Climate drivers and seasonal outlook for the Wellington Region

Winter 2022 summary

Spring 2022 outlook

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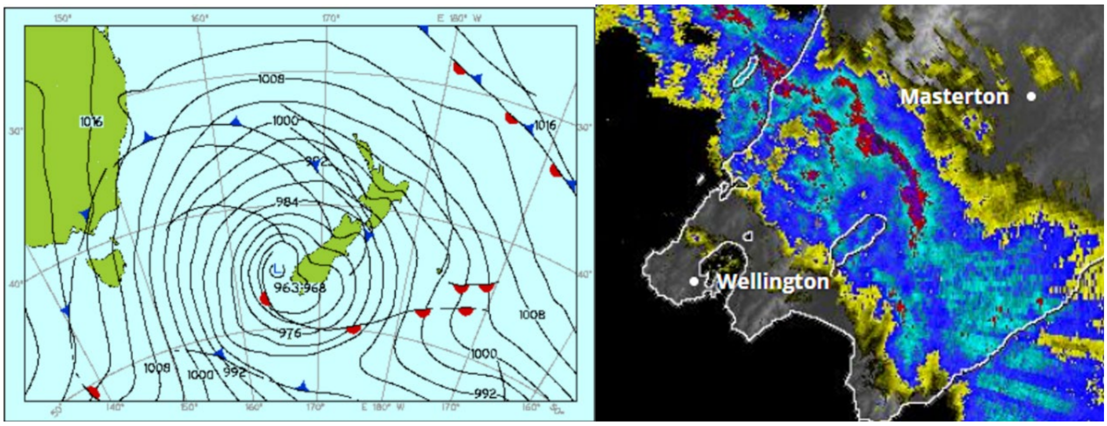
Environmental Science Department



June 2022 was a month of fierce weather activity. A 968hPa low pressure crossed the southern South Island in the morning of June 1st. Just a week later, another impressive series of storms culminated in a new low (963 hPa, pictured on the left image) crossing the southern tip again. The Wellington region experienced severe thunderstorms and impressive rainfall rates of 10 mm in five minutes measured in Kelburn on 9 June, which corresponds to 120 mm/h rate. **Left:** Synoptic Chart for 6pm on June 12, when the second low finally crossed the southern tip. **Right:** Radar image for 7pm June 12. An impressive line of thunderstorms, hail and potential tornadoes was crossing the region from Kapiti to the Wairarapa. Images courtesy of MetService.

Overview

Winter 2022

Winter 2022 was the warmest on record for our region, and New Zealand as a whole, for the second consecutive year. On top of that, the western side of the ranges also had the wettest winter on record. Importantly, the sum of the total rainfall for summer and winter (i.e. added up) was the largest on record by a very substantial margin for Wellington, after the two individual seasons were also unprecedented. The cumulative impact of a record wet winter following a record wet summer led to highly saturated soils without time for recovery, contributing to widespread slips by the end of winter. Various other records were also observed either individually or seasonally. For night-time minimum temperature, for example, virtually all stations in the region had all-time records broken for both the highest averages and the warmest individual nights. For maximum day-time temperatures the records were slightly less widespread but still of interest. Noteworthy records were set for Paraparaumu with almost 20 degrees on 26 July (that's the mid of winter!), and 22 degrees in Ngawi on 19 August. In the Wairarapa, Martinborough measured 115 km/h gusts on 13 June, which is also an all-time record, along with almost 160 km/h on 21 July for Baring Head (in that case it was a southerly blast!). Severe thunderstorms and even tornadoes also affected the region several times this winter, at times, with a large thunderstorm line crossing the whole region from west to east (see back cover above). On all accounts, this was one of the most remarkable winters the region has ever recorded.

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 a negative Indian Ocean Dipole over spring.

Climate outlook for spring 2022

Most international climate models are predicting that spring in our region will be warmer than average, with the seas expected to remain warmer than normal around New Zealand. The combined effect of the climate drivers described above also increases the likelihood of continued above normal rainfall for the west of the ranges, and about normal rainfall for the Wairarapa. There is a high chance that extreme weather events will continue to batter the region, both westerly and easterly events, as the oceanic waters remain anomalously warm.

