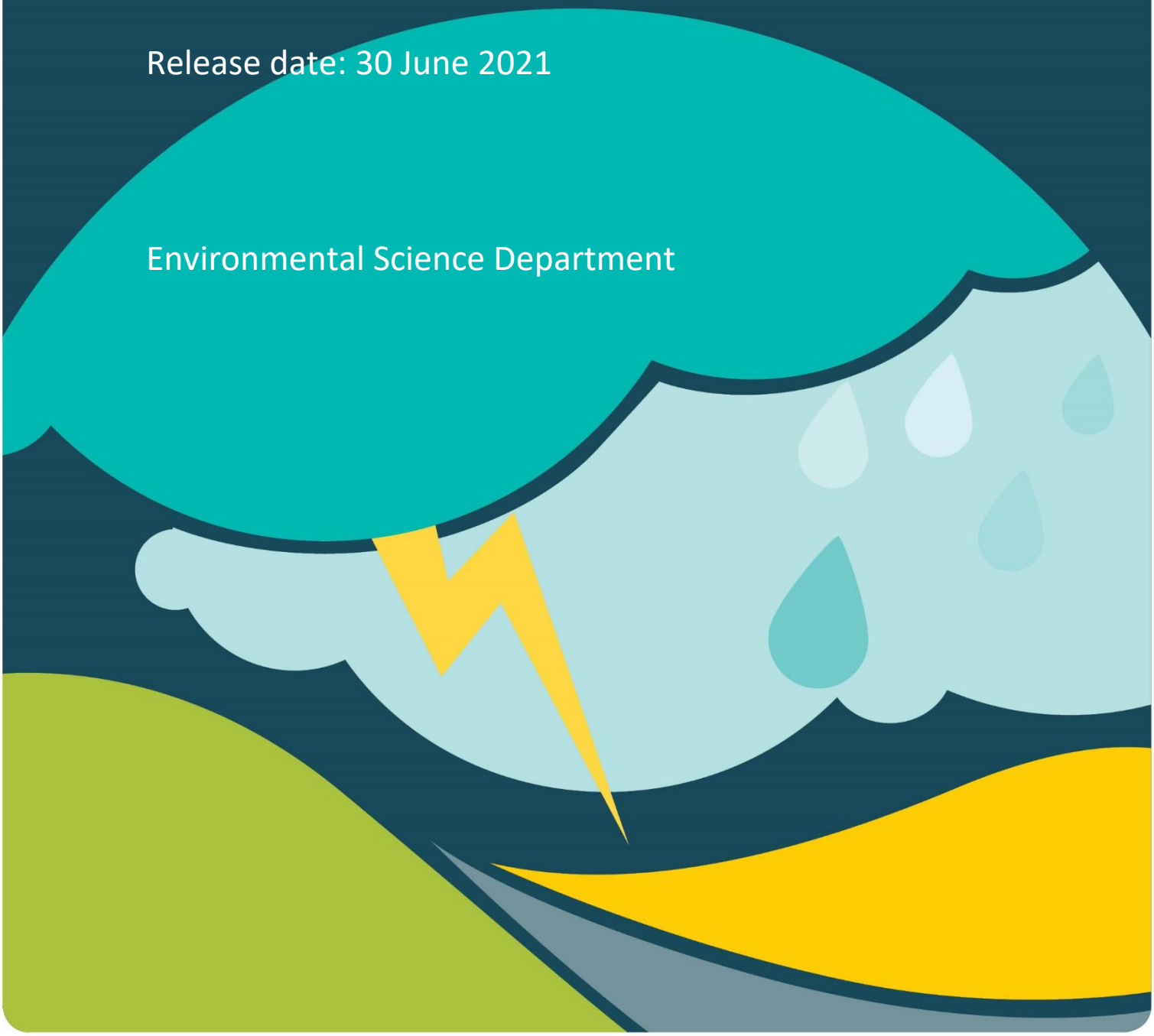
Climate and Water Resources Summary for the Wellington Region

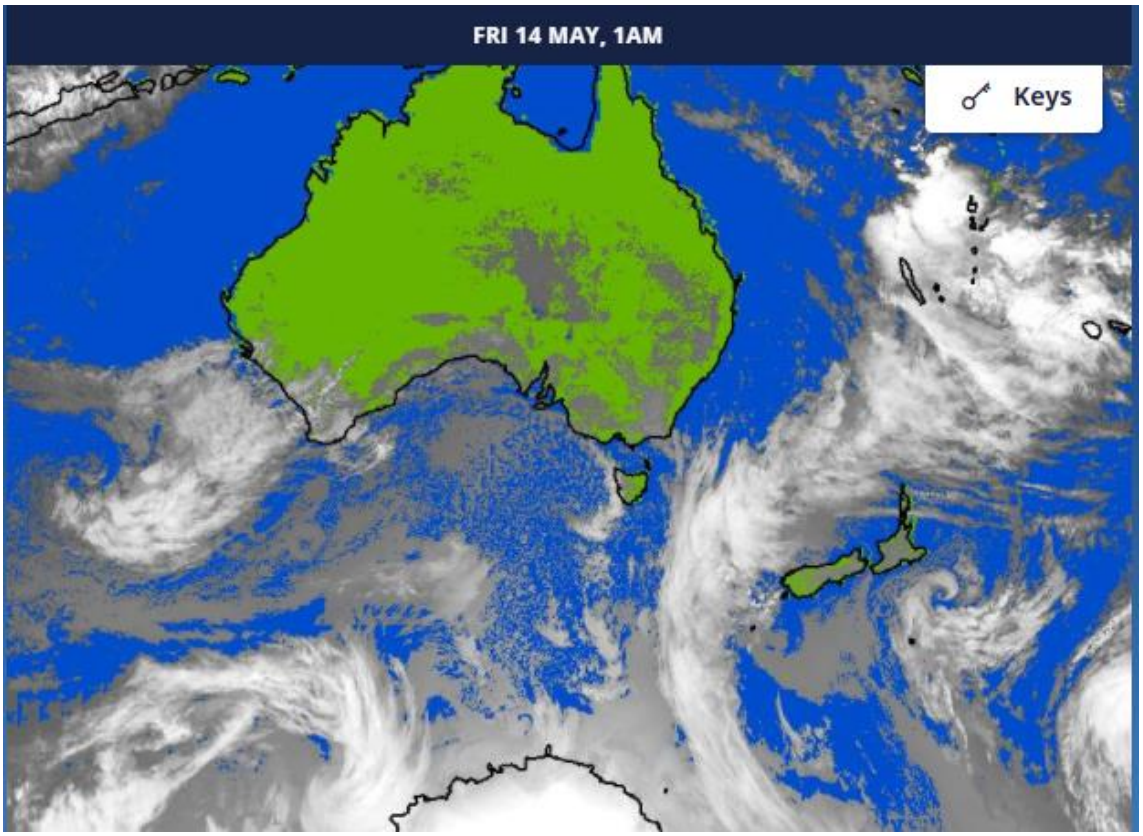
Autumn 2021 summary

Winter 2021 outlook

Release date: 30 June 2021

Environmental Science Department





In May, early frosts started to be felt in the Wellington Region. On the 14th, most of New Zealand was cloud free in the morning, and a small extratropical cyclone to the east of the North Island pushed considerably colder air inland. In Masterton, the temperature dropped to near minus three degrees just after half past three in the morning, before cloud cover pushed by the eastern cyclone prevented further heat loss. The temperature also dropped below zero in Upper Hutt, and to about three degrees in Kelburn. Credits to MetService for the satellite image shown.

Overview

Autumn 2021

Autumn 2021 saw the end of a very unusual La Niña, and continuing variable atmospheric flow oscillating between westerly fronts, strong easterly flow, and calm weather under blocking highs. Temperatures were generally between half and one degree above the seasonal average for our region, although quite variable with late warm days, near record warm nights and early frosts. Masterton showed this extreme variability well, with 26.1°C on May 10th being the second hottest May temperature on record for that location, followed by a frost with near three degrees below zero (at 1.5 metres above ground) only four days later. Rainfall was generally irregular, resulting in normal or above average seasonal totals in the west, and significantly drier than average in the eastern Wairarapa. April in particular was exceptionally dry, with only 15mm rainfall recorded in Masterton, this being the third lowest (for April) since measurements began in 1926. The region was generally about 10% less windy than average for the seasonal average, but some notable extreme gusts around 150 km/h were the third highest on record both in April and May.

