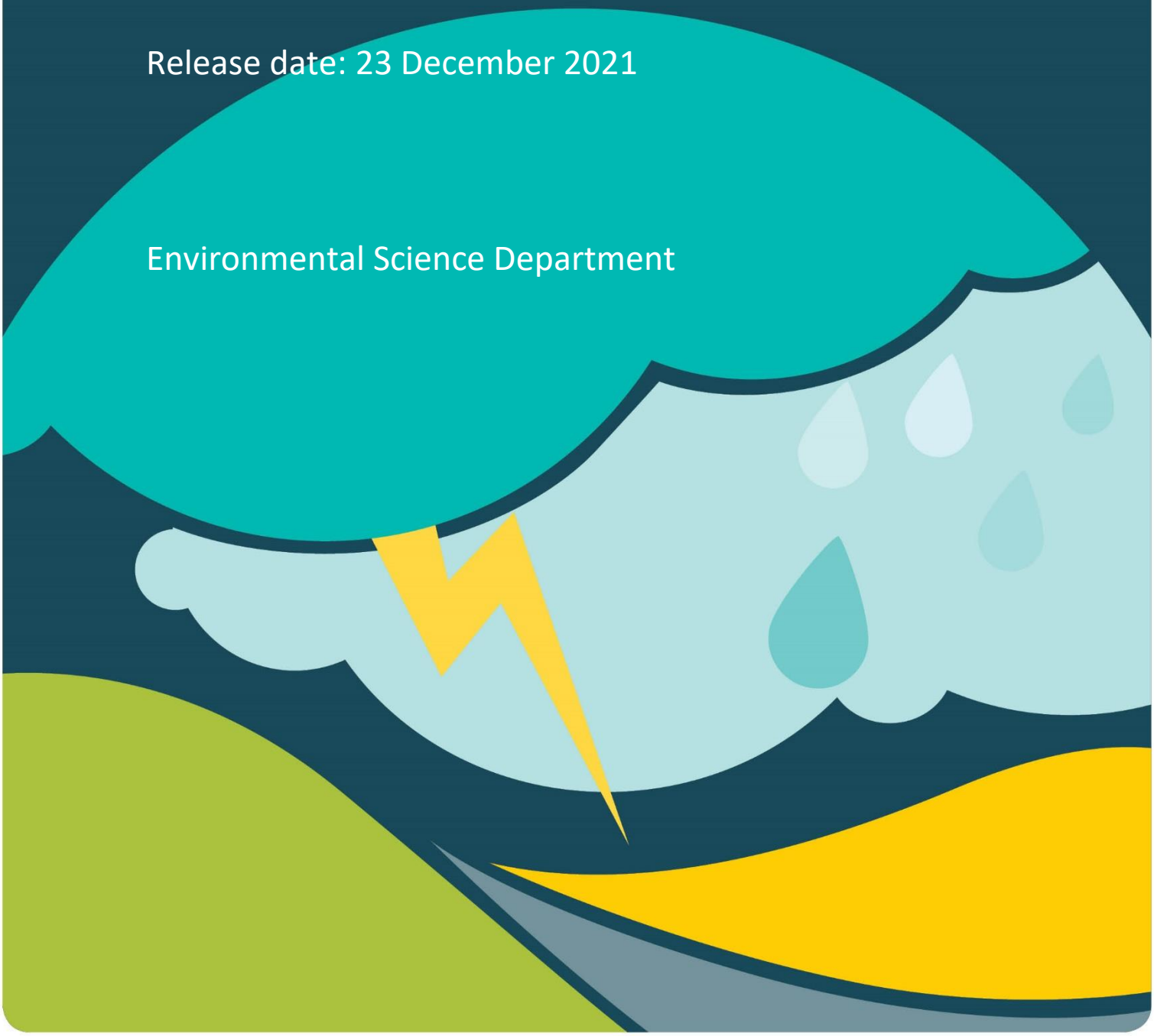
Climate and Water Resources Summary for the Wellington Region

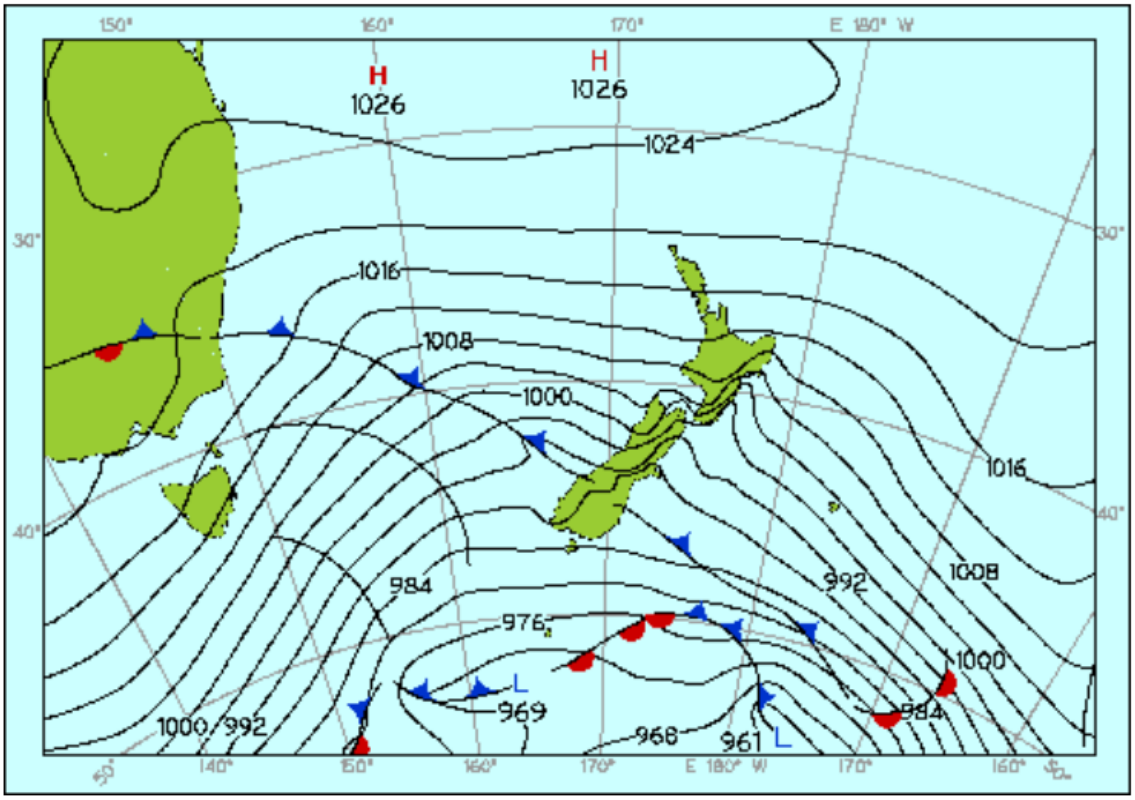
Spring 2021 summary

Summer 2022 outlook

Release date: 23 December 2021

Environmental Science Department





Our La Niña 2021 spring was very unusual. North-easterly flow prevailed during several weeks as expected during La Niña events, but the easterly pattern was interrupted by fiercely strong westerlies at times. Such was the case on 10 September, when the eastern coast of the Wairarapa measured remarkable wind gusts of almost 200 km/h. Castle Point measured a maximum gust of 178km/h, this being the highest on record since measurements started in 1972. Synoptic chart for 06am 10 September 2021, courtesy of Metservice.

Overview

Spring 2021

Spring 2021 highlighted a marked strengthening of La Niña. Marine heatwave conditions were seen around New Zealand, resulting in the second warmest on record seasonal average for the entire country (after the warmest November on record). In the Wairarapa it was also the second warmest spring on record, behind only 1988, an incredibly windy and warm spring was felt under another La Niña. It was also very dry, with only 11mm in Masterton in November being the 4th lowest since 1926. November saw widespread warm records all over the region, and in September the second highest wind gust for all Wairarapa springs was measured, with a remarkable 178km/h clocked at Castlepoint. There were also some near record low daytime temperatures during a brief unseasonal cold spell in October, and some significant frosts early in September. North-easterly humid flows gave a tropical like feeling to the region, especially in November, alternating with fierce westerlies earlier in the season.

