

Local climate profile

Kentish Municipality



Past and current climate:

- The Kentish municipality experiences a mainly temperate, maritime climate and relatively small seasonal variations (e.g. Sheffield has an average daily maximum temperature of around 22 °C in January, 11 °C in July). The areas further inland and at higher altitude have a cooler climate with highland snows (e.g. Cradle Valley has an average daily maximum temperature of 17 °C in February, 4.6 °C in July).
- The average annual rainfall in the east of the municipality is around 1000 mm per year with a strong seasonal cycle (e.g. Railton receives 1046 mm, minimum of 48 mm in January and a maximum of 142 mm in July). Rainfall is much higher in the highland areas (Cradle Valley receives over 2500 mm).
- Rainfall in the Kentish municipality can come from the regular westerly frontal rain systems that cross Tasmania, however an important fraction of the rainfall comes from episodic systems from the north and northeast.
- Year-to-year rainfall variability in this area shows a correlation with the El Niño Southern Oscillation in winter and autumn (where El Niño winters are generally drier than average, La Niña winters are generally wetter than average), and some correlation with the Indian Ocean Dipole in winter and spring.
- Average temperatures have risen in the decades since the 1950s, at a rate similar to the rest of Tasmania (up to 0.15 °C per decade). Daily minimum temperatures have risen slightly more than daily maximum temperatures.
- There has been a decline in average rainfall and a lack of very wet years in the Kentish municipality since the mid 1970s, and this decline has been strongest in autumn. This decline was exacerbated by the 'big dry' drought of 1995-2009. The recent two years have seen above average rainfalls.

Future scenarios - from the Climate Futures for Tasmania project

Fine-scale model projections of Tasmanian climate were made for two hypothetical but plausible scenarios of human emissions for the 21st Century (taken from the special report on emissions scenarios (SRES) from the Intergovernmental Panel on Climate Change (IPCC)). The scenarios are of ongoing high emissions, A2, and one where emissions plateau and fall, B1. The climate response under the two scenarios is similar through the first half of the century, but the changes under the higher emissions scenario become much stronger than the lower scenario in the later half of the 21st Century.

1. Temperature

- Under the higher emissions scenario (A2), the municipality is projected to experience a rise in average temperatures of 2.6 to 3.3 °C over the entire 21st Century. The rise in daily minimum temperature is expected to be slightly greater than daily maximum temperature, and fairly similar in the different seasons. Under the lower emissions scenario (B1), the projected change over the entire century is 1.3 to 2.0 °C. A time series of projected mean Tasmanian temperature is shown in Figure 1.
- The projected change in average temperatures is similar to the rest of Tasmania, but less than the global average and significantly less than northern Australia and many regions around the world, especially the large northern hemisphere continents and the Arctic.

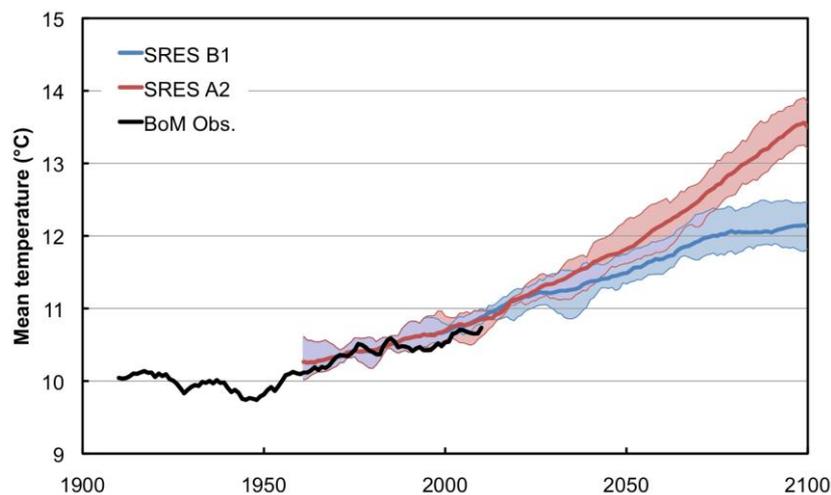


Figure 1. Tasmanian average temperature in observations (black) and model projections for the A2 scenario (red) and the B1 scenario (blue), all series are smoothed (11-year running average), shading shows the range of model projections. Changes under the higher scenario by the very end of the century are discussed in the examples below.