Climate drivers

La Niña has ended, but the region is still experiencing frequent incursion of easterly flows and blocking anticyclones. The Southern Annular Mode (SAM) has been predominantly positive for most of the year, and the Indian Ocean Dipole is borderline between neutral and negative. Most climate models are predicting near neutral conditions for most climate drivers to continue. However, the Sea Surface Temperatures (SSTs) around New Zealand have been warmer than average and are expected to remain warmer for most of the winter season, depending on whether the westerly fronts are able to disrupt the relatively stable (warm) oceanic layer near the surface.

Climate outlook for winter 2021

Based on the pattern above, the climate outlook is for continuing warmer than average temperatures, especially during the beginning of the season when we could have quite mild days. Rainfall is expected to continue to be normal or above average in the west, and below average in the Wairarapa. However, in light of the warm SSTs to the east of New Zealand, there is a higher than usual chance of heavy (easterly) rainfall events. These events could substantially change the seasonal totals, depending on their location and intensity.

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 neutral during winter and at least until the middle of spring. A high degree of interchange between westerly fronts and easterly, blocked flows, have characterised most of the 2020-2021 La Niña. Interestingly, such extremely variable flow has continued to affect New Zealand after ENSO returned to neutrality, with the late May Canterbury storm being a most remarkable example of an easterly blocking condition.

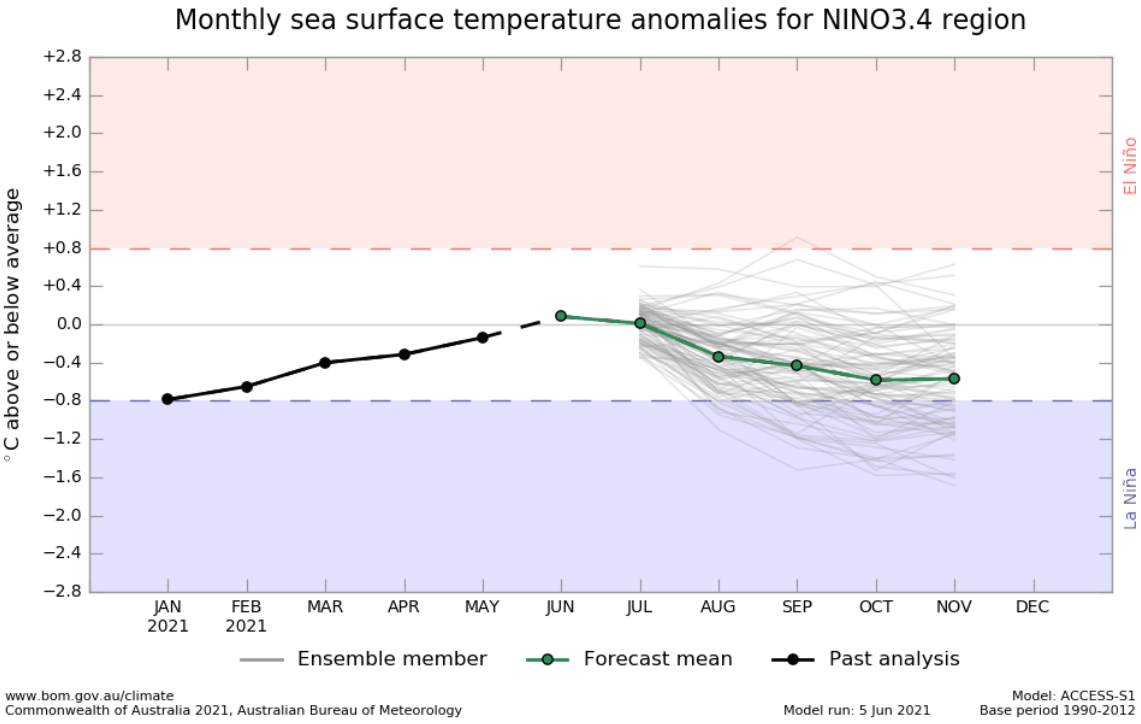


Figure 1.1: Averaged modelled projections (in green) show that ENSO is expected to remain within the neutral range over the next few months. Source: Australian Bureau of Meteorology.

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 8th June 2021.

The pattern shows a residual La Niña signature in the Equatorial Pacific, even though all ENSO indices are now back to neutral. Warmer than average SSTs are seen around and east of New Zealand. The southern Australian region shows a variable pattern, with several eddies of colder than normal water, implying a more pronounced westerly flow and transient fronts to the west. New Zealand, influenced by the

warmer waters to the east, was subjected to easterly blocking events and increasingly warmer air temperature anomalies, as the cold season arrived.

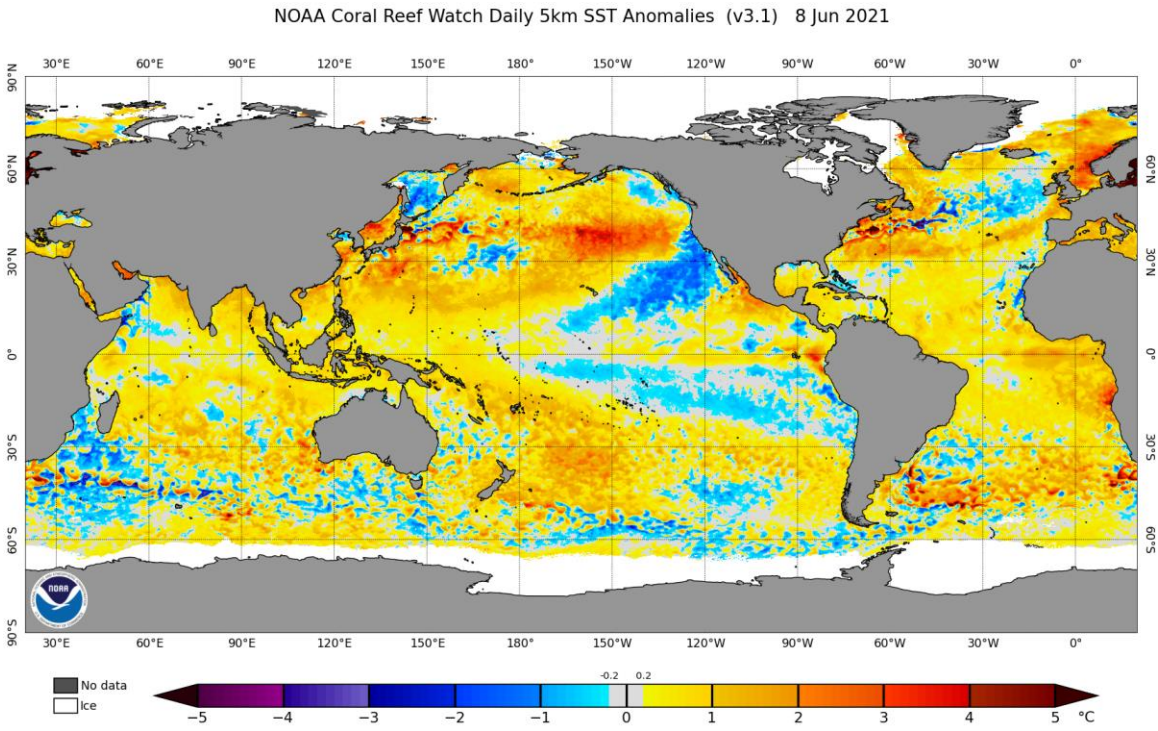


Figure 1.2: Sea Surface Temperature (SST) anomalies as of 8 June 2021. Sea ice coverage is shown in white. Water temperatures around New Zealand, and especially to the east and northeast of the country, are warmer than average. The Equatorial Pacific (ENSO) is showing a weak residual La Niña signature, with all indicators back to neutral. The sea ice extent (in white) has now stabilised to its long term average as of 8 June. 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 was predominantly positive in autumn, with warmer than average air temperatures, significantly below average rainfall in the Wairarapa, and normal to above normal rainfall in the west. Figure 1.3 shows that a blocking high to the east of New Zealand, consisting of a high to the south and a low to the north, largely dominated the seasonal flow. This pattern, together with a deeper anomalous low to the southwest, contributed to blocking the normal westerly flow. It has also created an anomalous northerly flow, which helps explain the mild conditions.

Interestingly, the atmospheric blocking to the east of New Zealand also enabled the formation of the severe Canterbury storm in the final days of May, as it blocked an extratropical cyclone just west of the North Island. The stalled cyclone pulled

moisture from the tropics, establishing a significant “atmospheric river” event (i.e., a corridor of humid flow) towards the South Island.