Climate drivers

The La Niña phenomenon is now fully developed, and the Southern Annular Mode is mostly positive. These characterise full coupling between the atmosphere and the ocean for the global effects expected during La Niñas. For New Zealand, the implication is the likely continuation of marine heatwave conditions well into summer.

Climate outlook for summer 2022

Virtually all international climate models are predicting a considerably hotter than normal summer ahead for New Zealand, with anomalous high pressure south-east of the country, and prevailing moist north-easterly flows. While warm summers are not unusual during La Niñas, the background global warming and current state of marine heatwaves around New Zealand amplify the normal La Niña signal. The Wellington region is in a rainfall transition zone, and is expected to be occasionally influenced by extreme rainfall periods in between long dry spells.

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 remain in the La Niña phase during most of summer. This pattern, together with warm oceanic waters around New Zealand, will be highly conducive to a much warmer than average summer and early autumn ahead.

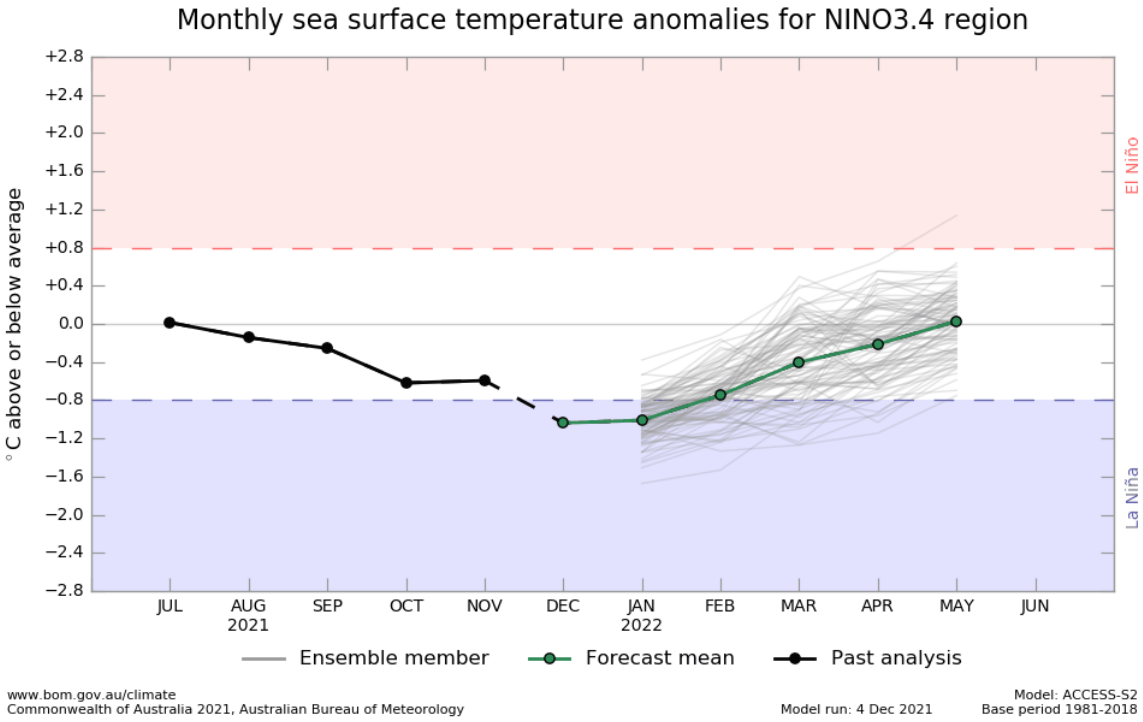


Figure 1.1: Averaged modelled projections (in green) show that ENSO is expected to remain in the negative (La Niña) phase until the end of summer. Source: Australian Bureau of Meteorology.

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 March 2021.

The pattern shows a well-developed La Niña phenomenon in the Equatorial Pacific, and warmer than average SSTs around all of New Zealand, characterising marine heatwave conditions. This large scale SST signature will locally reinforce the effects of global warming around New Zealand, creating the potential for a much warmer than average summer ahead.

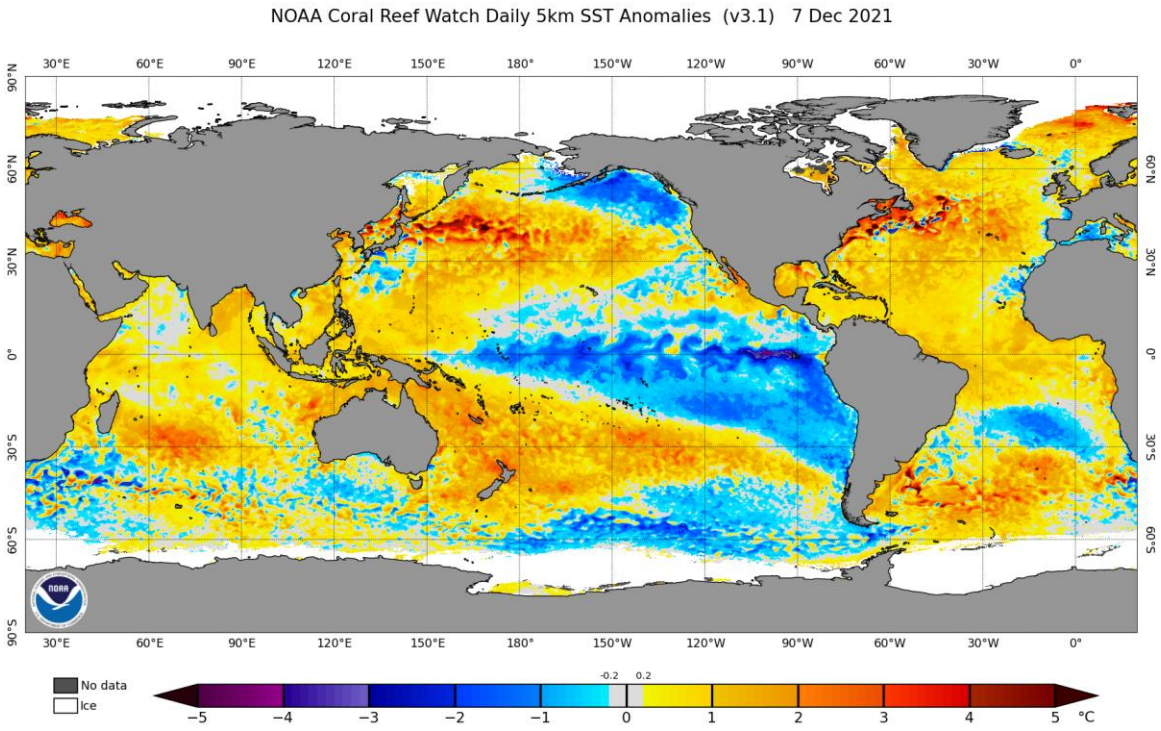


Figure 1.2: Sea surface temperature (SST) anomalies as of 7 December 2021. Sea ice coverage is shown in white. Water temperatures around New Zealand are well above average, characterising marine heatwave conditions. The Equatorial Pacific (ENSO) is showing a mature La Niña pattern. The sea ice extent (in white) was about two standard deviations below normal as of mid-December. 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.

The SAM has been strongly positive, strengthening the expected atmospheric influences for a La Niña event, with mainly below average rainfall and warm and humid weather in the Wellington Region. Figure 1.3 shows that the spring sea level pressure pattern was characterised by a strong high pressure south and east of the country. This pattern contributed to anomalous north-easterly flows with well above normal temperatures, and the maintenance of marine heatwaves around the country.

