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Climate and Water Resources Summary for the Wellington Region

Spring 2018 summary

Summer 2018/2019 outlook

Release date: 14 December 2018

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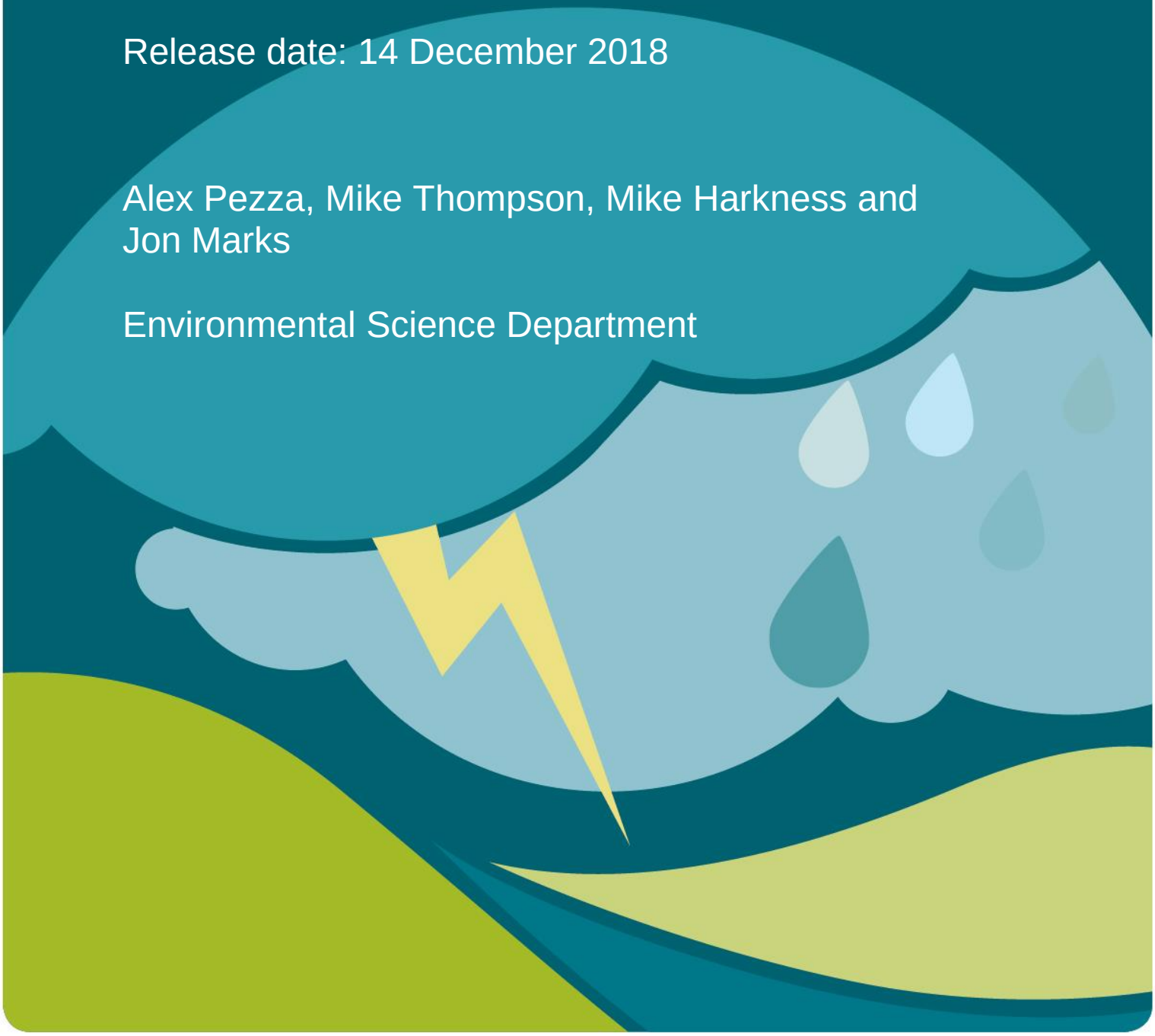
Environmental Science Department



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A fabulous Wellington sunset looking east at a storm dissipating over the Wairarapa. The easterly weather brought good rain over the Wairarapa in November, decreasing the drought risk for the time being. Many thanks to MetService for making the image available.

Overview

Spring 2018

Spring 2018 was extremely variable, with people sometimes describing the weather as having “five seasons in one day” around Wellington. While the seasonal average temperature ended up being slightly above normal as predicted, the day to day was anything but average. In October, Wellington had an extremely low relative humidity of 28% during an episode of descending dry air from the Southern Alps. A significant influence from subtropical air masses brought unsettled and warm westerlies early in November. This was followed by beach weather in the capital, with extended warm and calm days around mid-November under high pressure and unseasonably warm water temperatures. The region also had significant easterly rain events and thunderstorms with unsettled, blocked easterly flow late in November. Some isolated thunderstorms in the Wairarapa were severe, and caused significant localised damage.

Climate drivers

The El Niño - Southern Oscillation (ENSO) phenomenon remains under El Niño alert, with a strong probability of a new event developing in the new year. In fact, the water temperature in the Equatorial Pacific is already above the El Niño threshold, but the atmosphere is yet to follow suit in terms of impacts. This means that the ocean and the atmosphere are yet to “connect”, which is a pre-requisite for having an El Niño. The sea temperatures remain warmer than normal around and east of New Zealand, which is also unusual for an El Niño development. These competing effects mean that the weather has been and will likely remain extremely variable, and looking very different to what would be expected for an ENSO event, at least for now.

Climate outlook for summer 2018/2019

In light of a competing signal from the climate drivers, we expect a mixed westerly/easterly regime to alternate during the season. Easterly (heavy) rainfall events such as the one that happened late in November can certainly occur again. Rainfall is expected to be highly variable on a month to month basis, with low confidence for the total seasonal accumulation. Severe thunderstorms may contribute to above average totals in parts of the Wairarapa. Temperatures are expected to remain warmer than average, although very variable on a weekly/monthly scale.

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

Interactive climate change 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 scenarios modelled by the IPCC. Dynamical downscaling has been provided by NIWA: https://mapping1.gw.govt.nz/gw/ClimateChange/

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 now predicted to reach El Niño threshold soon, and remain weak during the first half of 2019.

Currently the oceanic waters are already above the El Niño threshold, but the atmospheric circulation is not yet responding accordingly. As such, the climate pattern around New Zealand is not showing any signs consistent with an ENSO event.

