Climate drivers and seasonal outlook for the Wellington Region

Spring 2022 summary

Summer 2022-2023 outlook

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Environmental Science Department

October 2022 was indeed a strange month for the Wellington Region. Who was expecting snow in the Wairarapa! This photo shows the snow coverage on the morning of 6 October, looking toward the Tararua Range with Parkers Road in the background (west of Masterton). Interestingly, we can see the lower Wairarapa side of the hills covered in snow, but not the higher elevation Tararuas. Most of Masterton, and especially the northern suburbs, got a good coverage of a few centimetres overnight, including the Gladstone area and most of the eastern hills – where some local 'snowman' were produced. Photo courtesy of Wairarapa Times Age.

Overview

Spring 2022

Spring 2022 was a season of sharp contrasts, oscillating between a predominantly humid north-easterly flow and polar blasts bringing significant snow accumulation to low levels in the Wairarapa towns in October (see photo on the cover). Total accumulated rainfall was well above average in the Wairarapa, but not as exceptional as the summer and winter totals across the region. Temperatures were significantly above average, largely due to the unseasonal warmth in November when marine heatwaves formed all around the country. It was the hottest November on record for virtually the entire region for the second consecutive year. For Wellington, spring 2022 was the third least windy on record, for records starting in 1960.

Climate drivers

The La Niña phenomenon continues to persist with a well-defined background signature for both the oceanic temperatures (cooler Equatorial Pacific, warmer waters around New Zealand), and the atmospheric circulation (easterlies for New Zealand). The Bureau of Meteorology in Australia is also predicting the end of a negative Indian Ocean Dipole over summer, even though La Niña effects will continue to be felt. The Southern Annular Mode has been, and is predicted to remain, significantly positive towards summer, mostly associated with dry and hot conditions in the South Island, as expected during La Niñas.

Climate outlook for summer 2022-2023

Most international climate models are consistently predicting that summer in our region will be significantly warmer and likely more humid than average, with the seas expected to remain near marine heatwave threshold in general around New Zealand. The Wairarapa should expect a higher than normal probability of thunderstorms developing under warm and humid, unstable air masses. Rainfall is expected to be average to above for the Wairarapa (totals largely depending on localised thunderstorms) and average to below on the Kāpiti Coast and Tararua Range.

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

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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 continue to remain in the La Niña phase at least until the end of the year. The influence of the La Niña easterly flow, with sea surface temperatures (SST) near marine heatwaves, should continue to impact the weather throughout most of summer.

