Is homogenisation of Australian temperature data any good?

Part 6. Halls Creek, Western Australia

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> The ACORN-SAT project is deeply flawed, unscientific and should be abandoned.
>
> Read on …

Summary

Multiple attributes of maximum temperature data (Tmax) for Halls Creek, and 23 sites used to homogenise Halls Creek Tmax were analysed using BomWatch protocols. Relationships between Tmax and rainfall, inhomogeneities in Tmax ~ rainfall residuals, frequency histograms and probability density functions, differences in cumulative distributions (percentiles), frequencies of daily temperatures <5th and >95th day-of-year dataset percentiles and their log_{10}-transformed Hi_N/Lo_N ratio were evaluated using objective statistical methods.

- Evidence is lacking that the climate at Halls Creek and that of the comparator sites used to homogenise Halls Creek has changed or warmed due to CO_2 or anything else.
- Creating trend by cooling the past compromises the physically deterministic relationship between Tmax and local rainfall. The most recent iteration of ACORN-SAT (Australian Climate Observations Reference Network – Surface Air Temperature) (ACORN-SATv.2.3) shows the highest Tmax trend (0.62°C/decade) but the Tmax ~ rainfall relationship is barely significant (P = 0.025). Rainfall also explains only 3.6% of variation in Tmax (R^2_{adj} = 0.036).
- At Halls Creek it was found that cool-bias increased as observed Tmax increased. Further, homogenised Tmax ~ rainfall residuals embed the very step-changes that the process aimed to correct. Homogenised data are therefore not homogeneous.
- Step-changes related to site changes altered counts of raw daily Tmax >95th day-of-year percentiles relative to those <5th day-of-year percentiles, which comprise the tails of daily data distributions. Cooling the past increases the apparent frequency of high temperature extremes exponentially after 1985. However, this artefact is unrelated to the true climate.
- Urban encroachment from 2011, and relocation of the site in 2015, where the AWS with 90-litre screen now operates over a red-gravel surface bereft of transpiring ground-cover, caused Tmax and daily extremes to increase, which biases comparisons with historic data.
- Relying on faulty metadata, and using reference series comprised of data that are not homogeneous to detect and adjust faults in target-site data, has no statistical or scientific merit.

As the ACORN-SAT project produces trends and changes that are unrelated to the climate it should be abandoned in its entirety.

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1. Introduction

The main question is whether trends and changes in raw and homogenised maximum temperature data reflect the conditions under which data were observed, site and instrument changes, or the true climate.

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Like Alice Springs, which was established to service the Overland Telegraph linking Adelaide to Darwin, the old post/telegraph office at Halls Creek in the Eastern Kimberley region of Western Australia was a repeater station for the telegraph line between Perth via Derby on Australia's west coast, and Java via Wyndham to the north[1,2] (Figure 1). Halls Creek was also where gold was first discovered in WA, and for a brief period after 1885 it was a boom-town of some 15,000 people, mainly men, living under canvas and in rough bark-huts under extremely arduous conditions.

According to https://en.wikipedia.org/wiki/Halls Creek, Western Australia, the gold-rush lasted less than 3-months. However, with its first-aid post, police station, government office and two hotels, old Halls Creek became a trading centre for local cattle stations and a contact-point for scattered Aboriginal communities. It was also the start of the famous Canning Stock Route to Wiluna some 2,000 km to the southwest.

Figure 1. The Old Halls Creek Post Office and store, photographed on 1 September 1938 by Mr S.D. Mills (National Archives of Australia (NAA)).

In the 1930s an aerodrome was established to service the inland route between Guildford (Perth) and Darwin. However, the closest suitable site was 9 miles (16 km) east of the town. By 1952, Halls Creek moved to the vicinity of the aerodrome and the old townsite was abandoned.

The Air Board (that preceded the Department of Civil Aviation) established an Aeradio station at the aerodrome in 1939. Plans in the National Archives show a timber-framed asbestos-cement (fibro) sheeted building, similar to Onslow except that the Onslow office was equipped with an internal latrine while the one at Halls Creek was not (Figure 2). The plan shows the office was divided in two, the meteorological office on one side, the radio office on the other with a connecting door, and a verandah with steps facing the landing ground.

Isolated from the town of then 16 people, life for those maintaining vigil 9-miles away at the Aeradio office was harsh (https://www.airwaysmuseum.com/Halls%20Ck%20Aeradio%2041-2.htm). Consequently, staff turnover was high. There was also very little aircraft activity. Nevertheless, rostered in shifts and possibly living on-site, an Officer-in-Charge and three staff (Figure 3) maintained the station, probably watered the ground above the earth-mat to maintain connectivity for the communication aerials, manually tracked weather balloons using a theodolite, and monitored and reported observations at 6am by radio, and later by field-telephone via the old post office to Perth, which as the cocky flies[3] is 1932 km south. As well as maintaining contact with aircraft and advising of inclement conditions, data for Halls Creek was used to forecast the

[1] https://telegramsaustralia.com/Forms/Colonial/West%20Australia/The%20lines/WA%20Kimberley.html

[2] http://inherit.stateheritage.wa.gov.au/Admin/api/file/e20df30a-a572-3275-86f6-96c6636dca20

[3] https://geodesyapps.ga.gov.au/distance

weather across northern Australia. During WWII, Aeradio became a unit within the Royal Australian Air Force (RAAF) from 1941 until 1946.

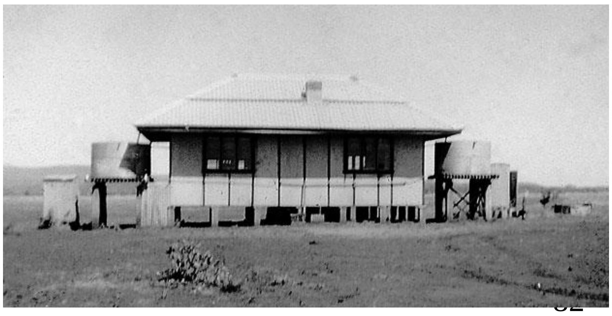

Figure 2. Rear of the Halls Creek aeradio office in 1941, with the latrine on the left and possibly the H_2/balloon hut on the right.

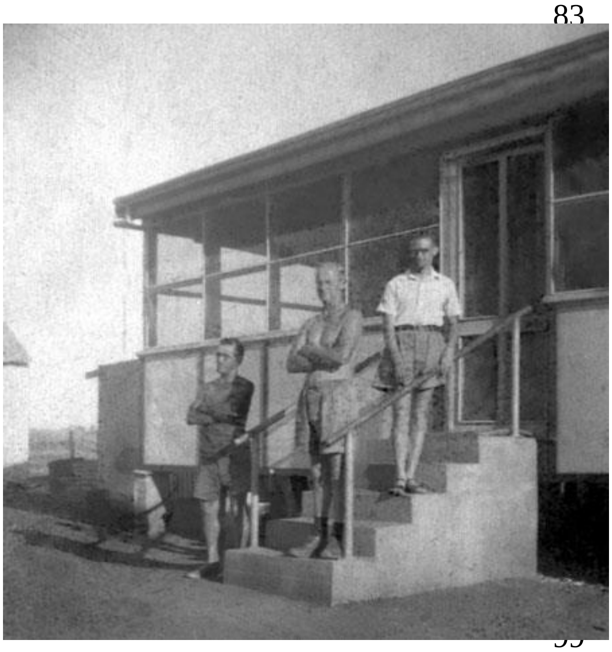

Figure 3. Aeradio staff on the steps of the Aeradio office in 1941-42. L-R John Tapper, Charlie Boileau and Frank Thomas, photograph by OIC, Keith Alston. (Photographs courtesy of the Civil Aviation Historical Society, Airways Museum, Essendon https://www.airwaysmuseum.com/Halls%20Ck%20Aeradio%2041-42.htm)

A 1952 plan for the townsite shows the location of the powerhouse equipped with two generators ventilated by 15-foot (4.5m diameter) propeller fans, three 70-foot (21m) aerial towers, water-main and the telephone line between the new post office and the Aeradio office. The meteorological enclosure was about 65m east of the now repurposed terminal at about Latitude -18.2216°, Longitude 127.6684° as estimated by Google Earth Pro (Figure 4).

Of the old post office site, Simon Torok noted in his 1996 PhD Thesis[1]:

Halls Creek (BoM ID: 2012)
08/1913: First correspondence
06/1916: New screen required, but position is near traffic. Iron legs sent.
07/1922: Particularly cool year, but no problems.
1930s: Observer problems.
11/1945: Screen in open, PO 50 yards to ESE. Site very open.
04/1952: PO moved so measurements ceased. Recordings at A.M.O. (meaning the former Aeradio/airport Meteorological Office).

ACORN-SAT metadata (Australian Climate Observations Reference Network – Surface Air Temperature) notes the Aeradio office site (ID 2012) commenced operating in 1944 but data was only archived from November 1949. The site moved about 650 m WNW in *about 1967* to the vicinity of a new meteorological office. The original 230-litre screen was replaced *in situ* with a 60-litre one on 25 August 1996[2]. Confusingly, data for an automatic weather station (AWS) installed *at the MO site* in another new 60-litre screen about 10 m away, also on 25 August 1996, was not

[1] Torok SJ (1996). Appendix A1, in: "The development of a high-quality historical temperature data base for Australia". PhD Thesis, School of Earth Sciences, Faculty of Science, The University of Melbourne.

[2] The Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT): Observation practices. BoM, 2012, Table 5, p. 11.

allocated a new ID number, but parallel observations continued until 2001 under the site number 2071. Datafiles show observations at the MO site ceased on 30 December 2018, by which time urban encroachment had contaminated the data.

Observations at the current AWS site (ID 2079) started on 18 September 2015. The screen is on the western side of the runway about 500 m southeast from the previous site on lower ground over mostly bare earth and gravel.

Thus, while *traffic* was hardly likely to have been an issue at the old post office in 1916, the Stevenson screen moved several times, and at least three times at the airport. Manually observed thermometers held in a 230-litre Stevenson screen were also superseded by an AWS operating in a 60-lite screen. An overlap was apparently used to transition between screens at the MO site, and possibly for the move to the current site, but metadata is vague in relation to that and it cannot be presumed that data available online has not been adjusted in-house. According to ACORN-SAT, data for the post office were merged with airport data on 1 January 1950.

Figure 4. The rescaled, reoriented 1952 townsite plan (20% opacity) overlaid on the May 2021 Google earth Pro satellite image showing location of the old terminal (T), (now re-purposed), the powerhouse (p) beside a gravel access road, the Aeradio office (a), and the meteorological enclosure (x), which is beside a drainage ditch. X_2 shows location of the MO site, and X3 is the current site. Three 70-foot (21m) towers behind the Aeradio office supported communication aerials. While the runway and apron were probably sealed for the first time in the 1960s, the pre-1952 building alignment remained unchanged.

2. Data and methods

> Methods of analysing trend and change in temperature records must be physically based, transparent, replicable, independent and unable to be manipulated to achieve pre-determined outcomes.
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Daily maximum temperature (Tmax) and monthly rainfall for the old post office, and sites at the airport (including the thermometer-AWS comparison (ID 2017)) were downloaded from the Bureau of Meteorology (BoM) climate data online facility. Daily data were abutted as per ACORN-SAT and summarised as described previously for Marble Bar, Meekatharra, Carnarvon and Potshot/Learmonth. The merged, summarised dataset is available as a datapack from www.bomwatch.com.au. Trend and change in the combined dataset were analysed using BomWatch protocols detailed in the Parafield (SA) case-study and subsequent reports.

Daily data for the grid-cell encompassing Halls Creek were also acquired from https://www.longpaddock.qld.gov.au/silo/ and summarised year by month. As SILO data are interpolated using data for surrounding weather stations, they may better reflect the general climate.

The question is whether trend and changes in the combined Tmax dataset for Halls Creek, reflect site and instrument changes or changes in weather and climate.

The second part of the report compares the same Tmax dataset analysed using BomWatch protocols, with adjustments made by various rounds of homogenisation spanning from HQ_1 in 1993 (Torok and Nicholls, 1996[1]), HQ_2 (Della-Marta et al., 2004[2]) to 2012, and recent versions of Blair Trewin's ACORN-SAT datasets, designated AcV1 to 2017 and AcV2.3 to 2021.

If homogenisation results in similar outcomes to those determined using objective, replicable BomWatch protocols then homogenisation objectives have been realised. Otherwise, problems and biases exist that were not adequately investigated by the two much publicised rounds of peer-review conducted by "*world-leading scientists*" in 2011 and 2015. It is noted that *peer-reviewers* did not produce a technical report based on case studies that either duplicated or worked through the Bureau's homogenisation processes from metadata to the final ACORN-SAT product.

An overarching issue is whether temperature measured by instruments held 1.2m above the ground in Stevenson screens (Figure 5) are capable of detecting small trends and changes in the climate that might be attributable to CO_2, coal mining or anything else.

Figure 5. The white, louvered, wooden 60-litre Stevenson screen surrounded by bare red, stony soil at the current (ID 2079) Halls Creek airport site (undated, from the ACORN-SAT Catalogue).

3. Results

3.1 The general climate

Located north of the Tropic of Capricorn and the Great Sandy Desert, and with little prospect of meaningful rain from April to October, the climate of Halls Creek is both monsoonal and arid (Figure 6). Average rainfall of 547 mm belies that rainfall is strongly skewed, episodic and nonstationary in the long term (Figure 7). For example, 10% of the rainfall since 1898 occurred in just seven or 5.6% of the 125 years of data, and 20% occurred in 15, or 12% of years. While rainfall in January, which is the wettest month averages 155 mm, 10% of years receive >300 mm. As potential evaporation exceeds monthly rainfall by a factor >2, there is also little prospect of a sustained positive soil moisture balance. Maximum and minimum temperatures decline between the autumn-spring Equinoxes, but due to low rainfall in winter, temperatures are warmest in late spring and early summer before commencement of the monsoon usually in December.

[1] Torok, S.J. and Nicholls, N. (1996). A historical annual temperature dataset for Australia. Aust. Met. Mag., 45, 251-260.