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).

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 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 warmer than average waters around New Zealand and marine heatwaves should continue to impact the weather throughout spring.

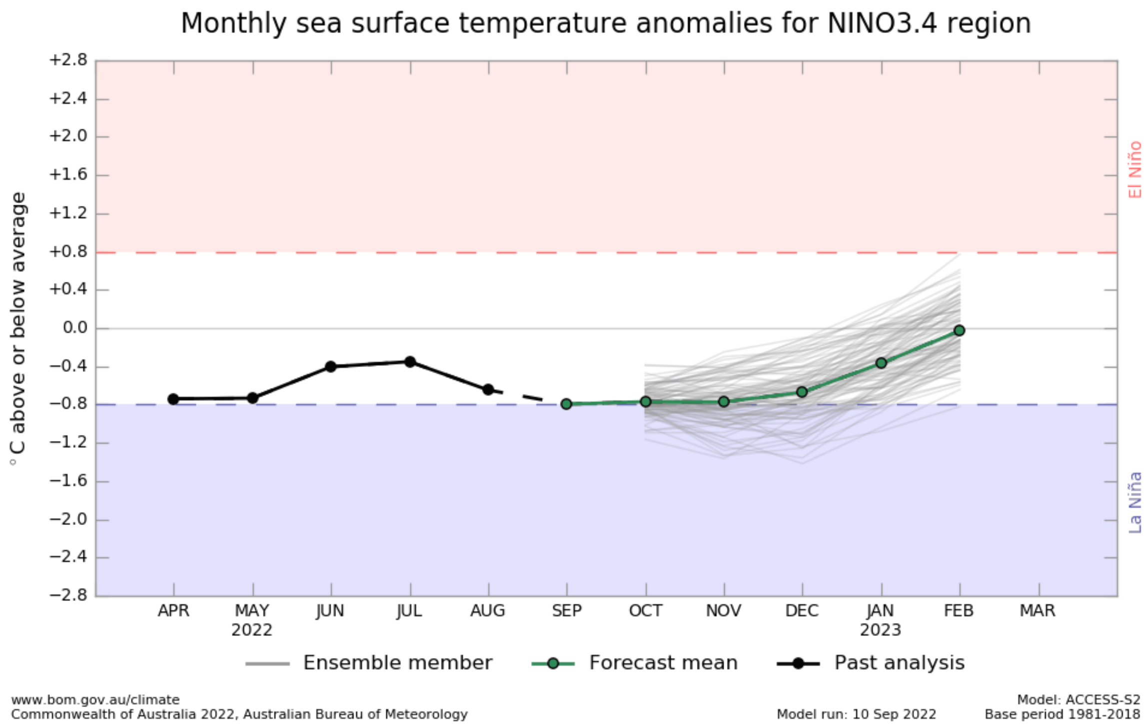


Figure 1.1: Averaged modelled projections (in green) show that the current cold phase of the ENSO phenomenon is expected to remain until the end of the year, and then slowly return to near normal. Source: Australian Bureau of Meteorology.

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 12 September 2022.

The overall pattern shows a new maturing La Niña in the Equatorial Pacific (cold tongue), and warmer than average SSTs around and north of New Zealand. The SIE (in white) is below average for this time of the year, thanks to a below average concentration to the west of the Antarctic Peninsula as seen by the dip on the map.