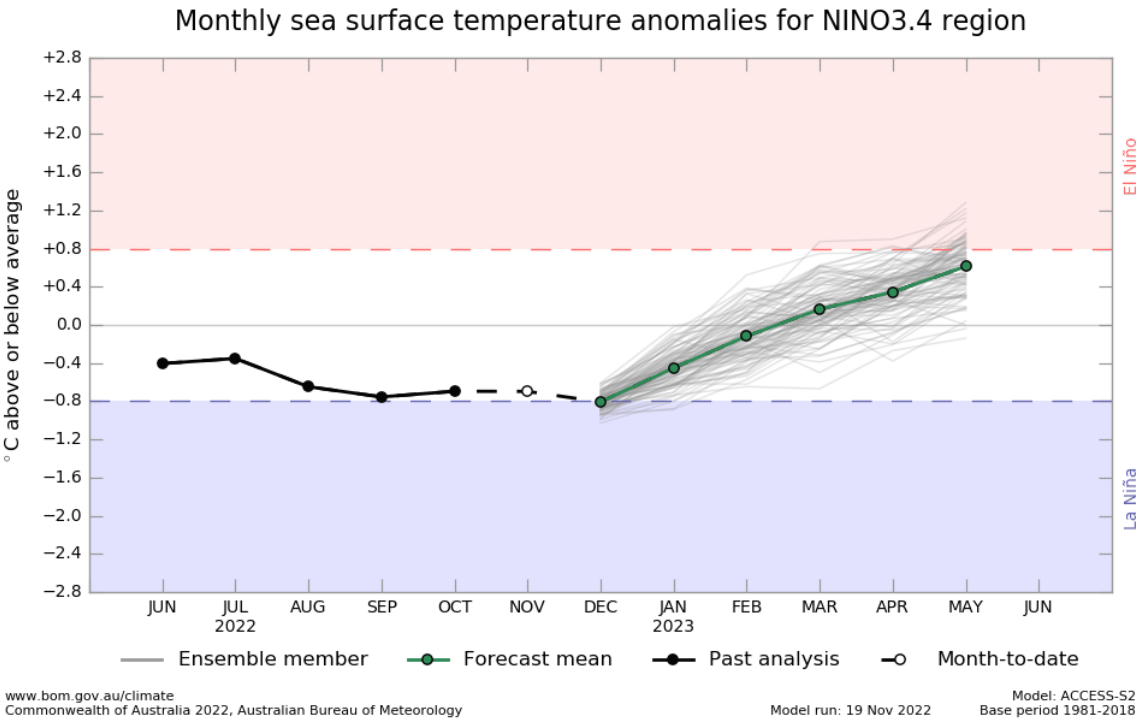


Figure 1.1: Averaged modelled projections (in green) show that the current cold phase of the ENSO phenomenon is expected to remain until the end of the year, and then progressively return back to near normal. Source: Australian Bureau of Meteorology.

1.2 Sea Surface Temperature (SST) anomalies

The SST anomalies and the total Sea Ice Extent (SIE, in white) are shown in Figure 1.2, as of 3 December 2022.

The overall pattern shows a mature La Niña in the Equatorial Pacific (cold tongue), and warmer than average SSTs around and north of New Zealand. The SIE (in white) remains below average, following an almost exact pattern to what was observed last year.

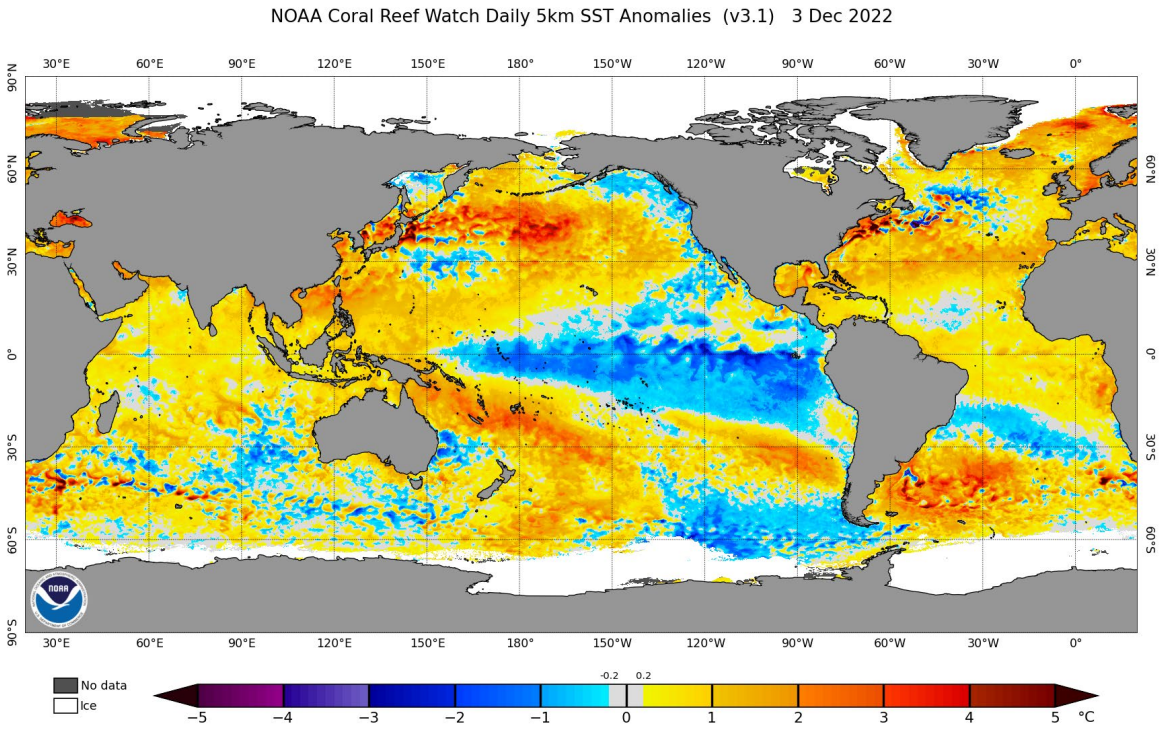


Figure 1.2: Sea Surface Temperature (SST) anomalies as of 3 December 2022. Sea ice coverage is shown in white. Water temperatures north of New Zealand are well above average. The Equatorial Pacific (ENSO) is showing an active La Niña pattern (cold equatorial waters) for the third consecutive year. The Sea Ice Extent (in white) has been consistently below the long-term average, and on a very similar trajectory compared to last year. 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. During La Niña summers, the focal centre of dryness associated with the positive SAM phase tends to concentrate more strongly to the west of the South Island.