[2] Della-Marta, P., Collins, D. and Braganza, K. (2004). Updating Australia's high quality annual temperature dataset. *Aust. Met. Mag*. 53, 15-19 https://www.cmar.csiro.au/e-print/internal/braganza_x2004a.pdf

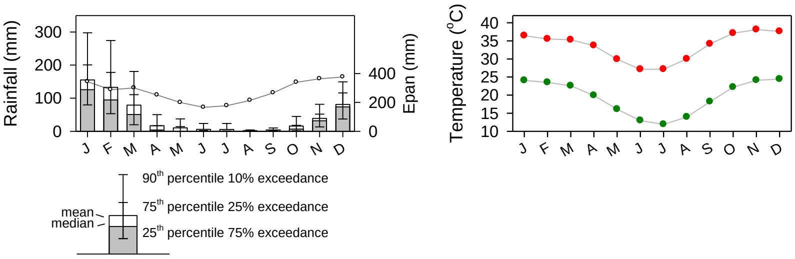

Figure 6. Monthly rainfall distributions, evaporation and average maximum and minimum temperatures at Halls Creek.

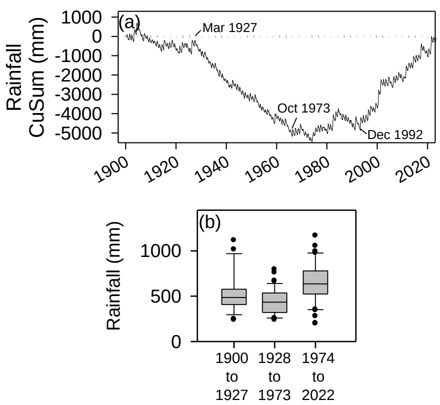

Figure 7. While rainfall observations before 1927 may not be accurate, the cumulative sum of differences from the mean in (a) was higher but in a declining phase before 1927 (the CuSum declined). Rainfall was cumulatively less than the mean from 1927 to 1973 but the period after 1973 was relatively moist (the CumSum increased. Box-plots in (b), show the upper and lower quartiles bound by the box, the median within, and outliers, and reflect the general trends in (a).

3.2 Trend and change in Tmax

Non-climate factors such as the conditions under which observations were made, the state of equipment and station re-locations profoundly affect trend and change in data. The Bomwatch approach uniquely examines latent signals in data that time-series analysis cannot.

Read on …

Replicable, defendable analysis of climate time-series requires that non-climate factors that impact observations are objectively identified. BomWatch protocols uniquely examine ‘hidden’ or latent signals in data that time-series analyses cannot. Trends produced by ‘joining-the-dots’ using Excel for example, are misleading and rarely reflect the climate.

The impact of site changes is generally evidenced as prolonged (decade-length) step-changes in the dataset mean or the mean of other attributes, which usually do not return to their previous level. However, as is the case at Halls Creek, instances occur where multiple changes cause data to cool for a period, or warm, around an unchanged long-term trajectory.

While many changepoint tests have been developed, including those in R packages available from CRAN (The Comprehensive R Archive Framework (https://cran.r-project.org/), sequential t-test analysis of regime shifts (STARS)[1] detects multiple changepoints within a time-series using the same target probability and time-length settings on a single pass[2]. Provided data are acceptably normally distributed (i.e., symmetrical about the mean) and the *P*-level of the t-statistic is adjusted for autocorrelation, the parametric Student’s t-test is also the most widely used test for comparing means of samples from groups of similar subjects. Depending on variance, STARS may detect a

[1] Rodionov, S.N. (2004). A sequential algorithm for testing climate regime shifts. *Geophysical Research Letters*, 31(9). https://doi.org/10.1029/2004GL019448

[2] (see also: https://www.researchgate.net/profile/Sergei-Rodionov-2/publication/268000612_A_brief_overview_of_the_regime_shift_detection_methods/links/5504990a0cf24cee3a018e67/A-brief-overview-of-the-regime-shift-detection-methods.pdf).

persistent change in annual mean temperature of 0.3°C, which is within the tolerance limits for adjustments made by AcV.2 [1].

Consistent with the First Law of Thermodynamics, Figure 8(a) shows rainfall reduces Tmax 0.187°C/100 mm (P <0.001) and explains 25.3% of Tmax variation (R^2_{adj} = 0.253). Rainfall-domain residuals were independent, normally distributed with equal variance across their range; however, as R^2_{adj} <0.50, the relationship is not precise (i.e., much variation in Tmax is unexplained).

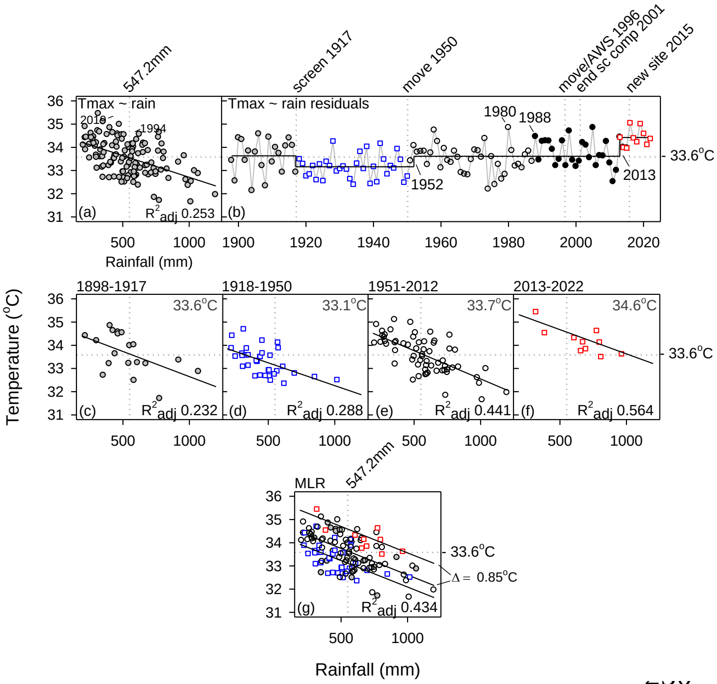

Figure 8. Trend and change in Halls Creek Tmax. (A statistical summary of phases (a) to (g) is given in Appendix 1.)

Step-changes in Tmax ~ rainfall residuals in (b), rescaled by adding grand-mean Tmax, show embedded discontinuities around the time of documented site changes in 1917, 1952, and 2013. A change was also detected in 1988 but as it was not significant (P >0.05), BomWatch protocols required it to be ignored.

Free-fit relationships between Tmax and rainfall in (c) to (f) show responses to rainfall are similar (refer to individual coefficients for Case (ii) in Appendix 1), and that variation explained (R^2_{adj}) ranged from 0.232 to 0.523, indicating segmented data were not equally precise. Data from 1918 to 1950 stepped-down relative to average rainfall/Tmax reference-lines, stepped-up to the same level as from 1898 to 1917, from 1951 to 2015, and stepped-up again in 2013 before the site moved in autumn 2015 (Appendix 1, Case (iii)). Rainfall-adjusted segment means are shown in grey-font in the upper right of each panel.

As mean Tmax and slope coefficients for the first and third segments were the same, those groups were combined into a single category and reanalysed (Figure 8(g) (Appendix 1 Case (iv)). Multiple linear regression verified that segmented responses to rainfall were the same (slope coefficients are statistically identical, thus regressions are parallel) and offset (rainfall-adjusted means were different), thus segmented relationships are not coincident as was the case previously for segments from 1898-1917 and 1918-1950 (Appendix 1 Case(iii)).

3.2.1 *Post hoc* analysis

> The BoM provides no *post hoc* assurances that homogenised data reflect the true climate.
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The First Law Theorem provides a physical reference frame for evaluating the quality of Tmax data used to track trends and changes in the climate. Segmented regressions (Figure 8 (c) to (f)) show responses to rainfall are negative, relationships are significant (Appendix 1, Case(ii)), that except for 1898-1917 and 1918-1950, they appear offset relative to reference lines, with slopes not

[1] Trewin, Blair (2018). *The Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) version 2*. Bureau Research Report No. 032. (http://www.bom.gov.au/climate/change/acorn-sat/documents/BRR-032.pdfRR-032 (bom.gov.au))

greatly affected by outliers. Variance was highest (and R^2_{adj} least) from 1898 to 1917 (R^2_{adj} = 0.232), probably because by June 1916 the screen was in a poor state, and least (R^2_{adj} = 0.523) after 2013, two years before the site relocated to the current position. Google Earth Pro satellite images show the site near the met-office became surrounded by new housing developments that proceeded apace between 2006 and 2011 and that by 2013, with the nearest houses crowded into small allotments just 29m north of the Stevenson screen and with air conditioner heat exchanges on their roofs, data were contaminated and the site was no longer viable.

Residuals from the analyses shown in Figure 8(g) were also examined graphically and statistically. A Q-Q plot showed residuals were normally distributed, the Breusch-Pagan test found they were homoscedastic (BP = 0.288, P = 0.592) and the Durbin-Watson test (DW= 2.089) confirmed they were independent (P = 0.624). Although an influence plot identified 1904, 1908, 1974, 2011 and 2016 as possible outliers, they were not influential according to Cook's distance. Thus, assumptions were verified and rainfall-domain analysis is complete.

Having simultaneously accounted for the effect of rainfall and step-changes on Tmax, **as no trend or change was evident in MLR residuals, it could not be claimed that the climate at Halls Creek has warmed due to other factors including CO_2, coalmining, electricity generation or anything else**.

While the overall least-squares trend of 0.024°C/decade from 1898 (Appendix 1, Case(v)) was not significant (P = 0.214), this is likely to change as data for the new site continue to accrue. Nevertheless, as trend is affected by step-changes related to site changes, and trend within data segments is not significant, time-series analysis using a *naïve* join-the-dots spreadsheet approach sidesteps the critical problem that raw data for Halls Creek are not homogeneous.

4. Interim discussion

Halls Creek Tmax shows no trend or change that could be attributed to CO_2, coalmining, electricity generation or anything else.

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While Tmax measured at Halls Creek since 1898 shows no trend or change that could be attributed to the climate, analysis reported here emphasises that undertaking trend analysis without considering processes affecting the data is problematic. Time-series analysis conducted using spread-sheet applications such as Excel are unable to partition the overall Tmax signal into the part reflecting the weather (i.e., the deterministic rainfall component) and the residual part that includes effects caused by site and instrument changes. Furthermore, as metadata cannot be trusted, it is impossible using metadata alone to judge if site changes happened that were not reported, or if those that were reported affected the data. Such questions can only be resolved using objective protocols and rigorous, objective statistical methods.

BomWatch protocols use naïve linear regression of the form Tmax ~ rainfall to remove effects due to rainfall. Permanent or semi-permanent excursions detected iteratively using a range of STARS length and probability settings in rescaled residuals, are confirmed where possible by cross-referencing with metadata and other information. Segments are analysed individually for goodness of fit, outliers and other aberrations. Segmented data are then compared and evaluated simultaneously as scenarios, using multiple linear regression, with rainfall the co-variable. Although multiple scenarios may be considered, for any dataset there is only one valid outcome, which is that:

- Segmented regressions are parallel (interaction is not significant thus segmented responses to rainfall are the same).
- Individual relationships are not coincident (rainfall-adjusted segment means are different, thus R^2_{adj} is not inflated by step-change variables that are not significant). As segments from 1898-1917 and 1918-1950 were coincident (rainfall adjusted means were the same: Appendix 1, Case (iii)) they were identified as a single group and analysed a second time (Appendix 1, Case (iv)).
- Assumptions underlying multiple linear regression are satisfied (namely that residuals are independent, normally distributed with equal variance across categories), and that outliers were not influential.
- Also, as a *post hoc* tests show data consist of non-trending segments separated by step-changes the naïve overall trend of 0.024°C/decade does not reflect the 'true' climate.

If climate change or climate warming exists it would be detectable as a residual signal only after significant factors have been accounted-for. **The hypothesis that the climate has changed or warmed due to factors in addition to changes in rainfall or the condition and location of the various sites where temperature has been measured is not supported in this case.**

5. Homogenisation

> If those advocating on behalf of *climate action* use the same datasets that have been homogenised using the same faulty methods, they are likely to be equally wrong.
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Halls Creek is one of 25 of the 112 ACORN-SAT sites in Western Australia used to monitor climate warming (Figure 9).

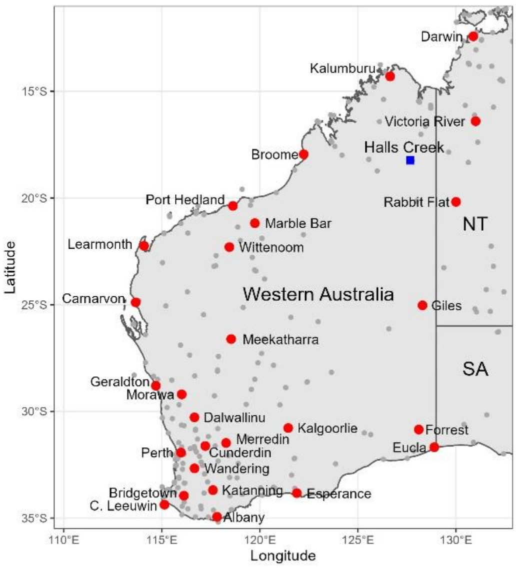

Figure 9. Halls Creek in the Kimberley Region of WA (blue square), and other ACON-SAT sites (red) used to monitor warming, and weather stations having more than 10-years of temperature data (grey dots).

Verification that homogenised datasets truly reflect the climate is central to the truthfulness of claims made by the BoM and CSIRO in *State of the Climate* reports, and claims made by the incessantly alarmist Australian Museum, the Australian Academy of Science, WWF and their affiliated Climate Council and others, including state government agencies such as the Water Corporation in WA[1] and Adapt NSW[2] who use the BoM's homogenised datasets to scare school children and mothers and to drive social agendas.

