to the positive phase are likely to reduce fire danger risk in the west of the South Island, and increase fire danger risk in parts of northern New Zealand, and the east of both islands.

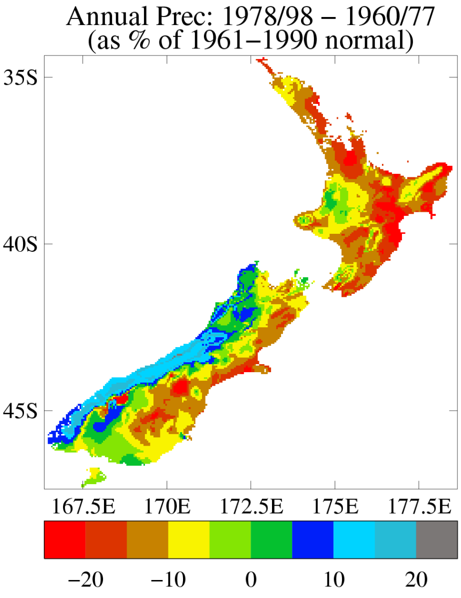

Figure 7. Differences in annual rainfall, as % of 1961-1990 climatology, from 1978-1998 to 1960-1977. This panel is from a high-resolution gridded data set that begins in 1960. © NIWA 2007

Weather Station	No. Years/Seasons		Full Year			Fire Season		
	IPO -	IPO +	IPO -	IPO +	Prob/Sig.	IPO -	IPO +	Prob/Sig.
KX	14	21	1385	1343	0.59	687	635	0.32
AKL	10	21	1099	1116	0.71	554	564	0.83
TGA	6	21	1314	1207	0.38	662	671	0.77
ROA	12	21	1554	1364	**0.03**	845	737	**0.10**
GSA	14	21	1023	994	0.61	503	515	1.00
NPA	14	21	1498	1428	0.31	754	784	0.50
OHA	16	18	911	899	0.63	481	511	0.33
PPA	14	21	1009	1039	0.61	509	571	0.18
WNA	16	21	1035	969	0.33	502	494	0.83
NSA	14	21	996	1066	0.95	535	553	0.97
KIX	12	21	853	811	0.63	474	426	0.31
WSA	6	21	2255	2262	0.86	1251	1245	0.91
HKA	12	21	2758	2952	0.11	1596	1715	0.37
CHA	16	21	608	646	0.46	331	336	0.90
DNA	13	21	640	740	**0.06**	410	451	**0.07**
NVA	16	21	1048	1134	**0.03**	625	685	0.15

Table 12. Average rainfall totals for 16 weather stations under the two IPO phases, averaged over the full calendar year and fire season months (Oct-Apr) (based on mean values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when medians rather than means were compared.

Table 12 compares averages for rainfall at each of the 16 stations under the two IPO phases over both the full calendar year and fire season months (i.e., Oct-Apr) only. Table 13 compares similar information for temperature. Values significant at the 90% level (i.e., probabality <0.10) using the Kruskal-Wallis test are highlighted. Essentially the differences are similar to those described above, and trends for the full calendar year were very similar to those for fire season months. In the case of rainfall, the positive phase of the IPO was generally drier in the north and east of the North Island, and northeast of the South Island, and wetter in the west and south of the South Island (see Table 12). However, only Rotorua (ROA) (see Figure 8) showed a statistically significant decrease in rainfall with positive IPO, and two stations (Dunedin (DNA) and Invercargill (NVA)) significant increases in rainfall under this positive phase.

Weather Station	**Full Year**			**Fire Season**		
	IPO -	**IPO +**	**Prob/Sig.**	**IPO -**	**IPO +**	**Prob/Sig.**
KX	18.1	18.0	0.77	20.3	20.1	0.57
AKL	17.3	17.4	0.97	19.8	19.8	0.93
TGA	17.4	17.2	0.22	19.8	19.5	0.27
ROA	15.7	15.5	0.45	18.5	18.2	0.28
GSA	17.6	17.9	0.11	20.3	20.6	0.11
NPA	15.9	15.9	0.89	18.2	18.1	0.64
OHA	16.1	16.0	0.78	18.7	18.5	0.53
PPA	15.5	15.4	0.71	17.8	17.5	0.30
WNA	15.2	15.2	0.65	17.4	17.4	0.83
NSA	15.4	15.5	0.32	18.1	18.2	0.55
KIX	13.4	13.8	**0.07**	15.7	16.0	0.11
WSA	15.2	14.6	0.12	17.3	16.5	**0.08**
HKA	14.3	14.2	0.97	16.5	16.3	0.51
CHA	14.6	14.9	0.15	17.6	17.8	0.36
DNA	13.3	13.4	0.51	16.2	16.2	0.85
NVA	12.2	12.4	0.19	14.6	14.8	0.28

Table 13. Average temperatures for 16 weather stations under the two IPO phases, averaged over the full calendar year and fire season months (Oct-Apr) (based on mean values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when medians rather than means were compared.

Differences were generally small for most stations at around +/- 10 to 70 mm (0% to 7% of the negative IPO average) over the full year, and +/- 5 to 30 mm (0% to 10%) for fire season months, although rainfall decreases did reach -190 mm (-12%) over the full year and -100 mm (-13%) for fire season months at Rotorua (ROA) (see Figure 8); rainfall increases with positive IPO also reached +85 to +100 mm (+8% to +16%) for the full year and +40 to +60 mm (10%) for the fire season at Dunedin (DNA) and Invercargill (NVA). Full year differences of -110 mm (-8%) at Tauranga (TGA), and +190 mm (+7%) for the full calendar year and 120 mm (+7%) over the fire season at Hokitika (HKA) were not significant. This was also the case for Kaitaia (KX) and Kaikoura (KIX) (see Figure 9) which showed large, but non-significant decreases of -50 mm (-8% and -10% respectively), and Paraparaumu (PPA) with a +60 mm (+12%) increase, for average fire season rainfall.

Little evidence of statistically significant temperature differences for IPO phases was found (Table 13), with only Kaikoura (KIX) demonstrating a significant increase during the positive IPO phase, although Tauranga (TGA) and Westport (WSA) did show some evidence of a decrease in temperature with positive IPO when median values (as opposed to means) were considered. Effects were generally small at +/-0.3 ºC, although did reach -0.6 ºC and -0.8 ºC at Westport (WSA) for the IPO-phase compared with IPO+ for the full calendar year and fire season, respectively.

FWI System Components

Comparisons of Fine Fuel Moisture Code (FFMC) and Buildup Index (BUI) for the two IPO phases are shown in Tables 14 and 15. For both the full year and fire season, the FFMC (Table 14) generally decreases in the far north (Kaitaia, KX) and in western areas of both islands, and increases in the east (Kaikoura, KIX), under the positive phase of the IPO. However, FFMC differences typically were small at +/-2 points, and only two stations showed statistically significant differences when medians were used. A further two stations (Auckland (AKL) which had higher FFMCs under IPO+ for the full calendar year, and Westport (WSA) which had lower FFMCs under IPO+) showed significant trends when medians were used.

For the Buildup Index (BUI) component (Table 15), differences under IPO phases were again relatively small at +/-4 points, and none of the stations showed evidence of significant differences using median values; however, there was some evidence of trends between IPO phases when means were used. In general, BUI values increased in the east (Kaikoura, KIX) (see Figure 9) during the positive phase of the IPO, but decreased in the west (Westport (WSA) and Hokitika (HKA)) and south of the South Island (Dunedin, DNA). Although not significant, BUI values for other stations in the east of both islands generally increased during the positive phase of the IPO, whereas stations in the central and western North Island, central regions and southern South Island generally decreased during this positive IPO phase. The BUI index does not appear to be changing with the same significance compared with FFMC, DSR or VH+E.

Weather Station	**Full Year**			**Fire Season**		
	IPO -	**IPO +**	**Prob/Sig.**	**IPO -**	**IPO +**	**Prob/Sig.**
KX	78.9	77.4	**0.03**	83.2	81.9	**0.03**
AKL	76.3	77.8	0.16	81.8	82.1	0.53
TGA	80.3	79.9	0.92	83.3	82.7	0.92
ROA	78.3	78.2	0.56	82.2	81.7	0.40
GSA	81.8	82.8	0.22	84.6	84.9	0.22
NPA	74.4	73.9	0.89	78.8	78.1	0.13
OHA	80.0	79.6	0.50	83.5	82.3	0.18
PPA	79.6	78.7	0.13	82.0	81.1	0.13
WNA	79.7	79.4	0.61	82.7	82.1	0.43
NSA	81.0	80.5	0.59	83.2	82.8	0.59
KIX	77.8	79.6	**0.01**	79.0	80.3	**0.01**
WSA	67.9	62.3	0.31	73.9	68.4	0.31
HKA	63.6	59.2	0.12	69.1	65.1	0.12
CHA	81.7	82.0	0.61	84.5	84.4	0.43
DNA	78.9	78.6	0.30	81.4	80.9	0.73
NVA	69.0	69.2	0.89	74.4	74.7	0.61

Table 14. Average Fine Fuel Moisture Code (FFMC) values for 16 weather stations under the two IPO phases, averaged over the full calendar year and fire season months (Oct-Apr) (based on median values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when means rather than medians were compared.

Weather Station	Full Year			Fire Season		
	IPO -	IPO +	Prob/Sig.	IPO -	IPO +	Prob/Sig.
KX	8.9	8.5	0.59	19.5	18.2	0.41
AKL	8.4	9.3	0.53	20.7	19.7	0.53
TGA	10.5	10.7	0.42	20.1	19.7	0.31
ROA	7.5	8.0	0.19	15.5	16.4	0.90
GSA	15.3	16.7	0.59	28.4	31.9	0.59
NPA	5.1	5.2	0.89	11.6	10.6	0.59
OHA	11.7	11.9	0.50	23.3	20.2	0.18
PPA	10.3	9.1	0.13	20.0	16.7	0.13
WNA	9.9	9.7	0.61	21.2	19.4	0.43
NSA	11.8	11.6	0.89	22.5	22.8	0.59
KIX	11.1	14.6	0.56	17.1	24.0	0.19
WSA	3.7	2.9	0.31	6.6	5.1	0.31
HKA	3.2	2.6	0.40	5.3	4.2	0.12
CHA	23.9	22.1	0.89	39.1	38.8	0.61
DNA	15.6	14.1	0.30	24.8	21.4	0.10
NVA	4.7	4.5	0.24	9.6	9.0	0.61

Table 15. Average Buildup Index (BUI) values for 16 weather stations under the two IPO phases, averaged over the full calendar year and fire season months (Oct-Apr) (based on median values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when means rather than medians were compared.

Fire season severity

Other variables to show evidence of trends with IPO phase changes were the two measures of fire climate severity, the Daily Severity Rating (DSR) and the number of days of Very High and Extreme (VH+E) forest fire danger (FFDC) (Tables 16 and 17). As a result of larger differences (+/-0.5 and up to +/-0.7 points), fire season differences in DSR values showed stronger trends than DSR values averaged over the full calendar year (Table 16). Fire season DSR generally increased in the northeast (Kaikoura, KIX) (see Figure 9) with the change to a positive IPO, and decreased in the far north (Kaitaia, KX), the west of both islands (Ohakea (OHA) and Hokitika (HKA)), central areas and coastal Otago (Dunedin, DNA).

Weather Station	**Full Year**			**Fire Season**		
	IPO -	**IPO +**	**Prob/Sig.**	**IPO -**	**IPO +**	**Prob/Sig.**
KX	0.20	0.13	**0.03**	0.99	0.64	0.13
AKL	0.15	0.17	0.53	0.81	0.81	0.53
TGA	0.25	0.20	0.42	0.87	0.68	0.92
ROA	0.07	0.06	0.56	0.38	0.35	0.40
GSA	0.49	0.50	0.89	1.68	1.85	0.59
NPA	0.04	0.04	0.22	0.26	0.19	0.13
OHA	0.32	0.33	1.00	1.31	1.04	**0.04**
PPA	0.18	0.16	0.41	0.70	0.57	0.13
WNA	0.47	0.42	0.43	1.69	1.43	0.89
NSA	0.21	0.16	0.59	0.99	0.88	0.41
KIX	0.10	0.24	**0.01**	0.25	0.50	**0.04**
WSA	0.01	0.01	0.31	0.04	0.01	0.31
HKA	0.01	0.00	0.12	0.02	0.01	0.40
CHA	0.66	0.65	0.89	2.22	2.35	0.61
DNA	0.21	0.20	0.73	0.69	0.57	**0.08**
NVA	0.01	0.02	0.61	0.11	0.11	0.61

Table 16. Average Daily Severity Rating (DSR) values for 16 weather stations under the two IPO phases, averaged over the full calendar year and fire season months (Oct-Apr) (based on median values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when means rather than medians were compared.

Trends for the average number of days of VH+E forest fire danger were very similar for the full calendar year and fire season with, in most cases, all severe fire weather days occurring within fire season months (Table 17). Differences between IPO phases were generally small at +/-2 days, although were as high as +/-8 days (at Kaitaia (KX) and Gisborne (GSA)). Like the DSR, the number of days of VH+E fire danger generally increased in east of both islands (Kaikoura (KIX) and although not statistically significant, also at Gisborne (GSA) and Christchurch (CHA)) with the change to a positive IPO, and decreased in the far north (Kaitaia, KX) and west (Westport (WSA) and New Plymouth (NPA) and, to a lesser extent, also Ohakea (OHA) and Paraparaumu (PPA)).

Weather Station	**Full Year**			**Fire Season**		
	IPO -	**IPO +**	**Prob/Sig.**	**IPO -**	**IPO +**	**Prob/Sig.**
KX	14.2	6.3	**0.07**	14.2	6.3	**0.07**
AKL	8.5	8.0	0.82	8.5	8.0	0.82
TGA	7.7	7.0	0.64	7.7	7.0	0.64
ROA	2.6	2.0	0.45	2.6	2.0	0.45
GSA	27.9	35.7	0.17	27.2	35.1	0.16
NPA	1.9	1.3	0.11	1.9	1.3	0.11
OHA	16.6	11.7	0.24	16.4	11.6	0.24
PPA	4.1	3.4	0.84	4.1	3.4	0.84
WNA	17.8	17.2	0.90	17.8	17.2	0.89
NSA	10.1	10.1	0.97	10.1	10.0	0.95
KIX	2.7	6.6	**0.02**	2.7	6.4	**0.04**
WSA	0.2	0	**0.06**	0.2	0	**0.06**
HKA	0	0	1.00	0	0	1.00
CHA	37.3	42.3	0.48	36.3	41.1	0.50
DNA	7.7	6.6	0.56	7.5	6.3	0.58
NVA	0.4	0.2	0.36	0.4	0.2	0.36

Table 17. Average number of days of Very High and Extreme (VH+E) Forest fire danger classes for 16 weather stations under the two IPO phases, averaged over the full calendar year and fire season months (Oct-Apr) (based on mean values). Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when medians rather than means were compared.

The reasons for these different responses to the IPO could not be pinpointed from the analysis, as fewer and different stations showed significant differences with IPO phase for rainfall or temperature. Kaikoura (KIX) (see Figure 9) was the only station to show a clear trend across all variables, with higher temperatures (and lower rainfall) contributing significantly to higher fire danger for all ratings investigated. While not as definitive, Westport (WSA) and Hokitika (HKA) did show some evidence that lower temperatures and higher rainfall under the positive phase of the IPO did result in lower fire season fire danger ratings. Similarly, Kaitaia (KX) showed some evidence that lower temperatures under positive IPO resulted in lower fire danger ratings, while Dunedin (DNA) showed that increased rainfall under positive IPO resulted in lower fire season severity.

These results are consistent with the differences in the broader spatial pattern of rainfall with the IPO change to the positive phase shown in Figure 7. Therefore fire danger ratings are likely to have been reduced during this phase in the west of the South Island and southern New Zealand. More importantly, fire danger ratings have almost certainly been higher in Gisborne, Hawke’s Bay, coastal Marlborough and eastern Canterbury during this 1978-1998 period.

5.2.3 Combined influence of IPO and ENSO

The last negative phase of the IPO from the 1950s to 1970s was associated with a general weakening of the westerly circulation in the New Zealand region, more anticyclones east of the country and fewer in the Tasman Sea, and more frequent La Niña events with regular oscillations between moderate to strong El Niño and La Niña events (Salinger *et al*. 2001). Mean temperatures in all regions increased during this period, and the main trends in rainfall were towards wetter conditions in the north of the North Island, particularly in autumn, yet drier conditions in the southeast of the South Island, especially in summer. More northeasterly flow accounts for all these trends. In contrast, the recent positive IPO phase from the mid 1970s saw a change to more southwesterlies over New Zealand and more frequent El Niño events, including several strong El Niños and only one La Niña (Salinger *et al*. 2001). The north of the North Island has become drier, mainly because of drier autumns, and the north, west, south and southeast of the South Island have all become wetter, caused largely by increased precipitation in the summer and winter seasons.

Thus it has been suggested that the IPO is associated with observed changes in interannual variability during the different phases of the IPO (Gershunov and Barnett 1998, Power *et al*. 1998, 1999, Salinger *et al*. 2001, Kiem *et al*. 2003, Kiem and Franks 2004, Verdon *et al*. 2006). In particular, this includes more frequent and possibly stronger El Niño events (and less frequent La Niña events) under the positive phase of the IPO, and more frequent La Niña events under the negative IPO phase. Hence there is a need to consider the combined influence of ENSO and IPO on fire dangers.

This was done by comparing composited data sets for the 16 stations used in the IPO analysis (see Table 1) for the various combinations of ENSO and IPO seasons: IPO-/El Niño (= -1), IPO-/Neutral (= -2), IPO-/La Niña (= -3), IPO+/El Niño (= +3), IPO+/Neutral (= +2), IPO+/La Niña= +1. The two extreme cases IPO+/El Nino (+3) and IPO-/La Nina (-3) are expected to the show the strongest trends if present, due to the reinforcement of the wind and weather patterns that characterise each of the components of these combinations. The test statistic only identified those seasons where the average and/or the median value for a particular ENSO/IPO phase was significantly different from others, and graphical output (e.g., see Figures 8 and 9) was used to qualitatively assess which of the possible ENSO/IPO outcomes were different from the others. This included consideration of the variability of data contained within each phase combination described using the standard error.

The positive phase of the IPO is typically associated with the strengthening of westerly quarter winds over the country, resulting in generally drier conditions in the north and east. El Niño conditions are also associated with stronger or more frequent winds from the west (especially in summer) and south west that often lead to drought in eastern areas and more rain in the west and south. The IPO+/El Niño combination should therefore result in significantly higher fire dangers in the east of both islands and parts of northern New Zealand, and significantly lower fire dangers in the west of the South Island. Conversely, the negative phase of the IPO is usually associated with weaker westerlies over the country, and more easterlies or north easterlies over northern New Zealand. La Niña is also generally characterised by more northeasterly winds that bring moister, rainy conditions to the northeast parts of the North Island. The IPO-/La Niña combination should therefore result in significantly lower fire dangers in the north and east, and significantly higher fire dangers in the west and south.

Tables 18-23 contain results for the comparisons of the various combinations of IPO and ENSO phases for weather elements and fire danger ratings averaged over full fire seasons (Oct-Apr), while comparisons averaged over 3-month climate seasons are contained in Appendix 3.

For full (Oct-Apr) fire seasons (see Tables 18-23), there were very few statistically significant trends (at the 90% level, i.e., probability <0.10), and none of the 16 stations showed differences with rainfall or temperature that were carried through to FWI System components or fire season severity measures.

Weather Station	Combined IPO/ENSO phase - Rainfall						
	-1	-2	-3	+3	+2	+1	Prob/Sig.
KX	598	502	873	601	817	663	0.33
AKL	445	478	664	512	660	586	0.62
TGA	340	366	839	537	731	614	0.27
ROA	620	651	928	605	805	755	0.67
GSA	433	375	647	505	602	396	0.28
NPA	574	604	920	681	837	722	0.58
OHA	330	452	547	434	503	457	0.73
PPA	385	402	631	486	622	508	0.40
WNA	418	475	649	449	590	451	0.62
NSA	400	404	587	476	638	557	0.35
KIX	346	339	536	379	531	267	0.28
WSA	840	658	1287	1087	1341	1090	0.60
HKA	1303	1121	1503	1435	1694	1553	0.81
CHA	244	289	364	291	404	287	0.50
DNA	295	247	344	369	454	287	0.43
NVA	472	508	547	621	621	562	0.87

Table 18. Average rainfall for 16 weather stations averaged over fire season months (Oct-Apr) (based on mean values) under combined phases of IPO and ENSO: -1 = IPO-/El Niño, -2 = IPO-/Neutral, -3 = IPO-/La Niña, +3 = IPO+/El Niño, +2 = IPO+/Neutral, +1 = IPO+/La Niña. Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when medians rather than means were compared.

For rainfall (Table 18), Paraparaumu (PPA) was the only station to show evidence of a statistical difference in average fire season (Oct-Apr) rainfall, and then only when medians as opposed to mean values were used. However, although not statistically significant, fire season rainfall was generally higher (+10 to +290 mm, or +3% to +47% above average) for the IPO+/Neutral (+2) and/or IPO-/La Niña (-3) combinations for all 16 IPO stations, and generally lower (-20 to -390 mm, or -6% to -40% below average) for the IPO-/El Niño (-1) and/or IPO-/Neutral (-2) combinations. Exceptions were the eastern locations (Gisborne (GSA) and Kaikoura (KIX)), where the lowest rainfall (-100 to -130 mm, or -20% to -33% below average) occurred during the IPO+/La Niña (+1) phase combination.

Weather Station	Combined IPO/ENSO phase - Temperature						
	-1	-2	-3	+3	+2	+1	Prob/Sig.
KX	16.8	18.0	17.3	17.7	17.1	17.9	0.66
AKL	16.2	17.1	16.6	16.9	16.3	17.3	0.90
TGA	15.3	17.9	16.6	16.9	16.2	16.9	0.66
ROA	14.4	14.8	15.5	15.0	14.2	15.3	0.84
GSA	16.0	17.1	16.5	17.3	16.5	17.6	0.66
NPA	14.5	15.8	15.0	15.6	15.1	15.5	0.76
OHA	14.3	15.7	14.7	15.5	14.6	16.1	0.57
PPA	14.1	15.3	14.6	15.0	14.4	15.3	0.61
WNA	13.8	14.9	14.2	14.7	14.2	15.1	0.59
NSA	13.7	14.9	14.1	15.1	14.1	15.1	0.75
KIX	12.4	13.1	13.5	13.5	12.6	13.3	0.81
WSA	13.1	15.7	14.5	14.1	13.7	14.6	0.59
HKA	13.1	13.7	14.3	13.8	13.3	14.0	0.88
CHA	12.7	14.1	13.2	14.3	13.1	15.6	**0.10**
DNA	12.6	12.6	11.9	12.9	11.8	12.8	0.77
NVA	10.5	11.8	10.9	11.8	11.1	11.9	0.86

Table 19. Average temperature for 16 weather stations averaged over fire season months (Oct-Apr) (based on mean values) under combined phases of IPO and ENSO: -1 = IPO-/El Niño, -2 = IPO-/Neutral, -3 = IPO-/La Niña, +3 = IPO+/El Niño, +2 = IPO+/Neutral, +1 = IPO+/La Niña. Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when medians rather than means were compared.

Christchurch (CHA) was the only station to show a significant difference for average fire season (Oct-Apr) temperature (Table 19), although higher temperatures (+0.1 to +1.7 ºC) generally occurred under the IPO+/La Niña (+1) and/or IPO-/neutral (-2) phase combinations and lower temperatures (-0.5 to -1.3 ºC) under IPO-/El Niño (-1) conditions. South eastern stations (Kaikoura (KIX) and Dunedin (DNA)) again differed from this trend, with higher temperatures (+0.4 to +0.5 ºC) occurring under IPO+/El Niño (+3) and lower temperatures (-0.5 to -0.6 ºC) under IPO+/Neutral (+2) conditions.

Weather Station	Combined IPO/ENSO phase - FFMC						
	-1	-2	-3	+3	+2	+1	Prob/Sig.
KX	75.3	77.0	72.2	78.3	73.2	75.0	0.79
AKL	74.0	74.9	73.9	78.4	74.3	75.5	0.72
TGA	81.7	79.4	75.7	79.5	76.6	77.7	0.19
ROA	79.4	74.9	75.1	79.1	74.0	76.0	0.11
GSA	80.2	79.8	78.0	80.8	79.7	80.7	0.20
NPA	73.5	72.5	70.1	75.4	70.2	71.8	0.36
OHA	80.6	78.2	77.1	80.1	75.8	76.7	0.53
PPA	77.4	77.5	77.4	78.6	77.2	76.1	0.93
WNA	76.8	78.3	75.2	77.7	76.2	78.4	0.69
NSA	79.4	77.6	79.8	81.0	75.6	77.1	0.22
KIX	77.2	77.4	77.9	79.6	78.1	78.4	0.16
WSA	63.0	64.0	67.1	63.6	61.3	62.0	0.87
HKA	60.8	58.4	64.7	61.5	58.0	54.9	0.18
CHA	78.9	81.0	81.7	81.4	78.4	81.8	0.70
DNA	73.7	78.5	79.5	78.8	75.5	77.5	0.44
NVA	60.9	66.2	67.6	65.0	66.9	68.1	0.72

Table 20. Average Fine Fuel Moisture Code (FFMC) for 16 weather stations averaged over fire season months (Oct-Apr) (based on median values) under combined phases of IPO and ENSO: -1 = IPO-/El Niño, -2 = IPO-/Neutral, -3 = IPO-/La Niña, +3 = IPO+/El Niño, +2 = IPO+/Neutral, +1 = IPO+/La Niña. Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when means rather than medians were compared.

