

16 **Rewriting Australia's Temperature History**

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The Bureau of Meteorology is one of Australia's most important national public institutions; so much depends on our knowledge of past climate and our ability to predict future trends and events. The Bureau's recordings of maximum and minimum temperatures across Australia provide information that is important to our understanding of such trends and patterns in a changing climate. The Bureau does not, however, simply report this information. Rather, complex remodelling is undertaken in the development and compilation of the official climate change statistics. In this chapter, I consider the results of the Bureau's 'homogenisations' of historic temperature measurements through two case studies: Darwin and Rutherglen.

The Bureau undertook some remodelling in 2018 that increased the overall rate of warming by 23% between Versions 1 and 2 of the Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) database (Trewin 2018). The Bureau claims that this remodelling of temperatures is justified for two reasons: because of changes to the equipment used to record temperatures; and because of the relocation of the weather stations. However, there have been no changes to equipment and no relocations since the release of ACORN-SAT Version 1 for either Darwin or Rutherglen.

Case study: Rutherglen

At an agricultural research station near Rutherglen in south-eastern Australia, maximum and minimum temperatures have been recorded

since November 1912 in a Stevenson screen in a paddock, as shown in Figure 16.1. This is an official Bureau of Meteorology weather station with values used to calculate official statistics. The trend in the raw minimum temperatures is for a slight cooling, which is a consequence of land-use change: specifically, the staged introduction of irrigation into the region for cropping, vineyards and orchards (Marohasy 2016).

In 2014, Graham Lloyd, Environmental Reporter at *The Australian*, quoting me, explained how the cooling trend in the minimum temperature record at Rutherglen had been changed into a warming trend by the Bureau by progressively reducing temperatures from 1973 back to 1912, as shown in Figure 16.2. For the year 1913, there was a large difference of 1.8 °C between the mean annual minimum temperature, as measured

Figure 16.1 Location of the temperature recording equipment at Rutherglen



The white circle marks the location of the Rutherglen weather station, with the associated image showing a standard Stevenson screen.

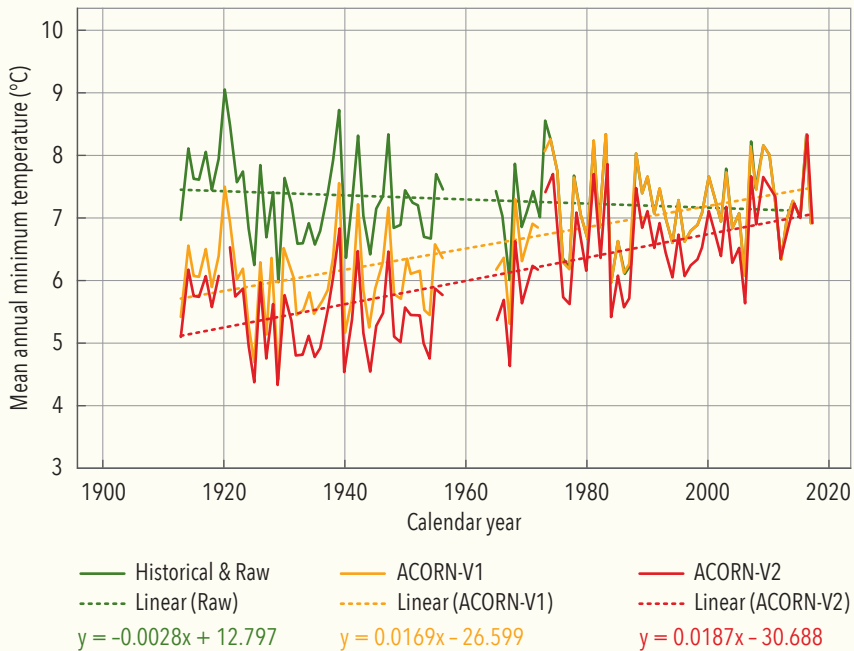
Source: Map data from Google, DigitalGlobe; image of Stevenson screen from Bureau website (<http://www.bom.gov.au/climate/cdo/about/airtemp-measure.shtml>, viewed 14 May 2017) and reprinted under Creative Commons (CC) Attribution 3.0 Licence.

at Rutherglen using standard equipment at this official weather station, and the remodelled ACORN-SAT Version 1 temperature. Remodelling the data to cooling the past relative to the present in this way has the general effect of making the present appear hotter.