Clearly if commentators holding themselves out to be experts all depend on the same homogenised data, their messages are likely to be the same. This group includes *misinformation expert* Dr John Cook at Monash University (https://www.monash.edu /mcccrh /people/john-cook) who proposed the fallacious 97% consensus meme, and climate modellers like Professor Andy Hogg and his $5.6M indigenous super-computer called *Gadi* at the Australian National University

[1] https://www.watercorporation.com.au/Our-water/Climate-change-and-WA

[2] https://www.climatechange.environment.nsw.gov.au/australian-climate-change-observations

(https://www.anu.edu.au/research/research-innovation-news/professor-hogg-to-take-climate-modelling-to-the-next-level) and other agencies and lobbyists. While Hogg believes "*Climate models are the best tools we have to predict the future of our planet and make better environmental decisions*"[1] it is vital that they are calibrated using data that is independently verified. Furthermore, if *Gadi* cannot replicate the past and present climate, it is useless for making *better environmental decisions* for the future.

Homogenisation of Australian temperature data commenced in the late 1980s when supervised by Neville Nicholls and Professor Ian Simmonds and with the support of a grant from the National Greenhouse Advisory Committee, Simon Torok undertook his PhD at the University of Melbourne[2]. To determine the necessary adjustments, Torok's *objective procedure* involved using median values for surrounding well-correlated stations to create comparative *reference series* for each of the 224 long-term weather stations he investigated.

Torok concluded that maximum and minimum temperatures have increased across Australia since about 1950 and that minimum temperatures have increased at a greater rate than maxima. The 1996 report co-authored by Nicholls (cited on p. 5) summarised his methods and findings.

Figure 10 shows adjustments made by Torok to long-term data for Halls Creek and the resulting trend in his homogenised *high-quality* dataset (HQ_1) calculated to 1993.

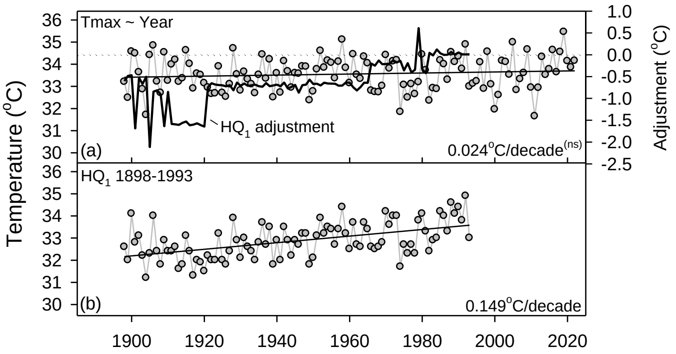

Figure 10. Adjustments made to Halls Creek Tmax by Simon Torok (thick line overlaid on the abutted time-series in (a)), and resulting trend in his homogenised dataset (b).

Torok used a comparator series comprised of neighbouring stations whose first-differenced data were highly correlated with first-differenced Halls Creek Tmax. He adjusted pre-1905 Tmax up by 0.3°C, up again by 0.8°C in 1911, down by 0.9°C in 1921, down by 0.5°C in 1966, up by 0.2°C in 1975 and down by 0.4°C in 1982. Using those adjustments to smooth variation in the original series, with its non-significant trend (Figure 10(a)) Torok derived a statistically significant trend of 0.149°C/decade over the period from 1898 to 1993 (Figure 10(b), Table 1).

Torok's HQ_1 homogenised datasets were followed by versions updated by Della-Marta et al. (2004) referred to as HQ_2[3], the final iteration of which was released in 2012[4] (Figure 11).

Della-Marta et al. (2004) found methods used by Torok were largely subjective, difficult to replicate and sensitive to the selection of reference stations and source data. However, while extending the record to 2012 they made limited changes. Consequently, Australia-wide trends calculated by Della-Marta et al. (2004) were about the same as those calculated 9-years earlier by Torok and Nicholls (1996) (0.6°C/100Yrs vs 0.59°C/100Yrs).

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[1] https://www.anu.edu.au/research/research-innovation-news/professor-hogg-to-take-climate-modelling-to-the-next-level

[2] Torok SJ (1996). "The development of a high-quality historical temperature data base for Australia". PhD Thesis, School of Earth Sciences, Faculty of Science, The University of Melbourne.

[3] Della-Marta, P., Collins, D. and Braganza, K. (2004). Updating Australia's high quality annual temperature dataset. *Aust. Met. Mag*. 53, 15-19 https://www.cmar.csiro.au/e-print/internal/braganza_x2004a.pdf

[4] Trewin, Blair (2018). *The Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) version 2*. Bureau Research Report No. 032. (http://www.bom.gov.au/climate/change/acorn-sat/documents/BRR-032.pdfRR-032 (bom.gov.au))

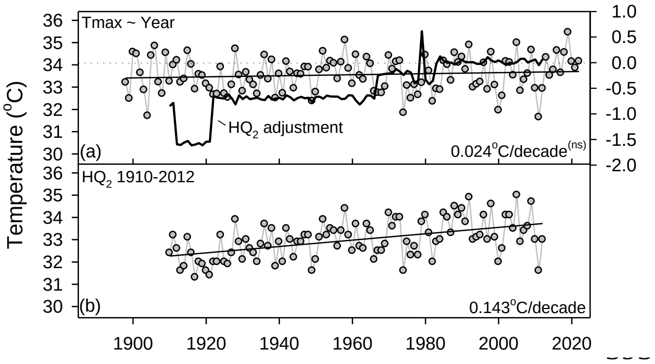

Figure 11. Shortening the dataset by ignoring data before 1910, lengthening it to 2012, and applying similar adjustments as HQ_1, Della-Marta et al. (2004) achieved a trend of 0.143°C/decade in HQ_2, identical to that shown in Figure 9.

The ACORN-SAT project stemmed from Blair Trewin's 2001 PhD[1] thesis. which was also supervised by Simmonds and Nicholls. The primary aim of ACORN-SAT is that homogenised datasets would be more homogeneous for extremes as well as for means[2]. To achieve this, Trewin used first-differenced correlated reference series to skew data distributions at identified changepoints using complex methods based on transfer functions.

As ACORN-SAT homogenisation differed markedly from methods used by Torok (1996) and Della-Marta et al. (2004), adjustments made by AcV1 to Halls Creek Tmax (1910-2017) were also considerably different (Figure 12).

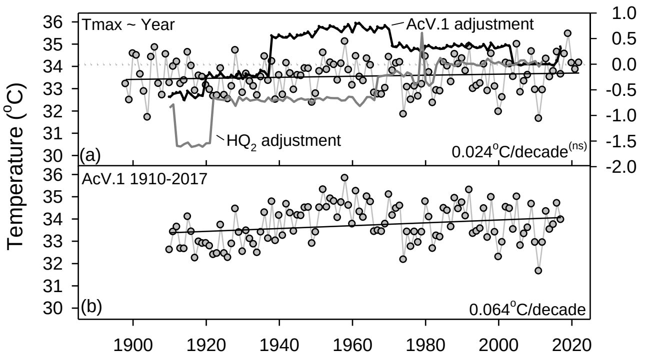

Figure 12. Adjustments made to post-1910 Halls Creek Tmax by AcV1 (black line in (a)) differed considerably from those made by HQ_2 (grey line), particularly in 1932, 1971 and 2004. While the resulting homogenised Tmax trend in (b) was within BoM and the Intergovernmental Panel on Climate Change (IPCC) predictions (0.6°C/100yr), cooling from 1958 to 2017 (of -0.12°C/decade) was inconsistent with the 'warming since 1950' narrative.

While iterations of AcV2 which replaced AcV1 in 2018, extended the data to 2021 (AcV2.3) adjustments made in 2018 were unchanged (Figure 13).

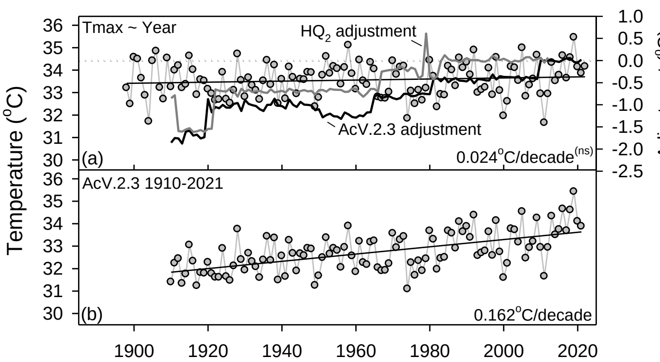

Figure 13. Adjustments made by AcV2.3 (black line), which are the same as those made by AcV2.0, compared with HQ_2 (grey line).

A notable feature of AcV2.3 is that the previous positive adjustments in AcV.1 became negative. No longer is there a negative trend in homogenised data from 1958, instead the overall trend of 0.162°C/decade seems smooth and plausible.

At the current rate of warming, AcV2.3 predicts that average Tmax will be 1.5°C higher in 2030 than it was in 1910, and 1.8°C warmer by 2050. Whether this remains in line with *Paris limits to*

[1] Trewin, B.C. 2001. *Extreme temperature events in Australia.* Ph.D. thesis, School of Earth Sciences, University of Melbourne.
[2] Trewin, Blair (2018). *The Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) version 2*. Bureau Research Report No. 032. (http://www.bom.gov.au/climate/change/acorn-sat/documents/BRR-032.pdfRR-032 (bom.gov.au))

warming as projected by Sophie Lewis, Andrew King and Daniel Mitchell in 2017[1] using climate models, depends on scientists at the BoM continuing to adjust data to agree with the *political narrative*, and it that narrative which drives the so-called *science*.

It is also clear that in the absence of intervention by Neville Nichols and his protégés within the BoM, that data originally collected to monitor and describe the weather is incapable of tracking long-term trends and changes in the climate. Data were never collected for that purpose and the 'bolt-on' experiment that commenced in the 1980s was always doomed to fail. It is to his discredit as a scientist that under the guise of ACORN-SAT, Trewin continues to adjust and massage data so they agree with *the science* portrayed by King, Lewis and Mitchell (2017) and others in the modelling fraternity, and by CSIRO.

5.1 *Post hoc* evaluation of homogenised Tmax data for Halls Creek

> *Misinformation* experts like Dr John Cook at Monash University, advocates at the WWF-affiliated Climate Council and Farmers for Climate Action, activist CEOs embedded at the Australian Museum and the Australian Academy of Science and elsewhere, and state government agencies have failed to evaluate the soundness of the homogenised data they rely on in pursuit of 'carbon' and social agendas.
>
> Read on …

During the life a weather station, sites and instruments change at various but fixed times, which may measurably affect data, but by making adjustments that are inconsistent in their timing and magnitude, the various rounds of data homogenisation move the goalposts to suit their political masters.

For instance analysis found that, as measured by the significance and variation explained by their relationship with rainfall, old post office data was of lesser quality than post-1950 airport data (R^2_{adj} 0.232 and 0.288 vs. 0.441 and 0.564). Analysis also identified that a change in rainfall-adjusted average Tmax of -0.51ºC (0.47ºC according to STARS) occurred in 1917 (Appendix 1(ii) and (iii)). With the changepoint cross-referenced to a site change, and its magnitude known, the appropriate adjustment is to reverse the change by adding 0.51ºC to the down-stepped data, but that is not what homogenisation did.

HQ_1 adjusted the 1917 changepoint four years later in 1921, and HQ_2 in 1922 and because they used comparative methods, the changes applied were not the same as the step-change they sought to adjust. In a similar vein, while AcV2.3 made an adjustment from 1 January 2010 which is not documented as a site change and not detected as a shift in Tmax ~ rainfall residuals by STARS, AcV2.3 failed to adjust for the up-step of 0.85ºC in 2013 (0.81ºC according to STARS) caused by urban encroachment and moving to the new site (Appendix 1(iv), segment 1 vs 3).

While due to the various step-changes, trend in the combined Tmax dataset is not different to zero trend, successive rounds of homogenisation resulted in trends becoming significant, with AcV2.3 warming at the highest rate (Table 1). On the other hand, while homogenised data is purported to better reflect the climate, rainfall explained a higher proportion of variation in raw-data than homogenised data, with the least being for AcV2.3.

Scatterplots of observed data (y) vs. those predicted or fitted by a model[2] (x) are said to be one of the richest forms of model validation and visualisation (https://stats.stackexchange.com/questions/104622/what-does-an-actual-vs-fitted-graph-tell-us). A perfect fit (y = x) would be

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[1] Lewis, S. C., King, A. D., & Mitchell, D. M. (2017). Australia's unprecedented future temperature extremes under Paris limits to warming. Geophysical Research Letters, 44, 9947–9956. https://doi.org/ 10.1002/2017GL074612

[2] See Pineiro et al (2008). How to evaluate models: Observed vs. predicted or predicted vs. observed? *Ecological modelling*, 216, 316–322. doi:10.1016/j.ecolmodel.2008.05.006

indicated by points lying directly along a 1:1 line. Alternatively, the lower the r^2 (the square of the Pearson correlation coefficient) the more dispersed and possibly skewed the datapoints would be.

Table 1. Trend statistics and goodness of fit with rainfall, for unhomogenised and homogenised Tmax data for Halls Creek. While $Tmax_{raw}$ trend was not significant (ns), rainfall explained 23.7% of Tmax variation. In contrast, trend in AcV2.3 Tmax was highly significant, but rainfall explained only 3.6% of Tmax variation.

	Tmax ~ Year			Tmax ~ rainfall		
Series	Coefficient (°C/decade)	*P*	R^2_{adj}	Coefficient (°C/100mm)	*P*	R^2_{adj}
$Tmax_{raw}$	0.024	0.214 (ns)	ns	-0.182	<0.001	0.237
HQ_1	0.149	<0.001	0.252	-0.142	<0.001	0.106
HQ_2	0.143	<0.001	0.243	-0.13	<0.001	0.093
AcV1	0.064	0.017	0.044	-0.185	<0.001	0.188
AcV2.3	0.162	<0.001	0.342	-0.091	0.025	0.036

For the $Tmax_{raw}$ ~ rainfall relationship, while the least-squares line is coincident with the 1:1 reference, which is expected, fitted values were skewed relative to observed data (Figure 14). Observed Tmax > *c.*33.6°C were predicted to be cooler by up to 1°C, while cool values were predicted to be warmer by up to 1°C, thereby evidencing bias. Including the (Sh)ift variable increased r^2 and improved alignment, but as the average difference (fitted minus observed) was negative above 33.6°C and positive below 33.6°C, skew was not completely eliminated.

