greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Climate and Water Resources Summary for the Wellington Region

Winter 2018 summary

Spring 2018 outlook

Release date: 13 September 2018

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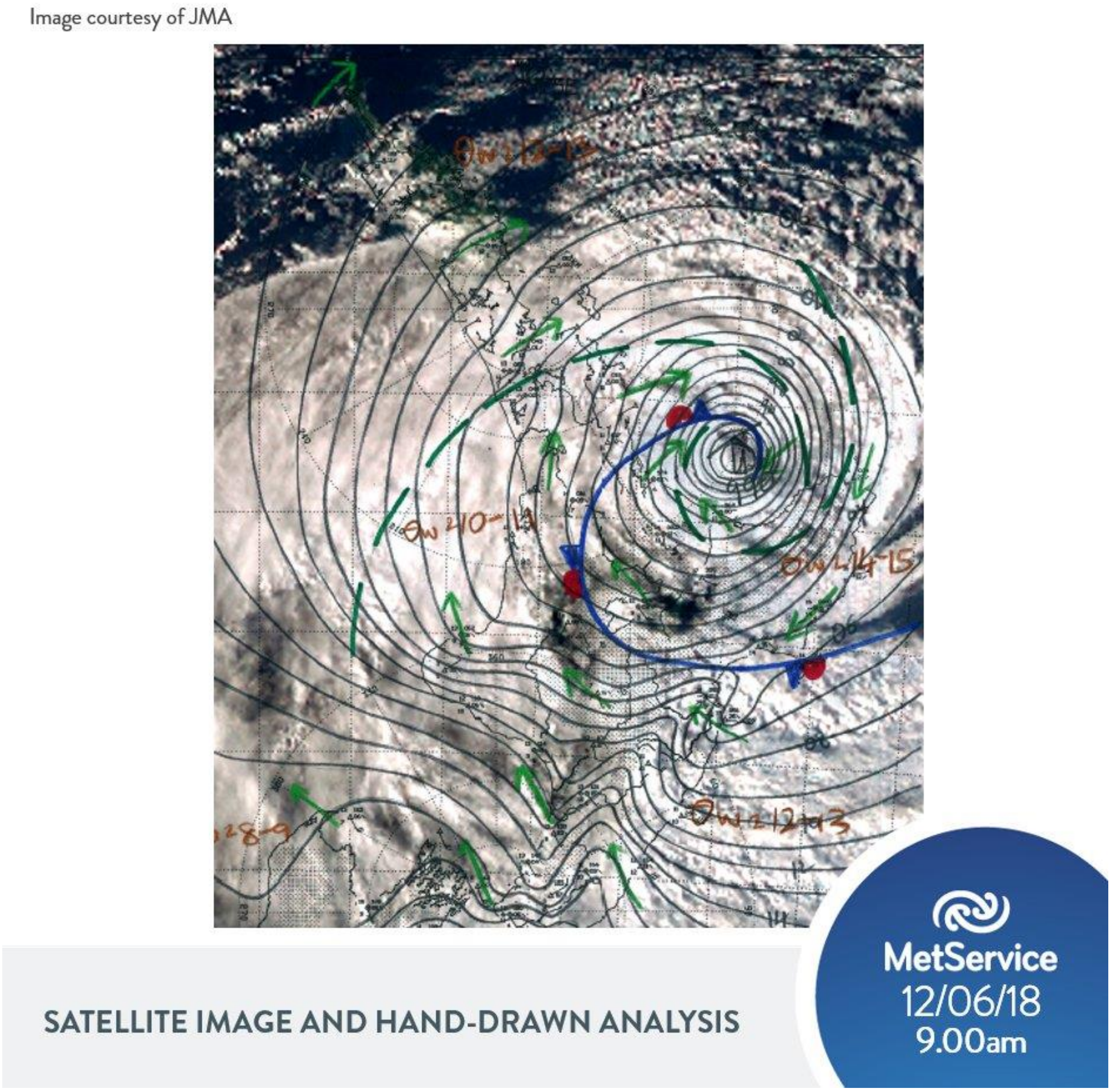
Environmental Science Department

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao



A very strong subtropical low brings a vigorous easterly circulation, with heavy rain over the eastern coast in June. *Source:* MetService Twitter

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Overview

Winter 2018

Like autumn, winter 2018 was marked by very unsettled weather patterns, starting very wet and cold and then moving towards a more normal rainfall pattern in the second half of the period. July was particularly warm, with Wellington hitting the 3rd highest mean July temperature on record, since 1927. Overall, Wellington had the third-equal warmest, and Martinborough had the 4th warmest winter on record.

Climate drivers

The El Niño - Southern Oscillation (ENSO) phenomenon has been in a neutral phase, therefore, this driver would have contributed towards normal conditions.

The Southern Annular Mode (SAM) has been predominantly negative, contributing towards a wet and unsettled winter pattern overall.

A large anomalous area of low pressure south of Australia also contributed to a predominantly north-westerly regime over New Zealand, alternating with significant easterly events such as the impressive subtropical low in June (featured above), with abundant rainfall in the Wairarapa.

Climate outlook for spring 2018

The ENSO phenomenon is now shifting towards an El Niño phase. However, the predicted event is so far of only small magnitude, and its manifestation is looking atypical, in that not all indicators are consistently “El Niño-like”. This is known as the “Modoki” variation of El Niño (or pseudo-El Niño), in which the oceanic warming affects the central Equatorial Pacific, but it doesn’t affect the western coast of South America. The name was coined by Japanese researchers after the classical Japanese word “Modoki”, which means “a similar but different thing”.

As a result, we expect only a small ENSO influence during spring, and even then not necessarily in the traditional sense. Based on a range of different climate models, we expect a spring with near to above normal temperatures and about average rainfall, without any particularly strong odds either way (i.e. towards strong positive or negative anomalies). The models still show an enhanced probability of significant easterly rainfall events (such as the one we had in June), even though this is not normally expected during the development phase of El Niños.

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: 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/

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 during our spring.

However, the intensity of the event being predicted is only weak, and not all climate indicators (e.g. oceanic winds) are responding as would have been expected during the onset of a classical El Niño. As such, we are not expecting pronounced impacts over our region during spring, pending a revision for late spring and the summer ahead, depending on how the phenomenon might evolve.

