greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

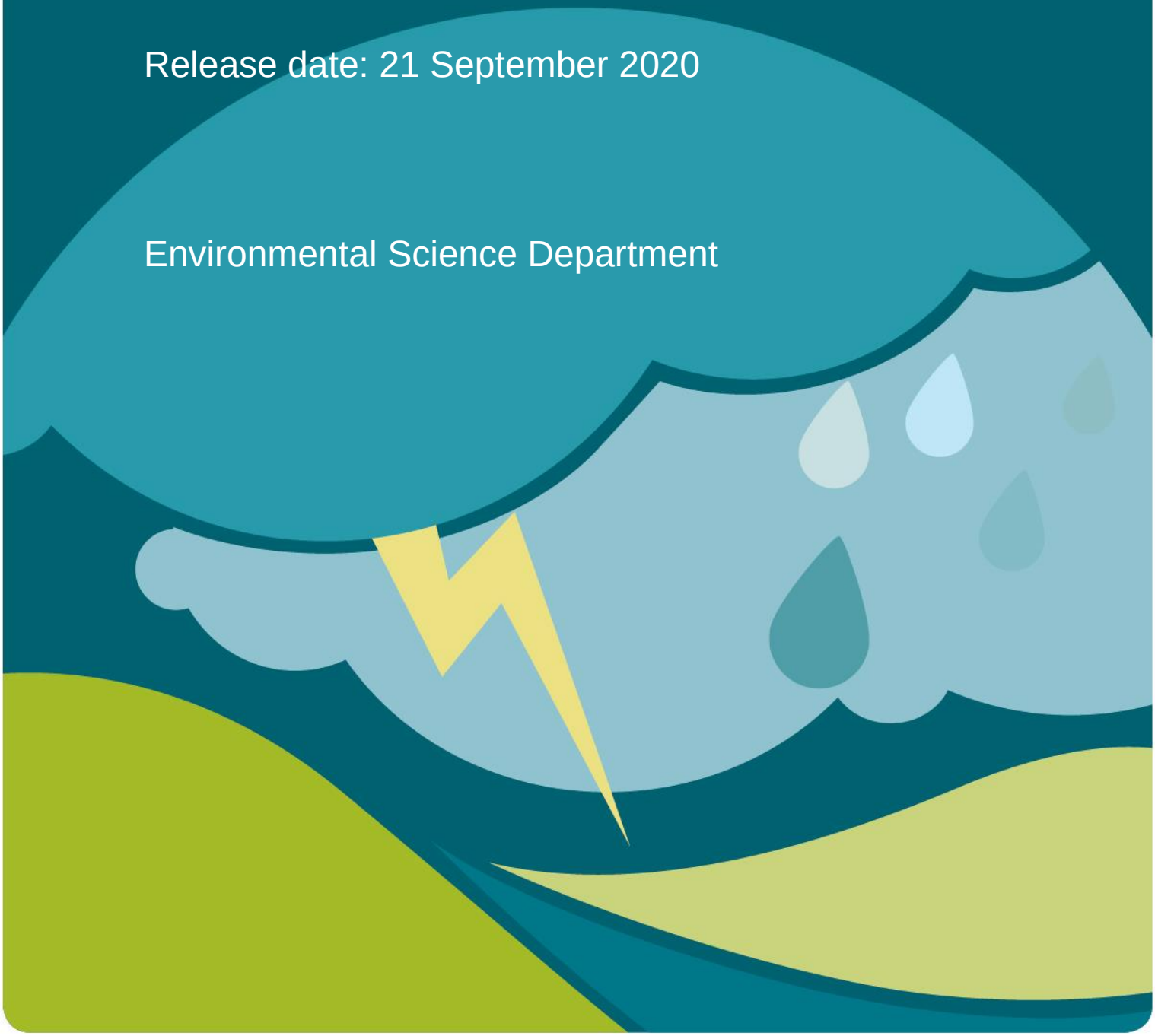
Climate and Water Resources Summary for the Wellington Region

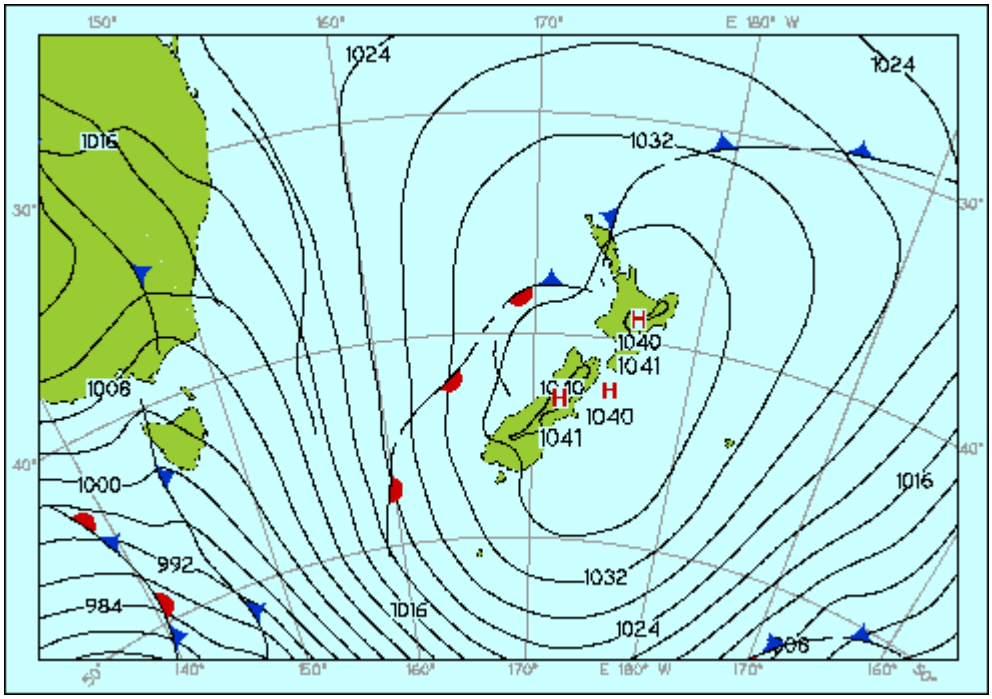
Winter 2020 summary

Spring 2020 outlook

Release date: 21 September 2020

Environmental Science Department





June was a mixed bag of weather, with mild temperatures and well above average rainfall for most of the region. In between the wet periods, the country was dominated by fairly strong high pressure cells, such as the one on the 13-14th.

As shown on the synoptic map above for 14th June at 6am, most of New Zealand was simultaneously experiencing pressures greater than 1040 hPa. Our many thanks to MetService for providing this image.

Overview

Winter 2020

Winter 2020 was characterised by anomalous high pressure to the east and southwest of New Zealand. This set up blocked the normal westerly flow and created conditions conducive to stable and mild days, with a weak north or northeast flow. The temperatures were well above average with Masterton having the hottest winter on record and Wellington the second warmest on record, for over 100 years of continuous records. The seasonal rainfall was overall below average with extremely low totals in August, which were partially offset by above average rainfall in June.

Climate drivers

A new La Niña phenomenon has been forming during the winter months, and is now looking well developed by the sea surface temperature signature. At the same time, a negative Indian Ocean Dipole (IOD) is also expected to develop during spring.

La Niña tends to be associated with warmer waters around New Zealand and winds from the north-easterly quadrant especially during summer. The reduced westerly flow in winter suggests that La Niña is already having some degree of influence and contributing to the mild temperatures observed.

The negative IOD also tends to reinforce the La Niña warming signal for the region. Hence, these drivers will contribute to amplifying the background global warming affecting our region in the coming two seasons.

Climate outlook for spring 2020

Even though the spring season started with increased westerlies and frequent fronts, most international climate models predict that high pressure areas will eventually dominate to the east of New Zealand. As such, there is a tendency for north-easterly flows to develop later in the season, further increasing the warm sea surface temperatures already established around the country. Based on these evolving drivers, rainfall is expected to be near or below average, and temperatures to be above average for the season as a whole.

Live regional climate maps (updated daily): Daily updated climate maps of regional rainfall and soil moisture are provided on GWRC's environmental data webpage (graphs.gw.govt.nz/#dailyClimateMaps).

Contents

1. Climate drivers

1.1 El Niño – Southern Oscillation (ENSO)

The ensemble projections of the Australian climate model below show that the ENSO phenomenon is predicted to develop into a La Niña event over spring. This suggests that the weather patterns may transition into a more easterly regime towards the end of the season, with above average temperatures and greater oceanic warming.