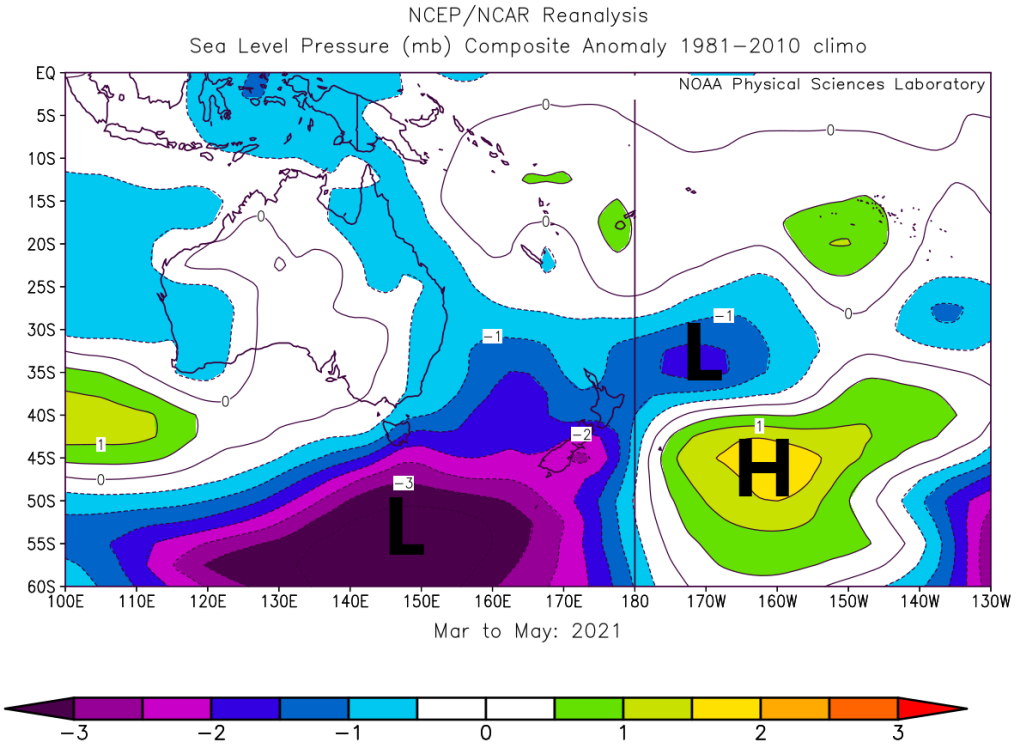


Figure 1.3: Mean sea level pressure anomaly map (hPa) for autumn 2021. The ‘H’ indicates the central position of the anomalous high pressure areas, and ‘L’ indicates the position of the anomalous low pressure. We can see an interesting pattern with a blocking high to the east of New Zealand, meaning a high to the south and a low to the north. This pattern, together with a deeper anomalous low to the southwest, has contributed to blocking the normal westerly flow at times, and pushing an anomalous northerly flow. Under this blocked pattern, the overall season has experienced substantially warmer than normal temperatures (10th warmest autumn on record for 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 crosses).

In general, we can see a pattern of warmer than average day and night time temperatures across the region. The southern Wairarapa had the highest warm daytime anomalies of the Wellington Region, enhanced by lack of rain and mostly clear skies.

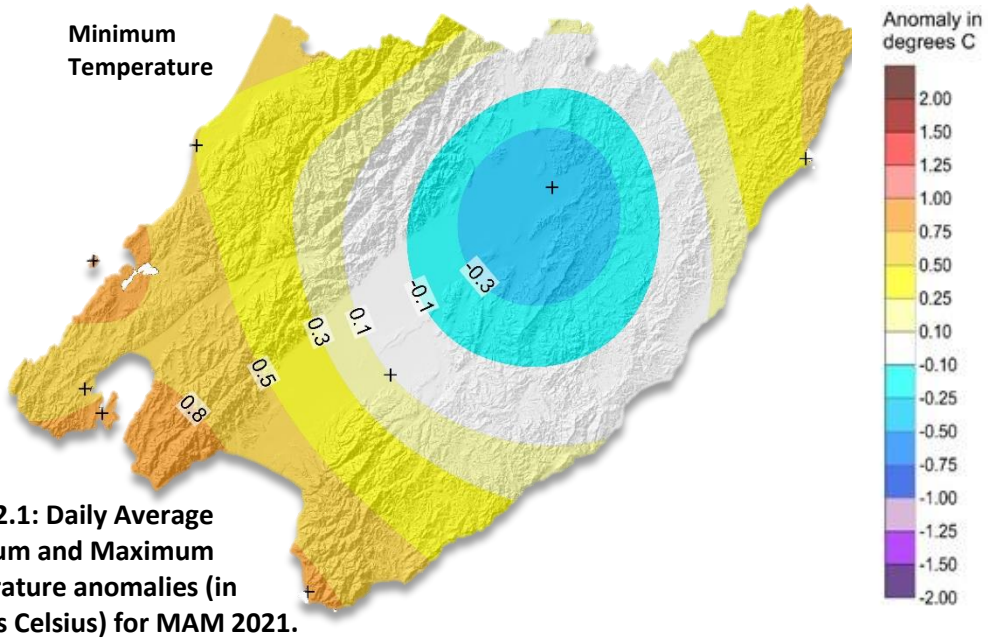
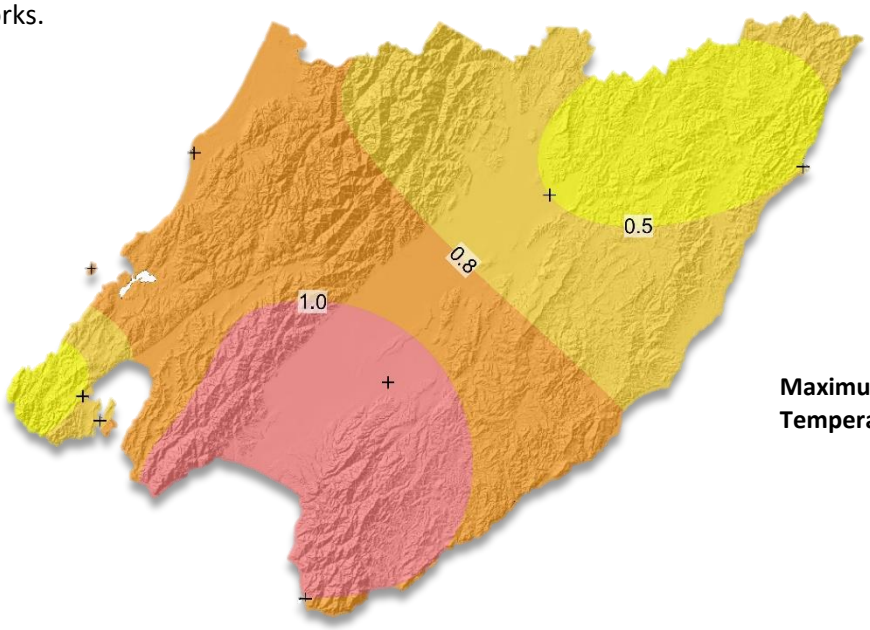


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies (in degrees Celsius) for MAM 2021. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from GWRC, NIWA and MetService networks.



2.2 Regional wind

Figure 2.2 shows the mean seasonal wind anomalies (against the 1981-2010 reference period). Virtually all of the region experienced below average wind speeds, except a small area around Cape Palliser. This pattern was associated with the blocking high to the east of New Zealand shown in Figure 1.3.