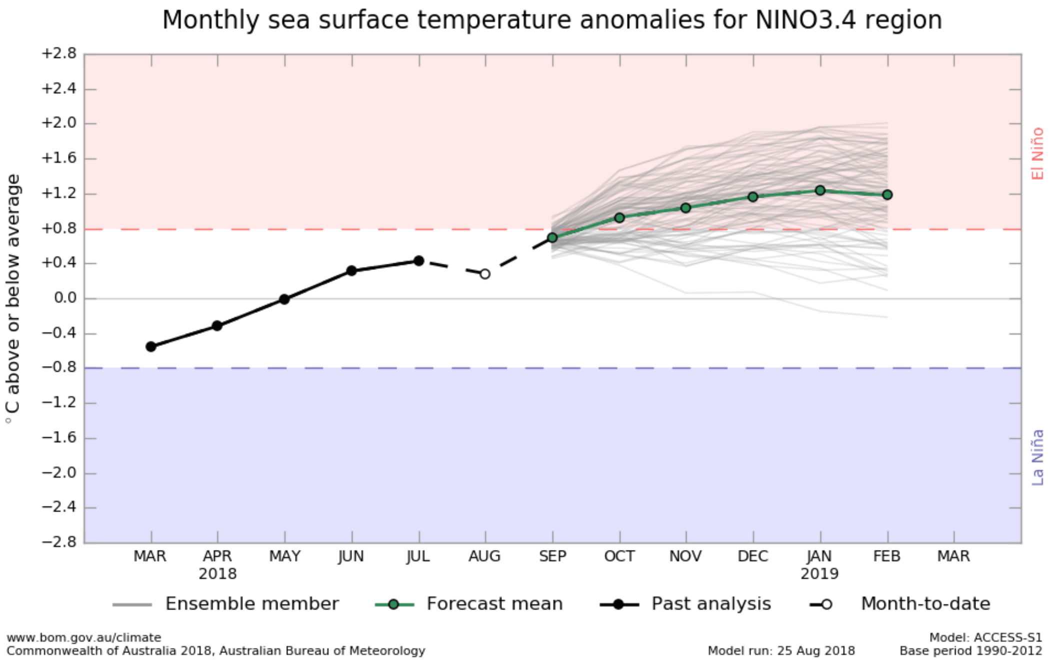


Figure 1.1: Averaged modelled projections (in green) show ENSO is expected to progress to the El Niño phase during spring. However, the prediction at this stage is only for a weak event. Source: Australian Bureau of Meteorology.

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 3 September 2018. The pattern shows normal or slightly cooler than normal waters southwest of New Zealand, and warmer than normal waters to the east. This pattern has remained unchanged throughout most of the winter.

In terms of ENSO, the evolution of a potential El Niño is not yet evident, but more warming is expected towards the central Pacific. This is typical of what has been coined El Niño “Modoki”, which is a variation of the classical ENSO pattern (or “pseudo-El Niño”), in which the oceanic warming affects the central Equatorial Pacific, but not the western coast of South America. The name was coined by

Japanese researchers after the classical Japanese word "Modoki", which means "a similar but different thing".
(http://www.jamstec.go.jp/frsgc/research/d1/iod/publications/modoki-ashok.pdf)

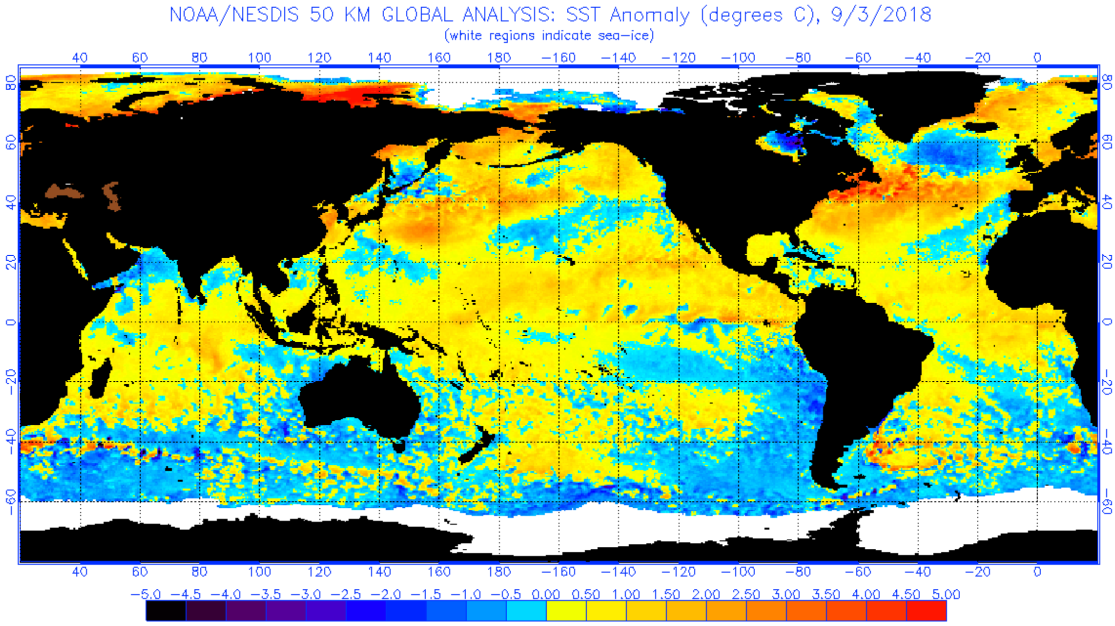


Figure 1.2: Sea surface temperature (SST) anomalies for 3 September 2018. Sea ice coverage is shown in white. Waters around New Zealand remain slightly cooler than average to the west, and warmer to the east. The Equatorial Pacific is in the neutral phase (neutral ENSO) progressing towards a new El Niño. 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 low pressure south of Australia, projecting an area of influence over New Zealand. This pattern, which was associated with the negative phase of the SAM, contributed to a more frequent north-westerly regime. The influence of these anomalies is evident in the rainfall anomalies (section 2.4), showing that overall the western coast had above average rainfall.

The blocking highs to the east of New Zealand, although not very strong, also contributed to produce both south-easterly and north-easterly events. Overall, both the low and the highs combined have reduced the frequency of southerly winds, helping explain the warm temperature anomalies observed over most of the country.