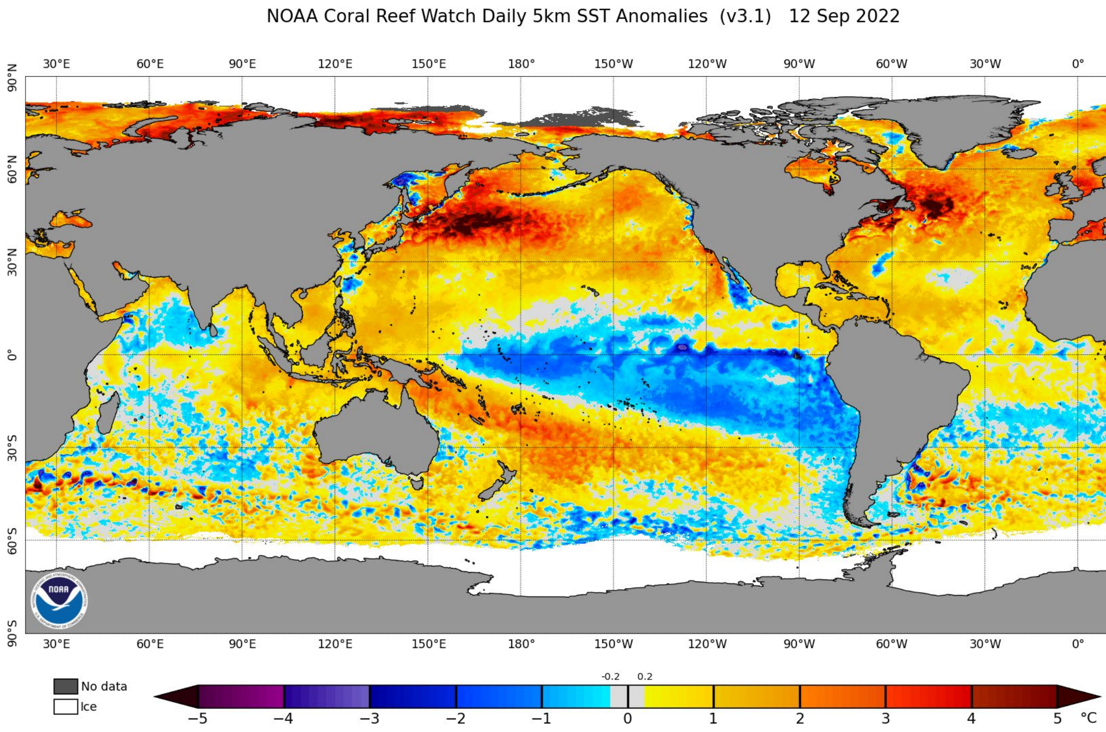


Figure 1.2: Sea Surface Temperature (SST) anomalies as of 12 September 2022. Sea ice coverage is shown in white. Water temperatures north of New Zealand are well above average. The Equatorial Pacific (ENSO) is showing another active La Niña pattern (cold equatorial waters) for the third consecutive year. The Sea Ice Extent (in white) has been consistently below the long-term average. Source: NOAA.

1.3 Southern Annular Mode (SAM)

The SAM is the natural pressure oscillation between mid-latitudes and the Antarctic region. Normally, positive SAM is associated with high pressures around the North Island keeping the weather stable and dry/cloud-free (especially in summer), whereas the opposite is expected when the SAM is in the negative phase.

The SAM has been predominantly positive (except in June), as normally expected for a La Niña year. The prevailing north-easterly flow coupled with a marine heatwave around New Zealand meant that there was significant atmospheric instability allowing for heavy rainfall events to develop, manifesting as atmospheric rivers with very substantial amounts of moisture-laden clouds.

According to observations by NIWA, the atmospheric rivers that affected New Zealand this winter were the strongest ever measured in recorded history. This helps explain so many rainfall records for both shorter and longer durations, which in turn contributed to widespread slips in many areas.

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

This La Niña-induced pattern continued to bring a substantial north-easterly flow into the country, creating very humid 'corridors' over marine heatwaves north of the country, and favouring the development of atmospheric river events with unprecedented strength.