The Bureau responded to Lloyd, claiming the changes were necessary because the weather recording equipment had been moved between paddocks. This is not a logical explanation where the local terrain is flat and, furthermore, the official ACORN-SAT catalogue clearly states that there has never been a site move (Bureau of Meteorology 2012).

Nevertheless, readers might want to give the Bureau the benefit of the doubt and let them make a single set of changes. But just six years

Figure 16.2 Homogenisation of Rutherglen's minimum temperatures



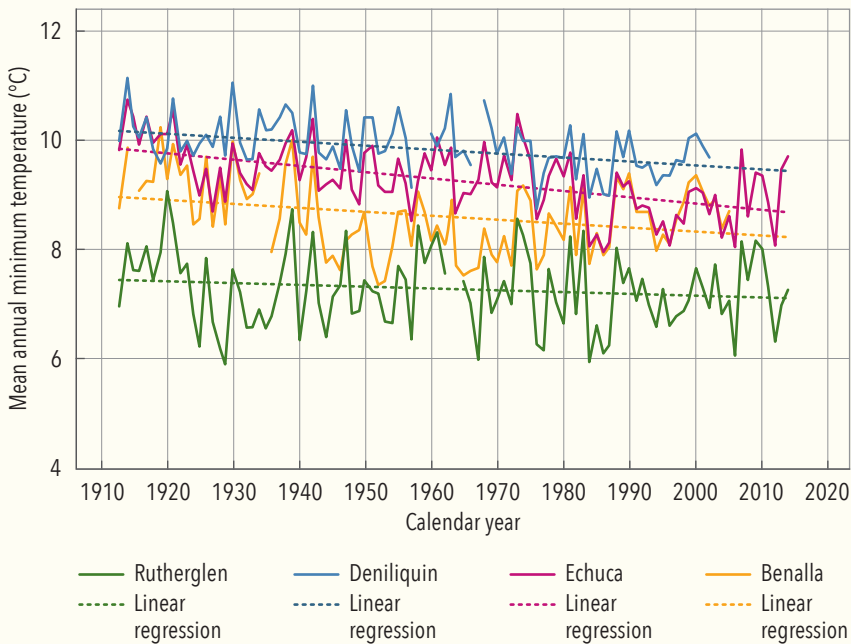
The historical observations (green) show a mild cooling trend of minus $-0.28\text{ }^{\circ}\text{C}$ per 100 years. This cooling trend has been changed to warming of $1.7\text{ }^{\circ}\text{C}$ per 100 years in ACORN Version 1 (orange). These temperatures have been further homogenised/remodelled in ACORN Version 2 (red) to give a slightly more dramatic warming, which is now $1.9\text{ }^{\circ}\text{C}$ per century.

Source: Raw data was downloaded as daily minimum from <http://bom.gov.au/climate/data/> and the ACORN-SAT data was downloaded from ftp://ftp.bom.gov.au/anon/home/ncc/www/change/ACORN_SAT_daily/.

later, the Bureau again changed the temperature record for Rutherglen. In Version 2 of ACORN-SAT, the minimum temperatures as recorded before 1970 at the Rutherglen Research Station have been further reduced, making the present appear even warmer relative to the past. The warming trend is now 1.9 °C per century.

The Bureau has variously claimed that they need to cool the past at Rutherglen to make the temperature trend more consistent with trends at neighbouring locations. But this claim is not supported by the evidence. For example, the historical recordings at the nearby towns of Deniliquin, Echuca and Benalla also show cooling, as shown in Figure 16.3. The consistent cooling in the minimum temperatures at all these locations

Figure 16.3 Mean annual measured raw minimum temperatures at Rutherglen and nearby locations



The chart shows the night-time temperatures as recorded at Benalla (1913–2005), Echuca (1913–2014), Deniliquin (1913–2002), and Rutherglen (1913–2014). The shorter records for Benalla and Deniliquin represent the longest complete records for these locations as measured at the same site.