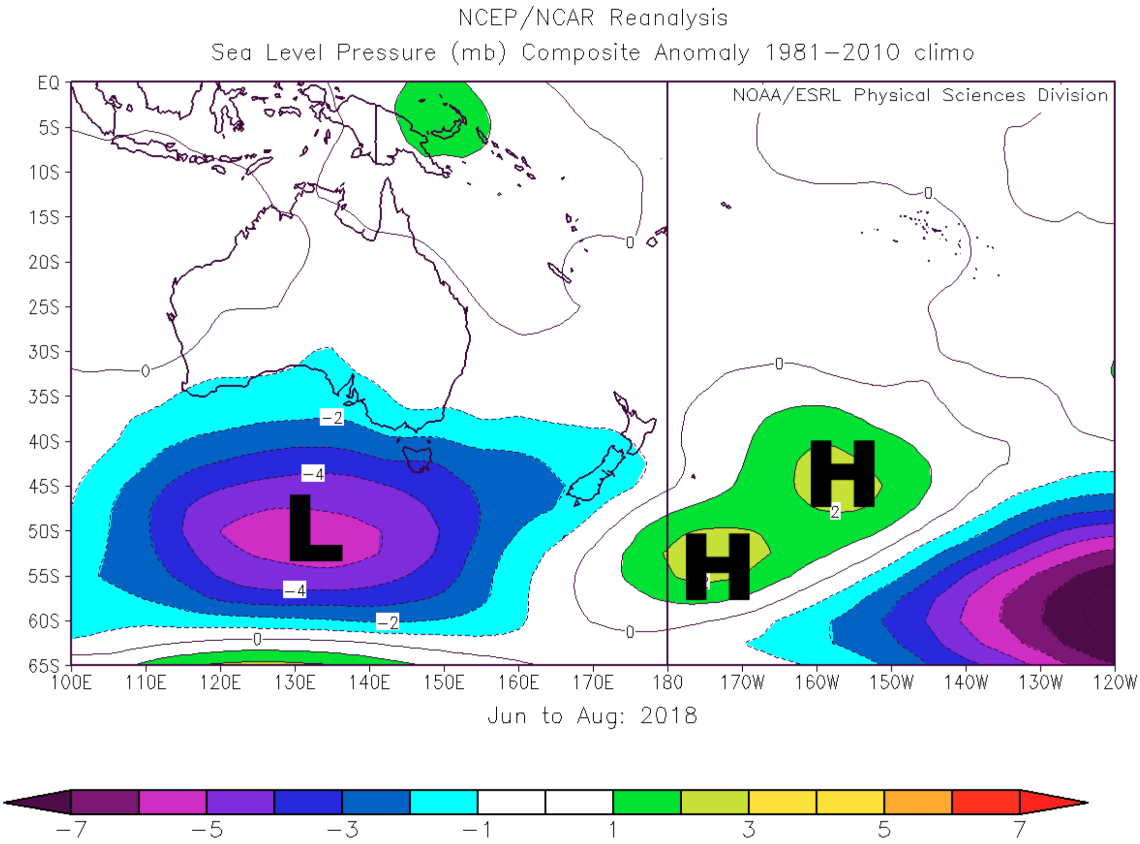


Figure 1.3: Mean sea level pressure anomaly (hPa) for JJA 2018. The 'H' indicates the areas of blocking high pressure east of New Zealand, and 'L' corresponds to an area of lower than average pressure south of Australia. This large low pressure area affected New Zealand, bringing more westerlies during winter. 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, especially for the western part of the region. Over Masterton, clear nights with radiative cooling (heat lost into space under clear skies) kept minimum temperatures slightly below average.

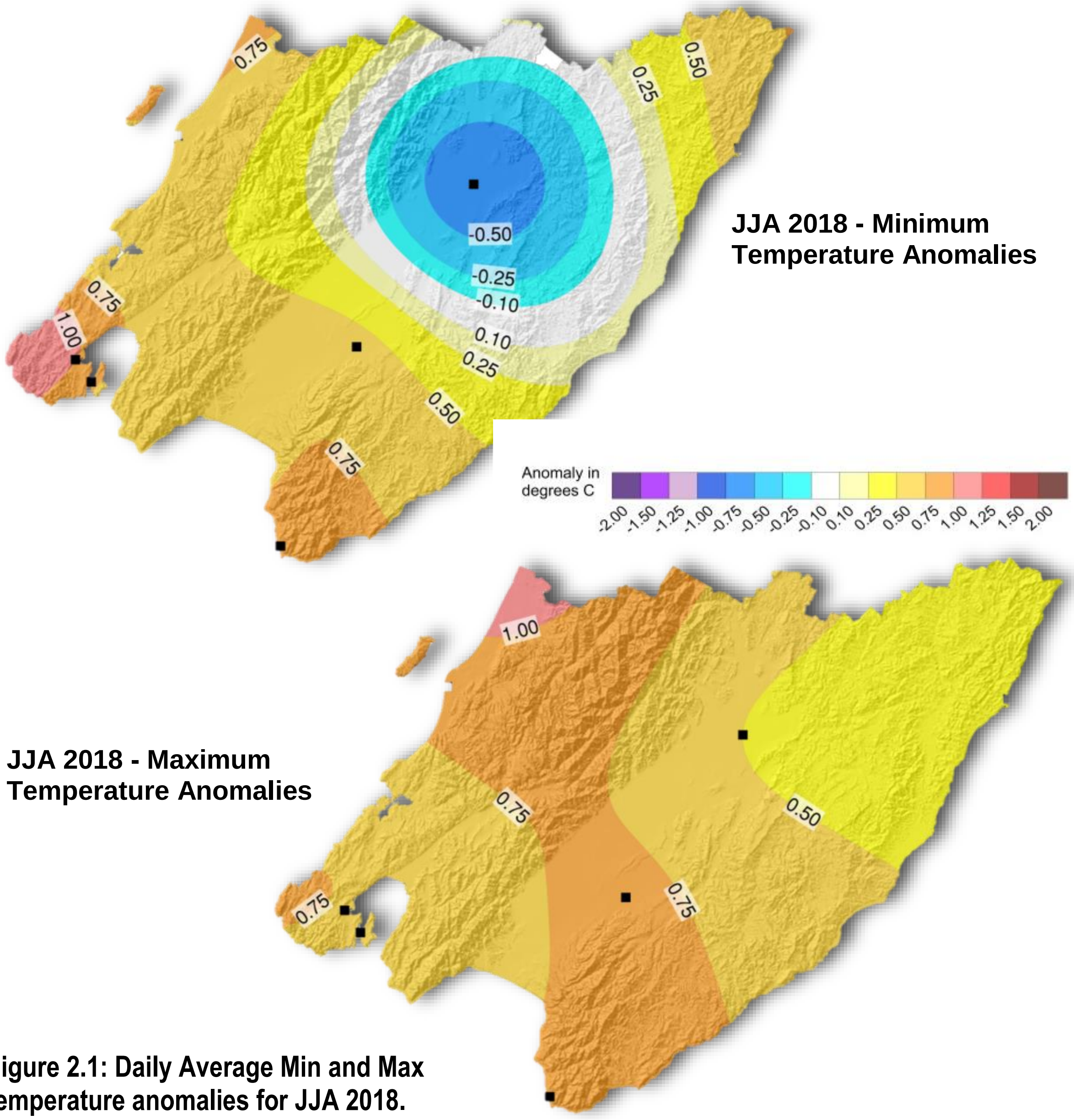


Figure 2.1: Daily Average Min and Max temperature anomalies for JJA 2018.
All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

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 winter months, in connection to the blocking areas of high pressure to the east of New Zealand shown in Figure 1.3.