For FWI System components, average fire season FFMC values (Table 20) were generally highest for the North Island under IPO+/El Niño (+3) and/or IPO-/La Niña (-3) for the southern South Island, and lowest under IPO+/Neutral (+2) or in the case of many North Island locations, IPO-/La Niña (-3), phase combinations; however, differences were small at +/- 5 points or +/-8% (see Table 20). When means (as opposed to medians) were used, Bay of Plenty stations (Tauranga (TGA) and Rotorua (ROA)) showed significantly higher average fire season FFMC values during IPO-/El Niño (-1) (and, to a lesser extent, also IPO+/La Niña (-3)), and lower FFMC values during IPO+/neutral (+2) or IPO-/La Niña (-3); Dunedin (DNA) showed significantly

Weather Station	Combined IPO/ENSO phase - BUI -1	-2	-3	+3	+2	+1	Prob/Sig.
KX	8.7	11.7	5.8	11.4	7.0	8.3	0.75
AKL	9.5	8.8	6.3	12.8	7.8	7.6	0.72
TGA	11.4	15.5	7.6	14.1	8.4	10.0	0.13
ROA	9.4	6.8	6.8	12.1	6.4	6.9	0.15
GSA	15.5	16.0	10.5	18.1	12.2	22.9	0.56
NPA	4.7	6.6	4.0	8.1	4.7	5.4	0.56
OHA	11.6	13.5	8.3	14.8	9.6	12.5	0.83
PPA	10.0	12.2	9.0	12.5	7.9	8.5	0.42
WNA	11.4	11.3	8.2	12.2	7.3	10.6	**0.10**
NSA	11.3	14.7	9.9	18.3	9.1	9.3	0.68
KIX	11.0	11.4	12.1	19.2	10.8	18.0	0.12
WSA	2.7	5.6	3.3	3.6	2.6	3.0	0.86
HKA	3.0	3.4	3.2	2.9	2.5	2.4	0.84
CHA	20.3	24.9	20.6	25.6	16.9	28.2	0.57
DNA	14.0	20.0	14.8	15.7	11.2	14.7	0.46
NVA	3.3	4.8	3.8	4.8	4.2	4.5	0.76

Table 21. Average Buildup Index (BUI) for 16 weather stations averaged over fire season months (Oct-Apr) (based on median values) under combined phases of IPO and ENSO: -1 = IPO-/El Niño, -2 = IPO-/Neutral, -3 = IPO-/La Niña, +3 = IPO+/El Niño, +2 = IPO+/Neutral, +1 = IPO+/La Niña. Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when means rather than medians were compared.

higher FFMCs under IPO-/La Niña (-3) and lower FFMCs with IPO-/El Niño (-1). Although not significant, South Island West Coast stations also showed their highest FFMC values under IPO-/La Niña (-3) and lowest values under IPO+/La Niña (+1) and/or IPO+/Neutral (+2) conditions. In general, average fire season (Oct-Apr) BUI values (Table 21) in the North Island were higher (+2 to +6 points, or +15% to +50% above average) under IPO+/El Niño (+3) and lower (-1 to -5 points, or -10% to -35%) under IPO-/La Niña (-3), and higher (+0.5 to +5 points, or +10% to +60%) under IPO-/Neutral (-2) and lower (-0.1 to -6 points, or -10 to -25% below average) in IPO+/Neutral (+2) phase combinations in the south. Eastern locations (Gisborne (GSA), Kaikoura (KIX) and Christchurch (CHA)) all showed their highest BUI values with IPO+/La Niña (+3) and/or IPO+/El Niño (+1) conditions, whereas south western stations (Westport (WSA), Hokitika (HKA), Invercargill (NVA) and, to some extent, also Dunedin (DNA) showed highest BUI values in IPO-/ Neutral (-2) conditions and lowest BUIs with IPO+/Neutral (+2) and/or IPO-/El Niño (-1) phase combinations. Wellington (WNA) was the only station to show a statistically significant difference, with highest BUI values in IPO+/El Niño (+3) and lowest BUIs with the IPO+/Neutral combination (see Table 21).

For the fire season severity measures, although there were no stations to show statistically significant differences between IPO/ENSO phase combinations, average fire season (Oct-Apr) DSR values (Table 22) were generally highest (+0.10 to +0.45 points, or +25% to +140% above average) in IPO+/El Niño (+3) and lowest (-0.05 to -0.40 points, or -25% to -60%) in IPO+/Neutral (+2) and/or IPO-/La Niña (-3) conditions. Eastern areas (Gisborne (GSA), Kaikoura (KIX) and Christchurch (CHA)) again showed their highest values (+50% to +60% above average) under the IPO+/La Niña (+1) phase combination, and lowest (-35% to -50% below average) DSR values with IPO+/Neutral (+2) conditions. Similarly, West Coast stations (Westport (WSA) and Hokitika (HKA)) also had their highest (+80% to +90% above average) values in IPO-/Neutral (-2) and lower (-40% to -45% below average) DSR values in IPO-/El Niño (-1) conditions (see Table 22).

Trends for average fire season (Oct-Apr) values of the number of days of VH+E Forest fire danger (Table 23) were not as readily apparent as those for the previous fire season severity measure, DSR. Tauranga (TGA) was the only station to show a statistically significant difference between IPO/ENSO phase combinations, with more days of VH+E fire danger (+5.6 days, or +150% above average) in IPO+/El Niño (+3), and fewer days (-3.5 days, or -100% below average) under the IPO+/La Niña (+1) combination. Eastern stations (Gisborne (GSA), Kaikoura (KIX) and Christchurch (CHA)) did show similar trends to the DSR, with increased fire season severity (by +2 to +8 days of VH+E, or +35% to +100% above average) with IPO+/El Niño (+3) and/or IPO+/La Niña (+1), but in this case the lowest number of days of VH+E fire danger (-1.5 to -8 days, or -20% to -65% below average) with IPO-/neutral conditions (-2) (as opposed to IPO+/Neutral (+2) for DSR). Differences were even more significant when the average number of days occurring under the highest phase combinations when contrasted with those for the lowest, with fire season severity at several stations increasing 8 to 80 times (i.e., 800% to 8000%) in one phase combination compared with another. For example, Tauranga (TGA) averaged 16.0 days/year of VH+E fire danger under IPO+/El Niño (+1) compared with only 0.2 days/year in IPO+/La Niña (+1), and Auckland (AKL) 16.0 days/year in IPO-/La Niña (-1) compared with 1.8 days/year in IPO+/La Niña (+1) (see Appendix 3). For Westport (WSA), days of VH+E Forest fire danger only occurred under the IPO-/La Niña (-3) phase combination (also see Table 23).

Weather Station	Combined IPO/ENSO phase - DSR						
	-1	-2	-3	+3	+2	+1	Prob/Sig.
KX	0.27	0.45	0.11	0.42	0.12	0.20	0.75
AKL	0.21	0.24	0.13	0.43	0.16	0.14	0.41
TGA	0.35	0.47	0.13	0.50	0.13	0.22	0.23
ROA	0.15	0.07	0.08	0.28	0.06	0.06	0.18
GSA	0.62	0.53	0.39	0.73	0.30	0.96	0.70
NPA	0.06	0.14	0.04	0.17	0.05	0.07	0.86
OHA	0.45	0.46	0.23	0.91	0.25	0.50	0.74
PPA	0.24	0.39	0.17	0.42	0.17	0.18	0.74
WNA	0.64	0.66	0.35	0.71	0.33	0.58	0.36
NSA	0.26	0.38	0.15	0.68	0.12	0.18	0.42
KIX	0.13	0.14	0.20	0.33	0.13	0.34	0.21
WSA	0.00	0.02	0.01	0.01	0.01	0.01	0.87
HKA	0.00	0.01	0.01	0.01	0.00	0.00	0.29
CHA	0.70	0.85	0.60	1.18	0.46	1.31	0.93
DNA	0.22	0.32	0.26	0.37	0.14	0.27	0.66
NVA	0.02	0.04	0.02	0.09	0.02	0.03	0.24

Table 22. Average Daily Severity Rating (DSR) for 16 weather stations averaged over fire season months (Oct-Apr) (based on median values) under combined phases of IPO and ENSO: -1 = IPO-/El Niño, -2 = IPO-/Neutral, -3 = IPO-/La Niña, +3 = IPO+/El Niño, +2 = IPO+/Neutral, +1 = IPO+/La Niña. Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when means rather than medians were compared.

Significant differences between IPO/ENSO phase combinations for both weather elements and fire danger ratings were more frequent when comparisons were made for 3-month climate seasons (Appendix 3). Winter (Jun/Jul/Aug) and spring (Sep/Oct/Nov) rainfalls were generally higher under ENSO neutral conditions (IPO+/Neutral (+2) and/or IPO-/neutral (-2)), and lower with El Niño (IPO-/El Niño (-1) or IPO+/El Niño (+3)). Similarly, winter temperatures were generally highest under La Niña conditions, including IPO+/La Niña (+1) and/or IPO-/La Niña (-3) for North Island and South Island West Coast stations, and IPO+/La Niña (+1) and/or IPO+/El Niño (+3) for other South Island locations. Westport (WSA) also showed significant differences in temperature for IPO/ENSO phase combinations in summer and autumn.

Weather Station	Combined IPO/ENSO phase – VH+E FFDC						
	-1	-2	-3	+3	+2	+1	Prob/Sig.
KX	7.2	5.6	7.0	4.4	3.3	1.9	0.84
AKL	2.8	2.2	8.2	5.0	4.9	1.3	0.76
TGA	5.3	2.6	2.8	9.3	1.7	0.1	**0.09**
ROA	1.7	0.4	2.0	1.9	0.9	0.0	0.27
GSA	19.0	9.1	11.6	25.1	14.0	24.1	0.93
NPA	1.7	0.6	0.4	0.3	1.0	0.6	0.87
OHA	8.1	6.8	10.5	6.8	5.2	9.0	0.93
PPA	1.3	1.4	3.3	1.8	2.3	0.9	0.98
WNA	13.0	6.0	9.0	12.5	7.9	7.9	0.97
NSA	6.8	3.5	4.0	7.8	5.7	0.9	0.55
KIX	1.4	1.3	0.9	4.9	2.7	3.6	0.67
WSA	0.0	0.0	0.2	0.0	0.0	0.0	0.17
HKA	0.0	0.0	0.0	0.0	0.0	0.0	1.00
CHA	18.8	17.2	19.0	27.2	18.0	29.0	0.96
DNA	2.4	3.4	4.6	2.4	3.5	5.6	0.74
NVA	0.0	0.3	0.1	0.3	0.1	0.0	0.20

Table 23. Average number of days of Very High and Extreme (VH+E) Forest fire danger classes for 16 weather stations averaged over fire season months (Oct-Apr) (based on mean values) under combined phases of IPO and ENSO: -1 = IPO-/El Niño, -2 = IPO-/Neutral, -3 = IPO-/La Niña, +3 = IPO+/El Niño, +2 = IPO+/Neutral, +1 = IPO+/La Niña. Values significant at the 90% level (i.e <0.10) using the Kruskal-Wallis test are highlighted in bold; values highlighted in blue font were significant when medians rather than means were compared.

For FWI System components, fewer significant differences for climate seasons were apparent for FFMC compared with BUI. Winter and/or spring differences between IPO/ENSO phase combinations for rainfall in particular were reflected in differences for FFMC during winter (Jun/Jul/Oct) at Kaitaia (KX), Rotorua (ROA), Ohakea (OHA) and Nelson (NSA), and in spring at Auckland (AKL) and New Plymouth (NPA). In addition, rainfall and temperature differences were apparent in FFMC differences during autumn at Rotorua (ROA) and Invercargill (NVA), and in summer at Kaikoura (KIX). For the BUI, significant differences between IPO/ENSO phase combinations also generally reflected rainfall differences (see Figures 8 and 9). Rotorua (ROA) and Gisborne (GSA) both showed significant differences in average

BUI values for three of the four climate seasons, while Tauranga (TGA), New Plymouth (NPA) and Ohakea (OHA) showed differences during two of the climate seasons. Significant differences during winter (Jun/Jul/Aug) were generally reflected in the highest BUI values under IPO+/La Niña (+3), especially for the North Island. Spring (Sep/Oct/Nov) differences at Rotorua (ROA), New Plymouth (NPA) and Paraparaumu (PPA) showed higher average BUI values under IPO-/El Niño (-3) conditions. Summer (Dec/Jan/Feb) differences at Auckland (AKL) and Tauranga (TGA) were greatest under IPO+/El Niño (+3), but at Hokitika (HKA) with the negative IPO phase generally. However, differences in BUI during autumn (Mar/Apr/May) under IPO+/La Niña (+1) were most significant, likely as a result of cumulative rainfall deficits, with Gisborne (GSA) and Ohakea (OHA) showing BUI values at least double the average of those during other phase combinations.

Trends for fire season severity measures with climate seasons were not as obvious. Fewer stations showed significant differences during winter (Jun/Jul/Aug) and spring (Sep/Oct/Nov) than either the weather elements or FWI System components, and differences during summer (Dec/Jan/Feb) were more common, again likely as a result of cumulative effects over previous months. For the DSR, Rotorua (ROA) showed significant differences in winter, spring and summer (see Figure 8), while West Coast stations (Westport (WSA) and Hokitika (HKA)) were significantly different in both summer and autumn (Mar/Apr/May). In this latter case, summer DSR values were highest with IPO-/Neutral (-2) and IPO-/La Niña (-3), and autumn differences highest under the IPO+/La Niña (+1) phase combination. For days of VH+E Forest fire danger, summer differences were highest under IPO-/La Niña (-3) for the North Island, and under IPO+/El Niño (+3) in Tauranga (TGA) and eastern locations (Kaikoura (KIX) and, although not statistically significant, also Christchurch (CHA)); in most cases, the number of days of VH+E fire danger were 1.5 to 2 times the average, and 3 to 6 times those for the lowest phase combinations.

Again, while definitive reasons for these differences between combined IPO/ENSO phases at particular locations could not identified, differences were generally consistent with the broader spatial pattern of differences in rainfall with IPO and ENSO. Examples showing how differences in rainfall (for both individual months and 3-month climate seasons) associated with ENSO, IPO and combined IPO/ENSO phases are reflected in corresponding differences in fire danger (described using both the BUI and DSR) at Rotorua and Kaikoura are illustrated in Figures 8 and 9, respectively. Winter and spring rainfall, in particular, were lower in the east under the IPO+/La Niña (+1) phase combination (see Figure 9), and in the central North Island (see Figure 8) and western areas under IPO-/El Niño (-1) (and in the north, central regions and Canterbury under El Niño generally). There also appears to be some evidence that fire dangers and fire season severity with ENSO are enhanced by IPO

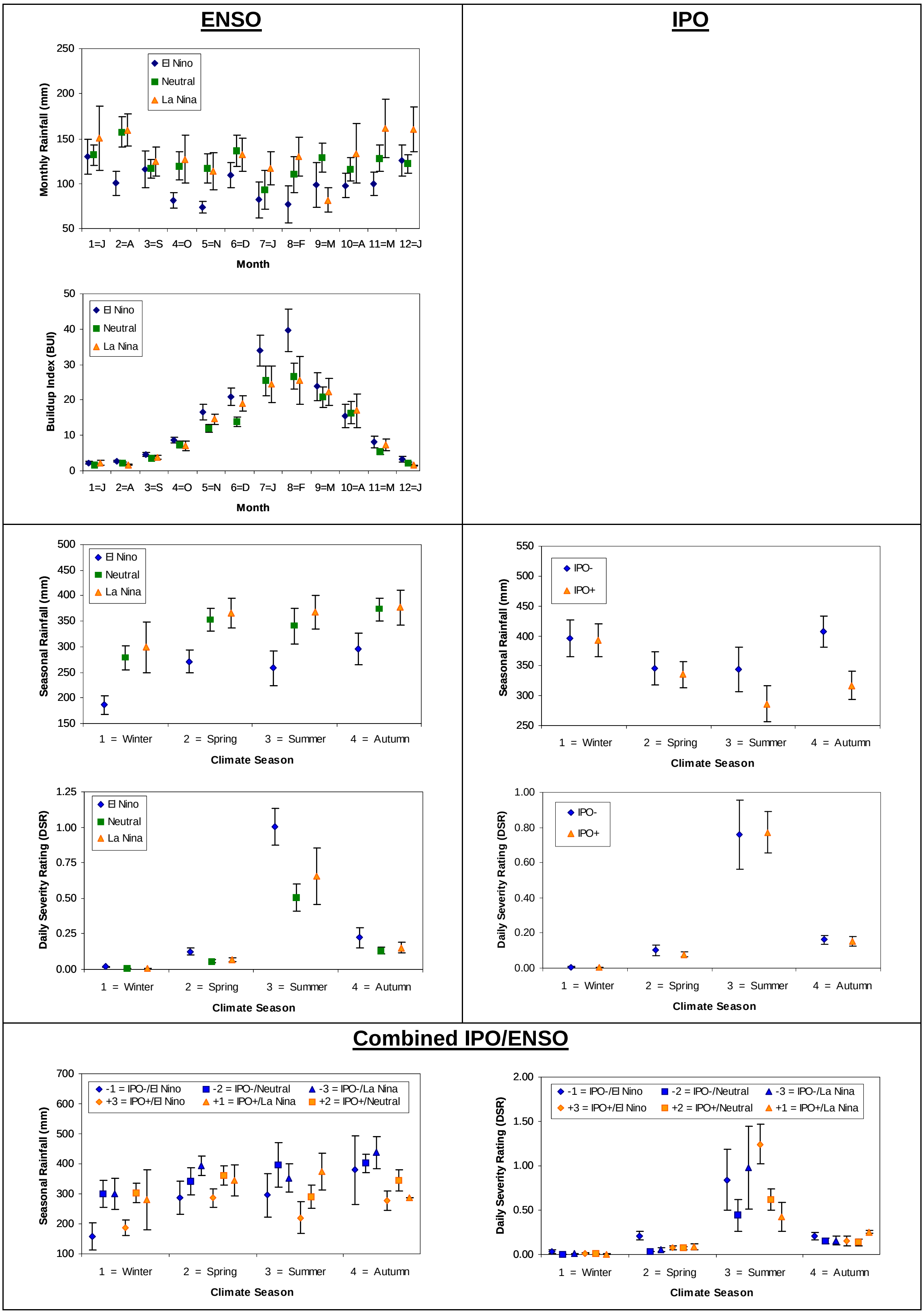

Figure 8. Comparisons of ENSO (left), IPO (right) and combined IPO/ENSO (bottom) effects on average rainfall and fire danger, depicted by the Buildup Index (BUI) and Daily Severity Rating (DSR), for Rotorua (ROA). Error bars indicate the standard error about the mean (for rainfall) or median (for BUI and DSR) value for each circulation phase.

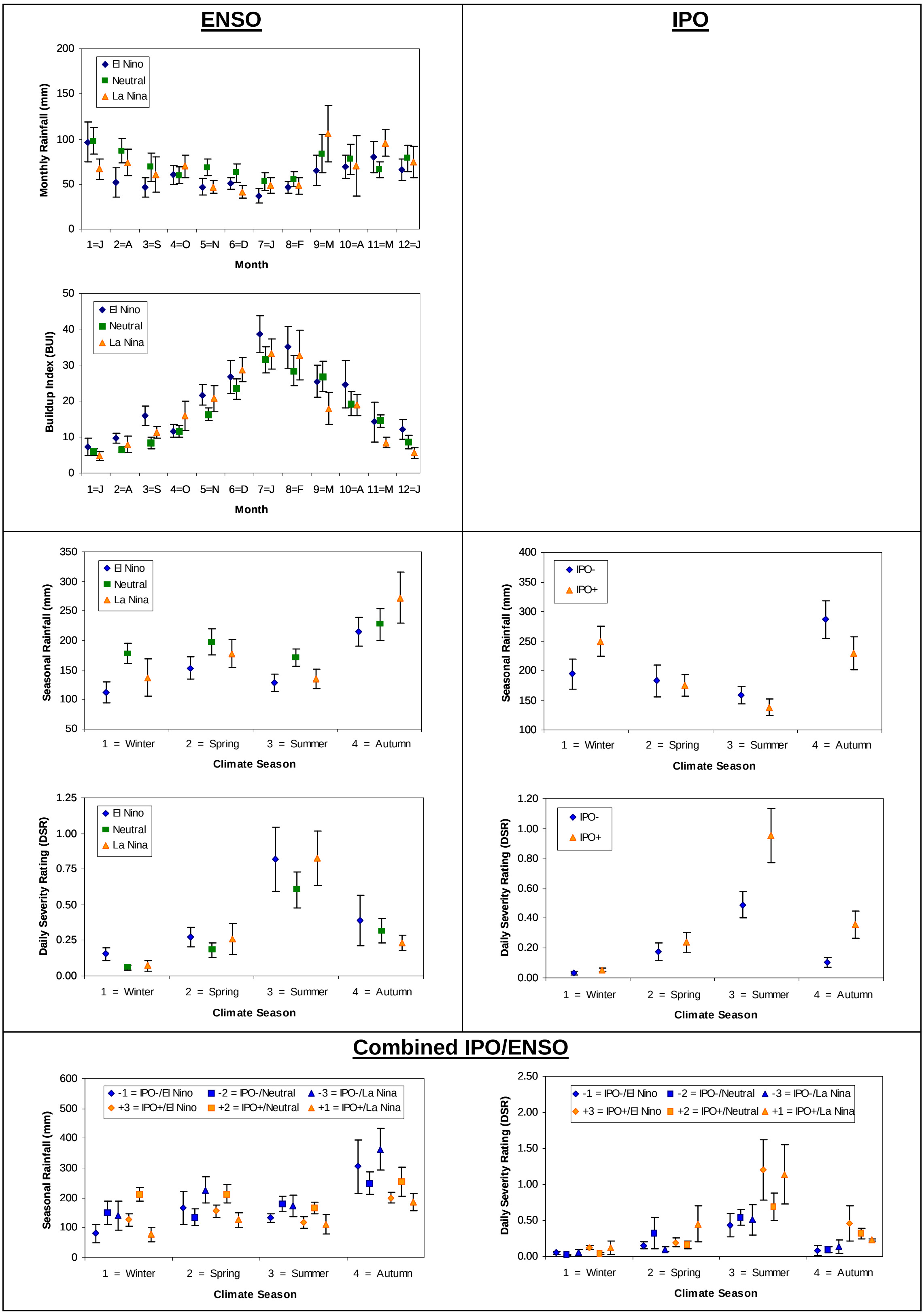

Figure 9. Comparisons of ENSO (left), IPO (right) and combined IPO/ENSO (bottom) effects on average rainfall and fire danger, depicted by the Buildup Index (BUI) and Daily Severity Rating (DSR), for Kaikoura (KIX). Error bars indicate the standard error about the mean (for rainfall) or median (for BUI and DSR) value for each circulation phase.

phase, due to the reinforcement of prevailing circulation patterns under these modes of atmospheric circulation and/or ocean temperature patterns. Eastern locations did show higher fire dangers for the IPO+/El Niño (+3) phase combination, especially during summer, although also showed some tendency for increased fire season severity with IPO+/La Niña (+1). As expected, fire dangers for South Island West Coast stations were also increased under the IPO-/La Niña (-1) combination, but also in IPO-/Neutral (-2) conditions, so that it could be considered that the IPO was the principal driver as opposed to ENSO or a particular IPO/ENSO combination.

6. Discussion

Effects of ENSO on Fire Danger

Study results show evidence of increased fire dangers in the east, and reduced fire dangers in the west and south of the South Island with El Niño, primarily owing to rainfall differences with ENSO phases. El Niño rainfall was lower in Northland, Auckland, Bay of Plenty and the central North Island, lower for both El Niño and La Niña in the west and south of the North Island, northeast of the South Island and coastal Canterbury and Otago. Lower La Niña fire season rainfall occurred in Southland. Temperature was less variable, but higher for both El Niño and La Niña events in Waikato, Bay of Plenty and the east of both islands, whilst temperatures were higher during La Niña episodes in the west of the North Island, central New Zealand and south of South Island.

The stations where significant effects in FFMC tended to be those that had significant phase differences in fire season rainfall, and the more general FFMC differences tended to be those that followed temperature effects as well. Under both El Niño and La Niña conditions, FFMCs were higher in Waikato and Bay of Plenty as well as the central, western and southern North Island and coastal Otago, or higher in the east of the North Island and north east of the South Island with El Niño, and higher during La Niña and lower in El Niño in the west and south of the South Island. The BUI was higher in Waikato and Bay of Plenty with El Niño events, and for both El Niño and La Niña in the central North Island, lower north Island and north east of the South Island. BUI was higher under La Niña in the west of the South Island, and higher in La Niña and lower in El Niño in southern New Zealand.

The differences in DSR were more of the classical ENSO response, as this measure integrates a number of climatic factors, and did not develop significant effects until later in the fire season. These were higher in many locations in the north and east of the North Island under El Niño, with all summer months showing significant increases. In contrast, DSR increases under La Niña were in the west of both islands and the south of the South Island, and developed later in summer (February) and persisted into autumn in the west of the North Island. As with DSR, the average fire season days of VH+E forest fire danger do respond quite distinctly to the ENSO phases, due to the reduced rainfall and more severe fire weather later on in the fire season. Marked increases were found in Bay of Plenty and the east of the North Island, and had developed during the fire season by the end of December; by autumn these differences were no longer present. In contrast under La Niña the increases in Very High and Extreme (VH+E) forest fire danger in the south of the South Island did not develop until February, and in March in the lower west of the North Island. These effects are in line with ENSO phase rainfall differences where rainfall generally is reduced in the north and east of the North Island from late spring until February under El Niño conditions. Generally later in summer and early autumn rainfall shows reductions under La Niña conditions in the lower west of the North Island and south of the South Island.

As well as being consistent with the general trends in, and, to a lesser extent, also temperature (Gordon 1986, Mullan 1995, Salinger and Mullan 1999), these results for the composite effects of ENSO on fire danger are also consistent with those reported by other New Zealand studies. In their studies of the climate factors contributing to high fire season severity in the previously identified fire climate regions (Heydenrych and Salinger 2002), Gosai *et al*. (2003, 2004) noted that El Niño conditions were likely to produce high fire dangers (reflected in Monthly Severity Ratings, MSR) in North Canterbury, and under the La Niña phase in the Mackenzie Basin, Central Otago and inland Southland (Gosai *et al*. 2003).

In the earlier investigation of the correlations between fire season severity (measured using Seasonal Severity Ratings, SSR) and global and regional climatic factors for 21 stations across the country, Heydenrych *et al*. (2001) found that the Southern Oscillation Index (SOI) – the measure of the strength of El Niño and La Niña events – was positively correlated to SSR for the west coast stations New Plymouth, Westport and Hokitika. Thus when the SOI is positive (i.e., La Niña), with more easterly or northeasterly flow over New Zealand, fire danger is higher at these locations. In contrast, SSR was negatively associated with the SOI at Gisborne and Kaikoura. When the SOI is negative (i.e., El Niño), more west to southwest flow occurs giving higher fire dangers in the eastern extremities of both islands. Sea surface temperature (SST) around New Zealand was also significantly correlated to higher fire danger at New Plymouth, Ohakea, Paraparaumu, Westport, Hokitika and Queenstown. Thus above average SSTs in the New Zealand region lead to higher fire dangers in western areas of both islands. However, Heydenrych *et al*. (2001) included a message of caution with their findings, noting that some of the stations investigated in their study had shown considerable variability from the results reported in the earlier study of Salinger *et al*. (1999). While SOI (and SST) were significantly correlated at many of the stations investigated, it was not the mostly strongly correlated of the indices investigated and featured in only a few of the regression equations developed by Heydenrych *et al*. (2001) to predict fire season severity ratings.

Although general trends were able to be detected for FWI System components and fire season severity with ENSO, El Niño and La Niña events evolve differently. Characteristically, El Niño events normally develop earlier in the fire season (i.e., October to January) then diminish later in summer (February to April), whereas La Niña episodes usually intensify later in the season (October-January). In addition, each El Niño or La Niña episode evolves differently, so that more definitive results may emerge upon examination of similar ENSO events. ENSO only accounts for part of the seasonal climate variability over New Zealand so other shorter duration phenomena, such as the Southern Annular Mode (Renwick and Thompson 2006) which controls the location and strength of westerly winds across New Zealand, individual rain events or the length of rain-free periods (as opposed to monthly or seasonal rainfall amounts), or the occurrence of extreme weather days with strong winds and/or low humidity, will also have significant influences on seasonal fire danger. However, ENSO does provide a climate signal that is mirrored in FWI System components and fire danger ratings.

Evidence of the effects of ENSO on increasing fire risk in various parts of New Zealand during El Niño and La Niña events is also seen in the historical record of fire occurrence. Many of the major fires recorded in New Zealand can be attributed to individual ENSO events. For example, the 1982/83 El Niño particularly affected the central North Island where 45 000 ha was burnt, including 15 000 ha of tussock and beech forest in the Ohinewairua Fire. Table 24 includes an incomplete summary of major fires by fire season and ENSO event type for period covered by the weather station records included in this study. A number of severe fire seasons prior to this period can also be related to the occurrence of ENSO events, particularly El Niños. The 1945/46 fire season is the worst in recent record, with a total of 238 900 ha burnt in 311 fires in Hawkes Bay, Rotorua-Taupo and North Auckland, including the 1946 Taupo/Tahorakuri forest fire which burnt 30 700 ha of which about 13 000 hectares of pine plantation (NZ Forest Service 1946). Other significant fire years include the February 1878 (El Niño) Waimate fires in South Canterbury and March 1918 (La Niña) Raetihi fires in the central North Island (McLean 1978), and the November 1955 (La Niña) Balmoral Fire in Canterbury (Pearce and Alexander 1994). Since the 1961/62 fire season, some 11 major fires have occurred during El Niño seasons, 13 during La Niña seasons, and 8 during neutral seasons.

