TEMPERATURE VARIABILITY: GLOBAL, REGIONAL AND LOCAL

Dr Vincent Gray, June 2007

Global Temperature

It is quite impossible to obtain a statistically or scientifically acceptable estimate of mean global temperature or its variability over time, from readings on the earth's surface, for the following reasons:

Random distribution of measuring equipment is impossible, and thus, so is a truly global average of known accuracy.

Continuous temperature measurement in any one location has only been possible recently. For a longer record "Mean Daily Temperature", must be used. This consists of the mean of the maximum and minimum temperature over a variable 24 hour period, which does not even usually refer to a standard day. Such a measurement gives only a biased average, of unknown accuracy, even at a single site..

There is no quality control system for weather station and ship measurements. Hardly anything is standardized, even within a single country. Instruments, shelter, location, distance from buildings and vegetation, personnel, and administration, vary widely. Some instruments are even on top of buildings. A recent study in the United States has shown that even the "approved" sites in that country are non-standard. (Davey and Pielke Sr 2005)

Measurement sites suffer from discontinuity of location and variability in numbers (100 weather stations in 1850, 8000 in 1980, 3000 today) as well as gaps in records

Attempts to correct for some of these sources of error are largely confined to the continental USA. In most countries there are too few sites for comparison purposes, and methods developed in one country may not be valid elsewhere.

The oceans constitute 71% of the earth's surface, but sea surface temperature measurements suffer from error to a greater degree than measurements on land. .

Weather data are considered commercial and are often not generally available to the public without a fee. The processing of the data is largely secret and is not available to independent observers or "peer reviewers",

A whole host of additional difficulties have been identified in recent papers by Pielke Sr et al 2007, Runnalls and Oke (2006) and D'Aleo et al.2007 They include, the high and variable thermal gradient at the surface, the effects of discontinuous changes in number and location of sites, instrument calibration and change, land-use changes, water vapour effects, political changes, wars, gaps in the data., and inadequate qualifications and reliability of some personnel.

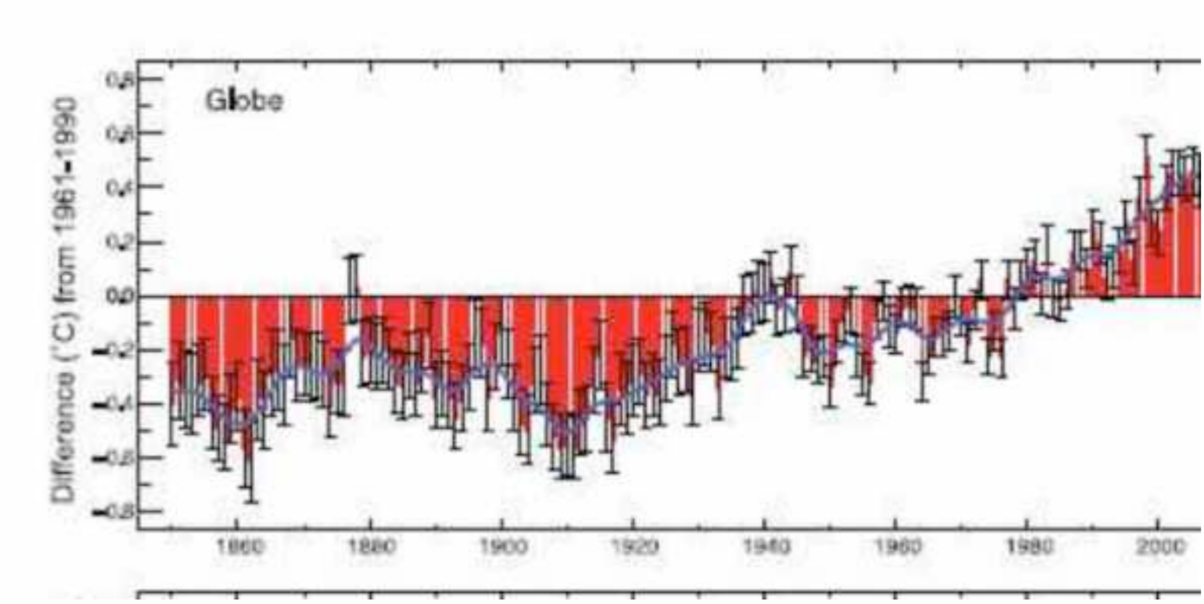

Figure 1 Global surface temperature anomaly record (Brohan et al 2006) with 95% uncertainty estimates

