MAJOR DATA INTEGRITY ISSUES

ISSUE SUMMARY

The United States and especially the global databases have serious problems that render them highly useless for determining accurate long-term temperature trends. Most of the issues mentioned below produce a warm bias in the data. The data disseminated fails to comply with the basic objectivity, utility and integrity guidelines of the Federal Information Quality Act ("objectivity" is a measure of whether disseminated information is accurate, reliable, and unbiased and whether that information is presented in an accurate, clear, complete, and unbiased manner; ''utility'' refers to the usefulness of the information to the intended users; ''integrity'' refers to the security of information—protection of the information from unauthorized access or revision, to ensure that the information is not compromised through corruption or falsification).

There has clearly been some cyclical warming in recent decades (most notably 1979 to 1998) confirmed by satellites, but the longer term trends are much more uncertain. The global surface station based data is seriously compromised by urbanization and other local factors (land-use /land-cover, improper siting, station dropout, instrument changes unaccounted for and missing data) and thus the databases overestimate the warming. Numerous peer-reviewed papers available to the authors of both the IPCC and CCSP but ignored in favor of cherry-picked papers by authors employed by the data centers themselves, in the last several years have shown this overestimation are the order of 30 to 50% from these issues alone. Divergence of satellite versus land/ocean databases in recent years also provides evidence of this data integrity problem.

The cessation of warming in the late 1990s and an increasing cooling trend since 2002 in the atmosphere and at least 2003 in the oceans call into question the entire premise of the 'greenhouse gas' driven global warming.

Data integrity problems contaminate the historical record that is the underpinning of the entire endangerment report

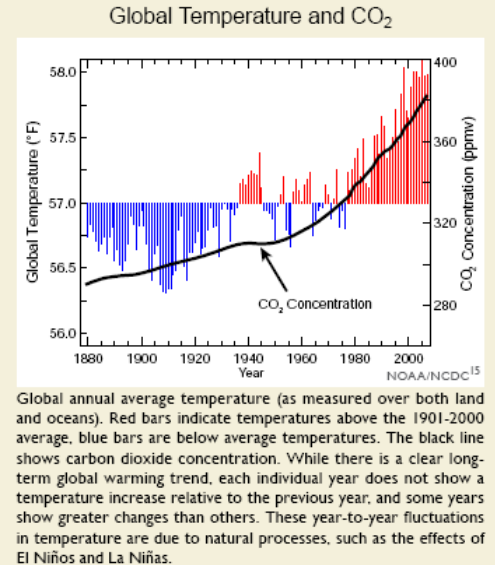
The key citations addressed here are:

TSD ES 2
Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. *Global mean surface temperatures have risen by 0.74°C (1.3ºF) (±0.18°C) over the last 100 years. Eight of the ten warmest years on record have occurred since 2001. Global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries.*

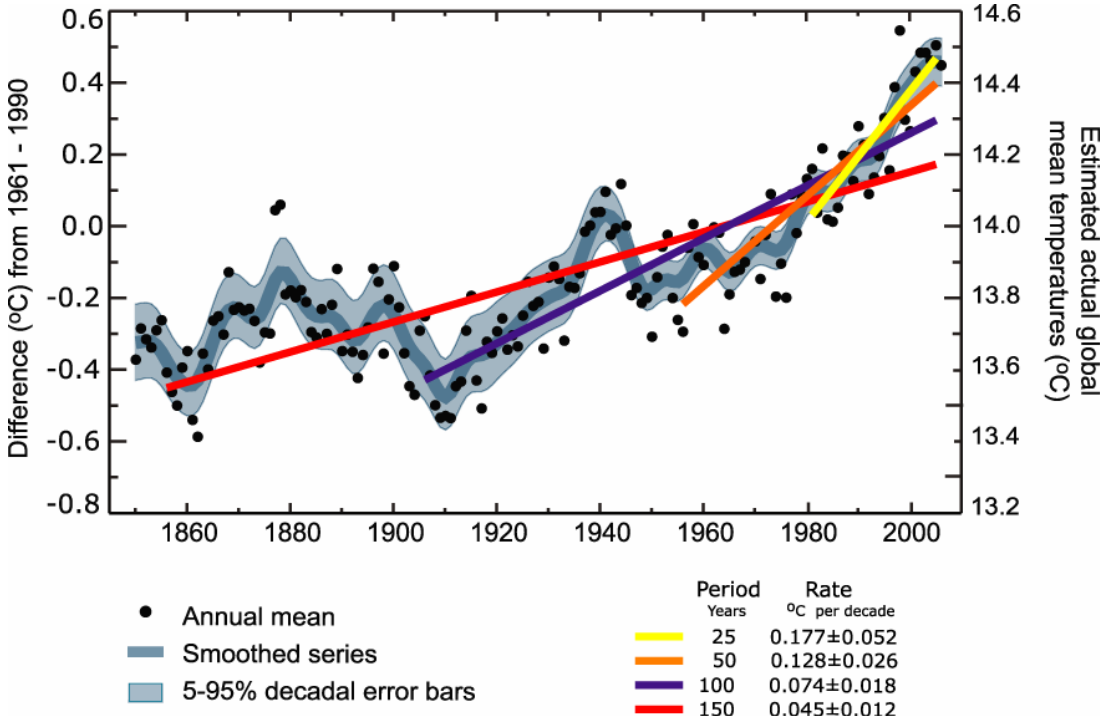
Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG

concentrations. *Climate model simulations suggest natural forcing alone (e.g., changes in solar irradiance) cannot explain the observed warming.*

U.S. temperatures also warmed during the 20th and into the 21st century; *temperatures are now approximately 0.7°C (1.3°F) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. Both the IPCC and CCSP reports attributed recent North American warming to elevated GHG concentrations. In the CCSP (2008g) report the authors find that for North America, "more than half of this warming [for the period 1951-2006] is likely the result of human-caused greenhouse gas forcing of climate change." Chart* on page 17



Global annual average temperature (as measured over both land and oceans). Red bars indicate temperatures above the 1901-2000 average, blue bars are below average temperatures. The black line shows carbon dioxide concentration. While there is a clear long-term global warming trend, each individual year does not show a temperature increase relative to the previous year, and some years show greater changes than others. These year-to-year fluctuations in temperature are due to natural processes, such as the effects of El Niños and La Niñas.



TSD Figure 4.2 page 23

COMMENTS:

SERIOUS DATA INTEGRITY ISSUES

There are major data coverage and integrity issues with the global and US data bases that make it impossible to make this claim that the warming is as depicted in the statements and shown in the diagrams given the following, confounding research/findings.

These include:

(1) Major questions about the impact of major station dropout observed since 1990
(2) Major questions about the handling of the missing data, which has in many large regions also increased dramatically since 1990
(3) Major issues as to how urbanization and land use (siting) changes, clearly man's greatest effect on local climates, are handled.
(4) Lack of visibility into the adjustments being made to the raw data. Some parts of this key process like time of observation adjustments are well documented and understood but most others are not. Data and documentation of the adjustments made is not being made available for independent review even when requests are being made through proper channels.
(5) Some instrumentation changes have taken place without apparent adjustments for known biases
(6) Ocean data given that 70% of the globe is ocean is critical to determining a global mean temperature. Changing methods not unlike changing instrumentation for land stations introduce biases and errors that must be properly accounted for. A potential remedy in the form of ARGO diving buoys is now in place, but the issue adds uncertainty to past assessment of global temperatures.

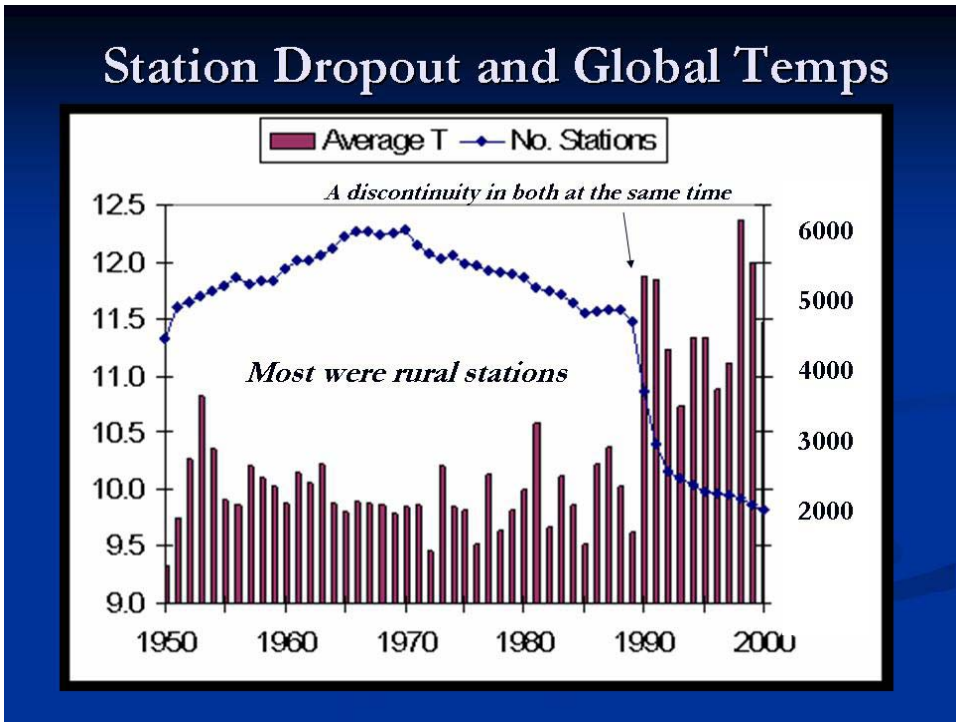
THE DATA BASE ISSUES

Though there has clearly been some cyclical warming in recent decades, the global surface station based data is seriously compromised by urbanization and other local factors (land-use /land-cover, improper siting, station dropout, instrument changes unaccounted for and missing data) and thus the data bases overestimate the warming. Numerous peer-reviewed papers in the last several years have shown this overestimation may be the order of 30 to 50%. Since the past temperature trends is the entire underpinning of both the IPCC and the CCSP findings about warming, and these issues are not properly addressed, the EPA should have rejected or at least questioned the findings soliciting opinions from qualified independent experts not associated with the data centers. The major issues include:

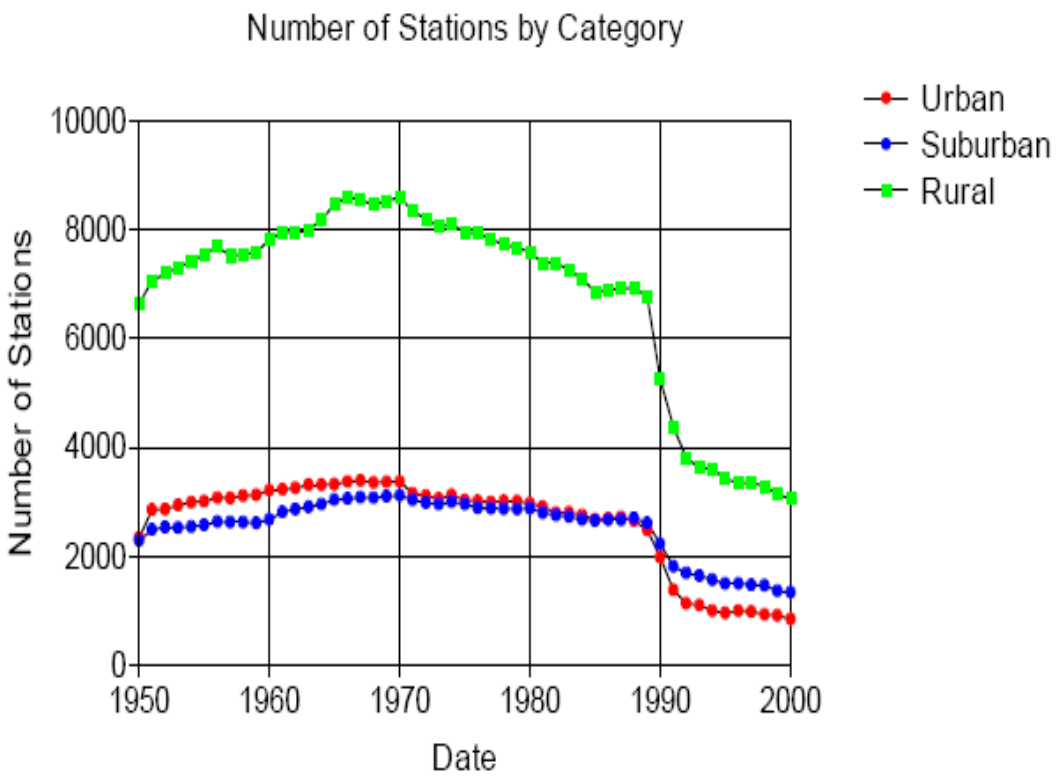
STATION DROPOUT

Station drop-out has occurred-- from a peak of 6,000 stations in 1970 to 2,000 today. The biggest dropoff occurred around 1990. The plot was made with downloaded GHCN 2 data with Annual mean global temperature in degrees Celsius and number of stations. Many of the stations that were dropped were rural. A larger percentage of the stations

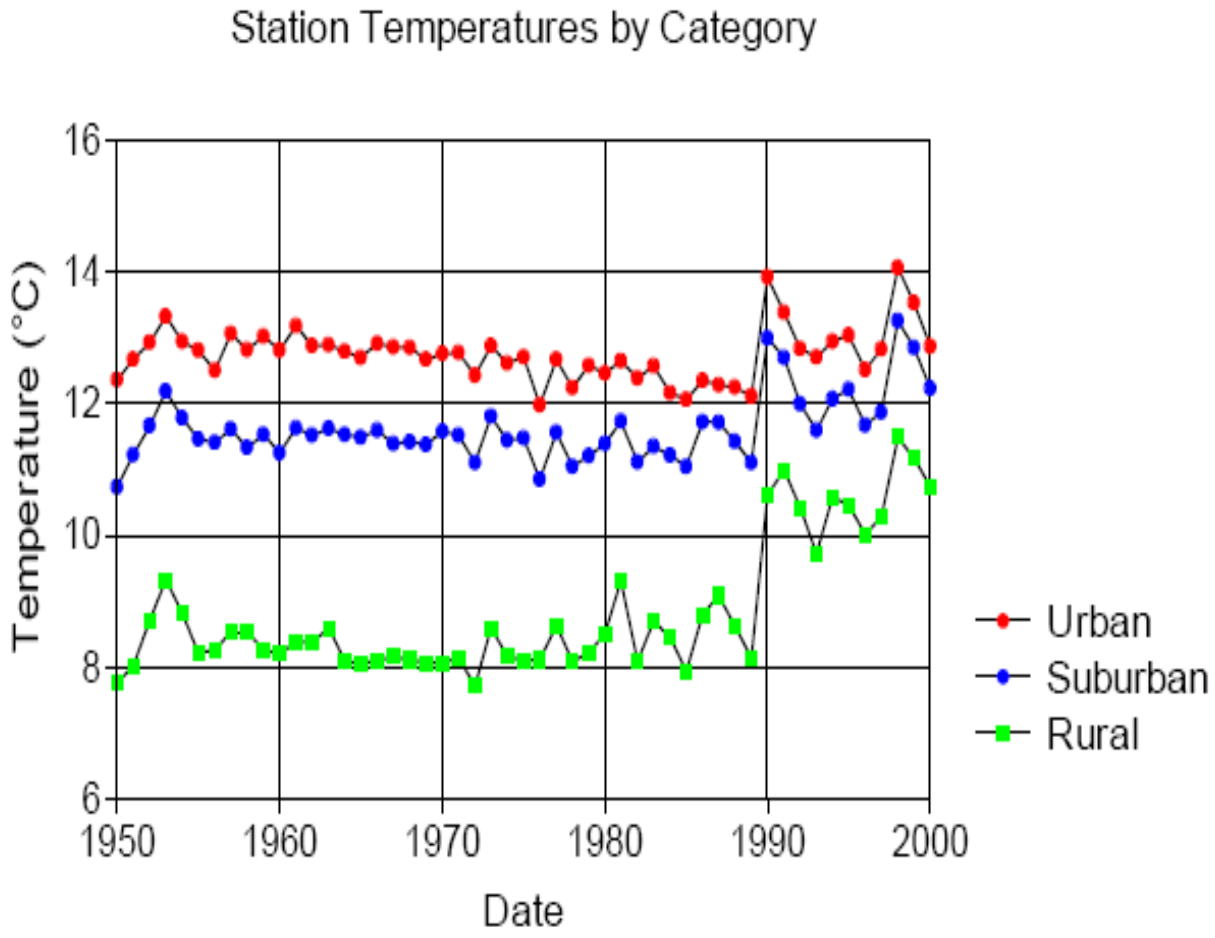
remaining were urban. Notice the discontinuity of mean temperature at the same time as the dropoff suggesting a sampling error was introduced.



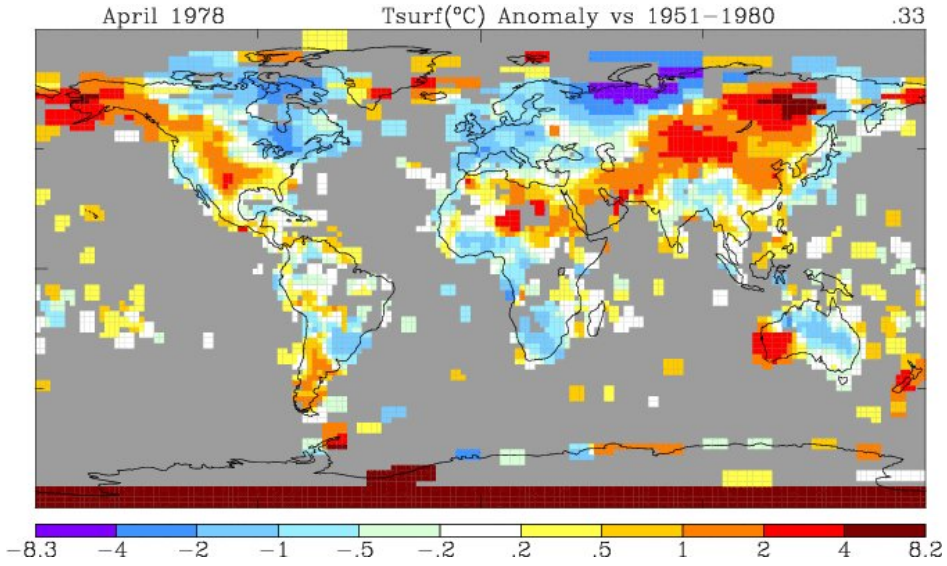
To see for yourself how rapid and extensive this is, look at this animation of reporting stations in recent decades, see the stations drop out rapidly around 1990.