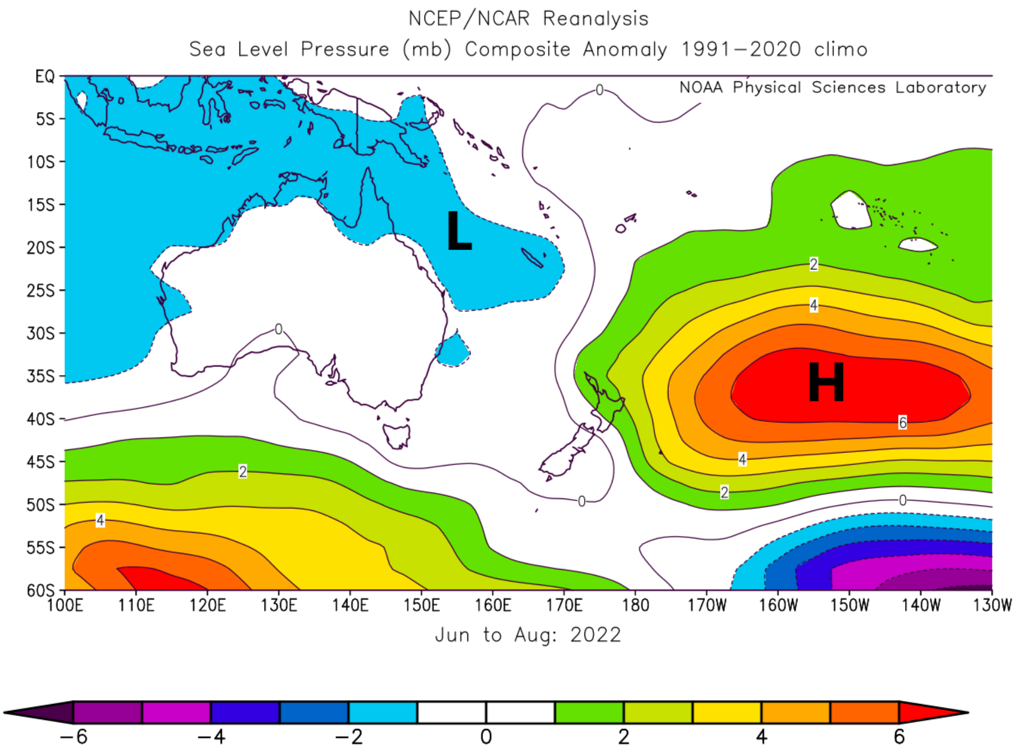


Figure 1.3: Mean sea level pressure anomaly map (hPa) for winter 2022. The 'H' indicates the centre of the anomalous high pressure areas and the 'L' indicate the anomalous low pressure areas. This pattern was associated with a positive Southern Annular Mode, and a predominant warm and moist north-easterly flow over New Zealand. The very active subtropical 'monsoon' is seen by low pressure east of Australia, which acted as a source of unprecedented atmospheric rivers affecting New Zealand. 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.

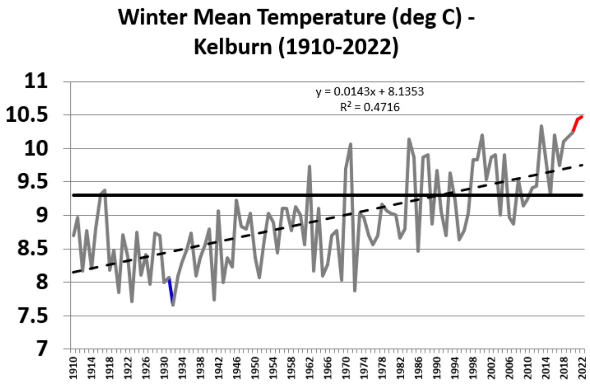
The key climate variables shown are; mean temperature, total sunshine hours, mean wind, total rainfall and total number of rain days (above 0.1 mm). Temperature measurements go back to the 1910s, allowing for a meaningful analysis of climate change trends. Most other variables also have long periods 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.

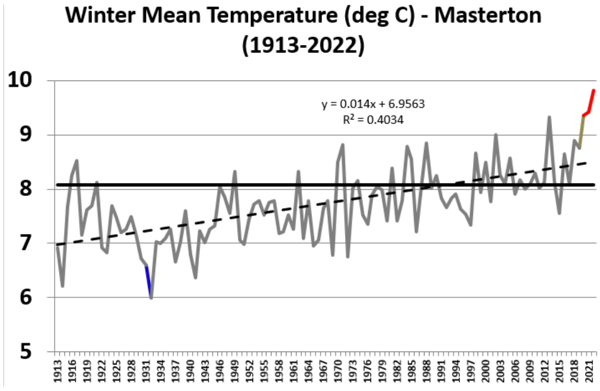
The red and blue bars show the extreme years of the entire measurement period. Red indicates seasons that were warmer, drier, sunnier and less windy than average (i.e., extreme hot/dry), and blue indicates seasons that were colder, wetter, cloudier and windier than average (i.e., extreme cold/wet). The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