Range	AvRain	AvSh+Rain
>33.6	-0.474	-0.353
<=33.6	0.482	0.358

The lack of alignment in extremes relative to the 1:1 reference could be due to the non-significant step-change in 1988 (*P* = 0.104). However, as data are rough anyway (particularly post-office data) and inclusion of the additional 1988 step-change made little difference to R^2_{adj} (0.434 vs. 0.452 with Sh(1988) included) it was ignored on statistical grounds.

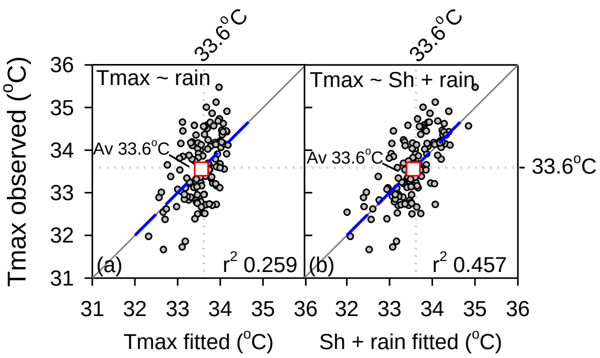

Figure 14. Scatterplots showing $Tmax_{observed}$ vs. Tmax fitted/predicted by rainfall alone (a) and by the Shift variable + rainfall (b) (i.e., Appendix 1(i) vs (iv)). Fitted values warmer than mean $Tmax_{observed}$ (33.6°C) were generally under-predicted (too cool) while those <33.6°C were warmer. The non-significant step-change in 1988 may have contributed skew. (The blue dashed-line is the least-squares fit which is expected to coincide with the 1:1 line; r^2 is the square of Pearson's linear correlation coefficient.)

Said to be free of site inhomogeneities and other non-climate impacts it is expected that homogenised Tmax fitted/predicted by rainfall (Table 1) would be better aligned with observed Tmax than was the case in Figure 14.

While rainfall is the same as in Figure 14, upper range HQ_1 values were shifted cooler relative to observed Tmax by up to 1.5°C, while lower-range values were slightly warmer (Figure 15). Consequently, as indicated by the least-squares (dashed blue) line, predicted HQ_1 became markedly skewed as observed Tmax increased. Similar problems were evident in fitted values for HQ_2.

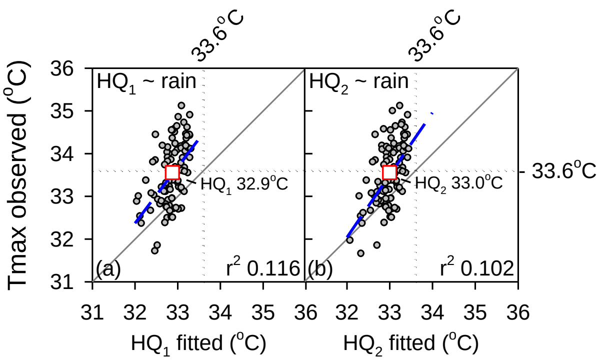

Figure 15. Scatterplots comparing observed Tmax and values fitted/predicted by relationships between HQ_1, and HQ_2 and rainfall. If homogenised data better represent the 'true' climate, points would be dispersed along the 1:1 line and the dashed blue least squares fit would fall on the 1:1 line (*vis-à-vis* Figure 14). Mean HQ_1 Tmax was 32.9°C and for HQ_2, 33.0°C (red-edged square).

Of the four homogenised Tmax datasets, ACORN-SAT v1 was most closely aligned with observed Tmax (Figure 16). However, trend was significant (Table 1, P = 0.017) the relationship with rainfall lacked precision (R^2_{adj} = 0.044). Figure 16 also shows upper-range AcV1 values are skewed cool while lower-range values are skewed warm. In contrast practically all fitted AcV2.3 data are vertically above the 1:1 line, indicating that in order to achieve the significant trend of 0.163°C/decade (Table 1) AcV2.3 homogenisation cooled past data unrealistically and too aggressively.

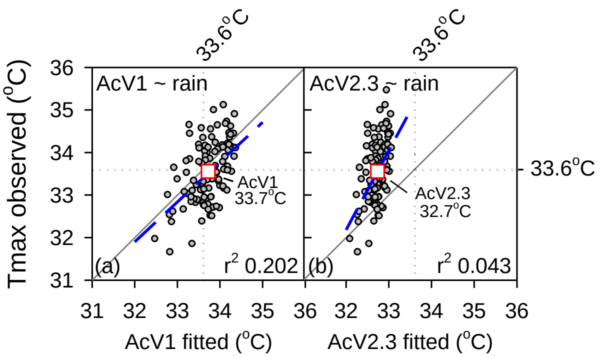

Figure 16. Scatterplots showing observed Tmax and values fitted/predicted by relationships between AcV1 and AcV2.3 and rainfall (Table 1).

Since the late 1980s when Bureau scientists commenced homogenising data by comparing target-site data with correlated neighbours whose data likely embedded parallel faults, the aim appears to have been to smooth step-changes caused by site changes so homogenised trends agreed with those predicted by climate models. Ultimately *the science* (the modelled climate) was driven top-down by the political narrative that underpins all that has happened since, including the Kyoto protocol, the Paris agreement, the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, and all that has flowed from that including the Murray-Darling Basin Plan, carbon taxes in various forms, restrictions on land-use and development and so-on.

The agenda seemed set by the World Meteorological Organisation (WMO) which with the United Nations Environment Programme (UNEP) jointly established the IPCC in October 1988[1]. Neville Nicholls was heavily involved with the WMO, he was Lead Author of the Section C, Supplement to the IPCC First Scientific Assessment Report (1991-1992) and Convening Lead Author of Chapter 3 of the IPCC Second Scientific Assessment (1993-1995) that dealt with observed climate variability and change.

It is not surprising therefore that Nicholls also took a leading role in overseeing homogenisation, and consequently, that Australia's temperature datasets were adjusted to align with the IPCC consensus.

[1] https://www.bomwatch.com.au/data-quality/part-2-marble-bar-the-warmest-place-in-australia-2/

5.2 Effect of homogenisation on temperature extremes

By cooling the past, homogenisation has vastly increased counts of upper-range Tmax extremes at the expense of lower-range extremes, which shifts the perception from a warming climate to one of extremes (i.e., the tails of data distributions have been adjusted so they agree with models).

Read on …

Extreme temperatures are those that occur in the tails of daily data distributions, typically values/year that are less than the 5th or greater than 95th day-of-year dataset percentiles (Lo and Hi extremes respectively) shown in Figure 17.

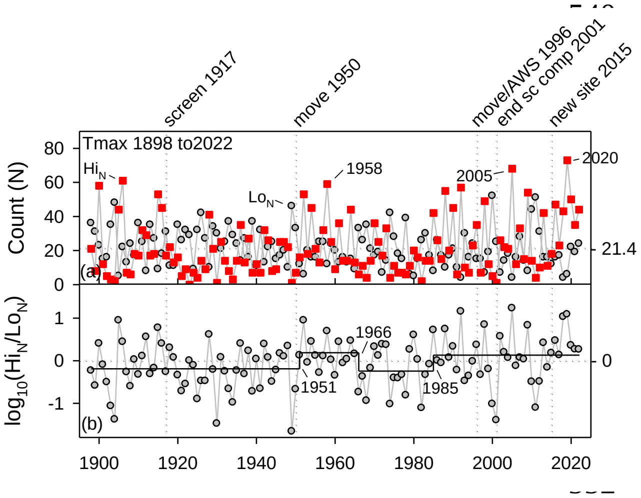

Figure 17. Counts/year of low (grey circles) and high (red squares) Tmax extremes (a) and inhomogeneities in their $\log_{10}$-transformed ratio. Step-changes in (b) may be related to a combination of site changes and persistent changes in the weather.

The $\log_{10}$-transformed ratio of Hi to Lo extremes (Hi_N/Lo_N) from 1898 to 2022 is expected to be random and homogenous in the long-term (Figure 17(b)). However, the ratio stepped-up in 1951 after the move to the airport, and down from 1966 to 1985 due apparently to increased rainfall.

While not available for HQ_1 or HQ_2, daily homogenised ACORN-SAT v.1 data was released in 2012 and with incremental updates, finished in December 2017. Also, updated incrementally since 2018, the most recent version of AcV.2 is AcV.2.3, which ended in December 2022.

Increased Hi_N extremes in 1936 caused a 'bubble' to emerge in AcV1 from 1951 to 1974, following which the ratio stepped down until 2017 (Figure 18).

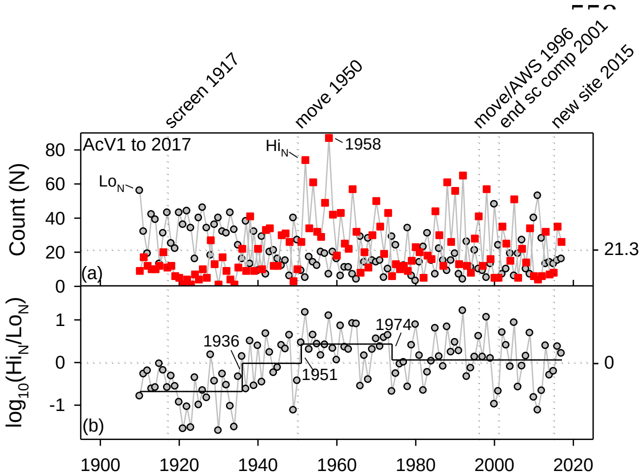

Figure 18. Effect of AcV1 homogenisation on temperature extremes to 2017. The Hi_N:Lo_N count of 87:7 in 1958, is unexplainable, as is the tapering of Hi_N counts after about 1985.

The down-step in 1974 (but not necessarily those in 1936 or 1951) could be related to the increase in average annual rainfall from 482mm to 646 mm in 1974 shown in Figure 7.

ACORN-SAT v.2 homogenisation (Figure 19) resulted in a markedly different outcome compared to previous iterations (Figures 17 and 18) with Hi_N extremes consistently higher after 1985 (note the change in scale of the y-axis from N = 90 in previous Figures, to N = 120).

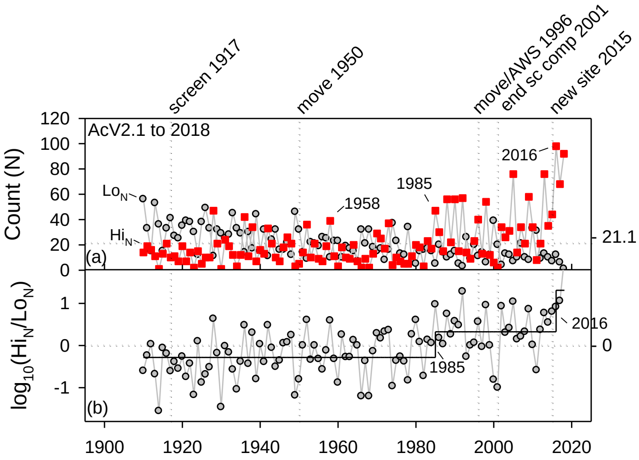

Figure 19. The effect on AcV.2 homogenisation on extremes to 2018. The 1958 ratio declined to 39:7.

The following in-line table summarises average Lo_N vs. Hi_N counts/yr before 1984 and between 1985 and 2017, for AcV1 and AcV2:

AcV1	1910-1984	Lo_N 22.4 Hi_N 20.5
	1985-2017	Lo_N 17.0 Hi_N 24.7
AcV2.1	1910-1984	Lo_N 17.0 Hi_N 24.7
	1985-2017	Lo_N <u>13.5</u> Hi_N <u>38.4</u>

AcV2.1 homogenisation skewed the distribution of upper-range extremes higher particularly after 1984. As nothing remarkable happened in 1985, while rainfall was low in 1989 (203 mm, ranked the driest year) and 1992 (217 mm ranked second driest), the average from 1985 to 2017 was 650mm. With a possible up-step in 2018, which as it occurs at the end of the record requires confirmation by incoming data, the trend towards increasing upper-range extremes in AcV2.3 continued to the end of the record in 2022 (Figure 20).

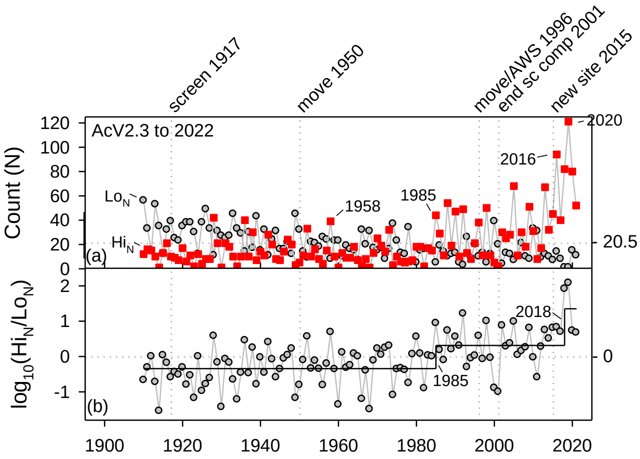

Figure 20. The effect of AcV.2 homogenisation on Tmax extremes to the end of 2022. While the visual effect in (a) seems plausible, the up-step in 1985 is not supported by metadata and it is unrelated to site or instrument changes. The apparent exponential increase in upper-range extremes after 1985 most likely reflects Trewin's AcV2 homogenisation methods, not the climate.

5.3 Comparator sites

Sites selected by inter-site correlation with target-site data used as comparators to detect changepoints and make adjustments, are either too short, too imprecise or their data are biased by embedded site-change effects. Using faulty data to adjust faults in homogenised data has no statistical or scientific merit.

Read on …

Of the total of 29 sites at 24 locations used to homogenise Halls Creek Tmax, seven are ACORN-SAT sites: Victoria River Downs, Rabbit Flat, Tennant Creek, Broome, Alice Springs, Camooweal and Boulia (Figure 21). All are scattered mainly through the Kimberley and Barkly Tablelands of eastern Central Australia and three are in Queensland (Figure 21). The furthest, Boulia, is 1357 km SE of Halls Creek (Figure 21).