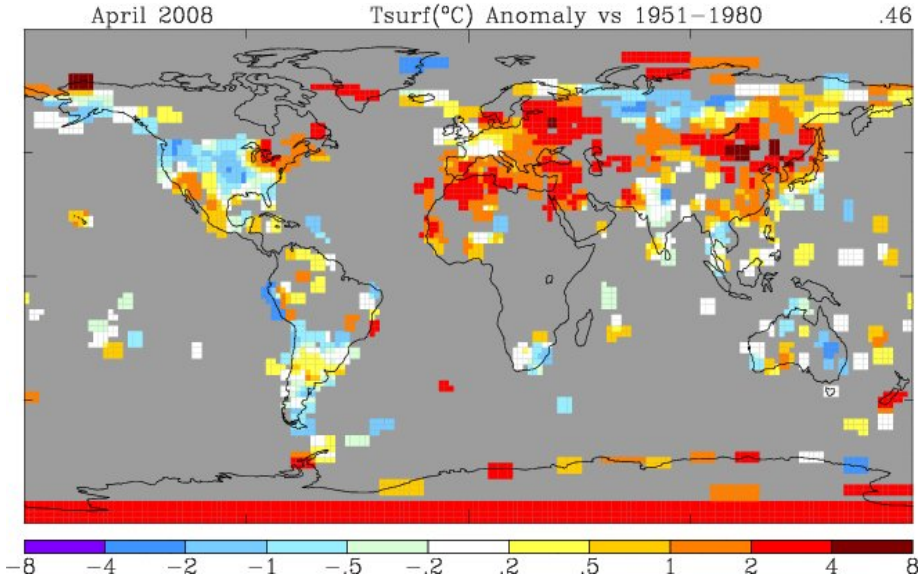


The GHCN downloaded data base was deconstructed above into the urban, suburban and rural numbers. Below the same was done for temperatures for these groupings. The discontinuities of temperatures match the discontinuities of number of stations suggesting an issue with ‘distribution changes’ not true climate change. The jumps suggests a misidentification of station class as Stephen McIntyre found with the GISS version of GHCN which NASA used to attempt an urban correction.



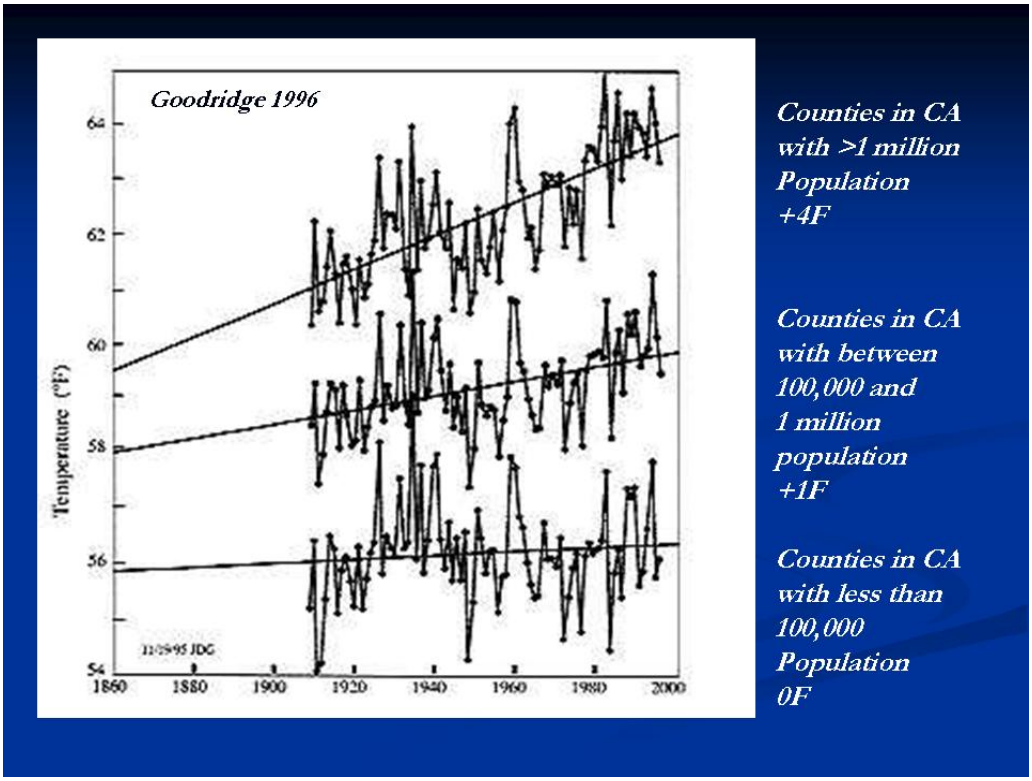
The increases in large holes in the network can be clearly seen in the gridded plots from NASA of NOAA based data with 250 km smoothing comparing 1978 with 2008





URBANIZATION

Dr. Thomas Oke (the winner of the American Meteorological Society Helmut Landsberg award in 2007 for his pioneer work in urbanization), in 1973 showed how even cities with 1000 population could have a significant warming relative to urban areas (2ºC). The global data bases do not consider an area a city and adjust for urbanization until the population exceeded 10,000. This introduces a warm bias into the data bases.



Zhou et al (2005) have shown global data bases (for China) not properly adjusted for urbanization. Block (2004) showed the same problem exists in central Europe. Hinkel et al (2003) showed even the village of Barrow, Alaska with a population of 4600 has shown a warming of 3.4ºF in winter over surrounding rural areas.

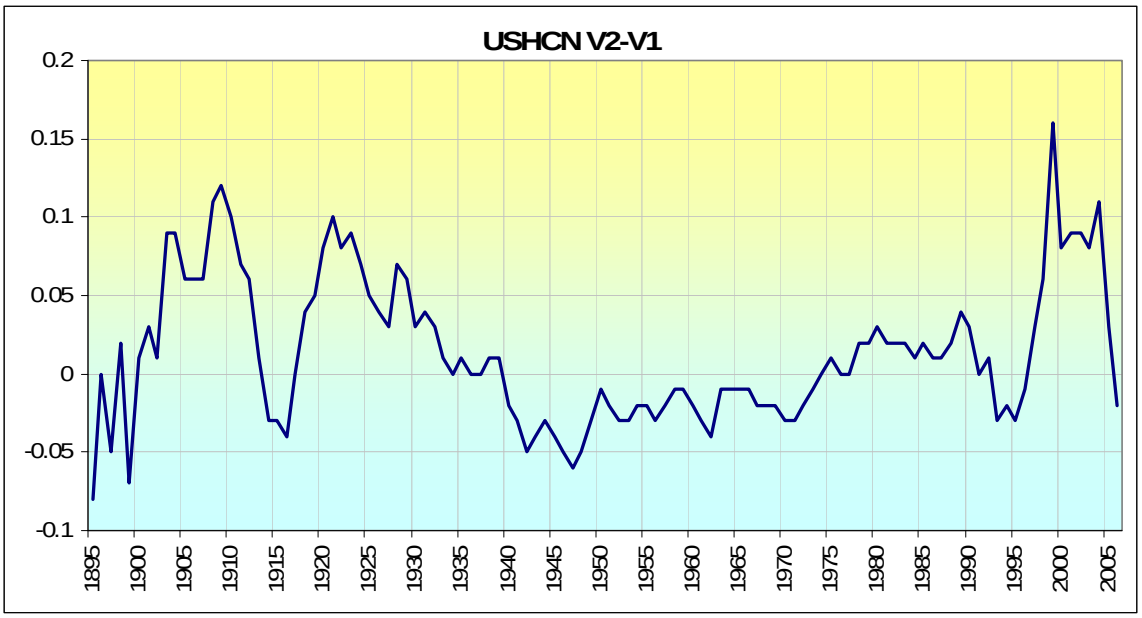
More and more of the world is urbanized (population increased from 1.5 B to 6.5 B today). Cities grow around airports where we measure temperatures. See this detailed review of this Urban Heat Island (UHI) issue. NOAA has argued urban contamination is not an issue based on papers by Parker and Peterson (which are challenged here and here). Even when adjustments are made, the adjustments are inconsistent with UHI.

In version 1 of NCDC's USHCN released in 1990, there was an urban adjustment based on Karl's own work (Karl, T.R., H.F. Diaz, and G. Kukla, 1988: Urbanization: its detection and effect in the United States climate record, *J. Climate*, **1**, 1099-1123). In a paper published in the *Bulletin of the American Meteorological Society* in 1989, Dr. Thomas R. Karl, senior scientist at the National Climate Data Center, corrected the U.S. surface temperatures for the urban heat-island effect and found that there has been a downward temperature trend since 1940. This suggested a strong warming bias in the surface-based temperature record.

In version 2 released in 2007, NCDC has removed the urban adjustment and employed a change point algorithm designed to find previously undocumented inhomogenieties like changes in siting, and land use. As Anthony Watts commented after his visit to NCDC at their invitation to discuss his efforts to document siting issues: the new change point

algorithm that replaces the prior adjustments for siting and urbanization can't be expected to catch and correct for things like: gradual UHI increase in the surrounding area, tree shading/vegetation growth/loss near the sensor increasing or decreasing gradually, a gradual buildup of surface elements around the sensor, such as buildings, asphalt, concrete etc.

Indeed the difference pattern between the two versions are hard to explain with early 20th century and again recent warming and a very slight cooling in between. This plot uses NCDC version 1 and version 2 US Annual Mean temperatures.



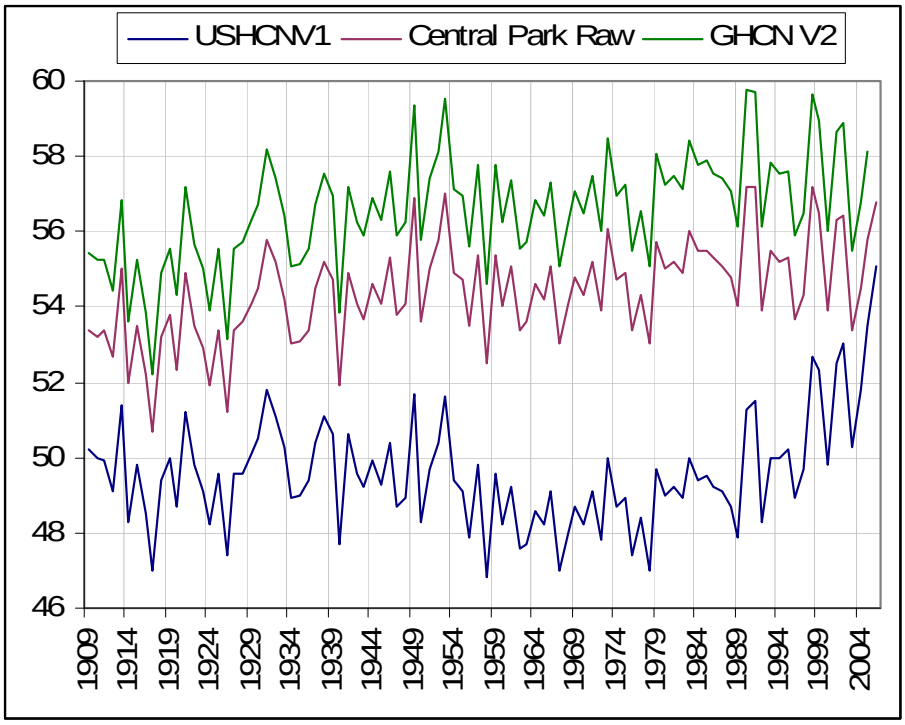
URBANIZATION ADJUSTMENTS MADE AND UNMADE - ONE TEST CASE

I will provide one key example of how the urban adjustment by NCDC has been used in two different data bases to adjust in one data base for the station down significantly and the other up, calling into question the processes involved and the overall integrity of the data.

