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The temperature record of Alice spring, Northern territory of Australia revisited

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ABSTRACT

The Northern Territory of Australia has been the subject of a paper[1] proposing the truly observed temperature trends clearly contrasting the reconstructed and homogenised global trends reported by the Australian Bureau of Meteorology (BOM), and a comment to the paper[24] by climate scientists of BOM with the right of reply to the author of[1] waived. The authors of[24] claim to present "*evidence that the results presented by Boretti (2013) are at least partly attributable to his failure to account for inhomogeneities in the underlying station data and to the use of time periods for trends which are different to those in the Bureau of Meteorology analyses with which he is comparing them*" to conclude "*The evidence, as presented in this paper, therefore fails to support his conclusions of inconsistencies between the Bureau of Meteorology analyses and the station data.*" It is shown here thatit is actually the "*homogeneization*"by the climate scientists of BOM, replacementof observed temperature profiles that do not supporting any warming withcomputed profiles supporting the warming, to be wrong. This paper confirms that the analysis[1] of the BOM data set "*High Quality*" (HQ) was correct. The paper also shows the present BOM data set Australian Climate Observations Reference Network (ACORN) is even more corrupted and unreliable than the previous HQ data set. The trends reported by the Australian Bureau of Meteorology were and are inconsistent with the truly measured profiles.

ARBITRARY CORRECTION OR DISREGARD OF NOT WARMING RECORDS

The authors of[24] claim that the analysis of the temperatures of the Northern Territory of Australia[1] fails to account for the "*inhomogeneities in the underlying station data and to the use of time periods for trends which are different to those in the Bureau of Meteorology analyses".* The "*homogeneization*" by climate scientists of BOM is actually arbitrary correction or disregard of measured temperature records not supporting warming trends. Similarlycontradictory is the claim about the time window, because while the warming trends are magnified by specific time windows, the "*homogeneization*" appears wrong in any window.

Regarding the use of specific time windows, not surprisingly the BOM climate scientists use as the shortest period for their trend maps "*1970 to present*", claiming the trends "*1980 to present*" would not be meaningfulbecause 30 years are not enough. But, the trend maps "*1970 to present*" were already available in the early 2000s.

Considering there are multi-decadal oscillations affecting the climate with in particular a quasi-60 years] with positive phases 1910-1940 and 1970-2000, and negative phases 1940-1970 end of the 1800s to 1910, and 2000 to present[20-23],there is the suspicion that the product "*1980 to present*" is unavailable simply be-

cause they show less warming than "*1970 to present*".

Recent papers have shown a lack of warming for the Northern Territory of Australia[1], where only two stations were recording temperatures since the end of the 1800s over an area larger than France.

[, or the Melbourne heat island contamination of the temperature records of Victoria, Australia lacking of warming leaving the capital city[3].]Both papers[1] and[3] were based on the data provided by the Bureau of Meteorology(BOM) at that time.Since then, the BOM replacedtheir continuously evolving "*High Quality*" (HQ) data set[15] with the Australian Climate Observations Reference Network (ACORN)data set[2], which is also continuously changing.

According to the BOM survey of Australian stations measuring maximum air temperature with more than 50y of data and 80% complete record produced 12 February 2009[13], these stations are 175 in total. However, if we limit our attention to the stations already open in 1940 and still open in 2009, the number drops drastically to 34. The stations already open in 1930 and still open in 2009 are only 22, and those open in 1910 and still open in 2009 only 17. Requiring completeness > 95%, this number drops to 12. Accepting changes of sites, this latter number increases to 17. Australia has a total Surface area (sq. km) of 7,741,220. The coverage is clearly insufficient.

According to this survey of long temperature recording sites,the Northern Territory has 5 stations listed, 14015 DARWIN AIRPORT, 14016 DARWIN POST OFFICE, 15087 TENNANT CREEK POST OFFICE, 15540 ALICE SPRINGS POST OFFICE and 15590 ALICE SPRINGS AIRPORT.

According to the BOM HQ annual temperature information[14], the primary purpose of the HQ dataset was to enable reliable analyses of climate trends and variability at annual and decadal timescales. Each station record was "*adjusted"* for discontinuities caused by changes in site location and exposure, and other known data problems. The high-quality records were "*homogenised"* from 1910, by which time most stations were believed by BOM to have been equipped with the current standard instrument shelter. 224 temperature records were reconstructed to a standard defined "*acceptable*" by BOM, 181 of which were identified as being "*non-urban*". A "*non-urban*" set of 99 stations from the updated dataset was then used to prepare timeseries of annual all-Australian temperature, and maps of trends in temperature.