Source: Data sourced from Climate Data Online, Australian Bureau of Meteorology, December 2016 <http://www.bom.gov.au/climate/data>.

has been caused by land-use change in this region – specifically, the development of water infrastructure and irrigation from the 1930s through to the 1970s (Marohasy 2016).

The changes to the raw data begin with changes to the daily temperatures. For example, on the first day of temperature recordings at Rutherglen, on 8 November 1912, the measured minimum temperature is 10.6 °C, as shown in Table 16.1. This measurement is changed to 7.6 °C in ACORN-SAT Version 1. In Version 2, the already remodelled value is changed again, to 7.4 °C – applying a further cooling of 0.2 °C.

If we consider historically significant events – for example temperatures at Rutherglen during the January 1939 bushfires that devastated large areas of Victoria – the changes made to the historical record are even more significant. The minimum temperature on the hottest day was measured as 28.3 °C at the Rutherglen Research Station. This value was changed to 27.8 °C in ACORN Version 1, a reduction of 0.5 °C. In Version 2, the temperature is reduced by a further 2.6 °C, producing a temperature of 25.7 °C.

This type of remodelling of temperature series will potentially have implications for understanding the relationship between past temperatures and bushfire behaviour. Of course, changing the data in this way

Table 16.1 Daily minimum temperatures Rutherglen, measured and homogenised

Station No.	Date	Raw & Historical	ACORN-V1	ACORN-V2
<i>Beginning of the record</i>				
82039	8/11/1912	10.6	7.6	7.4
82039	9/11/1912	5.6	4.0	3.4
82039	10/11/1912	16.1	14.5	12.7
82039	11/11/1912	5.6	4.0	3.4
<i>During the 1939 bushfire</i>				
82039	12/01/1939	20.9	19.9	17.4
82039	13/01/1939	20.9	19.9	17.4
82039	14/01/1939	28.3	27.8	25.7
82039	15/01/1939	18.9	16.9	15.9

Source: Data sourced from Australian Bureau of Meteorology.

will also affect analysis of climate variability and change into the future. By reducing past temperatures, there is potential for creating new ‘record’ hottest days for the same weather.

Case study: Darwin

Darwin is a city in northern Australia. Maximum and minimum temperatures were first recorded at Darwin from a thermometer in a modified Greenwich stand in the yard of the Darwin post office in 1882. In 1894, a Stevenson screen in the same yard replaced this modified Greenwich stand as the official standard equipment for the housing of the recording thermometer, as shown in Figure 16.4. In February 1941, a second weather station was established at the Darwin airport. A year later, in February 1942, the post office and its weather station were bombed during Japanese air raids. The airport weather station survived the bombing.

The historical maximum temperature record for Darwin shows a cooling of nearly 2 °C from 1895 to 1941; this is for the period when temperatures were recorded in a Stevenson screen at the post office. This cooling is changed to warming in the creation of the first version of ACORN-SAT. In the creation of ACORN-SAT Version 2 this warming trend of 1.3 °C per 100 years in ACORN-SAT Version 1 is increased to 1.8 °C per 100 years, as shown in Figure 16.5.

As an example of the type of changes made, the daily values at the beginning of the official record are reduced by 1.6 °C. For example, the maximum temperature measured at the Darwin Post Office on 6 January 1910 was 34.6 °C. This value was changed to 34.2 °C in ACORN-SAT Version 1. It is now 33.0 °C in Version 2, as shown in Table 16.2.

