Australia’s Wine Future
A CLIMATE ATLAS

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Australia’s Wine Future — A Climate Atlas

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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 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) (GST) over time. Blue points are the values for each grid cell for each of the 6 ensemble members. Solid lines are timeseries representing grid cells for colder and warmer locations within the region based on current conditions (1997–2017). Horizontal grey bars represent the mean GST value during 1997–2017 in selected regions across Australia. These provide a comparison between current conditions elsewhere and future conditions in this region. Coloured bars represent the projected global temperature increase expected into the future (following the RCP 8.5 scenario). These can be used to make decisions based on projected temperature variation rather than time (for example, if the rate of warming rapidly increases, useful information can still be extracted from these figures by using the shade boxes instead of the time-axis).

Figure 5: Probability distribution of GST for 20-year time periods from 2001 to 2100. Variability can occur spatially within the region, across years, or between ensemble members. Grey shapes represent the probability distribution of GST for contrasting regions during 1997–2017. A shift to the right (left) indicates warmer (cooler) conditions.

Figure 6: Probability distribution of growing year maximum GDD for 20-year time periods from 2001 to 2100. Variability can occur spatially within the region, across years, or between ensemble members. Grey shapes represent the probability distribution of growing year maximum GDD for contrasting regions during 1997–2017. A shift to the right (left) indicates warmer (cooler) conditions.

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: Probability distributions showing the range of dates at which the example phenological thresholds (1000, 1500, 2000, 2500) are reached for each time period. Variability can occur spatially within the region, across years, or between ensemble members. A shift to the left (right) indicates earlier (later) harvest dates. A wider (thinner) curve indicates a larger (smaller) range of harvest dates. A missing time period indicates that the specific phenological threshold was not reached within the growing year (July—June).
Figure 1: Observed mean Growing Season Rainfall (Oct–Apr) across all growing years from 1997–2017.

Figure 2: Change in Growing Season Rainfall (Oct–Apr) between the current (1997–2017) and historical (1961–1990) periods. Negative values indicate a trend towards drier conditions. Positive 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 grid cell is the mean of the 6 ensemble members. Vertical grey bars represent the projected mean Growing Season Rainfall value for each grid cell for each of the 6 ensemble members, and for each growing year within the time period. In each panel the vertical bars indicate the expected probability distribution of rainfall across the growing year. The current period (2001–2020) is shaded under the future time periods to highlight any differences expected into the future. Dots represent the mean monthly rainfall for each grid cell. If the violin shifts lower (higher) this indicates a change towards drier (wetter) conditions.

Figure 5: Projected Non-Growing Season Rainfall (May to September) for 20-year time periods from 2021 to 2100. Each grid cell is the mean of the 6 ensemble members. Vertical grey bars represent the projected mean Non-Growing Season Rainfall value for each grid cell for each of the 6 ensemble members, and for each growing year within the time period. In each panel the vertical bars represent the probability distribution of rainfall across the non-growing year. The current period (2001–2020) is shaded under the future time periods to highlight any differences expected into the future. Dots represent the mean monthly rainfall for each grid cell. If the violin shifts lower (higher) this indicates a change towards drier (wetter) conditions.

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 panel the vertical lines indicate the expected probability distribution of rainfall across the growing year. The current period (2001–2020) is shaded under the future time periods to highlight any differences expected into the future. Dots represent the mean monthly rainfall for each grid cell. If the violin shifts lower (higher) this indicates a change towards drier (wetter) conditions.

Figure 7: Distribution of 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 shapes 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: Number of rainy days during harvest for each 20-year period. Harvest refers to the date when Growing Degree Days (GDD) reach example phenological thresholds (1000, 1500, 2000, 2500) which were chosen to reflect development time of different grape styles and varieties. Rainy days during harvest were 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 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 this 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 rise (for example, if the rate of warming rapidly increases, where temperature changes are experienced earlier, useful information can still be extracted from these figures by using the coloured bars 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 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 drier (wetter) conditions. A missing time period indicates that the specific phenological threshold was not reached within the growing year (July–June).

Figure 7: 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 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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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 EHF during heatwaves 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. Generally increasing frequencies reflect a warming climate.

Figure 5: 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 6: Violin plots of daily minimum and maximum temperature during heatwaves. Colour of each curve indicates different 20-year periods. 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 right (left) indicates higher (lower) temperature heatwaves.

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

Figure 8: Distribution of 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 right (left) indicates heatwaves occurring earlier (later).
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Extremes — Cold

Figure 1: Observed mean frost risk days

Figure 2: Observed change in mean frost risk days

Figure 3: Projected mean frost risk days

Figure 4: Projected monthly minimum temperature

Figure 5: Projected monthly frost risk days

Figure 6: Projected accumulated frost intensity

Figure 7: Projected mean number of extreme cold days

Figure 8: Timeseries of accumulated frost intensity, which is the cumulative total of temperatures less than −2°C over a growing season. This index characterizes exposure to cold conditions. High values indicate cold winters/springs. Points are for each grid cell, averaged across the 6 ensemble members.

Figure 9: Time-series of the number of days per growing year when temperature falls below selected thresholds (−2°C, −5°C, −8°C). Arrows indicate the number of days per grid cell in the region. Values are averaged across the 6 ensemble members. Fewer instances reflect a warming climate.