The trends identified in this study of ENSO effects on fire danger, particularly El Niño, are similar to those found in Australia. Williams and Karoly (1999) reported a strong relationship between fire danger ratings and the phase of ENSO for 6 the 8 sites

Fire Season	ENSO Event Type	Fire Name (Month and Region)
1961/62		
1962/63		
1963/64	El Niño	
1964/65	La Niña	
1965/66	El Niño	
1966/67		
1967/68		
1968/69	El Niño	
1969/70	El Niño	Mawhera (Nov. 1969, West Coast)
1970/71	La Niña	Slopedown (Feb. 1971, Southland)
1971/72		Allanton (Sept. 1972, Otago), Rankleburn (1972, Southland)
1972/73	El Niño	Ashley (Feb. 1973, Canterbury), Mt White (Feb. 1973, Canterbury)
1973/74	La Niña	Mohaka (Nov. 1973, Hawkes Bay)
1974/75		Waimea (Mar. 1975, Nelson)
1975/76	La Niña	Hanmer (Mar. 1976, Canterbury)
1976/77	El Niño	
1977/78	El Niño	Wairapukao (Dec. 1977, BoP), Earthquake Gully (Mar. 1978, Taupo)
1978/79		
1979/80		Mt Thomas (1980, Canterbury)
1980/81		Hira (Feb. 1981, Nelson), Balmoral (Apr. 1981, Canterbury)
1981/82		Haldon/Waitangi (Feb. 1982, Mackenzie Basin)
1982/83	El Niño	McCrosties (Oct. 1982, Otago), Ohinewairua (Feb. 1983, Central N.I.)
1983/84	La Niña	
1984/85	La Niña	
1985/86		
1986/87	El Niño	Oxford (Feb. 1987, Canterbury)
1987/88	El Niño	Kaimaumau (1988, Northland)
1988/89	La Niña	Dunsandel (Dec. 1988, Cant'y), Whangamarino (Jan. 1989, Waikato)
1989/90		
1990/91		
1991/92	El Niño	Bottle Lake (Feb. 1992, Canterbury)
1992/93		
1993/94		
1994/95	El Niño	Berwick (Feb. 1995, Otago)
1995/96	La Niña	Mohaka (Nov. 1996, Hawkes Bay), Bottle Lake (Feb. 1996, Cant'y)
1996/97		
1997/98	El Niño	Harakeke (Oct. 1997, Nelson), Aupori (Nov. 1997, Northland), Welcome Bay (1998, Tauranga)
1998/99	La Niña	Alexandra (Feb. 1999, Central Otago), Omarama (Mar. 1999, Mackenzie Basin)
1999/00	La Niña	
2000/01	La Niña	Blenheim (Dec. 2000, Marlborough), Picton (Feb. 2001, Marlborough), Para (Mar. 2001, Marlborough), Okaramio (Mar. 2001, Marlborough), Cora Lynn (Mar. 2001, Cant'y), No Mans/Flock Hill (Mar. 2001, Cant'y)
2001/02		
2002/03	El Niño	Aupori (Feb. 2003, Northland), Kaimaumau (Feb. 2003, Northland)
2003/04		Canterbury (West Melton, Dec. 2003; Flock Hill, Jan. 2004; Dunsandel, Jan. 2004; Mt Somers, Jan. 2004)
2004/05	El Niño	Mohaka (Jan. 2005, Hawkes Bay), Papatotara (Jan. 2005, Southland)
2005/06		

Table 24. An anecdotal listing of significant New Zealand fire events by fire season and ENSO event types[2].

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[2] Compiled from Cooper (1980), Farrow (1993), Pearce (1994), Pearce and Alexander (1994), Pearce *et al*. (2000), and fire records held by the Ensis Bushfire Research group, Christchurch.

across Australia they investigated in their study. They found that the frequency of Very High and Extreme days (based on the McArthur Forest Fire Danger Index, FFDI) more than doubles during the warm phase of ENSO (El Niño). Lucas (2005) reported very similar differences between El Niño and La Niña years for sites in south-eastern Australia. He noted that statistically significant differences also existed for seasonal means of maximum temperature, rainfall and relative humidity at many of the stations. Given the strong correlations between rainfall and humidity, and rainfalland temperature, he believed it is reasonable to suggest that the differences in fire danger where therefore largely determined by the ENSO-rainfall relationship. However, Lucas (2005) also noted that despite the significant correlations between ENSO and rainfall, and by implication fire danger, ENSO only explains 15-35% of the variance in fire danger ratings in the Australian fire weather record. He suggests that closer investigation shows much of the difference between El Niño and La Niña years is in fact due to the very strong El Niños observed in 1982-3 and 1997-8, and that for weaker El Niño conditions the relationships are not as strongly defined.

Stern and Williams (1989), and Williams and Karoly (1999), have indicated that extreme fire danger days in southern Victoria tend to be much more frequent in the summers following El Niño years than the summers following La Niña years. El Niño events, in particular, tend to become established in the southern hemisphere autumn, and to persist well into the following summer or autumn. Wright and Jones (2003a) also noted that in southeastern Australia, severe fire weather conditions tended to be more frequent than normal in the spring and summer periods of El Niño years, and that the increased fire danger appeared to be related to below normal rainfall in the lead-up to the fire season, and a tendency for more frequent extremely hot, dry days and strong wind events in the season itself. By contrast, La Niña summers were generally associated with fewer severe fire weather days in the southeast. It has also been reported that, in northern Australia, the abundant vegetation following heavy rain-producing La Niña events often fuelled unusually extensive and severe fires (Luke and McArthur 1978, Tapper *et al*. 1993).

Effects of IPO on Fire Danger

Fire dangers were also found to vary with IPO phase across New Zealand, with study results for the IPO change from negative to positive being broadly consistent with the general climate trends for rainfall from these (Salinger and Mullan 1999, Salinger *et al*. 2001, Thompson 2006b). Although the FWI System component differences (FFMC and BUI) did not show many sites with significant effects, the negative phase BUI was higher in the west of the South Island. Differences in fire danger ratings were more distinct. Eastern areas showed large, if not always statistically significant increases in the positive phase, and western areas decreased. At eastern sites there can be large variability in rainfall. However, BUI was less sensitive to the IPO phase.

However, these differences were not as great as those associated with ENSO effects, largely due to the fact that IPO rainfall changes were small for the stations examined. This was in spite of almost universal increases in temperature with the change to the positive phase of the IPO (only Westport showed a temperature decrease for IPO+). The IPO analysis was also very much limited by the small number of stations available for analysis. Of the 16 stations available, 3 of these had ten years or less for analysis in the negative IPO phase, limiting the ability to obtain significant results.

Study results also showed some evidence that ENSO effects are enhanced by the IPO. Seasonal rainfalls during winter and spring rainfall were found to be lower in eastern areas under combined IPO+/La Niña conditions, but lower in the central North Island and west under IPO-/El Niño. Temperatures were also found to be higher in La Niña (under IPO- or IPO+), but lowest for the IPO-/El Niño combination. There was also some evidence that fire dangers during El Niño are enhanced during the positive phase of the IPO and reduced during La Niña conditions during the negative IPO phase, with several stations showing dramatic increases (in the order of 10-100+ times; see Appendix 3) in fire season severity in one phase combination compared with another.

Again, these findings are similar to those reported by Verdon *et al*. (2004) in their study of multi-decadal variability of forest fire risk in southeast Australia. They found that the risk of fire (again described using the McArthur FFDI) is significantly increased during El Niño events, with on average a 51% (and up to 120-170%) increase in the proportion of days with a High, Very High and Extreme fire danger rating (i.e., with McArthur FFDI >12) when El Niño years are compared to non-El Niño years. In addition, El Niño years occurring when the IPO is negative were found to be associated with an increased risk compared to all other El Niño years. The average increase in the probability of a High, Very High or Extreme fire danger day when IPO-negative years were compared to all other El Niño years was 63%, and this increased risk was statistically significant at 12 of the 14 stations they studied.

Many other international studies have also reported increases in fire danger or observed fire occurrence associated with changes in atmospheric circulation and sea surface temperatures at interannual to decadal time scales. These span recent history (Simard *et al*. 1985, Brenner 1991, Alden 1994, Harrison and Meindl 2001, Duffy *et al*. 2005) as well as the long term climatic and fire history records (Swetnam and Betancourt 1990, Villabla and Veblen 1998, Mote *et al*. 1999, Kitzberger 2002, Westerling and Swetnam 2003, Hessl *et al*. 2004, Keeley 2004, Schoennagel *et al*. 2005, Collins *et al*. 2006, Sibold and Veblen 2006, Roman-Cuesta and Carmona-Moreno 2007). In addition to ENSO and IPO (and its Northern Hemisphere equivalent, the Pacific Decadal Oscillation, or PDO), this also includes reference to a range of possible alternative broadscale modes of atmospheric circulation and/or ocean temperature patterns that may act independently of or modulate ENSO effects.

Some of those mentioned in the literature include mid-tropospheric (500 hPa height) anomalies (Johnson and Wowchuk 1993, Skinner *et al*. 1999) and the Artic Oscillation Index (Baltzer *et al*. 2005) in the Northern Hemisphere, and the Quasi-Biennial Oscillation (QBO), Indian Ocean Dipole, Southern Annular Mode (SAM), Antarctic Circumpolar Wave or Antarctic Oscillation Index (AOI), Madden-Julian Oscillation in the Southern Hemisphere (Wright and Jones 2003a, Lucas 2005, 2006), or even anthropogenic (man-made) causes such as the “enhanced Greenhouse effect” or “ozone depletion effect” (Wright and Jones 2003a, Lucas 2005). Hence further work is required to identify definitively the causes of climate variability in the Australasian region, and its impacts on fire danger in New Zealand.

Study Methodology

The analyses undertaken here only considered the influences of rainfall and, to a lesser extent, temperature differences associated with ENSO and IPO phase changes on fire danger. Future research could therefore also look at wind directions and speeds under different ENSO and IPO phases. Wind is a critical element affecting both the direction and speed of fire spread, and is therefore an important factor to be considered in assessing fire danger. El Niño conditions are typically associated with stronger and/or more frequent west to southwest winds, whereas La Niña events generally bring weaker westerlies and more northerly or north easterly winds. Similarly, the negative phase of the IPO is associated with weaker westerlies, and more easterlies and north easterlies over northern New Zealand, whereas the positive phase of the IPO brings more westerly winds over the country. Therefore, fire dangers measured by the Initial Spread Index (ISI) and Fire Weather Index (FWI) itself, which more directly incorporate the influence of wind speed, could be expected to be higher in the north and east of both islands under El Niño and/or the positive phase of the IPO and, conversely, higher in the southern North Island, parts of inland Canterbury, Otago and Southland, or lower in the north and east of the North Island and in Nelson/Marlborough during La Niña and/or negative IPO.

Relative humidity is also a critical factor affecting potential fire behaviour and fire danger, particularly the likelihood of ignition. One could assume that changes in wind direction associated with the differences in ENSO and/or IPO phase might also mean changes in predominant air mass characteristics, including their moisture content (i.e., humidity), and consequent fire danger (such as measured through the Fine Fuel Moisture Code, FFMC). While such differences in humidity could be ameliorated in coastal areas due to New Zealand’s maritime climate, through for example diurnal sea breezes, air mass and therefore relative humidity effects could be more important in inland areas and where orographic influences (such as foehn and lee rain shadow effects) become more important. Hence, future analyses of the impacts of ENSO (and IPO) on fire danger should also consider relative humidity differences.

The methodology used here to compare fire dangers under the different phases of the IPO was also somewhat different to that used in the most similar international study by Verdon *et al*. (2004), which looked at multi-decadal variability of forest fire risk over southeast Australia. Verdon *et al*. (2004) used the thresholds identified by Power *et al*. (1999) to distinguish between IPO phases and included a neutral phase with IPO values between +/- 0.5. In this way, years or seasons that do not show strong IPO trends are included in the neutral phase, and do not confuse signals for trends in climate or fire danger within the main phases themselves. However, removing 1977 from the analysis assisted. Use of such an approach might result in stronger trends being identified than were exhibited for stations with IPO in the present analysis. However some caution should be exercised when interpreting the results from such an approach, as Lucas (2005) has suggested that a significant proportion of the difference observed for opposing phases (in his case, of ENSO) can be attributed to a few strong events rather than a general trend with phase.

The length of available data record to calculate fire dangers was another limiting factor in the analysis, in particular into the effects of ENSO on fire danger. Some 19 of the 40 weather stations used in this analysis had only 15 years of record, or 14 full fire seasons that included a sample of four El Niño and four La Niña seasons, and six neutral seasons. The results here will be tempered by the samples of the El Niño, La Niña and neutral seasons. For example, although both 1997/98 and 1998/99 were strong El Niño and La Niña seasons respectively, the other three El Niño and La Niña events were weak and some did not last a full fire season. This sample size did not tend to produce significant analysis results, and the analysis should therefore be repeated some time in the future when a further 5-10 year of data (and another 3-4 events of each ENSO phase) might result in stronger trends being identified. Similarly, the number of stations used to investigate IPO effects on fire danger was severely limited by the available lengths of record, for the negative IPO phase prior to 1977 in particular, with the resulting 16 stations barely sufficient to indicate regional differences. Hence, the addition of future data and the establishment of the current phase of the IPO should also increase the number of stations with sufficient data for an improved comparison of IPO effects on fire danger.

Finally, climate variability can either dampen or enhance trends due to longer term climate change, such as those identified by Pearce *et al*. (2005). Under extreme and and mid-range climate warming scenarios, increased FFMC values are predicted to occur in Auckland, Bay of Plenty, Gisborne, Wellington and coastal Canterbury, and

BUIs predicted to increase in the east of both islands and north of the North Island. Small decreases occur in some southern South Island stations for FFMC. Significantly higher CDSR values and more days of VH+E forest fire danger were predicted in the east of both islands, Bay of Plenty and central (Wellington/Nelson regions) under high extreme and mid-range climate warming scenarios. Several stations, typically those in the south and west with low or no existing fire danger indicate little change for fire severity indices. Both ENSO changes to El Niño conditions and IPO changes to the positive phase are thus likely to exacerbate fire weather and fire danger especially in the Bay of Plenty and east of both islands, and dampen these conditions in the west and south of the South Island. The reverse, changes to La Niña conditions and negative IPO, would dampen severe fire weather and fire danger in the east of both islands. It is of note that the El Niño phase of ENSO and the positive phase of the IPO have reasonably similar directional circulation trends to those indicated by climate change scenarios – that of increased westerly quarter circulation. So these natural cycles of variability either reinforce or counteract currently expected long term trends due to climate change. However, if improved climate modelling yields different climate scenarios of circulation and precipitation changes, then these scenarios will require updating for FWI System components and fire severity indices.

7. Conclusions

The effects of natural climate variability on fire climate and fire danger trends have been investigated by examining two natural, global features of the climate system, the El Niño-Southern Oscillation (ENSO) and the Interdecadal Pacific Oscillation (IPO). These two measures of climate variability have previously been found to influence New Zealand’s climate, including rainfall and temperature which are critical inputs in determining fire danger. ENSO operates on seasonal, and the IPO on decadal time scales. After updating long-term fire weather records, phases of ENSO seasons (3-month periods) were defined using both the Southern Oscillation Index and sea surface temperature departures of the equatorial Pacific ocean Niño 3.4 region for El Niño, La Niña and neutral phases from 1961/62 to 2005/06. Long term weather records for 40 climate stations contained in the fire danger climatology database were selected on the basis with records encompassing a minimum of four ENSO events over the period 1992-2006. The two most recent phases of the IPO occurred from 1946-76 (negative) and 1978-98 (positive). Examination was limited to only 16 stations with adequate record length for statistical analysis. Summary statistics of weather inputs, FWI System components and fire danger class frequencies were calculated for each station for El Niño, La Niña and neutral phases of ENSO, and the negative and positive phase of the IPO. These included average values of temperature, rainfall, FFMC, BUI, DSR, and the number of days of VH+E Forest fire danger. Annual differences were compared with fire season months when most fires are expected to occur. For ENSO, climate seasons (winter, spring, summer and autumn) as well as individual months were examined to ascertain whether there was any key period of the year that was important. Evidence from these analyses suggests that seasonal fire danger, and therefore associated fire activity is different across New Zealand as a result of these features of climate variability.

The combination of effects on rainfall and temperature in parts of the country causes corresponding changes in FWI System components for some fire season months for ENSO. Average fire season rainfall was lower in the Bay of Plenty and east of the North Island under El Niño conditions. In the south of the South Island, El Niño seasons were wetter and La Niña seasons drier. In addition to significant differences over the fire season for the El Niño, La Niña and neutral ENSO phases, many stations showed significant differences in winter rainfall, especially in July, compared with other 3-month climate seasons. Average fire season temperatures were generally lower in the west and south of both islands during El Niño, and some cases also higher during La Niña episodes. Winter temperatures were higher during La Niña. Fewer stations showed significant differences between ENSO types in spring, whilst summer temperatures during La Niña showed increases and decreases under El Niño in the west and south of both islands. Autumn temperatures were cooler during El Niño and warmer during La Niña at all stations. Increased average fire season FFMC values occurred in Bay of Plenty and the east of the North Island under El Niño conditions, and for both El Niño and La Niña in some western and central North Island locations. FFMC was lower in the west of the South Island. The main climate season of affects was winter where FFMC was higher in many North Island areas and the north of the South Island. Fire season BUI values were generally higher under El Niño conditions in Waikato and the Bay of Plenty and the east of the North Island, and higher under both El Niño and La Niño in central and western North Island. BUI values were higher under La Niña and lower under El Niño conditions in the west and south of the South Island. In summer, there were significant differences in BUI between the north and east and west and south of New Zealand, with El Niño BUI values higher in the former and La Niña values higher in the latter regions. In autumn, significant differences in BUI values were confined to the south west of the North Island and south of the South Island with higher La Niña values. In all cases, significant El Niño values occurred earlier and La Niña values later in the fire season.

Regional differences in seasonal fire severity were also found between ENSO phases. Fire season DSR was higher under El Niño conditions in the east of the North Island and Bay of Plenty, and with La Niña conditions for the latter. DSR values were lower with El Niño and higher with La Niña conditions in the west and south of the South Island. For the summer season, significant differences are reasonably widespread, whilst in autumn significant differences only occurred in the west of the North Island for the La Niña phase, showing that La Niña effects occur later in the fire season. Average fire season values for the number of days of VH+E Forest fire danger show considerable variation under ENSO phases. These were significantly higher in the Waikato, Bay of Plenty and east of the North Island during El Niño episodes, with 2-3 times the number of days of VH+E fire danger (an extra 20-40 days) compared with neutral or La Niña conditions. During La Niña events, non significant increases in VH+E values occurred in the south of the South Island. Significant differences are reasonably widespread for summer throughout Bay of Plenty, the east of the North Island, and parts of the west of the South Island and Otago. The La Niña event increases showed significant differences later in the season (in February) in the south of the South Island compared with La Niña episodes. The effects of ENSO on increasing fire risk in various parts of New Zealand during El Niño and La Niña events are also seen in the historical record of fire occurrence. Over the last 45 years, 24 major fires have occurred during ENSO events, and eight during neutral periods.

For the change in IPO to the positive phase from the negative phase, small increases in fire season rainfall are seen at Hokitika, Dunedin and Invercargill and small decreases at Rotorua, Kaitaia and Kaikoura. Only Westport records a decrease in temperature, whilst Kaikoura records an increase. Fire season FFMC generally decreases in the far north and western areas of both islands, and increases in the east under a positive IPO. BUI differences were small, but increased in parts of the east during the positive phase of the IPO, and decreased in the west and south of the South Island. Fire season DSR showed stronger effects. It increased in Kaikoura, and decreased in the far north, west of both islands, central areas and coastal Otago for the positive phase change. The average number of days of VH+E forest fire danger increased in the east of both islands and decreased in the west of both islands and the far north. These differences were not as great as those associated with ENSO phases, with around 2-8 more days of VH+E forest fire danger having occurred in eastern areas during the IPO positive phase (i.e., the 1978-1998 period) compared with previous decades.

In considering the combined influences of ENSO and IPO, it was apparent that effects were driven more by ENSO than by the IPO. However, some trends were evident with the various phase combinations, including winter and spring rainfalls being lower in the east under IPO+/La Niña conditions, and in the central North Island and west under the IPO-/El Niño combination. Temperatures were also higher in La Niña conditions generally (i.e., for either IPO- or IPO+), but lowest under the IPO-/El Niño combination. There was also some evidence of enhancement of ENSO fire dangers by the IPO, with fire dangers during El Niño being enhanced during the positive phase of the IPO and reduced during La Niña conditions during the negative IPO phase. Several stations showed increases in fire season severity of the order of 10-100 times in one phase combination compared with another.

While these analyses have shown some general trends for the various phases of both ENSO and IPO, it is important to realise that each El Niño or La Niña event evolves differently, no matter what phase of the IPO it occurs under, so that it is often better to track seasonal development against similar ENSO events rather than over generalising on the basis of average trends for each phase derived from compositing seasonal data as has been done here. It is also important to recognise that ENSO only accounts for some of the total climate variability over New Zealand, and other shorter duration factors will also have significant influences on seasonal fire danger.

The analyses undertaken here were also restricted to a limited number of sites and, in the case of ENSO in particular, often to comparison of just a few El Niño and La Niña fire seasons, so that results could be improved by repeating the analysis in 5-10 years time when a greater sample size is available. In addition, the analysis focussed only on the influence of rainfall and, to a lesser extent, temperature differences associated with ENSO and IPO phase changes on fire danger. Due to their importance in fire danger rating, any future study of ENSO and IPO effects should also consider wind and relative humidity differences. The fire danger climatology archive provides an excellent and continually growing source of data on these weather inputs and associated fire danger ratings for an extensive number of locations across the country, and further more detailed analyses using this increasing data record will lead to improved assessments of the impacts of interannual and multi-decadal climate variability on fire danger and future fire occurrence.

The effects of natural climate variability cycles provide year to year variations in FWI System components and fire danger ratings that also reduce or enhance trends due to climate change, such as those identified in the previous study (Pearce *et al*. 2005). Changes of ENSO to the El Niño phase and of IPO to the positive phase have reasonably similar directional circulation trends to those indicated by climate change scenarios – that of increased westerly quarter circulation. The increases in FFMC, BUI, DSR and VH+E Forest fire risk days in the Bay of Plenty, the east of both islands and Wellington/Nelson that have been identified due to climate change will show similar year-to-year variability because of ENSO and the IPO. Should future climate scenarios for precipitation change with improved climate modelling, climate change impacts of fire danger will require revision.

Acknowledgements

Appreciation is extended to Maria McEwan (University of Canterbury, School of Forestry) and Fraser Townsend (ex Ensis Bushfire Research) for assistance in compiling the weather and fire danger datasets used in the analyses. Advice from Brett Mullan (NIWA) on classification of ENSO seasons, and invaluable statistical support from Mike Watt (Ensis-Scion, Forest Biosecurity and Protection) is also greatly appreciated. Acknowledgment is also made to NIWA and the NZFSC, for providing access and data from the NIWA’s Climate Database (CLIDB/CliFlo) and NRFA Fire

Weather archive (FWSYS/RuralNet), respectively. The research undertaken here was also supported by funding provided by the Foundation for Research, Science and Technology (FRST) through contracts C0X0403 (Rural Fire) and C01X0202 (Adaptation to Climate).

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Appendices

Appendix 1. El Niño-Southern Oscillation (ENSO) seasons, based primarily on 5-month running mean NINO3.4 Sea Surface Temperature anomaly exceeding 0.4°C for at least 6 months: C (cool) = La Niña, W (warm) = El Niño, with the negative (-) sign indicating a weak event only.

Year	ENSO Event Classification				5-month Nino3.4				3-month SOI				El Nino/ La Nina
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	
1961					-2	7	-8	-42	23	-47	-17	0	
1962					-21	-33	-14	-39	120	30	23	60	
1963			W-	W	-34	2	67	80	37	53	-53	-107	El 63/64
1964	W-		C-	C-	80	-43	-68	-95	-70	83	93	90	La 64/65
1965	C-		W	W	-66	-3	92	153	-30	-50	-173	-163	El 65/66
1966	W	W			115	48	16	-11	-63	-117	7	-27	
1967					-44	-36	-10	-39	73	-3	43	-10	
1968					-57	-51	36	43	17	17	57	-40	El 68/69
1969	W-	W-	W-	W-	90	48	37	68	-80	-57	-50	-87	El 69/70
1970	W-			C	54	19	-68	-71	-73	-10	20	143	La 70/71
1971	C	C	C	C	-127	-98	-61	-75	117	183	60	130	
1972			W	W	-56	14	101	167	37	-77	-147	-113	El 72/73
1973	W		C	C	164	3	-100	-164	-113	-7	100	180	La 73/74
1974	C	C	C-	C-	-189	-103	-47	-63	183	150	63	57	
1975		C	C	C	-51	-68	-114	-140	-13	110	190	177	La 75/76
1976	C			W-	-149	-48	24	83	147	53	-97	-10	El 76/77
1977	W-	W-	W	W	69	9	42	84	-10	-120	-167	-143	El 77/78
1978	W				78	-22	-44	-31	-143	-7	37	-37	
1979					8	12	10	44	-7	-27	-33	-30	
1980					53	19	13	0	-23	-103	-27	-47	
1981					-18	-5	-18	-7	-17	-63	83	7	
1982			W	W	11	37	116	198	43	-47	-230	-263	El 82/83
1983	W	W		C-	270	146	20	-62	-317	-160	-50	33	La 83/84
1984	C-			C-	-71	-31	-48	-69	13	-27	-27	-7	La 84/85
1985	C-	C-			-122	-77	-41	-43	-7	47	-20	-37	
1986				W-	-62	-33	29	93	-13	-27	7	-57	El 86/87
1987	W	W	W	W-	130	114	169	154	-130	-237	-197	-73	El 87/88
1988	W-		C-	C	80	-47	-148	-182	-50	27	67	183	La 88/89
1989	C	C			-183	-97	-41	-35	110	147	23	27	
1990					2	33	21	21	-93	0	-7	-50	
1991		W-	W	W	36	35	78	93	0	-163	-63	-140	El 91/92
1992	W	W			187	147	33	-12	-197	-173	-73	-93	
1993		W	W		23	83	46	30	-90	-150	-157	-83	
1994			W-	W	4	15	40	80	-10	-177	-167	-147	El 94/95
1995	W			C-	104	18	-13	-87	-80	-87	0	3	La 95/96
1996	C-				-87	-40	-11	-35	0	50	80	27	
1997		W	W	W	-46	43	180	255	77	-180	-200	-180	El 97/98
1998	W	W	C	C	251	104	-106	-122	-200	-210	110	110	La 98/99
1999	C	C	C-	C-	-152	-83	-93	-111	123	100	20	67	La 99/00
2000	C	C		C	-164	-78	-38	-62	100	103	-23	137	La 00/01
2001	C				-74	-20	16	-8	93	-13	-43	13	
2002			W	W	-2	28	95	145	-10	-93	0	-87	El 02/03
2003	W				122	13	16	48	-80	-80	-50	-37	
2004			W	W	27	17	57	80	10	-23	-113	-67	El 04/05
2005	W				57	41	37	-1	-136	-100	-23	30	
2006	C				-69	-17			37	33	-113		

Appendix 2. Average monthly values of climate and fire danger ratings for 40 weather stations under the three phases of ENSO. Values significant at the 90% level (i.e <0.10) are highlighted in bold; values highlighted in blue font were significant when means or medians were compared, respectively.