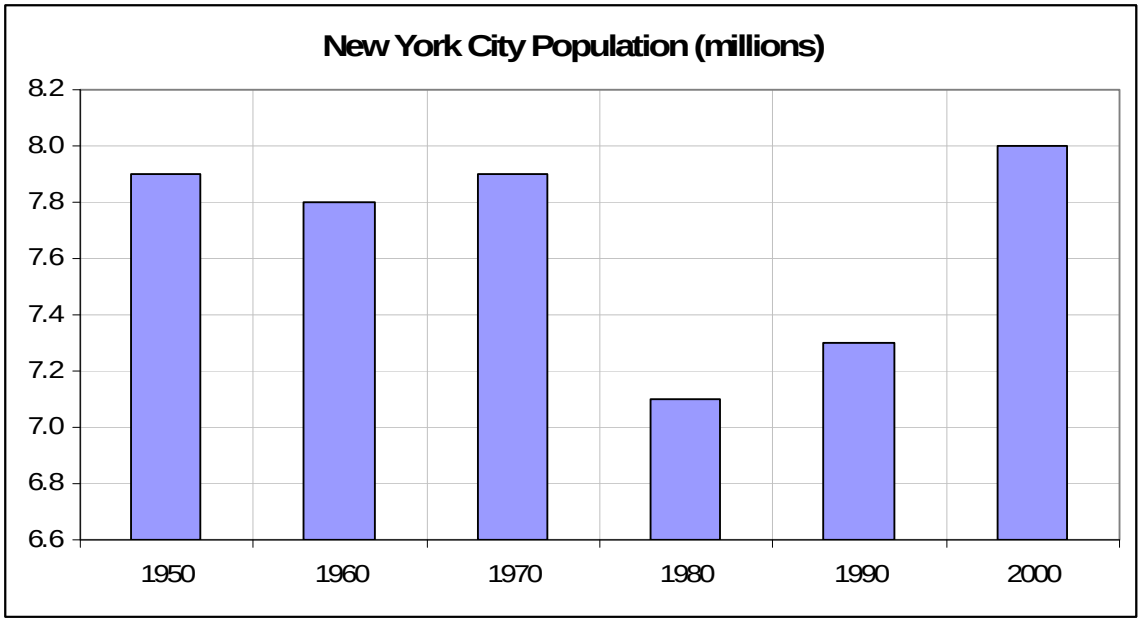
The station is New York City's Central Park. Raw observed data is available from NOAA's NWS in New York City on a monthly and annual basis extending back to 1869. NCDC takes that data and applies their adjustments for the US called USHCN and separately in the global data base GHCN now in release version 2.

Historical Central Park observations were taken from the periphery of the park from 1909 to 1919 at the Arsenal Building 5th Ave (between 63rd & 64th) and then since 1920 at the Belvedere Castle on Transverse Rd (near 79th & 81st).

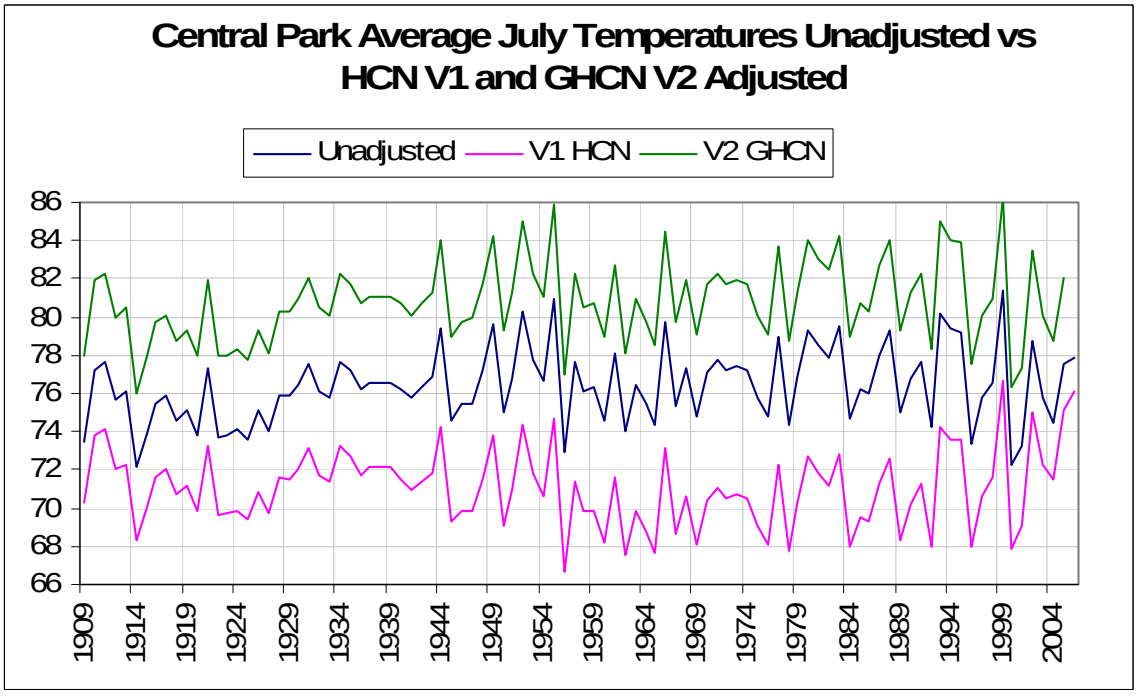
Here is a plot of the annual temperature from the three data set (RAW, USHCN V1 and GHCN V2) for New York City's Central Park. Data sources here are NWS NYC and NCDC.



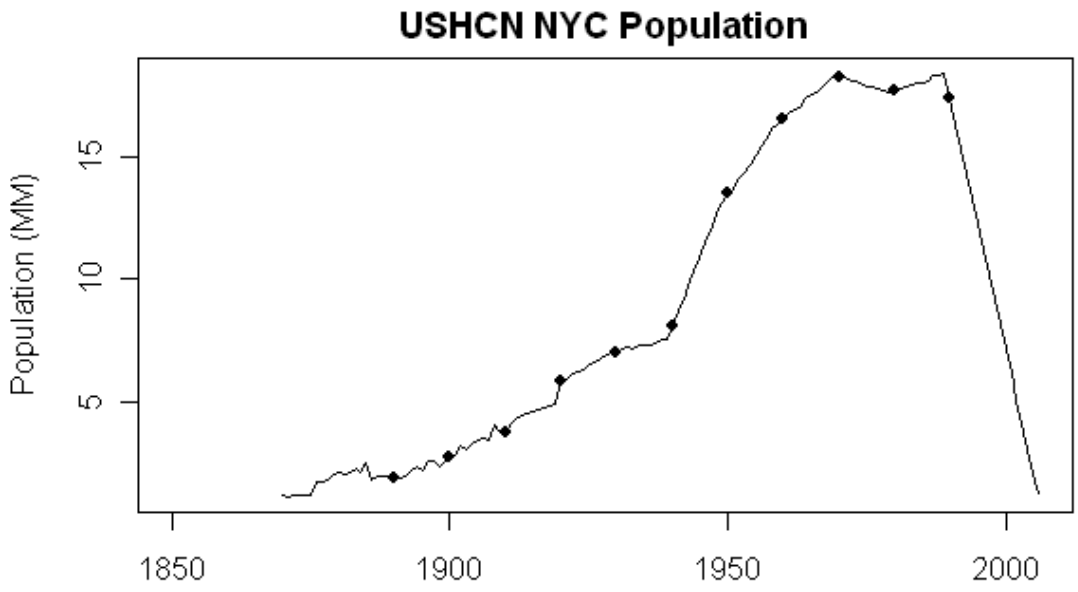
You can clearly see there is a startling significance in the three data sets with the USHCN V1 adjusted down significantly from the raw due to the urban adjustment and the GHCN inexplicably adjusted up from the raw observed annual means inn the middle. The difference between the data sets exceed 8F for most of the period from the 1950s to the early 90s. Then again inexplicably after about 1991, the USHCN downward adjustment diminished to less than 5F, implying a population decline. That has not been the case for New York City where the 5 borough population rose.



