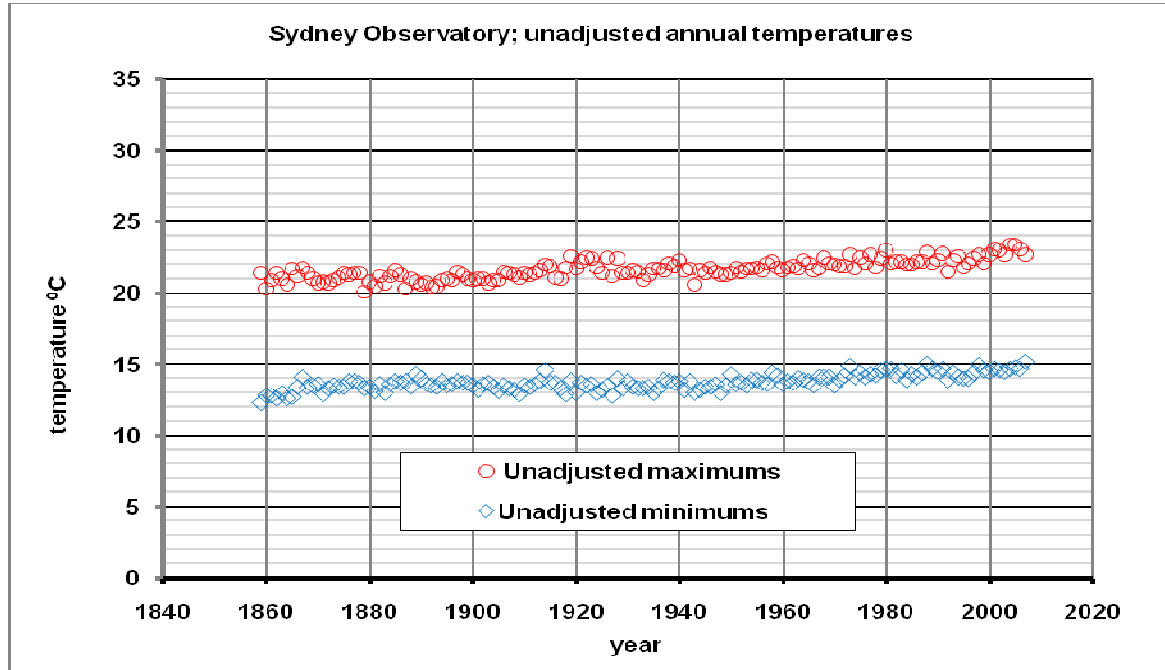


# CASE STUDY: Global Warming - the forest from the trees

## APPENDIX 4(a): Formation of the Sydney Observatory Hill High Quality Dataset

There is a continuous unbroken series of daily maximum and minimum temperature measurements at Sydney's Observatory Hill dating back to 1859 (*BOM 2009 b*) and an intermittent record right back to Lieutenant William Dawe's 39 months of observations between 1788 and 1791.



Unfortunately, the usefulness of this body of data for the detection and measurement of possible climate change is compromised by various influences that have little to do with wide-ranging global climate phenomena.

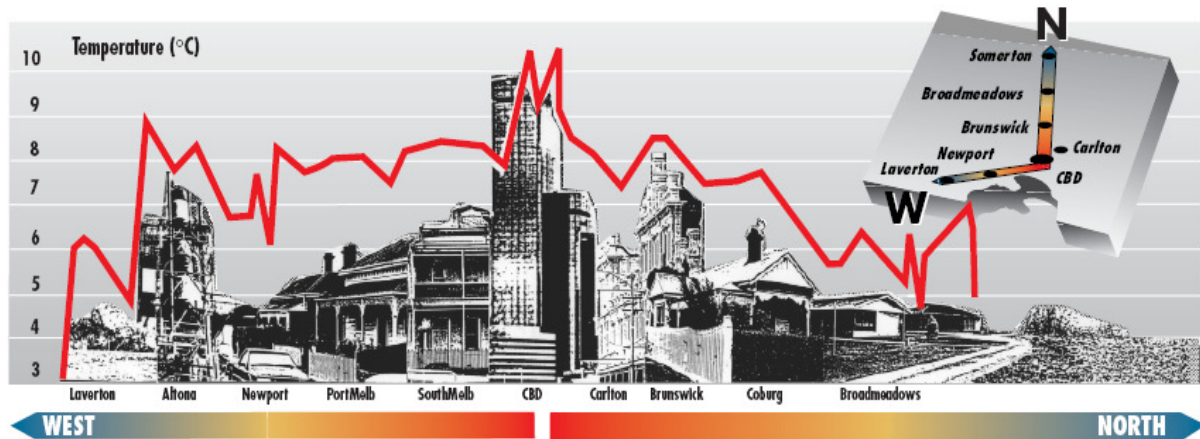
The first and most important of these compromising factors is the dramatic increase in human population and the localised Urban Heat Island effect that is likely to have resulted from it.