		Rainfall (mean)				Temperature (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
KX	1=J	133	148	200	**0.03**	13.9	14.1	14.5	0.21	64.7	63.9	62.0	0.59	1.7	1.4	1.5	0.97	0.02	0.01	0.01	1.00	0	0	0	0.59
	2=A	115	168	158	**0.04**	14.1	14.3	14.6	0.31	72.2	65.5	67.8	**0.00**	2.8	2.0	1.7	0.96	0.03	0.01	0.01	1.00	0	0	0	0.95
	3=S	105	131	118	0.45	15.3	15.3	15.8	0.31	72.3	71.0	74.7	0.25	3.9	3.2	4.0	1.00	0.08	0.04	0.04	0.99	0	0	0	0.99
	4=O	87	108	107	0.53	16.2	16.7	16.9	**0.03**	77.2	76.5	74.4	0.42	8.5	8.3	7.3	0.93	0.29	0.23	0.18	0.96	0	0	0	0.99
	5=N	81	94	103	0.61	18.2	18.2	18.9	**0.04**	80.4	79.8	79.9	0.96	16.4	13.4	13.3	0.78	0.78	0.55	0.42	0.68	0	0	0	1.00
	6=D	98	92	90	0.92	19.9	20.5	21.0	**0.00**	81.6	80.6	83.2	0.53	21.2	19.7	24.4	0.64	1.23	0.74	1.35	0.32	0.9	0.3	1.4	0.48
	7=J	72	72	119	**0.07**	21.9	22.3	22.2	0.32	84.1	84.3	83.3	0.90	29.2	33.0	28.8	0.56	1.70	2.14	1.86	0.50	2.3	2.6	1.8	0.70
	8=F	64	109	98	**0.09**	22.9	22.6	22.6	0.52	85.2	84.0	84.6	0.86	48.9	34.5	39.1	**0.01**	3.40	2.12	2.67	**0.01**	4.9	3.4	3.4	0.23
	9=M	58	97	75	0.19	21.2	21.6	21.8	0.36	84.3	82.8	85.0	0.62	32.8	26.6	26.7	0.13	1.62	1.40	1.39	0.59	0.5	1.6	0.7	0.43
	10=A	104	102	137	0.38	18.7	19.5	19.5	**0.03**	77.4	80.4	78.2	0.32	16.3	21.1	15.7	0.39	0.40	0.79	0.51	0.58	0.5	0.7	0.1	0.76
	11=M	117	126	115	0.88	16.3	17.1	17.6	**0.00**	72.2	74.3	80.0	**0.03**	6.2	7.4	9.1	0.75	0.07	0.11	0.17	0.99	0	0	0	0.99
	12=J	161	147	151	0.81	14.6	15.0	15.5	**0.04**	67.3	65.4	64.6	0.58	2.4	1.9	2.2	0.99	0.01	0.01	0.01	1.00	0	0	0	0.97
WRA	1=J	139	182	237	0.18	13.6	13.9	15.3	**0.06**	67.1	62.9	61.9	0.39	2.3	1.8	1.8	1.00	0.01	0.00	0.00	1.00	0	0	0	1.00
	2=A	95	131	125	0.62	13.7	14.2	14.3	0.80	70.1	68.1	72.5	0.58	2.4	3.3	2.6	1.00	0.01	0.01	0.01	1.00	0	0	0	1.00
	3=S	111	133	74	0.40	15.8	15.6	16.3	0.39	75.2	73.9	81.6	0.16	6.5	3.7	8.8	0.85	0.13	0.03	0.15	0.97	0	0	0	1.00
	4=O	70	114	71	0.45	16.8	17.0	17.9	0.12	80.1	76.9	80.4	0.59	9.8	9.6	14.9	0.78	0.27	0.20	0.52	0.84	0	0	0	1.00
	5=N	44	77	183	**0.01**	19.2	18.7	18.7	0.60	84.6	81.8	76.5	0.13	25.6	18.5	13.1	0.43	1.15	0.74	0.29	0.37	0.2	0.2	0	0.98
	6=D	56	126	92	0.23	20.4	20.7	21.5	0.17	84.5	81.7	84.5	0.71	39.2	24.7	22.7	0.12	1.87	0.73	1.11	0.13	1.0	0.2	0.2	0.60
	7=J	90	56	108	0.45	22.1	22.6	22.4	0.50	84.9	85.8	84.1	0.91	39.5	34.0	31.6	0.68	2.24	1.72	1.67	0.52	3.4	1.8	0.8	**0.00**
	8=F	77	88	52	0.60	23.1	22.0	22.7	0.21	84.9	83.8	81.8	0.72	51.6	31.3	30.4	**0.03**	2.08	1.24	1.34	0.26	1.8	1.0	0.4	0.20
	9=M	93	120	84	0.70	20.9	21.1	21.7	0.36	84.2	80.8	82.3	0.64	28.2	27.9	28.4	0.94	1.36	0.93	0.84	0.76	0.3	0.9	0	0.44
	10=A	62	85	187	**0.08**	18.4	19.4	19.3	0.13	80.9	76.9	73.1	0.28	26.1	23.9	18.7	0.84	0.57	0.81	0.14	0.58	0.5	0.8	0	0.71
	11=M	108	143	95	0.50	16.4	17.1	17.6	0.29	76.2	67.2	79.4	**0.00**	9.8	6.2	8.3	0.88	0.11	0.02	0.05	0.98	0	0	0	1.00
	12=J	148	127	117	0.80	14.9	14.5	15.6	0.24	72.3	65.0	60.2	**0.03**	6.9	1.8	3.0	0.81	0.10	0.00	0.00	0.98	0	0	0	1.00
DAR	1=J	129	131	203	**0.04**	13.5	14.1	14.1	0.53	58.7	56.0	53.5	0.63	1.8	1.1	0.9	0.98	0.00	0.00	0.00	1.00	0	0	0	1.00
	2=A	92	136	116	**0.09**	14.1	14.4	13.8	0.88	64.6	60.3	61.7	0.28	2.4	1.8	1.4	0.92	0.00	0.00	0.00	1.00	0	0	0	1.00
	3=S	117	101	79	0.28	15.7	15.6	15.7	0.98	68.0	70.7	78.7	**0.08**	4.2	4.4	6.8	0.88	0.03	0.02	0.04	1.00	0	0	0	1.00
	4=O	85	92	80	0.85	16.6	17.1	17.0	0.41	74.8	71.8	69.5	0.73	7.9	8.4	10.7	0.84	0.08	0.10	0.31	0.54	0	0	0	1.00
	5=N	62	87	76	0.46	18.5	18.3	18.4	0.98	77.2	77.1	76.7	0.99	17.3	13.8	17.1	0.66	0.44	0.27	0.37	0.71	0.4	0	0	0.21
	6=D	63	88	91	0.39	20.1	20.5	20.9	0.28	81.0	80.2	79.3	0.96	28.3	21.2	23.4	0.35	0.72	0.38	0.68	0.28	0.6	0.4	0.1	0.37
	7=J	71	74	104	0.28	21.8	22.3	21.8	0.32	82.5	78.7	75.2	0.35	35.4	30.7	22.7	**0.03**	1.34	1.00	0.62	**0.01**	1.1	0.8	0.1	**0.01**
	8=F	60	83	60	0.45	22.5	22.3	22.2	0.93	83.0	79.4	78.4	0.60	34.3	27.8	30.2	0.38	0.91	0.72	1.06	0.30	0.4	0.3	0.3	0.90
	9=M	68	95	77	0.40	20.7	21.7	20.8	0.25	81.9	79.4	78.6	0.70	25.7	22.8	20.2	0.75	0.66	0.67	0.38	0.40	0	0.4	0	0.29
	10=A	99	76	113	0.28	18.3	19.8	18.5	**0.02**	73.1	78.5	79.1	0.35	10.8	17.7	15.2	0.21	0.08	0.27	0.34	0.60	0	0.1	0	0.96
	11=M	111	116	110	0.95	16.0	17.2	17.6	**0.03**	70.9	63.9	76.3	**0.01**	7.0	5.7	8.2	0.87	0.02	0.01	0.06	0.98	0	0	0	1.00
	12=J	14.5	15.0	14.9	0.45	162	128	101	0.10	55.0	58.1	61.0	0.56	1.4	1.6	1.9	0.98	0.00	0.00	0.00	1.00	0	0	0	1.00

		Temperature (mean)				Rainfall (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
AKL	1=J	12.3	12.8	13.2	**0.08**	107	133	147	0.16	63.0	63.2	64.0	0.92	1.5	1.4	1.6	0.99	0.00	0.00	0.01	1.00	0	0	0	1.00
	2=A	13.2	13.6	13.8	0.33	89	120	110	0.19	69.5	66.9	65.2	0.27	2.5	2.3	1.6	0.98	0.01	0.01	0.01	1.00	0	0	0	1.00
	3=S	14.7	14.9	15.2	0.27	99	92	89	0.85	72.1	73.7	70.9	0.42	4.3	4.3	4.6	0.99	0.07	0.08	0.05	0.99	0	0	0	1.00
	4=O	15.9	16.7	16.8	**0.02**	87	85	89	0.97	76.2	78.8	74.5	0.15	7.9	9.9	6.3	0.70	0.24	0.32	0.17	0.88	0	0	0	1.00
	5=N	18.1	18.1	18.6	0.22	56	97	83	**0.06**	81.2	80.6	79.6	0.78	17.7	16.5	15.3	0.91	0.92	0.80	0.56	0.65	0.3	0.1	0.3	0.95
	6=D	19.6	20.5	20.8	**0.00**	76	96	77	0.43	82.1	81.2	83.0	0.73	22.5	19.5	24.5	0.51	1.15	1.03	1.22	0.77	0.5	0.7	0.7	0.91
	7=J	21.7	21.9	22.2	0.30	54	69	90	0.16	84.4	83.8	83.2	0.88	34.7	31.9	30.9	0.72	2.20	2.14	1.75	0.47	2.1	3.1	1.8	0.12
	8=F	22.3	22.0	22.4	0.37	60	84	70	0.38	84.2	83.1	84.6	0.78	43.4	39.4	47.3	0.34	2.78	2.09	2.65	**0.09**	2.8	1.8	3.6	**0.02**
	9=M	20.5	21.2	21.2	0.13	58	87	67	0.25	83.5	82.8	83.3	0.97	30.8	27.6	32.1	0.73	1.43	1.28	1.21	0.43	0.8	1.7	1.0	0.15
	10=A	17.8	18.6	18.9	**0.04**	89	91	95	0.97	76.7	78.5	81.0	0.35	13.8	17.0	18.4	0.69	0.30	0.40	0.57	0.85	0	0.2	0.7	0.81
	11=M	15.3	15.9	16.3	**0.05**	86	113	100	0.33	73.6	69.8	75.8	**0.03**	7.2	5.4	9.1	0.70	0.05	0.04	0.06	1.00	0	0	0	1.00
	12=J	13.4	13.5	14.2	0.21	118	109	104	0.78	66.1	62.3	64.1	0.25	1.9	1.6	1.8	0.94	0.01	0.00	0.00	1.00	0	0	0	1.00
HNA	1=J	10.8	11.7	12.7	**0.10**	115	156	203	0.16	60.7	60.8	58.6	0.89	1.2	1.8	1.1	0.99	0.00	0.00	0.00	1.00	0	0	0	1.00
	2=A	11.5	12.6	12.8	0.24	128	136	131	0.93	61.3	61.1	63.1	0.98	1.7	2.0	1.2	0.98	0.00	0.00	0.00	1.00	0	0	0	1.00
	3=S	14.2	14.6	14.8	0.57	100	104	91	0.97	73.7	71.7	73.2	0.92	4.9	4.5	4.5	1.00	0.04	0.03	0.01	1.00	0	0	0	1.00
	4=O	15.6	16.5	16.8	0.12	109	114	97	0.94	73.8	76.4	78.1	0.70	5.6	8.7	8.0	0.84	0.08	0.10	0.17	0.97	0	0	0	1.00
	5=N	17.6	17.7	18.2	0.56	78	121	115	0.51	80.4	77.4	77.9	0.85	11.9	13.1	15.4	0.85	0.42	0.21	0.40	0.83	0	0	0	1.00
	6=D	19.3	19.7	20.8	**0.04**	84	146	107	0.28	82.2	74.7	82.7	0.19	25.8	11.7	19.2	**0.08**	0.95	0.12	0.53	**0.10**	0.8	0	0	0.19
	7=J	21.7	21.7	22.4	0.40	90	66	99	0.76	84.4	83.8	84.0	0.95	32.0	22.0	23.9	0.13	1.34	0.84	0.84	0.17	1.2	0	0.4	**0.02**
	8=F	22.6	21.9	22.7	0.55	57	109	75	0.24	83.3	81.7	85.2	0.71	41.8	35.1	34.7	0.31	1.37	1.24	1.67	0.34	1.0	0.8	1.4	0.39
	9=M	19.7	20.4	21.7	**0.06**	140	87	37	0.33	81.8	83.4	85.6	0.92	16.2	24.8	50.8	**0.00**	0.32	0.64	2.26	**0.03**	0	0.2	2.0	**0.05**
	10=A	16.7	18.1	18.4	**0.07**	108	121	106	0.83	77.3	74.2	79.7	0.61	9.8	12.7	16.1	0.83	0.04	0.23	0.28	0.80	0	0	0.5	0.85
	11=M	14.5	15.3	15.4	0.58	149	138	83	0.71	66.2	64.2	76.5	0.17	6.3	5.3	7.9	0.95	0.05	0.01	0.01	0.95	0	0	0	0.99
	12=J	12.4	11.8	12.8	0.50	125	134	155	0.83	54.8	61.0	51.2	0.13	1.3	2.0	0.8	0.95	0.00	0.00	0.00	1.00	0	0	0	1.00
COR	1=J	12.9	13.3	14.5	**0.03**	200	226	407	**0.01**	68.2	63.3	60.9	0.25	2.0	1.3	1.6	0.98	0.01	0.00	0.00	1.00	0	0	0	1.00
	2=A	14.0	13.6	14.4	0.34	146	232	214	0.23	68.1	63.3	70.3	0.17	2.5	2.2	2.3	1.00	0.01	0.01	0.01	1.00	0	0	0	1.00
	3=S	14.7	15.0	15.8	**0.04**	219	189	124	0.23	65.0	68.6	76.8	**0.01**	2.7	2.8	5.3	0.77	0.01	0.01	0.10	0.93	0	0	0	1.00
	4=O	16.3	16.7	17.1	0.18	125	139	174	0.66	78.5	77.1	71.6	0.17	7.5	6.6	6.8	0.98	0.15	0.15	0.12	0.99	0	0	0	1.00
	5=N	18.3	18.0	18.5	0.46	90	139	195	0.18	80.7	75.8	76.9	0.40	16.9	10.6	11.9	0.23	0.67	0.18	0.23	0.13	0	0	0	1.00
	6=D	20.2	20.0	20.6	0.36	96	122	168	0.44	81.3	81.0	82.0	0.96	29.2	16.1	16.6	**0.00**	1.21	0.41	0.58	**0.01**	0.3	0	0	0.58
	7=J	21.4	21.6	22.1	0.41	82	99	202	**0.09**	84.0	82.3	79.5	0.55	43.9	23.7	17.5	**0.00**	2.04	0.99	0.51	**0.00**	2.3	0.9	0.2	**0.00**
	8=F	22.0	21.8	21.8	0.89	68	142	117	0.35	81.2	81.8	82.5	0.95	29.0	21.3	20.4	**0.05**	1.24	0.71	0.80	**0.09**	0.5	0.1	0.2	0.50
	9=M	20.4	20.9	21.7	**0.05**	147	202	155	0.46	81.0	78.8	82.9	0.60	16.3	11.9	15.1	0.64	0.51	0.31	0.47	0.78	0	0.1	0	0.95
	10=A	18.2	19.0	19.1	0.11	123	154	181	0.63	77.1	79.4	78.9	0.77	11.9	12.2	13.4	0.94	0.22	0.26	0.30	0.96	0	0	0	1.00
	11=M	16.0	16.4	16.7	0.38	93	136	194	0.30	74.3	75.4	79.8	0.50	7.5	6.0	7.9	0.87	0.06	0.03	0.07	0.99	0	0	0	1.00
	12=J	13.8	14.2	14.8	0.25	141	214	164	0.29	69.4	64.4	61.5	0.19	3.8	1.8	1.3	0.87	0.01	0.00	0.00	1.00	0	0	0	1.00
WTA	1=J	13.2	13.3	12.7	0.70	185	244	319	0.24	62.8	57.3	46.0	0.14	1.3	1.5	1.0	1.00	0.00	0.00	0.00	1.00	0	0	0	1.00
	2=A	13.4	13.8	12.3	0.13	162	188	155	0.83	69.3	64.8	54.6	0.19	2.3	2.9	1.3	0.99	0.02	0.01	0.00	1.00	0	0	0	1.00
	3=S	15.2	15.3	16.1	0.34	233	168	82	**0.07**	70.7	70.4	82.5	0.17	5.8	3.5	10.4	0.54	0.14	0.03	0.30	0.83	0	0	0	1.00
	4=O	16.6	16.9	17.5	0.27	121	166	97	0.52	78.8	73.7	80.2	0.61	7.8	7.9	19.2	0.13	0.20	0.20	0.79	0.34	0	0	1	0.57
	5=N	18.7	18.3	18.1	0.73	80	80	195	0.13	83.0	79.9	80.7	0.88	16.4	17.2	11.2	0.56	0.74	0.58	0.29	0.63	0	0	0	1.00
	6=D	20.1	20.3	21.0	0.26	94	195	114	0.21	83.2	76.7	82.6	0.57	26.1	16.0	20.1	0.27	1.39	0.35	1.01	**0.05**	0.4	0	0.2	0.80
	7=J	21.8	22.1	22.1	0.68	117	69	104	0.72	83.8	83.6	82.7	0.98	27.3	23.1	24.6	0.80	1.63	1.05	1.09	0.33	2.8	0.6	0	**0.00**
	8=F	22.9	21.5	22.6	**0.06**	120	147	99	0.69	82.0	82.0	79.2	0.90	25.7	29.3	21.3	0.41	1.26	1.10	1.02	0.84	0.8	0.6	0.2	0.49
	9=M	20.6	21.1	22.0	0.11	96	139	77	0.65	83.3	82.1	84.0	0.99	21.8	21.6	20.8	0.95	0.83	0.82	0.72	0.99	0	0.1	0	0.96
	10=A	18.2	19.3	19.3	0.13	68	162	192	0.20	80.9	77.9	69.6	0.41	20.9	15.7	6.7	0.22	0.46	0.50	0.02	0.65	0	0.3	0	0.74
	11=M	16.2	16.7	17.6	0.30	109	187	81	0.21	75.2	62.6	80.7	**0.03**	7.8	4.9	10.0	0.74	0.09	0.01	0.17	0.95	0	0	0	1.00

12=J	14.6	13.9	12.5	**0.02**	193	235	317	0.30	63.4	59.3	57.4	0.74	1.7	1.6	1.7	1.00	0.00	0.01	0.00	1.00	0	0	0	1.00

		Temperature (mean)				Rainfall (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
PAX	1=J	11.9	12.5	13.4	0.24	140	212	225	0.17	64.5	54.5	63.2	**0.04**	2.0	1.1	1.6	0.99	0.00	0.00	0.00	1.00	0	0	0	1.00
	2=A	12.6	13.2	11.2	**0.03**	91	121	125	0.72	67.1	64.8	59.4	0.49	2.2	2.0	1.8	1.00	0.01	0.00	0.00	1.00	0	0	0	1.00
	3=S	14.7	15.0	15.4	0.47	95	82	83	0.94	71.2	73.5	76.1	0.67	7.2	4.8	5.6	0.95	0.16	0.05	0.02	0.94	0	0	0	1.00
	4=O	15.9	16.8	17.2	0.10	91	91	70	0.88	76.6	75.0	78.1	0.84	8.9	9.4	9.4	1.00	0.09	0.10	0.15	0.99	0	0	0	1.00
	5=N	18.3	18.1	18.3	0.91	70	86	148	0.24	80.5	80.5	77.6	0.79	13.9	15.8	14.4	0.95	0.40	0.34	0.28	0.97	0	0	0	0.99
	6=D	19.9	20.3	21.0	0.17	71	153	97	0.19	81.7	78.2	82.9	0.61	29.8	17.5	18.3	0.27	1.08	0.21	0.46	0.12	0.6	0	0	0.71
	7=J	22.0	22.4	22.9	0.28	95	70	86	0.86	83.8	84.7	84.3	0.97	39.5	29.6	34.3	0.48	1.80	1.22	1.19	0.27	2.8	0.2	0	**0.00**
	8=F	23.1	22.0	23.1	0.25	150	80	77	0.19	84.4	81.8	84.2	0.86	50.1	34.9	29.9	**0.03**	1.71	1.29	1.31	0.51	2.2	0.4	0.4	**0.00**
	9=M	20.1	20.9	22.1	**0.05**	97	69	58	0.75	82.7	83.8	85.3	0.91	20.2	26.3	37.8	0.25	0.43	0.77	1.15	0.47	0	0.1	0	0.60
	10=A	17.3	18.7	18.8	**0.06**	96	108	121	0.92	78.8	79.9	75.3	0.72	12.7	21.1	9.7	0.27	0.09	0.49	0.03	0.42	0	0	0	0.96
	11=M	15.3	15.8	16.3	0.43	132	103	61	0.53	70.8	67.2	75.1	0.41	9.0	13.2	7.5	0.78	0.06	0.23	0.01	0.86	0	0	0	0.99
	12=J	13.5	12.8	13.7	0.33	142	188	110	0.31	63.5	55.1	60.3	0.14	6.8	1.4	2.0	0.83	0.01	0.00	0.00	1.00	0	0	0	1.00
TGA	1=J	12.7	12.6	13.2	0.31	127	124	140	0.88	73.7	69.8	72.9	0.37	3.1	2.6	3.9	0.97	0.03	0.02	0.03	1.00	0	0	0	1.00
	2=A	13.3	13.3	13.7	0.57	83	127	111	0.21	76.3	70.4	71.1	0.11	4.8	3.6	2.6	0.91	0.06	0.03	0.02	0.99	0	0	0	1.00
	3=S	14.7	14.9	15.3	0.16	95	89	104	0.84	76.3	76.4	76.1	0.96	7.2	5.5	6.4	0.94	0.20	0.12	0.13	0.96	0	0	0	1.00
	4=O	16.3	16.4	16.8	0.24	82	101	94	0.80	80.5	77.5	77.8	0.58	11.2	10.6	9.8	0.96	0.42	0.36	0.38	0.99	0	0	0	1.00
	5=N	18.2	18.1	18.2	0.95	52	89	100	0.20	83.1	79.6	81.8	0.52	22.8	14.8	15.3	0.16	1.24	0.62	0.53	0.14	0.8	0.4	0	0.56
	6=D	19.6	20.2	20.7	**0.01**	67	111	109	0.21	83.3	80.9	83.3	0.68	32.5	19.7	23.8	**0.02**	1.71	0.60	1.23	**0.02**	1.7	0.1	0.8	**0.09**
	7=J	21.7	21.7	21.9	0.76	63	84	98	0.49	86.1	83.5	83.0	0.59	43.6	29.1	32.9	**0.00**	3.64	1.68	2.37	**0.00**	5.6	1.0	2.8	**0.00**
	8=F	22.3	21.7	22.0	0.28	61	89	93	0.49	85.5	83.8	83.0	0.75	59.1	32.6	31.0	**0.00**	3.67	1.20	1.64	**0.00**	4.6	1.6	1.4	**0.00**
	9=M	20.5	20.8	21.2	0.57	121	117	92	0.63	82.9	82.5	85.2	0.77	26.3	26.9	25.7	0.85	1.06	1.09	0.94	0.88	1.0	1.0	0.7	0.92
	10=A	18.0	18.7	18.7	0.11	81	123	144	0.14	72.1	78.3	79.5	0.10	14.7	19.0	18.9	0.55	0.43	0.65	0.51	0.81	0.1	0.3	0	0.90
	11=M	15.3	16.0	16.4	**0.03**	81	117	128	0.30	76.7	77.3	79.0	0.84	10.2	9.1	11.0	0.92	0.19	0.15	0.18	0.99	0	0	0	1.00
	12=J	13.2	13.4	13.9	0.27	102	110	141	0.43	73.8	69.2	68.1	0.21	4.9	3.6	2.9	0.80	0.03	0.02	0.01	0.99	0	0	0	1.00
TPE	1=J	12.8	13.0	14.2	0.21	162	152	260	0.20	70.4	63.5	18.0	**0.00**	2.6	3.7	0.6	0.93	0.02	0.00	0.00	1.00	0	0	0	1.00
	2=A	13.3	13.8	14.3	0.73	110	167	113	0.33	73.5	60.9	5.3	**0.00**	4.5	3.4	0.0	0.88	0.04	0.00	0.00	0.98	0	0	0	1.00
	3=S	15.0	15.3	16.1	0.11	140	112	95	0.63	66.4	68.6	39.4	**0.02**	7.0	5.2	3.0	0.85	0.02	0.01	0.01	1.00	0	0	0	1.00
	4=O	16.8	16.8	17.2	0.71	110	170	89	0.20	64.3	70.1	63.9	0.81	9.2	9.3	8.8	1.00	0.04	0.20	0.01	0.71	0	0	0	1.00
	5=N	18.8	18.4	18.5	0.83	60	88	167	**0.10**	57.2	75.2	44.3	**0.02**	11.4	16.3	5.0	0.24	0.04	0.56	0.00	**0.04**	0	0.7	0	**0.00**
	6=D	20.3	20.3	21.2	0.15	79	206	103	**0.02**	81.5	68.0	66.3	0.32	31.8	13.2	13.9	**0.01**	0.35	0.27	0.15	0.77	0	0	0	1.00
	7=J	21.9	22.0	22.4	0.53	122	64	89	0.41	83.7	81.3	63.6	0.14	30.0	24.2	22.5	0.49	0.47	0.77	0.33	0.28	0	0	0	1.00
	8=F	22.8	21.3	22.9	**0.01**	83	134	102	0.60	81.6	76.7	67.8	0.40	38.5	26.5	18.7	**0.01**	0.68	0.50	0.37	0.31	0	0	0	1.00
	9=M	20.5	20.9	22.1	**0.09**	98	131	89	0.62	74.2	79.5	77.9	0.80	18.0	24.7	19.6	0.42	0.42	0.36	0.04	0.21	0	0	0	1.00
	10=A	18.0	18.8	19.2	0.21	70	196	158	**0.02**	78.4	72.4	63.6	0.66	17.7	16.2	6.9	0.44	0.30	0.21	0.01	0.56	0	0	0	1.00
	11=M	15.7	16.3	17.3	0.13	93	183	161	0.13	61.2	63.5	46.8	0.45	10.1	6.6	4.6	0.79	0.12	0.01	0.01	0.89	0	0	0	1.00
	12=J	13.8	13.5	14.6	0.23	136	123	135	0.96	61.2	66.1	3.1	**0.00**	3.1	2.9	0.0	0.95	0.01	0.00	0.00	0.99	0	0	0	1.00
WKA	1=J	12.2	12.7	13.3	0.34	181	158	231	0.39	74.5	72.7	61.2	**0.02**	2.9	2.8	1.6	0.99	0.02	0.02	0.00	1.00	0	0	0	1.00
	2=A	13.1	13.4	13.4	0.93	81	127	102	0.48	78.1	74.0	78.2	0.39	4.8	4.1	2.6	0.98	0.10	0.02	0.01	0.99	0	0	0	1.00
	3=S	14.7	15.1	15.4	0.34	88	79	87	0.97	78.6	78.1	81.1	0.70	9.9	6.2	6.7	0.91	0.24	0.11	0.10	0.98	0	0	0	1.00
	4=O	16.6	16.7	17.3	0.33	76	144	81	0.18	81.1	78.7	81.6	0.68	11.6	11.1	11.6	1.00	0.52	0.45	0.55	0.99	0	0	0	1.00
	5=N	18.5	18.0	18.6	0.46	52	76	138	0.16	83.6	80.9	81.8	0.72	20.8	18.9	17.3	0.95	1.55	1.05	0.61	0.50	1.0	1.3	0	0.72
	6=D	20.0	19.9	21.2	**0.02**	64	165	100	**0.05**	85.1	79.2	83.2	0.22	39.2	15.7	19.6	**0.05**	3.09	0.69	0.97	**0.01**	4.0	0.2	0	**0.04**
	7=J	22.1	21.8	22.7	0.19	63	63	68	0.99	85.9	84.3	85.4	0.87	53.6	23.1	37.4	**0.01**	4.08	1.49	2.37	**0.00**	6.8	1.6	2.4	**0.00**
	8=F	23.2	21.7	22.9	**0.01**	54	87	115	0.35	84.9	84.0	84.8	0.94	67.1	36.2	32.4	**0.00**	4.64	1.94	2.16	**0.00**	6.8	2.4	1.6	**0.00**
	9=M	20.3	20.8	22.3	**0.02**	119	75	106	0.54	83.9	85.1	84.1	0.93	23.4	33.0	26.6	0.27	0.96	1.55	0.83	0.33	0.3	1.8	1.0	0.41
	10=A	17.7	18.7	19.1	**0.06**	49	160	128	**0.03**	82.3	78.8	74.7	0.28	23.1	19.7	11.6	0.59	0.52	0.75	0.31	0.82	0.5	0.4	0	0.94
	11=M	15.4	16.0	16.4	0.32	85	136	111	0.49	79.6	75.7	82.1	0.28	15.0	9.4	10.3	0.79	0.23	0.13	0.07	0.98	0	0	0	1.00

