It's time climate scientists distinguished between remodeled data and actual observations

By Jennifer Marohasy

It is often the case in science, that we want and expect the data to look a particular way. This is because scientists would like to have their theoretical models confirmed as accurate representations of reality. With the advent of computer modelling it is now easy to remodel data. But the genuine scientist is always honest to the data, fiercely guarding its integrity, questioning their own preconceptions and prejudices rather than changing this evidence.

It is the propensity, increasingly legitimized in the peer-reviewed climate science literature, to remodel data that is central to my dispute with the Australian Bureau of Meteorology (BOM). The practice is termed homogenization and is intended to correct for temperature changes that have occurred at individual stations due to non-climatic factors – for example relocations. However, not only is the data remodeled in ways that often change both the magnitude and direction of temperature trends, but the homogenized data is increasingly presented in media releases, final reports and peer reviewed publications as original data. For example, Sophie C. Lewis and David J. Karoly, in their most recent publication in the Bulletin of the American Meteorological Society (Volume 95), labelled the average annual temperature derived from a weighted average of 112 temperature series each of which had been passed through complex algorithms, "observations". A more appropriate label would have been "homogenized and weighted annual average temperature". The same temperature series was used last week here at The Conversation by Neville Nicholls and labelled, "Surface temperature (BOM)". It shows a steady increase in the average annual temperature for Australian from 1910 to the present consistent with global warming of approximately 0.8 degree Celsius per century.

http://jennifermarohasy.com/wp-content/uploads/2011/08/Changing_Temperature_Data.pdf
http://theconversation.com/an-independent-inquiry-into-the-bureau-of-meteorology-bring-it-on-32692

The Bureau does acknowledges at its website that this series, the series used by Lewis, Karoly and Nicholls, represents "new data", it is referred to by the acronym ACORN-SAT, Australian Climate Observations Reference Network –Surface Air Temperature'.
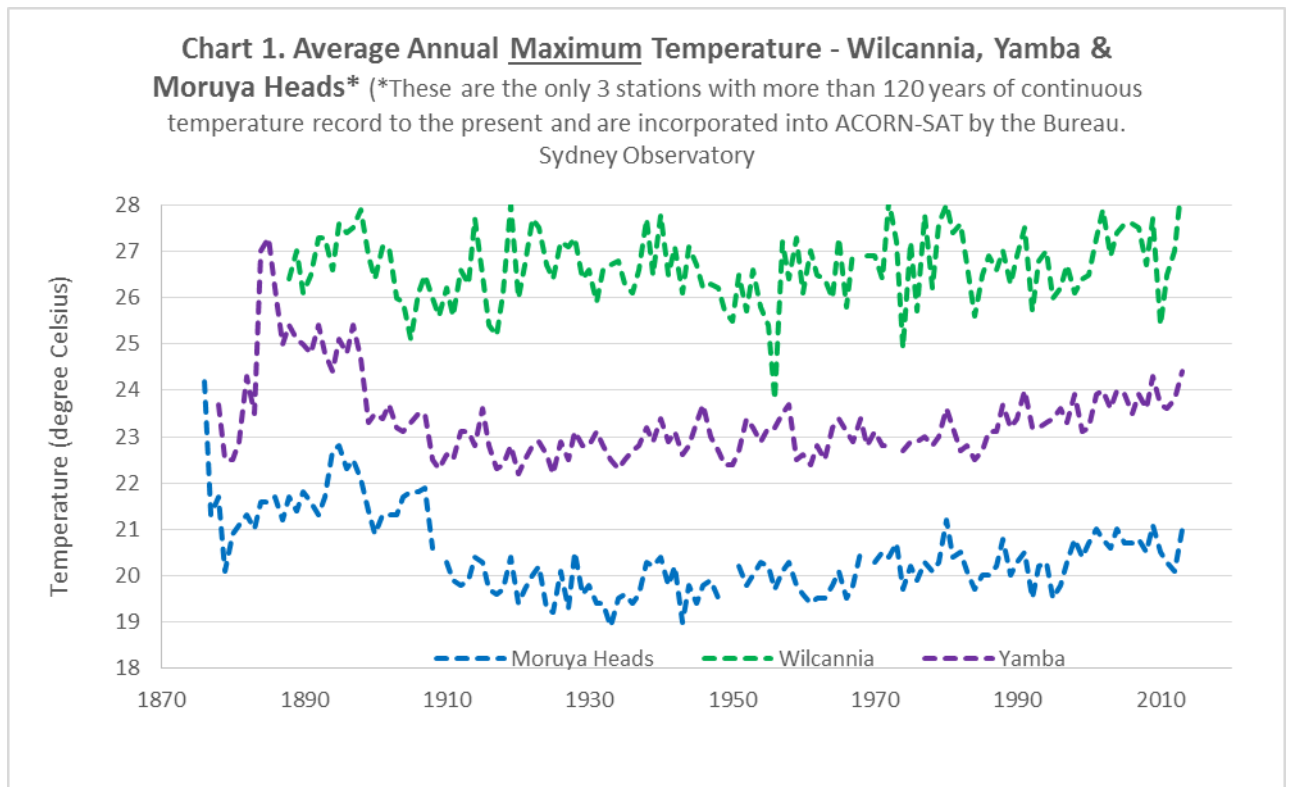
There are key papers (e.g. James Hansen et al. 2001, Journal of Geophysical Research, Volume 106), which clearly state when developing such new reference series, homogenization should be applied judiciously. In particular, in the absence of metadata describing the non-climatic variable that has created a statistically significant discontinuity it is advisable not to homogenize (e.g. Lei Zhang et al. 2014, Theoretical and Applied Climatology, Volume 115). The Bureau, nevertheless, routinely homogenized data from individual stations used to compile ACORN-SAT on the basis of "statistical methods without specific metadata support". http://www.bom.gov.au/climate/change/acorn-sat/documents/ACORN-SAT-Station-adjustment-summary.pdf