*"The Urban Heat Island (UHI) refers to the observation that towns and cities tend to be warmer than their rural surroundings due to physical differences between the urban and natural landscapes. The concrete and asphalt of the urban environment tend to reduce a city's reflectivity compared with the natural environment. This increases the amount of solar radiation absorbed at the surface. Cities also tend to have fewer trees than the rural surroundings and hence the cooling effects of shade and evapotranspiration are reduced. The cooling effects of winds can also be reduced by city buildings...."*

*As cities grow, the UHI effect becomes stronger, creating an artificial warming trend in the temperature record. ...*

*The UHI is most noticeable during clear, still nights when rural areas are most effectively able to radiate the heat gained during the day back to space, while the urban environment retains a greater proportion of heat (see Figure below). Depending on the weather conditions, overnight temperatures in the centre of a large city can be up to 10 °C warmer than the rural surroundings."*  
(BOM, 2009 f, p. 16).

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Temperatures across Melbourne on a still and clear night. (BOM, 2009 f, p.17 based on Torok et al. 2001).

Other than urbanisation, there are many specific local factors that compromise the temperature records of nearly all Meteorological Stations, particularly those records that date back to before 1900. In the case of Sydney Observatory, various changes in instrumentation and measurement circumstances have occurred over the years since 1859. The **metadata** for the Sydney Observatory temperature record up until 1993 was summarised by Torok (1996) from the official correspondence as follows:

### Record of Changes in Circumstances of temperature measurements at Sydney Observatory (BOM No. 066062)

**Late 1860s:** Instruments moved to large shed after being held on Glaisher stand



Thermometer shelter at Sydney Observatory after the late 1860s.

**1910:** Instruments moved from shed to Stevenson Screen.

**1917:** Instrument site shifted from Observatory to a location at the cottage where they are to the present. Differences due to move were calculated to be 1.2 °F (0.67 °C) cooler at the old site for maximum temperatures and 0.5 °F (0.28 °C) warmer for minimum temperatures (Torok, 1996, Vol.2 p. 258.)

Based on the above documented metadata and on a combination of objective and subjective analysis techniques described in Torok and Nicholls (1996), the following adjustments to the long

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term Sydney Temperature record were carried out as documented in *Torok (1996) Vol 1 Table 7.1.1. on p.187.*

Year	Magnitude of this adjustment in °C	Accumulated adjustment in °C	Basis for calculation of correction	Overall description
<b>Changes to the Minimum temperature series</b>				
<1951	+0.4	+0.4	Objective test; Detect; Documented (inconclusive) building	0.4 °C was added to <b>all</b> annual values prior to 1951 due to a possible influence of buildings; and according to an objective estimation of the extent of discontinuity based on a neighbourhood reference set of stations
<1908	-0.5	-0.1	Range; Detect; Documented supply of Stevenson Screen	0.5 °C was subtracted from <b>all</b> annual values prior to 1908 due to the shift of thermometers from shelter house to a Stevenson Screen; and detected and estimated by analysis of Diurnal Temperature Ranges and by comparison with nearby stations.
<1866	+0.5	+0.4	Range; Detect; Documented Screen changed	0.5 °C was added to <b>all</b> annual values prior to 1866 due to the shift of thermometers from a Glaisher stand to a shelter house; and detected and estimated by analysis of Diurnal Temperature Ranges and by comparison with nearby stations.
<b>Changes to the Maximum temperature series</b>				
<1947	+0.4	+0.4	Objective test; Detect Documented building (inconclusive)	0.4 °C was added to <b>all</b> annual values prior to 1947 due to a possible influence of buildings; and according to an objective estimation of the extent of discontinuity based on a neighbourhood reference set of stations
<1929	- 0.4	0.0	Median; Range; Detect;	0.4 °C was subtracted from <b>all</b> annual values prior to 1929 as detected and estimated by analysis of Diurnal Temperature Ranges and comparison with nearby stations
<1918	+0.7	+0.7	Objective test; Range; Detect; Documented move	0.7 °C was added to <b>all</b> annual values prior to 1918 due to the move of site; and according to an objective estimation of the extent of discontinuity based on a neighbourhood reference set of stations
<1908	+0.5	+1.2	Objective test; Range; Detect; Documented Stevenson Screen supplied	0.5 °C was added to <b>all</b> annual values prior to 1908 due to the shift of thermometers from shelter house to a Stevenson Screen; and according to an objective estimation of the extent of discontinuity based on a neighbourhood reference set of stations
=1886	-0.5	(+0.7)	Objective test; detect	0.5 °C was subtracted from the <b>individual</b> 1886 value as detected and estimated by comparison with nearby stations
=1885	-0.5	(+0.7)	Objective test; Detect	0.5 °C was subtracted from the <b>individual</b> 1885 value as detected and estimated by comparison with nearby stations
=1884	-0.5	(+0.7)	Objective test; Detect	0.5 °C was subtracted from the <b>individual</b> 1884 value as detected and estimated by comparison with nearby stations