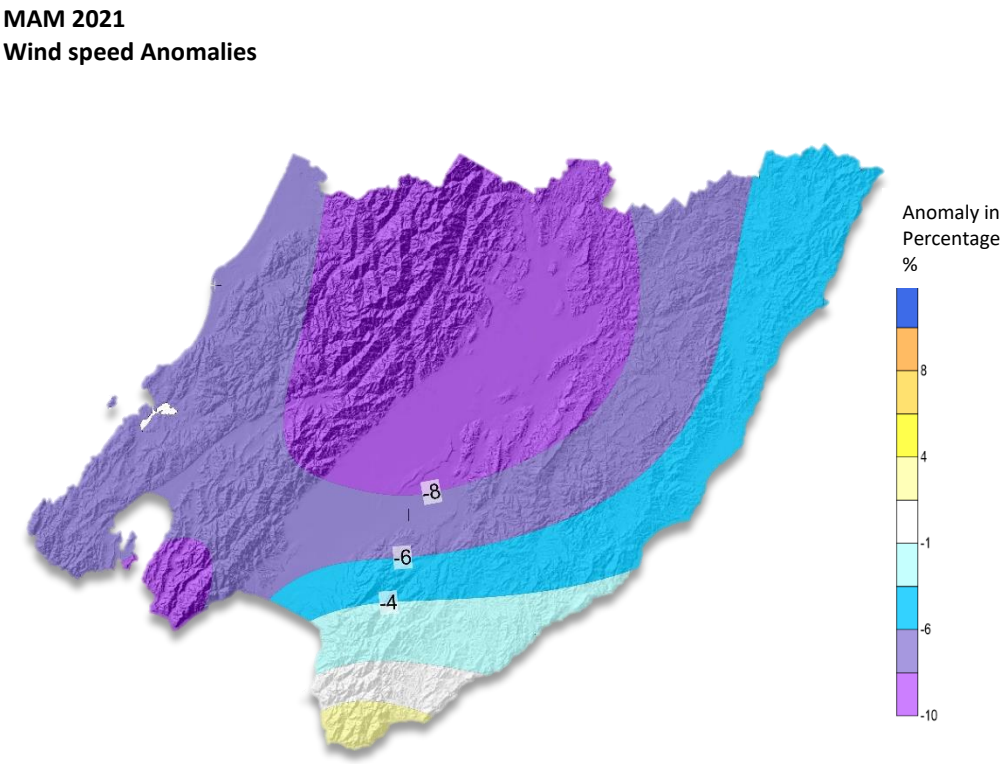


Figure 2.2: Daily mean wind anomalies (as percentage departure from the average) for MAM 2021. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from NIWA and MetService

2.3 Regional soil moisture

Figure 2.3 shows that the soil moisture levels were well below normal for most of the region at the beginning of winter. With the demise of La Niña, there was an expectation of a more normal rainfall pattern, but that is yet to be seen. As a result of a persistent blocking high to the east of the country, the Wairarapa in particular has largely missed out on heavy rainfall events.

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

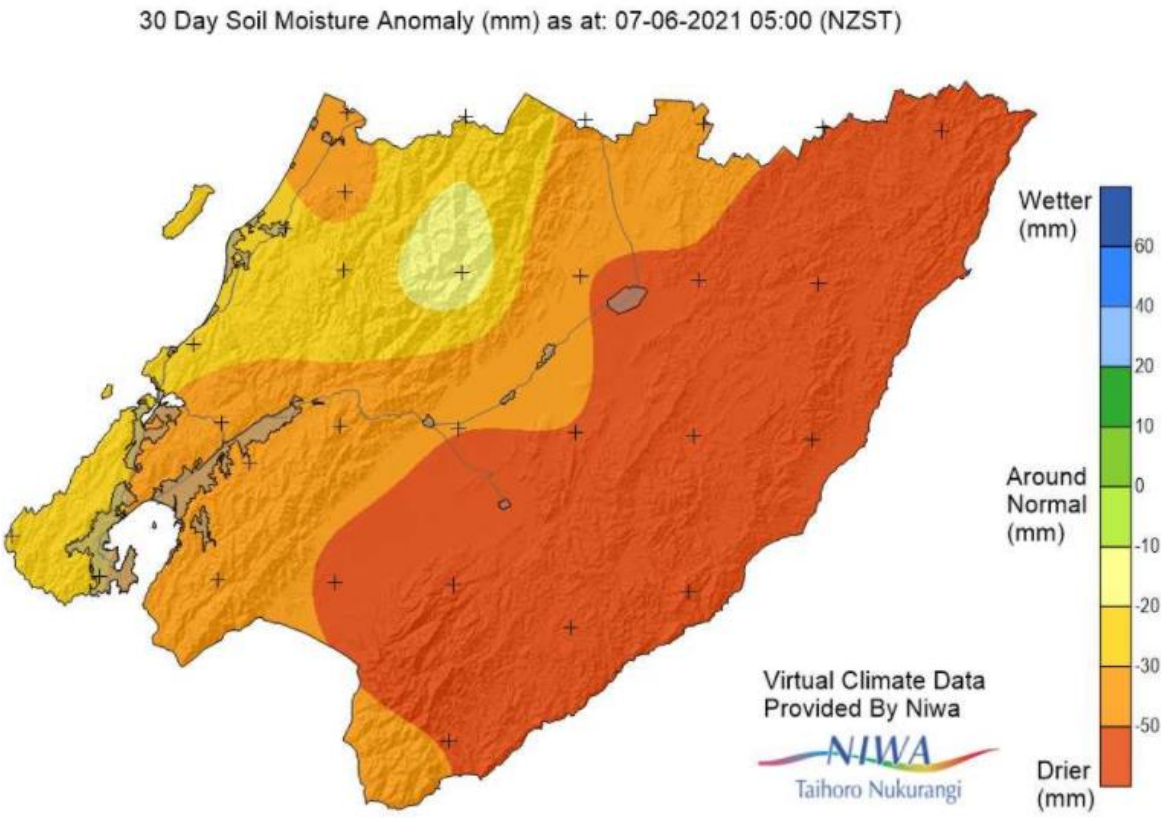


Figure 2.3: 30 Day soil moisture anomaly as at 7th June 2021. Most of the region shows well below average soil moisture levels. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. *Note that this data is indirectly calculated by modelling and interpolation 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 autumn rainfall expressed as a percentage of the long-term average. Rainfall during March was average to below average in eastern and southern areas and above average to the northwest. April was very dry across much of the region. Some parts of the Wairarapa had only 20-30% of average April rainfall.

The overall seasonal pattern for autumn showed near average conditions to the west and below average conditions to the east (60-80% of average across much of the Wairarapa).

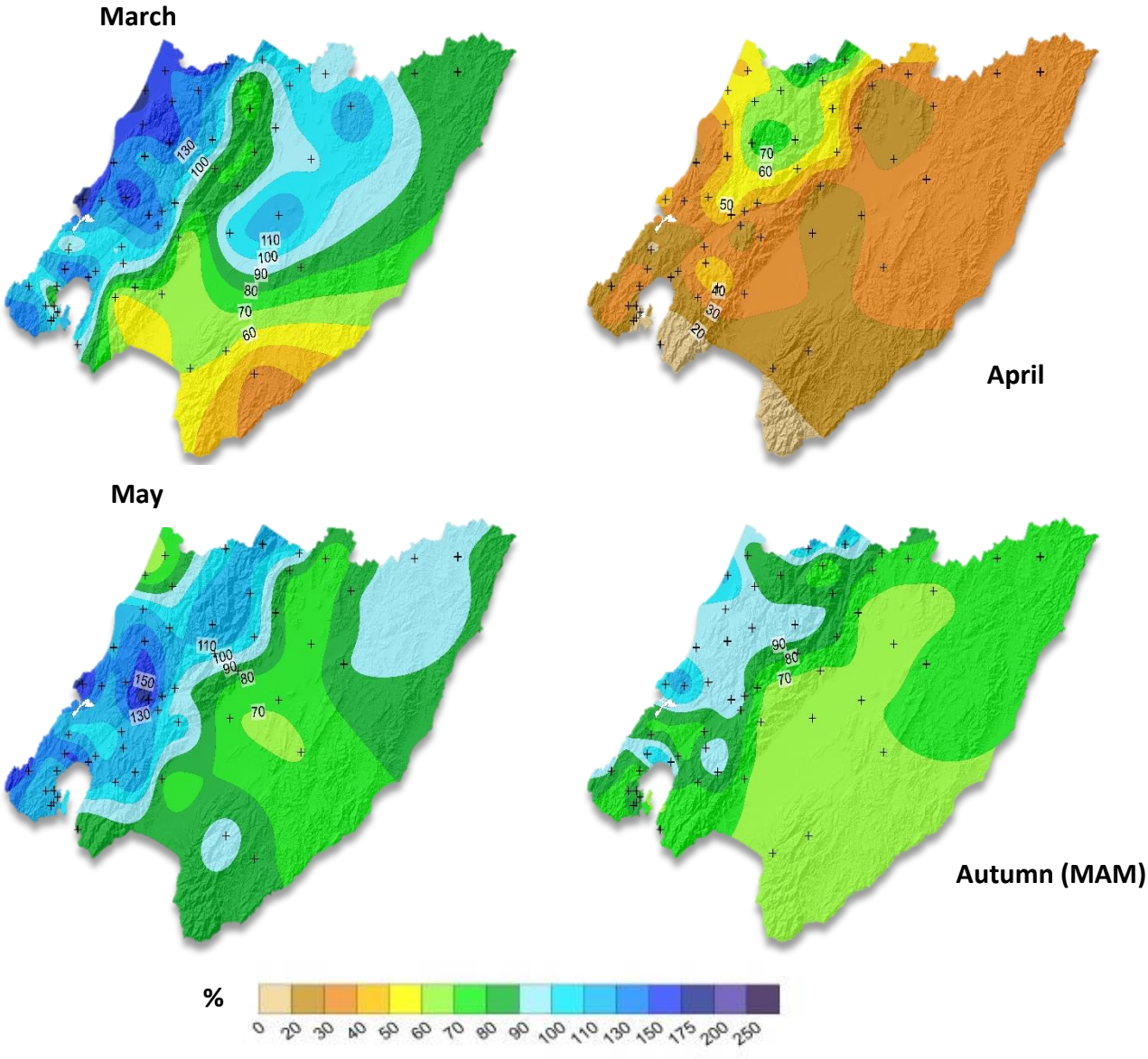


Figure 2.4: Rainfall for March (upper left), April (upper right), May (lower left) and Autumn (lower right) 2020 as a percentage of the long-term average. Source: GWRC

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.