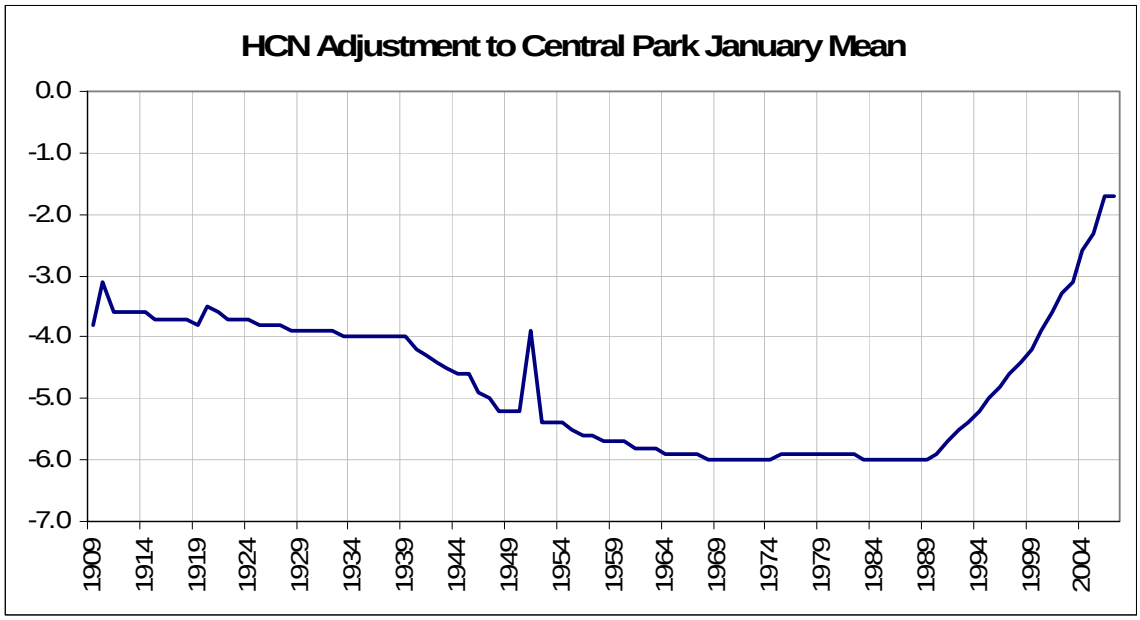
The differences were even more exaggerated for the July monthly averages with differences exceeding 11F, again diminishing to 6F by 2006.



Steve McIntyre reverse engineered this adjustment to calculate the New York City population that would have to be used in the USHCN urban adjustment. It would have had to revert to the population of the 19th century to produce that change.



The analysis was repeated for January Central Park temperatures, and again a significant adjustment was noted to USHCN and again that adjustment diminished in the last two decades though New York did not become less urban.



If our own NCDC can't determine what the correct temperature for July should be to within 11F or annual to within 8F for a well established major center with a well maintained and complete record, how can we trust the data base to give us changes the order of a few tenths of a degree for trend analysis and critical policy making when other data sites are less consistently available or of this quality.

GHCN's adjustment **up** of NYC data, clearly an urban location, also calls into question the global adjustment process. These kinds of what appears to be arbitrary adjustments imply lack of ***data quality assurance and constitute a clear violation of the data quality act.***

NASA CONTINUES AN URBAN ADJUSTMENT – ARE THEY A VIABLE ALTERNATIVE?

NASA's adjustments of GHCN raw data have been shown by Steve McIntyre to be erratic with the majority actually warming urban areas like GHCN did for Central Park instead of adjusting temperatures down.

NASA Urban Adjustments

Negative adjustments	1848	45%
Positive adjustments	2236	55%
Total adjustments	4084	100%

Steve McIntyre, Climate Audit

The GISS GHCN adjustments also were observed to occur frequently. John Goetz in February 2008 found on average 20% of the historical record was modified 16 times in the prior 2 1/2 years. The largest single jump was 0.27 C. This occurred between the Oct 13, 2006 and Jan 15, 2007 records when Aug 2006 changed from an anomaly of +0.43C to +0.70C, a change of nearly 68%.

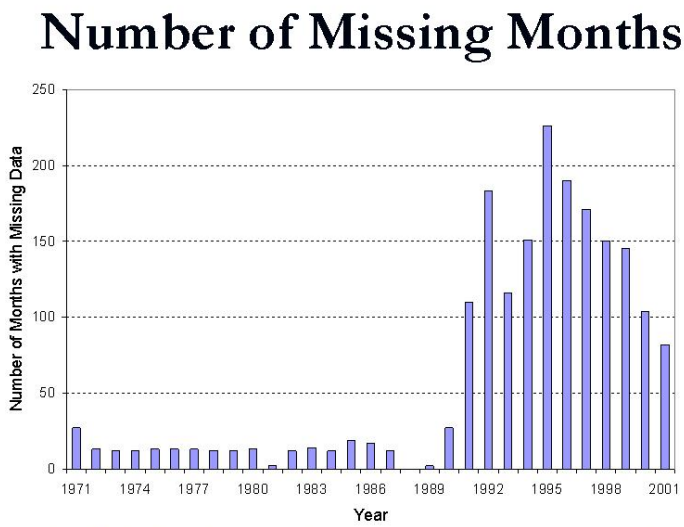
Steve McIntyre also noted that the issues globally with the NASA GISS data base are due to great uncertainties as to population and other local factors such as siting. Outside of the USA, southern Canada and northern Mexico, GISS uses population data to define rural stations. Hansen et al 1999 provided the following definitions for "rural", "small" and "urban": "We use the definition of Peterson et al 1997 for these categories: that is, rural areas have a recent population of less than 10,000, small towns between 10,000 and 50,000 and urban areas more than 50,000. These populations refer to approximately 1980."

The GISS sites are defined to be "rural" if the town has a population of under 10,000. Unfortunately, the population data utilized by GISS to classify the stations is out of date. Stations at cities with populations greatly exceeding 10,000 are incorrectly classified as rural. For example, in Peru, there are 13 stations classified as rural. Of these, one station is located at a city with a population of 400,000. Five stations are at cities with populations between 50,000 and 135,000.

Steve McIntyre says here, "If the supposedly "rural" comparanda are actually "urban" or "small" within the Hansen definitions, then the GISS "adjustment" ends up being an almost completely meaningless adjustment of one set of urban values by another set of urban values. No wonder these adjustments seem so random." NASA is not a viable alternative to NOAA's contaminated data set.

MISSING DATA

Another issue that has been an issue over the entire history of observations is the erratic nature of station histories and the missing data that must be somehow accounted for.



For the 110 Russian weather stations reporting weather data continuously from 1971 to 2001, the total number of missing monthly observations each year (McKitrick and Michaels)

To see how pervasive and serious the station dropout and missing data is, go to this site , scroll down to the map and click on any region. You will see stations listed - notice the highly variable reporting periods. Start clicking on stations. You will get plots. But before you move to other stations go to the bottom and click on "Download monthly data as text". You will see for many/most stations numerous "999.9"s meaning missing data. How do you come up with annual averages when one or more months are missing?

I was told that in most cases the data is available (Environment Canada told Steve McIntyre when he inquired on the availability of data that they have their data we show

as missing) but that NOAA and NASA are making no efforts to go out and get it. This is a violation of the Data Quality Act. NOAA NCDC is obliged to retrieve and maintain the most complete global data base for processing, not try and make due with a data base full of holes.

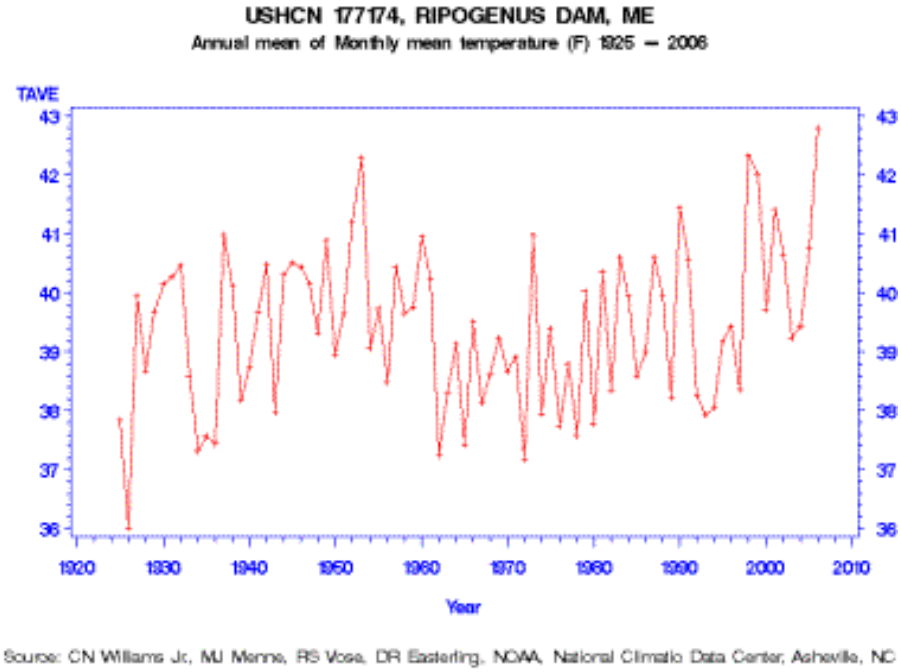
INFILLING OF MISSING DATA

The approach of estimating missing data using surrounding stations works if the stations are nearby and their anomalies were spatially consistent. The same or interpolated anomaly could be applied to the missing station, This is no easy task in the global data bases when surrounding stations are often hundreds of miles away as is the case in vasr areas of the world. Other efforts have included using prior or surrounding months to estimate the missing month or months. Even when surrounding stations exist, if they are contaminated by siting or urban issues then we are introducing errors into the data base.

EXAMPLE RIPOGENUS DAM, MAINE

Last summer, volunteers from the Kristen Byrnes Science Foundation completed surveys of the United States Historic Climate Network (USHCN) temperature stations in Maine that are used to measure climate change. The survey determined that none of the stations in Maine were free of microclimate or urbanization biases. One station did surprise the surveyors. Ripogenus Dam, a station that was officially closed in 1995.

Despite being closed in 1995, USHCN data for this station is publicly available until 2006.



Part of the USHCN data is created by a computer program called "filnet" which estimates missing values. According to the NOAA, filnet works by using a weighted average of values from neighboring stations. In this example, data was created for a no longer existing station from surrounding stations which in this case were all subject to microclimate and urban bias.