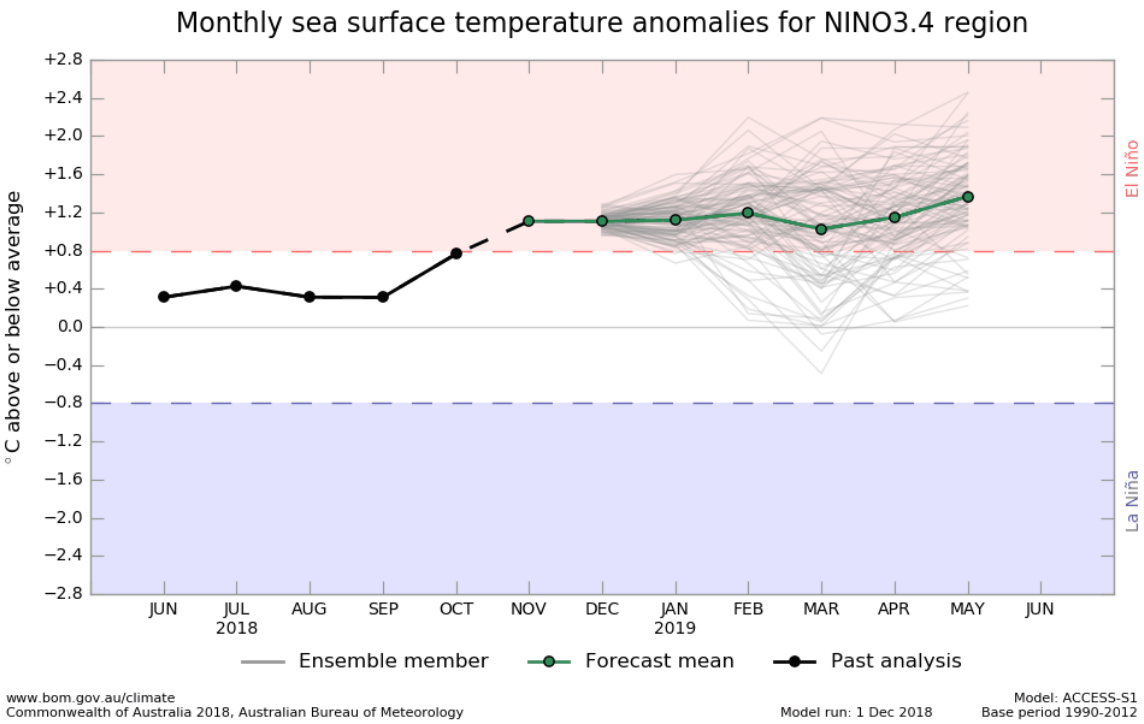


Figure 1.1: Averaged modelled projections (in green) show ENSO is expected to progress into a weak El Niño phase during 2019. Source: Australian Bureau of Meteorology.

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 for 6 December 2018. The pattern shows warmer than normal waters around and east of New Zealand. This is very atypical for an El Niño progressing year, as it tends to bring warmer temperatures, increased frequency of easterly winds, and increased rainfall to the Wellington Region.

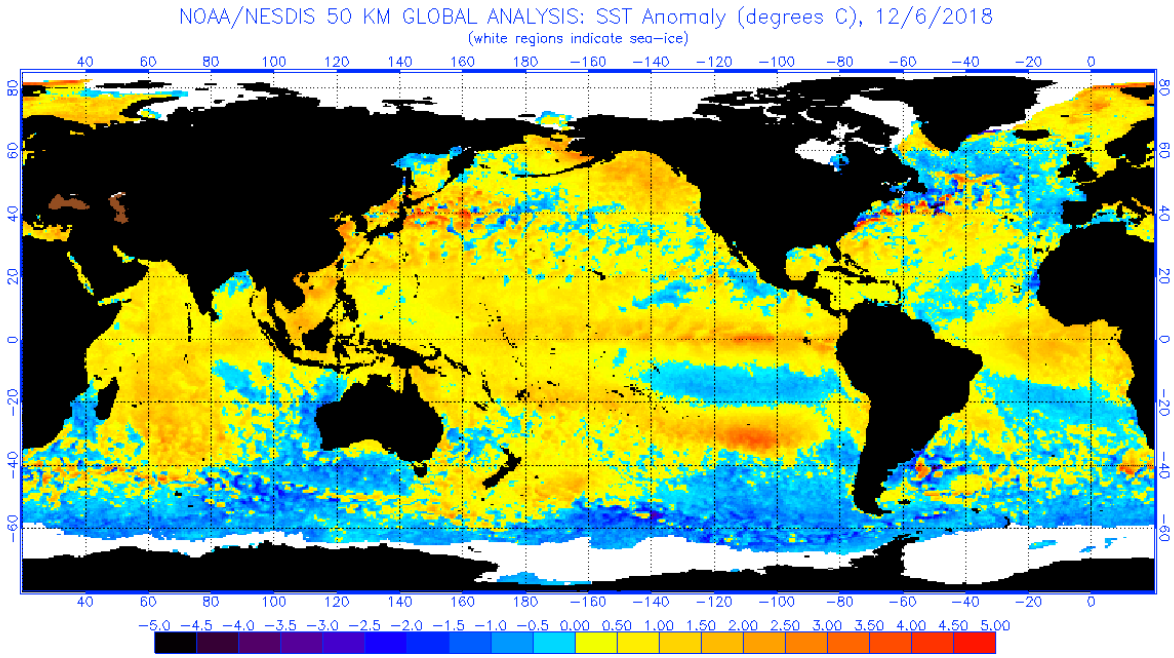


Figure 1.2: Sea surface temperature (SST) anomalies for 6 December 2018. Sea ice coverage is shown in white. Waters around New Zealand remain warmer than average to the south and east of the country. The Equatorial Pacific is within the El Niño threshold, but without the full atmospheric coupling required in order to have a formal El Niño event. In other words, even though the ocean temperatures are El Niño-like, the atmosphere is not responding as expected. 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 a large area of anomalous high pressure south-east of New Zealand during spring. This anticyclonic circulation was a very persistent feature especially in November, producing a blocked moist, easterly flow that induced severe thunderstorms, and some impressive rainfall amounts over the Wairarapa. This pattern was associated with the positive phase of the SAM, even though the position of the high meant an increase in easterly rainfall.

The easterly weather has continued to be the predominant mode into the first half of December, marking a very unusual El Niño development.

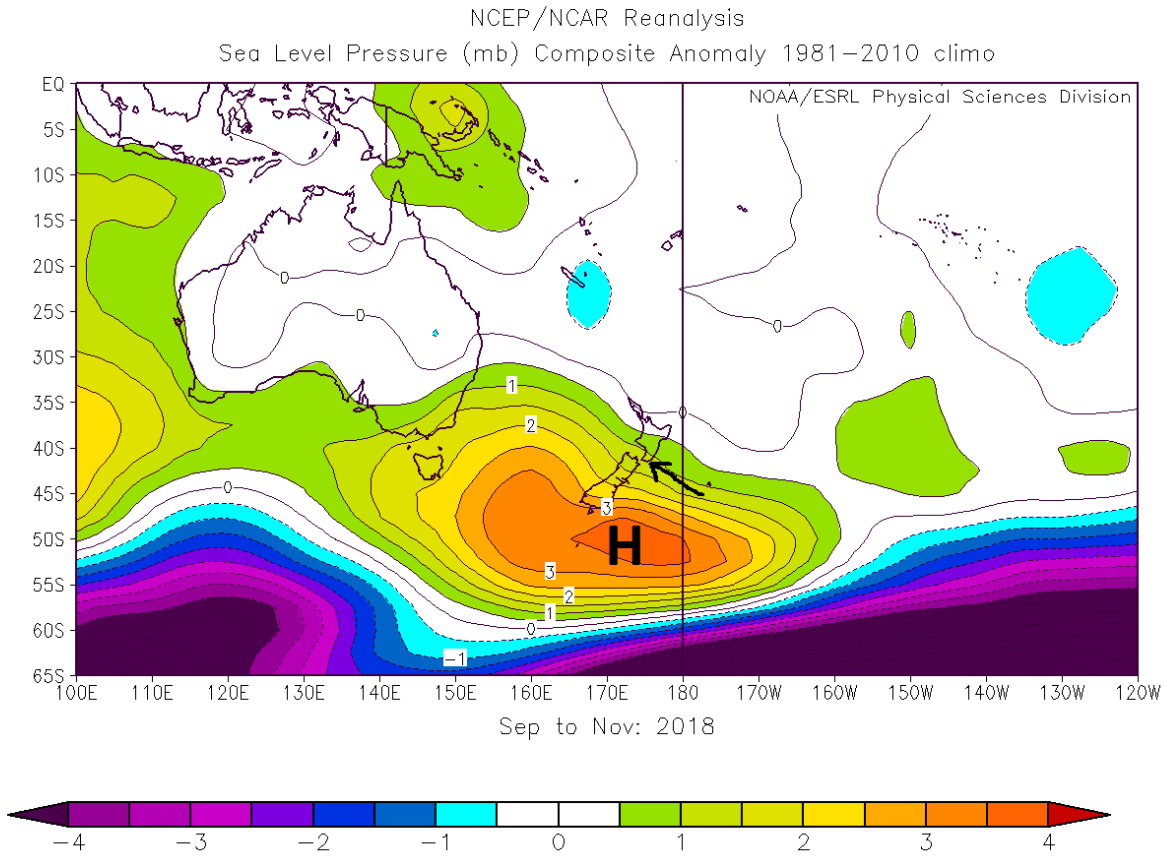


Figure 1.3: Mean sea level pressure anomaly (hPa) for SON 2018. The 'H' indicates the areas of blocking high pressure south of New Zealand. This large high pressure area created an anomalous easterly flow over New Zealand, bringing more rain to the east coast and inland Wairarapa. Source: NCEP Reanalysis.