Excepting sites making-up the Halls Creek record (the old post office, airport and the AWS), of the 26 remaining comparators, 50% have records shorter than 30 years. Wyndham Port (ID 1005) is the shortest (January 1957 to October 1967), has no useful metadata and Tmax shows no correlation with rainfall. Similarly, Wonarah (ID 15034) 900 km away, which opened in January

1957, has only 16 relatively complete years of data, no useful metadata, Tmax and rainfall are unrelated (p_{unc} = 0.569), but data was used to homogenise Halls Creek Tmax for a ‘statistical’ change in January 1965, which was not detectable in Tmax ~ rainfall residuals (Figure 8(b)).

Because all but one of the comparator datasets used to homogenise Halls Creek Tmax were not homogeneous (Appendix 2), and all were selected on the basis of first-differenced linear correlation with first-differenced Halls Creek data, reasoning by Trewin that “the use of multiple reference stations provides a high level of robustness against undetected inhomogeneities at individual reference stations”[1] is nonsensical.

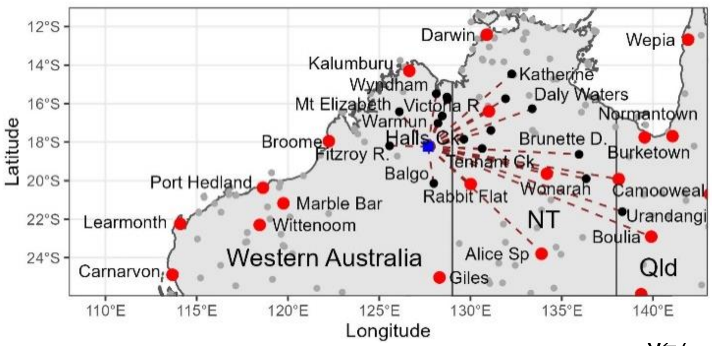

Figure 21. Sites used to homogenise the combined dataset for Halls Creek (black circles). Adjustment sites span 9.25° of Latitude and 14.34° of Longitude. As the cocky flies[2], the distance southeast from Halls Creek to Boulia, Queensland, is 1375 km.

Warmun (ID 2032), which is 145 km north of Halls Creek, was used to adjust for ‘statistical’ changes in Tmax in 2010, 1981 and 1965. Tmax data commencing in 1962 is analysed in Figure 22.

While Tmax depends on rainfall (Figure22(a)), rainfall only explains 37.6% of Tmax variation (R^2_{adj} = 0.376). A highly significant step-change in rescaled Tmax ~ rainfall residuals in 1986 (STARS 0.68°C, P <0.001) in (b) shows data were not homogeneous, consequently the naïve raw data trend of 0.019°C/decade (P <0.001) (not shown) was spurious.

Free-fit segmented regressions (c) and (d) show data to 1985 was of higher quality than later data (R^2_{adj} = 0.559 vs. 0.494) and that relative to reference lines, regressions were likely to be offset and parallel (slope coefficients, 0.268 vs. 0.213°C/100mm were about the same).

Multiple linear regression in (e) confirmed that rainfall reduced Tmax 0.229°C/100mm, rainfall-adjusted segment means were different (34.6°C vs. 35.3°C) and the step-change and rainfall simultaneously explained 53.8% of Tmax variation. Outlier years (2016 and 2018) were affected by missing data; however, they were not influential on the outcome of the analysis. MLR residuals were independent, normally distributed with equal variance across categories, thus rainfall-domain analysis is complete.

As no trend or change is detectable in MLR residuals, there is no evidence that the climate has changed or warmed. *Post hoc* analysis confirmed that data consisted of two non-trending segments disrupted by an up-step of 0.73°C (0.156$_{se}$), most likely due to a site change in 1985/1986. Although, metadata provides no useful information, the Stevenson screen may have moved to its present position further away from watered lawns and trees in 1985, the former 230-litre screen may have been replaced by a 60-litre one, or developments may have occurred nearby that caused the data to warm independently of the climate.

Daly Waters (ID 14618), Northern Territory, was a repeater station on the overland telegraph linking Adelaide and Darwin that opened in August 1872. Operating as a stopover for aircraft flying between Australia and Asia and on to London in the 1930s the nearby aerodrome was Australia’s

[1] P. 12 in afore cited Trewin, Blair (2018) (see p. 10)
[2] https://geodesyapps.ga.gov.au/distance

first international airfield. It was taken over by the Royal Australian Air Force (RAAF) and used as a long-range Unites States Army Air Force bomber base during WWII. (https://en.wikipedia.org/wiki/Daly_Waters_Airfield#History).

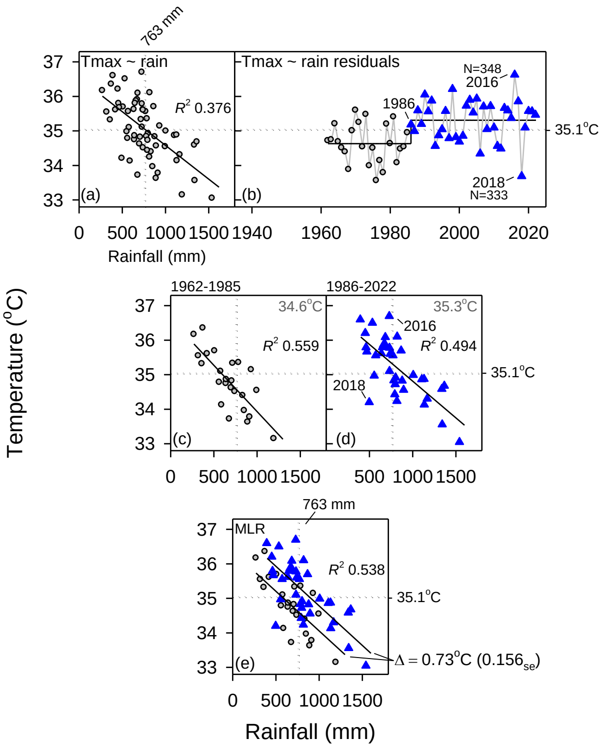

Figure 22. Analysis of Warmun Tmax. Data are available from 1962 to 2022 (see Figure 21 for location).

Aeradio commenced operating at Daly Waters in 1939 (call sign VZDW; see https://www.airwaysmuseum.com/Daly%20Waters%20Aeradio%2040s.htm). Cross referenced by Google Earth Pro and the site-summary metadata site diagram for March 1999, the Aeradio meteorological enclosure was located at Latitude -16.2641°, Longitude 133.3770°, which would have been to the rear of the now-demolished office, and SE of the historic QANTAS hanger.

While during an interim period, from 1970 to 1986, observations transferred to a site in town (ID 14618, possibly the post office), an AWS (at Latitude -16.2637°, Longitude 133.3782°), which established on 26 July 2000 about 126m ENE of the 1939 enclosure.

Supported by a statistical summary (Table 2), graphical analysis of Daly waters Tmax is shown in Figure 23. (Incomplete years from 1982 to 2000 were ignored.) Due to step-changes in Tmax ~ rainfall residuals in 1978, which although records are missing is probably when the Aerado/Flight Services office closed and the site moved to the village, and the up-step in 2013, Tmax is not homogeneous. Nevertheless, data were used to homogenise Halls Creek AcV.2 Tmax for the move from the old post office to the aerodrome in 1950 and for an ‘statistical’ change from January 1965 (Figures 12 and 13).

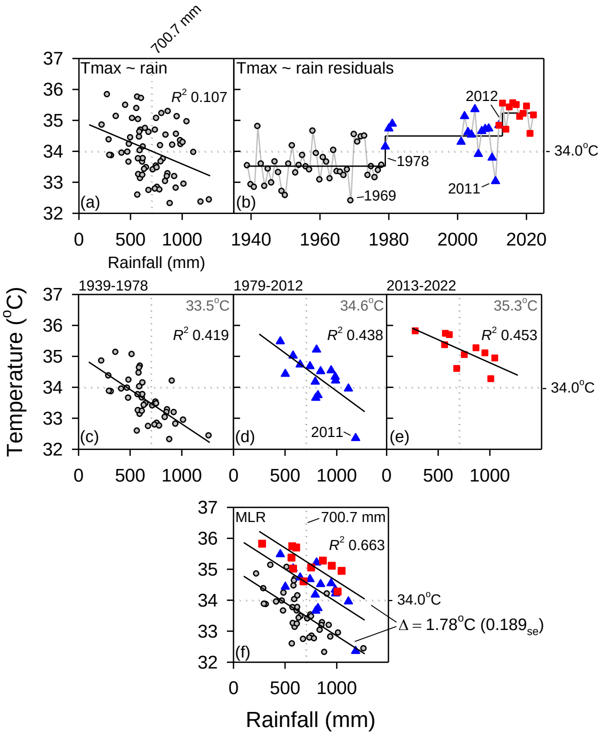

Figure 23. Analysis of Daly Waters Tmax.

While a former 230-litre screen was probably replaced by a 60-litre one in 2012, Google Earth Pro satellite images show shrubs and tussocks were completely removed to a distance >50m around the fenced enclosure between July 2013 and July 2018, which remains the case up to March 2020.

Table 2. The statistical summary for Daly Waters Tmax (refer to Figure 23). Case (i) links to Figure 23(a), Case (ii) to Figure 23(b), and Case (iii) refers to MLR analysis (Figure 23(c). Case (iv) refers to *post hoc* trend analysis that shows overall trend of 0.191°C/decade is spuriously related to step-changes in 1979 and 2013 (i.e., that data consist of non-trending segments disrupted by step-changes).

Model	Coef. (°C/100mm)	P	R^2_{adj}	Segment	RainAdj (SE) (°C)	RSS ($R^2_{partial}$)	
Daly Waters							
(i) Tmax ~ rain	-0.141	0.005	0.107			46.66	
(ii) Tmax ~ rain							
1939-1978	-0.222	<0.001	0.419				
1979-2012	-0.246	0.004	0.438				
2013-2021	-0.149	0.020	0.453				
(iii) Tmax ~ Sh_{res} + rain	-0.238	<0.001	0.500	1939-1978	33.5[a] (0.085)	17.05	Interaction
				1979-2012	34.6[b] (0.141)	(63.5%)	Tmax ~ Sh_{res} * rain
				2013-2021	35.2[c] (0.168)		ns
				Delta$^{(2 \text{ vs } 1)}$	1.09 (0.168)		
				Delta$^{(3 \text{ vs } 1)}$	1.78 (0.189)		
				Delta$^{(3 \text{ vs } 2)}$	0.68 (0.217)		
(iv) Tmax ~ Year	(°C/decade)						
	0.191	<0.001	0.306	1939-1978			P = 0.96 (ns)
				1979-2012			P = 0.40 (ns)
				2013-2021			P = 0.99 (ns)

Urandangi (Site IDs 37043 and 37058) is located 33 km E of the Northern Territory border with Queensland and 187 km NW of Mt Isa (Figure 21). Temperature has been measured since before January 1957. The place is isolated with a permanent mainly Aboriginal population of about eight adults and 13 children, living under atrocious conditions in old caravans and shacks (https://www.dailymail.co.uk/news/article-8821909/Queensland-town-Urandangi-changed-dramatically-years-stunning-photoraphs.html).

Staffed by two teachers and two assistants, the local 2-room school caters for 12 primary school students. The airport runway is sealed and the community is serviced by fly-in-fly-out medical assistance and other services provided by the Royal Flying Doctor Service.

The Stevenson screen was located in the yard behind the so-named Dangi pub, which is also the post office, grocery store, camping ground and petrol station. An automatic weather station opened at the airport, 5km ENE of the former site on 11 September 2012 and thermometers were removed from the screen at the hotel on 18 September 2012 leaving no effective overlap.

Metadata is very sparse; however, site diagrams indicate a possible change between 29 July 1998 and 1 August 2001 (possibly installation of a 60-litre Stevenson screen). No site-summary metadata is available for the AWS at the airport, but Google Earth Pro locates the site at Latitude -1.5995 °, Longitude 138.3648°. While the weather station is isolated and poorly documented, Urandangi is important because in addition to Halls Creek, data have been used to homogenise ACORN-SAT data for Tennant Creek (NT), Richmond airport, Longreach, Camooweal and Boulia in Queensland, and Birdsville S.A. Analyses of Urandangi Tmax is shown in Figure 24.

Rainfall reduces Tmax 0.268°C/100 mm and explains 26.3% of Tmax variation (R^2_{adj} = 0.263, Figure 24(a)). Step-changes in Tmax ~ rainfall residuals in 1979 and 1998 in (b) show that as data are affected by non-rainfall factors the dataset is not homogeneous. While slope coefficients ((c) to (e)) are about the same (0.256, 0.275 and 0.321°C/100mm), segmented regressions step-up relative to average Tmax and rainfall, with data from 1979 to 1997 showing the greatest scatter and consequently poorest linear fit (d).

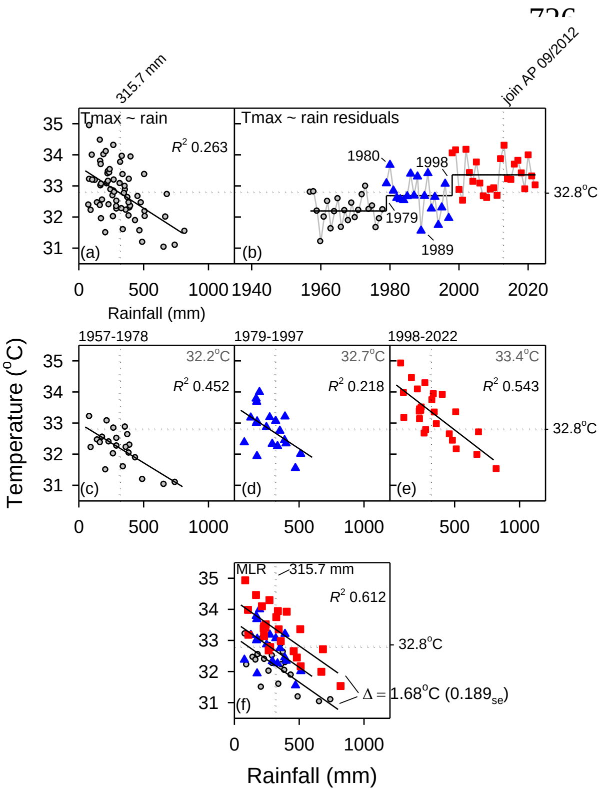

Figure 24. Analysis of Tmax data for Urandangi (ID 37043) joined with the airport AWS (ID 37058). Average rainfall-adjusted Tmax for the three segments is shown in the upper-right of (c) to (e). While Tmax was observed at the Dangi pub until September 2012, the up-step in 1998 is consistent with a former 230-litre screen being replaced by a 60-litre one. It also appears that data prior to 1979 may have been affected by watering or shade.