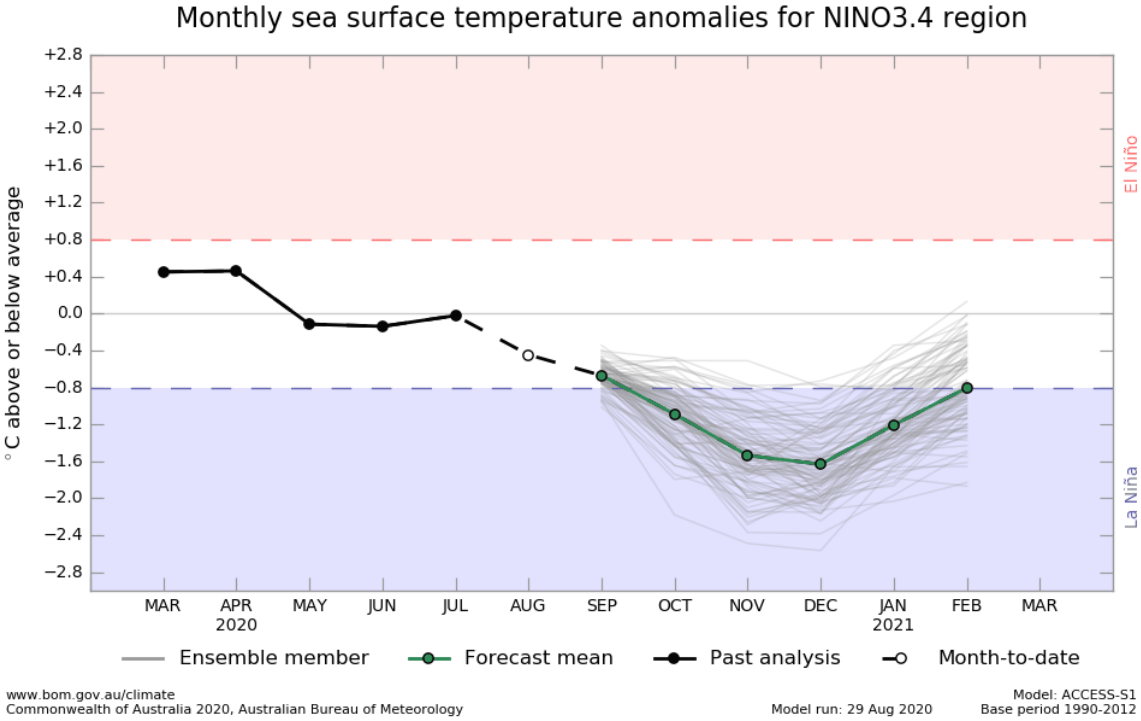


Figure 1.1: Averaged modelled projections (in green) show ENSO is expected to be in a negative phase (La Niña) during spring. Source: Australian Bureau of Meteorology.

1.2 Sea Surface Temperature anomalies

The Sea Surface Temperature (SST) anomalies and the total sea ice extent (in white) are shown in Figure 1.2 as of 13 September 2020. The pattern shows warmer than normal waters over the Tasman and east of New Zealand, and colder than normal south of Australia. A well-developed La Niña signature is now evident in the Equatorial Pacific Ocean. This could amplify the warming waters around New Zealand later in the season, and potentially create marine heatwaves. The sea ice cover around Antarctica has largely recovered compared to the same period last year, and is now around normal.

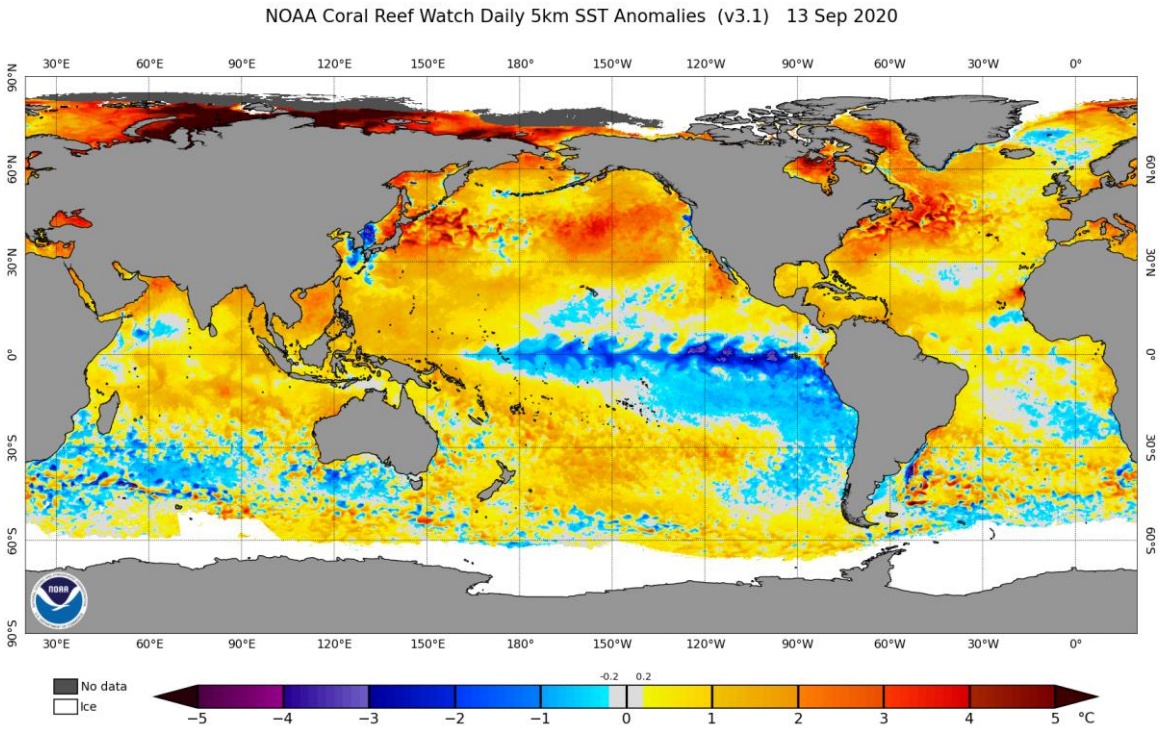


Figure 1.2: Sea surface temperature (SST) anomalies as of 13 September 2020. Sea ice coverage is shown in white. Waters around New Zealand are warmer than average in the Tasman Sea and east of the country, and remain cooler than average to the south of Australia, where a strong south-westerly wind pattern has caused further snow and frosts in Victoria and Tasmania during winter . The Equatorial Pacific (ENSO) is showing a well-developed La Niña pattern. It is expected that warmer north-easterly flows will develop around New Zealand, once the atmospheric circulation 'locks in' to the La Niña forcing. Source: NOAA.

1.3 Southern Annular Mode (SAM)

The SAM is the natural pressure oscillation between mid-latitudes and the Antarctic region. Normally, positive SAM is associated with high pressures around the North Island keeping the weather stable and dry/cloud-free (especially in summer), whereas the opposite is expected when the SAM is in the negative phase.

Figure 1.3 shows that the winter pattern was characterised by a long corridor of anomalous high pressure extending all the way from the sub-Antarctic waters south of Australia to the east of New Zealand. This set up contributed to weakening the normal westerly flow and the southerly fronts, bringing very mild temperatures and prolonged dry periods.

The SAM has been oscillating between the positive and negative phases, without a clear hemispheric pattern. During La Niña, there is a tendency for the SAM to be more on the positive side, contributing to warmer temperatures and dry periods during spring