2. What is the data showing?

2.1 Regional temperature

Figure 2.1 shows the 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).

We can see that warmer than average temperatures prevailed for the most part, except a cold nocturnal pattern around Masterton and slightly cooler daytime around Castlepoint. This pattern is related to the onshore easterly flow and some cold outbreak events from the southerly quadrant, which kept the eastern coast and inland areas relatively cooler than the west coast.

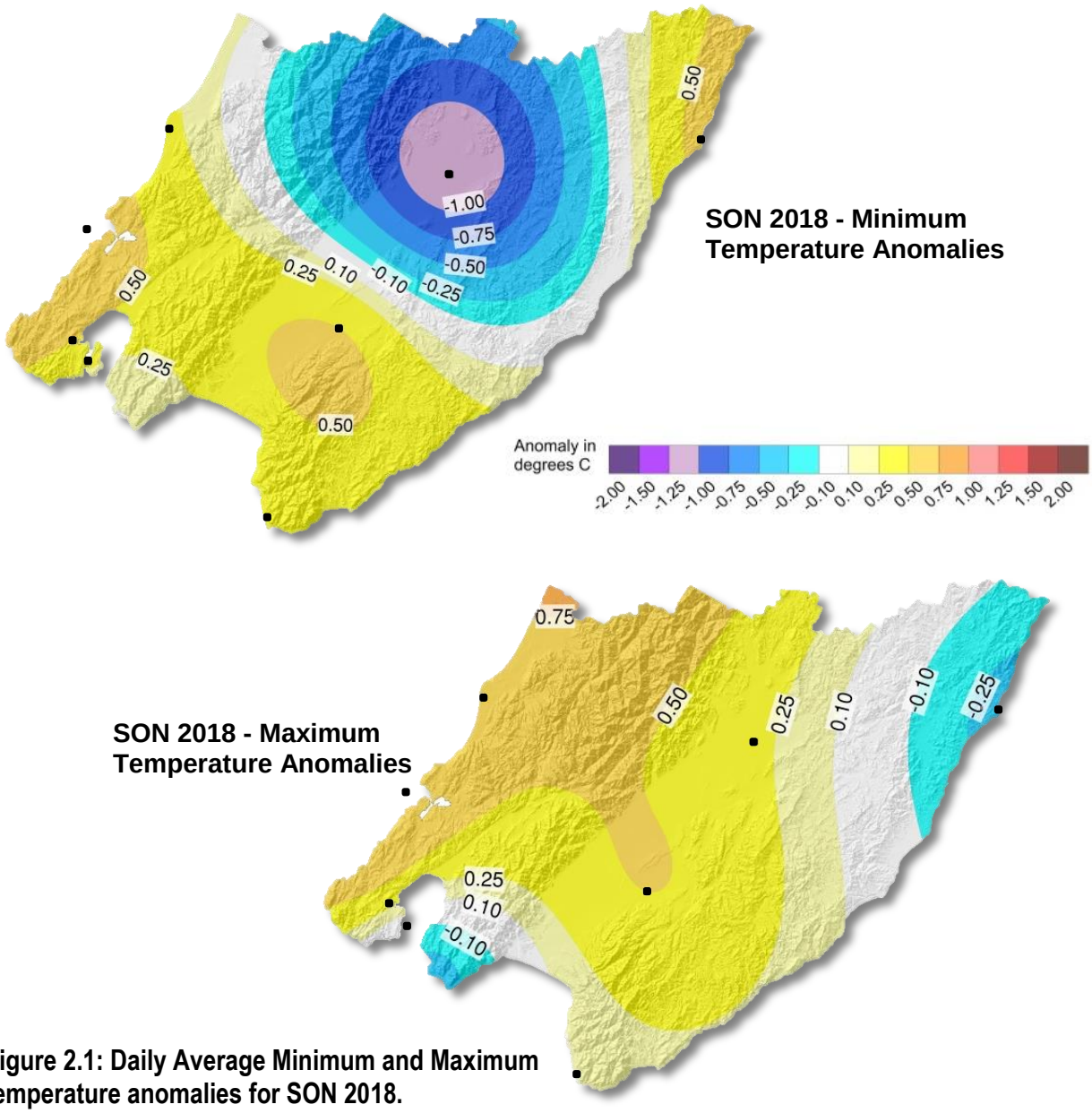


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies for SON 2018.
All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

2.2 Regional wind

Figure 2.2 shows the mean wind anomalies (against the 1981-2010 reference period) based on a smaller network of stations than for temperature. We can see that the region had a pattern of lower than normal wind speeds over the spring months, connected to the blocking areas of high pressure to the south of New Zealand shown in Figure 1.3. This set up countered the normal westerly flow.

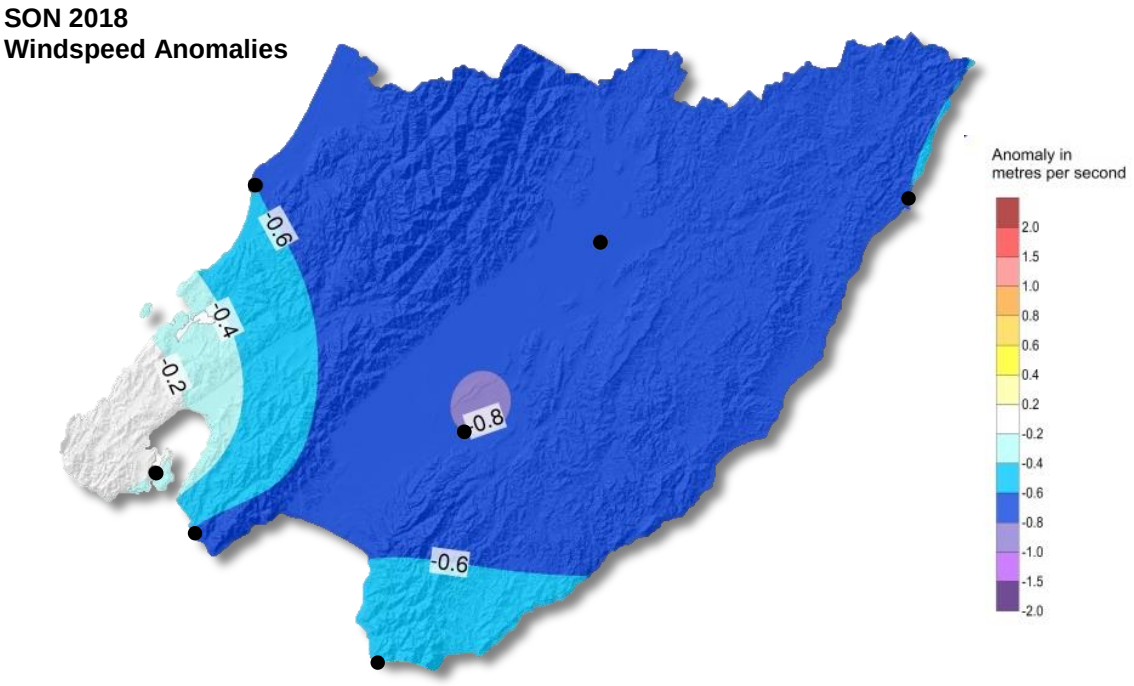


Figure 2.2: Daily mean wind anomalies (in m/s) for SON 2018. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from NIWA and MetService.