The list of then 131 stations proposed in[14] for the high-quality Australian annual temperature dataset includes three stations for the Northern Territory, 014015 DARWIN AIRPORT, 015135 TENNANT CREEK AIRPORT and 015590 ALICE SPRINGS AIRPORT.

[086071 MELBOURNE REGIONAL OFFICE and 089002 BALLARAT AERODROME are listed in between the more numerous stations from Victoria.]

The old BOM HQ data set already suffered from arbitrary corrections to the temperature data, that were the subject of many investigations, such as the one performed by Jo Nova and Ken Stewart[4].

A team of independent auditors, bloggers and scientists went through the HQ dataset and found significant errors, omissions and inexplicable adjustments. According to the team[4], the old HQ increased the warming trends by 40% nationally and 70% in the cities.

The team and Senator Cory Bernardi put in a Parliamentary request to get the Australian National Audit Office (ANAO) to reassess the BOM records. In response, the BOM (afraid of being audited and still not providing all the data, code and explanations that were needed), decided to replace the old HQ record with the ACORN data base.

Since the BOM changed the data set, the auditing of the old set by ANAO was not implemented. However, instead of fixing the flaws in the HQ data set, BOM further complicated the procedure to determine the temperature trend at any location, using a temperature that is different from what is actually measured by the thermometer and cherry picking the temperature records that more support warming trends.

The independent BOM analysts' team carefully examined the new ACORN data set to conclude[4]:

- Like the old HQ series, the Acorn record is also still impossible to replicate.
- The record is much shorter than 100 years for many sites. It's supposed to be high quality, but it has many gaps and spurious errors.
- Like the old series, ACORN's trends are very

different from what the raw data shows.

- Hot and cold extremes have been adjusted, for the most part warming winters and cooling summers, and at some sites new and more extreme records have been set.
- Contrary to the ACORN claim of a random set of adjustments of both up and down the independent auditors point the positive adjustments are larger than the negative.

As Stewart points out[4], in the CAWCR Technical Report No. 049[2], it appears that the BOM are using a new technique to homogenize and correct the data which involves comparing the data to the 40 nearest neighbouring stations. Many as 20% of the stations of Australia are presently more than 100 km away from their closest neighbour. Yet it is an international standard that temperature stations should not be more than 100 km apart. The situation was much, much worse in the past, with 22 to 26 stations providing values from 1930 to the present in a country larger than Europe.

Further comments on the continuously evolving ACORN data set, changing from one definition to the other like the previous HQ data set, may be found in[15-17].

While the global warming trend results remain unchanged, the chaos in the BOM products is incredible as demonstrated by the nearly 1000 instances where the maximum temperatures were lower than the minimums recorded the same day in their "*best possible data set*".

In some cases, even if there is no heat island effect or a nearby air conditioner, car parking or tram stop to bias the thermometer reading, and the undesired measurements are unfortunately (1) corrected or (2) neglected.

The Northern Territory of Australia and particularly Alice Spring[1] falls in the first category, because this unique location very far from the nearest measuring stations impacts significantly on the global warming for Australia and the world and cannot be neglected.

Ballarat[3] falls in the second category, not proposing the same warming of the Melbourne downtown station, possibly not having changed from a nearly rural station at the time of opening to the present situation. The Melbourne station in now in the middle of a 4.5 million people capital city with the thermometer in front of a very trafficked downtown road few metres from a glass covered bus and tram stop[3].

The ACORN data set[2] arbitrarily correct the undesired measurements results as in the case of Alice Spring, or simply neglect the undesired measurements results as in the case of Ballarat (and other rural Victorian stations) not affected by the Melbourne Urban Heat Island.

The ACORN-SAT dataset includes data from 112 locations across Australia[10,18]. Of these 112, 60 are claimed to have data since 1910.

Which are the quality stations to consider for the purpose of assessing the effects of global warming? Those with measured values of the Long T list[13] or the HQ list[14] or those with reconstructed time series of ACORN[10,18]? This lack of clarity makes truly scientific assessments difficult if not impossible.

Ii is shown below, Figure 1, how the ACORN corrections of the truly measured temperatures in the case of Alice Spring lacks of any scientific basis.

The temperatures from 1910 to 1950 were made 0.8 ºC cooler than the measured values by "*homogenization*" and "*use of latest analysing techniques*". Yet there is only one station with good measurements and nothing else around to homogenise with.