In a newspaper article in *The Weekend Australian*, the Bureau claims the changes to the Darwin record in Version 2, of ACORN-SAT are necessary for the following reasons:

For the case of Darwin, a downward adjustment to older records is applied to account for differences between the older sites and the current site, and differences between older thermometers and the current automated sensor. In other words, the adjustments estimate what historical temperatures would look like if they were recorded with today’s equipment at the current site. (Lloyd 2019)

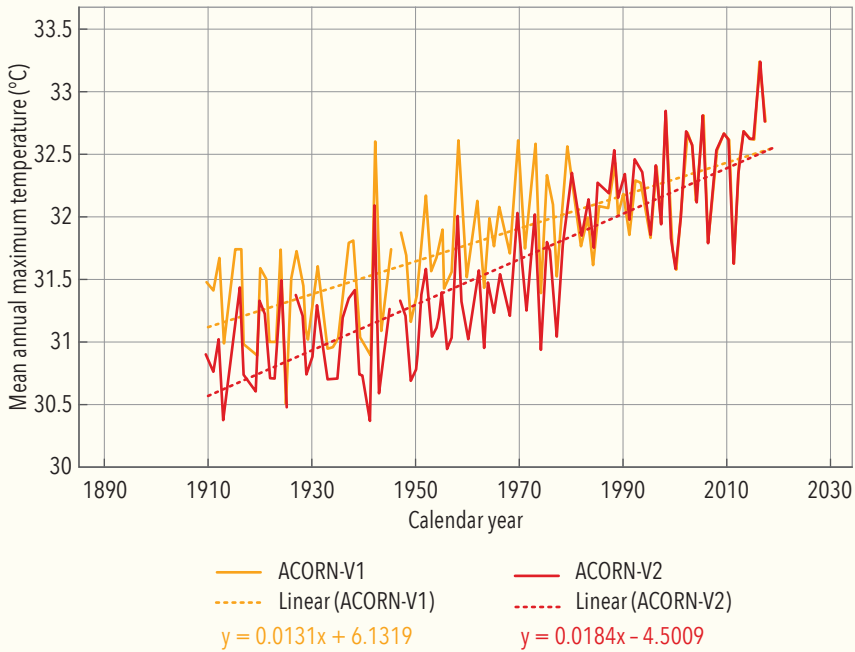
Figure 16.4 Historical photographs showing the Stevenson screen at the Darwin post office



Top photograph taken February 26, 1890 outside the telegraph inspector's residence showing the Stevenson screen in foreground at left (white louvered box on a stand). Second (middle) photograph taken outside the post office circa 1930 does not show shading by trees. Third (bottom) photograph taken outside the post office January 1, 1940.

Source: Northern Territory Library.

Figure 16.5 ACORN-SAT Version 1 and Version 2 temperature trends for Darwin



The extent of warming increases from 1.3 °C per 100 years to 1.8 °C in the latest revisions by the Bureau to Australia's temperature history.

Source: Data as daily maximum temperatures downloaded from <http://bom.gov.au>.

Table 16.2 Daily temperatures measured and homogenised for Darwin, January 1910

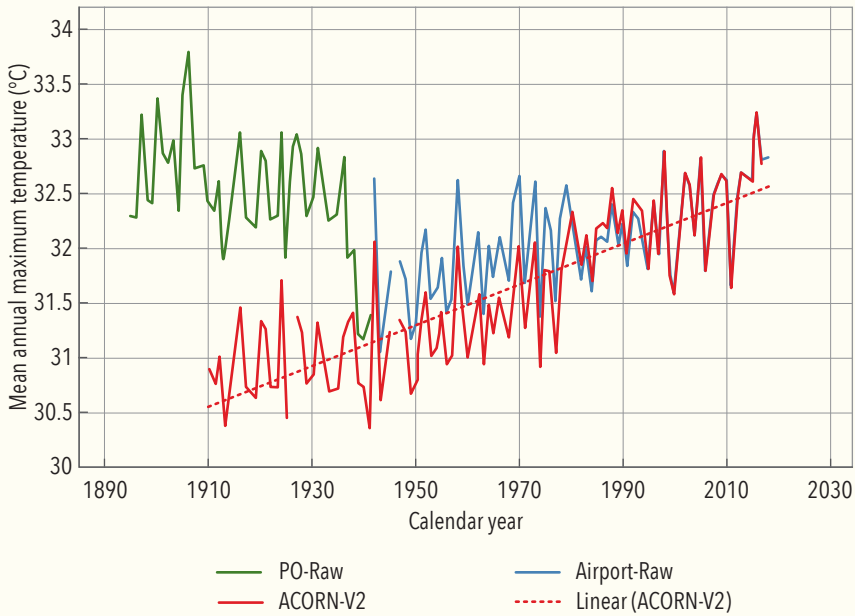
Darwin Daily Maximum Temperatures - Depending on Dataset