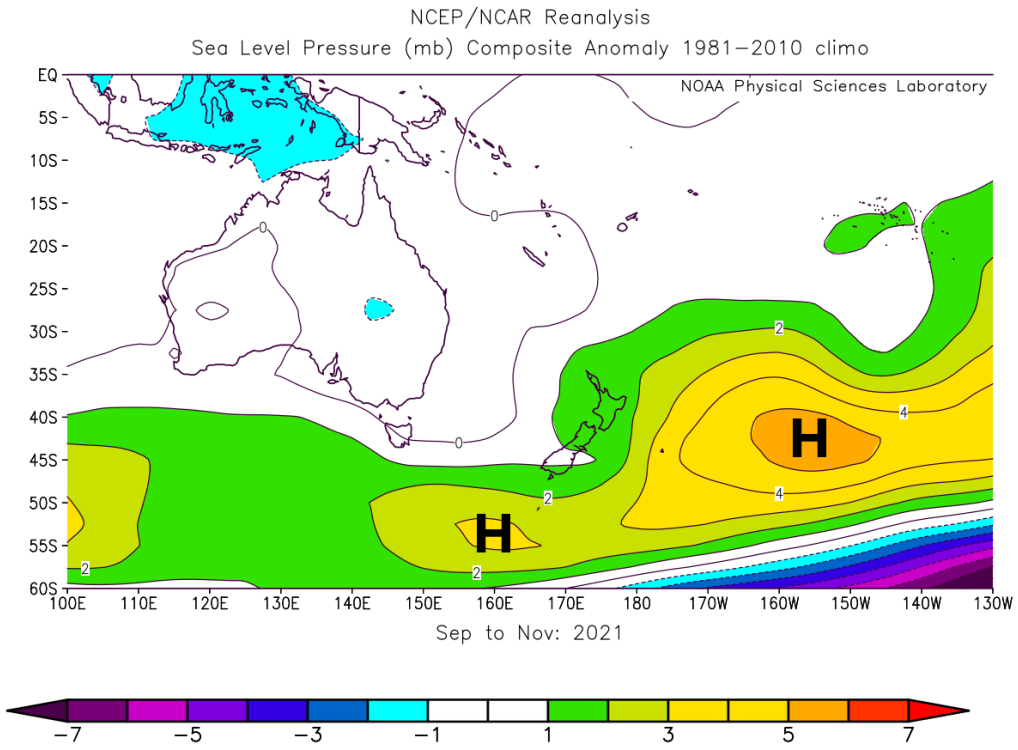


Figure 1.3: Mean sea level pressure anomaly map (hPa) for spring 2021. The 'H' indicates the central position of the anomalous high pressure areas south and east of New Zealand. This pattern was associated with a positive Southern Annular Mode, and a warm and moist north-easterly wind flow over New Zealand. 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 and MetService (all meteorological stations indicated by dots).

There was a fairly consistent pattern of warmer than average seasonal temperatures, particularly for the night-time minima in the southern Wairarapa.

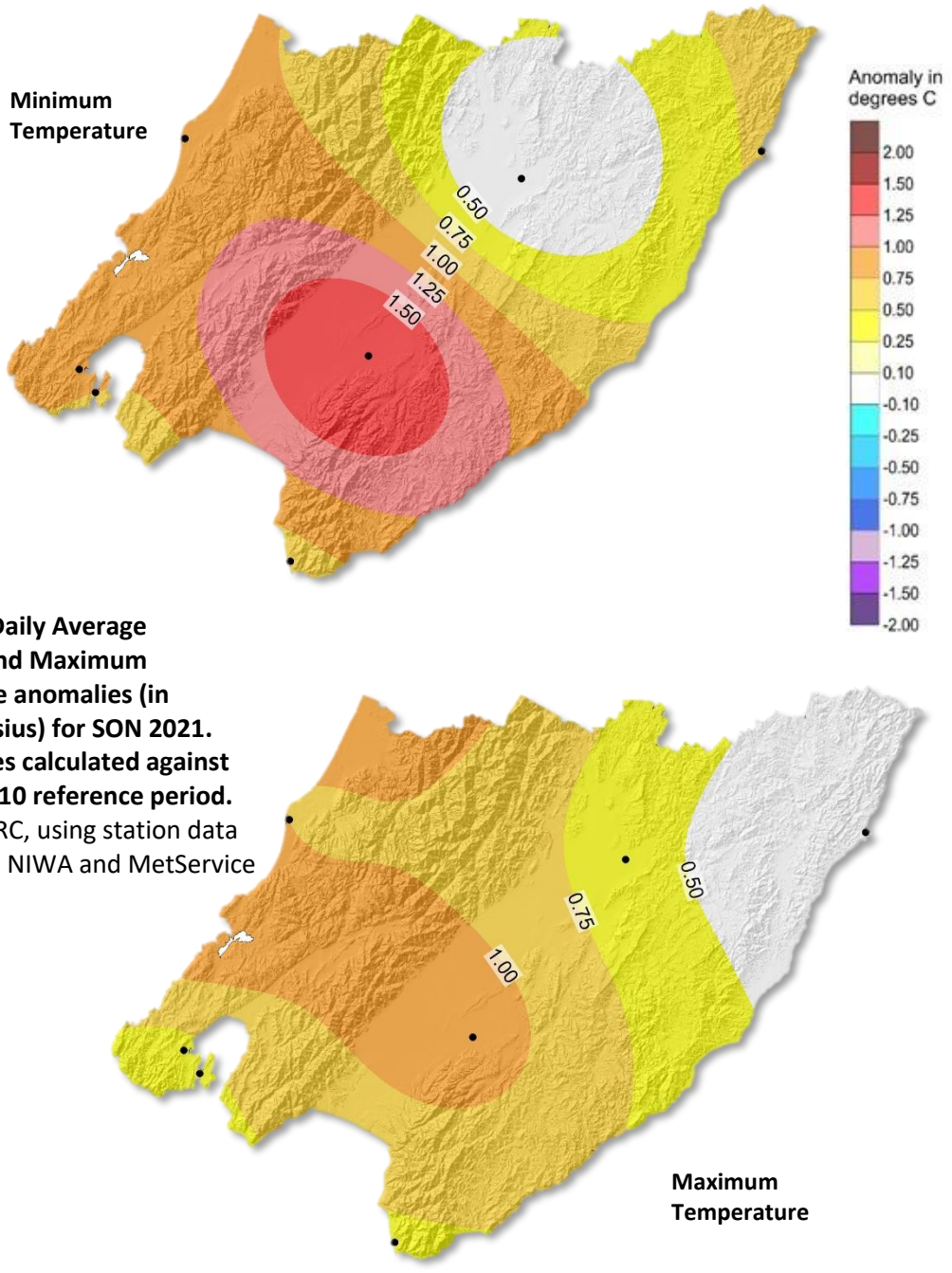


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies (in degrees Celsius) for SON 2021. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from GWRC, NIWA and MetService networks.

2.2 Regional wind

Figure 2.2 shows the mean seasonal wind anomalies (against the 1981-2010 reference period). Most of the region experienced well below average wind speeds (up to 10%), except the area between Ngawi and Martinborough.