INSTRUMENTATION CHANGES UNADJUSTED FOR

Stephen McIntyre has shown in The HO-83 Hygro-thermometer that the change to the HO-83 went unadjusted for even though Karl 1995 noted a discontinuity of about 0.5ºC before and after switchover. Gall et al.(1992) first questioned this instrument's accuracy issue in the Tucson Arizona climate station. No record of procedures for adjusting for this instrument bias change has been found.

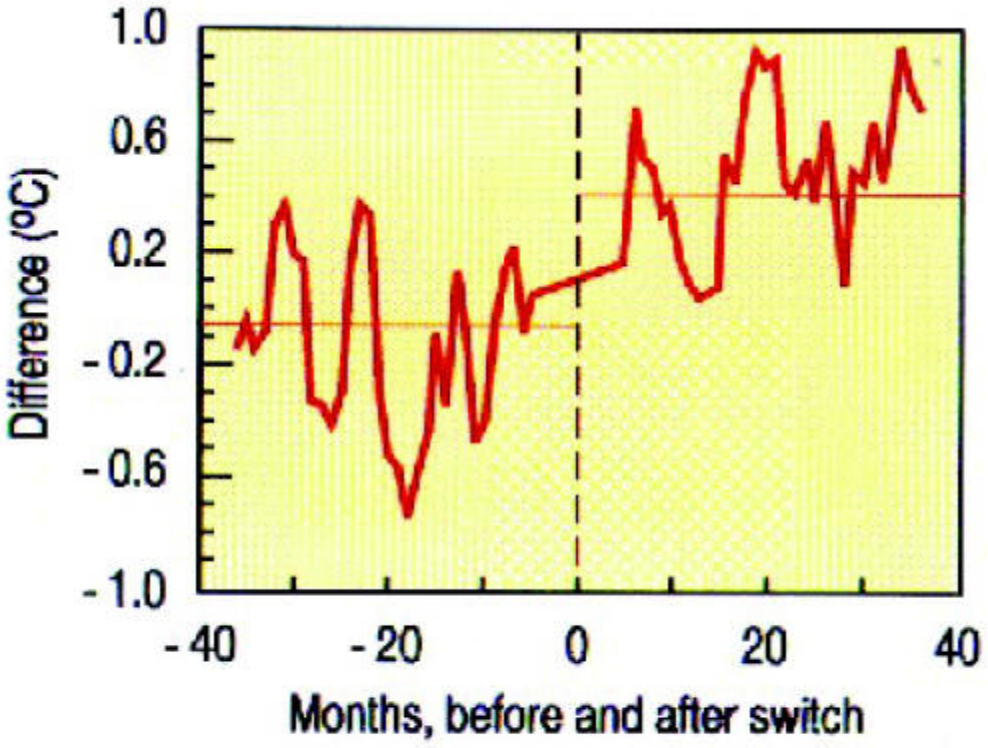
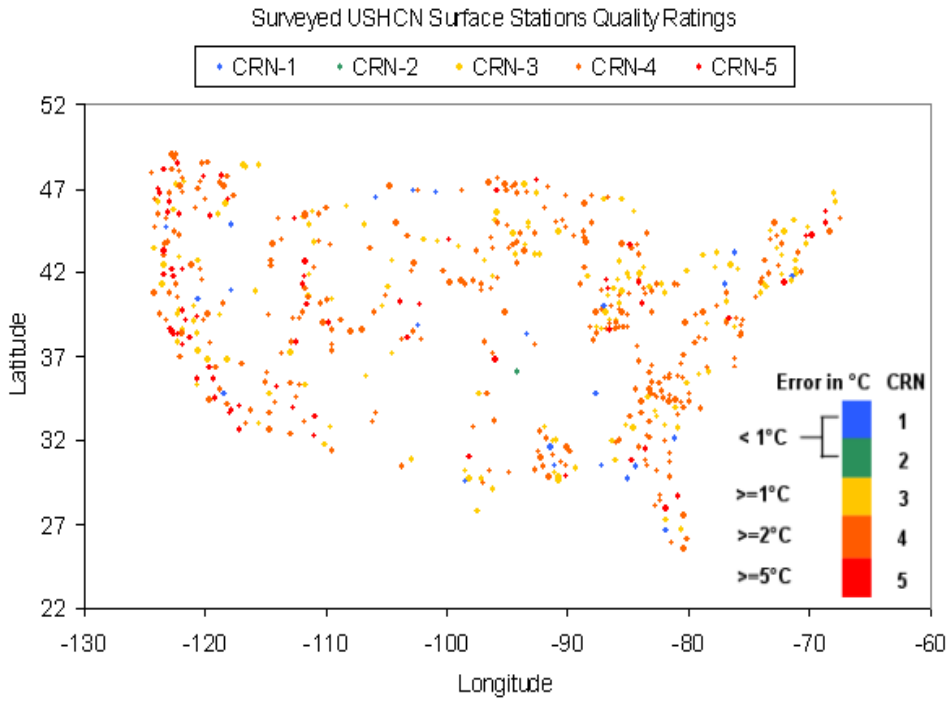


FIG. 2. Effects of changing instruments from the HO63 to the HO83 series on the maximum temperature in the United States (Karl et al. 1995).

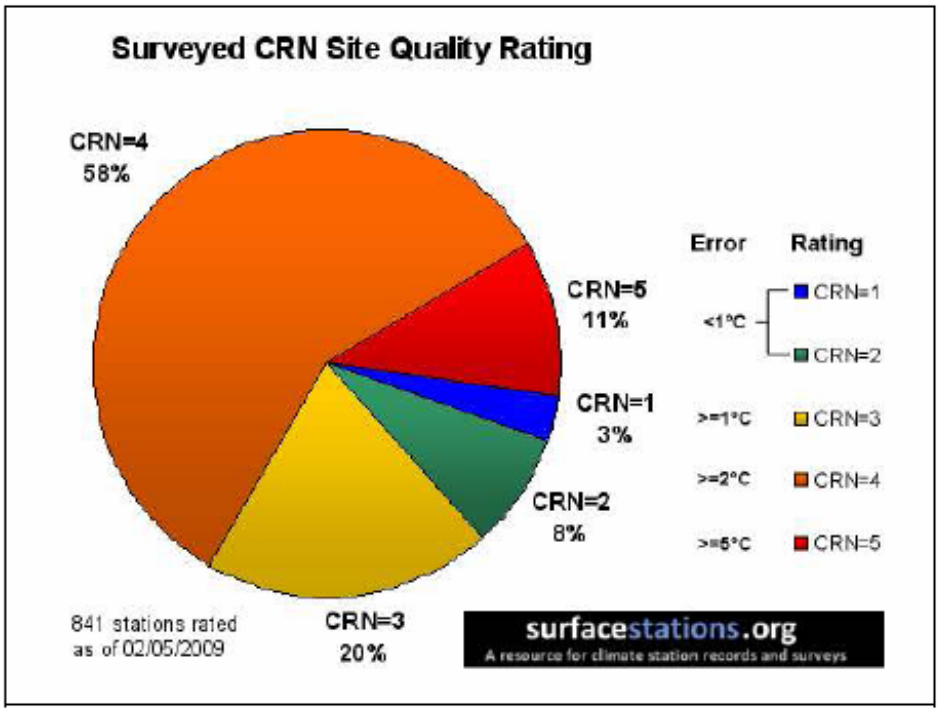
BAD SITING

Pielke and Davey (2005) found a majority of stations including climate stations in eastern Colorado did not meet WMO requirements for proper siting. He has extensively documented poor siting and land use change issues in numerous peer review papers, many summarized in the landmark paper Unresolved issues with the assessment of multi-decadal global land surface temperature trends (2007).

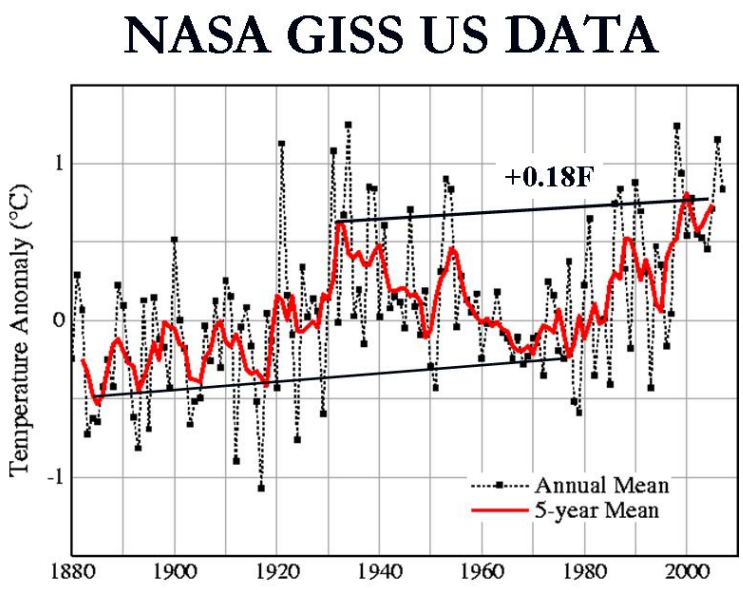
Anthony Watts started a volunteer effort to document siting issues with all 1221 stations in US. He and his team is now through over 554 stations. He and his team is now through over 554 stations. See the results on http://surfacestations.org and numerous examples highlighted on http://wattsupwiththat.wordpress.com. All of these siting issues identified introduce a warm bias.



Using the government's own rating system, Anthony has shown a majority of the stations are inadequately sited (89% are CRN 3-5).