Despite these insuperable problems vigorous efforts have been made to develop corrections for surface records (summarised well by Trenberth and Jones 2007). An example of 95% confidence levels which are claimed for the surface record is given in Figure 1 (Brohan et al (2006).

It is admitted by Brohan et al that this record omits a number of "unknown unknowns" (pace Donald Rumsfeld) The above considerations suggest that these are likely to be high. This paper attempts to estimate some of them by comparing the global temperature anomaly record in Figure 1 with a number of other temperature records, global, regional, and local

Global Records

The best comparatively recent measure of globally averaged temperature anomalies is that supplied by the Microwave Sounder units on NASA satellites since 1979 (MSU 2007) from measurements in the lower troposphere. The "Land" record is shown in Figure 2 as it ignores variability specific to land surfaces, but still applies to 71% of the earth.

This record shows no significant overall change between 1979 and 1997; a sudden and temporary rise in 1998 from the El Niño event of that year, a reversion to the 1979-97 average between 1999 and 2001, and then and a small upward climate shift from 2001 to the present with a relatively stable temperature.

Weather balloon measurements in the lower atmosphere from 1958 are shown in Figure 3 (Thorne et al 2005). They also include 95% estimates of uncertainty. They are affected by poor representativity and inaccuracy, but they tend to confirm the global temperature variability after 1979 of Figure 2. They also show a cool period from 1960 to 1978 which is also present in Figure 1. However, the record shows no significant overall temperature change between 1958 and 2002, in contrast to Figure 1.

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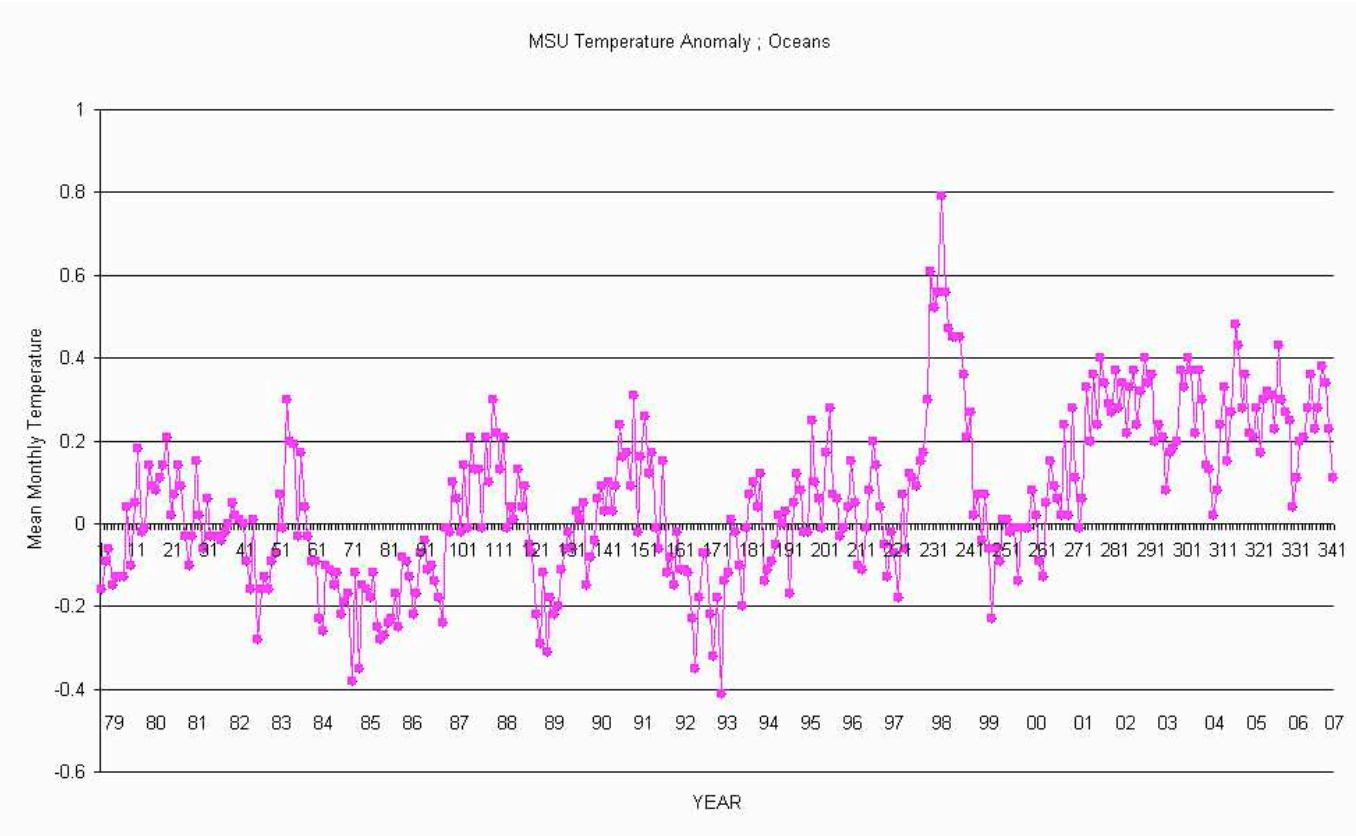