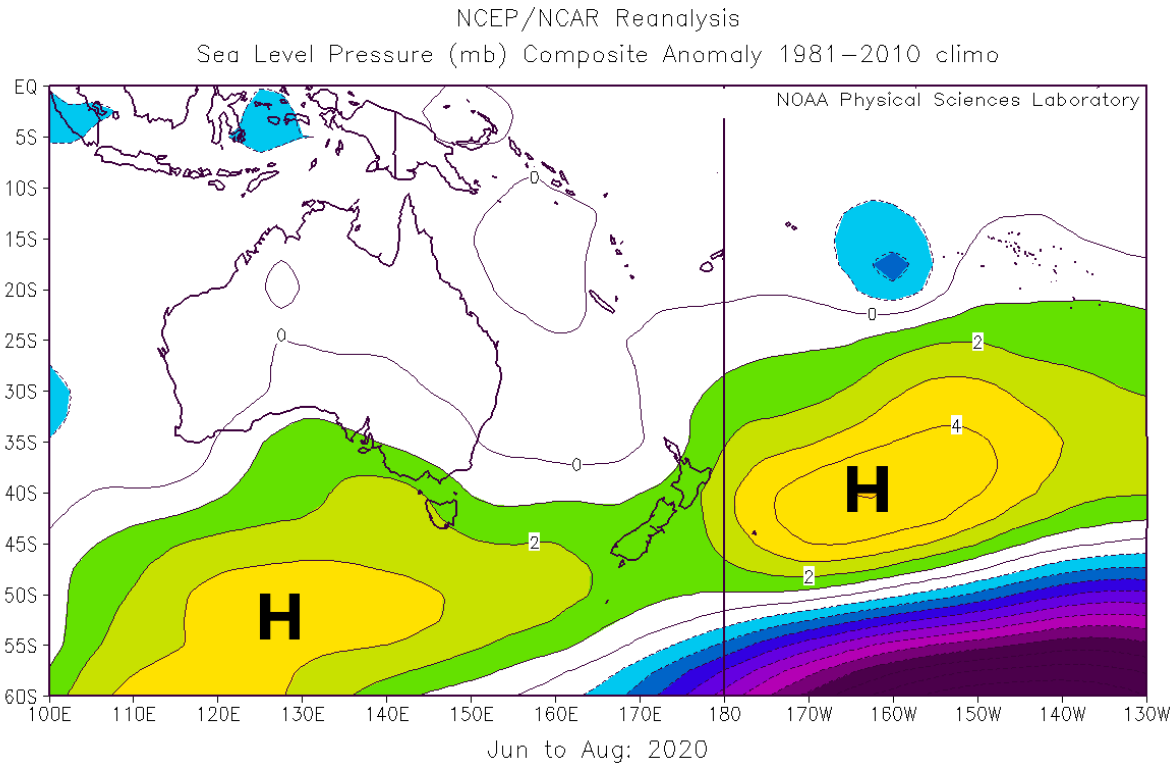


Figure 1.3: Mean sea level pressure anomaly (hPa) for winter 2020. The 'H' indicates the central position of the anomalous high pressure areas. This pattern was associated with a suppression of the normal westerly flow during winter, with a predominance of stable and mild days, in between short periods of extreme weather events. Source: NCEP Reanalysis.

2. What is the data showing?

2.1 Regional temperature

Figure 2.1 shows the seasonal minimum and maximum temperature anomalies (against the 1981-2010 reference period) for the region based on all monitoring sites available from GWRC, NIWA, MetService and New Zealand Rural Fire Authority (all meteorological stations indicated by dots).

Warmer than average temperatures continued for the region, especially for maximum temperatures in the southern Wairarapa and northern Kāpiti coast. Masterton night-time temperatures were much closer to average, highlighting the local influence of the dry conditions facilitating the radiative cooling at night.

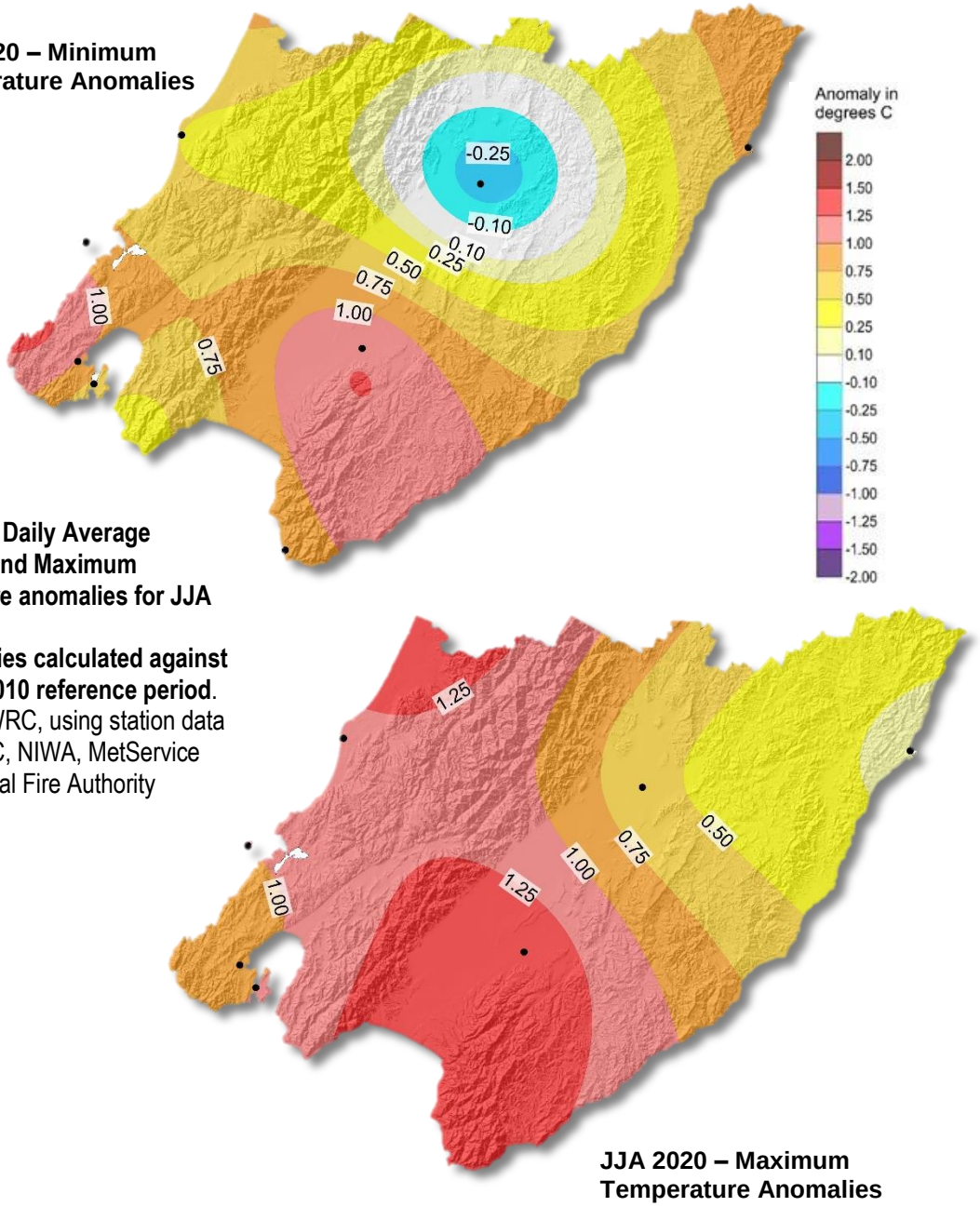


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies for JJA 2020.
All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

2.2 Regional wind

Figure 2.2 shows the mean seasonal wind anomalies (against the 1981-2010 reference period) based on a smaller network of stations than for temperature. Virtually all the region experienced well below average wind speeds as a result of the influence of the blocking anticyclone east of New Zealand, with less frequent fronts and prolonged stable periods.

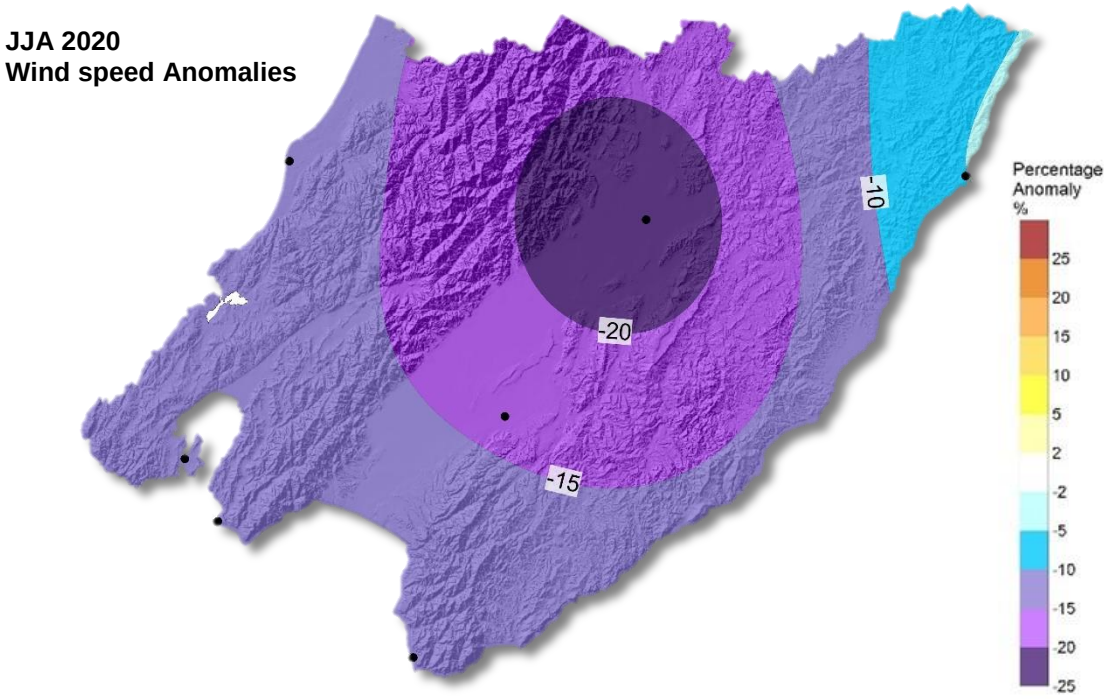


Figure 2.2: Daily mean wind anomalies (as percentage departure from the average) for JJA 2020. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from NIWA and MetService

2.3 Regional soil moisture

Figure 2.3 shows that the soil moisture levels were around or slightly below normal for most of the region at the end of winter. This reflects the insufficient rainfall recharge during winter, after the last hydrological year (finishing 31st May) had already finished in deficit. With warmer temperatures predicted ahead, there is a chance that a new water deficit may develop during the season.