2.3 Regional soil moisture

Figure 2.3 shows the spring 2018 soil moisture anomaly map for the region. Most of the region experienced around normal soil moisture levels, a touch drier in the Wairarapa. There was a significant recovery in soil moisture in the Wairarapa towards the second half of November, with the region currently featuring well above normal soil moisture for this time of the year.

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

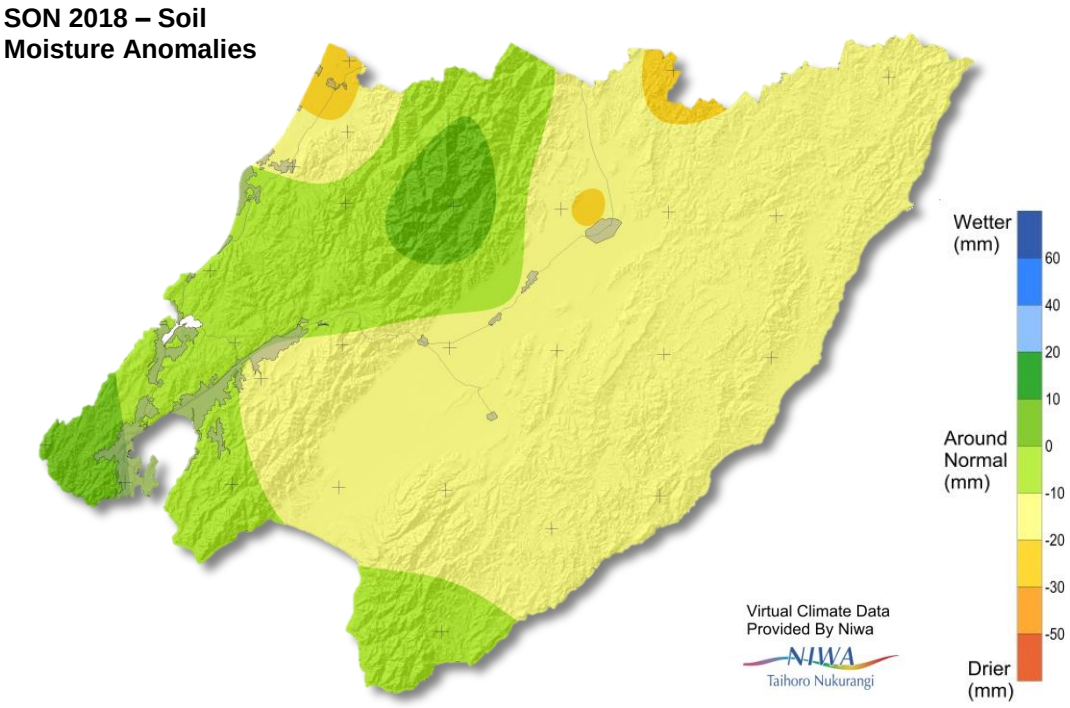


Figure 2.3: Spring (SON 2018) soil moisture anomaly. Moisture levels show normal or slightly below normal conditions for most of the region. We note, however, that moisture levels are currently well above average, after copious easterly rainfall in the second half of November. Source: GWRC, using selected 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 should only be used for a general indication of the spatial variability.***

2.4 Regional rainfall

Figure 2.4 shows the regional month by month (and total spring) rainfall expressed as a percentage of the long-term average. The pattern was quite variable from month to month. September saw well above average rainfall in eastern and southern areas while parts to the west and north had well below average rainfall.

October was a very dry month almost everywhere, with northern parts of the Ruamahanga valley receiving as low as 40% of the monthly average rainfall. November was totally different with well above average rainfall dominating the landscape. Areas of the eastern hill and Wairarapa valley received in excess of 300% of the normal November rain.

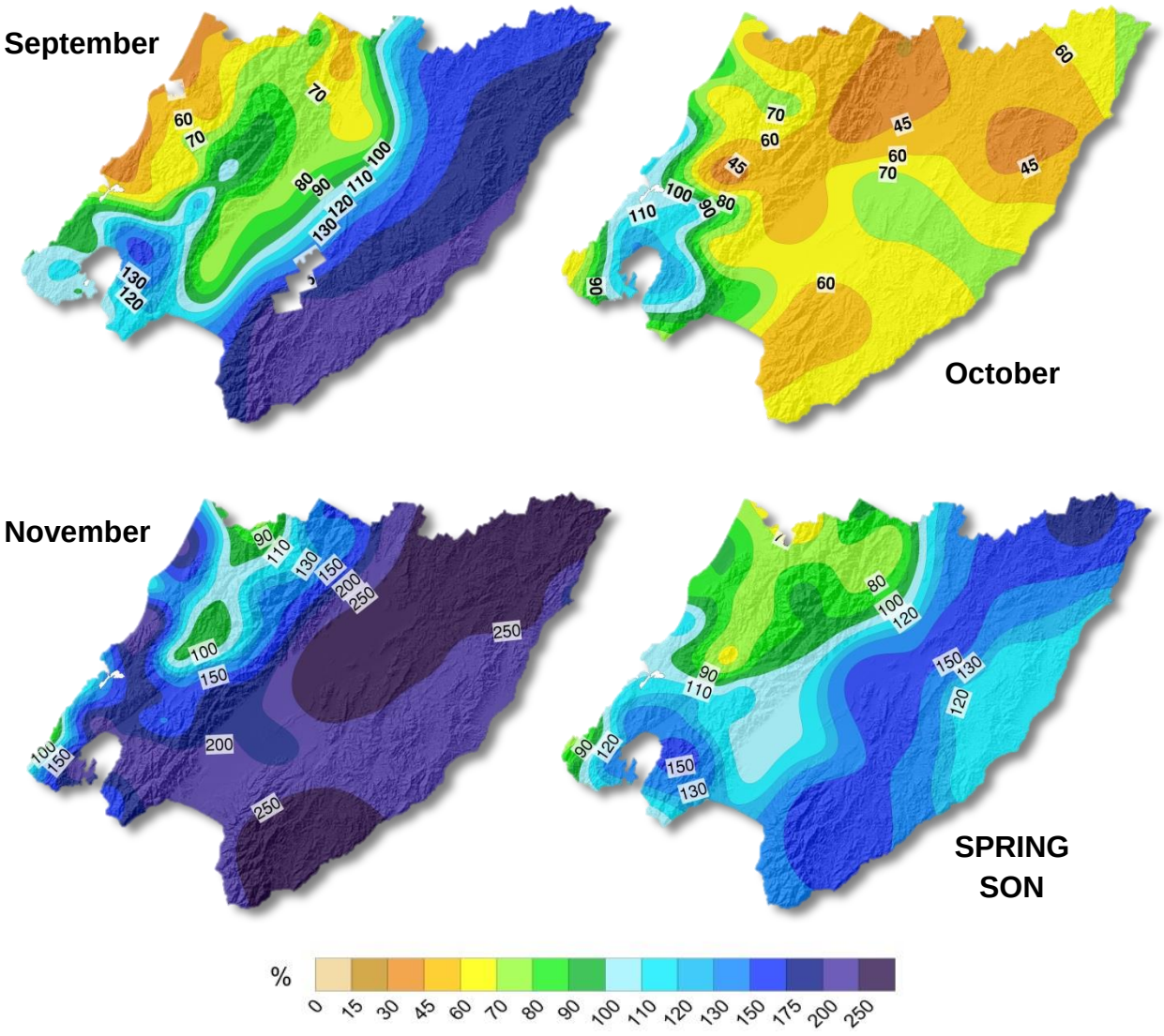


Figure 2.4: Rainfall for September, October, November and SON 2018 as a percentage of the long-term average. Rainfall was extremely variable; September was wet to the east and dry to the west, October was dry in most places and November was very wet all over. Source: GWRC and NIWA.