Multiple linear regression (MLR) in (f), confirms segmented relationships are offset and parallel and that non-rainfall factors caused Tmax to increase by 1.68°C between 1957 and 2022. MLR residuals were independent, normally distributed and aside for outliers caused by missing observations/yr from 1997 to 1999, variance was the same across categories.

As there was no trend or change in residuals indicative of factors such as CO_2, coalmining or anything else, there is no evidence that the climate has changed or warmed.

5.4 The effect of moving the site to the Urandangi airport on data distributions

Observations transferred from the yard of the Dangi pub to the AWS at the airport on 11 November 2012, 2013 was also the third driest year since Tmax records commenced in 1957. Ignoring data for the change-year (2012) and for 2013, daily data distributions for complete years from 2003 to 2011 and 2014 to 2022 were compared. Table 2 shows numbers of daily observations, and that rainfall conditions were little different between the 2003-2011 and 2014-2022 data segments. However, while the site at the pub was in the vicinity of watered lawns and planted trees, the AWS at the airport was surrounded by an uninterrupted arid landscape.

The histogram showing relative data distributions as counts within classes (Figure 25(a)) is somewhat more difficult to compare and interpret than the same data presented as probability density functions (PDF), which show the probability or likelihood of daily Tmax falling within a continuous range[1].

While the histogram (Figure 25(a)) shows instances where counts of daily Tmax at the hotel exceed those of the AWS over specific ranges such as around 36°C, and vice versa at the airport when hotel Tmax exceeds 40°C, the PDF provides a more comprehensive view of the same information. For instance, while the likelihood of daily Tmax between 34.0°C and 41.8°C (hotel median and 95th percentile values) are higher at the hotel, the likelihood of extreme daily temperatures (Tmax > 95$^{th}_{hotel}$ percentile) is consistently higher at the airport.

[1] https://en.wikipedia.org/wiki/Probability_density_function

Table 2. Differences between datasets for the Dangi pub and the Urandangi airport AWS, excluding the change-year (2012) and the extremely low rainfall year in 2013.

Statistic[1]	Dangi pub 2003 to 2011 (mm)	Airport AWS 2014 to 2022 (mm)	Test and *P* level
Samples (N)	3230	3201	
Average rainfall	367	303	
Minimum rainfall	109	105	
Maximum rainfall	671	683	
Average Tmax	32.89°C	33.42°C	t-test $P = 0.001$[1]
Median Tmax	34.0°C	34.2°C	Mood test $P = 0.405$
Equal distributions	na	na	K-W[2] test $P < 0.001$

[1] Tmax is not normally distributed, but as N>50, the test is robust

[2] Kolmogorov-Smirnov test that two samples are taken from populations with equal distributions

Assuming that rainfall and exposure play a minor role and that both sites were equipped with 60-litre Stevenson screens, the likelihood of upper-range extremes has increased at the airport relative to those previously observed in the yard of the Dangi pub. Whether this is because manual observations at the hotel were less precise than AWS data, or there was a problem with the thermometer, or conditions were markedly different is unknown. However, as warm-tail data distributions are unlikely to be comparable, daily Tmax extremes at the airport are not fairly compared with those for the hotel.

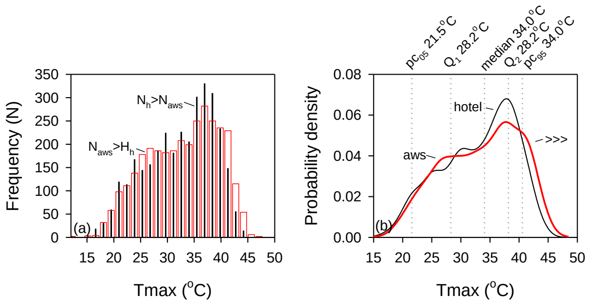

Figure 25. Histograms of daily Tmax observed at the Urandangi hotel (h) and airport (aws) (lines within red bars in (a)), and (b), probability density functions (PDF) of the same data. As PDFs are determined over the same x-axis scale and the area under each curve is unity, curves are directly comparable.

While histograms and PDFs compare the ***shape*** of data distributions, differences between empirical cumulative distribution functions (CDFs) or percentile plots, show ***where*** across the percentile range, and to what extent, data distributions differ (Figure 26).

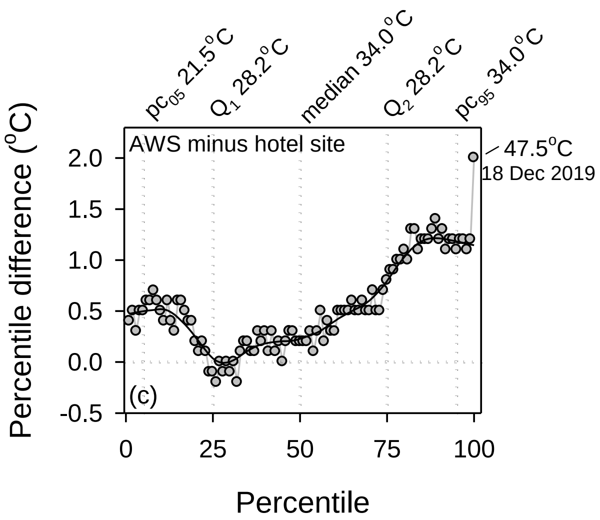

Figure 26. Differences between cumulative distribution functions (percentile plots) for comparable tranches of AWS and hotel data. The LOWESS (LOcally Weighted Scatterplot Smoothing) curve tracks the trajectory of the difference. As the value 47.5°C on the 18 December 2019 is almost 1°C warmer than the general trend (which shows AWS data over-range by *c.* 1.2°C), the datapoint is probably faulty.

Presuming climatic conditions were about the same, temperatures within the lower quartile were warmer at the airport by up to 0.6°C and increased quasi-linearly between the median and the 80th percentile to an asymptote of about +1°C.

Such a dramatic difference is unlikely to reflect an abrupt shift in the climate due to CO_2, coalmining or anything else. Figures 25 and 26 also clearly show the risk associated with comparing upper-range extremes across disparate sites, which due to their position in the landscape and changes in equipment and observing practices, are likely to be different.

At **Halls Creek**, the effect of homogenisation on data distributions for the common period from when the site moved to the meteorological office in 1974 until December 2017, which marked the end of the AcV1 dataset is shown in Figure 27.

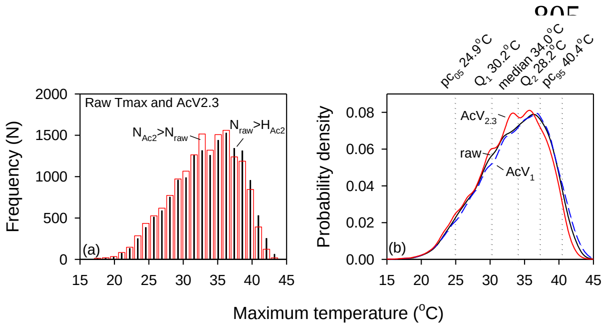

Figure 27. Because homogenisation has cooled the past relative to recent daily temperatures (Figure 13), the overall frequency of daily values > *c.* 37°C is higher for raw data (black lines in (a)) than for AcV2.3. (AcV1 frequency is not shown). Probability density functions in (b), including AcV1, are little-different to slightly cooler in their upper range (37°C to 45°C). (Headers show percentile and quartile temperatures for $Tmax_{observed}$.)

While PDFs in Figure 27(b) compare the *shape* of data distributions, they do not show *where* across percentile ranges adjustments made by ACORN-SAT affect data distributions (Figure 28). Surprisingly and inexplicably while AcV1 generally warmed Tmax by 0.2 to 0.3°C, AcV2.3, *cooled* the same raw data by up to 0.5°C, particularly above the raw data median of 34°C.

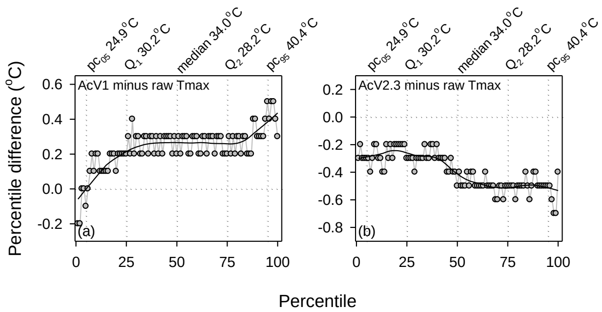

Figure 28. *Post hoc* evaluation of ACORN-SAT adjustments, over the percentile range of raw Tmax. In their extremes (daily Tmax >95th percentile), AcV1 was warmer by up to 0.4°C, while AcV2.3 was cooler by up to -0.5°C.

5.5 Inhomogeneities in homogenised Tmax data

Homogenisation aims to adjust data for the effect of non-climate impacts, so trend in homogenised data reflected the climate alone[1]. As outlined previously in Section 5, while HQ_1 and HQ_2 adjusted data at annual and monthly scales, ACORN-SAT aimed to adjust data distributions so homogenised datasets were more homogeneous for extremes as well as for means. An evaluation of whether such objectives have been realised is to test for residual changepoints in relationships between homogenised data and rainfall (Figure 29).

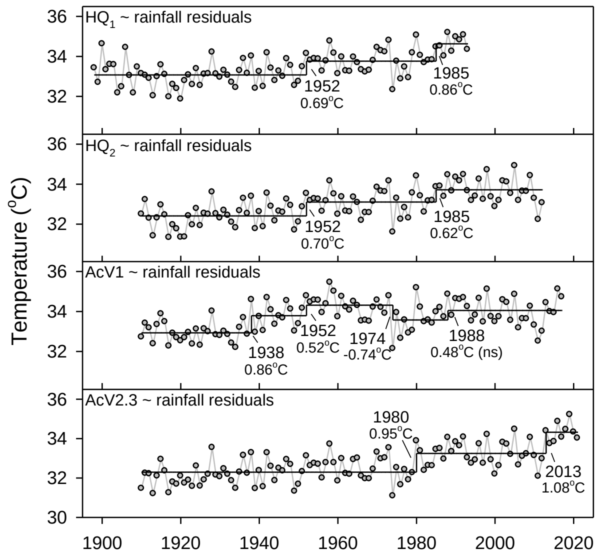

Figure 29. STARS analysis of rescaled rainfall residuals for homogenisation iterations from 1993 to 2021.

No homogenised Tmax datasets for Halls Creek are homogeneous. For HQ_1 and HQ_2 residual step-changes coincide approximately with the move from the old post office to the airport in 1950 and a 'statistical' change adjusted for in 1982, which

[1] Trewin, Blair (2012). Techniques involved in developing the Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) dataset. CAWCR Technical Report No. 049

moved forward to 1985. Note that HQ_2 applied the same adjustments as HQ_1. Step-changes in AcV1 were re-adjusted by AcV2.3, however a significant up-step remained in 1980 and 2013. (No adjustment was made by AcV2.3 for urban encroachment in 2013 or moving to the new site in 2015.)

Because data have been so-altered by the homogenisation process, multiple linear regression was unable to verify robustness of relationships. Akin to using annual rainfall for a distant weather station, say Urandangi, Daly waters or Boulia to explain variation in annual Tmax at Halls Creek, using reference series derived from disparate, distant sites results in homogenised Tmax datasets that were unrelated to local weather.

6. Discussion and conclusions

The objective of this study was to examine trend and change in the combined Tmax dataset for Halls Creek that might be attributable to of CO_2 or other anthropogenic factors. Case-studied previously using data for Parafield, South Australia[1] methods referred to collectively as BomWatch protocols have proven to be robust, statistically sound and replicable across multiple sites. BomWatch protocols were also used to evaluate the soundness and explore biases in the various iterations of homogenised Tmax data for Halls Creek.

Rainfall is the physically deterministic co-variable affecting Tmax and the study found no evidence that the climate of the eastern Kimberley region of Western Australia typified by Halls Creek has changed or warmed independently of site-related factors and rainfall. So, while dry years are warm and the drier it is the warmer it gets, despite the effect of relocations and instrument changes, the inverse relationship between Tmax and rainfall has not changed or broken-down due to CO_2, coalmining, electricity generation or anything else.

On average, rainfall reduces Tmax by -0.234°C/100mm, varying somewhat depending on the conditions under which observations were made. For instance, R^2_{adj} was less, indicating variance was higher for Tmax observed at the old post office compared to sites at the airport after 1950 (Figure 8(c) to (f) and Appendix 1(ii)). Due to urban encroachment, Tmax was also considerably warmer after 2013.

6.1 The Halls Creek metadata problem

Metadata is entirely inadequate for apportioning the effect of site changes on temperature time-series and without a rigorous statistical framework it is impossible to determine appropriate adjustments. Aside from the brief notes provided by Simon Torok, which are not formally published, conditions prevailing at the old post office were largely unknown. As the climate was generally dry (Figure 7), the down-step in Tmax data from 1917 (figure 8(b)), suggests the screen was located in an area that was watered during the dry season, or shaded, or that it was in a particularly poor state beforehand. The screen may also not have even been supplied before 1917.

The site at the airport did not move to the meteorological office in ***about*** *1967* but observations would have commenced there on an exact date. Furthermore, ACORN-SAT metadata failed to mention when observations commenced at the current site (X3 in Figure 4). Instead, it was inferred that a comparison found no significant difference between 'sites' the sites being two 60-litre Stevenson screens one housing thermometers and the other an automatic weather station located 10m apart at the site near the meteorological office. Thus, there was no inter-site comparison and because the 230-litre screen was replaced by a 90-litre screen on 25 August 1996, which is the day the comparison commenced, there is no between-screen comparison either.