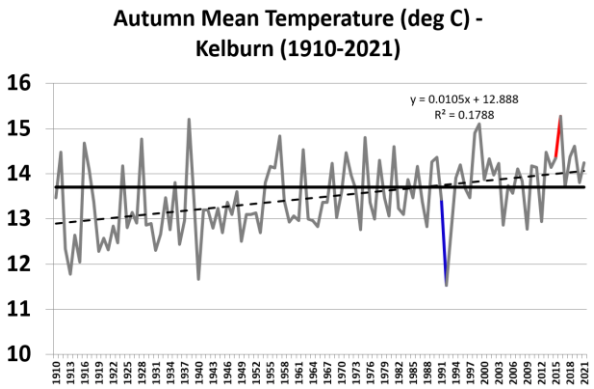
The red and blue bars show the extreme years of the entire measurement period. Red indicates seasons that were warmer, drier, sunnier and less windy than average (i.e., extreme hot/dry), and blue indicates seasons that were colder, wetter, cloudier and windier than average (i.e., extreme cold/wet). The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

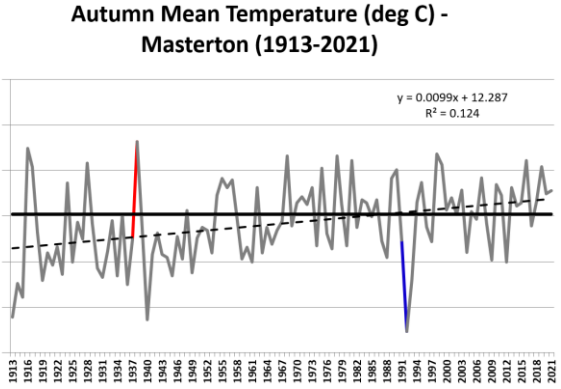
An analysis of linear trends associated with climate change is plotted onto the graph only when the trends are statistically significant from zero at 99% confidence level.

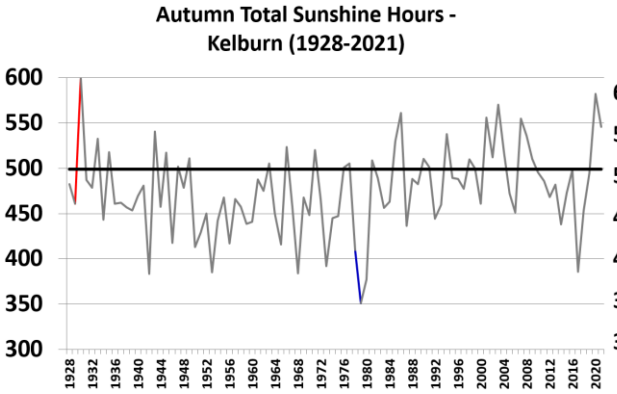
The climate change and variability summary for autumn is:

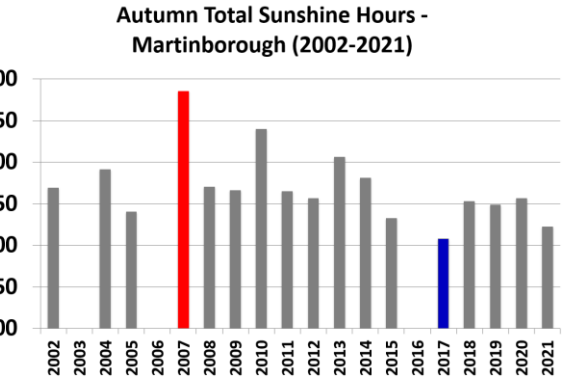
- Statistically significant trends are seen only for temperature, meaning that autumn is getting warmer as a result of ongoing climate change, with a similar trend (one degree per century) for both Wellington and the Wairarapa;
- Autumn 2021 temperatures were about half degree above average for both Wellington and the Wairarapa;
- Sunshine hours were very much above average in Wellington for the second consecutive autumn, and close to average in the Wairarapa;
- Seasonal average wind speed was below average for Wellington;
- Seasonal rainfall and rain days were well below average in the Wairarapa.

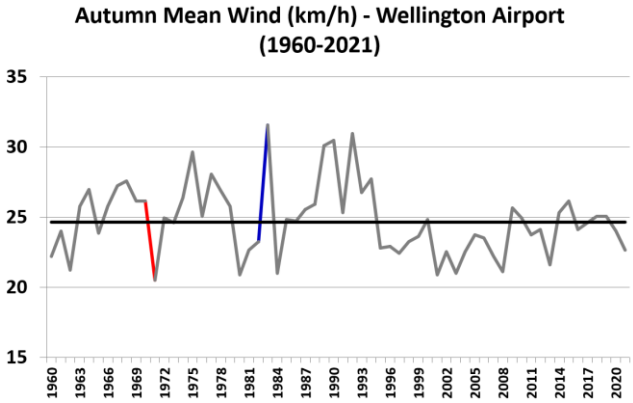
What is the data showing?

