

Local climate profile

Meander Valley Municipality



Past and current climate:

- The Meander Valley is a diverse area, from the western highlands of over 1000 m altitude, across the sharp gradient of the Great Western Tiers to the agricultural area in the east around Deloraine. The climate is correspondingly diverse, from the cool highland region with regular snow falls in winter, to the more temperate climate in the valley (Westbury has an average daily maximum temperature of 23 °C in January, 10 °C in July).
- There is a gradient of average annual rainfall across the municipality from around high rainfalls of over 2000 mm per year and a strong seasonal cycle on the plateau (e.g. Lake MacKenzie receives 2090 mm per year, with 108 mm in January, 270 mm in July), down to the rain shadow region in the valley that receives less than 800 mm of rainfall (e.g. Westbury receives 779 mm, minimum of 34 mm in February and a maximum of 92 mm in August).
- Rainfall in the Meander Valley municipality can come from the regular westerly frontal rain systems that cross Tasmania, however the main valley is in a rain shadow of the Great Western Tiers. An important fraction of the rainfall comes from episodic systems from the north and east, including cutoff lows.
- Year-to-year rainfall variability also varies across the municipality, in the highlands there is a correlation of rainfall with the average westerly circulation and the Southern Annular Mode. In the east, there is some 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), some correlation with the Indian Ocean Dipole in winter and spring, and with atmospheric blocking, especially in summer.
- Average temperatures have risen in the decades since the 1950s, at a rate similar to the rest of Tasmania (up to 0.1 °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 Meander Valley 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.

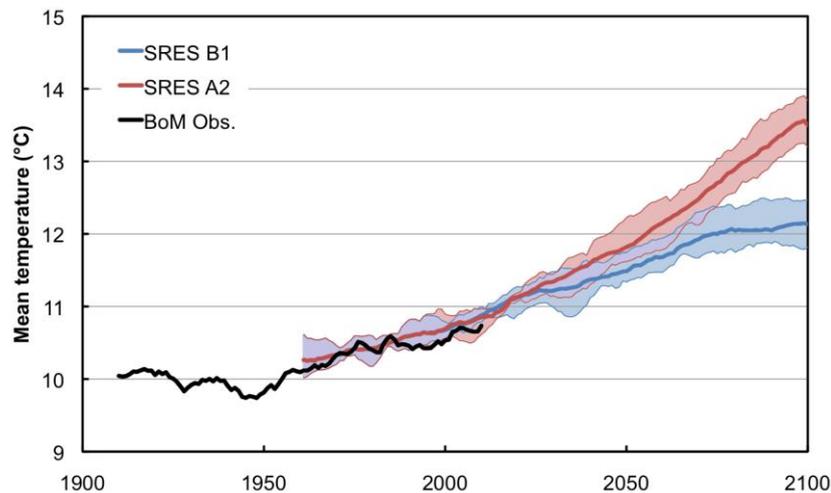


Figure 1. Tasmanian average temperature in observations (black) and model projections for the A2 scenario (red) and the B1 scenario (blue), all series are smoothed (11-year running average), shading shows the range of model projections. Changes under the higher scenario by the very end of the century 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. For Port Sorell 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 30 days per year in the lowlands, to almost 50 days per year at some locations, with night time temperatures over 20 °C occurring occasionally. The number of summer days is projected to double in highland areas.
 - The temperature of very hot days increases more than the change in average temperature (by 3 to 4 °C in some locations in some seasons).
 - A reduction in frost-risk days, in the lowlands this is from around 50 per year to less than 25 per year, and a reduction in the highlands from more than 100 days to less than 75.
 - 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 up to 12 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. Due to the strong rain shadow effect in this region, it was one of the most difficult regions to model, and was subject the largest model biases of any area in Tasmania. Keeping in mind these problems, the model projections indicate that 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, but a decrease in rainfall in the highlands of the municipality.