Date	Raw	ACORN-V1	ACORN-V2	Diff Raw-V2	Diff Raw-V1
1 Jan 10	34.2	33.8	32.8	1.4	0.4
2 Jan 10	32.7	32.3	31.5	1.2	0.4
3 Jan 10	32.7	32.3	31.5	1.2	0.4
4 Jan 10	33.6	33.2	32.4	1.2	0.4
5 Jan 10	34.6	34.2	33.0	1.6	0.4
6 Jan 10	34.6	34.2	33.0	1.6	0.4

The daily maximum temperatures for early 1910 as shown in the three different datasets for Darwin

Source: Raw data was downloaded from <http://bom.gov.au/climate/data/> and ACORN-SAT was downloaded from ftp://ftp.bom.gov.au/anon/home/ncc/www/change/ACORN_SAT_daily/.

Figure 16.6 Measured maximum temperatures and ACORN-SAT Version 2 temperatures for Darwin



There is a large difference between the ACORN-SAT temperature series (red line) and the historical measurements (green line) from 1937 back to 1910. The Bureau remodels the data on the basis there was shading by trees before 1937. It is more likely there was a cyclone in March 1937 clearing away vegetation that had previously screened the post office from the sea breeze.

Source: Raw data downloaded from <http://bom.gov.au/climate/data/> and ACORN-SAT data downloaded from ftp://ftp.bom.gov.au/anon/home/ncc/www/change/ACORN_SAT_daily/.

In March 2012, when Version 1 of ACORN-SAT was published, the Bureau was claiming in its catalogue (Bureau of Meteorology 2012) that there was abnormal cooling of the Darwin temperature record before 1 January 1937 because of shading from trees. Somewhat peculiarly, this was then used as a justification for adjusting *all* the temperatures down before this date back to 1910, in effect further dramatically cooling the early record as shown in Figure 16.6. Might it have been more logical to warm that period of the record to correct the ‘artificial cooling’ caused by the trees?

Regarding actual causes, it could be the case that a cyclone caused the reduction in temperatures in early 1937. According to the *Northern Standard* newspaper reporting on 12 March 1937, there was a cyclone that:

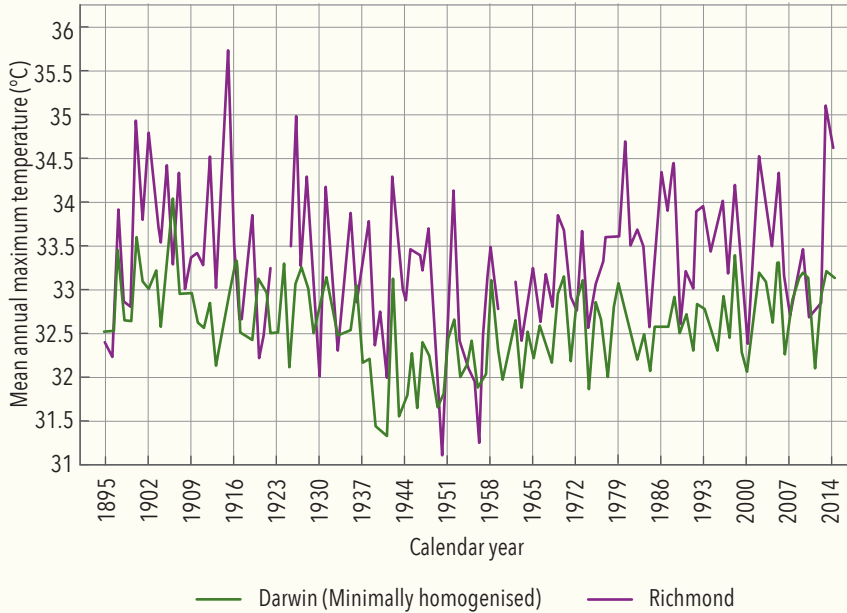
... raged and tore to such vicious purpose that hardly a home or business in Darwin did not suffer some damage ... Telephone wires and electric mains were torn down by falling trees and flying sheets of iron, windmills were turned inside out, garden plants and trees were ruined, roads and tracks were obstructed by huge trees ...