The SAM has been predominantly positive, and is predicted to remain positive during summer. The combination of a positive SAM and La Niña, with background global warming escalating the likelihood of marine heatwaves around New Zealand, should virtually guarantee a warmer than average, and likely humid, summer season. The total rainfall amounts will be largely dependent on the formation of atmospheric river events, ex-tropical cyclones, and the propagation of moist air masses unstable enough to generate thunderstorms.

Figure 1.3 shows that the spring sea level pressure pattern was characterised by a combination of high pressures to the east and south of New Zealand, and low pressures over Australia.

This La Niña-induced pattern continued to bring a substantial north-easterly flow into the country, creating very humid 'corridors' and favouring the development of atmospheric river events, with seasonal rainfall largely above average in the Wairarapa.

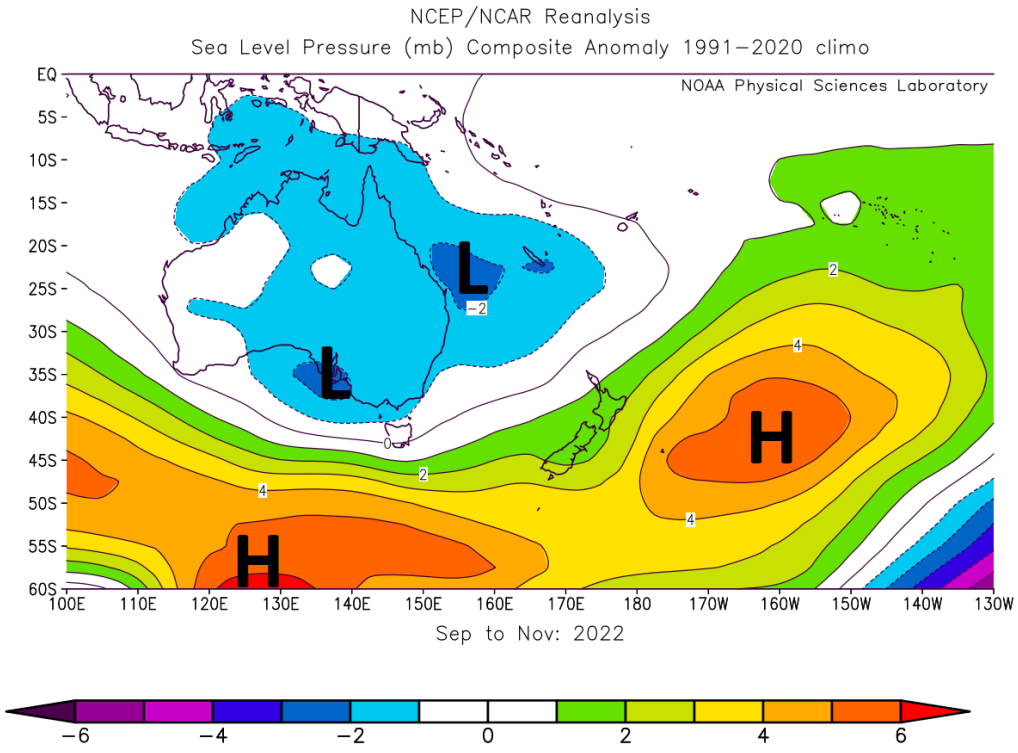


Figure 1.3: Mean sea level pressure anomaly map (hPa) for spring 2022. The 'H' indicates the centre of the anomalous high pressure areas and the 'L' indicate the anomalous low pressure areas. This pattern was associated with a positive Southern Annular Mode, and a predominant warm and moist north-easterly flow over New Zealand. The very active subtropical 'monsoon' is seen by low pressure east of Australia, which caused unprecedented floods in New South Wales. The moist air arriving in New Zealand further increased its moisture while crossing the marine heatwave area north of the country. Source: NCEP Reanalysis.

2. Seasonal variability and outlook

2.1 Trend analysis

The graphs below (Figure 2.1) 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 different from zero at the 99% confidence level.