[1] https://www.bomwatch.com.au/data-quality/part-1-methods-case-study-parafield-south-australia-2/

Metadata also failed to mention the increasing influence of urban expansion after 2011, and that the MO site became unviable after 2013, two years before observations transferred to the current site on 18 September 2015.

While hailed as one of the best datasets in the world (Long-term temperature record: Australian Climate Observations Reference Network – Surface Air Temperature (bom.gov.au)) inexact ACORN-SAT metadata used to underpin the homogenisation process provides considerable scope to make adjustments to changepoints that made no difference to the data, and also to ignore changes that did. The much-acclaimed peer review process by "a panel of world-leading experts" in 2011[1] failed to investigate the Bureau's methods from the ground-up – from metadata to the finished product. Also, peer reviewers of submitted manuscripts including Trewin's *A daily homogenized temperature data set for Australia* submitted to the *International Journal of Climatology* in 2013 (https://doi.org/10.1002/joc.3530), or the later paper *An updated long-term homogenized daily temperature data set for Australia* (Trewin et al., 2020) published in the *Geosciences Data Journal* (https://doi.org/10.1002/gdj3.95) are generally not in a position to undertake an inside-out examination of methods and data.

While ACORN-SAT V2.3 made homogenisation adjustments in 2010 (statistical), 1996 (90-litre screen), 1981 (statistical), 1965 (statistical), 1950 (move) and 1920 (statistical), the only verifiable step-changes in Tmax data were in 2013 (urban encroachment), 1952 (move), and 1917 (screen). As was the case at Marble Bar before 1913, it seems likely that before 1917 temperatures were measured using thermometers exposed on the shaded verandah of the post office and not in a screen at all.

6.2 The metrology problem

Temperatures observed using meteorological thermometers are coarse at best. While the uncertainly of an observation is ½ the interval scale (0.5°F for a Fahrenheit thermometer or 0.25°C for a Celsius one), observational precision depends on the skill and training of the observer, the care with which instruments are handled and unconscious biases such as observing the wetted perimeter of the glass rather than the meniscus, parallax error (reading at an angle to the horizontal) and systematic rounding up or down. Observers may habitually round to the nearest upper or lower index for example. While changing observers or replacing an instrument may result in bias sufficient to affect long-term trend, deterioration of the Stevenson screen – peeling paint or accumulation of dust and grime may also impact regardless of other factors. Thus, as a 'bolt-on' experiment that commenced in the 1980s to meet the needs of the WMO and IPCC, the joining together of disparate datasets to create long series is fraught with problems.

As a matter of caution, the change to rapid-sampling highly precise platinum resistance thermometers and automatic weather stations, may result in high frequency 'noise' that otherwise would not be observable, being incorporated as data into the temperature signal. At Halls Creek, an AWS was apparently installed on 25 August 1996, in a separate 60-lite screen, on the same day that another 60-lite screen replaced the previous 230-litre one. The *real* comparison should have involved thermometers housed as they were in the former 230-litre screen, verses he AWS and 60-litre screen and it is incomprehensible why that was not done routinely across the Bureau's network.

6.3 Homogenisation

Four iterations of homogenisation (HQ_1, HQ_2, AcV1 and AcV2.3) of the same data resulted in substantially different adjustments (Figures 10 to 13), and substantially different trends (Table 1).

[1] http://www.bom.gov.au/climate/data/acorn-sat/documents/ACORN-SAT_Report_No_1_WEB.pdf

Adjustments made by AcV2.3 were different in sign to those made by ACV2.3, and both were different to HQ_2. As site changes only happen once, is it inconceivable that adjustments are applied at different times and that over time, their magnitude also changes. Cooling the past relative to the present (and ignoring the substantial up-step in 2013) imposes an artificial forcing on Tmax data ensuring present-day temperatures will always be warmer than those measured at the old post office and the Aeradio site at the airport even though average rainfall was 200mm less/yr from 1928 to 1973 (443mm) than from 1974 to 2022 (646mm) (Figure 7).

With the exception of Victoria River Downs (ID 14825), which is an ACORN-SAT site, of the 23 non-ACORN-SAT datasets used to homogenise Halls Creek Tmax, two were mentioned as being too short (Wyndam Port and Wonarah), and three were analysed in the previous Section 5.3 (Figures 22 to 24). Analysis of the remaining 18 sites using BomWatch protocols, including Victoria River Downs is summarised in Appendix 2.

While data for some were affected by missing observations/year (e.g., Yuendumu, ID 15528), except Barrow Creek (ID 15525) all were affected to varying extents by site changes, only some of which were documented in site-summary metadata. As inhomogeneities are not adjusted before comparator datasets are compiled as reference series and used in the homogenisation process, the combined effect of embedded inhomogeneities is bound to contaminate the detection and adjustment of faults in target-site data. Consequently, it is highly unlikely that homogenised data would be homogeneous (Figure 29).

6.3.1 ACORN-SAT temperature extremes

Frequency of daily observations <5th and >95th day-of-year dataset percentiles shown in Figure 17 is confounded with both rainfall and effects due to site-changes. As was the case for Tmax, the effect of rainfall on the $Log_{10}(Hi_N/Lo_N)$ ratio was removed using linear regression (as outliers in 1904, 1923, 1930 and 1949 were potentially influential, robust least trimmed squares regression was carried out using PAST, from the University of Oslo[1]). The $Log_{10}(Hi_N/Lo_N)$ ~ rainfall coefficient was determined to be significant relative to bootstrapped 95% confidence intervals. Step-changes in the rescaled $Log_{10}(Hi_N/Lo_N)$ ~ rainfall residuals were detected in 1920, 1950 and 2016 (Figure 30) indicating ratio data were not homogeneous.

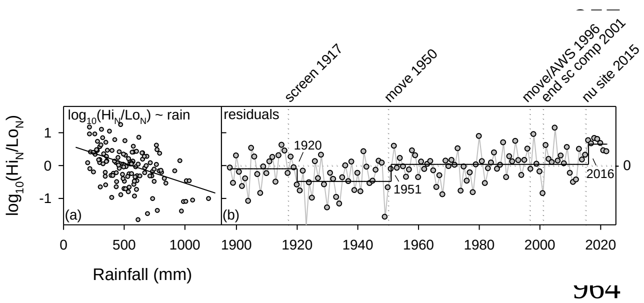

Figure 30. STARS analysis of Tmax extremes ($Log_{10}(Hi_N/Lo_N)$) detected step-changes in 1920 (*P*=0.008), 1951 (*P* <0.001) and 2016 (*P* <0.001), following replacement or installation of the Stevenson screen at the old post office, the move to the aerodrome Aeradio office and the move to the current site, over stony bare ground in 2015.

As STARS residuals shows no trend or change that could be related to another factor such as CO_2 coalmining, electricity generation or anything else, the hypothesis that extreme temperatures (Tmax >95th day of year percentiles) are increasingly prevalent due to climate change is rejected. The finding further strengthens the argument that by manipulating data distributions ACORN-SAT homogenisation (Figures 18 to 20) has increased numbers of upper-range temperatures in order to support *the science* (i.e., the models on which the narrative depends).

[1] https://www.nhm.uio.no/english/research/resources/past/

6.4 *Post hoc* evaluation of the Bureau's homogenisation methods

Homogenisation as undertake by the BoM and other organisations including NASA, the National Oceanic and Atmospheric Administration and the UK Met Office use variations of the same comparative methods to remove (adjust) the effect of site and instrument changes on data. Consequently, no homogenised datasets are likely to reflect trends and changes in the 'true' climate. As rainfall is the physically causal covariable affecting Tmax, it follows that homogenised Tmax should be more closely correlated with rainfall than unadjusted data. However, that was not found to be case for Halls Creek (Table 2).

By way of contrast, in Figures 22 to 24, BomWatch protocols were used to detect and analyse the effect of site changes on Tmax data for Warmum, Daly waters and Urandangi. Determining the timing and magnitude of changes in Tmax ~ rainfall residuals and accounting for the effects of site changes and rainfall simultaneously using multiple linear regression, left no trend or change that could be attributed to CO_2, coalmining, electricity generation or anything else. **There is no evidence therefore that the climate at those sites (and others listed in Appendix 2) has changed or warmed or that relationships between Tmax and rainfall have broken-down.**

The outcome of the statistical model: Tmax ~ (Sh)ift$_{factor}$ + rainfall, where Sh$_{factor}$ represents changepoints detected by STARS, and Tmax is the original raw data for each site is shown in Figure 30. In effect, the Sh$_{factor}$ realigns Tmax ~ rainfall relationships in proportion to the magnitude of the site-change offset, thus except for outliers and possible poor-quality data, observed data and those predicted by multiple linear regression fall reasonably closely, linearly, on the 1:1 line. As the 1:1 line represents a perfect fit, if step-changes detected by STARS are misaligned or data are faulty, predicted values will also be offset relative to data observed.

To be clear, *outcome* values are those fitted or predicted by the model. Scatterplots of observed data vs. those predicted *for the same points* show how well statistical models describe the process generating the data, in these cases Sh$_{factor}$ and rainfall impacting simultaneously on observed Tmax. (Average Tmax for Halls Creek (33.6°C) serves as a reference. Thus, the distribution of Tmax data for Warmun was warmer than Halls Creek, while that for Urandangi was cooler.)

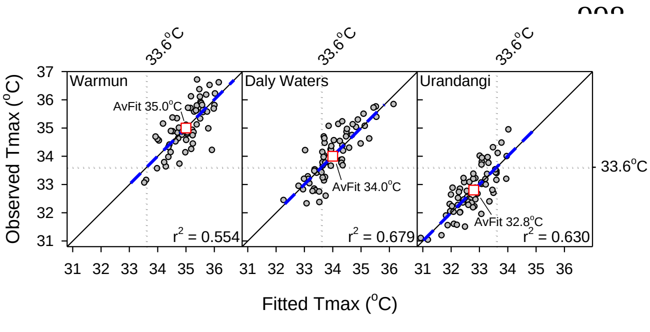

Figure 30. Scatterplots showing relationships between observed Tmax at Warmum, Daly Waters and Urandangi and the same datapoints fitted/predicted taking account of step-changes ((Sh)ifts) and rainfall simultaneously. (Data were analysed in Figures 22 to 24). Note that r^2 refers to the square of Pearsons linear correlation coefficient. Grand-mean Tmax$_{fitted}$ for each site is indicated by the white square.

While the least-squares fit (blue dashed line) is expected to lie on the 1:1 line, scatter is due to variation in Tmax that has not been accounted for, and which statistical analysis has confirmed is independent and random (i.e., the 'noise' component, which includes faulty and outlier data). In all cases, datapoints are dispersed without undue bias, indicating there is no unaccounted-for 'hidden' variable.

Based on the stated presumption that homogenised data better reflect the 'true' climate than Tmax$_{observed}$, homogenised Tmax data was previously compared with Tmax$_{observed}$ for Halls Creek in Figures 15 and 16. Although less-so for AcV1, homogenised Tmax data were too cool relative to observed Tmax, with cool-bias increasing as Tmax increased. It was noted that in order to achieve the significant trend in AcV2.3 of 0.146°C/decade, past data were cooled too aggressively.

In a similar vein, homogenised Tmax is compared with those fitted or predicted by rainfall alone in Figure 31 (coefficients are given in Table 1).

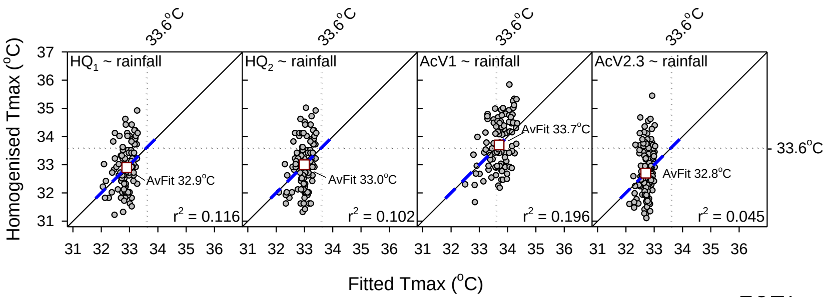

Figure 31. As homogenisation has ostensibly accounted for site and instrument changes so homogenised Tmax reflects the 'true' climate, a close 1:1 relationship is expected between homogenised Tmax values and the same values predicted by local rainfall (compare with Figure 14).

If it were the case that homogenised Tmax reflected the 'true' climate i.e., that the homogenisation process unbiasedly removed effects due to site changes, fitted/predicted values in Figure 21 would be highly linearly correlated (r^2 >0.25) and points would align with the 1:1 line as they did previously in Figure 30 for Warmum, Daly Waters and Urandangi. However, as past data has been cooled relative to recent data and, as shown in Figure 29, rescaled homogenised Tmax residuals are not homogeneous, physically deterministic relationships between homogenised Tmax and rainfall have broken-down.

6.5 Is homogenisation any good?

The short answer is no.

According to the First Law Theorem, evaporation of rainfall removes heat from the environment at the rate of 2.45MJ/kg, equivalent to 1mm of rainfall/m^2. Average rainfall of 547.2mm potentially removes 1340.7MJ of latent heat, which is 16.4% of average total solar exposure of 8169MJ. The heat not removed by evaporation and convection is advected to the near-surface atmosphere as sensible heat, which is measured during the heat of the day, around 3pm, by thermometers or PRT sensors housed in Stevenson screens.

There is therefore a physical expectation that annual Tmax is negatively correlated with rainfall, and that the drier it is the warmer it gets. Statistical significance of that relationship and goodness of fit (R^2_{adj}) measure the strength of the relationship, and consequently the overall quality of the data. As rainfall is a more robust climate variable than Tmax, lack of a relationship usually indicates a problem with Tmax data not the converse and in many cases low numbers of Tmax observations/year was to blame.

Further, provided they are significant, accounting for site-related inhomogeneities improves the significance of the rainfall coefficient and the goodness of fit statistic. At Halls Creek, from R^2_{adj} = 0.253 for rainfall alone, to 0.443, taking account of site changes (Appendix 1); at Warmun from 0.376 to 0.538 (Figure 22); Daly Waters, from 0.107 to 0.500 (Table 2) and Urandangi, 0.263 to 0.612 to name a few.