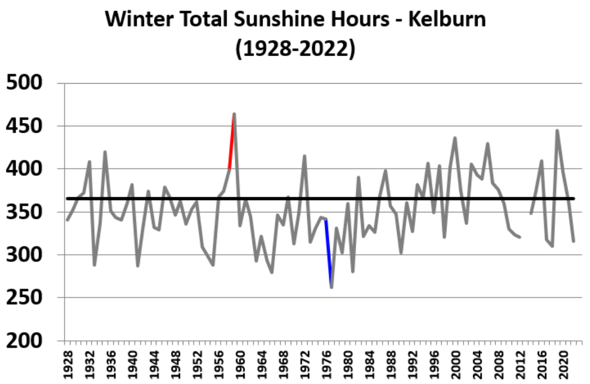
An analysis of linear trends associated with climate change is plotted onto the graph only when the trends are statistically different from zero at the 99% confidence level.

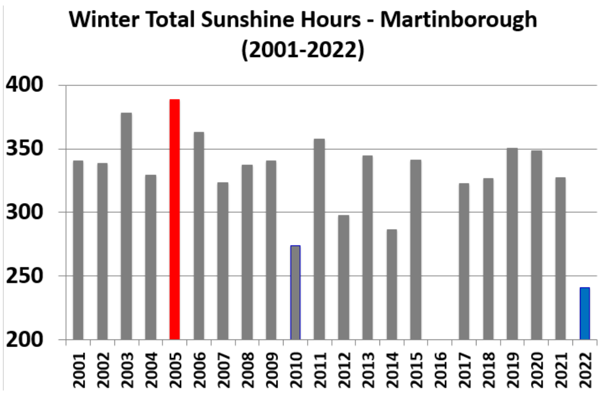
The climate change and variability summary for winter is as follows:

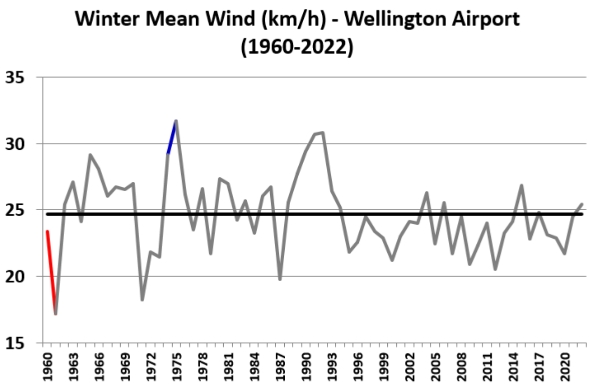
- Statistically significant trends are seen only for temperature, meaning that winter is getting warmer as a result of ongoing climate change. The long-term warming trend is about one and a half degree per century for both Wellington and Masterton. Notably, the winter warming is largely stronger in magnitude than the warming trends for any other season in our region;
- Winter 2022 temperatures were the warmest on record for the second consecutive year for both Wellington and the Wairarapa;
- Sunshine hours were well below average;
- Seasonal average wind speed was near average;
- Seasonal rainfall was the highest on record for Wellington, by a large margin. Rain days were above average, but not exceptional.

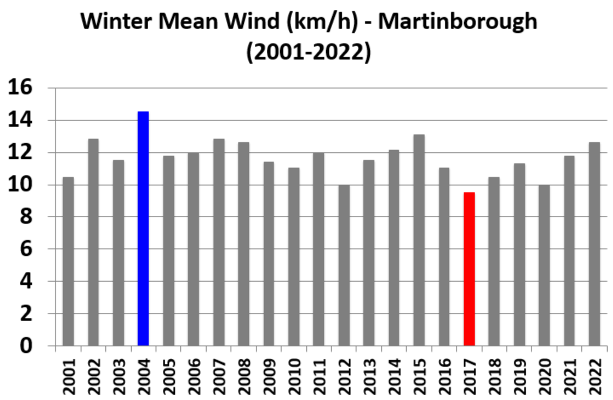

Winter Mean Temperature (deg C) - Kelburn (1910-2022)
y = 0.0143x + 8.1353
R² = 0.4716