The climate change and variability summary for spring is as follows:

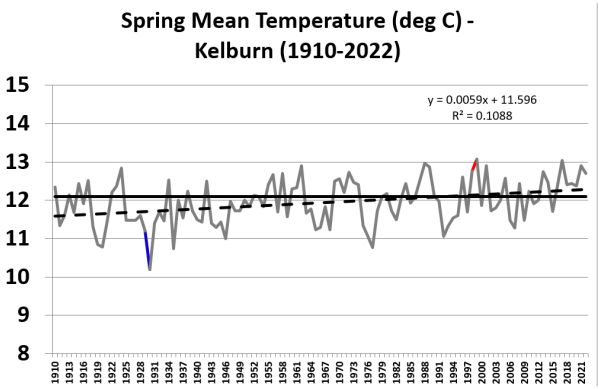
- Statistically significant trends are seen only for temperature and wind, meaning that spring is getting warmer and less windy in Wellington as a result of ongoing climate change. The long-term warming trend is about 0.5 and 0.6 degree per century for Masterton and Wellington respectively. Spring has a much smaller warming trend (about a third) compared to the maximum seasonal warming observed in winter;

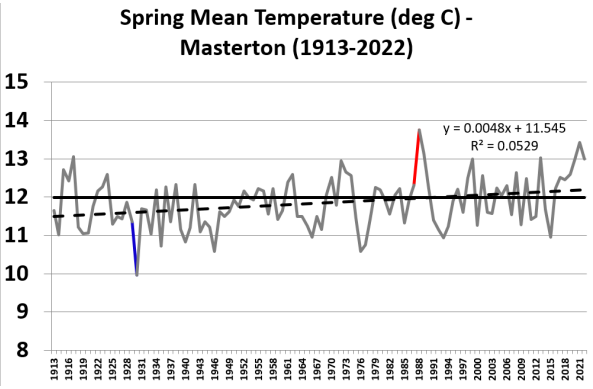
- Spring 2022 temperatures were significantly warmer than normal for both Wellington and the Wairarapa;

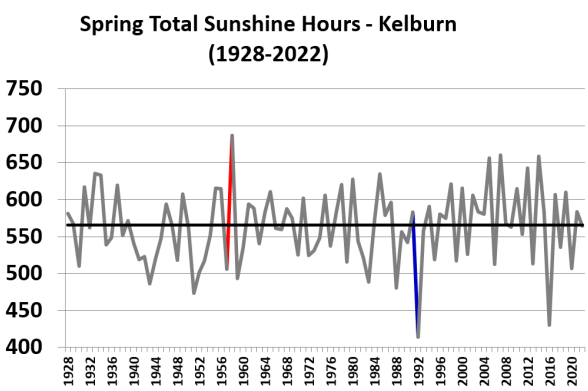
- Sunshine hours were about average in Wellington and below average in the Wairarapa;

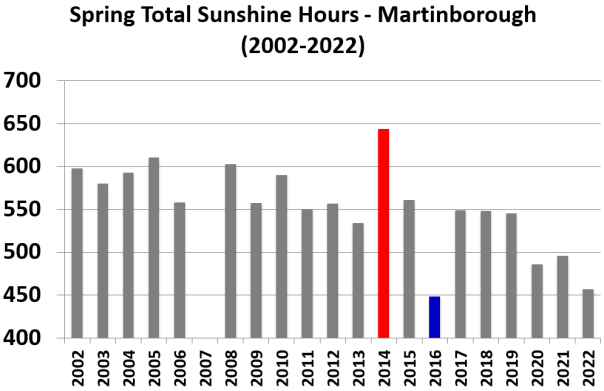
- Seasonal average wind speed was the third lowest on record in Wellington, and below average in the Wairarapa;

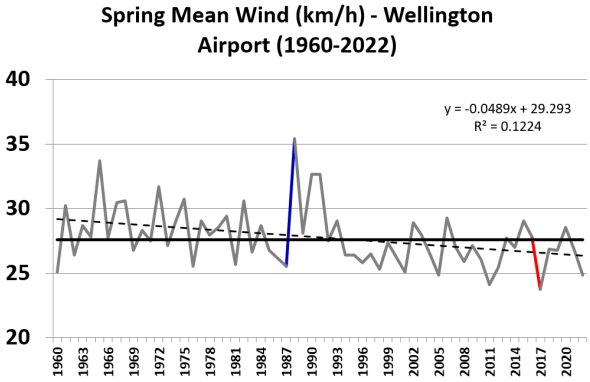
- Seasonal rainfall was near average and rain days were well above average for Wellington. For the Wairarapa, rainfall was well above average.