- The projected change in average temperature is accompanied by a change in the frequency, intensity and duration of hot and cold extremes of temperature. Under the A2 (higher) scenario by the end of the century the projections indicate:
 - The number of Summer Days (>25 °C) increases from up to 10 days per year to more than 30 days per year at some locations, and night time temperatures over 20 °C occurring in the lowlands.
 - The temperature of very hot days increases more than the change in average temperature (by 3-4 °C in some locations in some seasons).
 - A reduction in frost-risk days in the highlands from over 75 per year, to less than 25 per year.
 - Warm spells (days in a row where temperatures are in the top 5% of baseline levels) currently last around 6 days, are projected to last more than 10 days longer.

2. Rainfall, runoff and rivers

- The projected pattern of change to rainfall and runoff is similar in nature between the two scenarios, but stronger by the end of the century under the A2 scenario. The general long-term influence of climate warming by the end of the century is for a slight increase in annual average rainfall in the lowlands and a slight decrease in rainfall in the highlands of the Kentish municipality.

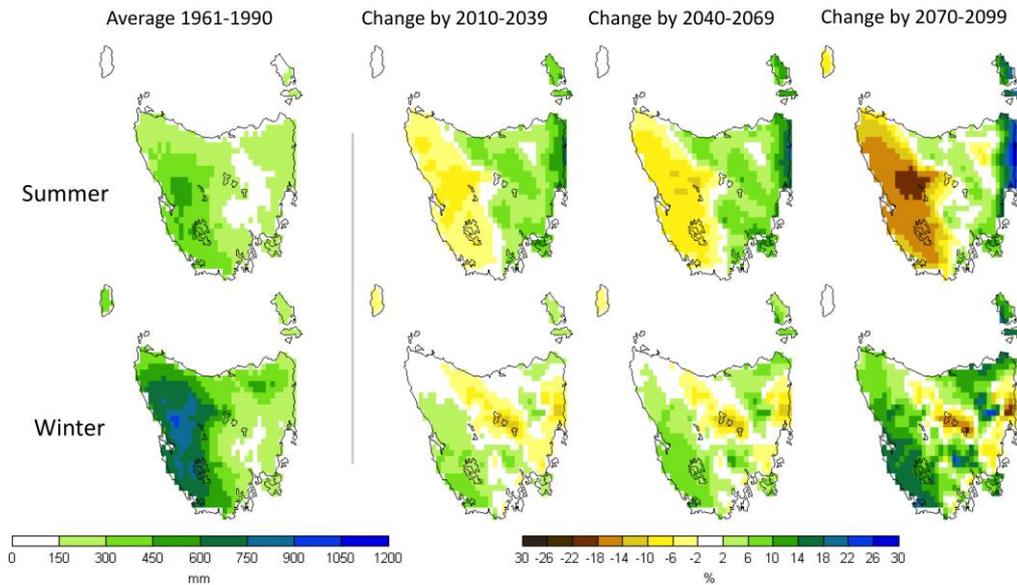


Figure 2. Average rainfall in summer and winter – the left hand side plots show the average rainfall in the baseline period (1961-1990), the plots to the right show the proportional change (%) from that amount in various periods in the 21st century in the average of six climate model projections under the A2 (higher) emissions scenario.

- The model mean projection under the A2 scenario by the end of the century is for a reduction in annual average rainfall in the lowlands (model mean is for 0 to 5%), but a decrease in the highlands (0 to -10%). Most models agree with this change. The tendency is for little change under the B1 scenario.
- The model mean shows that rainfall in the lowlands is projected to slightly increase in winter, spring and summer, with little change in autumn, and decrease in all seasons in the highlands (see Fig 2 for summer and winter).
- The long-term effect of greenhouse warming is on top of the usual cycles of rainfall, including droughts, termed 'natural variability'. The model projections indicate that the recent dry conditions of the 'big dry' drought is not a new ongoing climate average state. These projections indicate that in the long term, drought frequency and severity in the area may stay similar to today or even reduce slightly in the lowlands.
- The projected increase in rainfall is driven by changes to the average circulation of the region and the incidence of the main rain-bearing weather systems from the east and north, including a change in atmospheric blocking and cutoff lows.