This would suggest that rather than shading by trees, there were no trees after the cyclone, possibly allowing cooling from the sea breeze. In a study of modifications to orchard climates in New Zealand, McAneney et al. (1990) showed that screening could increase the maximum temperature by 1 °C for a 10 metre high shelter. Whichever, neither the equipment nor the site changed between ACORN-SAT Version 1 (2012) and Version 2 (2018). To be clear, the weather station has been at the airport since February 1941 and an automated sensor was installed on 1 October 1990. A Stevenson screen was first installed at the post office site in 1894, while a Stevenson screen has always been used at the airport site.

I generated a minimally homogenised temperature record for Darwin, taking into consideration only the move from the post office to the airport based on the available single year of overlapping data. This temperature series shows no overall warming trend. Rather it is consistent with other locations in northern Australia with long high-quality records, for example Richmond in north-western Queensland, that show cooling and then warming, as shown in Figure 16.7.

The calculations of temperature change at Darwin, including for the minimally homogenised series, were submitted for publication in *The International Journal of Climatology* in early 2015. On 25 June 2015, I was informed by the editor that the paper had been assessed by two referees who were leading international experts in this field. Major revisions to the manuscript were requested by the second referee and subsequently made. In an email received from the editor on 7 December 2015, it was stated that both referees were satisfied with the revisions that

Figure 16.7 Annual mean maximum temperatures as measured at Richmond and Darwin



Richmond, in inland north Queensland, has a continuous temperature time series from 1895 to 2014. Over this period maximum temperatures were recorded in a Stevenson screen using a mercury thermometer at the same site. The annual mean maximum temperatures shown for Richmond (purple line) have not been adjusted in any way, they represent the original historical measurements.

Source: Unpublished manuscript by Jennifer Marohasy and John Abbot, JOC-15-0396.R1.

had been made. The second referee said that the minimally homogenised series for Darwin probably represented the best estimate of what had actually happened to the temperatures at Darwin, since at least 1941. I waited for galley proofs until 9 February 2016, when I received an email from the editor informing me that the manuscript was now rejected and would not be published by the journal; no logically consistent reason was provided. Certainly the manuscript was critical of the Bureau's homogenisation of the historical Darwin temperature record.

Conclusion

Science is a method of study that purports to explain natural phenomena based on direct observation and measurement. Official historical

temperature series are assumed to be scientific, and represent actual observations. Yet clearly temperature series are significantly remodelled by the Bureau to the extent that they differ in magnitude and direction from the original. In short, the official series are constructs that accord with popular climate change theory that claims a continual increase in temperatures through the twentieth century, but this has not been the reality in all places. The potential to report this in the peer-reviewed literature is limited, with detailed criticisms denied.

ACORN-SAT Version 2 is the official temperature record for Australia. It was completed just in time for the new remodelled values to be included in the next report of the United Nations Intergovernmental Panel on Climate Change (IPCC). This new version of our temperature history will also underpin annual state-of-the-climate reports that are always widely reported in the mainstream media as the historical temperature record for Australia. The remodelled temperature series are also passed on to universities, CSIRO, and other climate scientists, who base much of their climate research on these 'second-hand' statistics that do not accord with the actual historical measurements.

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