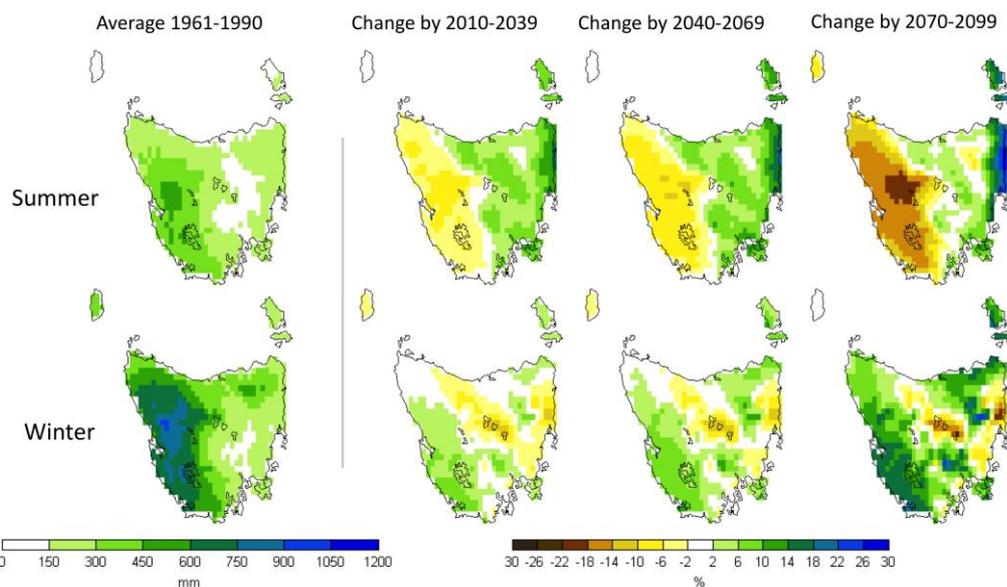


Figure 2. Average rainfall in summer and winter – the left hand side plots show the average rainfall in the baseline period (1961-1990), the plots to the right show the proportional change (%) from that amount in various periods in the 21st century in the average of six climate model projections under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

- The model mean projection of annual average rainfall under the A2 scenario by the end of the century is for a slight increase in rainfall in the lowlands (model mean is for 0 to 5%), but a reduction in rainfall in the highlands (model mean up to -10%). As mentioned above, this area had the largest biases in the models, however most models agreed with this sign of change. The tendency under the B1 scenario is for little change except a small reduction in rainfall in the highlands.
- The model mean shows that rainfall in the lowlands is projected to slightly increase in all seasons, and decrease in the highlands in all seasons, but with some slight differences in spatial pattern (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 agricultural area may even reduce slightly due to the increase in average rainfall.

- The projected increase in rainfall is driven by changes to the average circulation of the region, including the average strength of the westerlies, as well as 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. However, this varies in different areas. For the Meander Valley municipality under the A2 (higher) scenario by the end of the century there is projected to be:
 - A reduction in the number of rain days with >1 mm per year (6 fewer in the lowlands, up to 17 less in the highlands), but significantly more rain per rain day (up to a 15% increase).
 - Up to 3 more very wet days each year in the lowlands (where rainfall exceeds 10 mm), but up to 5 fewer days in the highlands.
 - An increase in the maximum instantaneous rainfall rate of over 30% in some seasons, and an increase in rainfall on the wettest day of the year (17% in the highlands, 25% in the lowlands).
 - An increase in rainfall brought by rare extreme events: a 200-year average recurrence interval (ARI) event for daily rainfall at is projected to increase by more than 25%. More common 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:
 - There is a gradient in the projected change to average runoff, similar to rainfall, in all seasons. Runoff is projected to decrease in the highlands, and show little change or a slight increase in the lowlands.
 - Proportional (%) increases in average runoff are larger than the change to rainfall, with decreases of over 20% possible in the highlands in some seasons.
 - Runoff amounts during high events are projected to decrease in the highlands but increase in the lowlands, whereas daily runoff amounts during low flows are projected to stay much the same or reduce everywhere.
 - There is a range of projected trends in river flows in this region between the different models, but the central estimate is for slight reductions to average flows, including in the Mersey, Quamby and Liffey River system (central estimate is around -7% mid century and -2% at the end of the century), and in the upper reaches of the Fisher River in the highlands (-8%), with changes to the seasonality of flows.
 - Inflows into Meander Dam are projected to reduce slightly (-13% towards the end of the century), but reliability to meet current demand is projected to remain above 90%.

3. Agricultural impacts

- Frosts are projected to decrease significantly with a warming climate. In the agricultural area of the Meander Valley, frost-risk days are projected to reduce from 50 to less than 25 by the end of the century under the higher emissions scenario. Damaging spring frost may still occur rarely.
- 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 Deloraine area are projected to fall from around 2200 hours in the baseline period to 1600 or less 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 Deloraine, the annual count of GDDs is projected to increase from around 750 to around 1450 by the end of the century under the higher emissions scenario. This may reduce the time to harvest of many crops, change what can be grown and affect other aspects of crop management.
- Please see Holz et al. (2011) for more detail on the agriculture analysis. Also, the impact of climate change on agriculture in the Meander Valley is the focus of a study at the Tasmanian Institute of Agricultural Research (TIAR) under the 'Wealth from Water' program. Please contact TIAR for more information.

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

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