12=J	13.3	12.8	13.3	0.57	144	120	144	0.83	73.1	72.1	63.3	**0.10**	3.8	3.0	1.9	0.98	0.01	0.03	0.00	1.00	0	0	0	1.00

		Temperature (mean)				Rainfall (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
ROA	1=J	9.9	10.4	10.8	**0.06**	130	132	150	0.78	71.3	67.2	70.5	0.21	2.3	1.6	2.2	0.98	0.01	0.01	0.04	0.99	0	0	0	1.00
	2=A	11.1	11.2	11.4	0.80	101	157	160	**0.05**	71.3	67.2	66.9	0.21	2.8	2.2	1.7	0.89	0.01	0.01	0.00	0.99	0	0	0	1.00
	3=S	12.8	12.8	13.4	0.12	116	117	125	0.93	74.5	71.6	71.6	0.40	4.5	3.6	3.7	0.95	0.06	0.02	0.02	0.99	0	0	0	1.00
	4=O	14.5	15.0	15.3	**0.06**	81	120	127	0.16	78.5	75.5	74.5	0.28	8.7	7.5	7.1	0.93	0.15	0.10	0.15	0.98	0	0	0	1.00
	5=N	16.9	16.6	17.3	**0.09**	74	117	114	0.16	81.0	77.3	80.2	0.27	16.6	12.0	14.7	0.54	0.50	0.19	0.30	0.33	0	0	0	1.00
	6=D	18.6	18.9	19.6	**0.01**	110	137	132	0.48	80.6	77.6	81.0	0.34	20.9	13.9	19.0	0.19	0.68	0.34	0.64	0.21	0.1	0	0.2	0.79
	7=J	20.8	20.6	20.8	0.87	82	93	117	0.40	84.6	82.6	80.8	0.37	34.0	25.5	24.5	**0.03**	1.55	0.97	1.06	**0.01**	1.3	0.8	0.8	**0.06**
	8=F	21.1	20.6	20.5	0.24	77	110	130	0.13	84.3	82.0	80.5	0.35	39.6	26.7	25.6	**0.00**	1.75	0.72	0.74	**0.00**	1.3	0.5	0.3	**0.00**
	9=M	18.8	19.2	19.4	0.69	99	129	82	0.15	82.7	81.1	83.9	0.57	23.8	20.8	22.2	0.45	0.82	0.54	0.65	0.27	0.2	0.2	0.1	0.80
	10=A	15.9	16.5	16.7	**0.09**	98	116	133	0.55	78.5	78.7	77.1	0.87	15.5	16.4	17.0	0.91	0.30	0.28	0.29	0.99	0.1	0	0.1	0.84
	11=M	13.0	13.6	14.0	**0.04**	100	128	162	0.16	77.7	73.8	75.1	0.33	8.2	5.3	7.3	0.57	0.06	0.03	0.04	0.99	0	0	0	1.00
	12=J	10.8	11.1	11.5	0.22	126	122	160	0.40	70.7	65.6	65.2	**0.09**	3.2	2.2	1.6	0.96	0.03	0.01	0.00	1.00	0	0	0	1.00
APA	1=J	8.5	9.0	10.3	**0.03**	87	92	128	0.32	67.5	65.7	66.3	0.80	1.9	4.3	1.6	0.80	0.01	0.05	0.00	0.94	0	0	0	1.00
	2=A	9.6	9.7	10.0	0.94	64	88	103	0.25	71.9	69.6	68.6	0.56	2.3	5.3	2.0	0.69	0.01	0.04	0.01	0.93	0	0	0	1.00
	3=S	11.3	11.6	12.0	0.25	80	76	81	0.96	71.8	73.7	72.6	0.80	4.0	6.8	3.6	0.76	0.02	0.07	0.02	0.98	0	0	0	1.00
	4=O	12.8	13.6	13.8	**0.06**	87	96	88	0.87	75.8	74.9	73.1	0.68	6.3	8.7	7.5	0.86	0.12	0.13	0.17	0.97	0	0	0	1.00
	5=N	15.0	14.9	15.7	0.16	59	88	72	0.29	80.4	78.1	81.8	0.45	14.0	12.8	17.2	0.67	0.33	0.23	0.43	0.67	0	0	0	1.00
	6=D	16.7	17.2	18.1	**0.01**	70	116	114	**0.03**	82.0	79.1	80.4	0.62	22.6	14.3	17.5	0.21	0.65	0.34	0.34	0.33	0.2	0.1	0	0.82
	7=J	18.9	18.9	19.5	0.32	59	80	97	0.18	84.6	81.8	82.9	0.62	34.7	23.7	23.7	**0.03**	1.61	0.86	1.07	**0.00**	2.1	0.7	0.8	**0.00**
	8=F	19.1	18.7	19.2	0.48	57	83	73	0.35	82.6	81.2	84.2	0.58	31.6	25.5	26.2	0.43	1.21	0.82	1.06	0.22	0.8	0.8	0.5	0.59
	9=M	16.9	17.7	18.3	**0.06**	78	78	55	0.64	81.9	81.7	83.2	0.93	21.3	22.7	32.3	0.37	0.67	0.55	1.00	0.32	0.3	0.3	0.8	0.52
	10=A	14.2	15.1	15.1	0.12	69	79	58	0.63	79.0	78.4	79.9	0.91	15.4	16.8	20.8	0.74	0.20	0.31	0.44	0.58	0	0	0	1.00
	11=M	11.6	12.3	12.4	0.25	73	81	63	0.71	77.0	74.9	77.2	0.64	8.9	7.9	11.2	0.82	0.06	0.05	0.09	0.97	0	0	0	1.00
	12=J	9.8	9.9	10.2	0.81	101	75	91	0.32	67.4	67.7	65.1	0.81	1.8	3.9	1.4	0.85	0.00	0.03	0.00	1.00	0	0	0	1.00
GSA	1=J	12.1	12.5	13.1	0.15	123	124	105	0.68	70.4	69.9	73.7	0.28	3.6	3.0	4.3	0.98	0.02	0.01	0.09	0.96	0	0	0	1.00
	2=A	13.3	13.5	13.6	0.89	89	95	95	0.95	76.9	73.4	73.6	0.23	7.4	5.7	6.3	0.98	0.18	0.08	0.12	1.00	0	0	0	1.00
	3=S	15.2	15.1	15.9	0.13	79	84	81	0.97	79.8	78.2	79.9	0.69	12.8	7.9	11.2	0.79	0.61	0.22	0.46	0.88	0.5	0	0	0.90
	4=O	17.1	17.3	17.9	0.16	61	82	53	0.36	83.0	82.3	83.1	0.92	18.5	16.7	22.5	0.74	1.17	0.88	1.98	0.40	1.0	0.4	2.0	0.59
	5=N	19.4	19.0	19.5	0.49	58	68	60	0.87	85.1	84.7	84.2	0.93	34.8	28.4	34.3	0.67	3.78	2.24	2.37	0.11	5.5	2.6	3.2	0.15
	6=D	21.0	21.2	22.0	**0.04**	61	82	56	0.37	85.7	84.6	85.5	0.85	41.1	33.5	47.3	0.17	3.64	2.42	4.29	**0.09**	5.5	4.1	7.1	0.18
	7=J	23.0	22.8	22.4	0.51	42	52	81	0.17	87.2	85.9	85.5	0.73	62.4	46.1	45.2	**0.03**	6.67	4.27	2.74	**0.00**	10.8	7.6	5.5	**0.00**
	8=F	22.7	22.5	22.2	0.67	88	66	74	0.54	85.1	84.7	84.1	0.92	61.5	44.4	38.3	**0.01**	4.89	2.83	2.42	**0.02**	8.2	4.9	3.2	**0.01**
	9=M	20.9	21.0	20.9	0.89	86	97	99	0.84	82.7	82.8	80.7	0.68	42.3	32.3	30.6	0.40	3.29	1.52	1.46	0.24	4.2	2.8	2.7	0.82
	10=A	18.0	18.5	18.7	0.40	103	97	92	0.91	82.4	80.0	79.3	0.47	25.5	21.7	37.0	0.17	0.70	0.68	1.73	0.57	2.4	0.6	3.1	0.28
	11=M	15.3	15.9	16.1	0.23	96	77	136	**0.04**	78.9	78.0	73.5	0.14	14.2	15.2	10.0	0.82	0.40	0.43	0.20	0.90	0.1	0.5	0	0.87
	12=J	12.9	13.3	13.6	0.31	114	104	125	0.64	74.9	74.5	69.6	**0.09**	7.0	5.7	5.2	0.92	0.11	0.04	0.02	1.00	0	0	0	0.98
NRA	1=J	11.7	12.4	11.2	0.38	119	109	240	**0.00**	76.2	74.4	49.7	**0.00**	8.3	5.3	1.1	0.90	0.10	0.09	0.00	1.00	0	0	0	1.00
	2=A	12.6	12.8	10.3	**0.02**	64	76	134	0.22	81.2	76.2	62.1	**0.00**	8.3	8.9	1.6	0.91	0.30	0.22	0.00	0.98	0	0	0	1.00
	3=S	14.9	14.7	15.5	0.54	50	60	38	0.74	82.5	80.2	84.5	0.51	19.9	11.6	17.7	0.77	1.15	0.20	0.91	0.72	0	0	0	1.00
	4=O	16.6	16.5	17.4	0.42	60	90	27	0.12	84.2	81.9	83.6	0.74	17.8	20.4	29.2	0.62	1.13	1.19	3.01	0.27	0.2	1.3	3.8	0.37
	5=N	19.5	17.8	17.6	**0.02**	35	61	86	0.32	87.2	84.0	82.9	0.44	36.9	31.4	30.2	0.89	4.50	2.54	1.23	**0.05**	8.0	3.8	1.0	**0.02**
	6=D	20.7	19.8	21.0	0.22	39	112	32	**0.02**	86.9	81.2	85.2	0.21	63.7	25.5	35.0	**0.01**	8.39	1.29	3.12	**0.00**	14.2	1.6	4.6	**0.00**
	7=J	22.0	21.5	21.4	0.73	36	71	95	0.15	86.3	84.4	84.5	0.77	73.2	27.0	54.8	**0.00**	6.83	1.48	2.77	**0.00**	12.4	2.0	5.6	**0.00**
	8=F	22.2	20.6	21.7	**0.08**	51	91	48	0.27	84.7	82.8	84.5	0.76	60.9	32.9	41.3	0.14	4.23	1.36	2.53	0.11	6.8	1.2	4.4	**0.10**
	9=M	20.0	20.2	20.5	0.86	63	56	70	0.93	83.0	84.6	83.8	0.91	46.0	45.4	40.6	0.47	3.24	2.45	0.98	0.20	7.0	6.1	2.5	0.20
	10=A	17.1	17.8	17.8	0.62	51	85	119	0.22	83.4	81.4	77.9	0.55	29.2	29.7	11.4	0.27	0.92	0.96	0.15	0.80	2.5	1.1	0	0.68
	11=M	14.6	15.5	16.2	0.21	84	107	52	0.30	80.2	77.3	83.1	0.36	20.7	10.3	14.7	0.65	0.33	0.18	0.30	0.99	0.5	0.1	0	0.98

12=J	13.5	12.8	10.5	**0.01**	84	103	114	0.73	78.1	76.6	57.9	**0.00**	10.6	7.8	4.1	0.94	0.31	0.22	0.00	0.98	0	0	0	1.00

		Temperature (mean)				Rainfall (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
NPA	1=J	11.5	11.8	11.8	0.62	112	161	178	**0.01**	66.6	61.0	58.1	**0.02**	2.0	1.2	1.3	0.29	0.02	0.01	0.02	0.80	0	0	0	1.00
	2=A	12.2	12.4	12.0	0.44	113	135	148	0.31	66.3	63.6	59.6	0.12	2.2	2.2	1.1	0.83	0.02	0.04	0.00	0.96	0	0	0	1.00
	3=S	13.5	13.8	13.8	0.37	110	104	157	**0.03**	67.3	70.2	60.3	**0.00**	2.9	3.3	1.7	0.78	0.03	0.04	0.01	0.97	0	0	0	1.00
	4=O	14.4	15.1	15.2	**0.02**	95	121	152	**0.03**	70.0	74.0	64.5	**0.00**	5.3	5.4	3.4	0.70	0.06	0.07	0.03	0.95	0	0	0	1.00
	5=N	16.1	16.4	16.9	**0.05**	94	122	116	0.56	75.0	73.8	75.1	0.91	9.0	7.3	7.8	0.89	0.17	0.14	0.15	0.99	0	0	0	1.00
	6=D	17.7	18.6	18.9	**0.00**	117	130	97	0.30	76.4	73.4	78.3	0.21	12.2	10.1	13.6	0.54	0.37	0.20	0.41	0.46	0.3	0.1	0	0.42
	7=J	19.5	20.1	20.5	**0.01**	98	96	114	0.68	80.1	79.9	79.4	0.98	17.5	16.3	16.5	0.96	0.57	0.53	0.50	0.90	0.1	0.3	0.2	0.63
	8=F	20.8	20.5	20.5	0.63	73	108	105	0.17	82.1	80.9	82.4	0.86	27.5	21.3	21.8	0.11	1.18	0.79	0.88	**0.05**	1.1	0.9	0.3	**0.02**
	9=M	19.0	19.6	20.0	0.35	76	117	65	**0.03**	81.2	80.4	82.3	0.83	19.4	18.5	21.9	0.45	0.55	0.53	1.00	**0.06**	0.2	0.4	0.7	0.42
	10=A	16.3	17.3	17.8	**0.00**	134	113	122	0.62	72.9	77.5	80.9	**0.08**	8.0	10.5	15.7	0.12	0.08	0.24	0.43	0.26	0	0	0.4	0.32
	11=M	14.2	14.8	15.3	**0.04**	130	144	131	0.89	72.2	68.5	73.6	0.12	3.8	3.1	5.8	0.64	0.02	0.02	0.05	0.95	0	0	0	1.00
	12=J	12.3	12.6	12.3	0.40	133	143	125	0.61	63.7	63.3	63.8	0.98	1.3	1.4	1.5	0.95	0.01	0.01	0.01	0.97	0	0	0	1.00
RUX	1=J	6.5	6.9	10.8	**0.00**	107	167	385	**0.00**	49.8	41.8	46.0	0.54	1.0	1.0	1.0	1.00	0.00	0.00	0.00	1.00	0	0	0	0.98
	2=A	6.6	7.3	10.1	**0.02**	96	152	155	0.29	50.7	39.9	49.8	0.23	0.9	1.2	1.0	1.00	0.00	0.00	0.00	1.00	0	0	0	0.98
	3=S	8.8	9.5	10.4	0.24	131	139	108	0.65	54.1	52.2	61.9	0.55	1.8	3.5	1.3	0.90	0.01	0.01	0.00	1.00	0	0	0	1.00
	4=O	10.2	11.6	12.2	**0.09**	131	118	125	0.90	53.5	62.4	63.3	0.46	1.4	4.1	4.9	0.77	0.00	0.02	0.06	0.95	0	0	0	1.00
	5=N	12.8	12.6	13.2	0.78	101	108	117	0.99	69.2	64.9	70.4	0.83	5.5	7.7	9.2	0.73	0.03	0.02	0.04	1.00	0	0	0	1.00
	6=D	14.5	15.2	16.5	**0.06**	105	120	129	0.94	69.7	67.3	75.4	0.64	10.7	8.6	10.6	0.97	0.10	0.04	0.11	0.89	0	0	0	1.00
	7=J	17.1	17.6	17.5	0.71	81	90	144	0.29	78.0	77.8	78.0	1.00	17.7	19.1	13.3	0.41	0.45	0.42	0.16	0.15	0	0.6	0.4	**0.00**
	8=F	18.0	16.6	18.4	0.14	75	112	57	0.43	75.1	71.0	80.4	0.55	25.8	13.8	21.5	0.15	0.53	0.10	0.42	**0.04**	0	0	0.2	0.36
	9=M	14.9	15.3	17.1	0.16	144	80	71	0.36	68.2	73.4	80.1	0.63	6.6	18.8	29.5	**0.03**	0.09	0.26	0.57	0.17	0	0	1.0	**0.00**
	10=A	12.3	13.1	13.2	0.61	124	106	113	0.99	58.3	64.2	66.4	0.70	2.7	8.0	8.5	0.64	0.00	0.01	0.01	1.00	0	0	0	0.98
	11=M	10.0	9.8	11.4	0.47	148	160	87	0.32	44.5	37.9	55.9	0.28	1.0	2.0	3.2	0.98	0.00	0.00	0.00	1.00	0	0	0	0.98
	12=J	8.1	7.0	10.7	**0.00**	167	143	178	0.78	34.7	38.0	59.1	**0.05**	0.2	0.4	1.0	0.98	0.00	0.00	0.00	1.00	0	0	0	0.99
WUA	1=J	11.6	11.6	10.4	0.13	82	111	165	**0.06**	66.5	65.2	63.2	0.74	3.5	2.9	1.3	0.92	0.04	0.03	0.00	0.72	0	0	0	1.00
	2=A	12.7	12.4	10.9	**0.01**	84	82	69	0.87	68.8	68.8	71.9	0.98	5.7	4.5	2.6	0.84	0.09	0.06	0.01	0.65	0	0	0	1.00
	3=S	13.6	14.0	14.3	0.31	79	76	95	0.70	73.3	74.1	72.9	0.95	6.0	7.2	5.0	0.85	0.17	0.13	0.06	0.94	0	0	0	1.00
	4=O	14.9	15.5	15.8	0.17	84	88	122	0.25	76.3	75.0	73.7	0.78	7.0	7.4	6.9	0.98	0.20	0.17	0.17	1.00	0	0	0	1.00
	5=N	16.6	16.8	17.1	0.62	107	99	95	0.93	79.0	77.2	79.8	0.85	13.0	11.7	14.8	0.82	0.69	0.47	0.67	0.64	0	0	0	1.00
	6=D	17.9	18.7	19.7	**0.00**	85	112	91	0.47	79.9	75.4	81.4	0.34	14.6	12.6	20.4	0.16	0.54	0.45	0.73	0.67	0.1	0.1	0.4	0.84
	7=J	20.0	20.4	20.7	0.32	54	72	73	0.64	82.8	82.3	83.3	0.98	28.9	20.6	27.1	**0.10**	1.93	0.96	1.40	**0.00**	1.4	1.0	1.6	0.49
	8=F	20.7	20.4	20.6	0.85	78	79	62	0.77	81.9	80.7	83.5	0.83	29.9	22.2	24.5	0.28	1.48	0.74	1.13	**0.05**	2.3	0.8	1.4	**0.04**
	9=M	18.7	19.4	19.8	0.26	63	80	39	0.31	81.7	80.9	83.8	0.81	18.4	22.6	31.5	0.12	0.69	0.80	1.26	0.50	0.1	0.6	1.8	0.10
	10=A	16.2	17.2	17.9	**0.03**	114	73	71	0.21	74.8	77.6	83.3	0.32	9.2	12.6	29.1	**0.00**	0.16	0.25	1.40	**0.00**	0	0	0.8	0.39
	11=M	14.4	14.8	15.2	0.43	109	94	109	0.78	72.3	73.4	74.7	0.91	5.0	7.8	9.6	0.68	0.03	0.07	0.25	0.83	0	0	0	0.97
	12=J	12.5	12.5	12.6	0.95	102	101	232	**0.00**	64.4	67.4	59.5	0.24	2.2	3.7	1.4	0.84	0.01	0.03	0.00	0.95	0	0	0	1.00
OHA	1=J	10.7	11.0	11.2	0.70	63	91	127	**0.00**	73.1	67.7	66.3	**0.01**	4.6	2.5	2.1	0.79	0.03	0.01	0.01	0.39	0	0	0	1.00
	2=A	12.0	11.9	12.3	0.82	58	83	89	0.16	77.4	71.6	71.1	**0.01**	6.1	4.4	3.0	0.72	0.09	0.06	0.01	0.94	0	0	0	1.00
	3=S	13.7	13.3	13.8	0.55	67	66	95	0.14	77.6	77.0	70.6	**0.00**	7.2	6.6	4.6	0.85	0.18	0.17	0.09	0.98	0	0.1	0	1.00
	4=O	14.9	15.5	15.4	0.26	69	74	88	0.50	80.4	79.6	76.3	0.18	11.4	11.2	7.0	0.59	0.55	0.48	0.32	0.92	0	0	0	1.00
	5=N	16.9	17.1	17.6	0.39	72	71	60	0.72	82.2	80.7	81.3	0.60	19.3	17.7	16.6	0.86	1.35	1.10	1.21	0.93	0.7	0.2	0.6	0.89
	6=D	18.6	19.3	19.8	**0.02**	82	91	71	0.46	82.5	80.5	83.8	0.22	22.3	22.2	24.8	0.91	1.07	1.47	1.57	0.65	0.8	1.7	3.6	**0.04**
	7=J	20.3	20.9	21.0	0.21	56	74	79	0.35	84.1	84.4	83.6	0.81	30.3	28.9	28.1	0.94	2.48	2.19	2.46	0.89	3.8	3.0	2.7	0.53
	8=F	20.9	21.0	20.8	0.95	53	62	61	0.83	84.0	84.9	85.3	0.99	43.3	33.5	36.3	0.13	4.26	2.26	3.29	**0.00**	5.8	3.1	4.1	**0.03**
	9=M	18.9	19.9	19.9	0.21	57	86	31	**0.01**	82.9	82.2	85.4	0.56	27.8	32.9	37.0	0.78	1.72	1.80	2.49	0.74	2.0	2.7	4.8	0.35
	10=A	16.1	17.2	18.1	**0.01**	89	66	55	0.21	78.6	81.6	84.3	0.28	17.5	20.7	45.5	**0.00**	0.49	0.80	2.28	0.12	0.3	0.8	4.2	**0.01**
	11=M	13.4	14.2	14.6	**0.08**	70	85	88	0.63	77.0	76.7	73.4	0.25	8.0	8.8	10.9	0.93	0.16	0.12	0.32	0.97	0	0.2	0.2	0.99