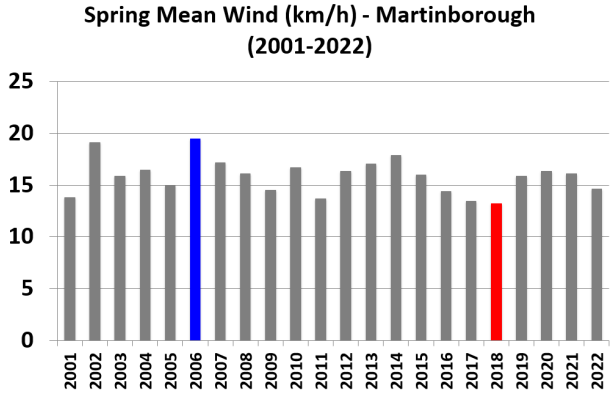

Spring Mean Temperature (deg C) - Kelburn (1910-2022)
y = 0.0059x + 11.596
R² = 0.1088


Spring Mean Temperature (deg C) - Masterton (1913-2022)
y = 0.0048x + 11.545
R² = 0.0529


Spring Total Sunshine Hours - Kelburn (1928-2022)


Spring Total Sunshine Hours - Martinborough (2002-2022)


Spring Mean Wind (km/h) - Wellington Airport (1960-2022)
y = -0.0489x + 29.293
R² = 0.1224


Spring Mean Wind (km/h) - Martinborough (2001-2022)

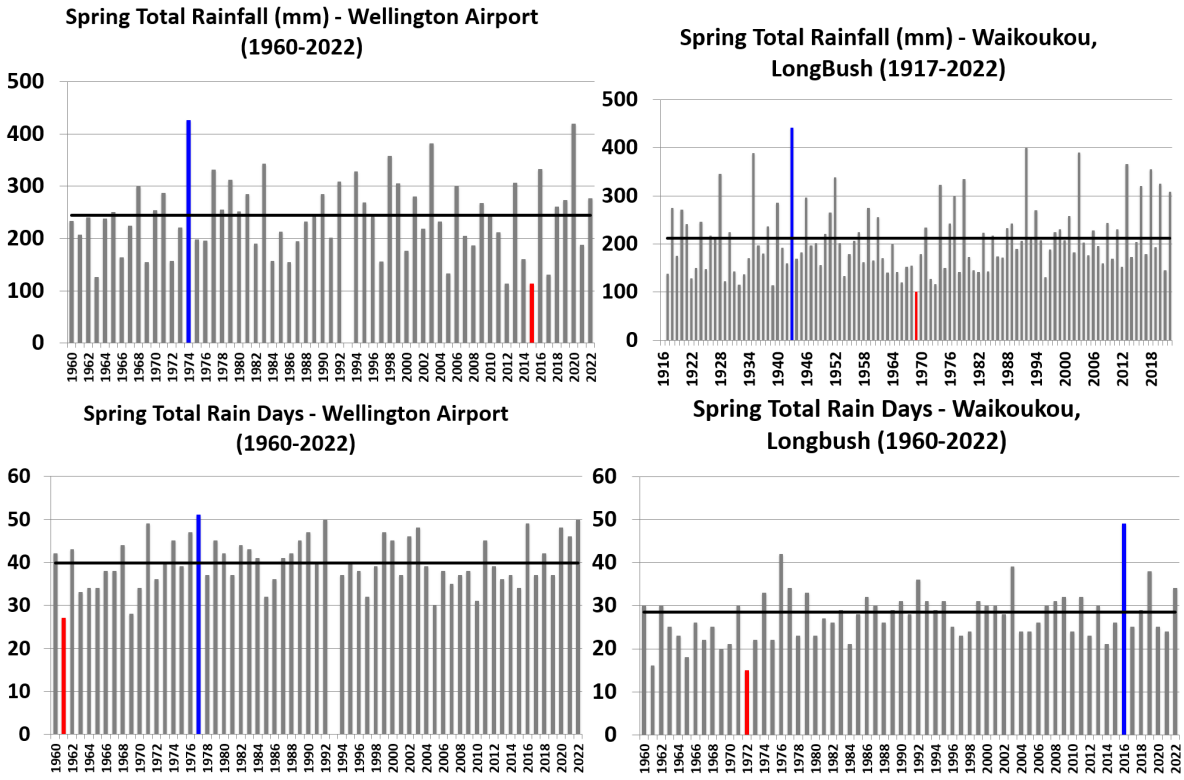


Figure 2.1: Climate change and variability graphs for spring in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs, 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 (or data point) of each graph shows the last available data for the currently analysed season, unless there are missing data.