Live regional climate maps (updated daily): Climate maps for regional rainfall and soil moisture (updated daily) are provided online at GWRC's environmental data webpage http://graphs.gw.govt.nz/#dailyClimateMaps

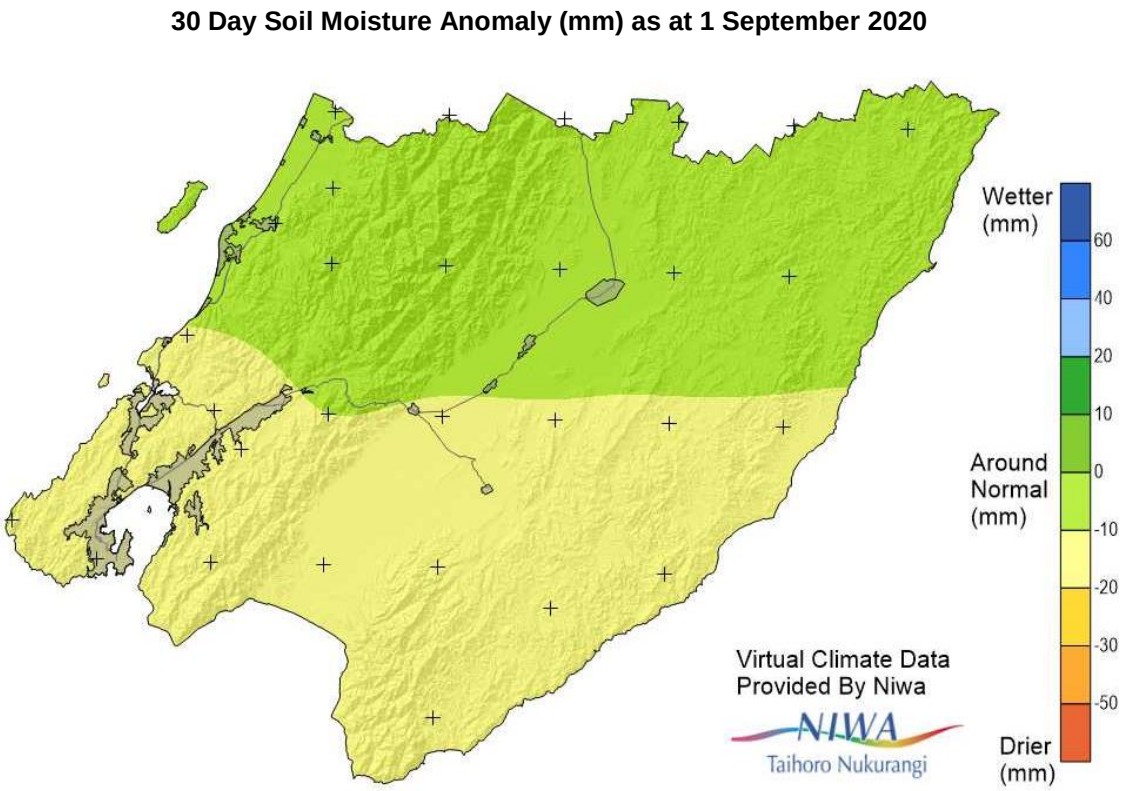


Figure 2.3: 30 Day soil moisture anomaly as at 1st September 2020. Most of the region shows a modest recovery of moisture levels, still tending to be on the negative side (ie, slightly drier than normal). Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. *Note that this data is indirectly calculated by modelling and interpolation techniques, and does not necessarily reflect the results obtained by direct measurements. This map only provides a general indication of the spatial variability*

2.4 Regional rainfall

Figure 2.4 shows the regional monthly winter rainfall expressed as a percentage of the long-term average. June was very wet around Wellington while July was dry around Wellington and normal in the Wairarapa.

August was extremely dry for most of the region with rainfall totals as low as 25 percent of normal occurring across large parts of the Wairarapa and eastern hills.

The overall average winter pattern resulted in normal total accumulation to the north and below normal to the south of the region

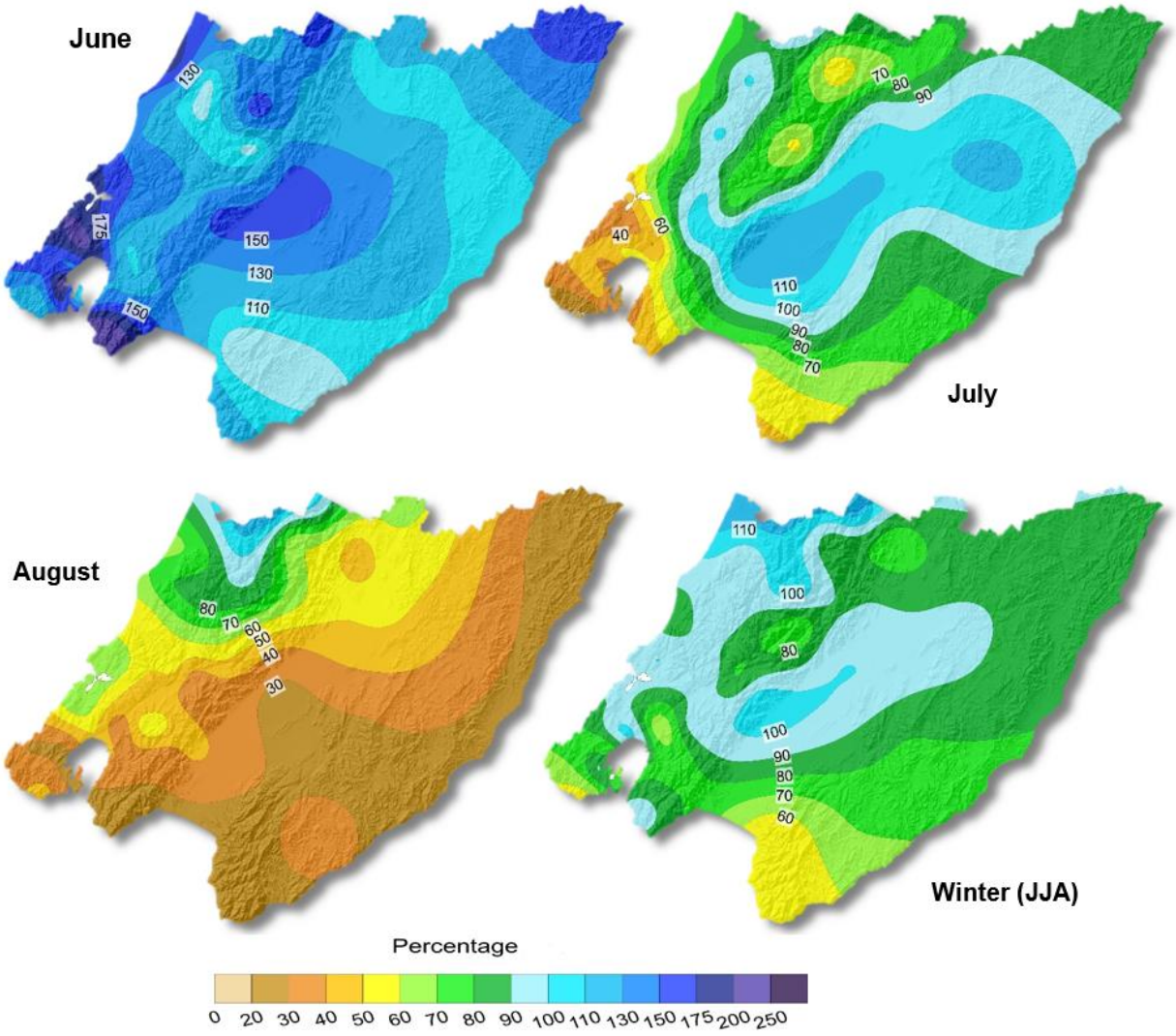


Figure 2.4: Rainfall for June (upper left), July (upper right), August (lower left) and Winter JJA (lower right) 2020 as a percentage of the long-term average. Source: GWRC

2.5 Climate change and variability indicators

The graphs below (Figure 2.5) show summaries of seasonal climate change and variability for Wellington and the Wairarapa using reference climate stations, chosen based on length of data record and availability.