Alice Spring has two measuring stations, Post Office and Airport, less than 10 km apart. The results for the two stations must be coupled together to produce a long composite record. The two stations have overlapping data over the period 1942 to 1953. The Alice Spring raw temperatures are still available on the BOM web site for Station Number 15540 (Post Office) and Station Number 15590 (Airport). The latest maximum and minimum monthly average temperatures for the Post Office and the Airport locations were downloaded April 22, 2014 from the web links[5-8].

The Post Office station was open from March 1978 to December 1953. The completeness is apparently close to 100%. The temperatures for September 1890 missing. These values are obtained interpolating neighbouring months and years. The temperatures for January and February 1878 are also missing and are extrapolated from neighbouring months and years.

The Airport station was open November 1941 and it is currently operational. The completeness is isapparently close100%. The data available April 22,

2014 are complete only up to the year 2013. In 2014, only the months January to May and October have maximum temperature data, and only the months January to May and December have minimum temperature data.

With reference to the data downloaded March 21, 2011 (the data that were used for[1]), the new data downloaded April 22, 2014 suffer of minor changes.

For the Post Office location, some temperatures have been increased or reduced, with changes up to +0.6/-0.5 ºC for the maximum temperatures and +0.5/ -1.0 ºC the minimum temperatures, for no apparent reason. Similarly, for the Airport location, changes have been introduced up to +0.2/-0.2 ºC for the maximum temperatures and +0.5/-0.3 ºC the minimum temperatures again without any evident goal.

In Figure 1a,bare the monthly average maximum and minimum temperatures for the Post Office and the Airport coupled together to show a significant consistency. The Post Office results are shifted by 0 ºC for the maximum values and -0.1 ºC for the minimum values because of the change of site.

The data for the Alice Spring Post Office station 1878 to 1953[5,6], the data for the Alice Spring Airport station 1942 to 2012[7,8] and the ACORN data nominally for the station 015590 Alice Springs now covering the period 1910 to 2013[11,12] are finally analysed in Figure 1c,d,e and f.

Which is the temperature record to consider for Alice Spring? The one that may be obtained composing the measured temperature records for the Alice Spring Post Office station no. 15540covering the period 1878 to 1953[5,6] and the data for the Alice Spring Airport station no. 15590 covering the period 1942 to 2012[7,8]? Or it is the reconstructed temperature record nominally for same Alice Spring Airport station no. 15590 covering the period 1910 to 2013[11,12], surprisingly described as a measurement result?

According to BOM "*The Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) dataset has been developed for monitoring climate variability and change in Australia. The dataset employs the latest analysis techniques and takes advantage of newly digitised observational data to provide a daily temperature record over the last 100 years. This data will enable climate researchers to better understand long-term changes in monthly and seasonal climate, as well as changes in day-to-day weather.*"

As it is shown clearly in Figure 1c,d,e and f, the "*better understanding*" of the long term changes in the seasonal climate is made possible, according to the BOM climate scientists, by making cooler the temperatures before 1953 up to almost 0.8 ºC to produce a warming trend that simply does not exist in the measurements, and neglecting the fact that the maximum temperatures of the 1800s were larger than the latest record high temperatures.

Figure 1.c and 1.d are the yearly averaged measuredand ACORN reconstructed minimum and maximum temperatures. The measured data set coversthe period January 1878 to December 2012 (monthly data). The ACORN reconstructed data set covers the period January 1, 1910 to December 31, 2013 (daily data). Linear trends are shown on the figure. It is evident that:

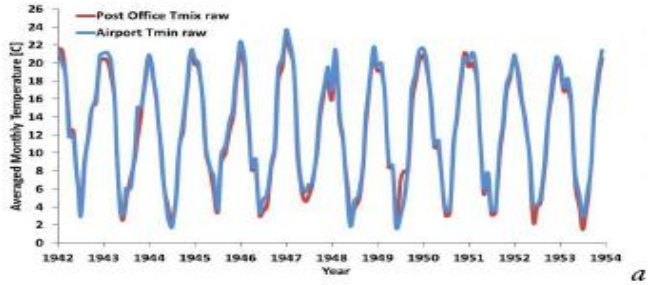
- The truly measured maximum temperatures are warming0.0003 ºC/year, while the reconstructed maximum temperatures are warming 0.0180 ºC/year.
- The truly measured minimum temperatures are warming 0.0042 ºC/year, while the reconstructed minimum temperatures are warming 0.0136 ºC/year.