So, how does the ACORN-SAT data, and in particular the average annual temperature for Australia derived from this procedure, compared to the actual recorded temperatures – the observations?

Maximum and minimum temperatures for thousands of individual stations, many with very short records, are available at the Bureau's website. There is not, however, a comparable 'raw' reference series. I am currently developing such a series. This is occurring through the identification of individual stations with exceptionally long continuous temperature series, for example, a continuous record at the same location for more than 120 years to the present. There are six such stations in New South Wales: Coonabarabran, Hay, Moruya Heads, Newcastle, Wilcannia and Yamba. Data

from only three of these stations is currently incorporated into ACORN-SAT: Wilcannia, Yamba and Moruya Heads.   Sydney Observatory Hill also has a record spanning more than 120 years to the present, but this series is significantly affected by growth of the city and warming associated with new asphalt and buildings (known as the Urban Heat Island, UHI), and so has not been included. http://www.bom.gov.au/climate/data/index.shtml?bookmark=200
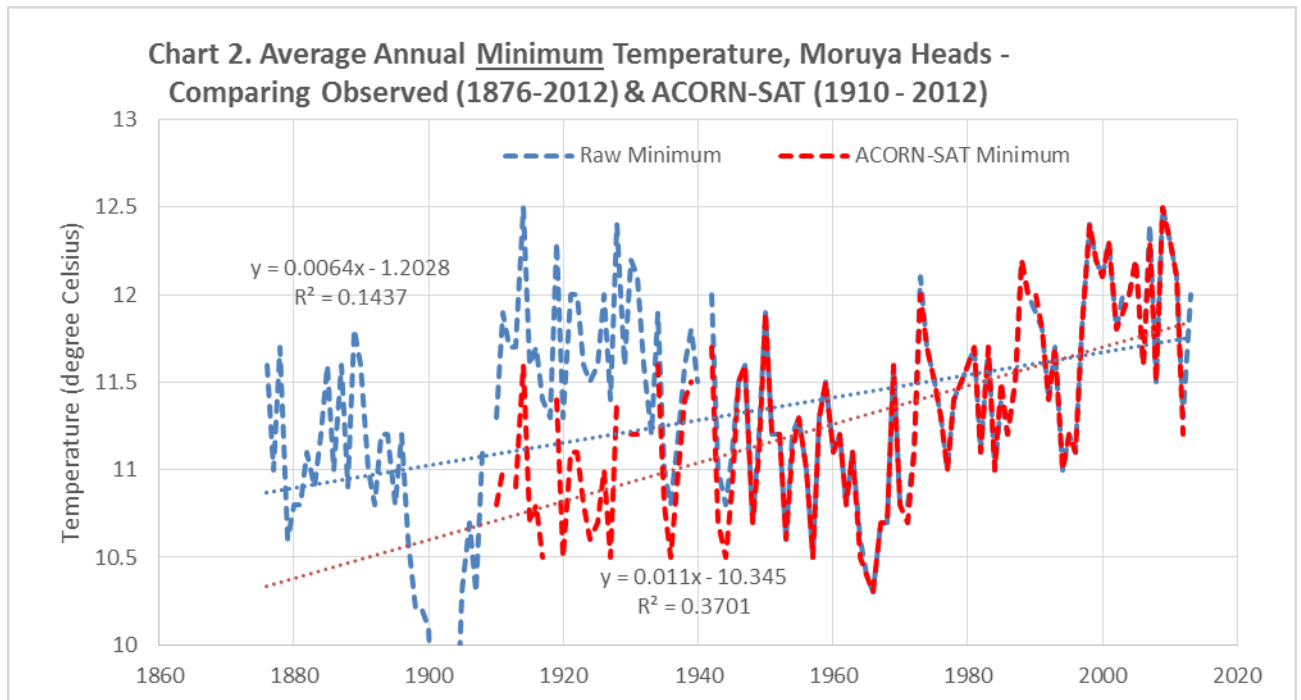
Many scientists, accustomed to seeing remodeled data, would protest that the average annual maximum temperatures trends for Wilcannia, Yamba and Moruya Heads could not represent reality because they do not show consistent warming, Chart 1.