12=J	11.2	11.8	11.9	0.19	75	94	87	0.45	74.7	70.5	70.1	**0.09**	3.9	4.1	2.8	0.95	0.04	0.02	0.01	0.99	0	0	0	1.00

		Temperature (mean)				Rainfall (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
LNX	1=J	11.1	11.4	9.7	0.16	71	125	53	0.13	64.4	59.2	70.3	0.29	3.1	2.4	5.2	0.95	0.00	0.02	0.01	1.00	0	0	0	1.00
	2=A	11.6	12.1	8.5	**0.00**	63	76	49	0.85	72.6	65.5	73.2	0.31	4.6	4.0	5.9	0.97	0.02	0.02	0.01	1.00	0	0	0	1.00
	3=S	13.2	13.7	13.6	0.78	103	108	100	0.98	70.9	68.2	67.3	0.72	4.6	6.9	3.2	0.85	0.02	0.09	0.01	0.97	0	0	0	1.00
	4=O	14.1	15.3	15.3	0.15	97	92	139	0.31	69.0	75.0	68.6	0.30	4.3	6.9	5.8	0.88	0.03	0.02	0.03	1.00	0	0	0	1.00
	5=N	15.8	16.1	16.9	0.28	102	129	105	0.72	73.1	73.1	77.2	0.79	8.7	11.1	12.2	0.80	0.13	0.12	0.27	0.93	0	0	0	0.99
	6=D	17.1	18.0	19.5	**0.01**	103	130	97	0.67	74.9	68.2	78.2	0.23	13.4	8.4	14.6	0.87	0.17	0.02	0.16	0.98	0	0	0	0.96
	7=J	19.9	19.8	21.0	0.20	71	57	52	0.87	82.5	79.1	85.0	0.68	26.2	16.7	33.2	0.17	0.88	0.21	1.22	0.11	0.4	0	0	0.70
	8=F	21.1	20.2	21.1	0.53	73	103	59	0.45	82.0	80.2	84.5	0.85	35.2	25.1	38.1	0.51	1.50	0.53	1.42	0.23	1.4	0	0.6	**0.02**
	9=M	18.4	19.1	20.2	0.19	118	59	45	0.20	78.0	82.2	84.7	0.71	17.9	33.4	32.5	0.38	0.49	1.10	0.91	0.65	0	0.3	1.5	0.42
	10=A	15.5	17.2	17.5	**0.04**	104	70	61	0.66	78.0	77.6	77.1	0.93	13.9	21.1	15.8	0.80	0.17	0.32	0.20	0.90	0.3	0	0.5	0.47
	11=M	13.9	15.0	15.2	0.15	96	92	112	0.87	74.4	71.9	74.9	0.81	7.2	10.7	8.6	0.97	0.04	0.04	0.02	0.96	0	0	0	0.88
	12=J	12.2	11.8	9.8	**0.03**	125	120	88	0.59	61.2	61.7	65.1	0.85	2.8	1.8	2.2	0.99	0.01	0.00	0.00	1.00	0	0	0	0.99
CPX	1=J	10.7	10.8	11.8	0.44	134	143	110	0.74	69.2	66.1	76.0	0.31	1.9	1.9	3.3	0.99	0.01	0.03	0.04	1.00	0	0	0	1.00
	2=A	11.0	11.3	10.7	0.71	106	100	62	0.62	68.2	70.5	76.5	0.55	2.6	4.0	2.7	0.95	0.18	0.10	0.07	0.97	0	0	0	1.00
	3=S	12.5	13.0	13.0	0.70	50	82	53	0.55	81.1	69.4	78.6	**0.07**	12.2	5.8	6.9	0.57	1.59	0.21	0.52	0.57	0.2	0	0	0.99
	4=O	13.7	14.4	14.3	0.44	104	89	52	0.34	77.1	75.2	79.6	0.73	5.5	8.2	10.4	0.73	0.32	0.74	1.06	0.88	0	0	0.3	0.98
	5=N	15.4	15.4	14.6	0.41	55	126	88	**0.09**	82.6	78.2	78.2	0.61	16.0	13.5	17.3	0.83	2.82	1.38	0.75	0.32	1.2	0.2	0	0.82
	6=D	16.8	17.2	18.1	0.15	56	102	48	0.21	81.1	76.8	82.0	0.59	32.1	15.6	24.0	**0.06**	5.75	1.04	2.64	**0.01**	7.2	1.4	5.0	**0.01**
	7=J	19.0	18.9	18.7	0.93	61	86	78	0.75	83.2	82.9	82.6	1.00	30.7	27.5	34.7	0.49	2.84	2.24	1.66	0.84	5.8	4.2	4.4	0.85
	8=F	19.8	18.1	19.1	**0.06**	86	104	59	0.40	83.9	77.9	83.2	0.48	38.9	21.8	25.2	**0.06**	5.17	0.89	1.52	**0.01**	7.2	0.8	2.6	**0.00**
	9=M	18.2	17.4	17.9	0.49	79	81	118	0.64	79.9	81.2	79.9	0.95	21.8	20.0	15.1	0.67	1.75	1.19	1.14	0.98	3.5	2.7	2.0	0.74
	10=A	15.5	15.7	16.4	0.63	85	93	75	0.90	67.2	78.7	80.8	**0.05**	16.3	12.7	15.0	0.81	0.61	0.56	0.66	0.97	1.8	0.9	0	0.72
	11=M	13.8	13.8	14.9	0.42	79	94	94	0.89	71.6	72.3	81.2	0.36	7.4	7.0	7.3	0.99	0.24	0.43	0.37	0.98	0.3	0	0	0.99
	12=J	12.1	11.6	12.0	0.69	91	103	77	0.82	72.5	67.9	72.7	0.65	3.7	2.4	3.0	0.99	0.20	0.12	0.02	0.99	0	0	0	1.00
MSX	1=J	10.5	10.0	11.5	0.50	90	129	115	0.54	62.9	59.3	56.6	0.60	2.9	2.3	2.1	0.99	0.01	0.00	0.00	1.00	0	0	0	1.00
	2=A	11.6	11.1	10.7	0.56	72	111	77	0.51	71.3	63.3	66.9	0.24	4.5	3.3	2.6	0.94	0.03	0.01	0.00	1.00	0	0	0	1.00
	3=S	13.7	13.8	14.4	0.75	60	112	60	0.28	79.9	71.4	76.6	0.27	11.7	8.3	7.6	0.89	0.20	0.11	0.07	0.99	0	0	0	1.00
	4=O	15.3	15.9	16.1	0.70	97	86	88	0.95	76.9	77.8	78.9	0.94	7.1	11.9	9.6	0.81	0.06	0.30	0.15	0.91	0	0	0	1.00
	5=N	17.5	16.9	16.6	0.73	74	88	87	0.95	82.8	79.2	78.8	0.73	19.0	17.3	17.1	0.99	1.08	0.30	0.25	0.49	0.6	0	0	0.90
	6=D	19.0	18.9	20.9	**0.08**	62	82	67	0.95	83.5	80.0	84.3	0.72	29.9	18.6	27.5	0.60	1.83	0.78	1.32	0.53	3.4	0.2	2.6	0.12
	7=J	21.9	21.3	21.5	0.92	67	60	76	0.93	85.1	85.4	84.5	0.99	43.8	37.2	34.3	0.69	2.53	1.92	1.64	0.65	5.8	3.8	3.6	0.41
	8=F	22.5	20.6	22.0	0.19	74	89	84	0.81	87.2	81.7	85.5	0.57	61.0	34.2	42.9	**0.04**	4.66	1.81	2.09	**0.00**	8.8	2.0	2.6	**0.00**
	9=M	19.2	19.5	20.4	0.59	129	86	60	0.59	81.7	82.7	82.8	0.98	26.3	34.0	37.1	0.74	1.89	0.89	0.79	0.17	3.8	2.0	3.5	0.21
	10=A	15.7	17.0	17.4	0.31	62	71	55	0.95	76.4	79.4	79.3	0.83	16.7	25.2	29.6	0.54	0.29	0.52	0.28	0.96	0.5	0.7	0.5	1.00
	11=M	13.6	13.4	15.3	0.23	100	102	91	0.99	73.5	65.4	78.5	**0.09**	10.8	8.2	11.1	0.92	0.09	0.07	0.06	1.00	0	0.1	0	1.00
	12=J	12.1	10.9	10.9	0.40	101	123	53	0.33	68.3	56.5	71.5	**0.02**	3.1	2.2	5.4	0.92	0.01	0.01	0.01	1.00	0	0	0	1.00
PPA	1=J	11.1	11.3	11.8	0.17	69	108	150	**0.00**	70.2	69.8	65.9	0.16	3.8	2.5	2.7	0.72	0.04	0.02	0.03	0.99	0	0	0	0.99
	2=A	11.7	11.9	12.1	0.59	88	95	105	0.71	74.2	71.9	74.3	0.39	3.2	3.7	3.0	1.00	0.04	0.05	0.02	0.97	0	0	0	1.00
	3=S	13.0	13.2	13.5	0.39	79	76	103	0.24	75.2	75.8	73.6	0.48	5.2	5.6	4.8	0.99	0.08	0.12	0.09	0.99	0	0	0	1.00
	4=O	14.1	14.6	14.9	**0.04**	78	101	116	**0.09**	76.3	76.5	75.9	0.92	8.2	7.8	5.9	0.80	0.20	0.15	0.13	0.98	0	0	0	1.00
	5=N	15.8	16.0	16.4	0.20	87	96	65	0.21	78.6	78.5	80.0	0.78	13.8	13.1	15.0	0.96	0.61	0.46	0.54	0.93	0.1	0.1	0.1	1.00
	6=D	17.4	18.0	18.6	**0.00**	89	93	66	0.27	79.3	78.7	80.7	0.67	18.2	16.3	22.3	0.47	0.62	0.63	0.89	0.65	0.2	0.1	0.3	0.90
	7=J	19.0	19.5	20.0	**0.01**	68	76	69	0.86	82.5	82.7	83.6	0.88	25.7	24.0	31.4	0.27	1.18	1.17	1.68	0.17	0.6	0.9	1.3	0.48
	8=F	19.8	19.6	20.0	0.41	45	76	59	0.17	83.1	81.9	84.2	0.58	37.1	30.9	33.3	0.61	2.05	1.59	1.70	0.42	1.7	0.9	0.8	0.14
	9=M	18.4	18.8	19.1	0.58	50	78	42	**0.08**	83.2	81.7	83.3	0.66	27.4	28.5	34.3	0.43	1.24	1.17	1.47	0.55	0.2	1.1	1.6	0.14
	10=A	15.8	16.6	17.1	**0.02**	90	69	82	0.43	77.5	80.1	81.3	0.36	14.8	19.6	23.8	0.40	0.33	0.57	0.73	0.72	0	0.1	0.1	0.95
	11=M	13.5	14.2	14.7	**0.03**	79	92	111	0.38	78.0	76.9	79.2	0.61	7.7	9.6	8.5	0.83	0.09	0.16	0.12	0.96	0	0	0	0.99

12=J	11.8	12.1	12.5	0.17	107	103	102	0.95	69.9	70.1	70.8	0.93	3.8	3.6	2.9	0.96	0.05	0.04	0.01	1.00	0	0	0	0.99

		Temperature (mean)				Rainfall (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
WNA	1=J	10.7	11.1	11.6	0.10	86	115	138	**0.05**	69.7	68.5	66.3	0.43	2.6	2.2	1.7	0.72	0.04	0.02	0.01	0.97	0	0	0	1.00
	2=A	11.4	11.5	11.8	0.64	96	96	106	0.88	70.1	69.6	74.5	0.11	3.1	2.9	2.8	0.95	0.09	0.05	0.06	0.94	0	0	0	1.00
	3=S	12.8	12.9	13.3	0.39	75	78	91	0.65	75.6	75.3	76.5	0.88	5.4	5.6	4.6	0.95	0.29	0.29	0.22	0.98	0	0.2	0	0.98
	4=O	13.9	14.7	14.7	**0.04**	61	92	107	**0.03**	78.2	77.7	76.5	0.75	9.8	8.3	6.7	0.73	0.70	0.63	0.52	0.94	0.3	0.1	0	0.97
	5=N	16.0	16.1	16.2	0.71	78	82	71	0.84	81.8	80.6	80.2	0.76	18.3	15.3	14.5	0.62	2.21	1.19	1.27	0.10	1.3	0.5	0.8	0.75
	6=D	17.3	18.0	18.6	**0.00**	71	83	59	0.42	82.1	80.7	83.4	0.47	25.0	19.2	26.2	0.22	2.40	1.81	2.44	0.42	3.0	1.1	2.7	0.13
	7=J	19.1	19.5	19.4	0.39	61	76	62	0.61	83.8	83.4	83.9	0.98	31.0	28.4	33.9	0.43	3.59	2.95	3.26	0.50	5.1	4.0	5.8	0.22
	8=F	19.3	19.6	19.5	0.63	43	65	47	0.36	83.4	83.3	84.2	0.93	37.5	34.2	35.9	0.89	3.74	3.33	2.94	0.40	5.9	4.3	3.7	0.16
	9=M	17.9	18.3	18.6	0.55	62	74	58	0.60	82.6	80.9	82.6	0.64	26.6	26.9	27.9	0.90	2.95	1.77	2.03	**0.03**	4.1	2.8	3.3	0.21
	10=A	15.4	16.1	16.7	**0.04**	94	75	92	0.44	78.8	80.0	80.1	0.85	17.0	17.5	19.7	0.88	0.67	0.97	1.12	0.83	1.7	0.7	0.6	0.52
	11=M	13.2	14.0	14.3	**0.03**	101	88	104	0.62	76.0	77.2	74.9	0.59	6.7	9.5	6.2	0.60	0.17	0.29	0.19	0.96	0	0.0	0	1.00
	12=J	11.5	11.9	12.1	0.29	116	105	110	0.81	69.0	68.9	68.0	0.91	3.5	2.6	3.1	0.97	0.07	0.05	0.02	0.98	0	0	0	1.00
NSA	1=J	9.7	10.0	10.4	0.23	65	108	108	**0.06**	74.9	69.3	67.9	**0.02**	5.9	3.5	4.2	0.69	0.02	0.01	0.01	0.99	0	0	0	0.97
	2=A	11.4	11.3	11.6	0.88	66	104	116	**0.05**	76.9	71.3	74.2	**0.05**	5.8	4.1	3.9	0.53	0.04	0.01	0.02	1.00	0	0	0	0.98
	3=S	13.2	13.2	13.8	0.11	92	73	80	0.63	75.2	77.7	75.6	0.49	6.4	6.4	6.1	0.99	0.16	0.10	0.10	0.98	0	0	0	1.00
	4=O	15.0	15.3	15.3	0.36	65	92	89	0.34	79.4	78.7	76.5	0.49	12.9	9.9	10.1	0.83	0.54	0.27	0.31	0.81	0.1	0	0.1	0.99
	5=N	17.0	16.7	17.2	0.26	68	89	84	0.58	81.8	80.2	80.5	0.78	21.9	15.5	15.9	0.42	1.29	0.84	0.76	0.48	1.3	0.1	0.3	0.30
	6=D	18.4	19.0	19.4	**0.00**	79	63	86	0.49	82.0	79.5	82.5	0.46	27.6	24.5	23.5	0.73	1.50	1.24	1.46	0.87	1.1	0.8	1.6	0.69
	7=J	20.1	20.6	20.6	**0.09**	56	63	101	**0.09**	83.5	84.3	83.4	0.89	35.1	39.2	31.6	0.37	2.29	2.67	1.91	0.16	3.0	4.3	1.7	**0.01**
	8=F	20.8	20.5	20.7	0.66	63	56	58	0.96	83.7	84.3	84.6	0.92	51.0	43.3	37.7	**0.06**	3.24	2.75	2.22	**0.09**	4.3	3.2	1.8	**0.01**
	9=M	19.0	19.3	19.5	0.81	64	81	70	0.69	83.6	82.5	84.0	0.73	33.6	38.8	29.0	0.34	1.56	1.86	1.22	0.54	1.7	2.1	1.0	0.58
	10=A	16.0	16.6	17.1	**0.05**	80	87	108	0.59	79.7	80.0	82.6	0.54	22.0	25.1	22.5	0.80	0.54	0.58	0.51	0.98	0.4	0.3	0.3	0.94
	11=M	13.3	13.5	14.1	0.19	104	100	79	0.52	78.5	77.6	79.4	0.71	11.7	12.0	13.2	0.71	0.08	0.10	0.09	1.00	0.2	0.0	0	1.00
	12=J	10.5	10.6	11.0	0.38	84	112	75	0.17	75.3	67.3	72.5	**0.00**	6.7	4.3	5.0	1.00	0.04	0.01	0.01	1.00	0	0	0	1.00
WBA	1=J	10.3	10.4	10.9	0.88	60	69	170	**0.01**	79.5	79.2	73.3	0.12	7.5	7.8	3.2	0.96	0.08	0.10	0.01	1.00	0	0	0	1.00
	2=A	11.9	11.9	11.7	0.86	40	100	40	**0.02**	82.4	78.3	76.9	**0.10**	10.5	9.6	5.6	0.93	0.18	0.11	0.02	0.99	0	0	0	0.98
	3=S	14.0	14.2	14.6	0.69	67	48	66	0.58	82.2	81.2	81.1	0.88	17.8	15.6	10.4	0.93	0.71	0.45	0.18	0.98	1.2	0.8	0	0.96
	4=O	16.1	16.3	16.3	0.96	46	82	82	0.33	82.5	80.7	81.1	0.74	22.3	14.4	13.6	0.91	1.18	0.64	0.53	0.97	2.8	1.2	0.3	0.83
	5=N	18.6	17.6	17.0	0.14	46	61	65	0.78	86.7	83.7	81.1	0.11	37.4	27.4	26.1	0.87	5.73	2.41	1.66	0.15	7.8	4.5	1.8	0.32
	6=D	20.0	19.7	21.1	0.20	40	57	44	0.85	86.3	84.1	86.7	0.60	55.3	35.4	43.9	0.85	7.24	3.68	4.91	0.53	10.8	5.6	8.8	0.68
	7=J	22.0	21.3	21.5	0.66	62	52	42	0.77	86.8	86.8	87.6	0.98	67.4	42.5	73.9	0.32	6.89	4.21	7.61	0.38	12.8	7.8	14.2	0.23
	8=F	22.0	20.9	22.1	0.28	59	69	27	0.24	86.8	86.3	87.6	0.91	70.3	54.0	85.8	0.35	6.75	4.06	6.49	0.65	10.0	5.2	10.2	0.41
	9=M	19.3	19.9	20.5	0.44	53	39	41	0.88	86.3	86.9	86.5	0.98	39.6	69.5	55.4	0.15	2.74	4.84	3.32	0.58	6.0	8.3	6.0	0.74
	10=A	16.2	17.1	17.3	0.38	35	50	63	0.72	84.6	82.7	83.8	0.67	38.7	47.7	25.4	0.76	1.31	2.01	0.61	0.92	1.5	3.8	1.5	0.74
	11=M	13.6	14.4	15.0	0.32	67	53	38	0.73	81.7	82.6	84.5	0.79	21.4	32.2	31.7	0.77	0.33	1.11	1.00	0.92	0.3	2.2	0	0.77
	12=J	11.5	10.9	11.1	0.75	100	70	76	0.45	77.6	77.0	74.7	0.71	11.6	10.7	8.5	0.95	0.18	0.19	0.03	0.98	0.2	0.3	0	0.99
KIX	1=J	8.9	9.3	9.6	0.37	96	98	67	0.35	73.9	75.0	71.7	0.54	7.3	5.8	4.7	0.93	0.09	0.04	0.07	1.00	0	0.0	0	0.98
	2=A	10.1	9.8	9.8	0.60	52	87	74	0.21	76.5	74.3	73.1	0.50	9.7	6.5	8.0	0.84	0.17	0.07	0.12	0.95	0	0	0	0.99
	3=S	11.3	11.3	11.7	0.62	46	69	60	0.53	78.5	75.6	77.4	0.43	15.9	8.4	11.3	0.27	0.35	0.14	0.15	0.64	0.3	0	0	0.60
	4=O	12.5	13.1	13.4	**0.08**	60	60	70	0.87	75.4	76.9	79.4	0.28	11.7	11.6	15.9	0.63	0.18	0.20	0.49	0.31	0	0.3	0.4	0.57
	5=N	14.7	14.6	14.4	0.82	47	69	47	0.46	79.1	78.7	78.8	0.98	21.7	16.3	20.7	0.50	0.56	0.37	0.39	0.77	0.8	0.2	0.3	0.39
	6=D	16.0	16.7	16.9	**0.03**	51	62	42	0.67	79.2	79.5	80.9	0.81	26.7	23.5	28.7	0.68	0.70	0.58	0.75	0.82	1.1	0.6	0.5	0.48
	7=J	18.0	18.0	17.7	0.68	37	53	49	0.73	80.7	80.3	80.6	0.99	38.6	31.5	33.1	0.43	1.12	0.95	0.90	0.69	1.5	1.2	0.9	0.45
	8=F	18.1	17.8	17.6	0.65	46	55	48	0.91	80.6	79.8	80.2	0.95	35.0	28.5	32.8	0.65	1.06	0.69	0.86	0.49	0.9	1.1	0.8	0.32
	9=M	16.4	16.6	16.7	0.86	65	84	106	0.31	79.8	76.5	79.5	0.29	25.5	26.9	18.0	0.52	0.67	0.67	0.35	0.69	0.9	0.8	0.4	0.80
	10=A	14.2	14.6	14.8	0.41	69	77	70	0.89	78.7	76.6	75.9	0.61	24.7	19.2	18.9	0.48	0.52	0.38	0.34	0.80	0.9	0.4	0	0.29
	11=M	11.7	12.2	12.5	0.24	80	66	96	0.45	73.6	77.4	74.9	0.25	14.2	14.5	8.5	0.66	0.19	0.21	0.10	0.94	0	0.2	0	0.82

12=J	10.1	10.1	10.3	0.90	66	78	75	0.81	76.9	74.6	72.4	0.35	12.1	8.7	5.5	0.49	0.18	0.14	0.02	0.77	0	0.0	0	0.96

		Temperature (mean)				Rainfall (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
WSA	1=J	10.6	10.7	11.3	0.37	151	184	232	**0.08**	60.3	54.9	57.4	0.51	1.4	1.4	1.9	0.82	0.00	0.01	0.01	0.75	0	0	0	1.00
	2=A	11.5	11.5	12.1	0.39	171	174	215	0.37	52.4	58.5	61.4	0.30	1.3	1.9	1.9	0.75	0.00	0.01	0.00	0.96	0	0	0	1.00
	3=S	12.5	13.0	13.3	0.14	193	188	199	0.92	52.9	58.9	54.6	0.41	1.6	2.2	1.7	0.88	0.00	0.01	0.01	1.00	0	0	0	1.00
	4=O	13.5	14.3	14.2	**0.06**	189	180	239	0.12	57.9	64.5	56.2	0.18	1.9	3.0	2.0	0.75	0.00	0.01	0.00	0.98	0	0	0	1.00
	5=N	14.7	15.2	15.9	**0.01**	191	182	146	0.31	57.8	65.3	69.4	**0.06**	3.7	5.2	6.4	0.18	0.02	0.05	0.06	0.67	0	0	0	1.00
	6=D	15.9	17.3	17.3	**0.00**	228	203	191	0.46	61.1	60.8	67.5	0.29	4.5	5.4	7.1	0.19	0.02	0.03	0.03	0.94	0	0	0	1.00
	7=J	17.6	18.4	19.0	**0.00**	157	207	164	0.18	70.3	71.4	75.4	0.57	7.5	8.8	11.1	**0.03**	0.06	0.11	0.19	**0.02**	0	0	0.1	**0.00**
	8=F	18.6	18.6	19.3	0.11	122	152	109	0.33	74.0	71.1	77.5	0.42	9.6	9.2	11.9	0.11	0.19	0.10	0.26	**0.00**	0	0	0	1.00
	9=M	17.2	18.1	18.7	**0.05**	139	171	152	0.56	71.6	72.7	79.0	0.41	7.7	7.6	8.8	0.71	0.09	0.07	0.15	0.26	0	0	0	1.00
	10=A	15.1	16.1	16.6	**0.02**	144	161	234	**0.04**	68.7	65.2	71.4	0.46	4.3	4.4	7.3	0.19	0.01	0.04	0.05	0.64	0	0	0	1.00
	11=M	13.2	13.1	14.3	**0.02**	163	216	170	0.13	58.0	51.6	62.7	**0.09**	2.6	1.4	3.1	0.24	0.01	0.00	0.01	1.00	0	0	0	1.00
	12=J	10.9	11.0	11.8	0.15	225	203	222	0.72	46.9	55.3	55.8	0.16	0.7	1.3	1.4	0.78	0.00	0.00	0.00	0.97	0	0	0	1.00
HKA	1=J	9.8	10.0	10.5	0.43	165	218	254	0.16	58.1	53.1	52.2	0.51	1.5	1.6	1.9	**0.05**	0.00	0.01	0.02	0.98	0	0	0	1.00
	2=A	10.9	11.3	11.2	0.69	205	233	241	0.70	56.8	58.2	51.9	0.47	1.8	1.9	1.6	0.94	0.00	0.01	0.01	0.98	0	0	0	1.00
	3=S	12.2	12.6	12.6	0.35	247	246	299	0.37	50.1	57.5	51.1	0.26	1.5	2.3	1.5	0.83	0.01	0.01	0.00	0.86	0	0	0	1.00
	4=O	13.1	13.9	13.8	**0.04**	242	260	327	0.11	56.3	59.9	53.5	0.45	2.1	2.6	1.8	0.90	0.00	0.01	0.00	0.96	0	0	0	1.00
	5=N	14.7	14.9	15.8	**0.01**	241	269	202	0.20	60.0	62.2	68.7	0.26	4.0	3.6	5.6	0.16	0.06	0.01	0.08	0.22	0	0	0	1.00
	6=D	16.1	17.0	16.9	**0.01**	262	273	256	0.90	61.6	59.7	60.4	0.92	4.7	5.1	5.2	0.88	0.02	0.04	0.02	0.62	0	0	0	1.00
	7=J	17.4	17.9	18.8	**0.00**	255	253	220	0.62	68.6	67.7	75.1	0.32	5.9	8.5	9.4	**0.01**	0.03	0.10	0.13	**0.00**	0	0	0	1.00
	8=F	18.3	18.1	18.8	0.12	183	184	162	0.82	71.1	72.7	76.3	0.66	8.1	8.6	10.0	0.11	0.11	0.07	0.15	**0.03**	0	0	0	1.00
	9=M	16.7	17.6	18.1	**0.03**	207	222	180	0.63	68.0	68.4	77.1	0.31	6.1	5.9	7.8	0.57	0.05	0.04	0.12	0.14	0	0	0	1.00
	10=A	14.3	15.4	16.0	**0.00**	223	233	247	0.93	60.5	62.2	67.6	0.55	2.8	3.2	4.9	0.38	0.00	0.01	0.02	0.88	0	0	0	1.00
	11=M	12.5	12.6	13.5	**0.07**	203	257	227	0.42	58.5	47.8	58.0	**0.06**	2.2	1.5	2.5	0.67	0.00	0.00	0.00	0.96	0	0	0	1.00
	12=J	10.1	10.4	11.0	0.15	232	256	220	0.58	48.5	51.6	55.3	0.58	1.0	1.4	1.6	0.13	0.00	0.00	0.00	0.96	0	0	0	1.00
CHA	1=J	8.4	8.7	10.0	**0.01**	67	70	104	**0.06**	72.0	69.9	69.4	0.47	6.1	5.1	5.0	0.96	0.03	0.02	0.05	1.00	0	0	0	0.98
	2=A	10.6	10.2	10.7	0.56	43	69	62	0.13	77.7	74.1	75.2	0.19	11.1	8.1	8.5	0.81	0.22	0.14	0.10	0.93	0	0	0	1.00
	3=S	12.6	12.4	13.2	0.16	37	43	50	0.69	80.5	80.1	82.4	0.55	18.7	14.8	17.8	0.75	0.79	0.56	0.65	0.98	0.5	0.8	0.5	1.00
	4=O	14.6	15.3	15.4	0.16	46	45	45	0.99	83.4	82.9	83.5	0.95	21.8	26.3	27.0	0.83	1.14	1.46	2.60	0.25	0.8	2.4	4.1	**0.09**
	5=N	17.0	16.9	16.9	0.98	48	54	42	0.68	84.4	84.5	84.5	1.00	36.4	34.2	33.9	0.92	3.00	2.39	2.41	0.77	5.4	4.3	4.6	0.79
	6=D	18.3	18.8	19.3	**0.09**	59	41	34	0.21	84.1	84.1	85.6	0.74	38.0	44.4	55.1	**0.04**	2.96	3.96	5.44	**0.02**	6.8	7.6	9.1	0.33
	7=J	20.4	20.2	19.6	0.36	32	57	41	0.16	86.0	85.5	85.0	0.90	51.7	55.3	60.1	0.41	4.79	4.60	4.62	0.99	9.5	8.6	8.3	0.79
	8=F	20.0	19.6	19.7	0.61	29	47	44	0.38	85.7	84.6	85.3	0.86	75.5	55.3	57.8	**0.02**	5.97	4.10	3.54	**0.02**	9.9	5.5	5.7	**0.01**
	9=M	17.9	18.0	18.5	0.68	37	58	61	0.31	84.5	82.8	82.9	0.72	51.6	47.0	37.5	0.32	3.73	2.86	1.92	0.24	7.1	5.4	2.7	**0.07**
	10=A	14.7	15.4	15.9	0.23	53	55	56	0.98	79.9	81.7	80.3	0.66	40.8	32.0	39.5	0.37	1.30	1.11	1.14	0.96	3.2	1.9	1.4	0.57
	11=M	11.7	12.3	12.7	0.40	64	53	54	0.73	75.9	76.4	76.7	0.95	12.9	18.2	15.2	0.69	0.12	0.24	0.23	0.99	0	0.5	0.3	0.92
	12=J	9.1	9.3	10.1	0.26	57	58	59	0.99	72.2	70.3	73.3	0.40	9.6	8.4	7.4	0.96	0.09	0.10	0.02	0.98	0	0	0	1.00
TUA	1=J	8.4	8.2	8.9	0.81	38	86	62	0.43	79.2	74.6	70.1	0.26	16.9	13.6	6.5	0.78	0.18	0.08	0.01	0.96	0	0	0	1.00
	2=A	10.5	10.0	10.0	0.78	25	72	18	0.40	82.3	76.7	82.7	0.31	19.3	14.4	12.1	0.78	0.27	0.08	0.09	0.88	0	0.1	0	0.98
	3=S	12.7	11.9	13.0	0.38	34	95	56	0.26	82.9	78.3	78.5	0.53	33.4	14.8	18.6	0.27	0.91	0.10	0.36	0.39	2.4	0	0.5	0.17
	4=O	13.9	14.0	14.4	0.77	43	71	46	0.74	79.8	77.9	80.9	0.81	23.3	16.0	19.0	0.84	0.62	0.51	0.46	0.97	2.2	0.8	0.3	0.36
	5=N	16.1	15.2	14.9	0.31	42	61	55	0.90	82.7	80.5	79.0	0.74	30.9	24.9	21.9	0.79	1.29	0.52	0.29	0.28	2.6	0.3	0	0.12
	6=D	16.7	17.0	18.3	**0.07**	71	47	52	0.79	79.6	81.1	80.0	0.93	38.9	30.0	24.5	0.60	1.65	0.89	0.46	0.22	3.6	1.4	1.4	0.21
	7=J	19.1	18.7	18.4	0.66	46	79	50	0.71	84.3	78.5	80.3	0.43	44.6	36.3	33.9	0.78	2.16	1.49	0.98	0.26	2.8	3.6	0.6	**0.07**
	8=F	19.1	17.5	19.4	**0.05**	66	44	37	0.70	84.1	80.9	83.4	0.78	51.2	22.2	47.8	0.13	1.60	0.36	1.59	0.17	2.6	0.2	2.4	0.32
	9=M	16.7	17.2	18.0	0.49	38	57	63	0.82	83.8	82.4	82.9	0.94	37.5	46.3	29.7	0.34	1.76	1.31	0.50	0.36	3.0	3.0	0.5	0.31
	10=A	14.1	14.9	14.7	0.60	31	57	64	0.73	80.5	80.0	78.8	0.96	44.5	41.1	18.6	0.33	0.99	0.78	0.13	0.61	1.8	1.1	0	0.69
	11=M	11.4	12.0	12.8	0.42	92	53	22	0.42	76.6	77.1	79.6	0.88	20.5	18.4	22.6	0.94	0.14	0.20	0.29	0.98	0.5	0.1	1.5	0.68