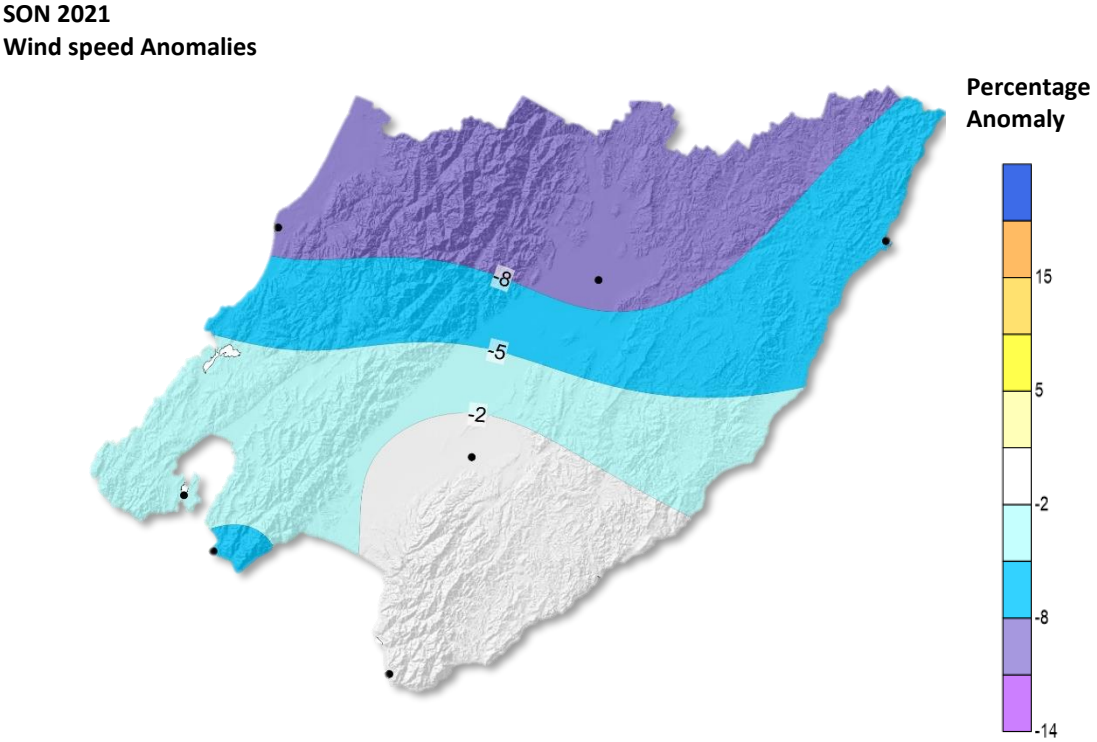


Figure 2.2: Daily mean wind anomalies (as percentage departure from the average) for SON 2021. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from NIWA and MetService

2.3 Regional soil moisture

Figure 2.3 shows that the soil moisture levels were above normal for most of the region at the beginning of summer. While this moisture uptake has been predominantly related to extreme rainfall events in December, it comes after a background of dryness in spring, and increased evaporation with warmer than average temperatures. Conditions can quickly change back to negative during dry and hot periods in the warm 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

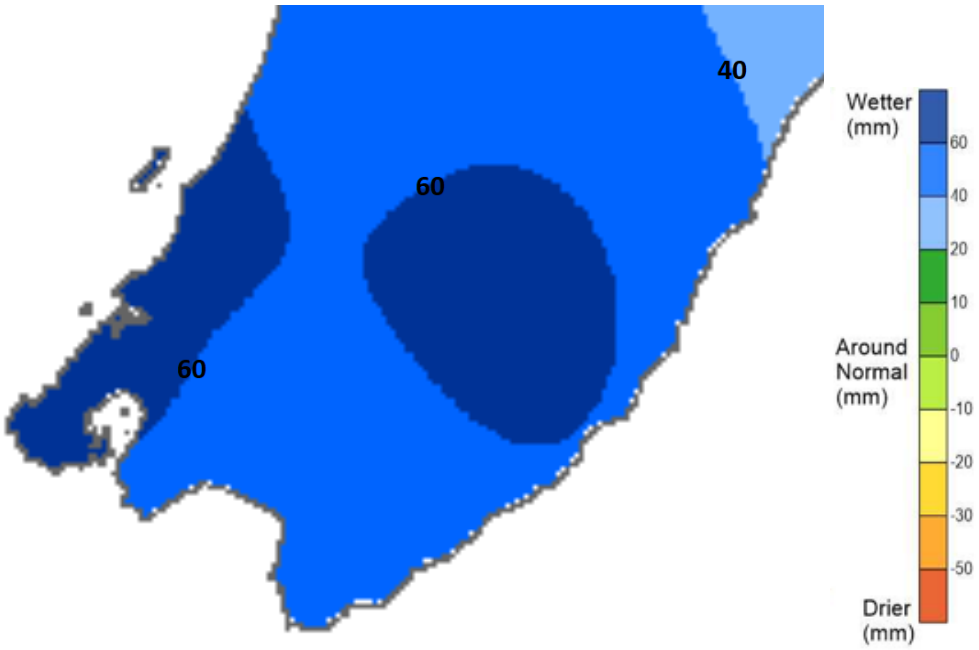


Figure 2.3: 30 Day soil moisture anomaly as at 19 December 2021. Most of the region shows above average soil moisture levels. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. *Note that this data is indirectly calculated by modelling and interpolation 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 spring rainfall expressed as a percentage of the long-term average. Rainfall during September was average to above average in eastern and southern areas and below average to the northwest. October and November were very dry across much of the region. Some parts of the Wairarapa had only 20-30% of average November rainfall.

The overall seasonal pattern for spring showed near average conditions to the west and below average conditions to the east.

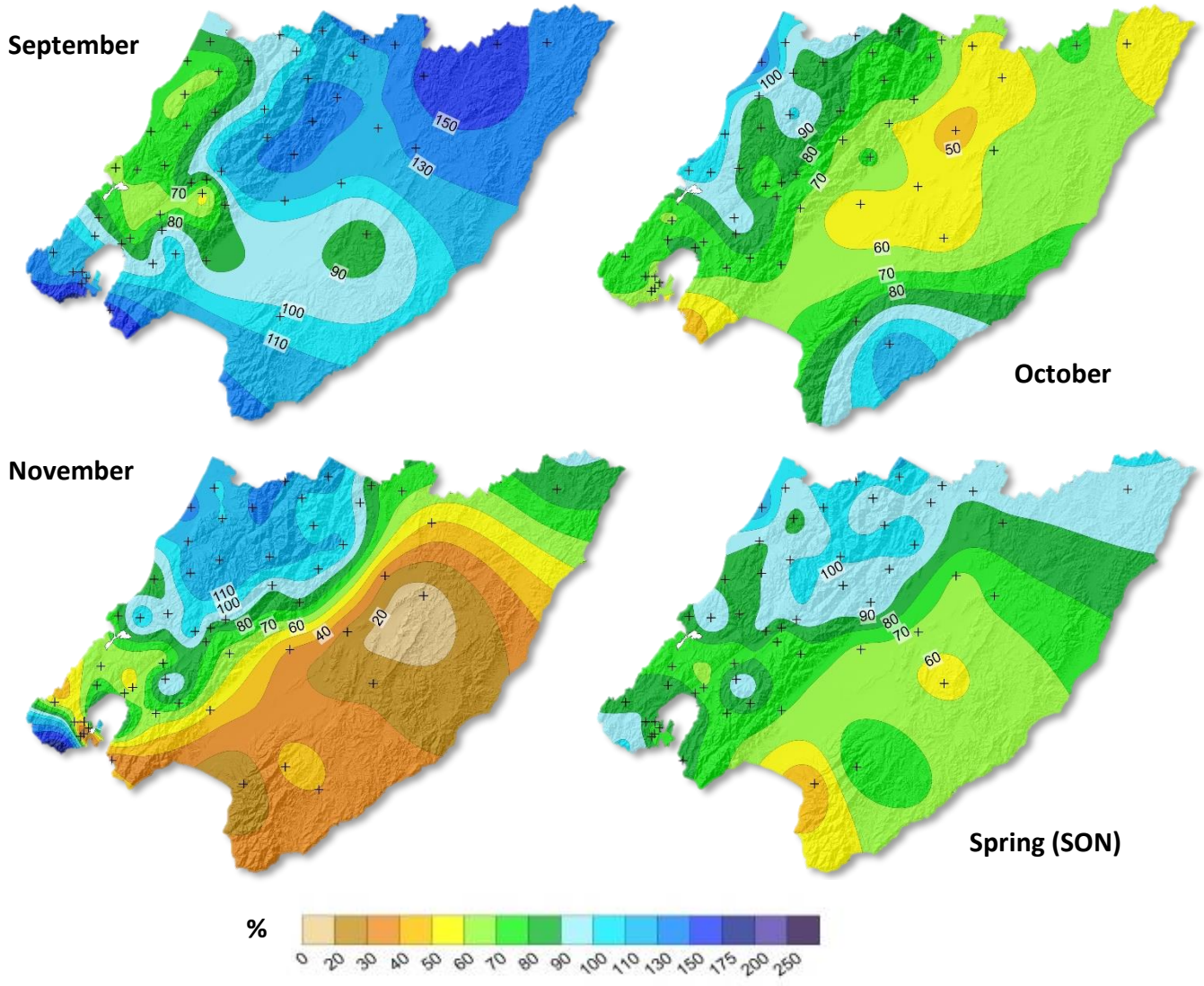


Figure 2.4: Rainfall for September (upper left), October (upper right), November (lower left) and Spring SON (lower right) 2021 as a percentage of the long-term average. Source: GWRC

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 significantly different from zero at 99% confidence level.