Figure 2 MSU (satellite) monthly temperature anomalies for the lower troposphere. (ocean only) (MSU 2007)

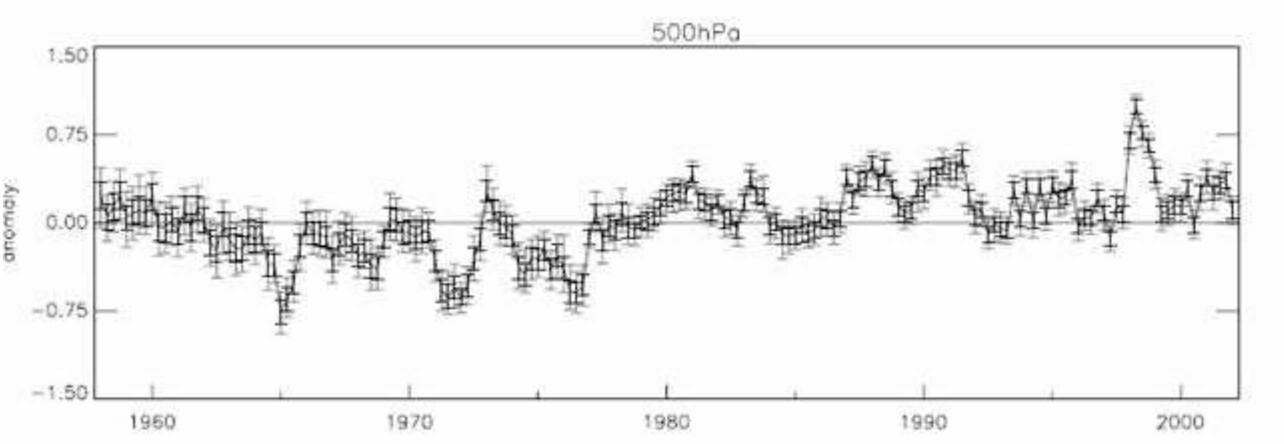

Figure 3 Global Mean monthly temperature anomalies for 500hPg lower troposphere from weather balloons (Thorne et al 2005)

Regional Temperature

Several countries have derived mean temperature anomaly records for their region from their local network by applying corrections. The best known is that for the continental USA, shown as Figure 4 (NOAA/NCDC 2007)

