Australia’s Wine Future
A CLIMATE ATLAS

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Australia’s Wine Future: Adapting to short-term climate variability and long-term climate change

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Heat

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 (Oct–Apr) from 1997–2017 minus 1964–1990.

Figure 3: Projected mean Growing Season Temperature (Oct–Apr) for 20-year time periods from 2021 to 2100.

Figure 4: Projected Growing Season Temperature (October to April)

Figure 5: Distribution of Growing Season Temperature

Figure 6: Distribution of Growing Degree Days

Figure 7: Projected cumulative Growing Degree Days

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

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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 (1997–2017 minus 1961–1990). Positive values indicate a trend towards drier conditions. Negative values indicate a trend towards wetter conditions.

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: Projected Growing Season Rainfall (October to April) for 20-year time periods from 2021 to 2100. Each violin represents monthly totals for each grid cell, for each of the 6 ensemble members, and for each growing year within the time period. In each violin, the grey bars represent the mean Growing Season Rainfall value during 1997–2017 in selected regions across Australia. These provide a comparison between current conditions (1997–2017) elsewhere and future conditions in this region and help identify future analogue regions. Coloured bars represent the projected mean global temperature increase into the future (following the RCP 8.5 scenario). These can be used to make decisions based on projected temperature change rather than time.

Figure 5: As with Figure 4, but for Non-Growing Season Rainfall (May to September). Horizontal grey bars represent the mean Non-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, and for each growing year within the time period. In each violin, the grey bars represent the mean Growing Season Rainfall value during 1997–2017 in selected regions across Australia. Differences in the shape of curves between the current and future periods indicate a change in the typical conditions. A shift to the left (right) indicates an increase in drier (wetter) conditions.

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. Grey shades represent the probability distribution of seasonal rainfall for contrasting regions during 1997–2017. Differences in the shape of curves between the current and future periods indicate a change in the typical conditions. A shift to the left (right) indicates an increase in drier (wetter) conditions.

Figure 8: Distribution of number of rainy days during harvest. Rainy days during harvest were defined as days with more than 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 across all growing years from 1997–2017. Aridity Index is a value that characterises the ratio between the mean annual rainfall and mean annual evaporation. Low (high) values indicate drier (wetter) conditions.

Figure 2: Observed percentage change in mean annual Aridity Index between the current (1997–2017) and historical (1961–1990) periods. This shows the change already experienced across the region. Negative (positive) values indicate a trend towards drier (wetter) conditions.

Figure 3: Projected mean annual Aridity Index for 20-year time periods from 2021 to 2100. Each grid cell is the mean of the 6 ensemble members. Decreasing (increasing) values indicate a trend towards drier (wetter) conditions.

Figure 4: Time series of annual Aridity Index. Points are the annual means for each grid cell in the region, for each of the 6 ensemble members. Aridity Index values >2 all indicate very wet conditions. There is no meaningful difference past this value, so higher values were not presented. Horizontal grey bars represent the mean annual Aridity Index from selected regions across Australia — these provide an example of conditions the region may transition towards in the future. Coloured bars represent the projected global temperature increase expected in the future (following the RCP 8.5 scenario) which can be used to make decisions based on projected temperature change rather than time (for example, if the rate of warming rapidly increases, where temperature change are experienced earlier, useful information can still be extracted from these figures by using the coloured boxes instead of the time-axis).

Figure 5: 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. 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 violin. If the violin shifts lower (higher) this indicates a change towards drier (wetter) conditions.

Figure 6: Distribution of seasonal Aridity Index (Winter, Spring, Summer, Autumn), 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. Grey shapes represent the probability distribution of seasonal aridity for contrasting region during 1997–2017. Differences in the shape of curves between the current and future periods indicate a change in the typical conditions. A shift to the left (right) indicates drier (wetter) conditions. A missing time period indicates that the specific seasonal threshold was not reached within the growing year (July–June).

Figure 7: Distribution of mean Aridity Index from July until harvest. Aridity Index values >2 all indicate very wet conditions.

Figure 8: Seasonal Aridity Index (Winter, Spring, Summer, Autumn), presented as a probability distribution for each 20-year period. Variability can occur spatially within the region, across years, or between ensemble members. Grey shapes represent the probability distribution of seasonal aridity for contrasting region during 1997–2017. Differences in the shape of curves between the current and future periods indicate a change in the typical conditions. A shift to the left (right) indicates drier (wetter) conditions. A missing time period indicates that the specific seasonal threshold was not reached within the growing year (July–June).
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: Projected mean number of extreme heat days. Increasing (decreasing) values indicate a trend towards more (less) intense heatwaves.

Figure 5: 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. Colour bars indicate each of the extreme threshold values. Generally increasing frequencies reflect a warming climate.

Figure 6: Time series of the number of days per growing year of 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 temperatures, 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 7: Violins plots of high temperatures (°C) per growing year for 20-year time periods from 2001 to 2100. Colours indicate extreme threshold values (90th, 95th and 99th percentile) of temperature during each growing year. The 99th percentile value reflects the 4th hottest day each growing year; the 95th percentile is the 18th hottest day each growing year; and the 90th percentile is the 36th hottest day each growing year. Generally increasing values reflect a warming climate.

Figure 8: Probability 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).
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Extremes — Cold

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 time 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 2100. 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: Projected monthly frost risk days

Figure 6: Projected accumulated frost intensity

Figure 7: Projected mean number of extreme cold days