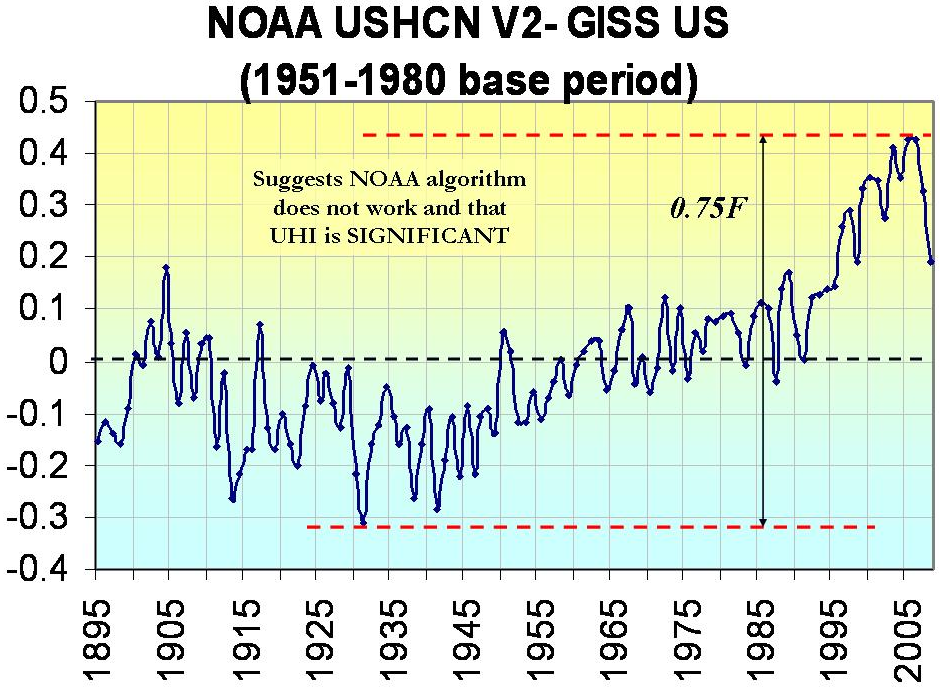


Even with the issues, the US network because it does not suffer from the same extent of station dropout and missing data shows minimal warming since the last cyclical peak in 1930.

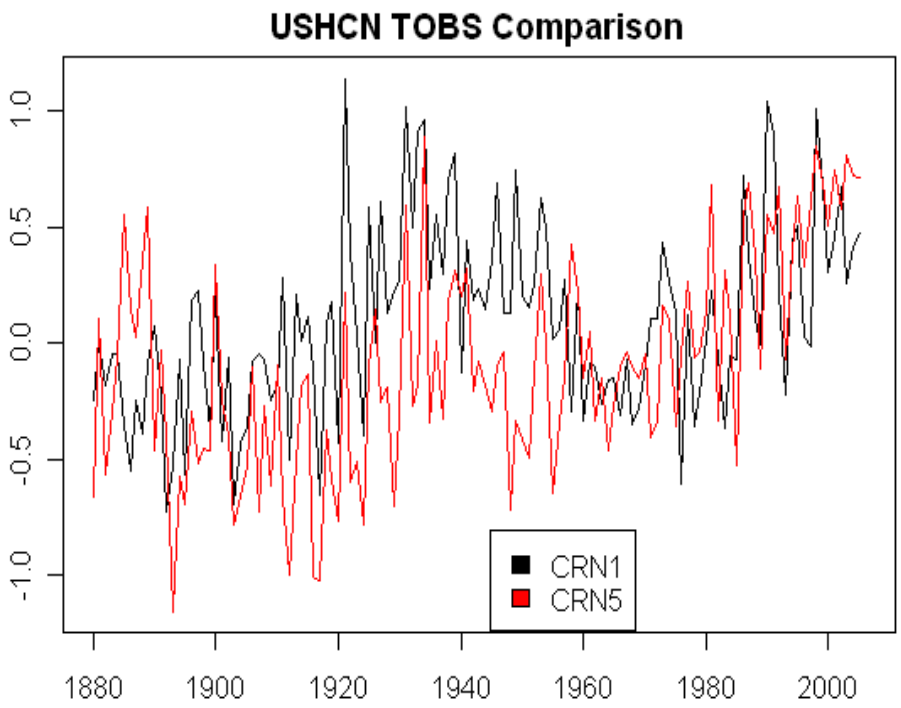


Even with siting and urbanization issues, not much warming

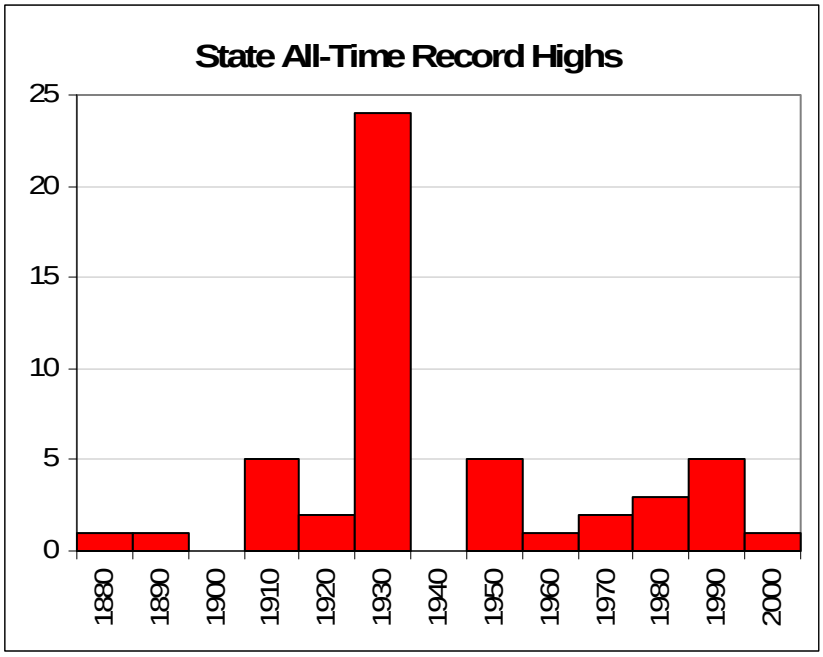
NASA unlike NOAA makes an attempt to adjust for urbanization. One could challenge the choice of 10,000 population as the threshold for urban given the finding by Oke (1973) and other that even a small town of just 1000 could have a significant 'urban' like warming of 2C. Nonetheless, the GISS version significantly lowers the US over the NOAA USHCN version 2 (0.75F) from 1930 to 2005.



In fact the trend for only the well sited stations rated CRN 1 show a lower second peak.



This is supported by the plot of All-time Record State Temperatures in which 38 of the 50 states set their new records in the decades prior to 1960.



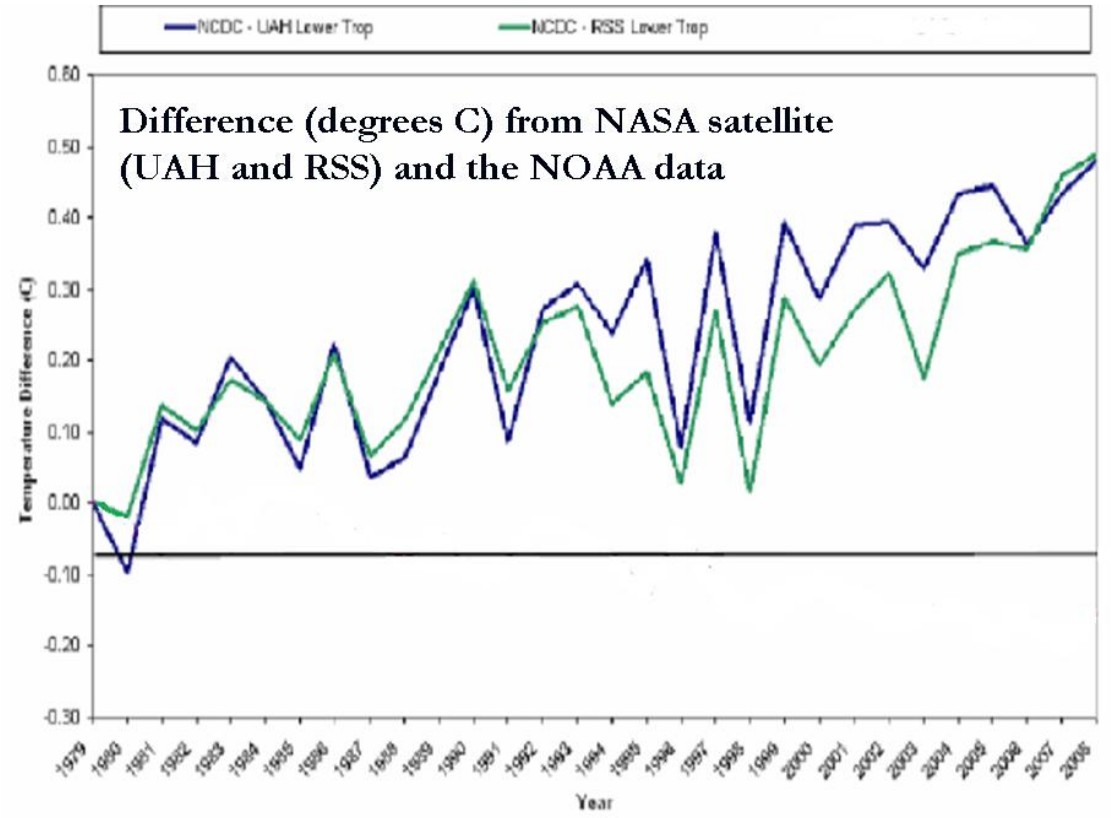
Numerous other papers have shown that contamination by urbanization and other local issues discussed may account for 30-50% of observed changes since 1900 (De Laat and Maurellis (2006), Kalney and Cai (2003), Pielke, Davey et al (2007), Pielke, Neilson (2007), Michaels and McKitrick (2007)). Instead the CCSP and IPCC chose to cherry pick the papers that supported the no urban adjustment methodology (Jones (1990),

Peterson (2003) and Parker (2004)) that have been shown flawed by later work including Pielke and Matsui (2006) and most recently Jones (2008) who has shown urban-related warming over China is shown to be about 0.1°C decade^{-1} over the period 1951–2004. This is consistent with Ren et al (2007) who in the abstract of their GRL paper noted that "annual and seasonal urbanization-induced warming for the two periods at Beijing and Wuhan stations is also generally significant, with the annual urban warming accounting for about 65-80% of the overall warming in 1961-2000 and about 40-61% of the overall warming in 1981-2000. Zhou (2004) also showed significant urban contamination in China data. China is not an outlier in this regard as we showed was the case even in the United States, considered a model for global observing systems.