12=J	9.6	8.7	9.3	0.30	27	123	50	**0.06**	79.2	66.8	79.0	**0.00**	19.7	12.7	20.3	0.91	0.11	0.16	0.11	0.97	0.2	0	0	0.97

		Temperature (mean)				Rainfall (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
THE	1=J	4.8	4.5	5.2	0.90	26	52	72	0.12	70.1	73.8	68.6	0.42	7.5	5.3	2.9	0.92	0.02	0.01	0.00	1.00	0	0	0	0.99
	2=A	7.1	7.0	7.2	1.00	50	36	24	0.65	77.2	79.6	81.7	0.73	6.8	11.1	8.1	0.92	0.03	0.09	0.03	0.99	0	0	0	0.95
	3=S	10.7	10.9	11.1	0.89	31	24	56	0.21	84.4	81.9	79.3	0.51	21.0	22.0	15.5	0.93	0.70	0.45	0.48	0.98	1.6	1.3	1.3	0.99
	4=O	13.5	13.6	13.7	0.96	24	37	39	0.70	86.5	81.7	82.4	0.50	35.3	34.2	26.4	0.89	2.16	0.71	0.98	0.53	4.2	2.3	2.8	0.76
	5=N	15.4	15.7	15.0	0.79	66	39	46	0.30	87.2	84.4	82.4	0.54	41.7	35.5	37.5	0.91	3.28	1.92	1.86	0.55	8.0	4.0	3.3	0.19
	6=D	17.1	17.7	18.9	0.13	47	69	57	0.50	86.4	82.9	87.6	0.65	48.2	41.9	54.5	0.83	2.86	2.09	3.76	0.53	7.4	4.4	7.6	0.50
	7=J	20.3	18.8	19.7	0.27	30	78	46	**0.04**	88.3	81.5	86.8	0.32	55.7	37.4	61.6	0.43	4.15	1.49	5.97	**0.01**	8.2	3.4	11.4	**0.01**
	8=F	20.5	17.9	20.0	**0.01**	37	41	34	0.95	88.1	85.3	88.4	0.83	78.3	37.7	87.7	**0.01**	4.87	1.33	5.79	**0.00**	8.6	2.2	11.0	**0.00**
	9=M	16.1	16.4	18.1	0.29	34	31	32	0.98	85.2	81.9	88.4	0.42	45.8	69.8	81.9	0.18	1.23	3.60	5.38	**0.06**	3.8	7.2	13.5	**0.02**
	10=A	12.1	13.0	12.2	0.43	42	31	54	0.57	80.1	82.9	71.1	**0.07**	28.2	49.3	27.6	0.17	0.26	1.32	0.23	0.54	0.5	2.1	1.0	0.72
	11=M	8.9	9.4	10.5	0.49	29	46	41	0.65	80.7	76.2	80.5	0.43	20.7	27.4	17.9	0.78	0.28	0.36	0.14	0.98	0.8	1.0	1.0	1.00
	12=J	6.2	5.2	5.5	0.42	53	46	50	0.90	68.2	69.7	75.2	0.51	11.8	9.7	10.3	0.98	0.05	0.02	0.06	1.00	0.4	0	0	0.99
OUA	1=J	8.4	8.3	8.9	0.85	38	41	88	0.25	76.2	76.2	65.1	0.11	10.8	10.3	3.9	0.76	0.10	0.07	0.01	0.98	0	0.1	0	0.99
	2=A	10.2	9.7	10.2	0.80	51	69	36	0.48	80.5	76.9	76.9	0.57	11.3	13.0	6.5	0.70	0.18	0.11	0.01	0.91	0	0.1	0	0.99
	3=S	12.0	11.2	12.5	0.17	38	61	75	0.39	82.4	73.3	77.3	0.17	23.5	13.5	9.5	0.24	0.90	0.07	0.16	0.11	2.0	0	0	**0.06**
	4=O	13.1	13.2	13.9	0.51	43	63	57	0.78	80.7	76.2	77.0	0.61	25.7	10.9	14.8	0.20	0.71	0.22	0.36	0.50	1.2	0	0.3	0.40
	5=N	14.5	14.3	14.3	0.97	72	74	59	0.83	77.3	76.8	78.8	0.97	16.0	12.7	23.5	0.53	0.30	0.22	0.44	0.91	0.4	0	0.3	0.92
	6=D	15.1	15.9	16.8	**0.05**	77	76	66	0.88	77.4	75.6	73.9	0.77	14.8	21.4	16.3	0.57	0.27	0.82	0.30	0.33	0.2	1.2	0.6	0.49
	7=J	17.9	17.4	17.2	0.60	50	104	55	**0.09**	80.7	74.9	81.3	0.42	27.4	20.6	23.7	0.83	0.88	0.76	0.74	0.98	1.6	1.2	0.0	0.24
	8=F	17.7	16.7	17.9	0.20	60	81	44	0.39	79.1	76.2	80.8	0.69	27.5	11.5	28.9	0.15	0.77	0.16	0.74	0.29	0.8	0	0.2	0.87
	9=M	15.9	16.2	16.8	0.68	51	51	61	0.93	81.8	80.3	82.6	0.93	21.9	32.1	24.7	0.33	1.16	1.15	0.64	0.50	2.8	1.3	0	**0.09**
	10=A	13.6	14.3	14.3	0.51	76	60	90	0.56	70.9	78.2	69.8	0.14	16.9	30.3	9.1	**0.08**	0.19	0.73	0.01	0.21	0.3	1.3	0	0.31
	11=M	11.2	11.5	12.8	0.26	74	42	33	0.37	72.1	74.7	79.6	0.55	5.1	15.6	9.5	0.48	0.01	0.15	0.04	0.93	0	0	0	1.00
	12=J	9.4	8.7	9.3	0.54	44	64	54	0.58	74.9	69.7	79.7	0.20	8.4	9.9	9.1	0.98	0.07	0.07	0.05	0.99	0.2	0	0	0.97
DNA	1=J	7.2	7.3	7.7	0.61	35	60	51	0.19	73.7	68.8	70.3	**0.05**	5.0	4.4	6.6	0.83	0.02	0.01	0.01	0.98	0	0	0	0.94
	2=A	9.8	9.5	9.3	0.65	36	54	44	0.42	75.5	74.1	75.0	0.77	8.5	8.1	6.7	0.96	0.08	0.08	0.09	0.99	0	0	0	0.97
	3=S	12.0	12.1	12.5	0.39	47	38	49	0.67	77.8	78.9	80.4	0.47	11.9	12.2	15.9	0.62	0.26	0.22	0.40	0.85	0	0.1	0.1	1.00
	4=O	13.6	14.2	14.4	0.12	53	67	56	0.57	80.9	78.6	79.5	0.54	19.0	17.3	20.3	0.70	0.60	0.49	0.70	0.75	0.4	0.5	1.1	0.45
	5=N	15.5	15.5	15.5	0.99	58	55	61	0.89	79.4	80.6	80.6	0.80	22.1	22.5	23.7	0.89	0.74	0.83	0.79	0.97	0.6	0.8	0.8	0.96
	6=D	16.4	17.3	17.8	**0.00**	81	68	69	0.53	78.8	81.3	80.9	0.46	20.2	26.6	25.3	0.27	0.59	1.13	1.02	**0.07**	0.3	1.4	1.8	**0.03**
	7=J	18.2	18.2	18.5	0.79	70	76	71	0.93	81.0	80.9	81.1	1.00	24.0	26.1	27.1	0.72	0.96	0.87	1.13	0.66	1.1	1.3	1.1	0.88
	8=F	18.3	17.9	18.6	0.26	52	66	38	0.17	82.8	81.3	83.2	0.61	36.6	24.7	37.2	**0.05**	1.34	0.69	1.54	**0.04**	1.3	0.4	2.5	**0.00**
	9=M	16.2	16.8	16.9	0.40	61	60	63	0.98	81.3	81.6	80.3	0.87	24.8	31.3	27.9	0.34	0.67	1.18	0.79	0.12	0.7	1.6	0.7	**0.09**
	10=A	13.5	14.2	14.4	0.24	51	62	33	0.19	75.5	78.2	80.1	0.24	17.2	26.1	22.3	0.18	0.21	0.50	0.40	0.64	0.2	0.9	0.1	0.42
	11=M	10.1	10.4	11.4	0.11	72	56	34	0.13	72.0	73.7	74.9	0.62	10.3	13.5	13.3	0.80	0.05	0.10	0.11	0.94	0	0.1	0.4	0.76
	12=J	7.8	7.8	7.9	0.98	60	61	43	0.48	67.2	69.4	71.9	0.18	4.1	6.0	7.5	0.31	0.01	0.02	0.04	0.99	0	0	0	0.98
LAE	1=J	4.1	5.0	4.4	0.59	17	27	30	0.62	73.7	76.8	70.3	0.27	9.1	9.1	2.4	0.90	0.01	0.09	0.00	1.00	0	0	0	0.98
	2=A	7.8	7.7	6.1	0.35	21	19	11	0.96	79.0	79.9	79.9	0.95	12.1	14.7	6.6	0.86	0.13	0.15	0.02	0.95	0	0.3	0	0.94
	3=S	10.8	11.1	11.0	0.91	19	20	48	0.16	84.9	83.7	80.9	0.55	33.9	30.2	17.1	0.52	1.89	0.83	0.38	0.61	3.6	2.7	0.8	0.55
	4=O	13.2	14.0	13.1	0.54	31	44	41	0.69	85.0	82.8	80.9	0.53	42.5	34.6	27.2	0.61	1.79	1.06	0.78	0.81	4.4	4.0	3.3	0.92
	5=N	15.2	15.6	14.3	0.35	58	36	61	0.19	86.3	85.8	80.4	0.20	35.7	39.5	31.9	0.91	2.38	2.51	1.15	0.68	4.6	4.2	4.3	0.99
	6=D	16.6	18.1	18.6	**0.08**	66	62	60	0.93	84.0	82.3	86.6	0.43	36.3	47.3	45.4	0.73	2.27	4.98	2.81	0.14	5.8	6.4	4.8	0.79
	7=J	20.0	18.8	19.1	0.41	31	68	75	**0.02**	86.5	85.7	83.4	0.63	49.8	51.0	49.4	0.96	3.09	2.59	3.33	0.84	7.0	5.4	6.2	0.89
	8=F	19.9	18.1	19.8	**0.08**	55	41	25	0.14	87.3	83.9	87.4	0.50	66.3	38.2	70.8	**0.08**	5.06	1.25	4.27	**0.01**	8.8	1.8	8.4	**0.00**
	9=M	15.8	16.4	17.7	0.34	42	30	61	0.16	84.4	84.9	87.1	0.78	43.4	56.8	45.4	0.39	1.74	3.10	2.86	0.37	4.0	6.2	8.0	0.35
	10=A	12.0	13.2	11.5	0.22	46	35	66	0.17	78.6	82.6	74.5	0.12	25.2	56.1	20.1	**0.02**	0.25	1.35	0.05	0.53	0.8	1.9	1.0	0.84
	11=M	8.8	9.5	10.9	0.26	36	25	35	0.59	80.5	77.4	78.6	0.62	14.6	34.6	12.0	0.22	0.10	0.54	0.08	0.91	0	1.1	0	0.84

12=J	6.4	5.4	4.3	0.17	38	32	37	0.85	74.0	71.5	67.7	0.33	15.0	10.3	7.7	0.88	0.05	0.03	0.01	1.00	0.2	0	0	0.99

		Rainfall (mean)				Temperature (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
QNA	1=J	48	52	73	0.72	4.3	4.8	6.0	0.16	70.8	67.9	71.8	0.47	2.4	1.8	2.8	0.85	0.00	0.00	0.01	1.00	0	0	0	1.00
	2=A	95	58	58	0.19	7.2	7.1	7.2	0.87	66.2	72.5	75.7	**0.06**	2.2	3.5	3.5	0.96	0.00	0.01	0.01	1.00	0	0	0	1.00
	3=S	51	49	74	0.51	9.8	10.2	10.2	0.69	77.4	78.6	77.1	0.85	6.8	9.6	5.8	0.60	0.07	0.11	0.05	0.98	0	0.1	0	0.99
	4=O	58	59	103	0.10	11.8	12.5	12.3	0.40	82.3	82.0	75.9	0.11	12.8	14.4	9.6	0.64	0.35	0.32	0.16	0.87	0	0	0	1.00
	5=N	84	40	65	0.12	13.9	14.4	14.3	0.51	81.2	83.8	83.2	0.67	17.7	25.7	22.1	0.21	0.44	1.10	0.79	0.11	0	0.6	0.3	0.66
	6=D	64	79	58	0.57	15.4	16.2	16.8	**0.05**	83.0	81.2	83.5	0.75	22.9	25.6	30.0	0.30	0.87	0.86	1.19	0.54	0.4	1.5	0.9	0.22
	7=J	66	74	82	0.78	17.5	17.5	17.6	0.97	84.2	83.7	84.4	0.97	29.9	30.0	31.0	0.97	1.55	1.53	1.60	0.99	1.4	1.4	2.4	0.31
	8=F	61	69	25	0.14	17.2	16.8	17.8	0.14	83.8	82.1	85.9	0.44	32.6	30.4	48.4	**0.00**	1.17	0.96	2.75	**0.00**	1.5	1.4	4.6	**0.00**
	9=M	75	56	62	0.67	14.6	15.0	15.9	0.22	82.0	80.7	82.7	0.81	22.4	24.5	35.2	**0.07**	0.46	0.54	0.91	0.36	0.3	0.5	2.0	**0.06**
	10=A	95	66	56	0.32	11.5	12.6	12.6	0.15	69.8	79.4	80.1	**0.00**	7.5	21.7	21.6	**0.00**	0.01	0.33	0.26	0.62	0.1	0.2	0	0.99
	11=M	75	90	50	0.25	9.0	8.8	9.9	0.19	74.8	70.1	71.5	0.25	9.7	10.8	8.0	0.87	0.04	0.04	0.02	1.00	0	0	0	1.00
	12=J	76	86	54	0.58	5.7	5.6	5.8	0.94	64.6	62.3	61.5	0.66	3.0	1.9	1.7	0.99	0.00	0.00	0.00	1.00	0	0	0	1.00
LUX	1=J	65	81	30	0.65	6.9	6.6	7.1	0.90	62.7	58.4	64.0	0.85	1.4	2.3	2.0	0.99	0.00	0.02	0.00	1.00	0	0	0	1.00
	2=A	76	89	35	0.60	7.1	7.8	7.5	0.89	53.7	60.8	68.7	0.41	1.3	2.6	3.4	0.98	0.00	0.00	0.01	1.00	0	0	0	1.00
	3=S	77	66	100	0.17	8.7	10.1	11.5	**0.04**	61.0	71.5	70.7	0.17	2.4	4.7	5.0	0.87	0.01	0.04	0.04	1.00	0	0	0	1.00
	4=O	75	107	107	0.54	11.7	12.2	13.2	0.37	74.9	67.7	70.9	0.74	6.9	5.8	8.8	0.93	0.08	0.07	0.24	0.89	0	0	0.3	0.96
	5=N	123	113	91	0.49	13.0	14.2	13.9	0.36	72.8	73.4	75.6	0.90	9.1	9.9	11.8	0.91	0.10	0.11	0.17	1.00	0	0.3	0.3	0.93
	6=D	116	131	120	0.93	14.3	15.6	17.3	**0.01**	68.9	71.9	74.4	0.63	10.0	13.6	13.7	0.51	0.07	0.50	0.60	0.24	0	0	0.6	0.77
	7=J	84	129	109	0.59	17.4	17.4	17.8	0.89	79.6	74.9	78.9	0.95	14.5	17.6	13.6	0.36	0.32	0.69	0.22	0.30	0	2.2	0.6	**0.06**
	8=F	108	147	64	**0.08**	17.9	17.2	18.2	0.70	78.2	70.4	78.1	0.85	16.3	10.9	19.6	0.73	0.24	0.06	0.59	0.45	0.6	0.2	1.2	0.60
	9=M	131	86	94	0.45	14.4	15.1	17.6	0.15	67.1	72.4	82.7	0.44	5.8	20.4	24.8	**0.03**	0.04	0.84	0.51	**0.06**	0	2.2	0.5	**0.04**
	10=A	153	73	78	**0.04**	12.1	13.9	12.4	0.11	52.3	72.9	62.5	**0.01**	2.2	10.6	12.8	0.36	0.00	0.05	0.05	0.99	0	0	0	1.00
	11=M	108	99	86	0.98	9.3	10.0	13.0	**0.04**	48.2	58.5	74.3	**0.06**	0.7	3.2	4.9	0.91	0.00	0.01	0.01	1.00	0	0	0	1.00
	12=J	91	92	59	0.50	7.6	7.1	7.2	0.95	39.8	49.0	60.3	**0.08**	0.3	1.5	1.5	0.98	0.00	0.00	0.00	1.00	0	0	0	1.00
GCE	1=J	59	56	50	0.92	6.0	5.6	7.1	0.32	64.9	61.9	68.7	0.49	0.9	1.0	2.0	0.97	0.00	0.00	0.00	0.86	0	0	0	1.00
	2=A	58	66	57	0.87	7.7	7.8	7.9	0.97	67.2	68.1	67.9	0.98	1.8	2.2	2.6	0.98	0.01	0.01	0.00	0.97	0	0	0	1.00
	3=S	65	40	72	0.26	9.9	10.6	11.0	0.29	71.0	77.1	69.3	0.22	3.1	6.4	4.2	0.64	0.02	0.07	0.03	0.96	0	0	0	1.00
	4=O	66	72	96	0.36	12.0	12.8	12.8	0.41	74.9	76.6	69.3	0.31	7.8	8.2	5.1	0.71	0.06	0.07	0.01	0.93	0	0	0	1.00
	5=N	106	79	79	0.30	13.2	13.8	13.2	0.52	68.4	74.3	73.9	0.39	8.8	11.3	12.0	0.67	0.04	0.12	0.35	0.21	0	0	0	1.00
	6=D	125	73	105	**0.04**	14.1	15.6	16.7	**0.00**	67.2	72.4	76.7	0.15	8.2	17.2	14.3	**0.06**	0.07	0.26	0.20	0.45	0	0.2	0.2	0.81
	7=J	71	100	93	0.31	16.8	17.2	16.7	0.76	80.9	79.4	78.1	0.85	15.9	18.2	15.6	0.73	0.30	0.52	0.21	0.14	0.6	1.2	0.4	0.10
	8=F	99	89	47	**0.02**	17.0	16.1	17.4	0.24	76.4	75.5	80.6	0.53	14.9	14.3	26.1	**0.00**	0.16	0.14	0.63	**0.01**	0.2	0	0.8	0.13
	9=M	93	65	86	0.31	14.3	14.7	16.0	0.26	73.0	75.0	79.1	0.67	13.2	14.8	13.8	0.88	0.10	0.21	0.13	0.80	0	0.4	0.5	0.52
	10=A	75	64	60	0.79	11.7	12.2	12.3	0.74	65.8	69.0	67.2	0.77	4.0	9.4	7.8	0.32	0.01	0.08	0.01	0.75	0	0	0	1.00
	11=M	57	93	62	0.12	9.2	9.4	11.8	**0.03**	66.1	63.6	73.6	0.25	3.1	3.5	7.1	0.71	0.01	0.01	0.11	0.83	0	0	0	1.00
	12=J	74	81	74	0.91	7.1	6.5	7.7	0.42	52.5	52.9	60.8	0.39	0.5	0.7	1.5	0.99	0.00	0.00	0.00	0.96	0	0	0	1.00
MOA	1=J	121	155	108	0.75	6.4	5.3	8.2	**0.01**	44.3	41.7	44.1	0.93	0.4	0.6	0.4	1.00	0.00	0.00	0.00	1.00	0	0	0	1.00
	2=A	123	155	98	0.77	7.3	7.2	9.0	0.19	45.7	50.9	57.0	0.61	0.5	1.0	1.0	0.99	0.00	0.00	0.00	1.00	0	0	0	1.00
	3=S	105	172	114	0.53	10.0	10.2	10.5	0.83	67.2	62.7	61.5	0.70	2.5	3.8	3.7	0.94	0.01	0.02	0.01	1.00	0	0	0	1.00
	4=O	77	105	138	0.55	12.0	12.9	12.5	0.48	74.6	78.3	66.3	0.27	6.5	7.8	5.9	0.91	0.04	0.06	0.01	0.98	0	0	0	1.00
	5=N	135	85	90	0.57	13.1	14.3	13.9	0.27	69.0	77.1	79.0	0.36	6.2	12.2	14.5	0.15	0.05	0.15	0.20	0.80	0	0	0	1.00
	6=D	118	104	109	0.97	15.0	16.1	17.0	**0.03**	73.0	77.6	77.7	0.74	11.4	15.4	17.4	0.37	0.13	0.14	0.27	0.78	0.4	0	0	0.46
	7=J	69	78	100	0.80	17.8	17.6	17.8	0.97	81.4	80.7	82.3	0.98	18.9	24.5	20.4	0.40	0.43	0.83	0.50	0.18	0.2	1.2	0.4	**0.02**
	8=F	157	92	49	0.19	17.7	16.6	18.2	0.10	80.8	77.0	83.9	0.70	16.8	19.0	33.9	**0.00**	0.36	0.29	1.30	**0.00**	0.4	0	0.6	0.26
	9=M	113	93	67	0.96	14.3	14.9	16.6	0.13	73.5	76.4	81.5	0.81	10.0	13.2	26.3	**0.08**	0.04	0.09	0.37	0.84	0	0.2	1.0	0.17
	10=A	161	94	86	0.52	11.4	12.3	12.7	0.32	60.1	70.1	69.8	0.37	4.3	7.1	8.3	0.78	0.00	0.01	0.01	1.00	0	0	0	1.00
	11=M	155	142	118	0.95	9.4	9.3	11.5	**0.05**	59.1	49.7	59.5	0.42	3.0	2.0	3.3	0.96	0.00	0.00	0.00	1.00	0	0	0	1.00
	12=J	144	153	108	0.78	6.9	6.1	7.2	0.41	32.0	40.2	44.7	0.28	0.1	0.5	0.8	0.99	0.00	0.00	0.00	1.00	0	0	0	1.00

		Rainfall (mean)				Temperature (mean)				FFMC (median)				BUI (median)				DSR (median)				VH+E FFDC (mean)			
Station	Month	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob	El Nino	Neutral	La Nina	Prob
NVA	1=J	70	83	87	0.60	6.9	7.1	7.4	0.68	57.0	54.9	54.6	0.62	0.7	0.5	0.6	0.98	0.00	0.00	0.00	1.00	0	0	0	1.00
	2=A	77	66	79	0.59	8.8	9.0	8.6	0.52	63.9	67.1	62.4	0.18	1.5	2.1	1.2	0.70	0.00	0.01	0.00	1.00	0	0	0	1.00
	3=S	81	69	86	0.49	10.9	11.1	11.2	0.70	68.5	71.5	68.7	0.40	3.1	4.8	3.4	0.68	0.02	0.05	0.03	0.81	0	0	0	1.00
	4=O	106	80	89	0.15	12.0	13.0	12.7	**0.01**	70.1	75.3	72.7	0.10	4.8	7.4	5.7	0.37	0.06	0.11	0.09	0.89	0	0	0	1.00
	5=N	98	89	79	0.45	13.6	14.0	14.0	0.35	70.8	74.8	75.1	0.17	7.6	10.4	10.6	0.16	0.12	0.22	0.24	0.27	0	0.1	0	0.81
	6=D	102	91	107	0.55	14.8	15.9	16.0	**0.00**	72.5	76.0	72.8	0.27	10.4	13.4	11.3	0.18	0.17	0.28	0.23	0.39	0	0	0	1.00
	7=J	97	110	115	0.46	16.2	16.6	16.7	0.37	75.1	75.3	77.0	0.73	11.7	15.4	15.7	**0.05**	0.28	0.37	0.37	0.39	0	0.1	0	0.47
	8=F	85	89	65	0.23	16.6	16.5	17.0	0.40	77.5	76.0	78.2	0.64	17.1	13.1	18.7	**0.01**	0.36	0.24	0.56	**0.00**	0.2	0.2	0.6	**0.00**
	9=M	103	83	101	0.28	14.7	15.3	15.6	0.21	69.9	74.7	76.5	0.11	8.8	10.8	11.5	0.77	0.12	0.15	0.19	1.00	0.1	0.0	0	0.72
	10=A	119	101	88	0.27	12.3	13.0	13.4	**0.09**	60.3	67.9	69.4	**0.01**	2.3	6.2	4.8	**0.07**	0.01	0.04	0.01	0.86	0	0	0	1.00
	11=M	80	121	87	**0.01**	9.8	10.1	11.1	**0.06**	60.0	57.8	65.0	**0.05**	1.4	1.9	3.5	0.65	0.01	0.00	0.01	1.00	0	0	0	1.00
	12=J	117	98	93	0.29	7.4	7.6	7.6	0.86	47.6	54.3	55.8	**0.01**	0.2	0.6	0.8	0.95	0.00	0.00	0.00	0.97	0	0	0	1.00

Appendix 3. Average 3-monthly climate season values of climate and fire danger ratings for 16 weather stations under the combined phases of IPO and ENSO: -1 = IPO-/El Niño, -2 = IPO-/Neutral, -3 = IPO-/La Niña, +3 = IPO+/El Niño, +2 = IPO+/Neutral, +1 = IPO+/La Niña. Values significant at the 90% level (i.e <0.10) when means or medians (as indicated) were compared are highlighted in bold.