The key climate variables shown are; mean temperature, total sunshine hours, mean wind, total rainfall and total number of rain days (above 0.1 mm). Temperature measurements go back to the 1910s, allowing for a meaningful analysis of climate change trends. Most other variables also have long periods of measurement greater than 50 years, except sunshine hours and wind for the Wairarapa; these are only available for less than two decades, which is a very short period climatologically and does not allow for an analysis of trends.

The red and blue bars show the extreme years of the entire measurement period. Red indicates seasons that were warmer, drier, sunnier and less windy than average (i.e., extreme hot/dry), and blue indicates seasons that were colder, wetter, cloudier and windier than average (i.e., extreme cold/wet). The reference climatological average (1981-2010) is shown by a horizontal bar where available.

An analysis of linear trends associated with climate change is plotted onto the graph only when the trends are statistically significant at 99% level according to the Student's *t*-test.

The climate change and variability summary for winter is:

- Statistically significant trends are seen only for temperature (Wellington and Masterton), meaning that winter is getting warmer as a result of ongoing climate change. The long-term trend is about 1.3 degrees per century in Wellington and 1.1 degrees per century in Masterton

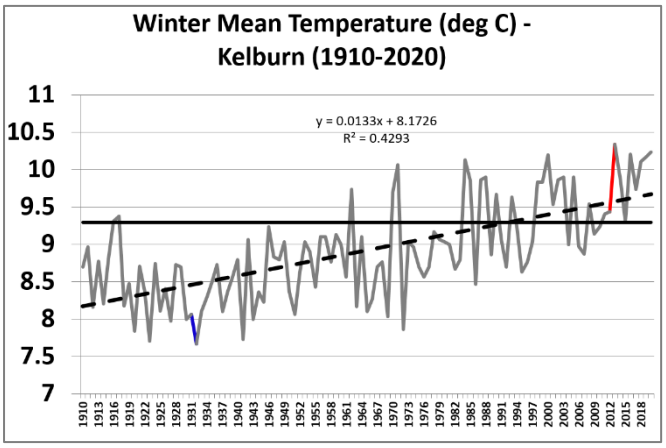
- Winter 2020 was the warmest winter on record for the Wairarapa, and the second warmest on record for Wellington

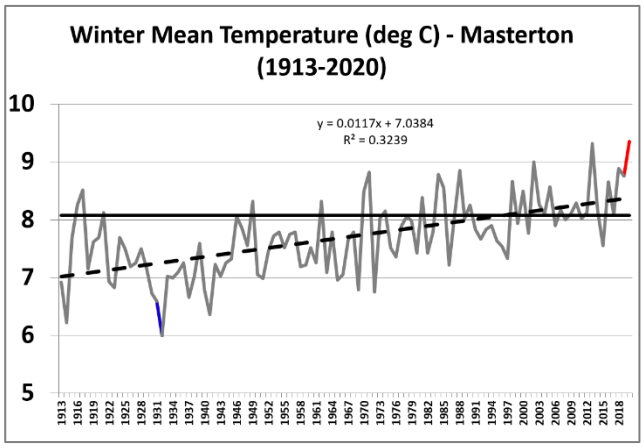
- Sunshine hours were well above average for Wellington highlighting the influence of the blocking anticyclones and dry weather for the most part

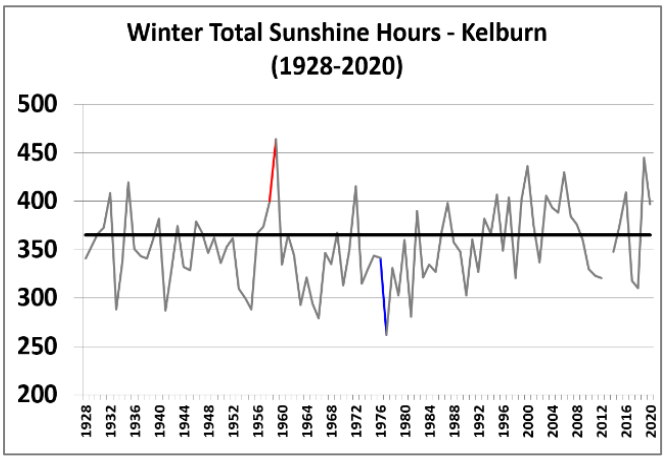
- Seasonal average wind speed was well below normal in Wellington, highlighting reduced westerly flow compared to normal and less active cold fronts

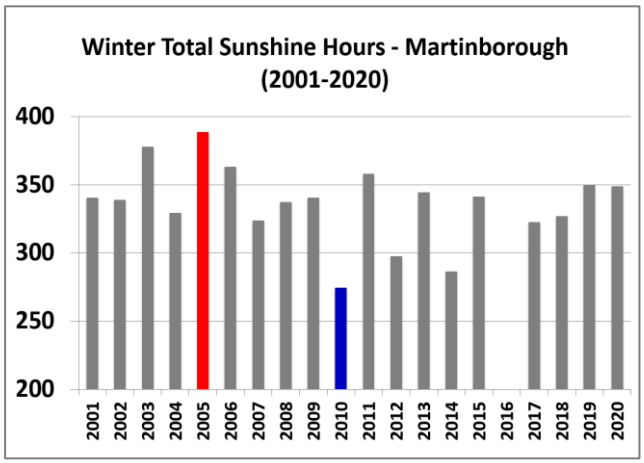
- Seasonal rainfall and number of rain days were below average in Wellington and in the southern part of the Wairarapa.

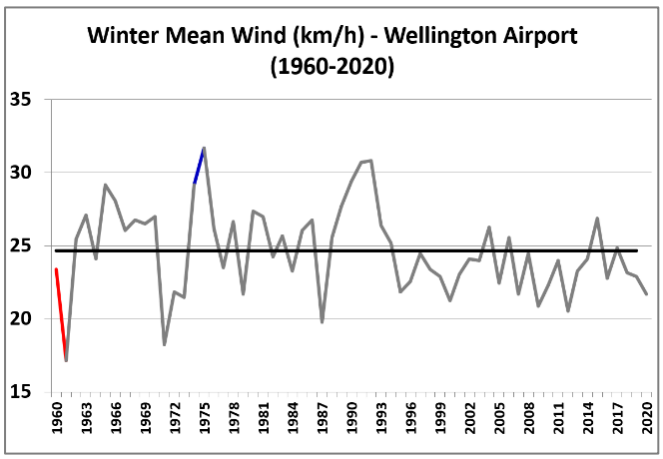
What is the Data Showing?

