Australia's Wine Future

A CLIMATE ATLAS

Remenyi, T.A.; Rollins, D.A.; Love, P.T.; Earl, N.O.; Bindoff, N.L.; Harris, R.M.B.

1Climate Futures, Antarctic Climate & Ecosystems CRC, University of Tasmania, Hobart
2Discipline of Geography & Spatial Sciences, University of Tasmania, Hobart
3Institute for Marine and Antarctic Studies (IMAS), University of Tasmania, Hobart

Riverina

This research was funded by the Wine Australia Project UT1504
Australia's Wine Future: Adapting to short-term climate variability and long-term climate change

Contact: Rebecca.Harris@utas.edu.au
Disclaimer

The material in this atlas is based on computer modelling projections for climate change scenarios and, as such, there are inherent uncertainties in the data. While every effort has been made to ensure the material in this atlas is accurate, Wine Australia and the University of Tasmania provide no warranty, guarantee or representation that the material will prove to be accurate, complete, up-to-date, non-infringing or fit for purpose. The use of the material is entirely at the risk of the user. The user must independently verify the suitability of the material for their own use.

To the maximum extent permitted by law, Wine Australia and the University of Tasmania, any other participating organisation and their officers, employees, contractors and agents exclude liability for any loss, damage, costs or expenses whether direct, indirect, consequential including loss of profits, opportunity and third party claims that may be caused through the use of, reliance upon, or interpretation of the material in this atlas.

Acknowledgements

The authors would like to acknowledge Wine Australia and the Antarctic Climate & Ecosystems CRC (University of Tasmania) for their funding and support.

Our CSIRO colleagues, Dr Marcus Thatcher, Dr Tony Rafter, Dr Claire Trenham and Dr Matt Paget produced the underlying data and collaborated in the validation and analysis of the climate trends.

Our UTas, SARDI and AWRI colleagues, Dr Fiona Kerslake, Dr Peter Hayman, Dr Dane Thomas, Dr Paul Pettie and Dr Mark Kristic provided valuable connections, perspectives and insights into the wine industry. Their involvement enabled us to understand the true needs of growers and wine makers.

Many industry contributors hosted us during visits and generously gave us their time in interviews. Their constructive feedback was invaluable in making sure that the atlas is relevant and accessible.

This project used the R programming language and would therefore like to recognise the efforts of the R-core team and those of RStudio in providing the tools and interfaces that made data analysis and visualisation possible and innovative. This project also used the L TEX typesetting system. We would like to recognise the contributors to this system.

A special thanks to Dr Michael Sumner for all his efforts upskilling our team in programming, workflow management, geospatial data and a host of specific programming packages we used within this project.

Requests and enquiries

Requests and enquiries concerning reproduction rights should be addressed to:

Communications and Media Office
University of Tasmania
+61 3 6226 2124
Media.Office@utas.edu.au

© Copyright The University of Tasmania 2019.

This work is copyright. It may be reproduced in whole or in part for study or training purposes subject to inclusion of an acknowledgement of the source, but not for commercial sale or use. Reproduction for purposes other than those listed above requires the written permission of the University of Tasmania. The University of Tasmania grants a Creative Commons Attribution 4.0 BY licence with the exclusion of any content provided by third parties. The details of the relevant licence conditions are available on Creative Commons website, as is the full legal code for the CC BY 4.0.
Australia's Wine Future — A Climate Atlas

RIVERINA

Heat

Figure 1: Observed mean Growing Season Temperature

Figure 2: Observed change in mean Growing Season Temperature

Figure 3: Projected mean Growing Season Temperature

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
Figure 1: Observed mean Growing Season Rainfall

Figure 2: Observed change in mean Growing Season Rainfall

Figure 3: Projected mean Growing Season Rainfall

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

Figure 5: Projected Non-Growing Season Rainfall (May to September)

Figure 6: Projected monthly rainfall

Figure 7: Distribution of seasonal rainfall

Figure 8: Distribution of number of rainy days during harvest
Australia’s Wine Future — A Climate Atlas

RIVERINA

Aridity

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
Australia’s Wine Future — A Climate Atlas

RIVERINA
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 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. 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 of High human heat stress. This is defined as days when daily maximum temperatures are >30°C and daily minimum humidity <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: 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 7: Probability distributions of daily maximum temperatures and minimum overnight temperatures 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 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).
Australia’s Wine Future — A Climate Atlas

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 2001–2010 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 minimum temperature

Figure 6: Projected accumulated frost intensity

Figure 7: Monthly average cumulative frost days for 20-year periods from 2001 to 2100. Values are a summary across all grid cells, for all years with each 20-year period, 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 8: 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 9: Time series of the number of days per growing year when temperatures fall below selected thresholds (-2°C, -5°C, -8°C). Arrows indicate the number of days temperatures fall below each threshold per growing year. Values are averaged across all grid cells and the 6 ensemble members. Fewer instances reflect a warming climate.