The climate change and variability summary for spring is:

- Statistically significant trends are seen only for temperature and wind, meaning that spring is getting warmer as a result of ongoing climate change, and less windy on average in Wellington. The long-term spring warming trend is about 0.6 degree per century for Wellington and 0.5 degree per century for Masterton. Spring is warming relatively less than any of the other seasons in the Wellington Region

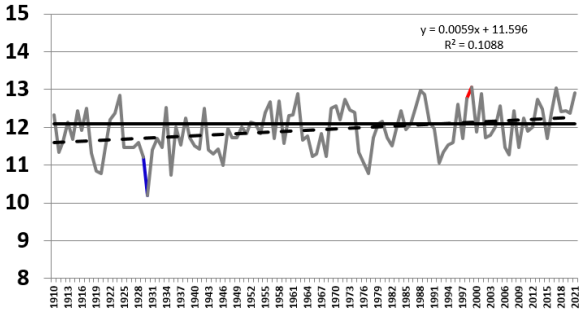
- Spring 2021 temperatures were well above average for both Wellington and the Wairarapa. It was the second warmest spring on record for Masterton, for measurements since 1913. The hottest spring on record (for Masterton) was in 1988, which was a La Niña year

- Sunshine hours were close to average, but more on the low side in the Wairarapa due to the prevailing easterly flow, with more cloud cover than in the western part of the region

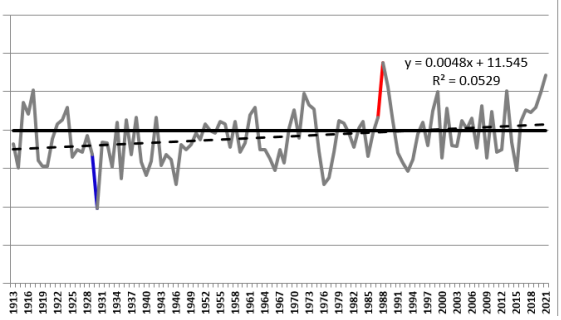
- Seasonal average wind speed was below average for Wellington, and average in the southern Wairarapa (Martinborough)

- Seasonal rainfall was well below average, but paradoxically number of rain days was well above normal, for both Wellington and the Wairarapa. Several days had high humidity levels and only minor amounts of rain with easterly flow, helping explain the interesting pattern above

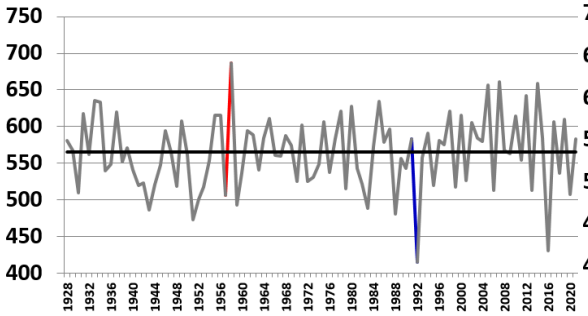
Spring Mean Temperature (deg C) - Kelburn (1910-2021)



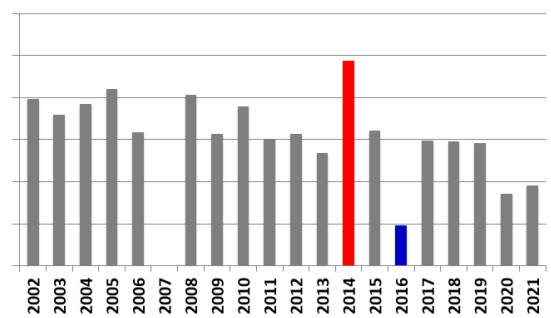
Spring Mean Temperature (deg C) - Masterton (1913-2021)



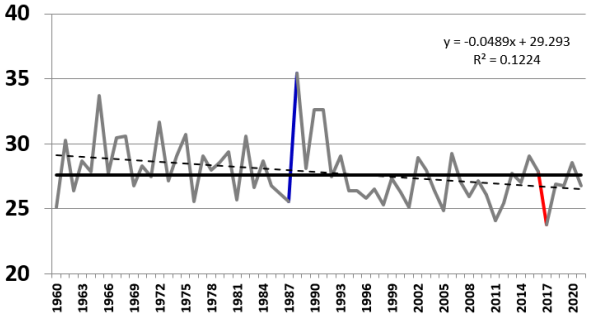
Spring Total Sunshine Hours - Kelburn (1928-2021)



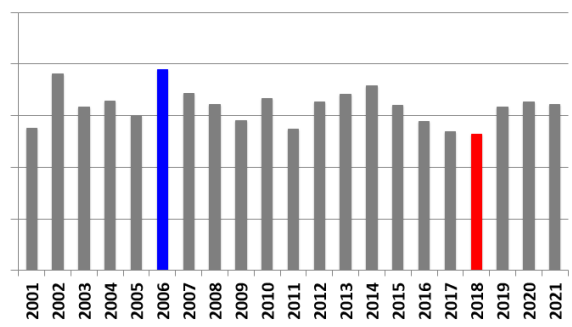
Spring Total Sunshine Hours - Martinborough (2002-2021)



Spring Mean Wind (km/h) - Wellington Airport (1960-2021)



Spring Mean Wind (km/h) - Martinborough (2001-2021)