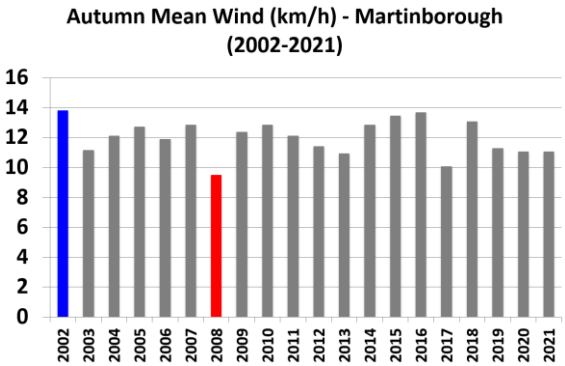












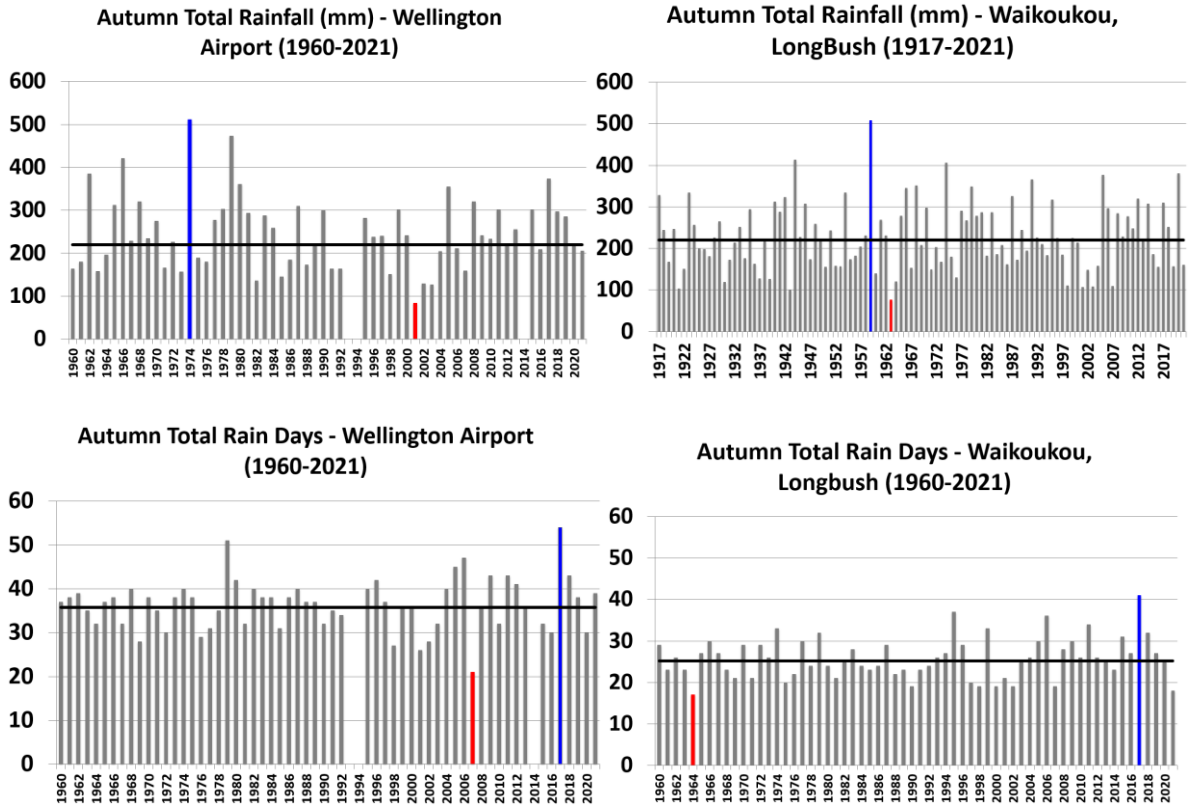


Figure 2.5: Climate change and variability graphs for Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs, the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

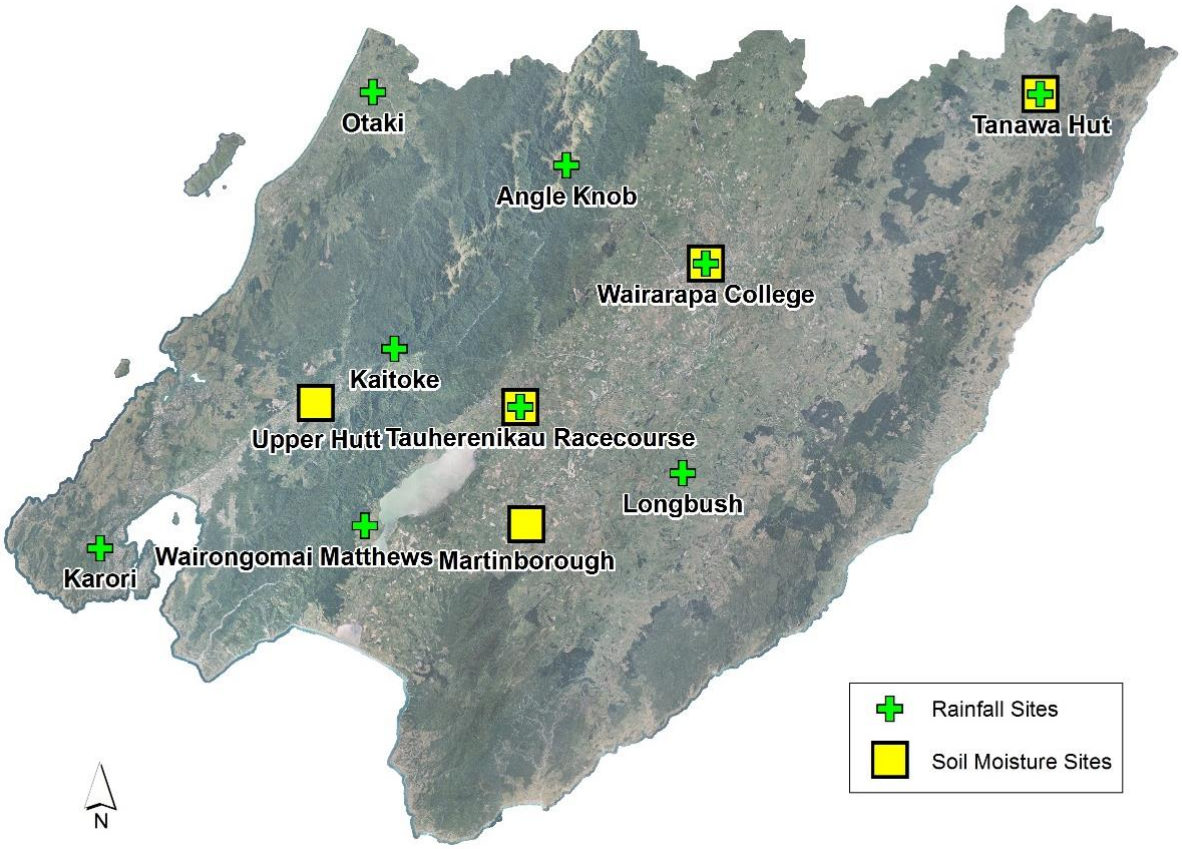


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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

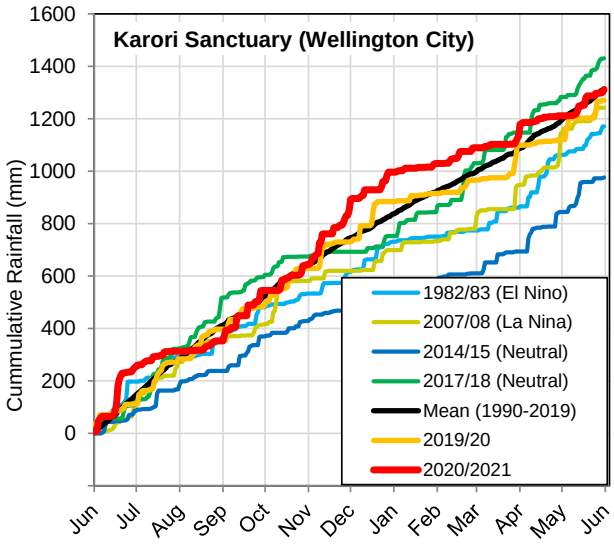
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry years have been included as well as the site average.

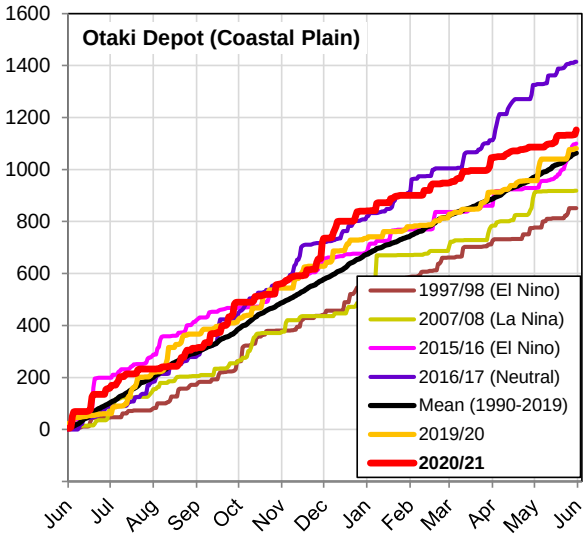
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

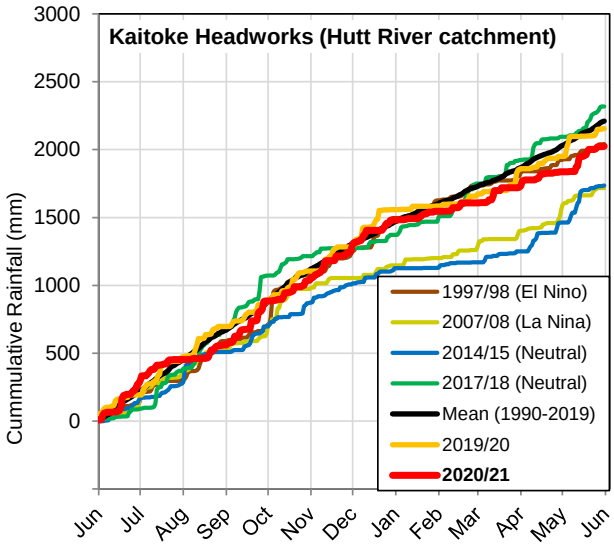
Overall, total rainfall accumulations in most areas have ended the autumn season below the average line, the exceptions being the Wellington city and the Kapiti coast. The Very dry conditions experienced during April are evident as a flattening of the graph on the rainfall accumulation graphs.