Chart 1. Average Annual <u>Maximum</u> Temperature - Wilcannia, Yamba & Moruya Heads* (*These are the only 3 stations with more than 120 years of continuous temperature record to the present and are incorporated into ACORN-SAT by the Bureau. Sydney Observatory

Similar trends, however, are also found in a more extensive analysis of data from over 60 locations across New South Wales (J. Marohasy et al. 2014, Sydney Institute Papers Issue 26). An assessment of climatic change at Bourke, Narrabri and Hay from 1880 to 1950 (E. L. Deacon, 1952, Australian Journal of Physics, Volume 6) documented "a marked falling trend over much of the period" consistent with the pattern for Moruya Heads and Yamba, Chart 1.   This is also consistent with studies of extreme heat events in Australia, with the period from October 1895 to January 1896 recognized as causing more deaths, and dramatically more deaths per 100,000 people, than during any period since (e.g. Lucinda Coates et al. 2014, Environmental Science & Policy, Volume 42). http://jennifermarohasy.com/2014/07/fewer-deaths-from-heat-events-but-reasons-obscured/ . Include a quote.

 In every instance, before incorporation into ACORN-SAT, the temperature series are first truncated and then homogenized.   Consistent with analysis of the overall impact of homogenization on temperature trends (B. Trewin, International Journal of Climatology, Volume 33, page 1524), the most obvious changes to Wilcannia, Yamba and Moruya Heads are to the minimum temperature series. Considering the annual average minimum temperature just for Moruya Heads: the first 34 years of the record are discarded with the remaining data homogenized so that the minimum temperature is dropped down by 0.38 degree during autumn, and 0.47 degree during spring, for all

years prior to 1946, Chart 2.   The net effect is to change an overall warming of 0.64 degree Celsius per century, into a dramatic warming of 1.1 degree Celsius per century, Chart 2.

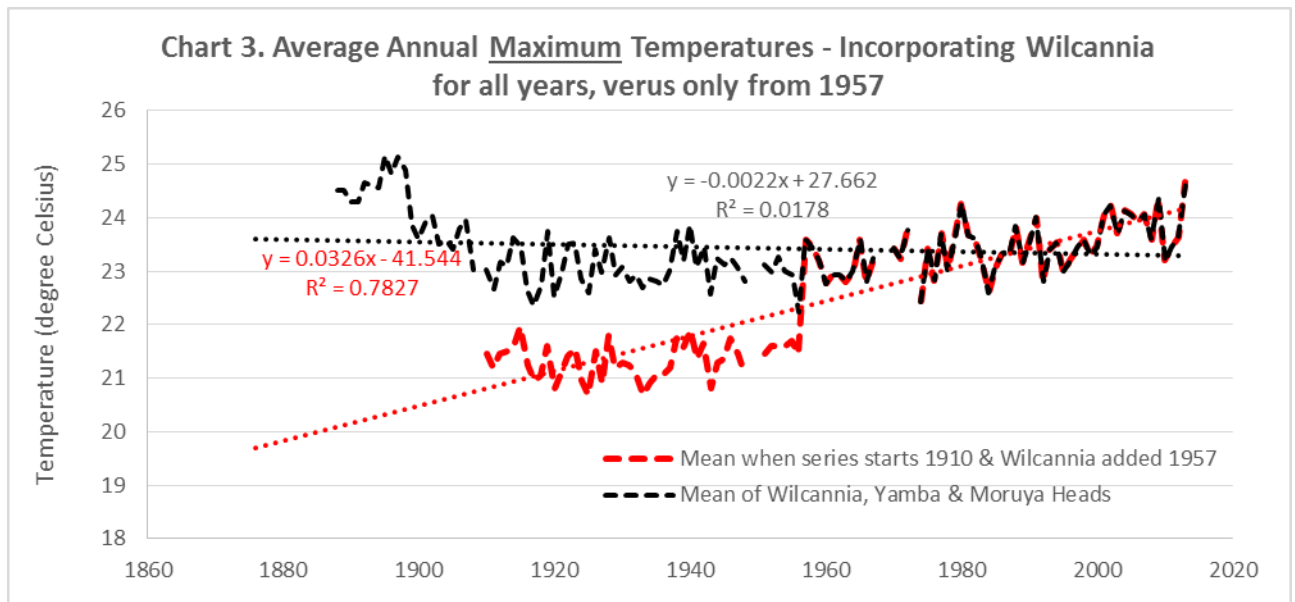Chart 2. Average Annual Minimum Temperature, Moruya Heads - Comparing Observed (1876-2012) & ACORN-SAT (1910 - 2012)