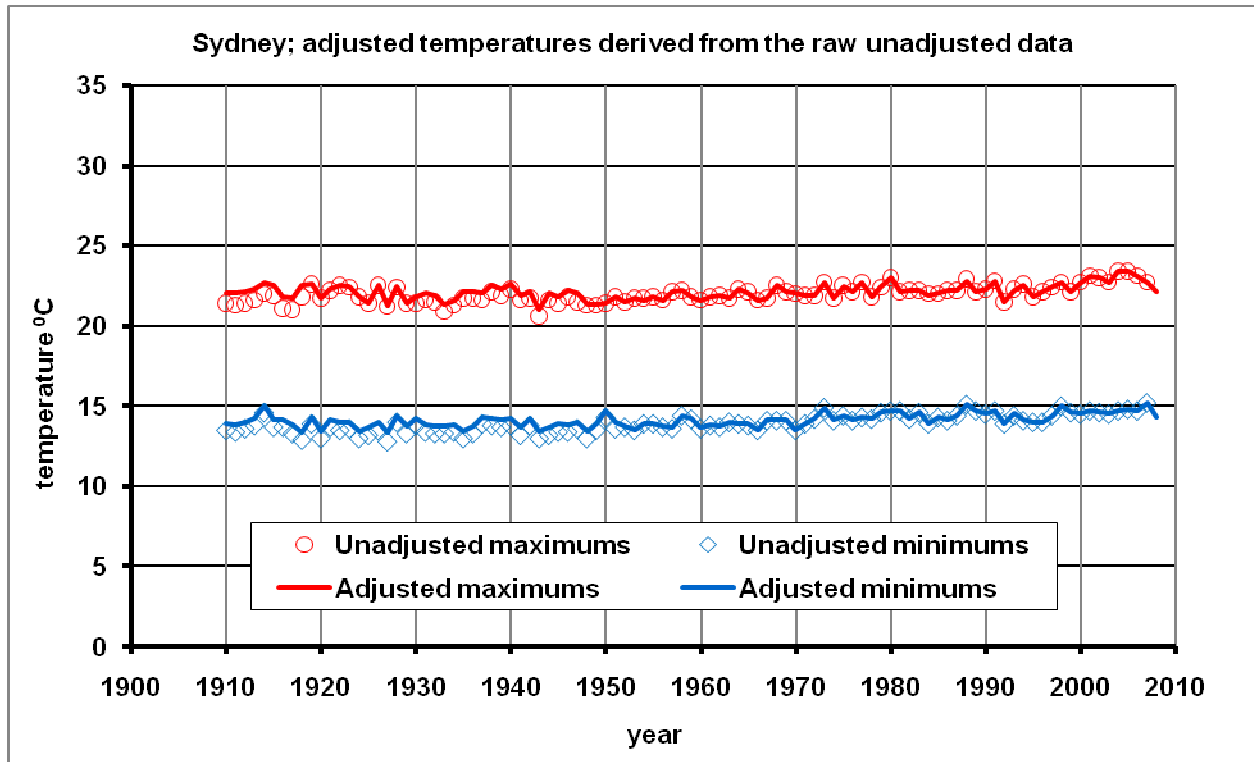
Since the work of *Torok and Nicholls (1996)*, the Sydney temperature data has been scrutinised and adjusted by further rounds of detection and estimation techniques (see, for example *Della-Marta et al. (2004)*).

It has been generally accepted by climatologists that in Australia the temperature record prior to 1910 is significantly less reliable than the subsequent record. So for the purposes of Climate

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Change research, the High Quality Dataset for Sydney as for the other 133 Australian locations is based on a starting date of 1910.

The figure below shows the current values of the High Quality Temperature Dataset for Sydney Observatory superimposed on the original unadjusted raw values (*BOM, 2009 b; BOM 2009 c*)



It should be noted that 34 stations (including Sydney Observatory) in the current Australian High Quality Temperature Dataset are classified as urban (population > 10,000 and having temperatures possibly subject to an Urban Heat Island effect).

For the purposes of a valid detection and estimation of Global Warming, many climatologists consider it preferable to remove these 34 urban sites from the dataset so as to only include the 100 rural sites.