Australia’s Wine Future
A CLIMATE ATLAS

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King Valley

This research was funded by the Wine Australia Project U1556
Australia’s Wine Future: Adapting to short-term climate variability and long-term climate change

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Citation


ISBN: 978-1-922352-06-4 (electronic); 978-1-922352-05-7 (print)

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Figure 1: Observed mean Growing Season Temperature (Oct–Apr) across all growing years from 1997–2017.

Figure 2: Observed change in mean Growing Season Temperature between the current (1997–2017) and historical (1961–1990) periods. Growing Season Temperature has increased across the region over recent decades.

Figure 3: Projected mean Growing Season Temperature (Oct–Apr) for 20-year time periods from 2021 to 2100. Growing Season Temperature is expected to increase steadily into the future. Each grid cell is the mean of the 6 ensemble members.

Figure 4: Projected Growing Season Temperature (October to April) for the region.

Figure 5: Distribution of Growing Season Temperature. Grey shapes represent the probability distribution of GST for contrasting regions during 1997–2017. A shift to the right (left) indicates warmer (colder) conditions.

Figure 6: Probability distributions showing the range of dates at which the example phenological thresholds (1000, 1500, 2000, 2500) are reached. A shift to the left (right) indicates earlier (later) harvest dates.

Figure 7: Cumulative Growing Degree Days (GDD) across the growing year (July–June). Dashed lines show GDD values (1000, 1500, 2000, 2500) for some example phenological thresholds. Each growing year is represented by a colored line. In future time periods, heat accumulates faster, thresholds are reached earlier and maximum GDD reached is higher.

Figure 8: Distribution of date when Growing Degree Days reaches threshold.
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Moisture

Figure 1: Observed mean Growing Season Rainfall (Oct–Apr) across all growing years from 1997–2017.

Figure 2: Observed change in mean Growing Season Rainfall (Oct–Apr) between the current (1997–2017) and historical (1961–1990) periods.

Figure 3: Projected mean Growing Season Rainfall for 20-year time periods from 2021 to 2100. Each grid cell is the mean of the 6 ensemble members.

Figure 4: Time series of Growing Season Rainfall (mm). Blue points are the annual values for each grid cell, for each of the 6 ensemble members. Horizontal grey bars represent the mean Growing Season Rainfall value during 1997–2017 in selected regions across Australia. Horizontal grey bars indicate the expected probability distribution of rainfall across the growing year. The current period (2001–2020) is shadowed underneath the future time periods to highlight any differences expected into the future. A shift in the curve to the left (right) indicates a change towards drier (wetter) conditions.

Figure 5: Violin plots of monthly rainfall (mm) for 20-year time periods from 2001 to 2100. Each violin represents monthly totals for each grid cell, for each of the 6 ensemble members. Horizontal grey bars represent the mean Growing Season Rainfall value during 1997–2017 in selected regions across Australia.

Figure 6: Violin plots of monthly rainfall (mm) for 20-year time periods from 2001 to 2100. Each violin represents monthly totals for each grid cell, for each of the 6 ensemble members. A shift in the curve to the left (right) indicates a change towards drier (wetter) months.

Figure 7: Seasonal rainfall (Winter, Spring, Summer, Autumn) (mm), presented as a probability distribution for each 20-year period. The shape of the curve is driven by the level of variability experienced within each 20-year period. Variability can occur spatially within the region, across years, or between ensemble members. A shift in the curve to the left (right) indicates a change towards drier (wetter) conditions.

Figure 8: Distribution of number of rainy days during harvest. Number of rainy days during harvest was defined as days with >10mm of rain from 7 days before to 7 days after the date each GDD threshold was reached. Variability can occur spatially within the region, across years, or between ensemble members. A shift in the curve to the left (right) indicates fewer (more) rainy days during harvest. A missing time period indicates that the specific phenological threshold was not reached within the growing year (July–June).
Figure 1: Observed mean annual Aridity Index

Figure 2: Observed change in mean annual Aridity Index

Figure 3: Projected mean annual Aridity Index

Figure 4: Projected Aridity Index

Figure 5: Projected monthly Aridity Index

Figure 6: Distribution of seasonal Aridity Index

Figure 7: Distribution of mean Aridity Index from July until harvest

Figure 8: Violin plots of monthly Aridity Index for 20-year time periods from 2001 to 2100. Each violin represents monthly averages for each grid cell, for each of the 6 ensemble members, and for each growing year within the time period. Each violin panel shows the expected probability distribution of Aridity Index for each month across the future periods. The current period (2001-2020) is shadowed underneath the future time periods to highlight any differences expected into the future. Dots represent the mean monthly Aridity Index for each grid cell. If the dots shift lower (higher), this indicates a change towards drier (wetter) conditions.