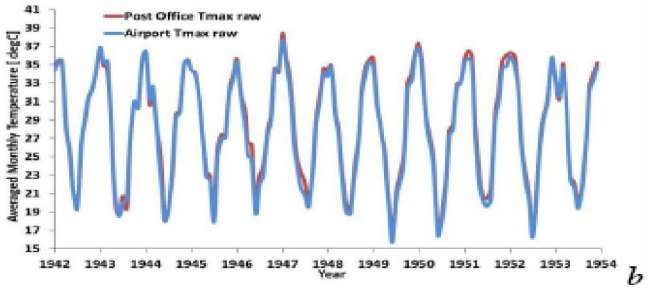
Figure 1.e and 1.f are the yearly averaged measured and ACORN reconstructed minimum and maximum temperatures compared over the same time window covering the period January 1, 1910 to December 31, 2012 for a better comparison of the trends. Linear trends are shown on the figure:

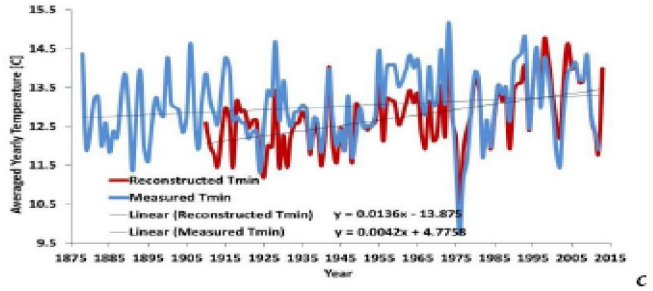
- The truly measured maximum temperatures are now warming 0.0110 ºC/year, while the reconstructed maximum temperatures are warming 0.0173 ºC/year.
- The truly measured minimum temperatures are now warming 0.0046 ºC/year, while the reconstructed minimum temperatures are warming 0.0133 ºC/year.

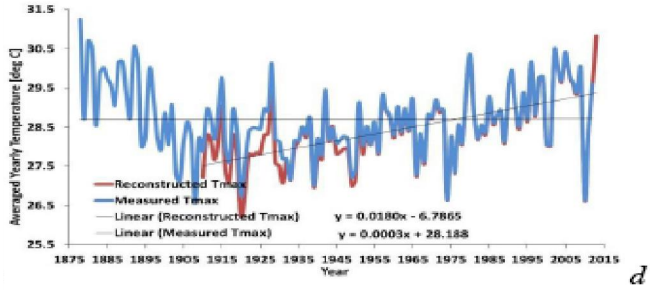
The trends appear therefore to be very different in any window, and the ACORN trends are definitely drastically increasing the warming.

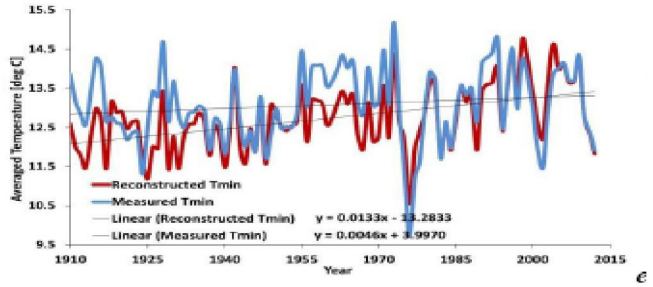
As Stewart notes[4], Alice Spring is an important

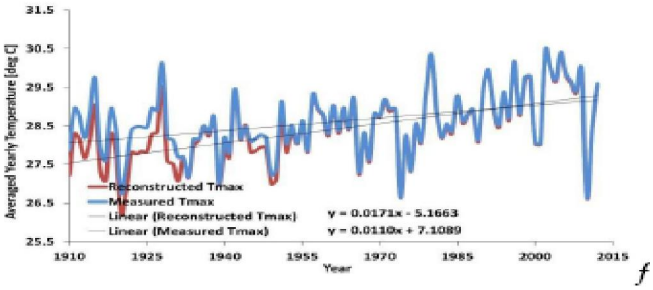


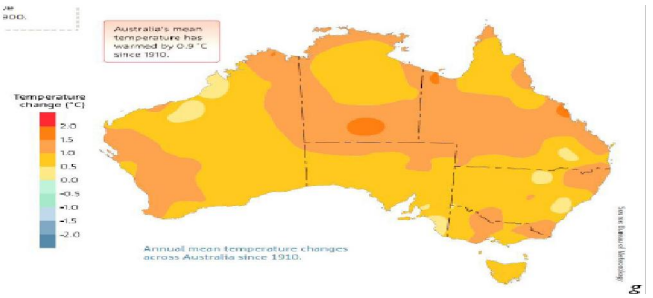












warmings in °C per year			
Values over the respective record length			
	TRUE	ACORN	Δ%
T_{min}	0.0042	0.0136	223.81
T_{max}	0.0003	0.0180	5900.00
$½ \cdot (T_{min} + T_{max})$	0.0023	0.0158	3061.90
Values over the common period January 1, 1910 to December 31, 2012			
	TRUE	ACORN	Δ%
T_{min}	0.0046	0.0133	189.13
T_{max}	0.0110	0.0171	55.45
$½ \cdot (T_{min} + T_{max})$	0.0078	0.0152	122.29