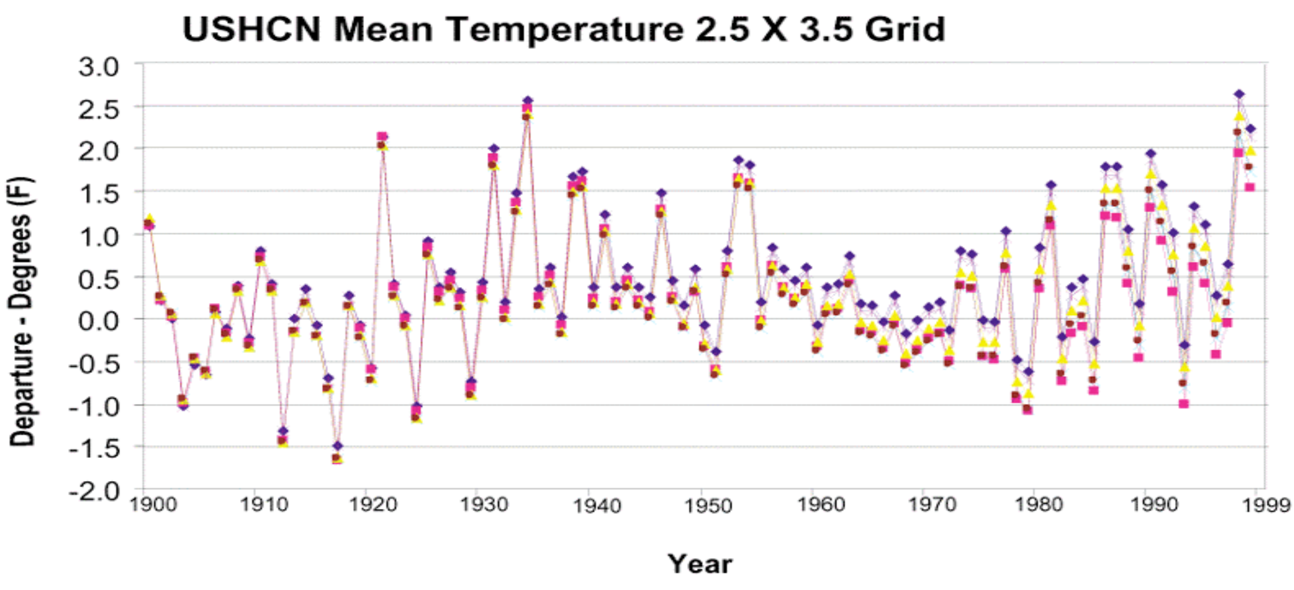

Figure 4 United States Temperature anomaly Record (in ºF) USHCN (Historical Climatology Network) (NOAA/NCDC 2007)