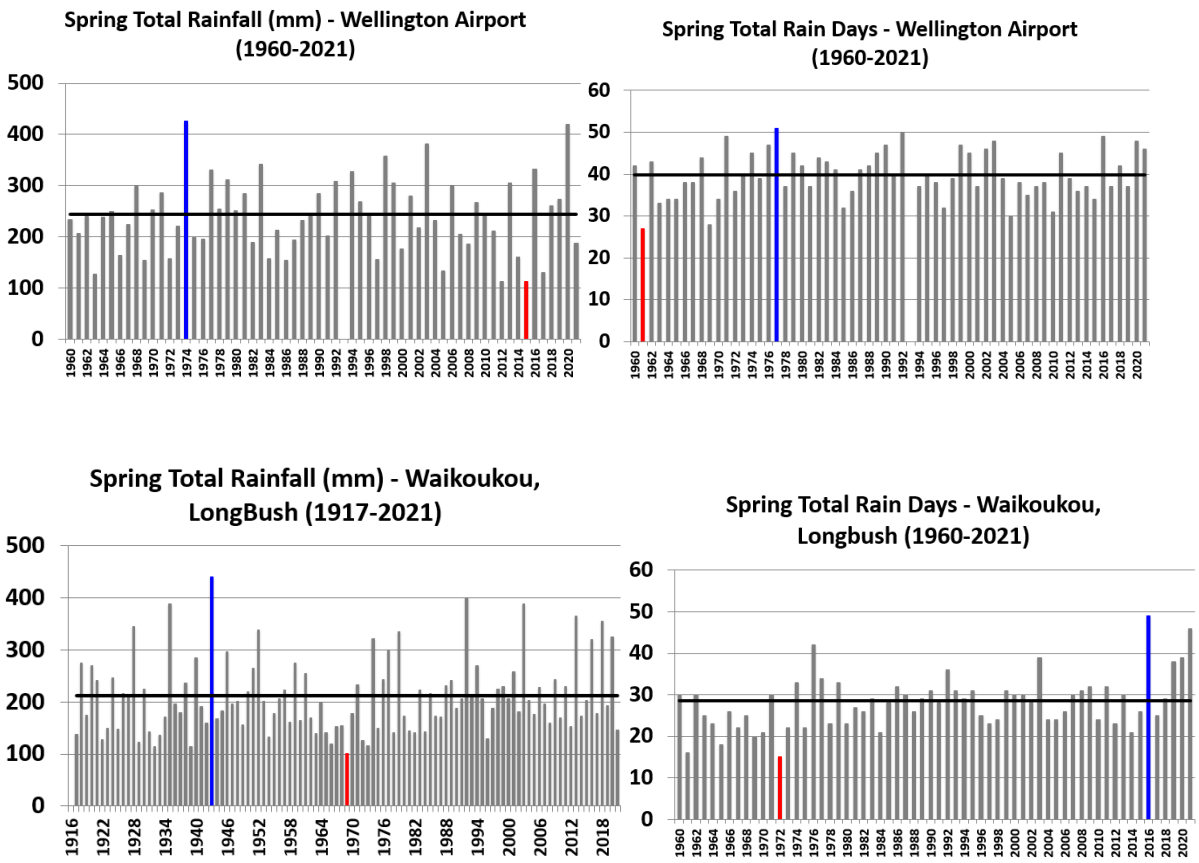


Figure 2.5: Climate change and variability graphs for spring in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs, 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.

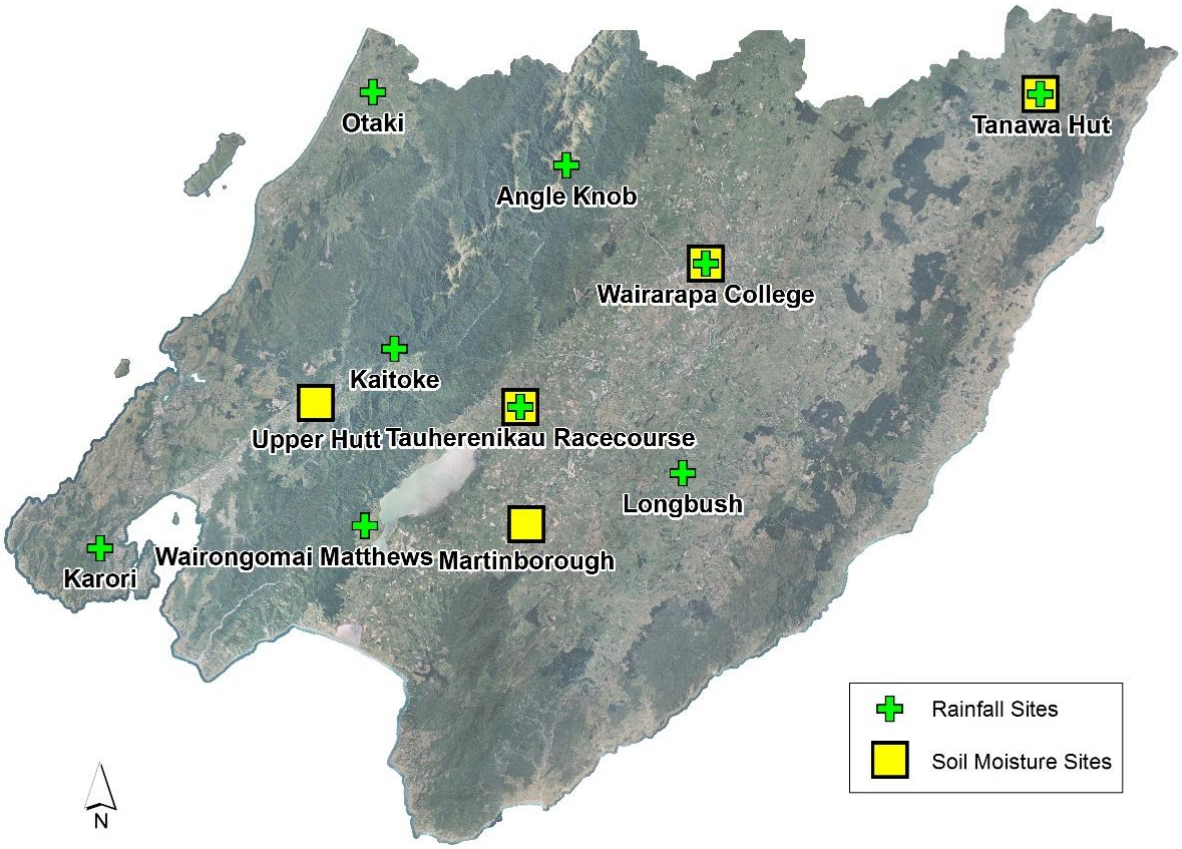


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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

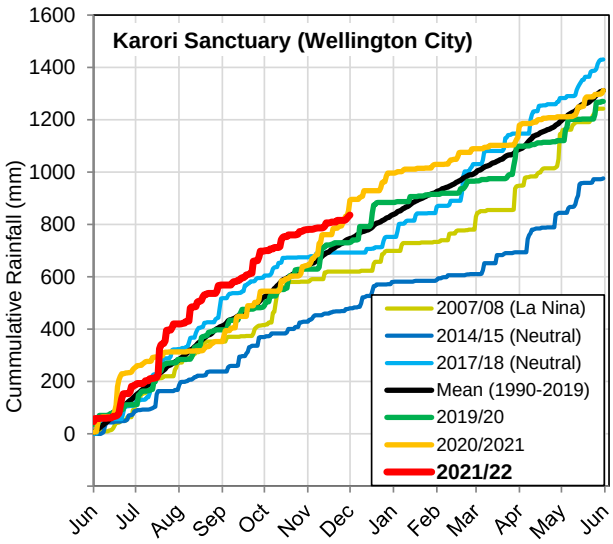
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry years have been included as well as the site average.

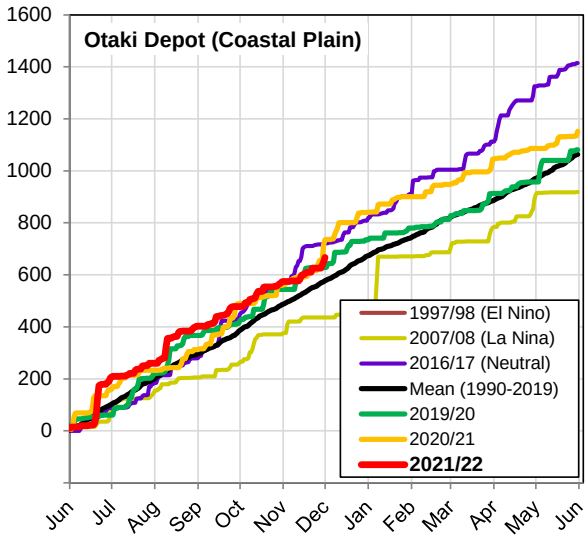
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

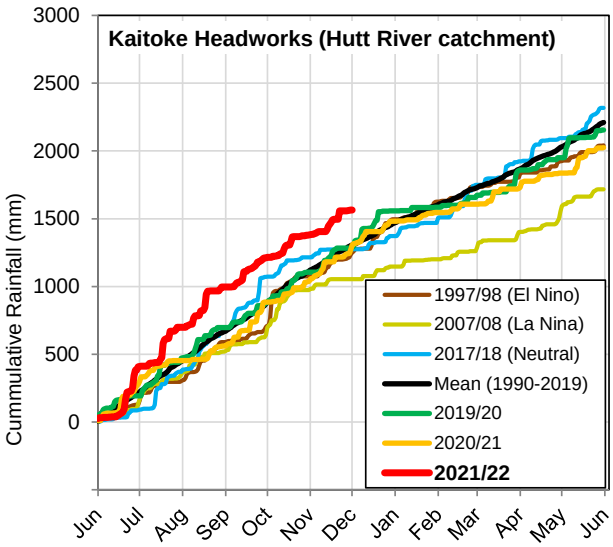
Overall, total rainfall accumulations in most areas have ended the spring season above the average line (in black), the exceptions being the eastern hill country. The very wet conditions experienced during June and July are evident as a sharp upwards movement on the rainfall accumulation graphs.