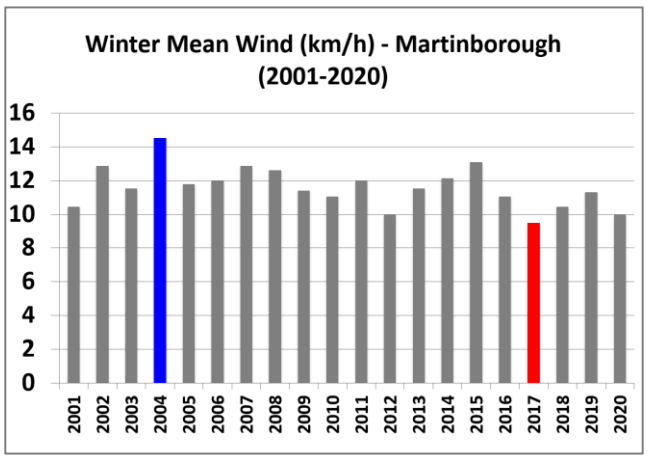












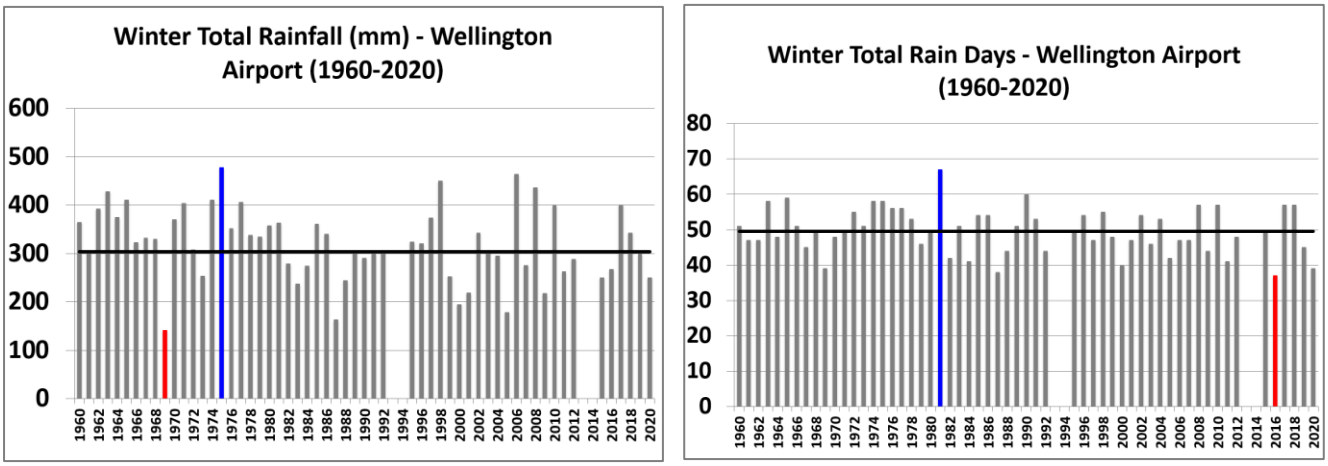


Figure 2.5: Climate change and variability graphs for winter in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs, the bright red and blue bars show the extreme min and max values for each time series (red for warm, dry, sunny and calm and blue for cool, wet, cloudy and windy). The key variables shown are: mean temperature, total number of sunshine hours, mean wind speed, total rainfall and total number of rain days (>0.1mm). Missing bars means that no reliable mean seasonal data was available for that particular year. The last bar of each graph shows the last available data for the currently analysed season, unless there are missing data.

2.6 Observed rainfall and soil moisture conditions for selected sites

Figure 2.6 shows the location of selected GWRC rainfall and soil moisture monitoring sites. Plots of accumulated rainfall and soil moisture trends are provided in the following pages.

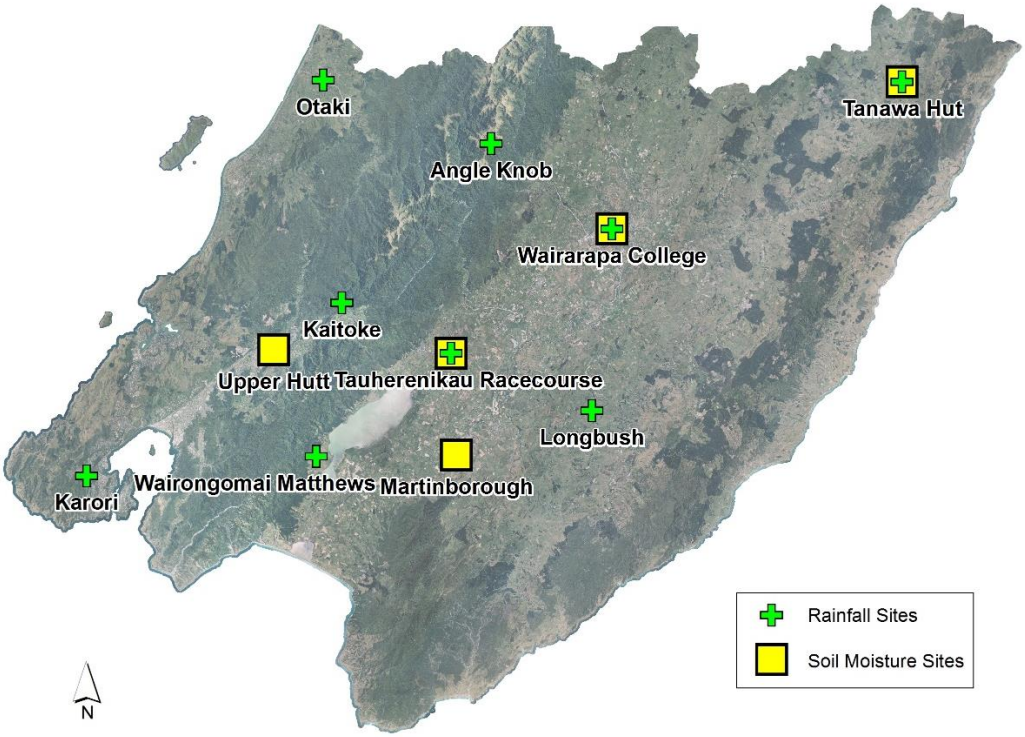


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

2.6.1 Rainfall accumulation for hydrological year (1 June to 31 May)

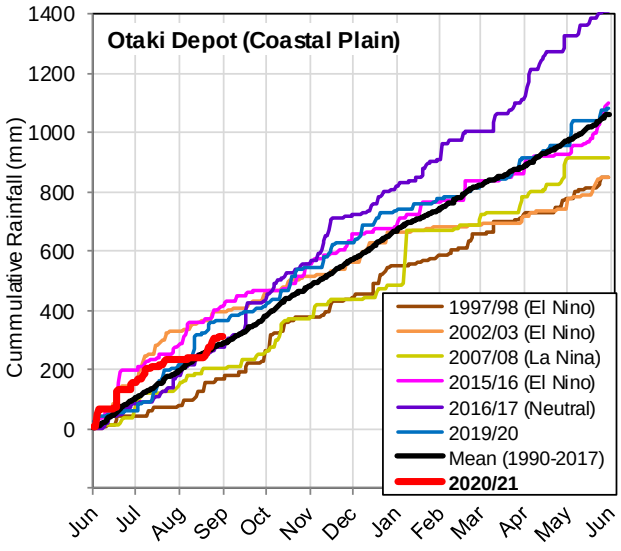
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry years have been included as well as the site average.

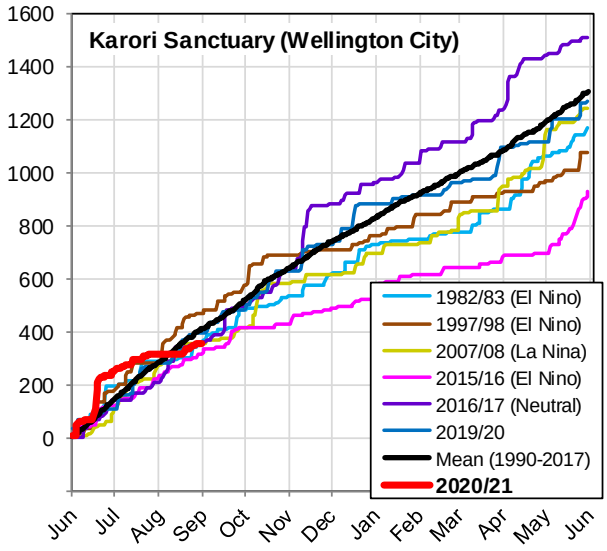
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral) at that time is also given.

GWRC does not operate a rain gauge in the southern-most parts of the Wairarapa Valley that is suitable for presenting data in this report. This means that we cannot be confident that the rainfall patterns seen elsewhere extend to this part of the region other than the VCSN data already presented.

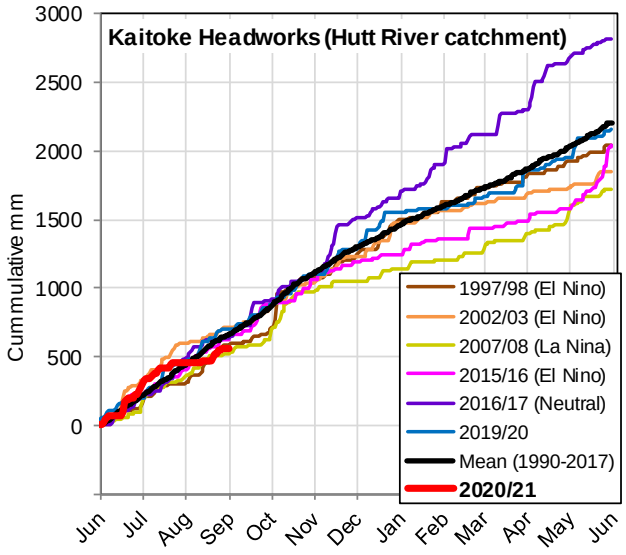
Overall, total rainfall accumulations from June to August have been close to average in some areas of Kāpiti and Wairarapa. However, accumulations are below average for Wellington, the Tararua ranges and Longbush, showing some local variability. During July wet conditions are shown at all sites with a sharp rise in rainfall accumulation, but dry conditions persisting through August has brought the total back to near or below average.