Figure 9: Mean annual Aridity Index accumulated from start of the growing season (July) to date of harvest, presented as a probability distribution for each 20-year period. Date of harvest refers to the date at which Growing Degree Days reach some example phenological thresholds (1000, 1500, 2000, 2500), chosen to reflect development time of different grape styles and varieties. Variability can occur spatially within the region, across years, or between ensemble members. A shift to the left (right) indicates an increase in drier (wetter) conditions. A missing time period indicates that the specific phenological threshold was not reached within the growing year (July-June).
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Extremes — Hot

Figure 1: Observed mean Excess Heat Factor (EHF) during heatwaves (as per Nairn and Fawcett (2013)), across all growing years from 1997–2017. EHF is an index that characterises heatwaves; high values indicate more intense heatwaves. The mean EHF is the mean value from all heatwaves that occurred from 1997–2017.

Figure 2: Change in mean EHF during heatwaves between the current (1997–2017) and historical (1961–1990) periods. Positive (negative) values indicate a trend towards more (less) intense heatwaves.

Figure 3: Projected mean Excess Heat Factor for 20-year time periods from 2021 to 2100. Each grid cell is the mean of the 6 ensemble members. Increasing (decreasing) values indicate a trend towards more (less) intense heatwaves.

Figure 4: Time series of the number of days per growing year with temperatures greater than 30°C, 35°C, 40°C and 45°C. Areas indicate the number of days each threshold is exceeded per growing year. Values are averaged across all grid cells and the 6 ensemble members. Colours indicate each of the extreme threshold values. Generally increasing frequencies reflect a warming climate.

Figure 5: Time series of the number of days per growing year with high human heat stress. This is defined as days when daily maximum temperatures are >30°C and daily minimum humidity is >60%. These conditions cause severe risk of heat stress to humans (and potentially low productivity) to those working in exposed areas. Humans cannot work in high temperature, high humidity environments without appropriate adaptive behaviours and equipment. Points are for each grid cell from each of the 6 ensemble members. Coloured bars represent the projected global temperature increase expected into the future (following the RCP 8.5 scenario) which can be used to make decisions based on projected temperature change rather than time.

Figure 6: Violin plots of high temperatures (°C) per growing year for 30-year time periods from 1981 to 2100. Colours indicate extreme threshold values (90th, 95th and 99th percentile) of temperature during each growing year. Generally increasing values reflect a warming climate.

Figure 7: Distribution of daily minimum and maximum temperature during a heatwave

Figure 8: Distribution of the date when heatwaves occur. The shape of the curve is driven by the level of variability experienced within each 20-year period. Variability can occur spatially within the region, across years, or between ensemble members. A shift to the left (right) indicates heatwaves occurring earlier (later).
Figure 1: Observed mean number of days at risk of frost during the growing season (October to April) over the period 1997–2017. Days at risk of frost are those with a daily minimum temperature < 2°C. High (low) values indicate high (low) frost risk.

Figure 2: Change in the mean number of days at risk of frost during the growing season (October to April) between the current (1997–2017) and historical (1961–1990) periods. Days at risk of frost are days with a minimum temperature < 2°C. High (low) values indicate increased (decreased) frost risk.

Figure 3: Projected mean number of days at risk of frost during the growing season (October to April) for 20-year periods from 2021 to 2100. Each grid cell is the mean of the 6 ensemble members. Increasing (decreasing) values indicate a trend towards higher (lower) frost risk.

Figure 4: violin plots of daily minimum temperature (°C) for each month for 20-year periods from 2001 to 2020. Each violin represents daily data for each grid cell, for each of the 6 ensemble members, and for each growing year within the time period; e.g. the top-left most violin represents the daily minimum temperature for every January day in the period 2001–2020, for each grid cell in the region, for each of the 6 ensemble members. The current period (2001–2020) has been shadowed underneath future time periods to highlight any differences expected into the future. Dots represent the means for each violin. If the violin shifts lower (higher) this indicates a change towards colder (warmer) conditions.

Figure 5: Monthly average cumulative frost days for 20-year periods from 2001 to 2100. Values are a summary across all grid cells, for each of the 6 ensemble members. This reflects how frost risk varies across the year within each 20-year period. The current period (2001–2020) has been shadowed underneath future time periods to highlight any differences expected into the future.

Figure 6: Timeseries of accumulated frost intensity, which is the cumulative total of temperatures less than 2°C over a growing season. This index characterises exposure to cold conditions. High values indicate cold winters/springs. Points are for each grid cell, averaged across the 6 ensemble members.

Figure 7: Time-series of the number of days per growing year when temperatures fall below selected thresholds (< 2°C, < 0°C, < −2°C). Areas indicate the number of days temperatures fall below each threshold per growing year. Values are averaged across all grid cells and for the 6 ensemble members. Fewer instances reflect a warming climate.