Figure 1 : Measured and ACORN reconstructed temperatures for Alice Spring. The composite measured record is obtained by combining the truly measured temperatures of two locations, Post Office and Airport. A minimal shift of 0 and -0.1 ºC is introduced in the maximum and minimum temperatures measured in the Post Office location. a,b: monthly average minimum and maximum temperatures from the Post Office and Airport locations over the overlapping period 1942 to 1953. Differences are minimal between the two locations. c,d: measured and ACORN reconstructed yearly average minimum and maximum temperatures over their respective record lengths. The measured warming for minimum and maximum temperatures are negligible 0.0042 and 0.0003 ºC/year, the reconstructed values 0.0136 and 0.0180 ºC/year, respectively 223.81% and 5900.00% larger than the legitimate values. Maximum temperatures end of the 1800s/beginning of the 1900s were larger than the present values. e,f: measured and ACORN reconstructed yearly average minimum and maximum temperatures over the period January 1, 1910 to December 31, 2012. The measured warming for minimum and maximum temperatures are 0.0046 and 0.0110 ºC/year, the reconstructed values 0.0133 and 0.0171 ºC/year, respectively 189.13% and 55.45% larger than the legitimate values. This is the result of arbitrarily making cooler the temperatures of the past for unclear reasons. Alice Spring has no nearby station to homogenise with. The truly measured record shows no significant warming trend since 1878. The corrected ACORN record shows much larger warmings. g: Warming trends from the latest state-of-the-climate report by BOM and CSIRO [19]. For Alice Spring the picture claims a warming since 1910 above 2 ºC, larger than the true average $½ \cdot (T_{max} + T_{min})$ warming over the same period of about 0.75 ºC, but also larger than the average $½ \cdot (T_{max} + T_{min})$ ACORN warming of about 1.5 ºC.

record because it covers a vast area dramatically adjusted by using the "*40 nearest stations*" when there are no sites close to it. Because it covers a vast area, Alice Springs contributes 7-10% of the national signal[4]. Figure 1 demonstrates that the warming of Alice Spring is overrated, and the Australian warming is also overratedas shown in [1,3] and other works.

The ACORN correction for Alice Spring is unclear:

- What "*neighbouring*" stations were used to make adjustments during the most part of the 1900s? There are no sites with overlapping digitised data close to Alice Springs for the most part of the record length.
- Which is the algorithm used to produce the drastic correction of Figure 1? Not having any "*neighbouring*" data to homogenise, the homogenisation claim appears an impossible exercise.
- Why the minimum temperatures are corrected also after 1950 while the maximum temperatures are not? In theory, similar algorithms should apply to correct both the minimum and maximum temperatures.

The correct inference of[1] based on actual measurements is that there has been no warming in the Northern Territory since the end of the 1800s, and the different trends proposed by BOM only result from the evident manipulations of what is actually measured by thermometers.

Figure 1.g is finally thewarming trend from the latest state-of-the-climate report by BOM and CSIRO[19]. For Alice Spring the picture claims a warming since 1910 above 2 ºC, larger than the true average $\frac{1}{2}\cdot(T_{max}+T_{min})$ warming over the same period of about 0.75 ºC, but also larger than the average $\frac{1}{2}\cdot(T_{max}+T_{min})$ ACORN warming of about 1.5 ºC. How was this extra warming produced?

CONCLUSIONS

Climate science definitely needs quality measurements, transparency, and free debate, and the BOM work has to be more open, stable, better justified and independently examined.

The data and the methods proposed by BOM should not be the subject of continuous changes, with replacement of data, adjustments and corrections, or inclusion and exclusion of stations.

As commented byJo Nova and Ken Stewart[4]:

- *"Australians are paying the BOM to give them an accurate unbiased analysis of the climate, yet volunteers repeatedly find errors that show the reports are sloppy, and inexplicable adjustments which increase the trend, while the BOM continues to claim the adjustments have zero effect, and the data is high quality*".
- "*Our climate records are not independently audited or assessed by any professional group, as financial data of this importance would be. If the BOM is so "confident" of their work, why are they so reluctant to explain it, or encourage it to be independently checked?"*

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