The urban contamination and distribution based errors can be also seen by comparing NOAA station and ocean based temperature anomalies with satellite derived temperatures. NOAA proclaimed June of 2008 as the eighth warmest June for the globe in the 129 years of record keeping with an anomaly of +0.9F while the University of Alabama Hunstville Microwave Sensing Unit (MSU) based lower tropospheric anomaly was actually below the normal for its period of record (-0.19F anomaly), ranking it as the 9th coldest June in its 30 years of record. RSS, the other satellite sensing data monitoring source ranked it as the 13th coldest of the prior 30 years.

The discrepancies continue. NOAA proclaimed May 2009 to be the 4th warmest for the globe in 130 years of record keeping. Meanwhile NASA satellites showed it was the 15th coldest June in the 31 years of its record. Over the satellite record since 1979, the new

NOAA adjusted data shows a gradually increasing divergence with NOAA temperatures.



Satellite not only provides more complete global coverage including the oceans, but also integrates the localized urban warming with the surroundings. NOAA according to Tom Karl has limited funding of station upgrades and the extent of the Climate Reference Network because it said we had more reliable satellite coverage. Unfortunately NOAA does not use this prize resource in tracking change.

OCEAN TEMPERATURE MEASUREMENTS

The change of methodology from buckets to ship intake and satellite raise question as to the accuracy of the global ocean temperatures at least in time relative terms. Since 70% of the world is ocean, this is no small issue. Hadley admits their ocean data is seriously lacking with coverage limited to maritime ship routes. Their coverage of the southern hemisphere is especially lacking and the southern hemisphere is 80% ocean. The new ARGO buoy deployment of 3000 diving sensing buoys is a welcome addition and should improve this in the future but will not help with the past data.

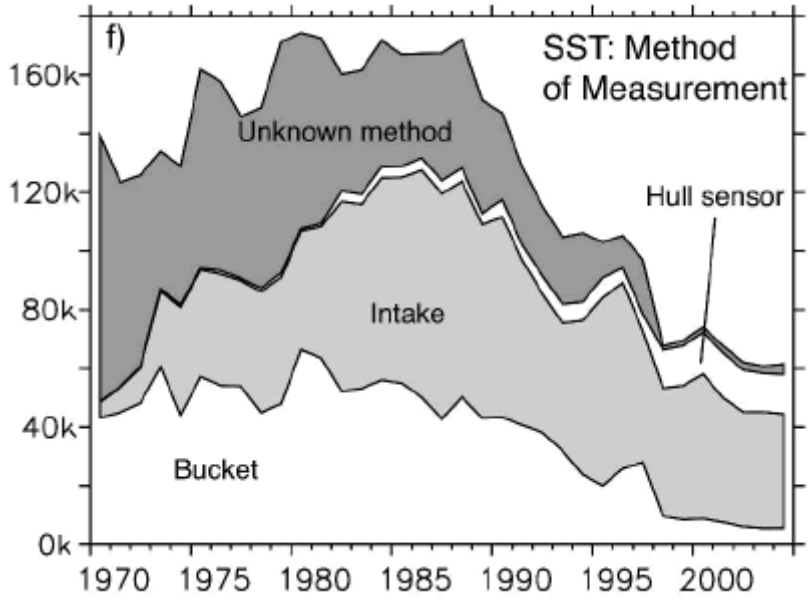
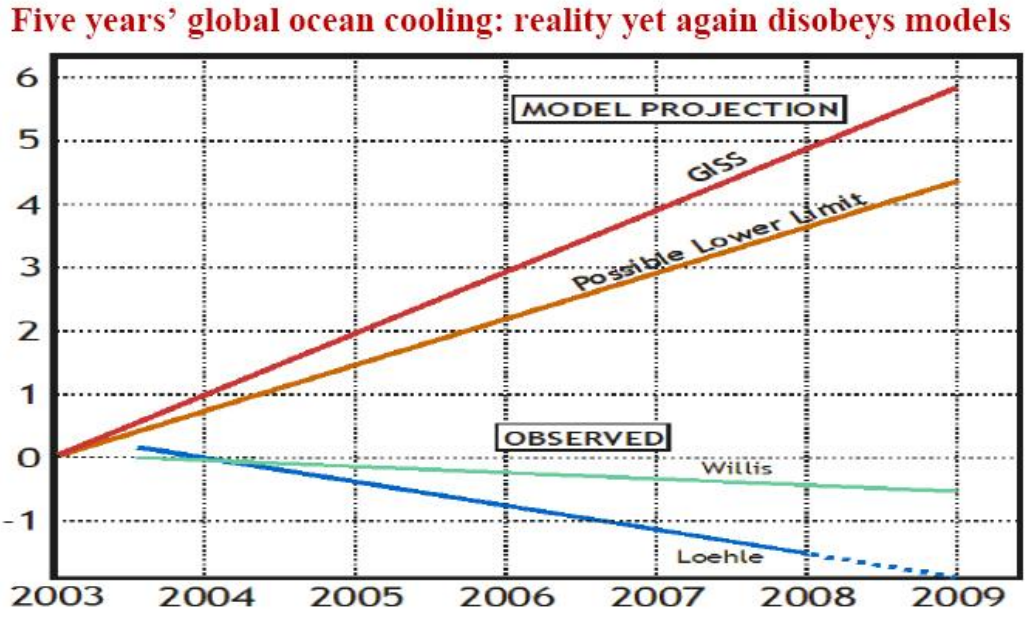


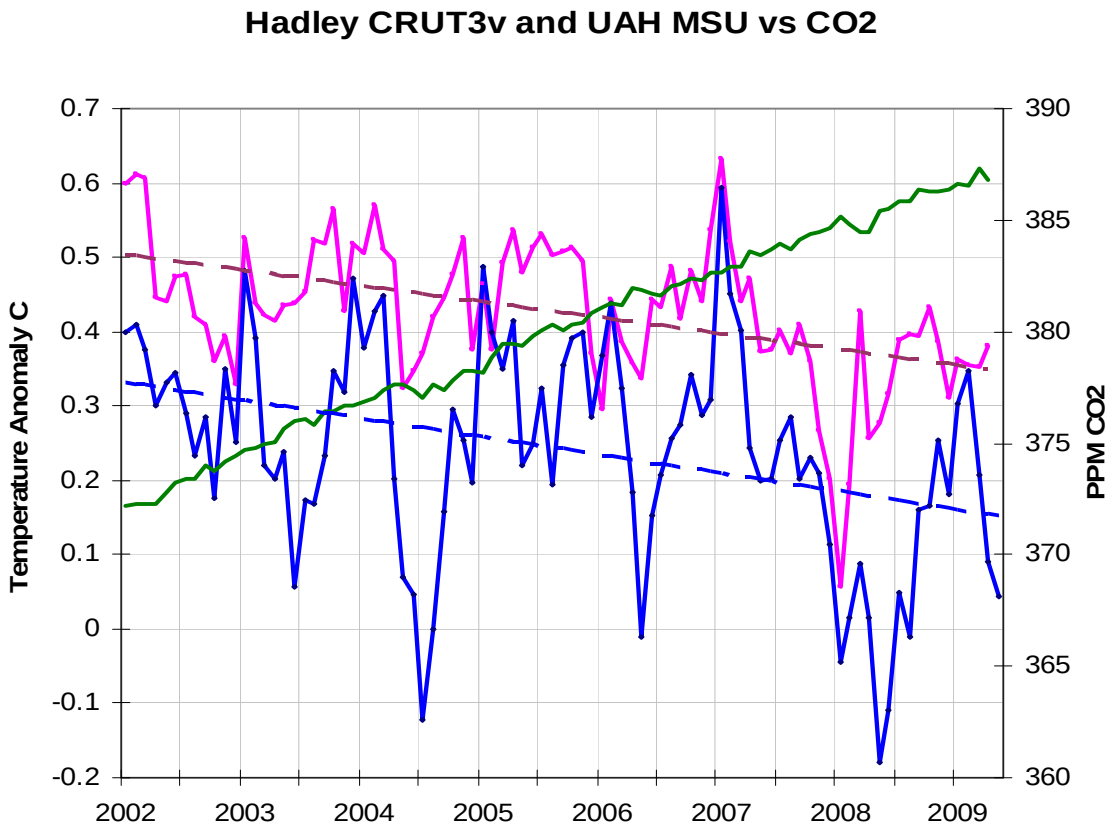
Chart from Kent (Kent, E. C., S. D. Woodruff, and D. I. Berry. 2007. Metadata from WMO Publication No. 47 and an Assessment of Voluntary Observing Ship Observation Heights in ICOADS. Journal of Atmospheric and Oceanic Technology 24, no. 2: 214-234.)

The deployed buoys and all the global data bases including satellite and land/sea surface have shown a trend down since 2002 (even as CO2 has increased 3.5%) clearly not depicted in the title page graph.

Willis (2008) and Loehle (2009) have shown ocean heat content dropping since 2003 when ARGO buoys first deployed.



TEMPERATURES HAVE BEEN COOLING FOR THE LAST 7.5 YEARS WITH NOT STATISTICALLY SIGNIFICANT WARMING IN 15 YEARS



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