2.2 Seasonal Outlook

- A mature La Niña is expected to continue to influence the weather patterns, with humid easterly flow;
- Sea Surface Temperatures are predicted to remain warmer than average around and north of New Zealand, providing greater moisture input for moist air masses with thunderstorms and extreme rainfall events;
- Total seasonal rain possibly below average in the Kāpiti coast and Tararua Range, and normal to above for most of the rest of the region;
- Above average temperatures. High humidity, and marine heatwaves likely

Whaitua*	Variables	Climate outlook for summer 2022-2023
Wellington Harbour & Hutt Valley	**Temperature:**	Above average; humid easterlies.
	Rainfall:	Average. High chance of extreme rainfall events.
Te Awarua-o-Porirua	**Temperature:**	Above average; humid easterlies.
	Rainfall:	Average. High chance of extreme rainfall events.
Kāpiti Coast	**Temperature:**	Above average; humid easterlies.
	Rainfall:	Average to below. High chance of extreme rainfall events.
Ruamāhanga	**Temperature:**	Above average; humid easterlies.
	Rainfall:	Average to above. High chance of extreme rainfall events and thunderstorms.
Wairarapa Coast	**Temperature:**	Average; humid easterlies.
	Rainfall:	Average to above. High chance of extreme rainfall events and thunderstorms.

*Whaituas are the whole catchment areas (https://www.gw.govt.nz/environment/freshwater/protecting-the-waters-of-your-area/)

Appendix 1 – Seasonal temperature and wind anomalies for selected stations

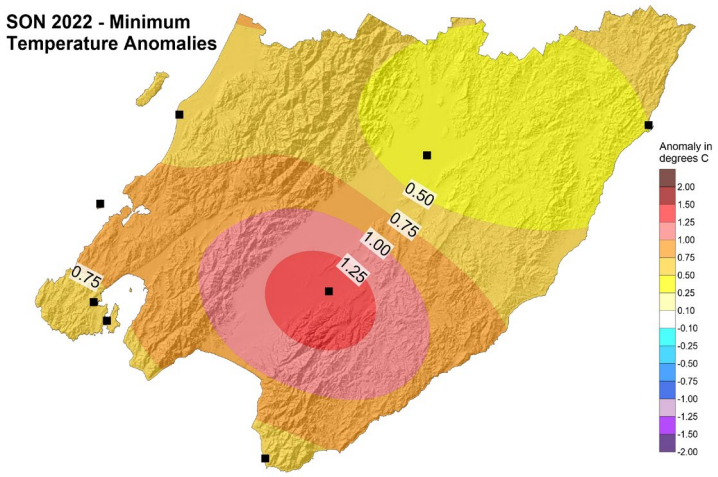
Sep-Oct-Nov 2022	Min T	Max T
Castle Point	**0.5**	**-0.1**
Kelburn	**0.7**	**0.7**
Masterton	**0.3**	**-0.1**
Ngawi	**0.6**	**0.4**
Paraparaumu	**0.6**	**1.0**
Wellington Airport	**0.7**	**0.7**
Martinborough	**1.4**	**0.6**
Mana Island	**0.9**	**1.4**

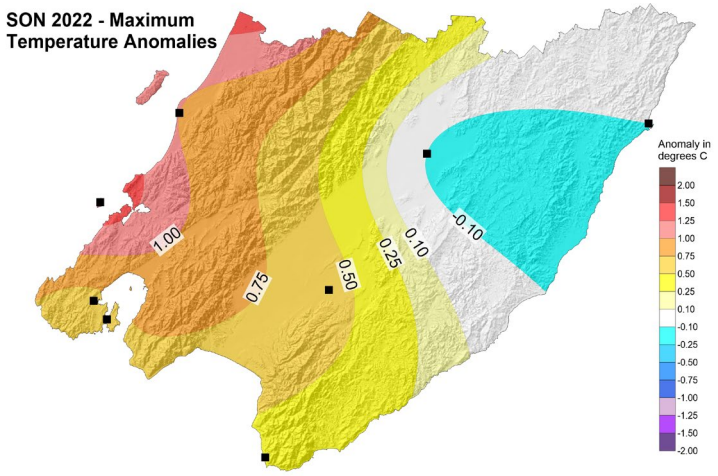
Table 1: Temperature anomalies (°C) for spring (SON) 2022 relative to the 1981-2010 climatology. Significant positive and negative anomalies (greater than 0.5°C magnitude) are highlighted in red (warmer than average) and blue (colder than average).