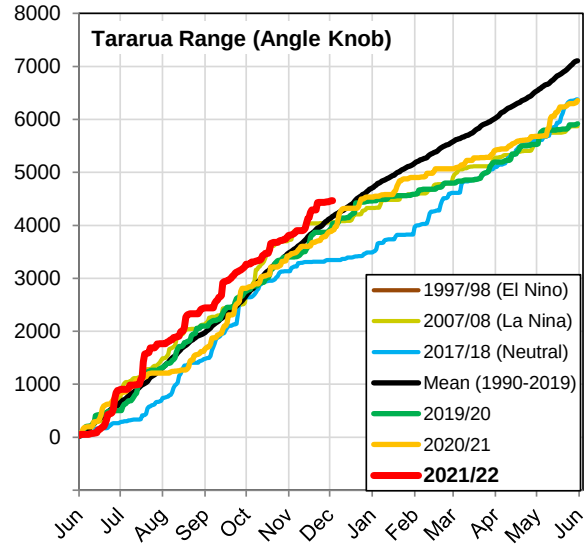
Kāpiti Coast and Southwest (Wellington City)



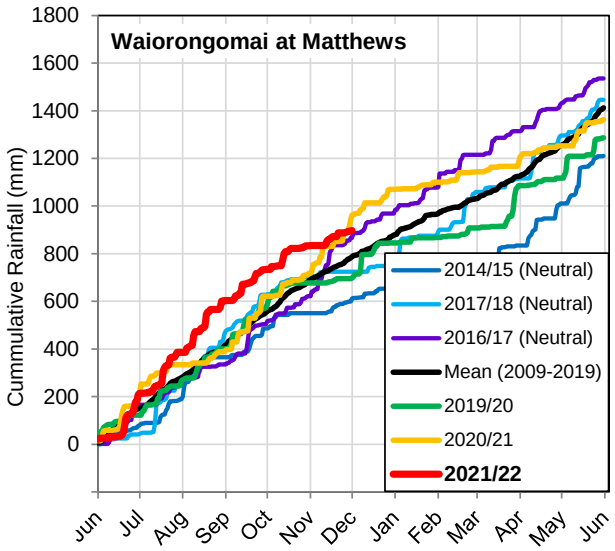


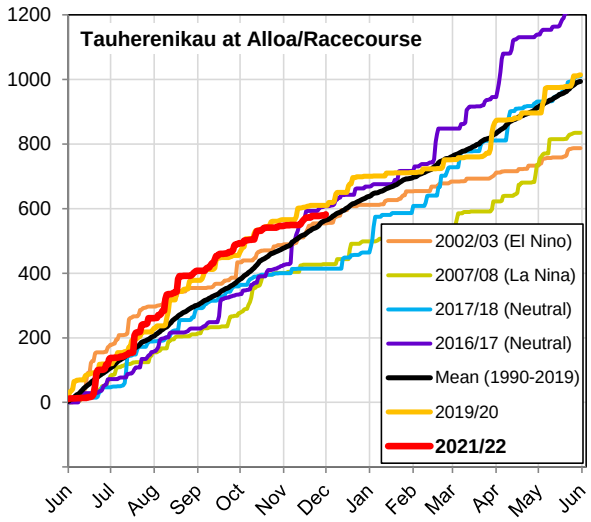
Hutt Valley and the Tararua Range

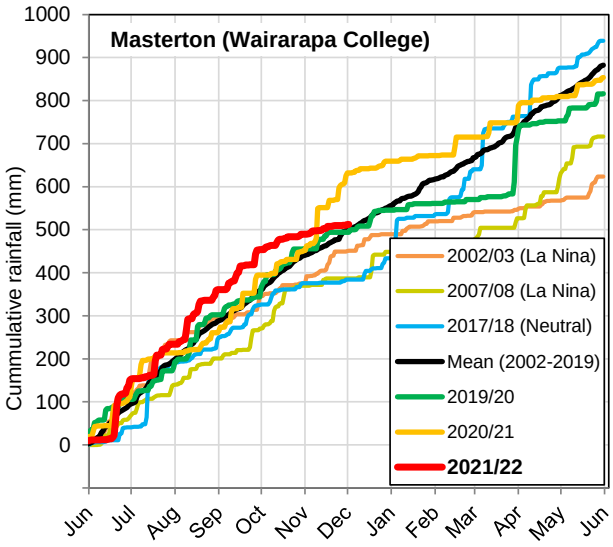


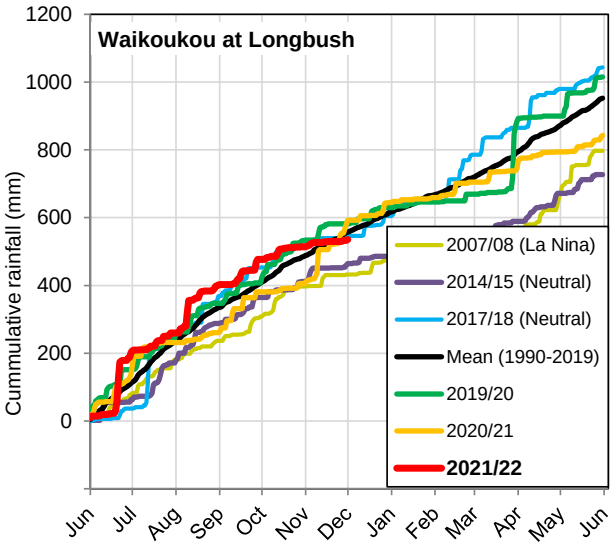


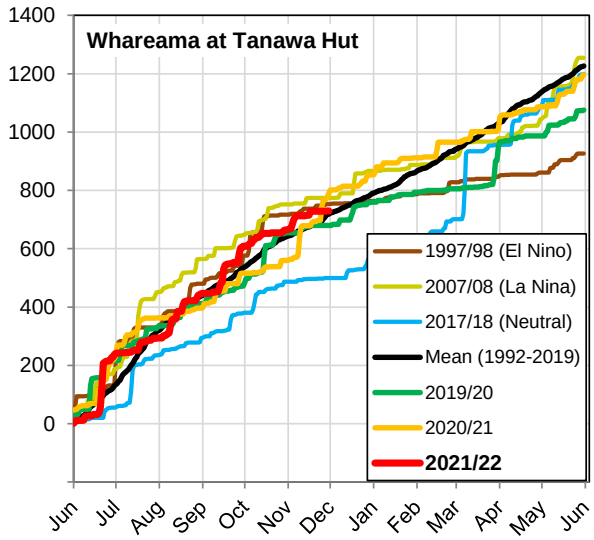
Wairarapa


Waiorongomai at Matthews
Cummulative Rainfall (mm)
1800
1600
1400
1200
1000
800
600
400
200
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
2014/15 (Neutral)
2017/18 (Neutral)
2016/17 (Neutral)
Mean (2009-2019)
2019/20
2020/21
2021/22


Tauherenikau at Alloa/Racecourse
1200
1000
800
600
400
200
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
2002/03 (El Nino)
2007/08 (La Nina)
2017/18 (Neutral)
2016/17 (Neutral)
Mean (1990-2019)
2019/20
2021/22