Winter Mean Temperature (deg C) - Masterton (1913-2022)
y = 0.014x + 6.9563
R² = 0.4034


Winter Total Sunshine Hours - Kelburn (1928-2022)


Winter Total Sunshine Hours - Martinborough (2001-2022)


Winter Mean Wind (km/h) - Wellington Airport (1960-2022)


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

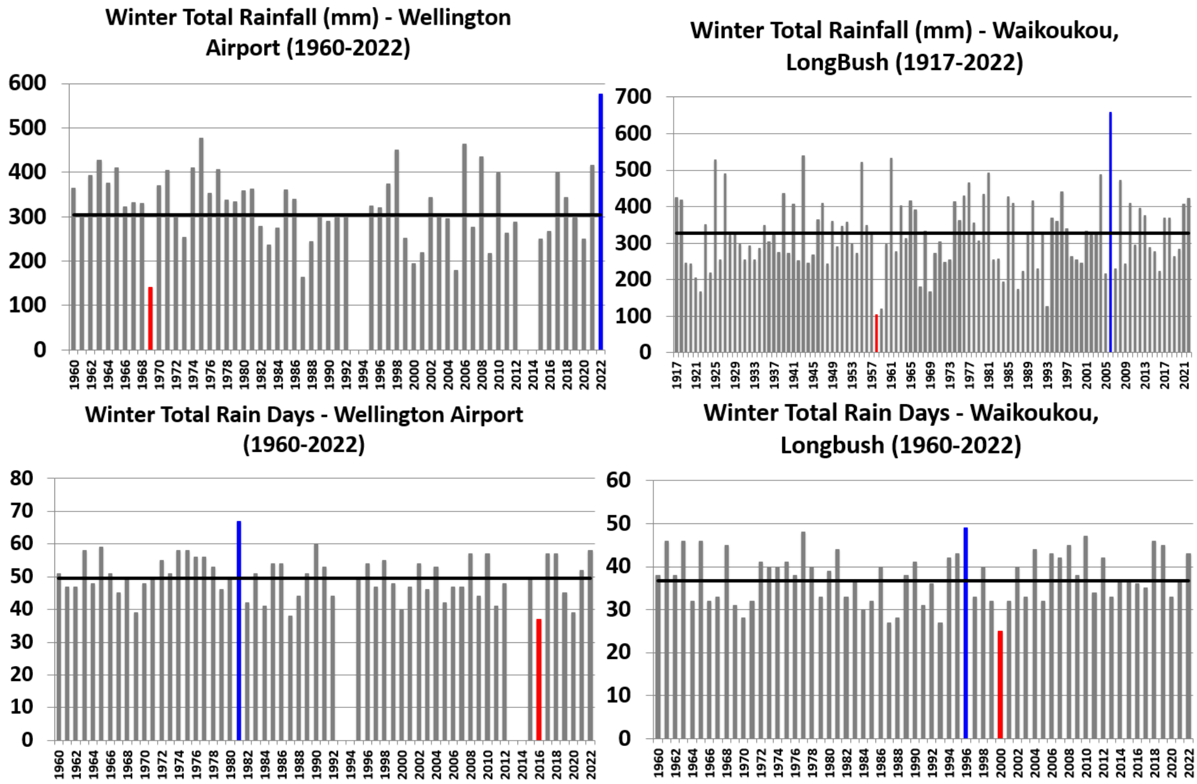


Figure 2.1: Climate change and variability graphs for winter in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs, 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 renewed 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 extreme rainfall events;
- Total seasonal rain above average in the west, and about average for the rest of the region;
- Above average temperatures, with remaining cold events more likely surging as south-easterlies.