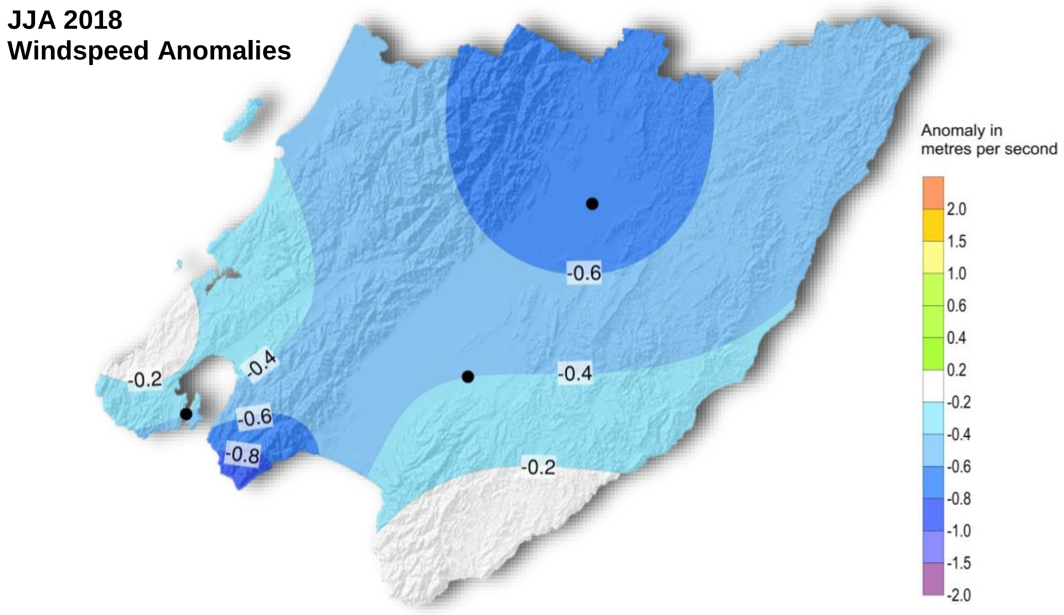


Figure 2.2: Daily mean wind anomalies (in m/s) for JJA 2018. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from NIWA and MetService.

2.3 Regional soil moisture

Figure 2.3 shows the winter 2018 soil moisture anomaly map for the region. Most of the region experienced around or above normal soil moisture levels – a pattern consistent with positive rainfall anomalies observed over the last few months.

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)

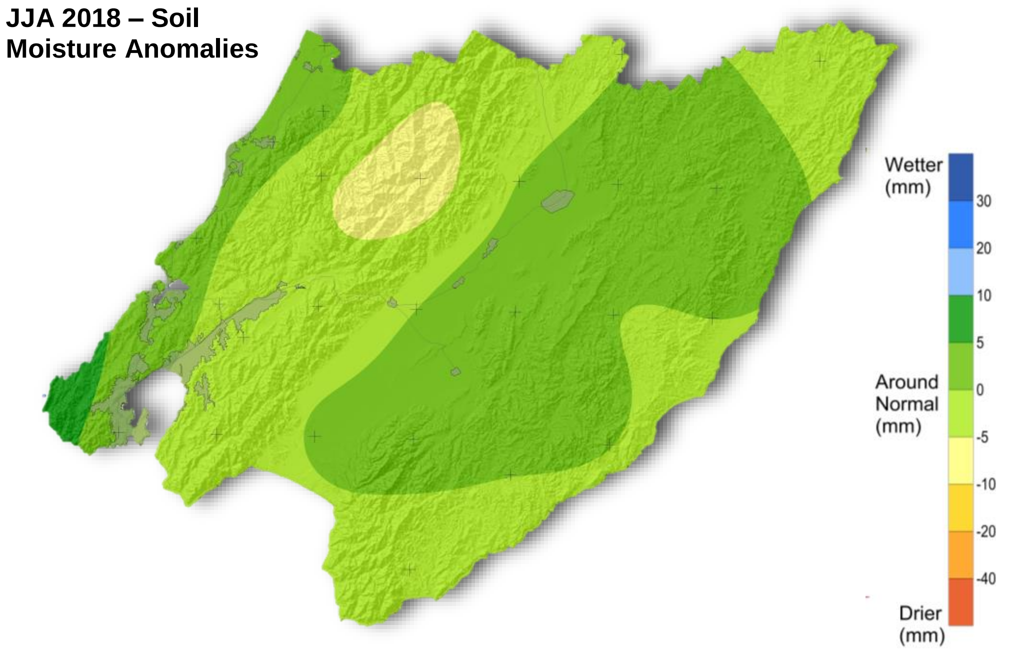


Figure 2.3: Winter (JJA 2018) soil moisture anomaly. Moisture levels show normal or above normal conditions for most of the region. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. ***Note that this data is indirectly calculated by modelling and interpolation 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 winter) rainfall expressed as a percentage of the long-term average. We can see that the pattern was extremely variable, with very wet conditions in the east for June, and very wet in the west during July. For the seasonal total, the influence of the westerly pattern led to abundant positive anomalies on the west coast, as a result of the negative Southern Annular Mode discussed in 1.3.

