Correct the Corrections: The GISS Urban Adjustment **June 2008**

NASA's Goddard Institute of Space Studies (GISS) publishes a global temperature index. The temperature record is contaminated by the effects of urban development and land use changes. NASA applies an "urbanization adjustment" to adjust the temperature histories to eliminate these effects. The resulting GISS temperature index is supposed to represent what the temperatures would have been in the absence of urbanization and land use changes. Most scientists assume that these adjustments are done correctly. The index is used to show that CO_2 emissions are causing climate change.

An audit by researcher Steve McIntyre reveals that NASA has made urban adjustments of temperature data in its GISS temperature record in the wrong direction. The temperatures in urban areas are generally warmer than in rural areas. McIntyre classified the 7364 weather stations in the GISS world-wide network into various categories depending on the direction of the urban adjustment. NASA has applied a "negative urban adjustment" to 45% of the urban station measurements (where adjustments are made), meaning that the adjustments makes the warming trends steeper. The table below shows the number of negative and positive adjustments made to the station temperature trends.

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

The urban adjustment is supposed to remove the effects of urbanization, but the NASA negative adjustments increases the urbanization effects. The result is that the surface temperature trend utilized by the International Panel on Climate Change (IPCC) is exaggerated.

The urban adjustment is done by comparing an urban station temperature trend with nearby rural station temperature trends. A trend means the average rate of change of temperature over a time interval. The GISS analysis first attempts to define the adjustment based on rural stations located within 500 km of the station. If these stations are insufficient to define a long-term trend then stations at greater distances up to 1000 km are employed. The average trend of the rural stations is calculated, and an adjustment is added to the urban station data so that the adjusted urban station trend equals the average rural station trend. If the rural station trend is greater than the urban trend, a "negative" adjustment is made to increase the urban trend. Note that the adjustments have nothing to do with the temperature differences between rural and urban stations, only their rate of change. A rural station may have a lower temperature than a nearby urban station, but have a greater trend with temperatures increasing faster. Further details of the urban adjustment procedure is given in a paper Hanson et al, 2001, here.[2]

This audit is discussed in Steve McIntyre's article "Positive and Negative Urban Adjustments", at the website http://www.climateaudit.org/.

The following table shows the complete results of the audit. Note that some stations have had both negative and positive adjustments during portions of their histories and are included in both the "Negative" and "Positive" totals, so these "Bipolar" adjustments are subtracted to determine the "Subtotal: Adjusted" station totals. Stations are categorized as U.S. and the rest of the world (ROW).

	U.S.	ROW	Total
Negative	740 (39%)	1108 (20%)	1848 (25%)
Positive	1003 (52%)	1233 (23%)	2236 (30%)
"Bipolar"	324 (17%)	335 (6%)	659 (9%)
Subtotal: Adjusted	1419 (74%)	2006 (37%)	3425 (47%)
No Adjustment	353 (18%)	2220 (41%)	2573 (35%)
Not Used	149 (8%)	1217 (22%)	1366 (19%)
Total	1921 (100%)	5443 (100%)	7364 (100%)

The audit shows that 74% of the USA stations are adjusted, but only 37% of the ROW stations are adjusted. There are almost as many negative adjustments as positive adjustments in the ROW stations. The contiguous USA land area is only about 7% of the world surface area, so the ROW stations have a much larger effect on the global temperature index.

The "Not Used" stations are those urban stations for which no adjusted version was calculated, generally because the record is too short.

The "No Adjustment" stations are those that are classified as rural. No adjustment is made for these stations.

GISS uses two different methods of categorizing stations as rural or urban.

Stations in the USA, southern Canada and northern Mexico are classified based on the amount of night time light measured by satellites from the station locations. Unlit stations are classified as rural stations.

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":