Whaitua*	Variables	Climate outlook for spring 2022
Wellington Harbour & Hutt Valley	**Temperature:**	Above average; cold events surging mostly as south-easterlies.
	Rainfall:	Average to above. High chance of extreme rainfall events.
Te Awarua-o-Porirua	**Temperature:**	Above average; cold events surging mostly as south-easterlies.
	Rainfall:	Average to above. High chance of extreme rainfall events.
Kāpiti Coast	**Temperature:**	Above average; cold events surging mostly as south-easterlies.
	Rainfall:	Above average. High chance of extreme rainfall events.
Ruamāhanga	**Temperature:**	Above average; cold events surging mostly as south-easterlies.
	Rainfall:	About average, with low confidence for the total seasonal accumulation.
Wairarapa Coast	**Temperature:**	Above average; cold events surging mostly as south-easterlies.
	Rainfall:	About average, with low confidence for the total seasonal accumulation.

*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

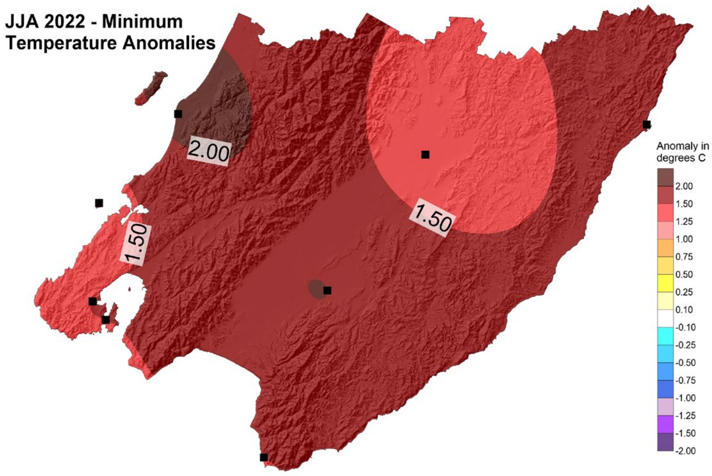
	JJA Min T	JJA Max T
Castle Point	**+1.7**	**+1.5**
Kelburn	**+1.5**	**+0.9**
Masterton	**+1.3**	**+1.0**
Ngawi	**+1.5**	**+1.5**
Paraparaumu	**+2.1**	**+1.4**
Wellington Airport	**+1.5**	**+1.3**
Martinborough	**+2.0**	**+1.3**
Mana Island	**+1.3**	**+1.4**

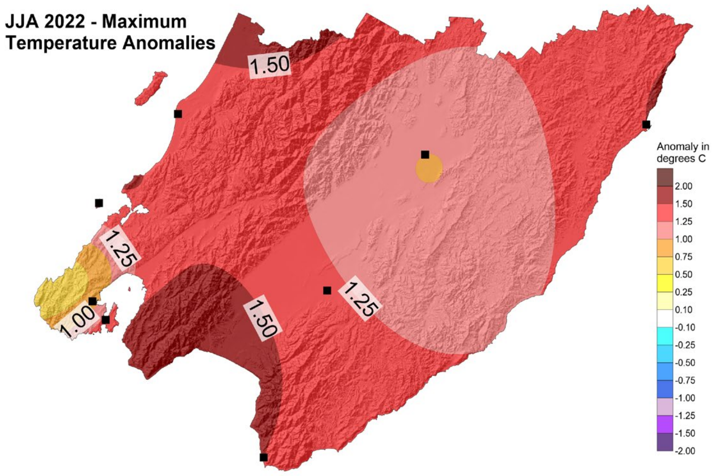
Table 1: Temperature anomalies (°C) for winter (JJA) 2022 relative to the 1981-2010 climatology. Significant positive and negative anomalies (greater than 0.5°C magnitude) are highlighted in red (warmer than average) and blue (colder than average).

	JJA **Wind %**
Castle Point	**6.7**
Masterton	**-0.3**
Ngawi	**13.9**
Paraparaumu	**8.6**
Wellington Airport	**3.1**
Martinborough	**5.9**
Baring Head	**2.4**