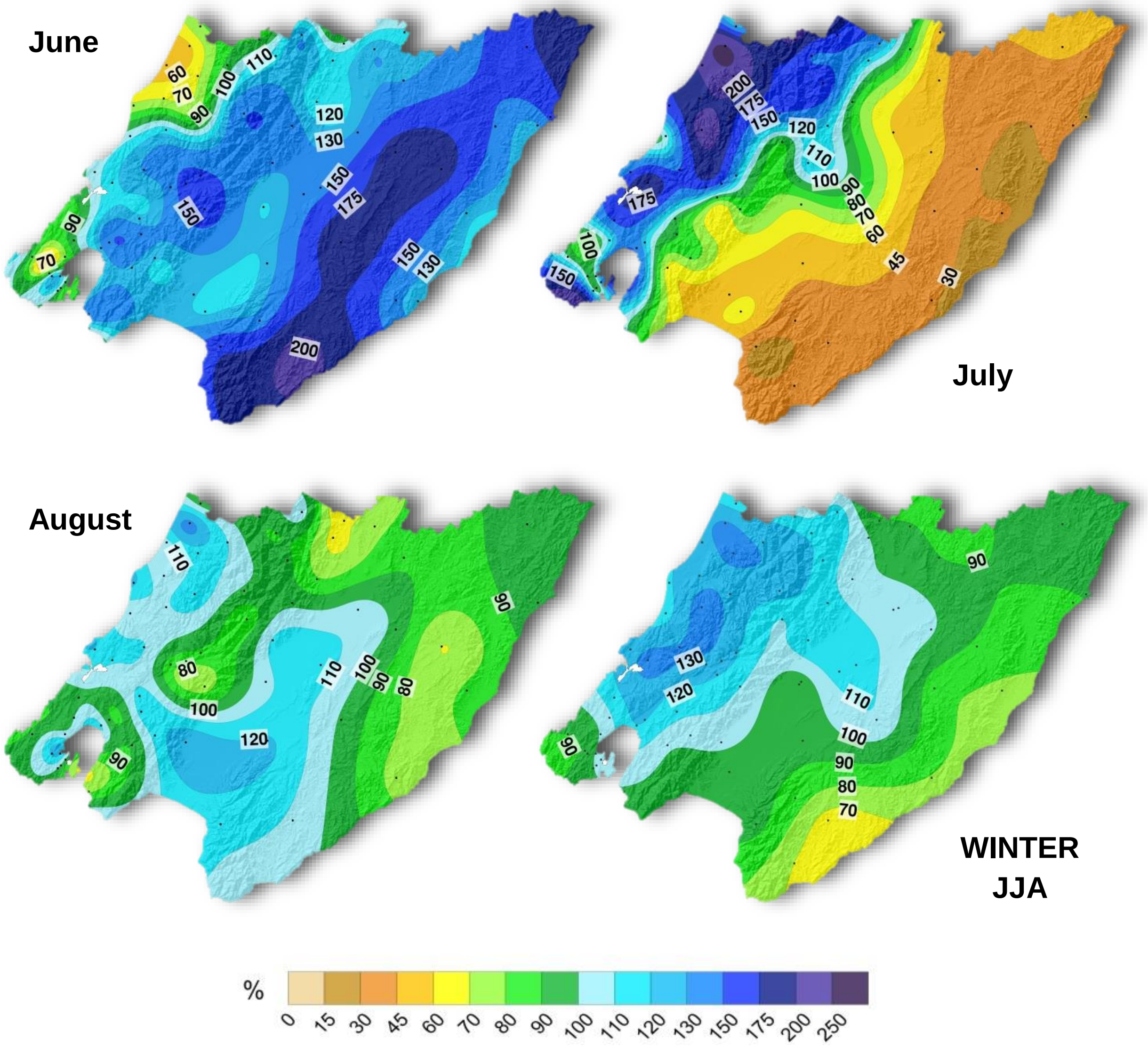


Figure 2.4: Rainfall for June, July, August and JJA 2018 as a percentage of the long-term average. Rainfall was extremely variable, very wet in the east in June, very wet in the west in July, and near normal in August. Source: GWRC and NIWA.

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 t-Student test.

The climate change and variability summary for winter is:

- Statistically significant trends are seen only for temperature, but they are fairly strong (1.3^{o}C per century in Kelburn and 1.2^{o}C per century in Masterton over the period 1910-2018);
- Winter 2018 temperature was well above average for both Wellington and the Wairarapa;
- Sunshine hours were very low for Wellington, but near normal for the Wairarapa;
- Wind speed was slightly below average;
- Rainfall and rain days were above average in Wellington.

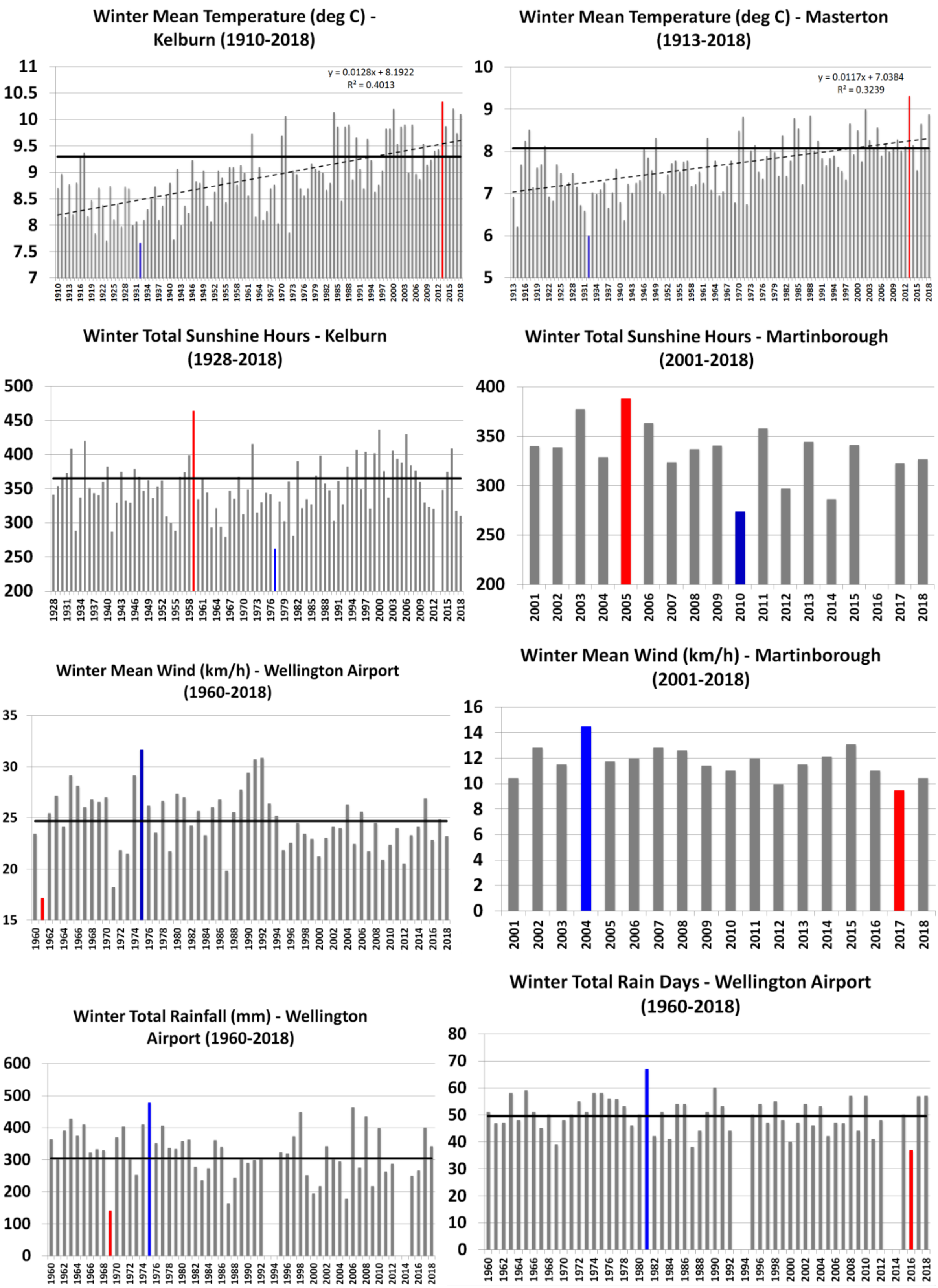


Figure 2.5: Climate change and variability graphs for winter in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (when available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs,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