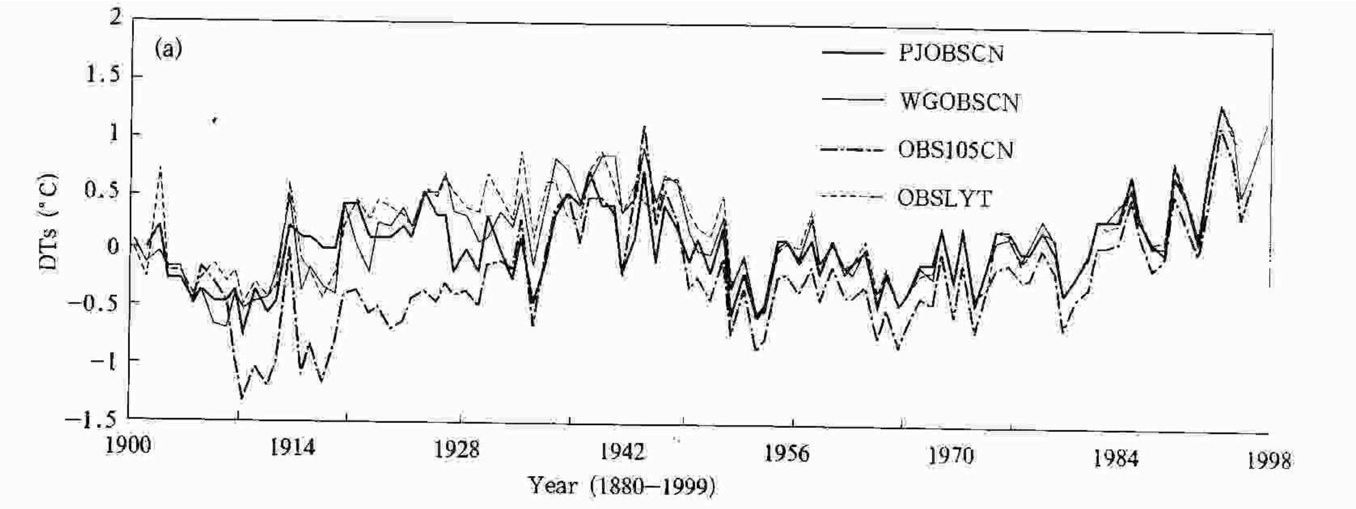

Figure 5 Amalgamated, "corrected" temperature record for China (Zhao et al 2005)

A similar country compilation has recently been made for China (Zhao et al 2005) and is shown in Figure 5

There is a remarkable agreement between these two records. Both show a cyclic change with a trough before 1930, a peak period from 1930 to 1950, another trough from 1950 to 1976 and the beginning of another peak period from 1976 which has now reached its probable maximum value. These records confirm the MSU record (Figure 2), only for latest high period, and the radiosondes (Figure 3) the transition from the previous trough. They do not confirm the overall upwards trend from 1900 shown in Figure 1.

Local Temperatures

There are a few long-lived local temperature records where the local bias has remained fairly steady and which give records that confirm the variability shown above, including the warm shift in the 1930s and 50s resembling that seen today This effect as particularly evident in the Arctic. A number of these local records are available on John Daly's website (Daly 2007).

An example is shown in Figure 4. for Reykjavik and Akureyri in Iceland.

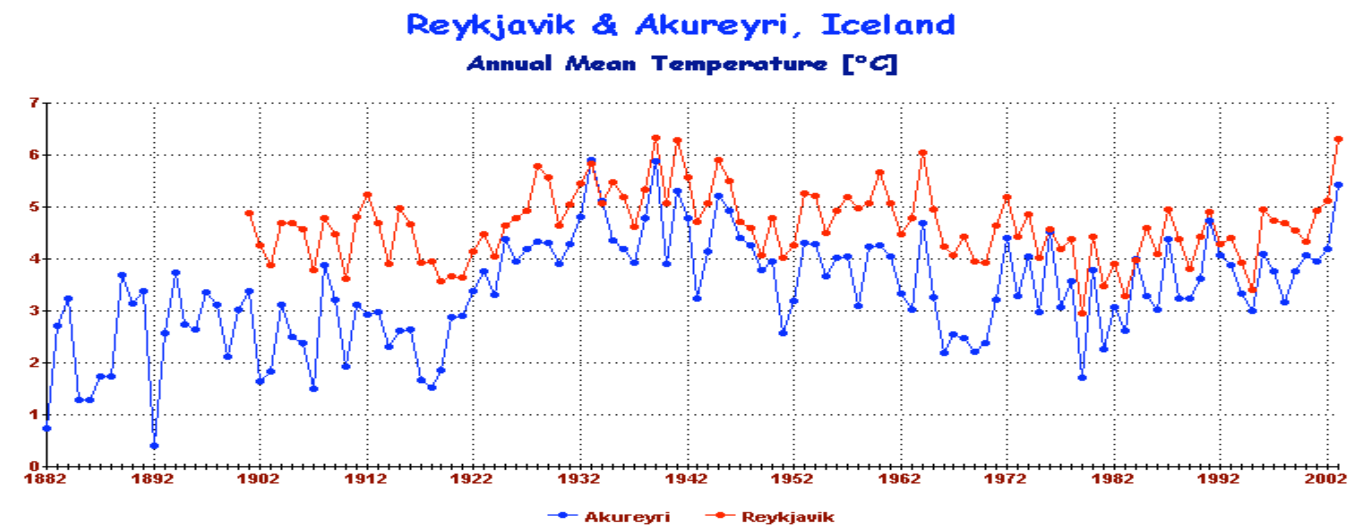

Figure 6. Weather station records from Reykjavik and Akureyri, Iceland. (Daly 2007)