However, none of this, including the First Law Theorem applies to homogenised data. In contrast to BomWatch protocols, which does not alter Tmax data, homogenisation cools the past relative to current data, to the point that correlation with rainfall is lost. The homogenisation process is also riddled by complexity including the use of anomalies relative to averages calculated from 1961 to 1990, during which time most sites changed or moved. Changepoints in homogenised Tmax also bear little resemblance to site factors that may have affected data, including watering, lackadaisical observing practices, worn-out thermometers and derelict screens.

6.6 Implications of the study

As outlined in the Marble Bar study[1], although not openly stated, homogenisation was basically planned as a consensus[2] method of adjusting temperature data to meet the need by the IPCC, CSIRO and the BoM to find evidence the climate was warming due to anthropogenic emissions of CO_2. It was also important that data supported the *models* informing the politics of global warming, particularly the Toronto Agreement (1988), which Australia signed in 1990, the Kyoto Protocol (1998) and the Paris Agreement (2016). In the background, loud support is provided by well-organised, multiple activist megaphones, most notably green-groups funded, organised or coordinated by WWF and the trade union movement. It was through this mechanism that former-WWF President Robert Purves' Environment Fund, used money and influence to leak Tim Flannery's outrageous claims about global warming into school curricula throughout Australia.

The pillar of man-made climate change, its associated cheer-squads, its political impetus and all that has happened since 1988, including agreements by Australian states to implement land clearing laws, the Murray-Darling Basin Plan, bushfire management, environmental protection and energy policy, depend entirely on the theses that homogenised temperature data truly reflect the climate, and that as a result, *the environment* is in a state of irredeemable peril.

However, the mythical claim has been entirely fabricated by the Bureau of Meteorology, CSIRO, the ABC, activist green groups such as the WWF-affiliated Climate Council, and like organisations around the world who use essentially the same techniques to 'prove' a link between CO_2, global warming and climate change.

6.7 How did Australian science come to this?

While heavily involved with the World Meteorological Organisation's World Climate Research Program (1986 to 1990), and with then Bureau Director from 1978 to 2003 Dr. John Zillman also serving as WMO's Vice President (1987 to 1995), Neville Nicholls oversaw the homogenisation of Australia's long-term temperature records by Bureau scientists, including supervising Simon Torok's PhD thesis, which was funded by the Australia's National Greenhouse Advisory Committee, and also that of Blair Trewin.

As the central pillar of the global warming thesis, datasets homogenised by Bureau scientists supported Section C of the Supplement to the IPCC First Scientific Assessment Report (1991-1992) of which Nicholls was lead Author. Nicholls was also convening lead Author (from 1993 to 1995) of Chapter 3, *Observed climate variability and change*, of the IPCC Second Scientific Assessment (see: https://www.eoas.info/biogs/P003289b.htm). With Dr. John Zillman overseeing both the Bureau, and the WMO as Vice-President from 1987 to 1995, Nicholls was in a position to both influence and direct the Bureau's homogenisation efforts so outcomes supported the reports that he authored on behalf of the IPCC. Such behaviour by people Australians should be able to trust, is unconscionable and deserves loud condemnation from the community at large, and the science community in particular.

6.8 Conclusions

Multiple attributes of Tmax data for Halls Creek, and 23 sites used in their homogenisation have been examined using BomWatch protocols, including relationships between Tmax and annual rainfall, inhomogeneities in Tmax ~ rainfall residuals, frequency histograms and probability density

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[1] https://www.bomwatch.com.au/data-quality/part-2-marble-bar-the-warmest-place-in-australia-2/

[2] Peterson TC, Easterling DR, Karl TR, Groisman P, Nicholls N, Plummer N, Torok S, Auer I, Boehm R, Gullett D, Vincent L, Heino R, Tuomenvirta H, Mestre O, Szentimrey T, Salinger J, Forland EJ, Hanssen-Bauer I, Alexandersson H, Jones P, Parker D. 1998. Homogeneity adjustments of in situ atmospheric climate data: a review. *International Journal of Climatology* 18: 1493–1517.

functions, differences in cumulative distribution functions (percentile plots), frequencies of daily data <5th and >95th day-of-year dataset percentiles and their $\log_{10}$-transformed Hi_N/Lo_N ratio. Attributes that have not been presented, but cursorily examined include standard deviation/yr, absolute highest and lowest temperatures/yr, counts of daily observations/yr, and indices of the precision with which observations were made.

Evidence is lacking that the climate at Halls Creek and that of the 23 comparator sites has changed or warmed due to CO_2 coalmining, electricity generation or anything else.

Cooling past data relative to the present in order to satisfy requirements of *the science* portrayed by models and by CSIRO in *State of the* Climate Reports, and the IPCC, relationships between homogenised Tmax data and annual rainfall have diminished considerably compared to $Tmax_{observed}$. The most recent iteration, AcV2.3, which has the highest trend (0.62°C/decade), shows the least significant relationship with rainfall (P = 0.3), which only explains 3.6% of variation in homogenised Tmax (R^2_{adj} = 0.025). Without the BoM and CSIRO re-writing laws of thermodynamics, ACORN-SAT has failed its primary objective, which is that homogenised data unbiasedly reflect the climate alone.

Scatterplots comparing observed Tmax with homogenised values predicted by rainfall showed cool-bias increased as Tmax increased, thus exposing an irrefutable weakness in the Bureau's methods. The challenge appears to have been to negate warmer temperatures related to lower rainfall pre-1973 (Figure 7). While BomWatch protocols found good agreement between predicted vs. observed data for Halls Creek, Warmum, Daly Waters and Urandangi, four iterations of homogenised Halls Creek data were consistently biased cool.

It is not possible for homogenisation to create a trend by cooling the past, without compromising the physically deterministic relationship with local rainfall. As goodness of fit is consistently less than raw Tmax ~ rainfall, and homogenised residuals embed step-changes that the process aimed to correct, homogenised data do not reflect the climate of Halls Creek and the wider east Kimberley Region.

Another outcome of ACORN-SAT homogenisation is that cooling the past relative to the present axiomatically increases counts of daily Tmax/yr >95th day-of-year percentiles relative to counts <5th day-of-year percentiles. However, removing the effect of rainfall on the $\log_{10}$-transformed ratio shows step-changes related to site changes alone were responsible (Figure 30). In the absence of concurrent data allowing an instrument by screen by site comparison, relocating to the current site in 2015 where the AWS with 90-litre screen operates over a red-gravel surface bereft of transpiring ground-cover, exacerbates the problem of replacing manually observed thermometers housed in 230-lite screens with rapid-sampling PRT-probes operating in infrequently maintained 60-litre screens.

Homogenisation and the ACORN-SAT project have failed on multiple counts. As homogenised data are unrelated to local climates, homogenisation has no statistical or scientific merit and should be abandoned.

Dr Bill Johnston

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Disclaimer

Unethical scientific practices including the homogenisation of data to support false political narratives undermines trust and is not in the public interest. While the persons mentioned or critiqued may be upstanding citizens, which is not in question, the problem lies with their approach to data, use of poor data or their portrayal of data in their cited and referenceable publications as representing facts that are unsubstantiated, statistically questionable or not true. The debate is therefore a scientific one, not a personal one.

Acknowledgements

Impetus for this research arose from the realisation, that spearheaded by WWF and Tim Flannery self-proclaimed as "*one of Australia's leading writers on climate change*[1]", and others they should be able to trust, school children from primary school to Year 12; students at university, and the public at large have been groomed relentlessly by BoM, CSIRO, *misinformation* expert *97%-consensus* fantasist Dr John Cook and colleagues at Monash University, the Australian Museum, IPCC, the Climate Council and high-ranking professors to believe that the world is facing a tipping-point due to global warming caused by CO_2, for which there is no substantive evidence.

Dr Neville Nicholls, who commenced as a cadet meteorologist with the Bureau of Meteorology in 1970[2] and later in 1986 was a member of the World Climate Research Programme when Dr John Zillman was Australia's permanent WMO representative and later President, oversaw BoM scientist Simon Torok's PhD and co-supervised Blair Trewin's PhD, which underpinned much of the Bureau's subsequent homogenisation effort. A contributor to the World Economic Forum[3], Nicholls is currently Emeritus Professor at Monash University and he is acknowledged for stirring my interest in the dark-art of using data homogenisation to create bogus climatic trends and changes. The damage wrought by elitist scientists including Dr Sarah Perkins-Kirkpatrick, Sophie Lewis, Andrew King, Daniel Mitchell and Professor Andy Hogg and his $7.6M indigenous super-computer *Gadi* at ANU, to the integrity of science in Australia, the national economy and the wellbeing and employment prospects of future generations in the name of climate change is deplorable.

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[1] https://www.climatecouncil.org.au/author/tim-flannery/
[2] https://www.eoas.info/biogs/P003289b.htm
[3] https://www.weforum.org/agenda/authors/neville-nicholls

Appendix 1.

Halls Creek maximum temperature statistical summary (refer Figure 8).

Model	Coef. (°C/100mm)	*P*	R^2_{adj}	Segment	RainAdj (SE) (°C)	AIC	
(i) Tmax ~ rain	-0.187	<0.001	0.253			255.12	
(ii) Tmax ~ rain							
1898-1916	-0.217	0.021	0.232				
1917-1950	-0.196	<0.001	0.288				
1951-2015	-0.243	<0.001	0.441				
2016-2022	-0.209	<0.001	0.564				
(iii) Tmax ~ Sh_{res} + rain	-0.234	<0.001	0.438	1898-1916	33.6[a] (0.133)	222.37	1898-1916 & 1951-
				1917-1951	33.1[b] (0.101)		1987 means identical
				1952-2012	33.6[a] (0.074)		(33.6°C vs 33.7°C).
				2013-2022	34.5[c] (0.184)		Segments combined in Case (iv).
(iv) Tmax ~ Sh_{res1} + rain	-0.234	<0.001	0.443	1898-1916&	<< combined	220.37	Interaction
				1952-2012[1]	33.6[a] (0.064)		Tmax ~ $Sh_{res}1$ * rain
				1917-1951[2]	33.1[b] (0.099)		*P* = 0.79 (ns)
				2013-2022[3]	34.5[c] (0.183)		
				$\text{Delta}_{(1\ vs2)}$	-0.51 (0.119)		
				$\text{Delta}_{(1\ vs3)}$	0.85 (0.193)		
				$\text{Delta}_{(2\ vs3)}$	1.36 (0.211)		
(v) Tmax ~ Year	(°C/decade)			Segments			
Overall (1898-2022)	0.024	0.214	ns	1898-1916			P = 0.39 (ns)
				1917-1951			P = 0.35 (ns)
				1952-2012			P = 0.16 (ns)
				2013-2022			P = 0.59 (ns)

[**Notes**: Case numbers (i) to (v) are provided for reference; RainAdj refers to rainfall adjusted means (with standard errors) calculated by the *emmeans* package with turkey *P*-level adjustments for multiple comparisons; AIC refers to the Akaike Information Criterion; segment refers to data-segments defined by step-changes identified using sequential t-tests (STARS); ns indicates non-significance (*P* >0.05).]

Appendix 2. Statistical analysis of comparator sites

		Method >>	OLS		STARS			MLR		
Station	Station ID	Dates (Yrs)	Tmax ~ rain R^2	ShYear	Delta °C	P	ShMax *P*	Delta (°C)	R^2	Notes
Argyle AP	2064	1999-2019 (28)	0.577	2013	0.51	0.012	<0.001	0.61	0.665	
Balgo Hills	13007	1987-2015 (29)	0.512	1996	0.58	0.019	0.013	0.68	0.602	
Barrow Creek	15525	1964-1987 (24)	0.540	ns						
Burnette Downs	15085	1969-2018 (50)	0.549	1988	0.39	0.019	ns	0.27		
				2013	0.64	0.024	0.011	0.64	0.599	
Delamere Range	14949	1997-2023 (27)	0.191	2013	0.89	<0.001	<0.001	0.89	0.513	
Fitzroy Comp.	3006	1957-1982 (26)	0.595	1974	-0.42	0.148	0.048	-0.47	0.644	
Fitzroy R. AP	3093	1998-2002 (25)	0.351	2016	0.61	0.027	0.040	0.61	0.442	
Inverway	14836	1974-1987 (27)								Note1
Katherine Council	14902	1957-1984 (28)	0.382	1978	0.47	0.009	0.013	0.49	0.500	
Kimberley Res.	2014	1965-2009 (45)	0.142	1986	0.74	<0.001	<0.001	0.79	0.458	
Kununurra	2038	1965-1985 (21)	0.322	1976	-0.52	0.054	0.021	0.56	0.473	
Lajamanu	14829	1999-2022 (24)	0.493	2013	0.93	0.011	0.005	1.05	0.634	
Newcastle Waters	15089	1964-1979 (16)	0.633	1970	0.77	ns	0.017	0.83	0.782	Note2
				1975	-0.89	ns	0.772	ns		
Mt. Elizabeth	1018	2004-2021 (18)	0.322	2016	0.96	0.008	<0.001	1.09	0.598	
Victoria R.	14825	1965-2022 (57)	0.229	2008	0.90	<0.01	<0.001	0.84	0.402	
				2013	1.11	<0.001	<0.001	1.07	0.439	
Wave Hill	14840	1974-2021 (48)	0.245	1979	1.47	<0.001	<0.001	1.49	0.479	
				1988	0.71	0.005	0.005	0.71	0.356	
Wyndham	1013	1969-2014 (46)	0.421	1985	0.44	0.033	0.021	0.42	0.477	Note3
				1999	-0.30	ns				
Yuendumu	15528	1965-2019 (55)	ns							Note4

Note 1. Inverway. No useful data before 1974. Average N 1974-1987 = 249/yr; most years <300 observations/yr.
Note 2. Newcastle Waters. Up-step of 0.83°C (0.237_{SE}) from 1969 to 1975;
Note 3. Wyndham. Up-step from 1985 to 1998 (0.42°C (0.175_{SE})
Note 4. Yuendumu. Missing and unreliable data. As Tmax ~ rainfall ns, analysis abandoned.