The average annual temperature trend for Australia derived from ACORN-SAT is a combination of maximum and minimum values for 104 stations from across the Australian landmass. Because the stations are not evenly distributed, a weighting is applied to each station. It is not clear, however, how this is applied and how ACORN-SAT procedures deal with the addition of hotter stations in later years.

In the case of the three stations, Wilcannia, Yamba and Moruya Heads, even though all three stations have records that begin by 1910, Wilcannia is not incorporated into ACORN-SAT until 1957. According to the ACORN-SAT catalogue this is because there is no data available for this station before this date. But this is demonstrably false with Wilcannia (Reid Street, Site No. 046043) commencing operations in 1879 according to the Bureau's own website concerned with raw data. http://www.bom.gov.au/jsp/ncc/cdio/cvg/av?p_stn_num=046043&p_prim_element_index=0&p_di splay_type=enlarged_map&period_of_avg=&normals_years=&p_comp_element_index=0&redraw= null&p_nccObsCode=122

Wilcannia is the hottest of the three stations. Simply by incorporating Yamba and Moruya from 1910, and Wilcannia only in 1957 a global warming trend can be generated, Chart 3 (red line). To be clear, it is stated in the ACORN-SAT catalogue that Yamba and Moruya are incorporated from 1910, but Wilcannia only in 1957.

The claim is persistently made in correspondence from the Bureau that it is impossible to incorporate temperature data prior to 1910 into the official ACORN-SAT record because Stevenson screens had not been installed. Yet Stevenson screens had been installed at many stations in Queensland, South Australia, the Northern Territory and Western Australia by 1889. Furthermore, in the case of Wilcannia and Moruya Heads, Stevenson screens were installed in 1908. http://jennifermarohasy.com/wp-content/uploads/2014/01/BOM_Response-to-Dr-Marohasy_MARKUP.pdf

Chart 3. Average Annual Maximum Temperatures - Incorporating Wilcannia for all years, verus only from 1957

$y = -0.0022x + 27.662$
$R^2 = 0.0178$

$y = 0.0326x - 41.544$
$R^2 = 0.7827$

- - - Mean when series starts 1910 & Wilcannia added 1957
- - - Mean of Wilcannia, Yamba & Moruya Heads

General circulation models underpin anthropogenic global warming theory and they predict continual warming. Consistent with these models the ACORN-SAT maximum and minimum temperature series shows consistent warming for almost all stations from 1910. When these maximum and minimum values are combined, a net increase in the average annual temperature for Australia of 1 degree Celsius from 1910 is generated. The raw data from individual stations unaffected by any UHI affect, however, generally suggests a different history, with temperatures better described by the combined mean annual maximum temperatures for Wilcannia, Yamba and Moruya Heads, Chart 3 (black line). This pattern is one of cooling to about 1940 and warming from about 1960, with late 20th Century warming never reaching the heights of the late 19th Century warming.

Attempting to model extremely complex systems such as the earth's atmosphere and oceans is difficult, and perhaps not surprisingly the output from general circulation models might not always accord well with observations. Usually when models do not accord with reality, the deficiencies are in the model, rather than the observational data. At the very least, the genuine scientists might be skeptical of Australian climate scientists who label remodeled data as 'observations' and arbitrarily add hotter stations to the later years of a time series. It is almost as though leading Australian climate scientists have forgotten basic scientific standards and the need to always defend the integrity of the observational data – the evidence.

Acknowledgements