Sep-Oct-Nov 2022	Wind %
Castle Point	**-14.8**
Masterton	**-17.2**
Ngawi	**-7.4**
Paraparaumu	**-13.5**
Wellington Airport	**-9.9**
Martinborough	**-9.4**
Baring Head	**-3.8**

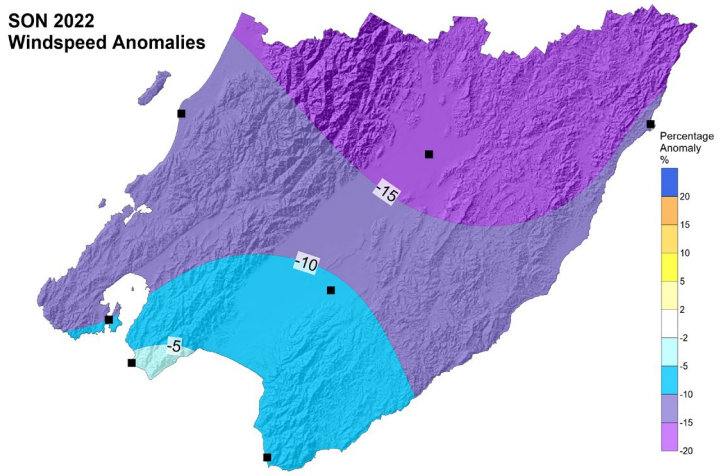
Table 2: Wind anomalies (%) for spring (SON) 2022 relative to the 1981-2010 climatology. Significant positive and negative anomalies (greater than 5%) are highlighted in red (calmer than average) and blue (windier than average).

Appendix 2 - Seasonal anomaly maps in relation to the (1981-2010) long-term averages

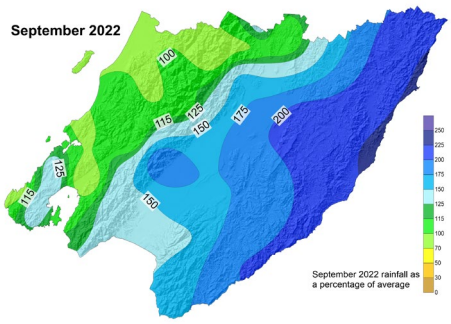


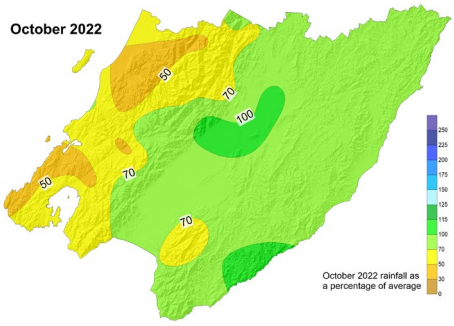


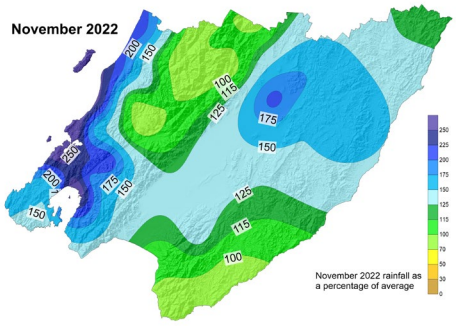
Min and Max Temperature anomalies (°C)

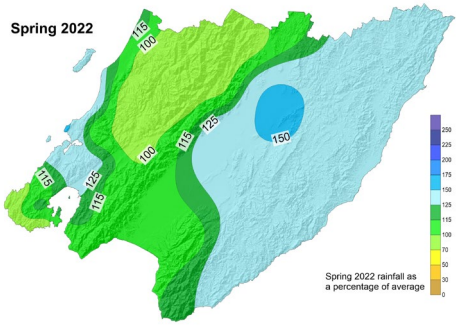


Wind anomalies (%)









Rainfall anomalies (%)

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 and rainfall tables (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/