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 doesn't 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 (a sense of extreme hot/dry), and blue indicates seasons that were colder, wetter, cloudier and windier than average (a sense of extreme cold/wet). The reference climatological average (1981-2010) is shown by a horizontal bar where available.

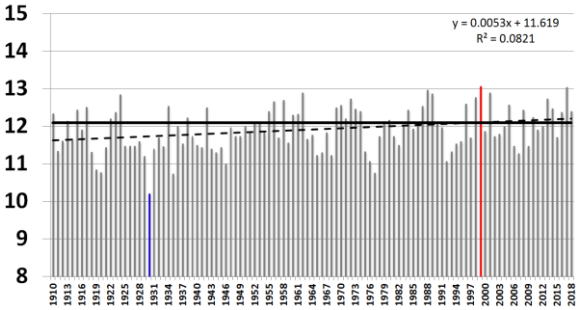
All maps are grouped together for convenience of style, using the same scale between Wellington and Wairarapa whenever possible (except for wind which is much lower over the Wairarapa). The last bar in all graphs is the season covered in this report; unless there are data missing (in which case a blank space is shown).

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.

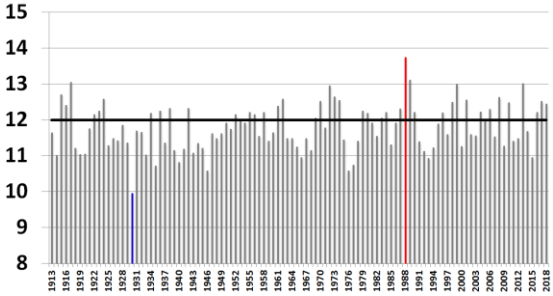
The climate change and variability summary for spring is:

- Statistically significant trends are seen only for temperature and wind speed in Wellington, meaning spring is getting hotter and less windy. The long-term spring wind reduction in Wellington is fairly strong (a reduction rate of 18% per century);
- Spring 2018 temperatures were above average for both Wellington and the Wairarapa;
- Sunshine hours were below average for Wellington and generally on the low side for the Wairarapa (no long-term climatology available);
- Wind speed was below average (lowest on record for the Wairarapa);
- Rainfall was around normal in Wellington and well above normal in the Wairarapa;
- Rain days were around normal in both Wellington and the Wairarapa.

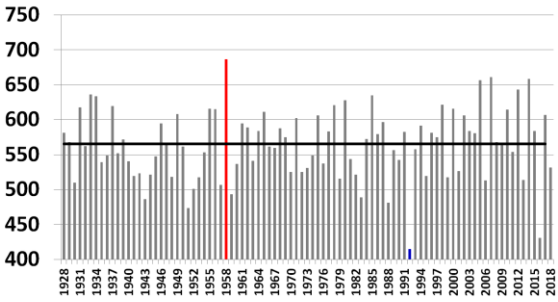
Spring Mean Temperature (deg C) - Kelburn (1910-2018)



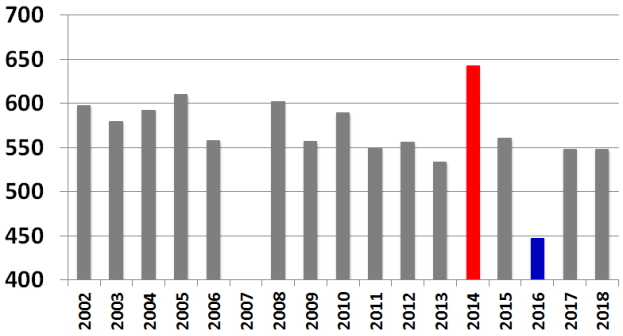
Spring Mean Temperature (deg C) - Masterton (1913-2018)



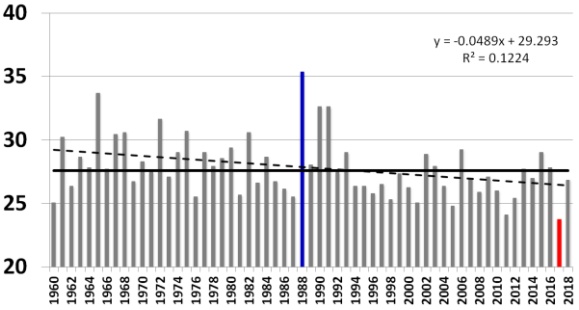
Spring Total Sunshine Hours - Kelburn (1928-2018)



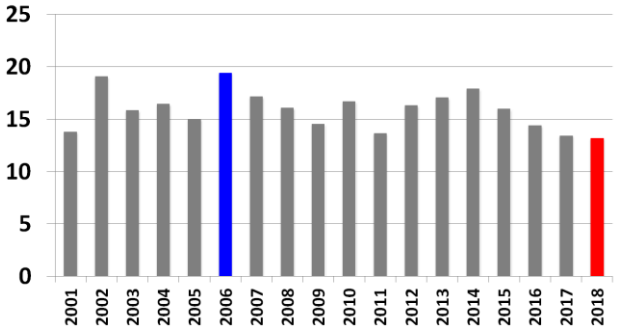
Spring Total Sunshine Hours - Martinborough (2002-2018)



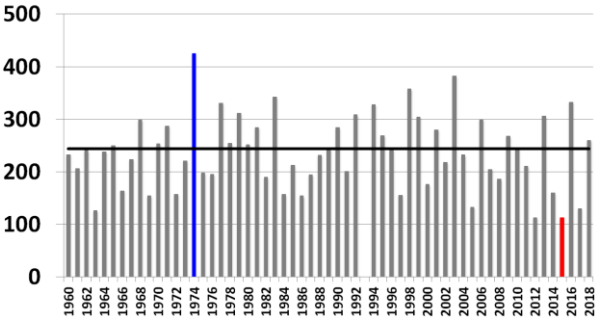
Spring Mean Wind (km/h) - Wellington Airport (1960-2018)



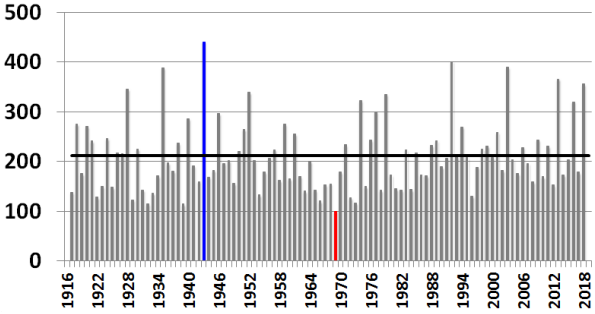
Spring Mean Wind (km/h) - Martinborough (2001-2018)



Spring Total Rainfall (mm) - Wellington Airport (1960-2018)



Spring Total Rainfall (mm) - Waikoukou, LongBush (1917-2018)



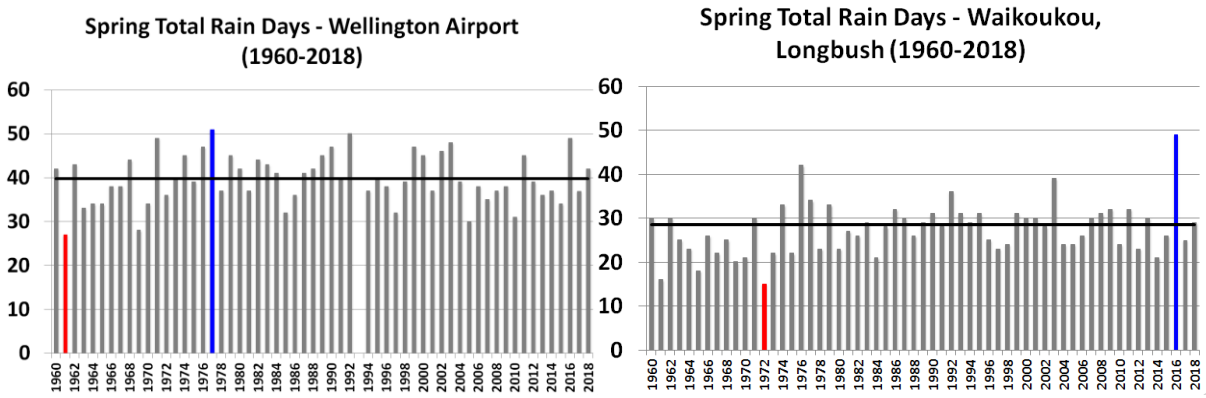


Figure 2.5: Climate change and variability graphs for spring in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs,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