- A major influence of greenhouse warming on rainfall is the tendency for heavier rainfalls interspersed by longer dry periods, and for greater extremes. For Kentish under the A2 (higher) scenario by the end of the century there is projected to be:
 - A reduction in the number of days that bring >1 mm of rain (around 7 fewer days in the lowlands, around 10 fewer days in the highlands on average), but an increase in the average rainfall per rain day.
 - Around 2 more very wet days each year (where rainfall exceeds the baseline 95th percentile), including 1 or 2 more days of >20 mm rainfall each year.
 - An increase in the maximum instantaneous rainfall rate of over 25% in some seasons, around 20% more rainfall on the wettest day of the year.
 - An increase in the rainfall brought by rare extreme: a 200-year average recurrence interval (ARI) event for daily rainfall is projected to increase by more than 35 mm (an increase of more than 35%). Other ARI events (ARI-10, ARI-50) are projected to increase by a similar proportion.
- Pan evaporation is projected to increase, by up to 19% under the A2 scenario by the end of the century, driven by the increases in temperature but also changes to relative humidity, wind speeds, cloudiness and radiation.
- Changes to rainfall and evaporation lead to changes in water runoff and river flows. This in turn has impacts on the inflows into dams and water storages. Under the A2 scenario by the end of the century:
 - Average runoff is projected to stay similar to current levels in all seasons in the lowlands, but reduce in the highlands.
 - Proportional (%) increases in average runoff are larger than the change to rainfall, so changes of around 10% or greater are possible in some seasons.
 - Daily runoff amounts during high events are projected to stay similar or increase, including those that may lead to erosion or flooding, daily runoff amounts during low flows are projected to stay much the same.
 - There is a range of projected trends in river flows in this region between the different models, but the central estimate is for little change or a slight reduction in average flows by the end of the century. For example, in the Mersey River (central estimate is around -1%), the Forth River (-8%), and the Don River (0%). There is projected to be changes to the seasonality of flows.

3. Agricultural impacts

- Frosts are projected to decrease significantly with a warming climate. At the coast, frosts are projected to become very infrequent, and in the highlands frost-risk days are projected to fall from over 75 days per year, to less than 25 days per year by the end of the century under the higher emissions scenario. Damaging Spring frost may still occur.
- Chilling affects the growth and flowering of berries, fruits and nuts. Accumulated chill hours are projected to decrease significantly in a warming climate, except in high-altitude sites where chilling will in fact increase (areas that are currently too cold). Chill hours in the Sheffield area are projected to fall from around 2200 hours in the baseline period to less than 1800 by the end of the century under the higher emissions scenario.

- There is a projected increase in Growing Degree Days (a measure of the heat to grow and ripen crops). At Sheffield, the annual count of GDDs is projected to increase from around 1000 or less, to over 1600 by the end of the century under the higher emissions scenario. This may reduce the time to harvest of many crops, or affect other aspects of crop choice and management.
- There is projected to be a similar proportion in the time in severe drought in the region by the end of the century as there is today, or perhaps a slight decrease in some regions of the lowlands. This is measured as the proportion of time when the standardized precipitation index (SPI) is less than minus two.

5. River floods – Mersey-Forth Rivers

Changes to design flood hydrographs were calculated for the 1:10, 1:50, 1:100 and 1:200 annual exceedance probability events for future periods using the climate model outputs and flood hydraulic models by partners at Entura consulting. Short duration events are projected to become more intense, so catchments with a critical duration of less than 72 hours will experience high flood levels and faster response times. The Mersey and Forth Rivers have a critical duration of less than 72 hours, so the peak flood discharge is projected to increase significantly through the 21st Century. Please see the full Entura report and accompanying maps for more details.