Masterton (Wairarapa College)
Cummulative rainfall (mm)
1000
900
800
700
600
500
400
300
200
100
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
2002/03 (La Nina)
2007/08 (La Nina)
2017/18 (Neutral)
Mean (2002-2019)
2019/20
2020/21
2021/22


Waikoukou at Longbush
Cummulative rainfall (mm)
1200
1000
800
600
400
200
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
2007/08 (La Nina)
2014/15 (Neutral)
2017/18 (Neutral)
Mean (1990-2019)
2019/20
2020/21
2021/22


Whareama at Tanawa Hut
1400
1200
1000
800
600
400
200
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
1997/98 (El Nino)
2007/08 (La Nina)
2017/18 (Neutral)
Mean (1992-2019)
2019/20
2020/21
2021/22

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

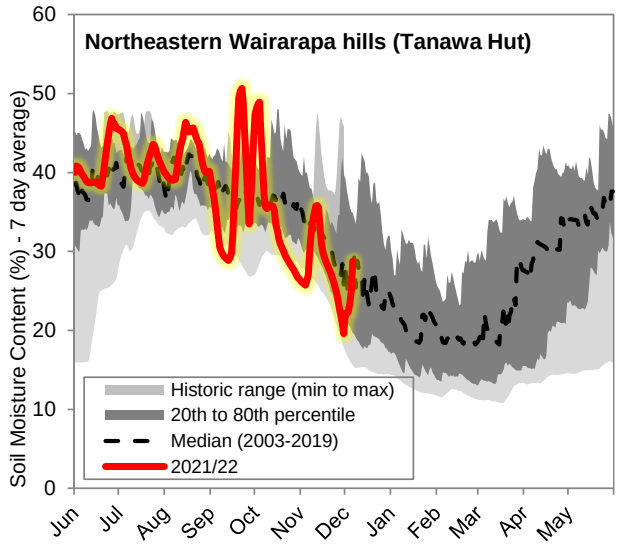
2.6.2 Soil moisture content (since 1 June 2021)

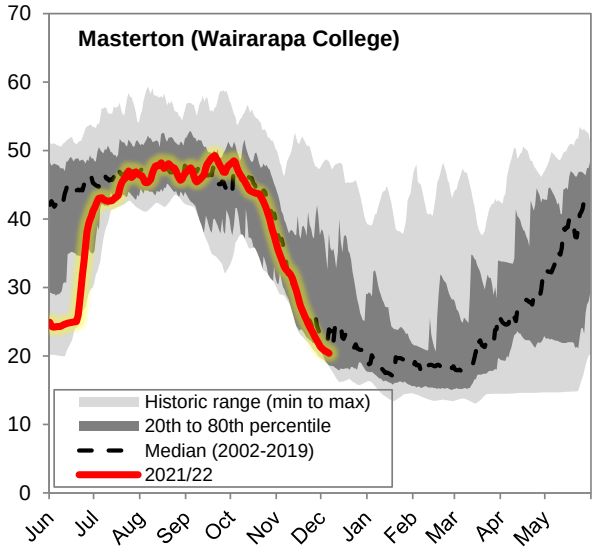
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2021. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar period in past years.

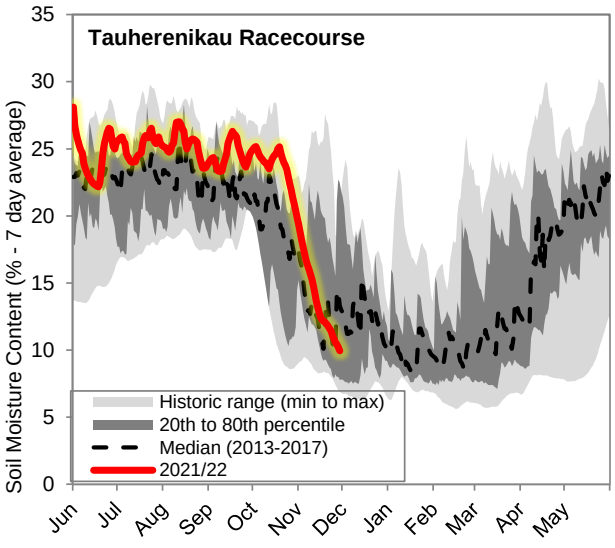
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

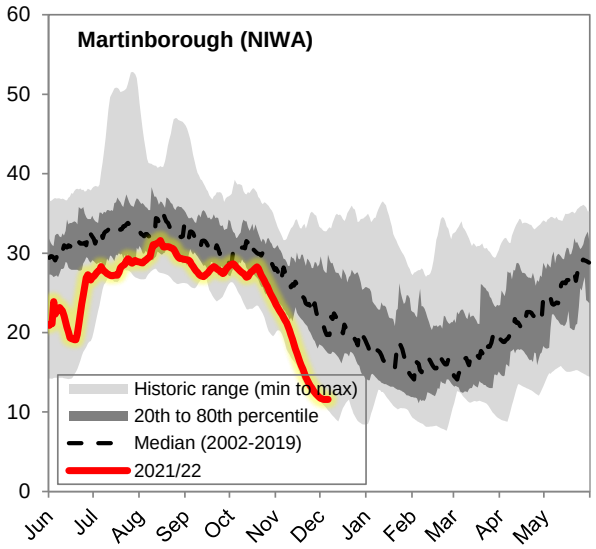
The cycle of a wet September, followed by a dry October and November is evident in the soil moisture graphs, particularly for the Tauherenikau and Martinborough monitoring sites.

Wairarapa









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 summer 2022

- A mature La Niña is expected to combine with a positive Southern Annular Mode, to create favourable conditions for humid north-easterly flows;
- Sea Surface temperatures are expected to remain at the marine heat wave threshold for extended periods around New Zealand;
- A variable rainfall pattern, with long dry periods (albeit humid) interrupted by heavy downpours. Easterly events likely;
- High chance of New Zealand being affected by at least one ex-tropical storm;
- Much warmer than average, with chances of a near record hot summer.

Whaitua*	Variables	Climate outlook for summer 2022
Wellington Harbour & Hutt Valley	**Temperature:**	Well above average.
	Rainfall:	About average, with low confidence for the total seasonal accumulation. High chance of extreme rainfall events.
Te Awarua-o-Porirua	**Temperature:**	Well above average.
	Rainfall:	About average, with low confidence for the total seasonal accumulation. High chance of extreme rainfall events.
Kāpiti Coast	**Temperature:**	Well above average.
	Rainfall:	About average, with low confidence for the total seasonal accumulation. High chance of extreme rainfall events.
Ruamāhanga	**Temperature:**	Well above average.
	Rainfall:	Below average in the east, with low confidence for the total seasonal accumulation. High chance of extreme rainfall events.
Wairarapa Coast	**Temperature:**	Well above average.
	Rainfall:	Below average, with low confidence for the total seasonal accumulation. High chance of extreme rainfall events.

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

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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:** https://www.gw.govt.nz/environment/environmental-data-hub/climate-monitoring/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)**

https://www.gw.govt.nz/assets/Documents/2017/06/Climate-Change-and-Variability-report-Wlgtn-Regn-High-Res-with-Appendix.pdf

- **Main climate drivers report (Climate Modes) (NIWA 2018)**
  https://www.gw.govt.nz/assets/Documents/2021/10/GWRC-climate-modes-full-report-NIWA-3-Sep-2018-compressed.pdf

- **Climate change extremes report (NIWA 2019)**

https://www.gw.govt.nz/assets/Documents/2021/11/GWRC-NIWA-climate-extremes-FINAL3.pdf

Climate Portals

- **GWRC Climate change impacts webpage**

https://www.gw.govt.nz/environment/climate-change/impacts-on-our-region/

- **GWRC Seasonal climate hub**
  https://www.gw.govt.nz/environment/environmental-data-hub/climate-monitoring/