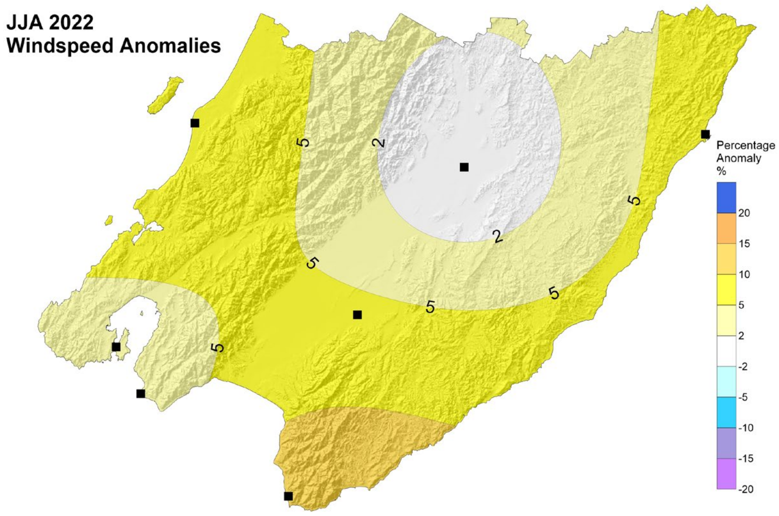
Table 2: Wind anomalies (%) for winter (JJA) 2022 relative to the 1981-2010 climatology. Significant positive and negative anomalies (greater than 10%) are highlighted in red (calmer than average) and blue (windier than average).

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

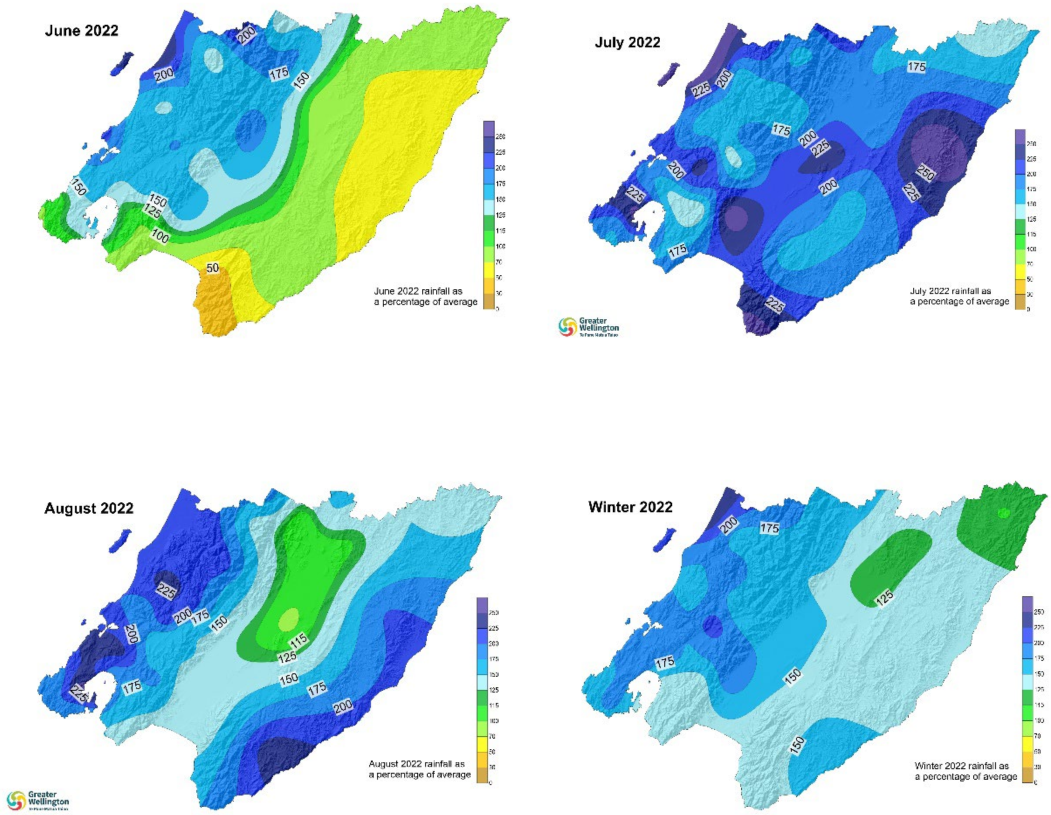




Min and Max Temperature anomalies (^{o}C)



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/