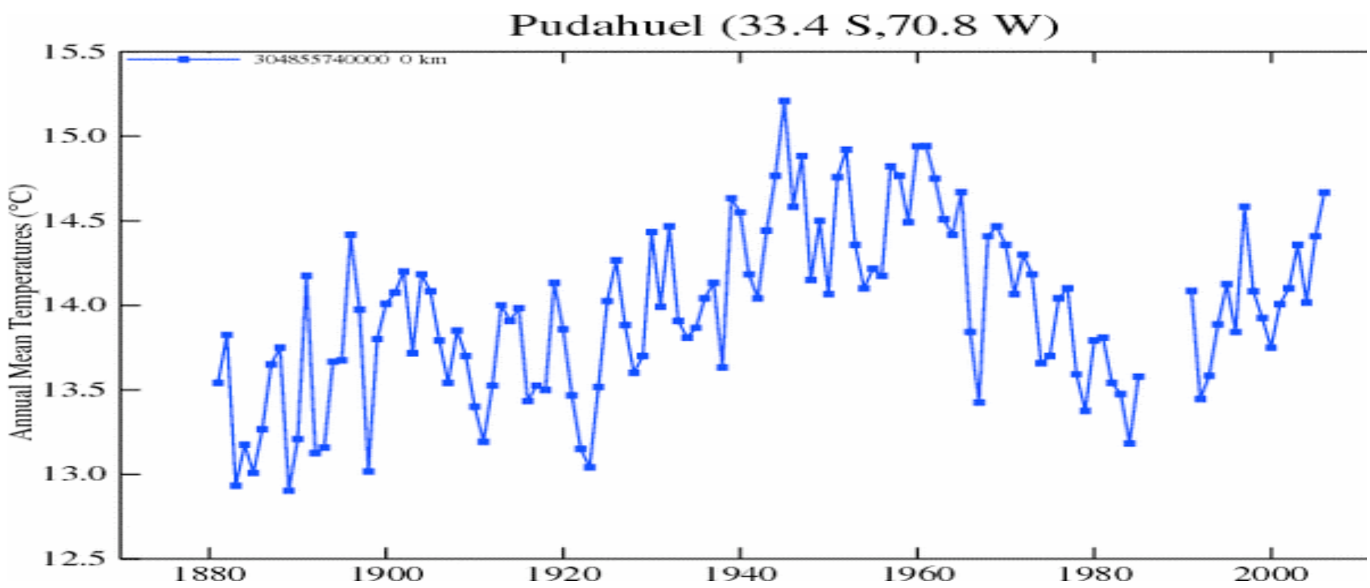

Figure 7 Temperature Record, Pudahuel, Chile

An example from the Southern Hemisphere is Figure 7, from Pudahuel in Chile

Conclusion

There are common features in all the global temperature records

A fall from 1880 to 1910
A rise from 1910 to 1940
A fall from 1940 to 1970
A rise from 1970 to 2002

The radiosonde record shows the last two and the MSU record only the last.

There are other similarities relating to volcanic and El Niño events.

The main difference between Figure 1, the surface record, and the rest, is a regular upward bias from the beginning. This has given a difference of +0.4ºC between 2002 and 1940 for Figure 1 which does not exist in the other four global records (4,5 6 & 7). This suggests that the main "unknown unknown" corrections that should be made to Figure 1 should be based on an acceptance of an upward bias throughout the record as a result of the inaccuracies described above. Figures 3,4,5,6 and 7, show that recent global and local temperatures are part of a fairly regular cycle, where the last warm period similar to today was in the 1940s.

Reliable global, regional and local temperature records show that temperatures variability is cyclic, with a period of about 60 years. The temperature does not display a distinguishable "trend". The most reliable records show peak temperatures around 1940 and 2005 and low temperatures around 1910 and 1970. These records are incompatible with a belief that there is a distinguishable upwards "trend' caused by greenhouse gas emissions.

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