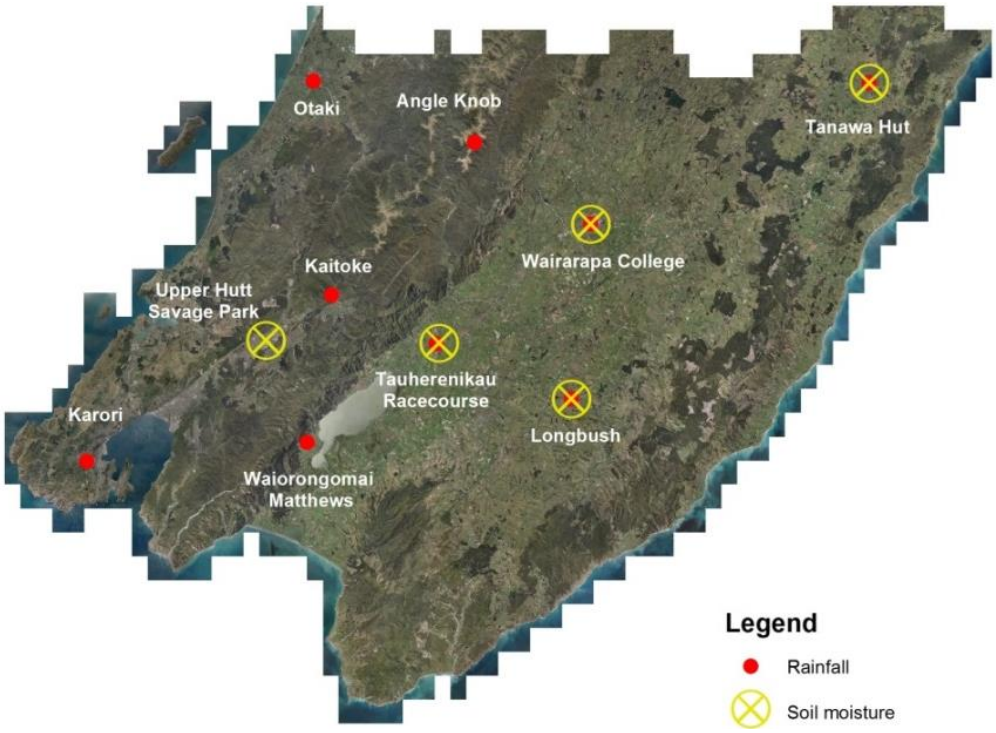


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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 summers have been included as well as the site average.

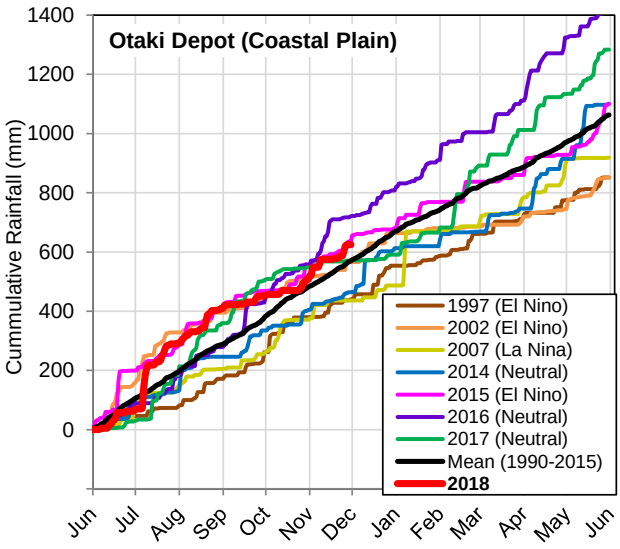
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

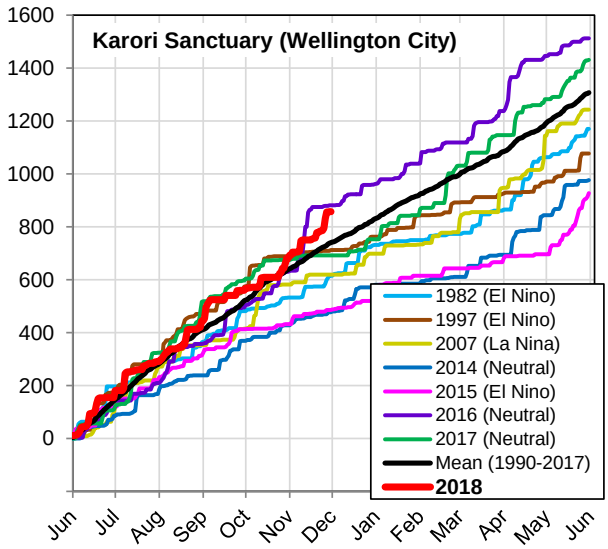
GWRC does not operate a rain gauge in the southern-most parts of the Wairarapa Valley that is suitable for presenting data in this report. This means that we cannot be confident that the rainfall patterns seen elsewhere extend to this part of the region other than the VCN data already presented.

Overall, rainfall accumulations for the year starting in June 2018 (labelled 2018 on the plots) are currently trending from near average to above average.

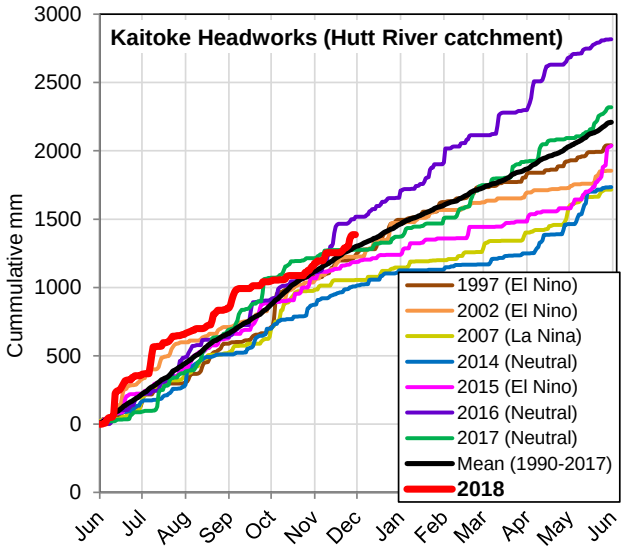
The below average rainfall experienced over much of the region during October is evident in flatter accumulations at all sites, but particularly at the Wairongomai, Tauherenikau, Tanawa Hut and Longbush locations. In contrast, the very wet November conditions are clearly shown in the steep accumulated rainfall at Masterton, Tauherenikau, Tanawa Hut and Longbush.