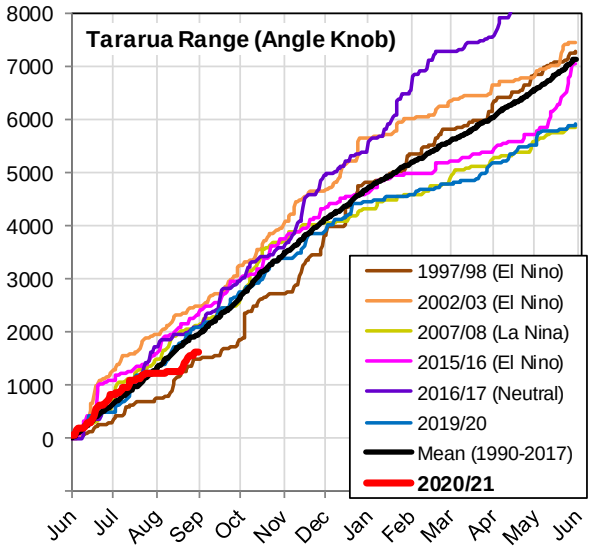
Kāpiti Coast and Southwest (Wellington City)



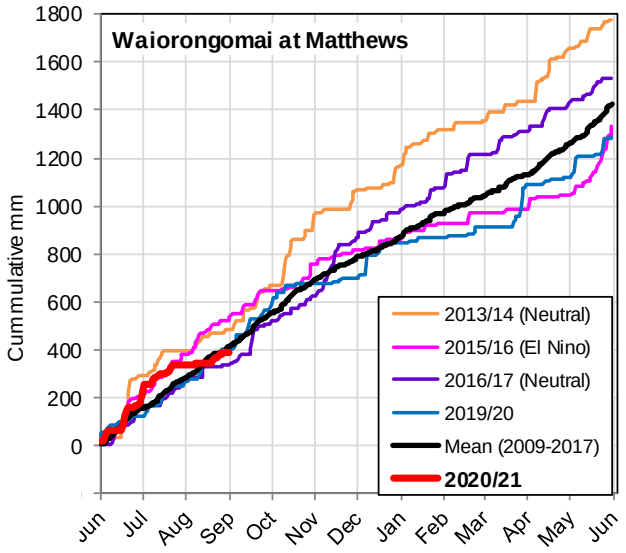


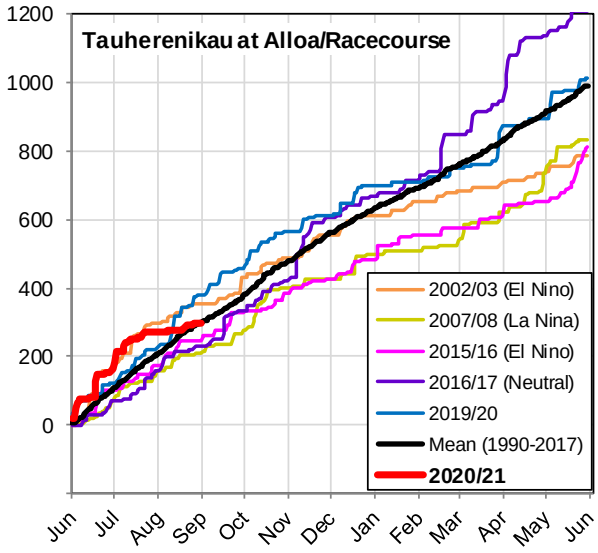
Hutt Valley and the Tararua Range

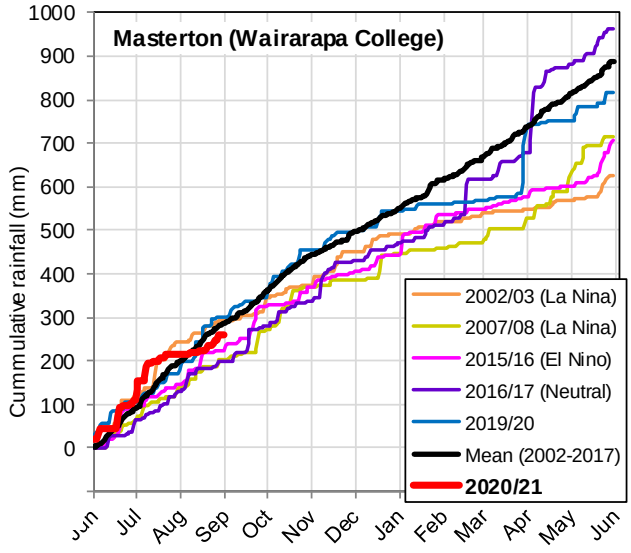


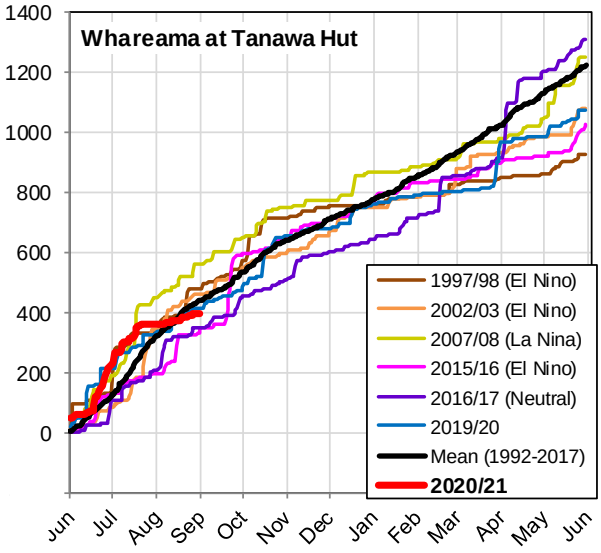


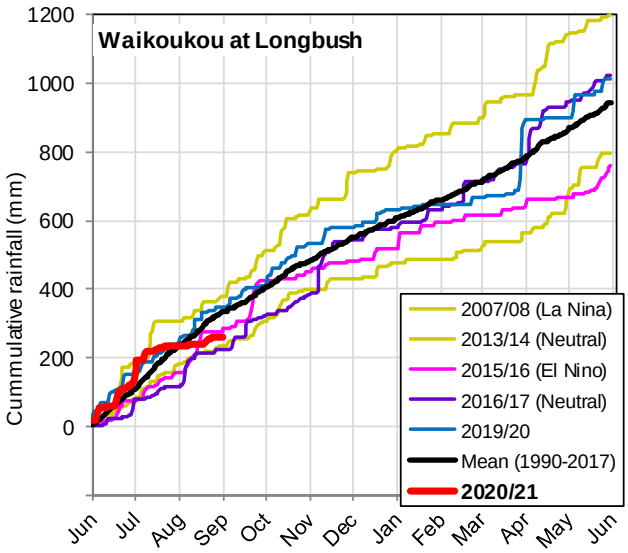
Wairarapa











Live cumulative plots (updated daily): Real-time graphs for cumulative rainfall are available online at GWRC's environmental data webpage (http://graphs.gw.govt.nz/). Select a rainfall monitoring site, then choose *Cumulative Historic* from the *Interval* selector, then optionally change the period from the last 12 months to the hydrological year (July – June) as required

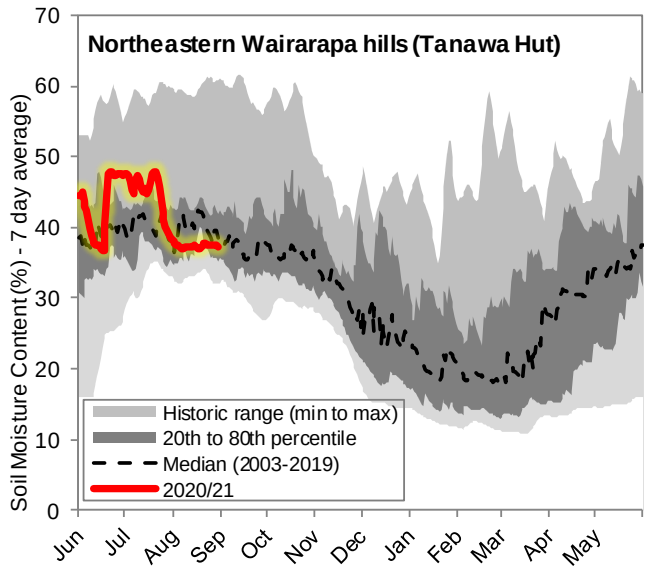
2.6.2 Soil moisture content (since 1 June 2020)

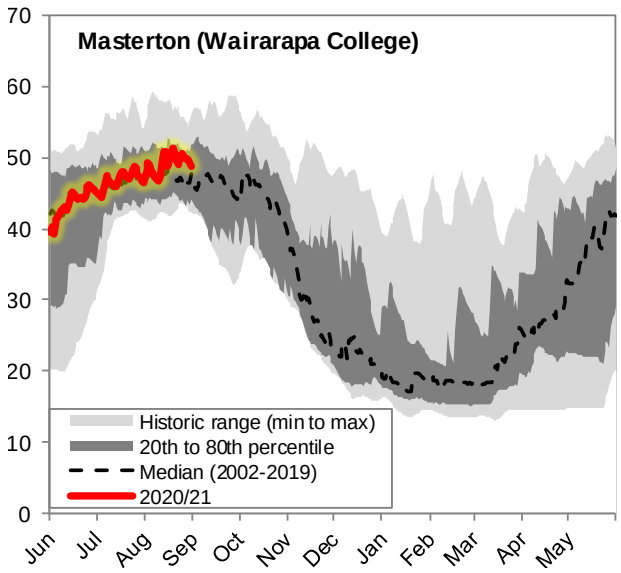
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2020. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar period in past years.