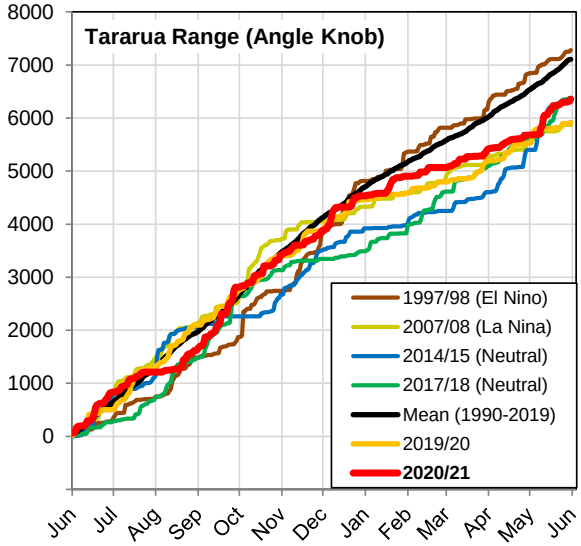
Kāpiti Coast and Southwest (Wellington City)



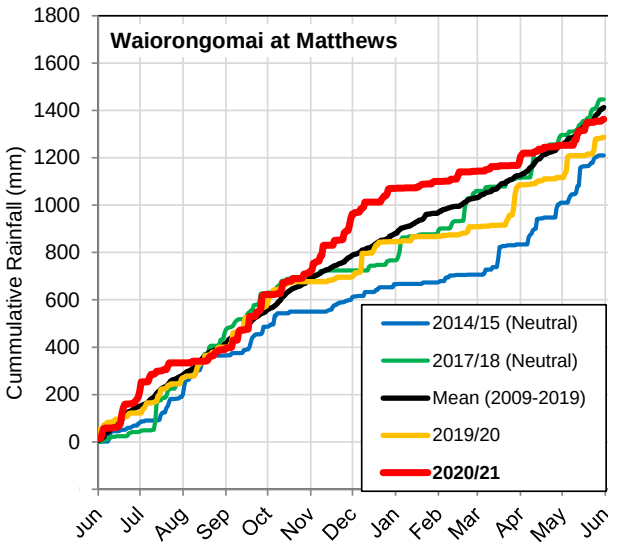


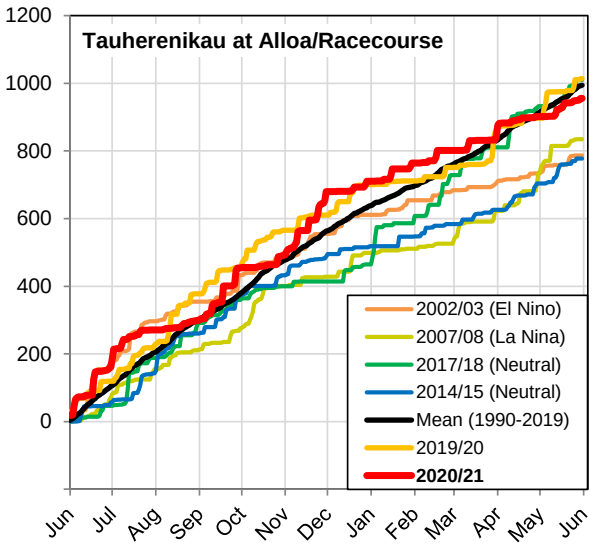
Hutt Valley and the Tararua Range

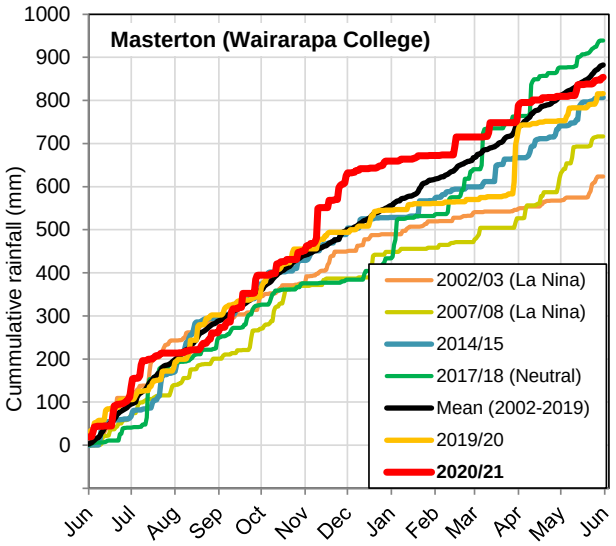


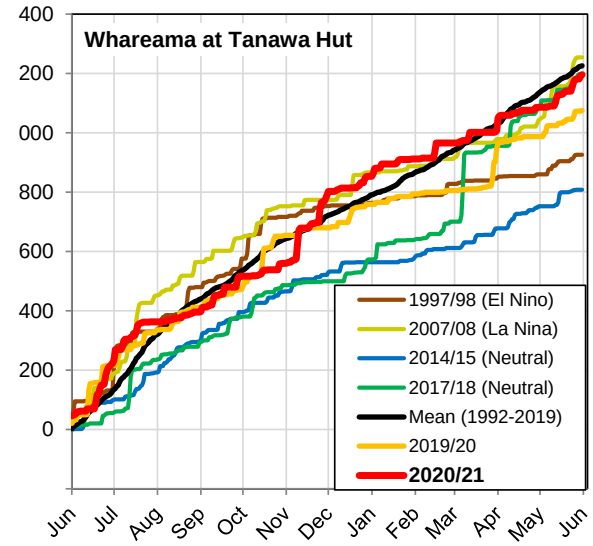


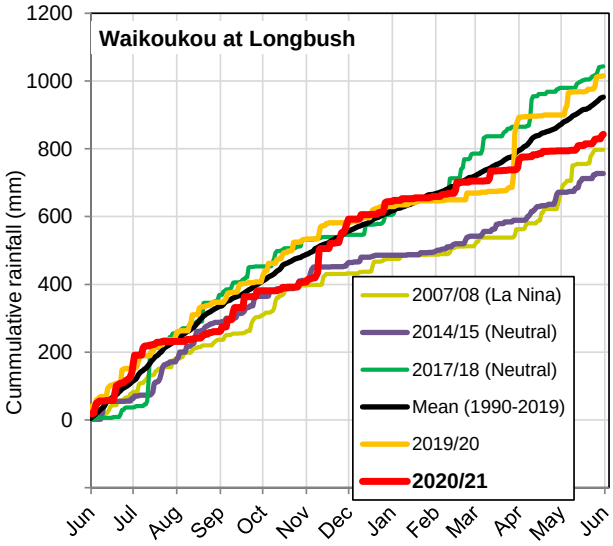
Wairarapa


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)
Mean (2009-2019)
2019/20
2020/21


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)
2014/15 (Neutral)
Mean (1990-2019)
2019/20
2020/21


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)
2014/15
2017/18 (Neutral)
Mean (2002-2019)
2019/20
2020/21


Whareama at Tanawa Hut
400
200
000
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)
2014/15 (Neutral)
2017/18 (Neutral)
Mean (1992-2019)
2019/20
2020/21



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

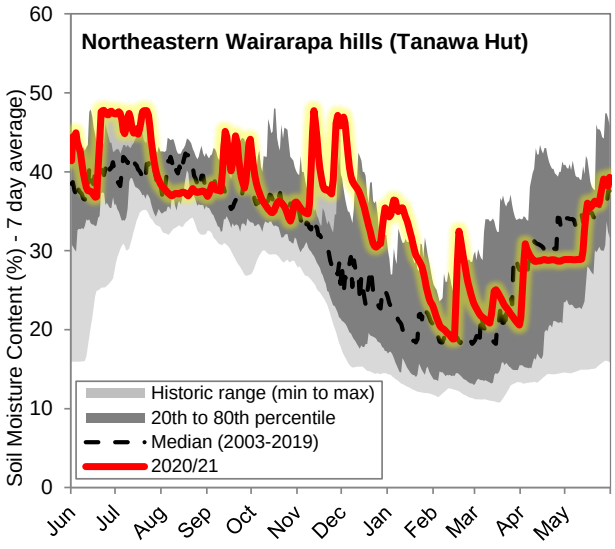
2.6.2 Soil moisture content (since 1 June 2020)

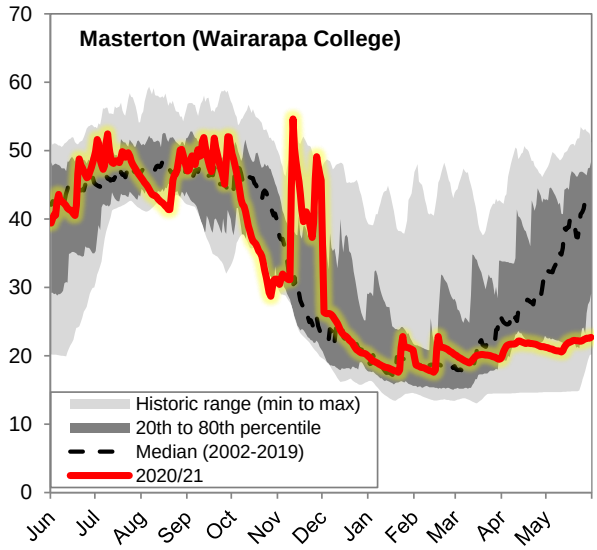
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2020. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar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