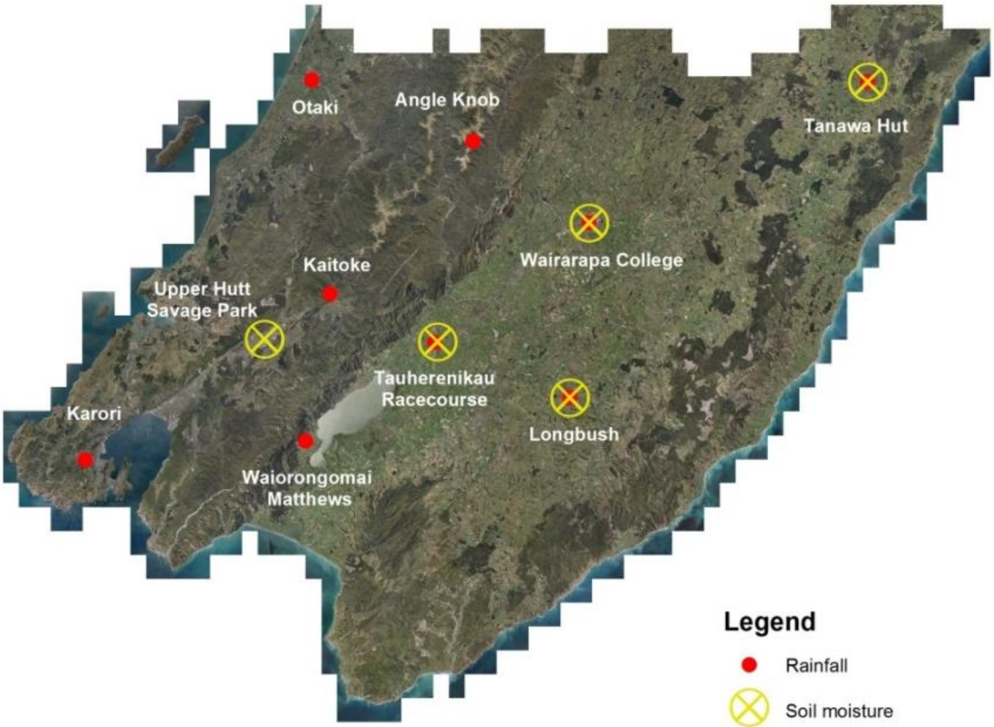


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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.

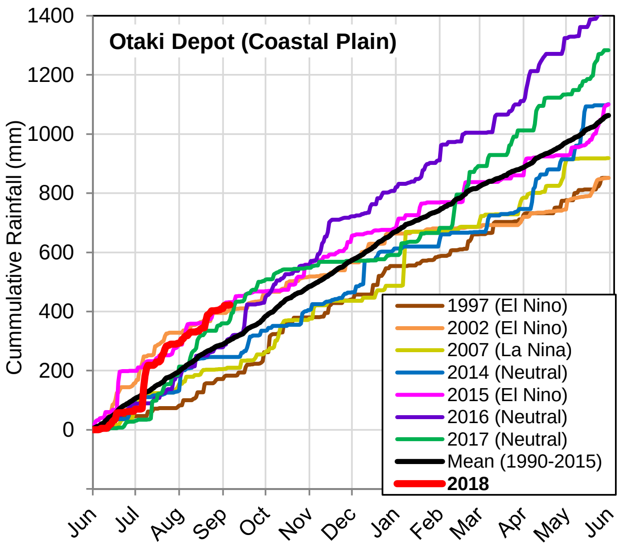
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

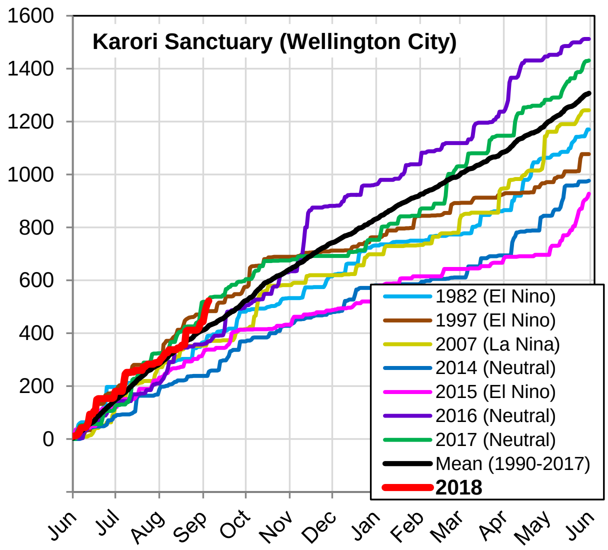
GWRC does not operate a rain gauge in the southern-most parts of the Wairarapa Valley that is suitable for presenting data in this report. This means that we cannot be confident that the rainfall patterns seen elsewhere extend to this part of the region other than the satellite and VCN data already presented.

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

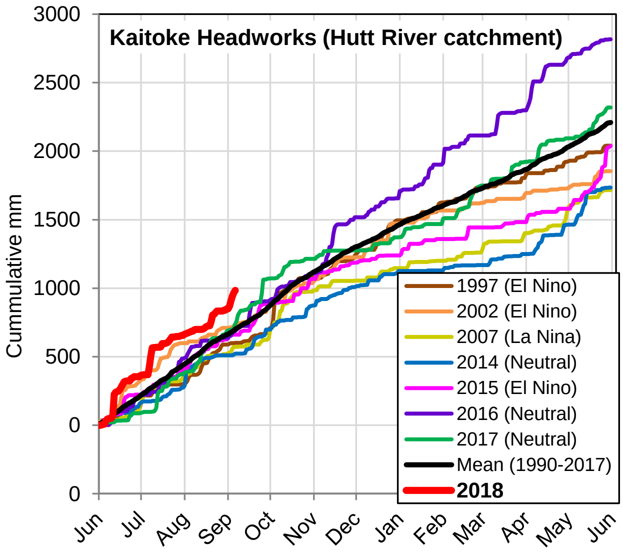
The above average rainfall experienced in the eastern hills during June is evident in the steep accumulations at the Tanawa Hut and Longbush sites. Likewise, the very wet July conditions over the Kapiti Coast are evident in the Otaki Depot graph.

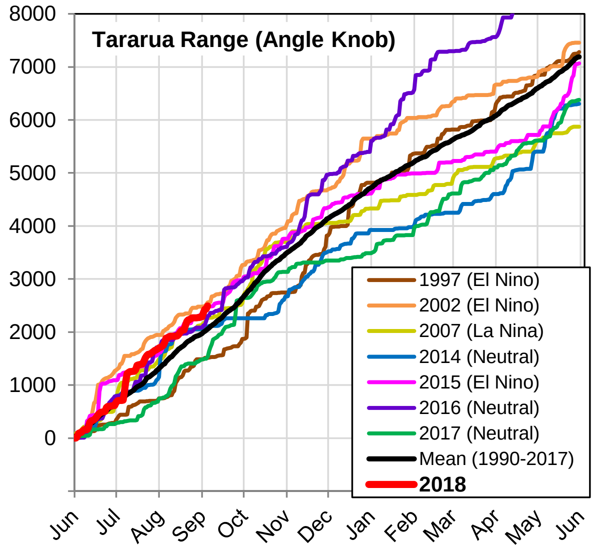
Kāpiti Coast and Southwest (Wellington city)