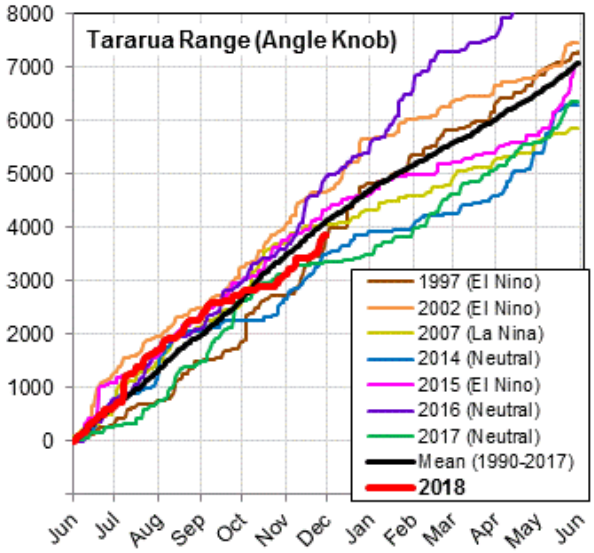
Kāpiti Coast and Southwest (Wellington city)



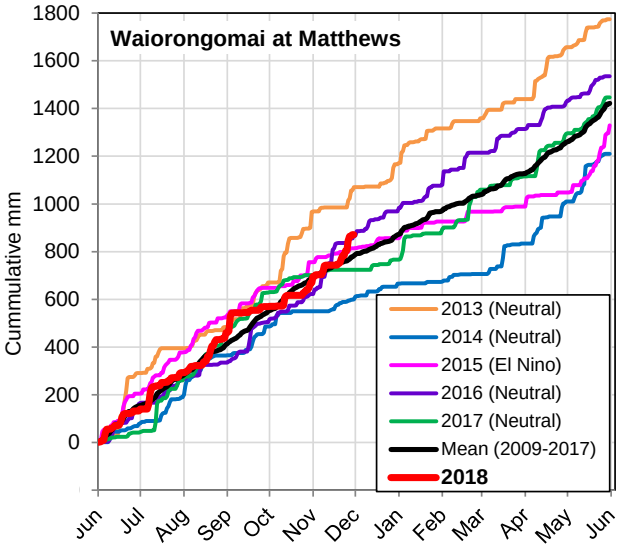


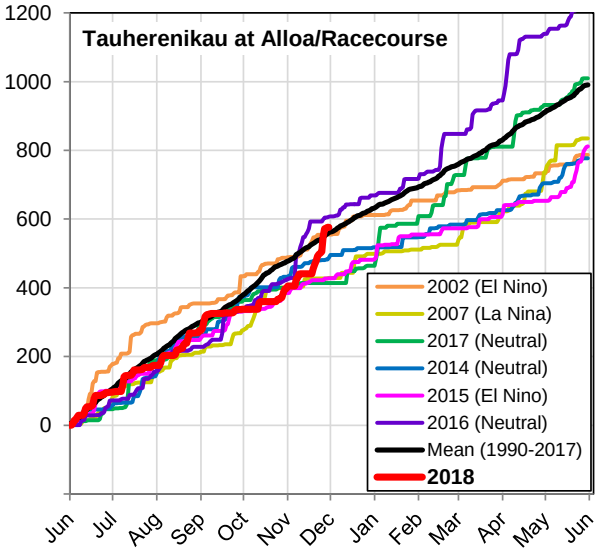
Hutt Valley and the Tararua Range

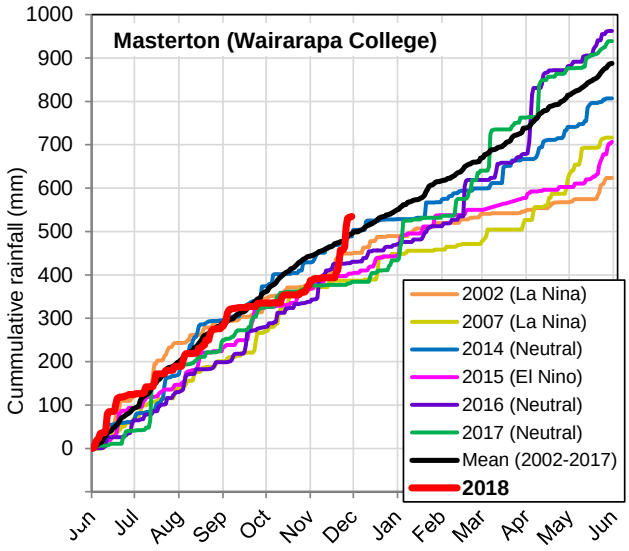


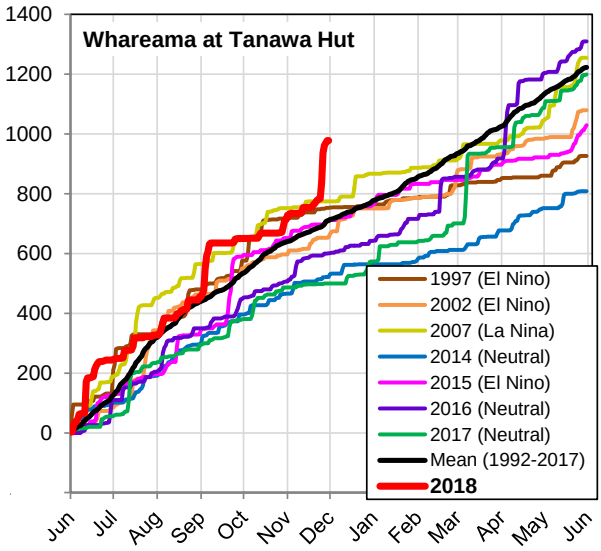


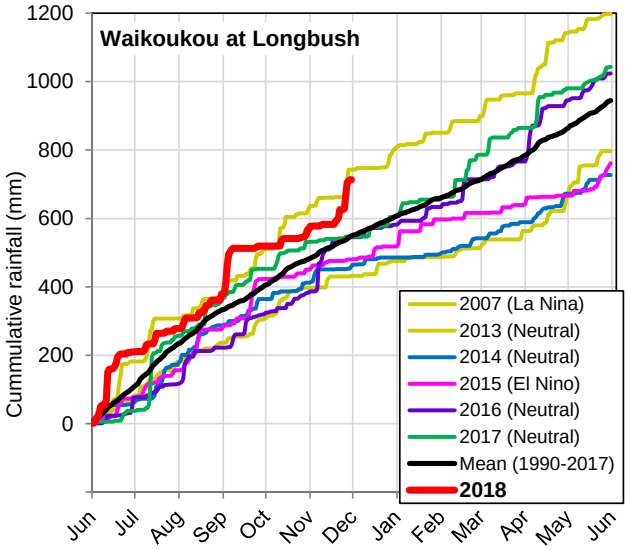
Wairarapa


Waiorongomai at Matthews
Cummulative mm
1800
1600
1400
1200
1000
800
600
400
200
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
2013 (Neutral)
2014 (Neutral)
2015 (El Nino)
2016 (Neutral)
2017 (Neutral)
Mean (2009-2017)
2018


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 (El Nino)
2007 (La Nina)
2017 (Neutral)
2014 (Neutral)
2015 (El Nino)
2016 (Neutral)
Mean (1990-2017)
2018


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 (La Nina)
2007 (La Nina)
2014 (Neutral)
2015 (El Nino)
2016 (Neutral)
2017 (Neutral)
Mean (2002-2017)
2018


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 (El Nino)
2002 (El Nino)
2007 (La Nina)
2014 (Neutral)
2015 (El Nino)
2016 (Neutral)
2017 (Neutral)
Mean (1992-2017)
2018



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 2018)

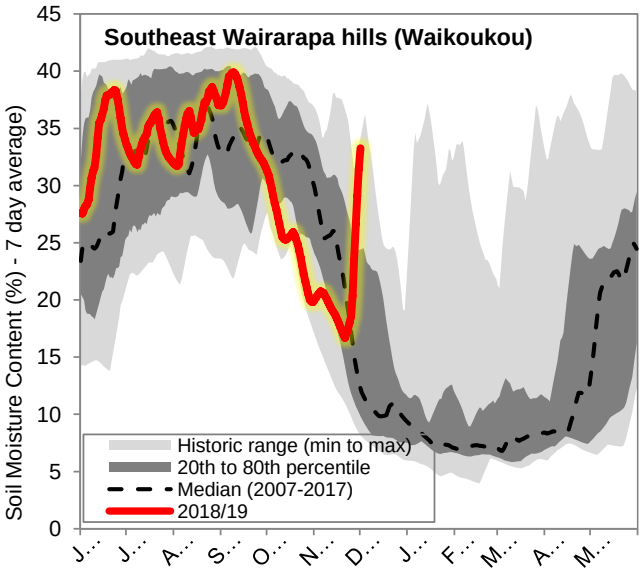
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2018. This is plotted over an envelope of the range of historic recorded soil moisture data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar period in past years.