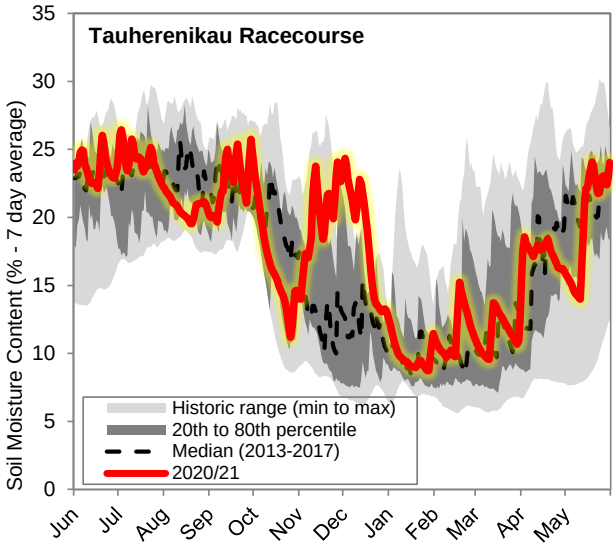
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

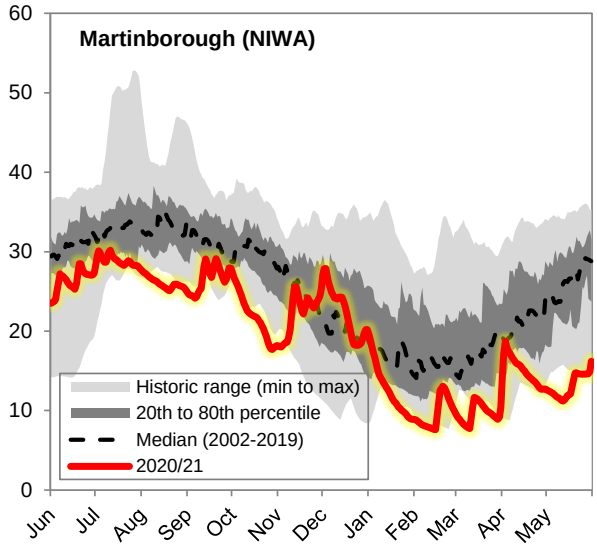
A dry April and May is evident in the soil moisture graphs, particularly for the Masterton and Martinborough monitoring sites, where soils were the driest on record for the time of year (records going back to 2002).

Wairarapa

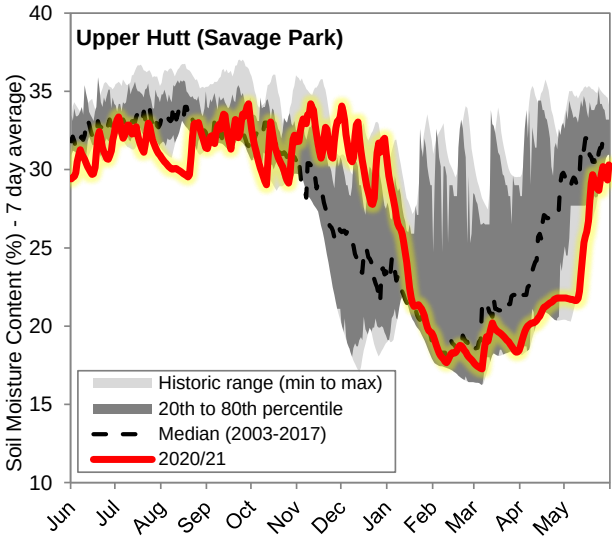

Northeastern Wairarapa hills (Tanawa Hut)
Soil Moisture Content (%) - 7 day average)
0
10
20
30
40
50
60
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Historic range (min to max)
20th to 80th percentile
Median (2003-2019)
2020/21


Masterton (Wairarapa College)
0
10
20
30
40
50
60
70
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Historic range (min to max)
20th to 80th percentile
Median (2002-2019)
2020/21


Tauherenikau Racecourse
Soil Moisture Content (% - 7 day average)
0
5
10
15
20
25
30
35
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Historic range (min to max)
20th to 80th percentile
Median (2013-2017)
2020/21

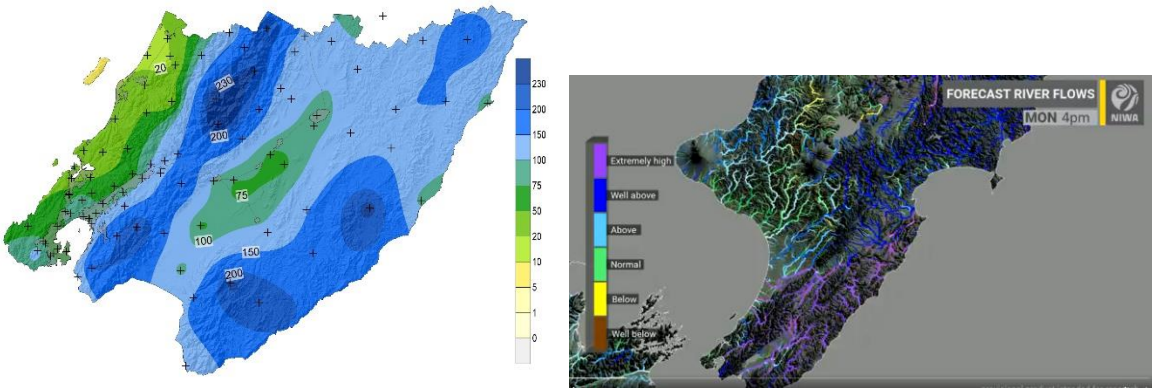

Martinborough (NIWA)
0
10
20
30
40
50
60
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Historic range (min to max)
20th to 80th percentile
Median (2002-2019)
2020/21

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.

Preliminary data for the winter solstice, Wairarapa's easterly storm: at the closing of this report, a significant easterly rainfall event produced totals above 230 mm in the eastern hills, mostly fallen within 48 hours during the weekend leading to the winter solstice (19-20 June). This rainfall was extremely well received by the farming community, bringing some relief to the dry soil moisture conditions shown above for Martinborough.



Total rainfall accumulation between 15:00 on Friday 18th June and 15:00 on Tuesday 22nd. The river flows forecast by NIWA for Monday afternoon (right panel) indicated extremely high flows for most of the region. There was some flooding around Martinborough. We thank NIWA for making the river flows forecast product available.

3. Outlook for winter 2021

- ENSO to remain neutral, as well as most of the other climate drivers. But the Southern Annular Mode (SAM) is expected to continue mostly positive, with increased blocked flow and westerly fronts more active south of New Zealand;
- Sea Surface Temperatures (SSTs) are expected to remain above average around and especially to the east and northeast of New Zealand;
- Mostly mild, warmer than average daytime. Normal frost pattern inland, during anticyclonic flow. High temperature fluctuations;
- Predominance of northerly flow, occasional short duration southerly blasts;
- Above average rainfall in the west, below in the east. High chance of heavy rainfall events, with irregular distribution forming the seasonal total rainfall.

Whaitua*	Variables	Climate outlook for winter 2021
Wellington Harbour & Hutt Valley	**Temperature:**	Above average daytime, average to above night-time.
	Rainfall:	Average to above. High chance of extreme rainfall events.
Te Awarua-o-Porirua	**Temperature:**	Above average daytime, average to above night-time.
	Rainfall:	Average to above. High chance of extreme rainfall events.
Kāpiti Coast	**Temperature:**	Above average daytime, average to above night-time.
	Rainfall:	Above average. High chance of extreme rainfall events.
Ruamāhanga	**Temperature:**	Above average daytime, near average night-time. Higher chances of normal frost occurrence, under reduced soil moisture and blocking anticyclones.
	Rainfall:	Mostly below average, but high chance of easterly rainfall events, which could substantially change the total seasonal accumulation depending on intensity and location.
Wairarapa Coast	**Temperature:**	Average to above.
	Rainfall:	Mostly below average, but high chance of easterly rainfall events, which could substantially change the total seasonal accumulation depending on intensity and location.

*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/