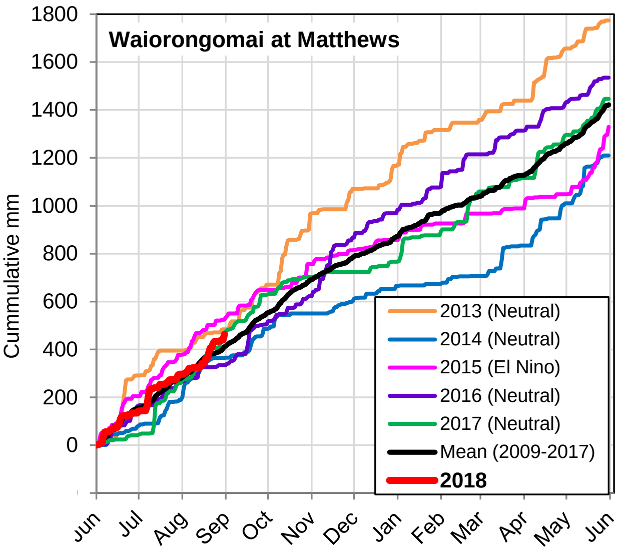


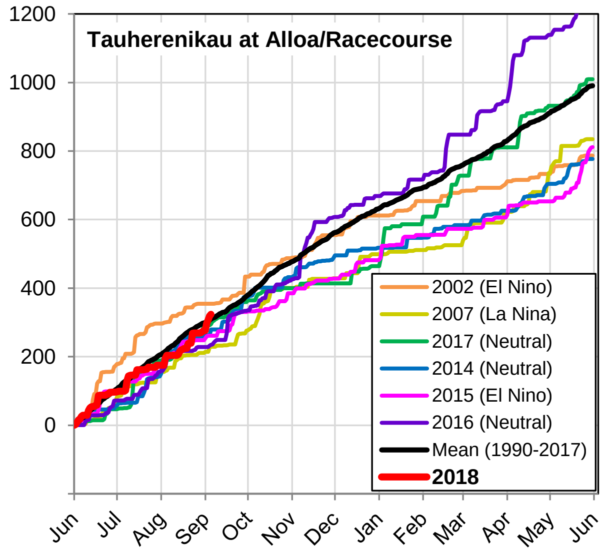
Hutt Valley and the Tararua Range

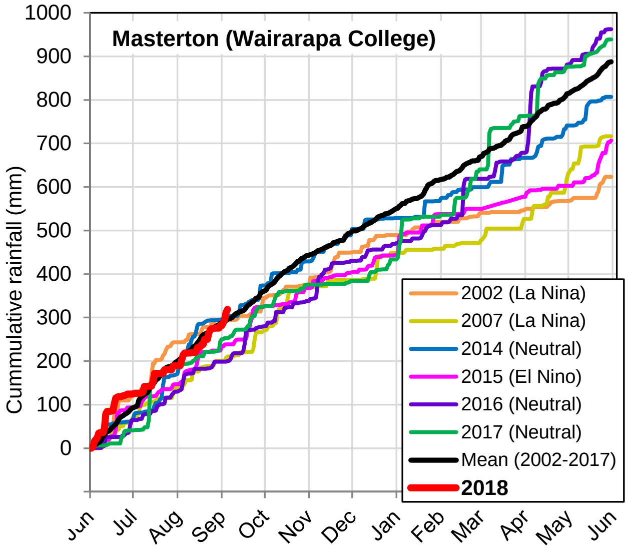


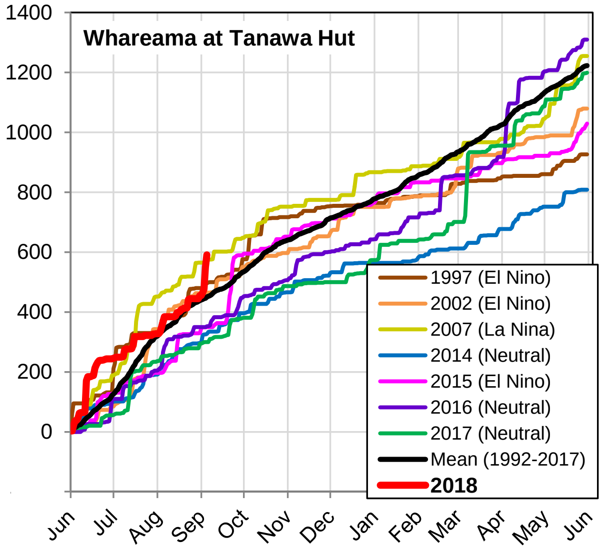


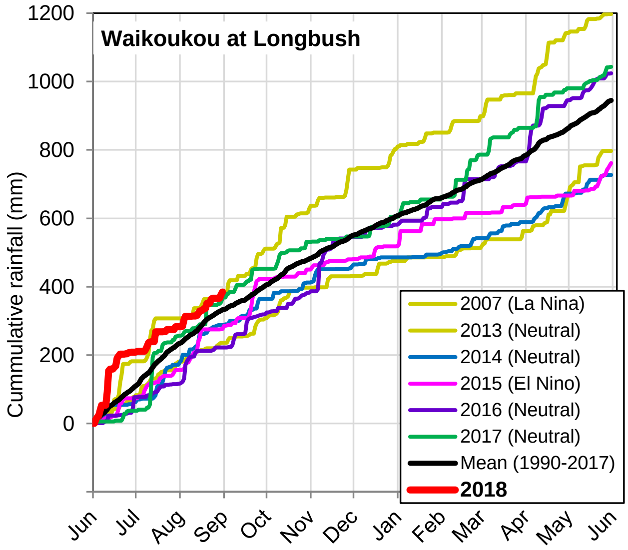
Wairarapa


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)

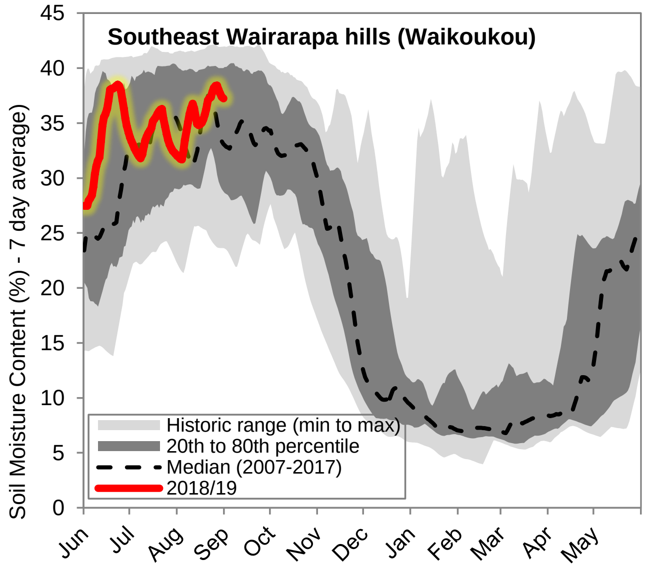
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2018. This is plotted over an envelope of the range of historic recorded soil moisture data (and the median) at the site to provide an indication of how the current soil moisture compares with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