	Climate		Rainfall			(mean)				Temperature			(mean)		
Station	**Season**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**
KX	1 = Winter	226	270	314	200	370	282	**0.03**	14.0	14.3	15.0	14.2	14.4	15.4	**0.00**
	2 = Spring	269	367	351	289	327	308	**0.06**	16.8	16.6	17.2	16.4	16.6	17.3	**0.06**
	3 = Summer	250	186	359	207	277	277	0.40	21.2	21.9	22.3	22.0	21.7	21.5	0.48
	4 = Autumn	367	316	310	261	303	297	0.43	18.7	19.3	20.0	18.7	19.4	19.3	0.15
AKL	1 = Winter	158	216	213	167	274	224	**0.07**	12.2	13.0	13.7	13.0	13.2	14.3	**0.00**
	2 = Spring	195	291	280	272	259	246	0.83	16.5	15.8	16.9	16.2	16.5	16.8	0.43
	3 = Summer	185	238	187	158	219	276	0.38	20.7	21.2	21.7	21.6	21.5	21.6	0.29
	4 = Autumn	265	290	250	225	290	295	0.71	17.2	18.5	18.9	18.0	18.5	18.3	0.25
TGA	1 = Winter	131	199	258	162	280	217	**0.06**	12.3	12.7	13.6	13.0	13.0	13.9	**0.02**
	2 = Spring	272	-	363	239	278	264	0.45	16.5	-	16.8	16.3	16.3	16.6	0.49
	3 = Summer	107	226	229	185	286	310	0.19	20.3	21.4	21.7	21.4	21.1	21.0	0.24
	4 = Autumn	-	327	449	276	329	279	0.22	-	18.2	18.7	17.9	18.4	18.3	0.54
ROA	1 = Winter	158	299	301	187	304	281	**0.04**	10.1	10.7	11.4	10.5	10.7	11.6	**0.01**
	2 = Spring	289	342	394	286	361	344	0.65	15.1	14.4	15.5	14.7	14.8	15.3	0.18
	3 = Summer	296	396	352	220	289	374	**0.10**	20.1	20.1	20.5	20.3	20.1	20.0	0.83
	4 = Autumn	379	402	437	278	345	287	0.21	16.2	16.5	16.9	15.8	16.4	16.4	0.36
GSA	1 = Winter	151	215	224	145	239	139	**0.09**	12.3	12.8	13.5	12.9	13.1	13.8	**0.03**
	2 = Spring	211	184	229	203	223	156	0.87	17.3	16.7	17.6	17.2	17.2	18.1	0.20
	3 = Summer	189	165	252	161	184	153	0.81	21.6	22.0	22.2	22.9	22.4	22.3	0.19
	4 = Autumn	248	239	334	303	306	336	0.58	18.0	18.4	18.4	18.1	18.6	18.5	0.92
NPA	1 = Winter	185	326	284	172	322	237	**0.04**	11.4	12.0	12.6	12.2	12.2	12.0	**0.04**
	2 = Spring	269	369	408	324	325	445	**0.00**	14.8	14.6	15.4	14.6	15.1	15.2	0.45
	3 = Summer	272	276	391	288	281	291	0.77	19.2	20.0	19.9	19.5	19.7	19.8	0.50
	4 = Autumn	353	372	359	331	408	216	0.31	16.8	17.1	17.8	16.4	17.3	17.4	0.24
OHA	1 = Winter	91	195	180	110	173	187	**0.02**	10.6	11.5	11.8	11.8	11.5	12.5	**0.00**
	2 = Spring	181	219	244	233	208	242	0.69	15.5	15.4	15.7	15.1	15.3	15.4	0.92
	3 = Summer	161	200	223	176	238	163	0.38	20.0	20.7	20.3	20.0	20.2	20.4	0.95
	4 = Autumn	186	236	193	226	237	147	0.68	16.6	17.1	17.6	16.0	17.1	17.4	**0.03**
PPA	1 = Winter	109	212	220	133	225	160	**0.02**	11.0	11.7	12.2	11.7	11.6	12.5	**0.01**
	2 = Spring	201	276	283	254	277	320	0.44	14.7	14.5	15.0	14.3	14.6	14.9	0.52
	3 = Summer	190	194	193	188	231	191	0.94	18.7	19.5	19.3	18.8	18.9	19.5	0.22
	4 = Autumn	220	237	271	218	276	180	0.62	16.3	16.4	17.1	15.8	16.5	16.7	0.28

	Climate		Rainfall			(mean)				Temperature			(mean)		
Station	**Season**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**
WNA	1 = Winter	162	217	240	140	231	166	0.19	10.8	11.3	11.8	11.4	11.2	12.3	**0.02**
	2 = Spring	180	227	275	205	261	272	**0.03**	14.2	14.6	14.7	14.3	14.5	14.7	0.85
	3 = Summer	156	210	184	140	188	155	0.49	18.4	19.1	18.9	18.8	19.1	19.3	0.51
	4 = Autumn	318	237	294	234	263	182	0.28	15.7	16.1	16.4	15.4	16.1	16.6	0.49
NSA	1 = Winter	108	210	168	114	263	172	**0.02**	9.9	10.5	10.9	10.7	10.4	11.5	**0.00**
	2 = Spring	241	280	244	225	260	277	0.81	14.9	14.5	15.4	15.1	15.1	15.4	0.59
	3 = Summer	177	150	241	187	178	277	0.30	19.3	20.1	19.8	20.0	20.0	19.9	0.43
	4 = Autumn	238	265	309	256	305	223	0.90	16.2	16.3	16.8	16.1	16.4	16.6	0.96
KIX	1 = Winter	81	151	139	126	211	77	**0.03**	9.1	9.7	9.9	10.2	9.5	10.5	**0.03**
	2 = Spring	165	135	227	155	213	126	0.35	12.7	12.7	13.2	13.0	13.1	13.2	0.88
	3 = Summer	133	178	172	118	166	111	0.74	16.8	17.3	17.2	17.9	17.7	17.7	0.19
	4 = Autumn	305	249	364	200	254	187	0.21	14.0	14.4	14.6	14.1	14.6	14.5	0.74
WSA	1 = Winter	289	331	382	301	442	381	0.21	10.3	10.7	11.7	10.8	10.9	11.8	**0.06**
	2 = Spring	625	-	530	540	574	625	0.77	14.2	-	14.7	13.4	14.1	14.1	0.15
	3 = Summer	345	398	432	491	587	423	0.19	17.3	19.6	18.9	17.5	17.7	18.2	**0.00**
	4 = Autumn	-	610	672	436	605	436	**0.07**	-	15.7	16.8	15.0	15.9	16.1	**0.07**
HKA	1 = Winter	292	433	443	337	549	430	**0.09**	9.7	10.5	10.9	10.4	10.4	10.9	**0.07**
	2 = Spring	801	844	735	681	770	975	0.23	13.6	13.0	14.2	13.2	14.0	13.7	0.18
	3 = Summer	603	530	539	697	747	637	0.27	17.5	17.9	18.0	17.3	17.6	17.9	0.57
	4 = Autumn	576	762	676	651	736	546	0.69	14.5	15.0	16.1	14.5	15.3	15.7	**0.04**
CHA	1 = Winter	81	104	125	79	172	149	**0.09**	8.3	9.4	9.3	10.0	9.0	12.8	**0.00**
	2 = Spring	126	128	131	132	148	121	0.89	14.7	15.1	15.2	14.8	14.8	15.3	0.77
	3 = Summer	105	134	129	99	143	109	0.43	19.1	19.5	19.0	20.1	19.6	19.8	0.52
	4 = Autumn	146	173	204	163	173	133	0.86	14.8	15.0	15.6	14.8	15.3	15.5	0.81
DNA	1 = Winter	80	63	94	68	158	54	**0.00**	7.5	8.2	8.1	8.4	8.0	8.3	0.22
	2 = Spring	156	152	162	165	170	161	1.00	13.8	13.5	14.0	13.4	13.9	14.2	0.69
	3 = Summer	157	168	160	193	232	153	0.20	17.5	18.0	17.9	17.9	17.7	18.2	0.76
	4 = Autumn	155	197	130	191	186	112	0.35	13.1	13.8	14.0	13.3	13.8	13.8	0.78
NVA	1 = Winter	134	150	142	150	183	145	0.59	7.1	7.8	7.7	7.9	7.6	8.0	0.14
	2 = Spring	255	263	235	290	228	257	0.79	12.2	12.3	12.6	12.2	12.9	12.7	0.49
	3 = Summer	215	240	254	281	328	291	**0.04**	15.7	16.4	16.2	16.3	16.2	16.6	0.48
	4 = Autumn	308	317	271	299	297	307	0.98	12.3	12.6	13.3	12.2	13.0	13.1	0.45

	Climate Season		FFMC			(median)				BUI			(median)		
Station		**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**
KX	1 = Winter	68.3	64.4	63.6	67.9	61.9	62.5	**0.09**	1.8	1.6	1.8	2.7	1.3	1.5	**0.08**
	2 = Spring	78.6	78.2	74.6	76.2	76.2	77.7	0.32	11.2	6.9	5.4	5.9	7.0	7.4	0.14
	3 = Summer	83.8	85.0	85.3	84.3	83.2	83.1	0.22	24.9	32.6	38.5	32.4	26.8	20.8	0.25
	4 = Autumn	80.3	80.8	81.6	79.0	80.7	83.2	0.24	14.7	13.6	14.2	14.5	14.6	17.2	0.95
AKL	1 = Winter	59.6	62.2	64.4	67.4	61.7	64.0	0.28	1.5	1.4	1.7	2.1	1.4	1.3	0.50
	2 = Spring	78.2	73.7	74.1	77.4	79.3	77.3	**0.02**	10.8	5.8	5.6	7.5	9.0	6.9	0.20
	3 = Summer	82.9	83.3	84.6	84.5	83.8	83.3	0.51	21.8	25.0	45.0	36.4	30.3	22.3	**0.05**
	4 = Autumn	77.9	76.8	79.7	79.7	78.6	81.3	0.47	6.8	10.9	15.6	16.0	14.9	18.2	0.70
TGA	1 = Winter	77.9	72.1	68.7	75.9	68.3	69.6	0.10	5.0	3.4	2.6	5.1	2.9	2.7	**0.09**
	2 = Spring	80.4	-	76.7	80.5	78.3	80.6	0.35	13.5	-	6.9	10.1	9.4	10.4	0.37
	3 = Summer	84.2	84.3	83.9	85.1	83.4	83.7	0.60	24.3	28.2	30.7	41.9	24.9	20.9	**0.02**
	4 = Autumn	-	81.6	82.5	77.0	80.7	83.6	0.94	-	14.9	13.9	14.5	13.7	21.9	0.38
ROA	1 = Winter	73.9	67.1	66.1	72.1	65.2	67.5	**0.05**	3.8	1.6	1.8	3.0	2.0	1.5	**0.10**
	2 = Spring	80.7	76.0	75.6	78.8	76.8	78.3	0.25	10.7	6.6	6.4	7.6	6.6	6.8	**0.04**
	3 = Summer	83.2	81.9	83.1	84.4	82.6	81.7	0.29	25.8	19.6	24.7	32.5	22.4	15.6	**0.10**
	4 = Autumn	82.4	79.6	82.0	79.4	79.3	82.4	**0.02**	11.6	10.1	9.7	12.8	11.7	17.4	0.15
GSA	1 = Winter	74.5	72.2	70.5	75.8	73.8	75.2	0.52	4.9	3.9	4.9	6.3	4.4	8.1	0.19
	2 = Spring	82.5	83.6	83.0	83.5	82.5	84.8	0.40	21.8	14.2	12.9	18.0	15.4	30.2	**0.04**
	3 = Summer	85.6	85.2	85.5	87.2	85.8	85.8	0.18	37.2	36.0	39.0	69.0	45.9	51.2	**0.05**
	4 = Autumn	82.8	82.8	78.3	82.1	81.1	81.8	0.28	25.5	20.3	14.0	19.7	18.4	60.0	**0.03**
NPA	1 = Winter	66.3	63.8	61.6	67.3	60.5	62.2	0.31	1.2	1.0	1.2	2.1	1.2	1.2	**0.09**
	2 = Spring	74.4	72.9	66.4	71.0	74.3	67.3	**0.01**	5.9	4.0	3.3	4.4	5.1	3.1	**0.00**
	3 = Summer	80.2	82.0	80.4	79.9	79.4	80.5	0.82	16.0	19.1	18.9	16.5	16.0	12.0	0.89
	4 = Autumn	78.8	76.5	78.9	76.6	75.9	80.7	0.16	7.3	8.0	10.1	8.1	7.6	11.8	0.69
OHA	1 = Winter	77.1	70.3	70.1	75.6	70.0	68.4	**0.01**	4.6	2.7	2.7	5.2	3.6	2.3	**0.08**
	2 = Spring	81.3	80.1	77.1	79.7	79.9	75.9	0.15	12.9	11.2	7.6	9.4	9.7	8.0	0.56
	3 = Summer	84.3	84.9	83.9	83.9	82.9	83.7	0.52	27.6	30.6	30.3	31.3	24.7	26.2	0.83
	4 = Autumn	82.0	81.2	82.8	79.6	80.5	84.0	0.33	22.4	17.9	22.8	12.7	17.8	32.8	**0.02**
PPA	1 = Winter	72.7	69.7	70.7	73.5	71.0	69.6	0.82	4.9	2.3	3.2	3.6	2.8	2.4	0.15
	2 = Spring	79.8	76.6	78.3	76.9	77.7	76.7	0.26	10.0	6.8	7.0	7.3	7.2	6.7	**0.05**
	3 = Summer	81.4	83.5	83.2	82.2	81.8	83.1	0.20	22.1	27.0	31.8	26.7	20.3	22.6	0.35
	4 = Autumn	82.8	79.4	82.0	80.5	80.1	82.2	0.53	17.4	15.7	21.0	14.4	16.9	23.2	0.95

	Climate		FFMC			(median)				BUI			(median)		
Station	**Season**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**
WNA	1 = Winter	68.1	69.3	68.2	72.3	67.2	71.8	0.51	2.6	2.1	2.6	3.8	1.8	3.3	**0.06**
	2 = Spring	81.2	80.0	79.5	80.1	78.7	78.4	0.40	11.0	9.1	6.9	9.0	7.2	7.4	0.16
	3 = Summer	83.1	83.5	84.1	83.5	83.2	84.0	0.78	28.9	25.3	31.2	31.3	27.1	26.3	0.82
	4 = Autumn	81.3	80.4	80.2	79.9	79.5	82.5	0.78	25.7	14.0	16.3	14.4	13.9	24.0	0.24
NSA	1 = Winter	77.3	68.7	73.1	77.8	67.0	70.7	**0.01**	5.2	3.1	4.8	7.9	3.4	4.1	**0.03**
	2 = Spring	81.3	79.1	80.5	80.0	79.8	78.3	0.52	12.4	8.6	9.0	12.7	8.6	9.5	0.20
	3 = Summer	82.0	84.1	84.4	83.6	83.8	83.6	0.37	29.7	32.2	28.5	37.6	34.5	22.4	0.55
	4 = Autumn	82.3	82.1	83.1	81.9	80.3	83.2	0.12	13.5	19.6	17.4	19.9	18.2	18.1	0.77
KIX	1 = Winter	75.6	76.3	73.7	78.4	74.5	76.2	0.51	6.1	6.0	5.5	10.0	5.1	9.6	**0.01**
	2 = Spring	77.1	77.7	78.6	78.8	77.6	79.9	0.83	13.3	13.5	10.1	14.6	10.8	22.1	0.11
	3 = Summer	78.5	80.5	79.3	81.7	80.9	81.9	**0.08**	22.0	24.4	24.1	42.2	28.6	36.1	0.11
	4 = Autumn	75.4	76.1	75.7	79.9	79.3	78.8	0.17	18.1	12.3	9.6	22.2	19.0	20.5	0.60
WSA	1 = Winter	53.5	54.1	57.6	52.6	55.3	57.0	0.95	1.0	1.0	1.5	0.9	1.5	1.1	0.72
	2 = Spring	62.0	-	64.9	58.0	62.6	57.3	0.71	2.9	-	2.8	2.0	3.0	2.2	0.47
	3 = Summer	66.8	78.1	79.5	69.6	68.9	73.2	0.54	6.5	11.7	10.6	7.1	6.2	8.8	0.10
	4 = Autumn	-	57.8	69.9	67.0	62.4	77.3	0.21	-	4.1	4.9	4.3	3.3	5.3	0.37
HKA	1 = Winter	57.1	53.9	58.3	52.2	51.4	40.7	0.33	1.5	1.5	1.7	1.2	1.4	0.6	0.59
	2 = Spring	59.3	52.8	62.8	54.9	61.8	53.6	0.25	3.2	2.0	2.4	2.1	3.0	1.8	0.35
	3 = Summer	68.4	74.8	74.5	64.5	65.3	67.0	0.14	6.2	10.0	7.6	5.4	5.7	5.9	**0.04**
	4 = Autumn	65.9	57.4	65.2	62.5	60.2	72.3	0.60	3.5	2.9	4.6	2.9	2.9	5.0	0.34
CHA	1 = Winter	73.2	74.2	72.9	75.4	69.5	77.5	0.42	5.9	6.5	7.0	10.0	5.4	8.6	0.18
	2 = Spring	83.6	84.2	84.6	83.1	82.6	83.1	0.23	25.0	25.2	24.4	23.3	20.5	29.3	0.84
	3 = Summer	84.8	85.3	85.2	85.9	84.8	85.7	0.58	46.9	47.0	55.1	59.0	48.6	54.5	0.90
	4 = Autumn	81.8	81.2	81.1	82.2	81.8	81.2	0.91	45.6	30.1	37.2	27.3	26.4	37.0	0.42
DNA	1 = Winter	68.6	75.4	72.3	75.0	68.2	73.2	0.20	3.9	9.5	7.3	6.4	3.8	5.7	**0.02**
	2 = Spring	79.7	80.4	81.4	79.7	80.5	80.5	0.63	15.4	18.7	19.4	15.6	15.0	18.7	0.75
	3 = Summer	81.0	82.5	82.1	82.3	81.0	80.6	0.68	25.8	27.1	32.2	27.7	23.1	23.7	0.62
	4 = Autumn	75.1	78.0	77.0	78.1	78.9	80.9	0.47	19.2	23.8	15.6	13.6	18.2	29.1	0.38
NVA	1 = Winter	53.3	57.6	58.5	55.1	58.7	57.9	0.62	0.6	0.9	0.9	0.5	0.8	0.5	0.44
	2 = Spring	73.1	72.2	73.1	70.3	75.9	73.7	0.16	4.9	6.0	6.8	4.8	7.1	5.1	0.62
	3 = Summer	76.0	77.9	77.3	77.0	75.3	75.9	0.81	12.6	16.6	15.5	14.4	11.3	11.7	0.23
	4 = Autumn	59.2	64.9	70.6	63.9	69.8	70.4	**0.02**	3.4	4.4	5.5	2.5	6.3	4.5	**0.03**

			DSR			(median)				VH+E FFDC			(mean)		
Station	**Climate Season**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**
KX	1 = Winter	0.01	0.01	0.01	0.01	0.01	0.00	0.10	0	0	0	0	0	0	1.00
	2 = Spring	0.41	0.18	0.10	0.15	0.14	0.10	**0.08**	0	0	0	0	0	0	1.00
	3 = Summer	1.62	1.81	3.06	1.86	1.22	1.00	0.25	9.8	8.0	12.5	7.3	6.0	2.6	**0.05**
	4 = Autumn	0.51	0.44	0.44	0.23	0.38	0.50	0.45	3.0	4.2	2.0	0.3	0.5	0	0.53
AKL	1 = Winter	0.00	0.00	0.00	0.01	0.00	0.00	1.00	0	0	0	0	0	0	1.00
	2 = Spring	0.34	0.09	0.08	0.22	0.27	0.12	0.99	1.3	0	0.6	0	0.2	0	1.00
	3 = Summer	1.06	1.03	2.93	2.41	1.74	1.07	**0.00**	2.5	1.8	12.0	7.6	7.7	1.8	**0.00**
	4 = Autumn	0.12	0.19	0.38	0.38	0.25	0.27	0.99	0	2.5	3.3	1.0	1.6	0	0.86
TGA	1 = Winter	0.07	0.01	0.01	0.03	0.01	0.01	1.00	0	0	0	0	0	0	1.00
	2 = Spring	0.61	-	0.11	0.29	0.26	0.33	0.82	0	-	0	1.2	0.4	0	0.96
	3 = Summer	1.52	1.26	1.74	2.79	0.81	1.04	**0.00**	8.0	4.5	5.7	13.6	2.6	0.2	**0.00**
	4 = Autumn	-	0.41	0.43	0.36	0.30	0.50	0.91	-	1.3	0	1.3	0.3	0	0.87
ROA	1 = Winter	0.03	0.00	0.01	0.02	0.01	0.01	**0.03**	0	0	0	0	0	0	1.00
	2 = Spring	0.21	0.04	0.06	0.08	0.07	0.09	**0.03**	0	0	0	0	0	0	1.00
	3 = Summer	0.84	0.44	0.97	1.24	0.62	0.42	**0.05**	2.2	0.8	3.3	3.1	1.7	0	**0.01**
	4 = Autumn	0.20	0.15	0.15	0.15	0.14	0.25	0.64	0.5	0.3	0.3	0.1	0.1	0	0.99
GSA	1 = Winter	0.07	0.02	0.08	0.09	0.04	0.07	0.54	0	0	0	0	0	0	1.00
	2 = Spring	1.61	1.07	0.71	0.75	0.62	1.87	0.16	11.8	6.0	2.3	4.5	2.6	9.6	0.36
	3 = Summer	3.44	2.30	2.56	6.46	3.54	3.57	**0.09**	16.2	12.6	19.0	32.9	21.2	17.2	**0.00**
	4 = Autumn	0.78	0.62	0.24	0.68	0.49	3.38	0.10	7.5	5.1	1.0	6.3	3.5	17.5	0.67
NPA	1 = Winter	0.01	0.00	0.01	0.01	0.00	0.00	0.98	0	0	0	0	0	0	1.00
	2 = Spring	0.07	0.03	0.01	0.02	0.05	0.01	1.00	0	0	0	0	0	0	1.00
	3 = Summer	0.43	0.71	0.75	0.48	0.41	0.33	**0.02**	2.5	1.2	0.8	0.4	1.5	0	**0.02**
	4 = Autumn	0.10	0.09	0.32	0.08	0.10	0.54	0.11	0	0.2	0	0.1	0.4	2.0	0.52
OHA	1 = Winter	0.05	0.01	0.01	0.05	0.02	0.01	**0.05**	0	0	0	0	0	0	1.00
	2 = Spring	0.60	0.40	0.30	0.40	0.36	0.30	0.47	0.8	0.4	0.8	0.8	0.2	0.3	1.00
	3 = Summer	2.09	1.91	2.30	2.62	1.53	1.65	0.69	10.0	9.6	13.5	10.3	6.2	5.8	**0.08**
	4 = Autumn	0.88	0.44	1.06	0.33	0.51	1.28	**0.01**	4.5	3.6	8.3	0.4	3.6	10.5	**0.09**
PPA	1 = Winter	0.08	0.01	0.02	0.03	0.03	0.01	1.00	0	0	0	0	0	0	1.00
	2 = Spring	0.26	0.09	0.15	0.15	0.15	0.09	0.99	0	0	0.2	0.2	0	0	0.98
	3 = Summer	0.82	1.29	1.72	1.28	0.94	0.87	**0.00**	2.0	2.6	4.3	2.6	2.0	0.4	0.35
	4 = Autumn	0.32	0.32	0.46	0.35	0.42	0.64	0.93	0	0.7	2.7	0.3	2.1	2.0	0.91

	Climate	DSR				(median)				VH+E FFDC			(mean)		
Station	**Season**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**	**-1**	**-2**	**-3**	**+3**	**+2**	**+1**	**Prob**
WNA	1 = Winter	0.05	0.03	0.01	0.07	0.03	0.03	0.28	0	0	0	0	0	0	1.00
	2 = Spring	1.05	0.65	0.40	0.47	0.39	0.47	**0.02**	2.2	0.4	0.8	2.2	0.1	0.8	0.99
	3 = Summer	3.23	2.30	2.87	3.23	2.67	2.39	0.69	12.5	7.3	15.0	15.9	12.4	7.0	**0.01**
	4 = Autumn	0.87	0.73	0.71	0.63	0.65	1.70	0.37	15.5	3.9	2.3	3.7	2.7	8.0	**0.01**
NSA	1 = Winter	0.03	0.00	0.01	0.04	0.01	0.01	0.16	0	0	0	0	0	0	1.00
	2 = Spring	0.39	0.21	0.22	0.36	0.18	0.20	0.13	0.6	0	0.5	2.8	0.1	0	0.79
	3 = Summer	1.90	1.92	1.62	2.24	2.21	1.08	0.79	8.8	8.0	6.0	8.6	9.1	0.8	**0.01**
	4 = Autumn	0.18	0.37	0.38	0.49	0.26	0.35	0.49	2.5	1.0	1.7	2.4	1.8	1.0	0.97
KIX	1 = Winter	0.05	0.02	0.05	0.12	0.04	0.12	**0.10**	0	0	0	0	0.1	0	1.00
	2 = Spring	0.15	0.32	0.10	0.19	0.16	0.45	0.32	0.3	1.0	0	1.0	0.5	1.6	0.89
	3 = Summer	0.43	0.54	0.51	1.20	0.69	1.14	0.35	0.8	2.5	1.5	5.7	3.1	3.0	**0.01**
	4 = Autumn	0.08	0.09	0.13	0.46	0.32	0.23	0.50	2.5	0.4	0	1.9	1.3	1.0	0.78
WSA	1 = Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0	0	0	0	0	0	1.00
	2 = Spring	0.00	-	0.01	0.00	0.01	0.00	0.62	0	-	0	0	0	0	1.00
	3 = Summer	0.07	0.24	0.19	0.03	0.04	0.08	**0.01**	0	0	0.3	0	0	0	**0.00**
	4 = Autumn	-	0.00	0.02	0.01	0.01	0.04	**0.00**	-	0	0	0	0	0	1.00
HKA	1 = Winter	0.00	0.00	0.01	0.00	0.00	0.00	0.27	0	0	0	0	0	0	1.00
	2 = Spring	0.01	0.00	0.01	0.00	0.01	0.00	0.14	0	0	0	0	0	0	1.00
	3 = Summer	0.01	0.13	0.07	0.02	0.02	0.02	**0.08**	0	0	0	0	0	0	1.00
	4 = Autumn	0.00	0.00	0.01	0.00	0.00	0.04	**0.00**	0	0	0	0	0	0	1.00
CHA	1 = Winter	0.03	0.05	0.04	0.08	0.04	0.09	0.63	0	0	0	0	0	0	1.00
	2 = Spring	1.31	1.28	1.46	1.08	1.01	2.16	0.77	7.4	9.6	8.2	7.2	6.4	13.8	0.67
	3 = Summer	3.30	3.32	3.73	5.64	3.77	4.75	0.55	18.7	20.3	23.0	31.0	21.4	23.4	0.13
	4 = Autumn	1.46	0.77	0.71	0.58	0.82	1.40	0.33	10.0	7.7	3.7	9.4	6.8	8.5	0.93
DNA	1 = Winter	0.01	0.06	0.04	0.03	0.01	0.03	0.56	0	0	0	0	0	0	1.00
	2 = Spring	0.38	0.41	0.60	0.36	0.39	0.66	0.51	0.3	2.0	2.0	1.0	1.2	2.8	0.79
	3 = Summer	0.80	0.89	1.50	0.98	0.65	0.83	0.34	3.0	2.8	5.8	2.9	2.4	4.4	0.53
	4 = Autumn	0.10	0.46	0.11	0.11	0.31	0.48	**0.03**	0	3.4	0.7	0.4	2.8	1.5	0.34
NVA	1 = Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.72	0	0	0	0	0	0	1.00
	2 = Spring	0.04	0.06	0.11	0.03	0.09	0.04	0.65	0	0	0	0	0.1	0	0.93
	3 = Summer	0.14	0.33	0.34	0.39	0.20	0.17	0.15	0	0.6	0.3	0.4	0	0	**0.00**
	4 = Autumn	0.01	0.01	0.02	0.01	0.03	0.01	0.18	0	0.1	0	0	0	0	0.94