Appendix – details of climate projections

Greenhouse gas emissions have an influence on the Earth's climate system, along with other human activities such as the emission of ozone-depleting substances, emission of aerosol (particles) and changing the land cover (e.g. deforestation). Sophisticated model simulations can be used to project the likely effect of these influences into the future given our current state of knowledge. It is impossible to predict exactly what future human emissions will be, so models are run under a set of plausible hypothetical emissions scenarios. A model simulation shows the likely effect if we follow that scenario, so it is not a single 'prediction' of the future. The simulation can't include the effect of things that are impossible to predict (such as major volcanic eruptions).

The Climate Futures for Tasmania project produced a set of climate projections at the regional scale for Tasmania. Two emissions scenarios were considered – one of ongoing high emissions (SRES A2), and one where emissions plateau and fall (SRES B1). The climate response under the two scenarios is similar through the first half of the century, but the changes under the higher emissions scenario become much stronger than the lower scenario in the latter half of the 21st Century.

Climate warming causes many complex changes to the earth's climate system. These changes include alterations to ocean currents, average atmospheric circulation and ocean-atmosphere cycles such as the El Niño Southern Oscillation. Projected effects that are relevant to Tasmania include a continued extension of the East Australia Current bringing warmer waters off the east and northeast coast of Tasmania, a pole-ward shift of the subtropical ridge of high pressure and shifts in the mid-latitude westerlies (the 'Roaring 40s'), and a change in remote climate drivers such as atmospheric blocking, the El Niño Southern Oscillation and the Southern Annular Mode. The position of Tasmania adjacent to the Southern Ocean means that the effect of climate warming is not as severe as other more continental regions.

The results presented in this report were made using established methods, including:

- Extreme value distribution fitting in a generalized Pareto distribution to calculate the average recurrence intervals (ARIs).
- Hydrology runoff models developed and calibrated for the Tasmanian Sustainable Yields project to estimate the runoff, river flows and inflows to storages.
- Standard agricultural indices such as the Utah model to calculate chill hours and standard

equations and a 10 °C threshold to calculate Growing Degree Days.

All information is drawn from the Climate Futures for Tasmania Technical reports please see these reports for more details, and to cite in other written work.

Reference list

- Bennett JC, Ling FLN, Graham B, Grose MR, Corney SP, White CJ, Holz GK, Post DA, Gaynor SM & Bindoff NL 2010, Climate Futures for Tasmania: water and catchments technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania
- Corney SP, Katzfey JJ, McGregor JL, Grose MR, Bennett JC, White CJ, Holz GK, Gaynor SM & Bindoff NL 2011, Climate Futures for Tasmania: climate modeling technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania
- Entura Consulting, 2010, Climate Futures for Tasmania Flood inundation mapping, Entura Consulting Technical report, 23 Dec 2010
- Grose MR, Barnes-Keoghan I, Corney SP, White CJ, Holz GK, Bennett JC, Gaynor SM & Bindoff NL 2010, Climate Futures for Tasmania: general climate impacts technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania
- Holz GK, Grose MR, Bennett JC, Corney SP, White CJ, Phelan D, Potter K, Kriticos D, Rawnsley R, Parsons D, Lisson S, Gaynor SM & Bindoff NL 2010, Climate Futures for Tasmania: impacts on agriculture technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania
- McInnes KL, O'Grady JG, Hemer M, Macadam I, Abbs DJ, White CJ, Bennett JC, Corney SP, Holz GK, Grose MR, Gaynor SM & Bindoff NL 2010, Climate Futures for Tasmania: extreme tide and sea level events technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania
- White CJ, Sanabria LA, Grose MR, Corney SP, Bennett JC, Holz GK, McInnes KL, Cechet RP, Gaynor SM & Bindoff NL 2011, Climate Futures for Tasmania: extreme events technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania

The material in this report is based on computer modelling projections for climate change scenarios and, as such, there are inherent uncertainties involved. While every effort has been made to ensure the material in this report is accurate, Antarctic Climate & Ecosystems Cooperative Research Centre (ACE) provides no warranty, guarantee or representation that material is accurate, complete, up to date, non-infringing or fit for a particular purpose. The use of the material is entirely at the risk of a user. The user must independently verify the suitability of the material for its own use.

To the maximum extent permitted by law, ACE, its participating organisations 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 report.