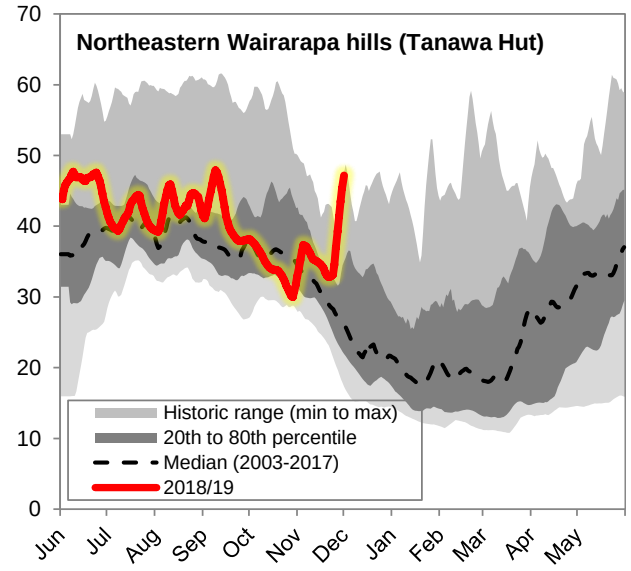
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

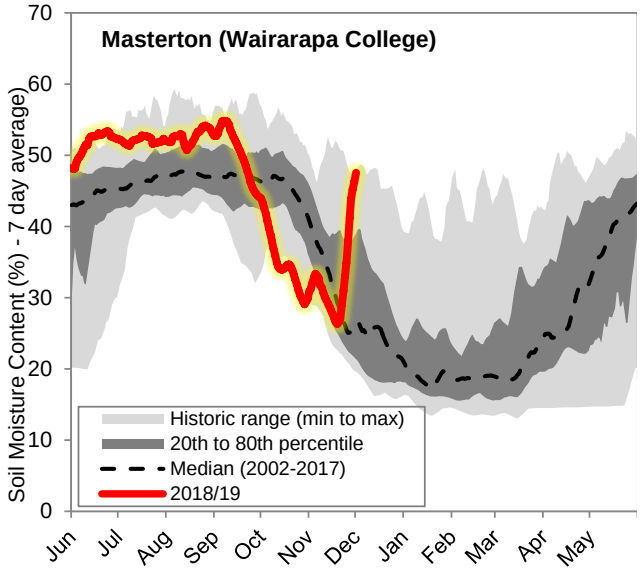
The soil moisture behaviour at the four sites in the Wairarapa had been tracking largely above average up until October when a month of very low rainfall caused soil moisture levels to drop away.

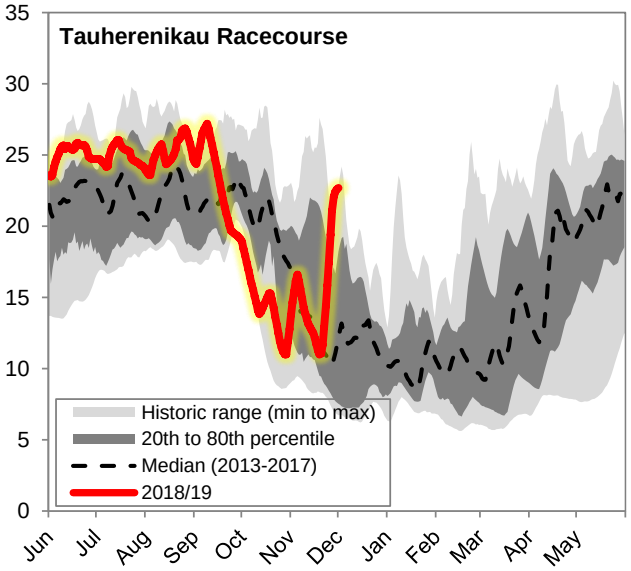
The exceptionally wet November conditions are evident in the sharp increases to soil moisture content at the Wairarapa monitoring sites.

(a) Wairarapa

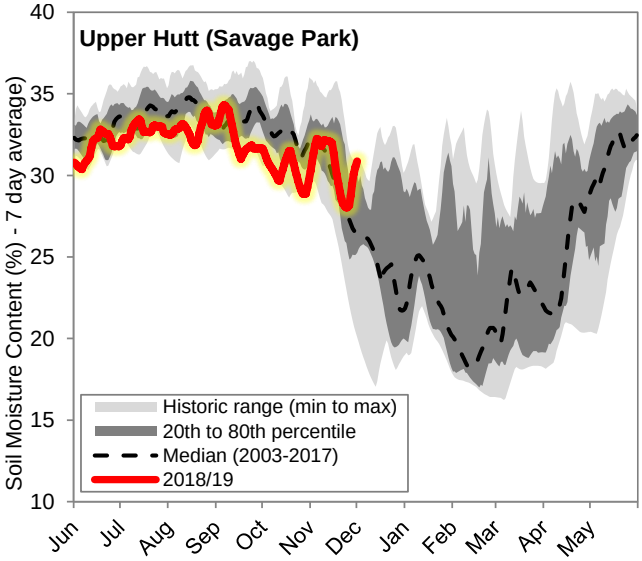








(b) Hutt Valley



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 2018/2019

- **El Niño** likely developing in the new year;
- "**Weird ENSO event**": not too strong, mixed signals, mixed effects. Climate unlikely to behave like normal El Niños (high confidence);
- Mixed **westerly/easterly regime.** Easterly (heavy) rainfall events likely to continue (moderate confidence);
- **Warm sea surface temperature** east of New Zealand increasing chance of thunderstorms and moist easterly flow (high confidence);
- **Variable rainfall**: High month to month variability, severe thunderstorms likely (low confidence for rainfall totals);
- **Warmer than average**: good chance of heat waves, but more unsettled and not as hot as the record summer of 2017-2018 (moderate confidence)

Whaitua*	Variables	Climate outlook for summer 2018/2019
Wellington Harbour & Hutt Valley	**Temperature:**	Above average. Heat waves likely, but in between cooler unsettled periods. Not like 2017-2018.
	Rainfall:	Very variable month to month. Low confidence for average totals.
Te Awarua-o-Porirua	**Temperature:**	Above average. Heat waves likely, but in between cooler unsettled periods. Not like 2017-2018.
	Rainfall:	Very variable month to month. Low confidence for average totals
Kāpiti Coast	**Temperature:**	Above average. Heat waves likely, but in between cooler unsettled periods. Not like 2017-2018.
	Rainfall:	Very variable month to month. Low confidence for average totals.
Ruamāhanga	**Temperature:**	Above average. Increased chance of heat waves, but not as hot as 2017-2018.
	Rainfall:	Irregular distribution, easterly events and severe thunderstorms likely, with potential localised flooding and damage. Low confidence for average totals.
Wairarapa Coast	**Temperature:**	Above average. Increased chance of heat waves, but not as hot as 2017-2018.
	Rainfall:	Irregular distribution, easterly events likely. Low confidence for average totals.

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

Acknowledgments

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.

Appendix

GWRC online climate mapping tools

Live regional climate maps (updated daily): Real-time 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 maps: Easy to plot climate change mapping, available for every season, for mid and late century. A total of 21 climate variables can be plotted, for every greenhouse gas emission scenarios modelled by the IPCC. Dynamical downscaling provided by NIWA: https://mapping1.gw.govt.nz/gw/ClimateChange/

GWRC Climate change webpage

http://www.gw.govt.nz/climate-change/

GWRC Seasonal climate variability and water resources webpage

http://www.gw.govt.nz/seasonal-climate-and-water-resource-summaries-2/

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