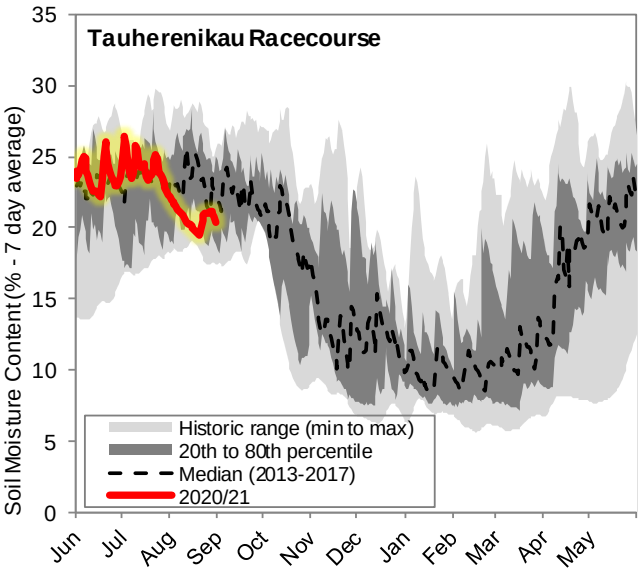
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated to provide accurate absolute measures of soil moisture.

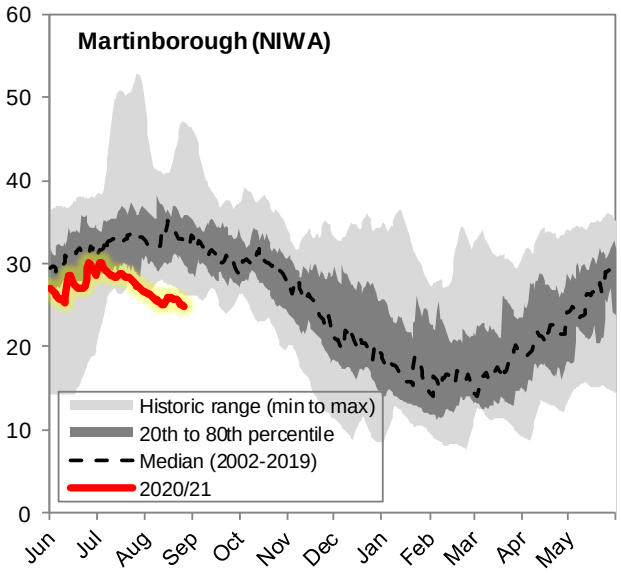
The very dry conditions that persisted through August are evident in the soil moisture readings at the Tanawa Hut and Tauherenikau racecourse sites, dropping from above average to below average. The NIWA site at Martinborough has had consistently low readings. We're working alongside with NIWA to better determine if long-term trends for that site are due to local effects or mainly a climate change signal.

Wairarapa

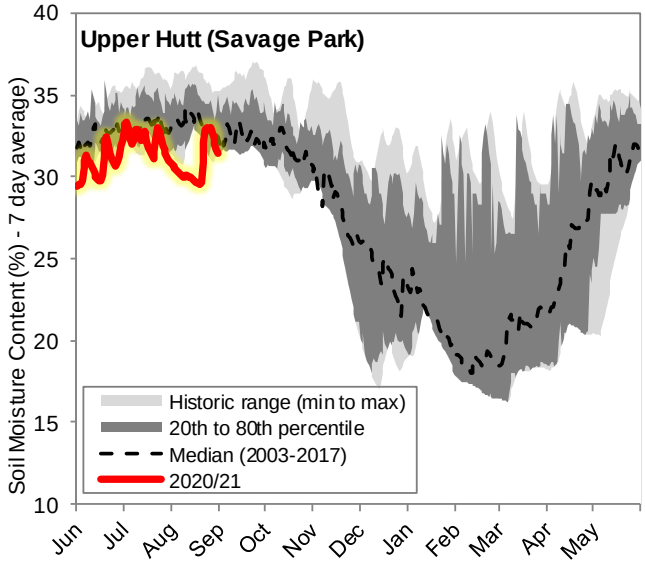








Upper Hutt



Live soil moisture plots (updated daily): Real-time "envelope" graphs for soil moisture are available online at GWRC's environmental data webpage (http://graphs.gw.govt.nz/). Select a soil moisture monitoring site, then choose *Envelope Graph* from the *Interval* selector, then optionally change the period from the last 12 months to the hydrological year (July – June) as required.

3. Outlook for spring and early summer 2020

- A La Niña has already developed, and is expected to reach full strength later into spring;
- Sea Surface temperatures around New Zealand are expected to remain mostly above average, especially to the east of the country. Marine heatwaves are possible later in the season;
- Warmer than average air temperatures, with possible early heat waves later in the season;
- Normal to below average rainfall. Low confidence for total seasonal accumulation, high month-to-month variability

Whaitua*	Variables	Climate outlook for spring 2020
Wellington Harbour & Hutt Valley	**Temperature:**	Average to above. High chance of early heat waves forming later in the season.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability.
Te Awarua-o-Porirua	**Temperature:**	Average to above. High chance of early heat waves forming later in the season.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability.
Kāpiti Coast	**Temperature:**	Average to above. High chance of early heat waves forming later in the season.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability.
Ruamāhanga	**Temperature:**	Average to above. High chance of early heat waves forming later in the season.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability.
Wairarapa Coast	**Temperature:**	Average to above. High chance of early heat waves forming later in the season.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability.

*See http://www.gw.govt.nz/assets/Environment-Management/Whaitua/whaituamap3.JPG for whaitua catchments

Acknowledgements

We would like to thank NIWA for providing selected VCSN data points for the calculation of the regional soil moisture map and for supplementing the rainfall percentage maps in data sparse areas.

Online resources

GWRC online climate mapping tools:

- **Live regional climate maps (updated daily):** Climate maps for regional rainfall and soil moisture (updated daily) are provided online at GWRC's environmental data webpage (graphs.gw.govt.nz/#dailyClimateMaps)

- **Drought check:** http://www.gwrc.govt.nz/drought-check/

- **Interactive climate change and sea level rise maps:** This webpage provides easy to plot climate change mapping that illustrates the predicted future impacts of climate change in the Wellington Region. Maps are available for every season, for mid (2040) and late century (2090). A total of 21 climate variables can be plotted, for every greenhouse gas emission scenario modelled by the IPCC. Dynamical downscaling provided by NIWA: https://mapping1.gw.govt.nz/gw/ClimateChange/

Key Reports:

- **Main climate change report (NIWA 2017)**
  http://www.gw.govt.nz/assets/Climate-change/Climate-Change-and-Variability-report-Wlgtn-Regn-High-Res-with-Appendix.pdf

- **Main climate drivers report (Climate Modes) (NIWA 2018)**
  http://www.gw.govt.nz/assets/Our-Environment/Environmental-monitoring/Environmental-Reporting/GWRC-climate-modes-full-report-NIWA-3-Sep-2018-compressed.pdf

- **Climate change extremes report (NIWA 2019)**
  https://www.gw.govt.nz/assets/Climate-change/GWRC-NIWA-climate-extremes-FINAL3.pdf

Climate Portals

- **GWRC Climate change webpage**
  http://www.gw.govt.nz/climate-change/

- **GWRC Seasonal climate hub**
  http://www.gw.govt.nz/seasonal-climate-hub/