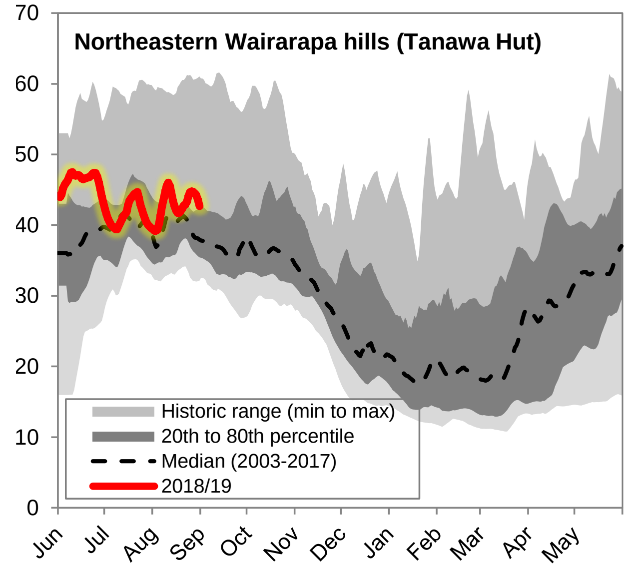
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

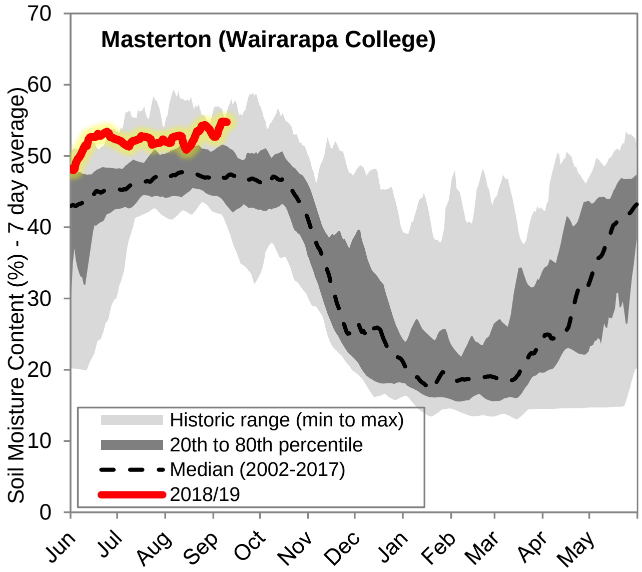
The soil moisture behaviour at the four sites in the Wairarapa has shown largely above average levels for the first three months of the 2018/19 year.

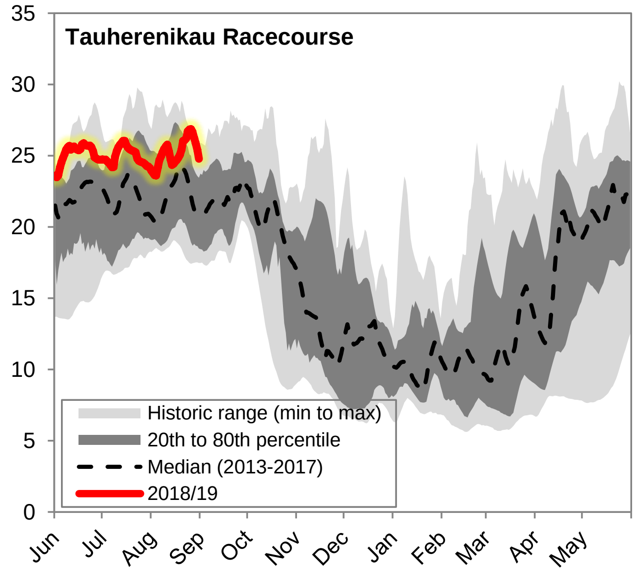
Levels at the Upper Hutt site have been tracking about average as of September.

(a) Wairarapa

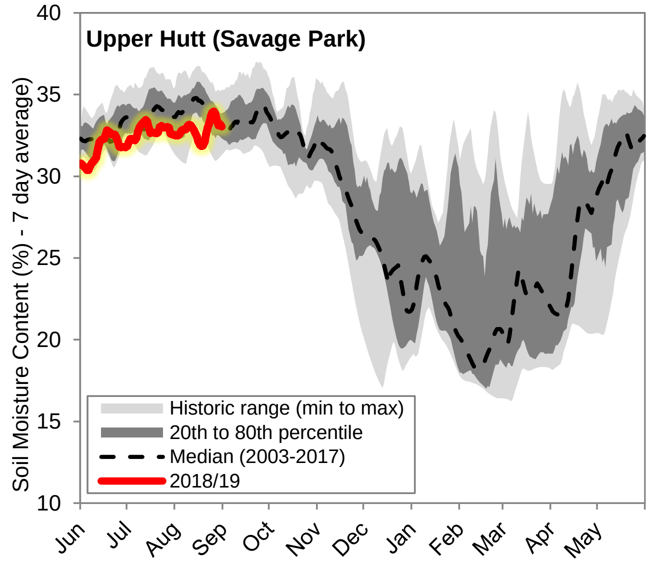








(b) Hutt Valley



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 spring 2018

- ENSO entering a new El Niño phase, but likely only weak and non-conventional (so-called El Niño "Modoki", or "pseudo El Niño");
- Sea Surface Temperature cooler to the west and warmer to the east of New Zealand contributes to counteract potential ENSO impacts;
- Possibly more easterly regime, which is opposite to the expected during "normal" El Niños (low confidence);
- Abrupt cold outbreaks in between long warmer periods (high confidence);
- Rainfall: About average, heavy easterly events likely (low confidence for average total);
- Temperatures: Average to above (moderate confidence);

Whaitua*	Variables	Climate outlook for spring 2018
Wellington Harbour & Hutt Valley	**Temperature:**	Average to above. Abrupt cold spells between longer warmer periods.
	Rainfall:	About average for the season, but very variable month to month.
Te Awarua-o-Porirua	**Temperature:**	Average to above. Abrupt cold spells between longer warmer periods.
	Rainfall:	About average for the season, but very variable month to month.
Kāpiti Coast	**Temperature:**	Average to above. Abrupt cold spells between longer warmer periods.
	Rainfall:	About average for the season, but very variable month to month.
Ruamāhanga	**Temperature:**	Average to above. Abrupt cold spells between longer warmer periods.
	Rainfall:	About average for the season, but very variable month to month. Significant easterly events possible.
Wairarapa Coast	**Temperature:**	Average to above. Abrupt cold spells between longer warmer periods.
	Rainfall:	About average for the season, but very variable month to month. Significant easterly events possible.

*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