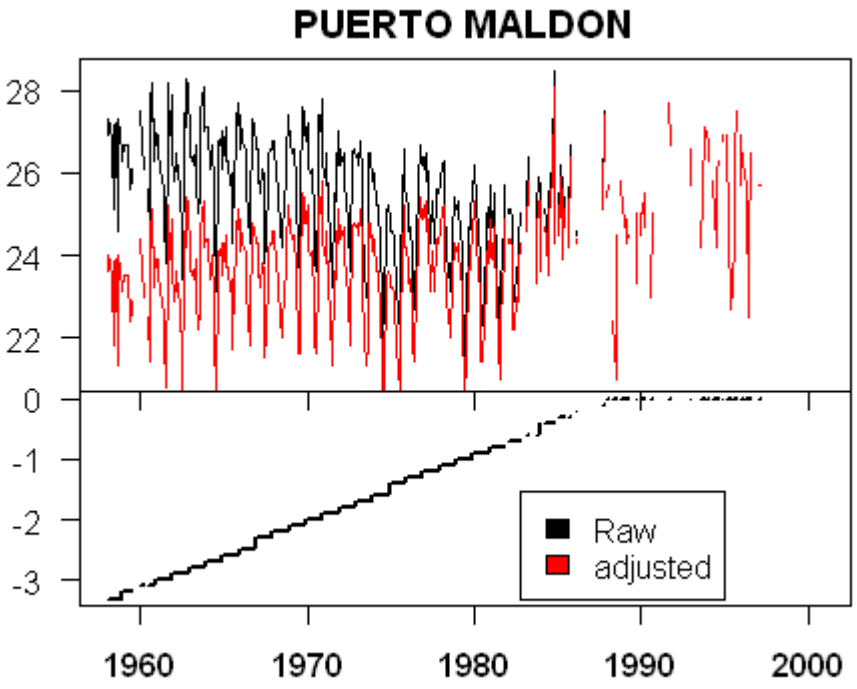
> "We use the definition of Peterson et al 1997 for these categories: that is, rural areas have a recent population of less than 10,000, small towns between 10,000 and 50,000 and urban areas more than 50,000. These populations refer to approximately 1980."[1]

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.”

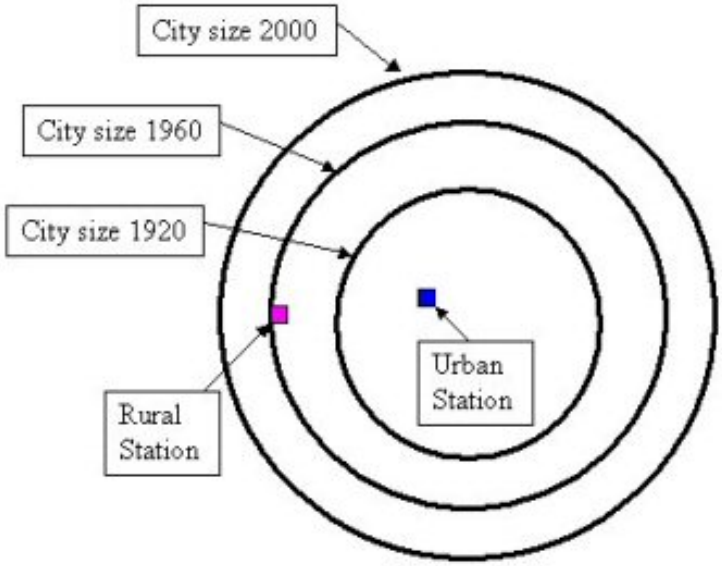
Here is an example of an urban negative adjustment from Peru:

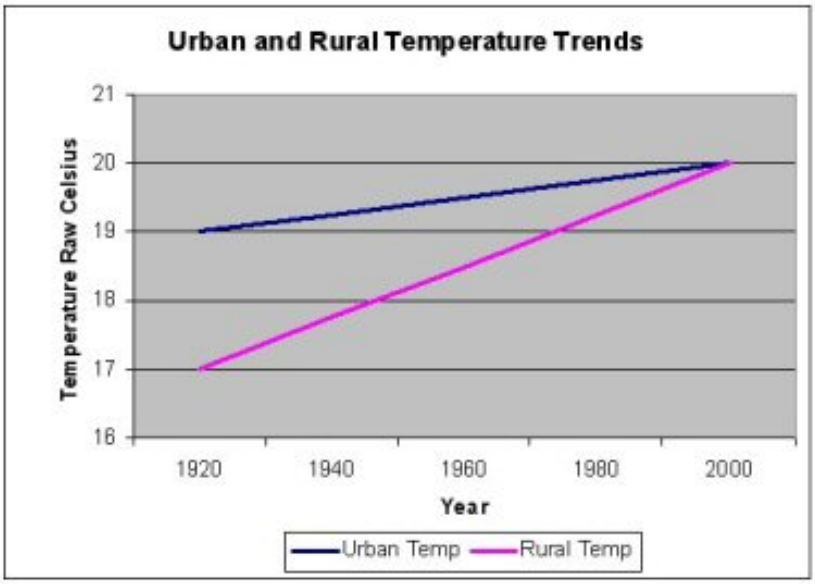


Note that the raw data shows no warming, but after applying the negative urban adjustment, the adjusted data shows a significant warming trend. The adjustments are applied to reduce the past temperatures by up to 3 degrees Celsius. This is a very large adjustment when compared to the total warming of the twentieth century of 0.6 Celsius estimated by the IPCC.

The data shows that the stations classified as rural are almost as likely to have as much a warming trend as urban stations. Why would almost half of the urban stations have lower warming trends than the nearby rural stations? It is very unlikely that heat sources near urban stations were gradually removed.

A population increase of 500 in a town of 2000 people would have a much larger effect on temperature measurements than the same increase in a city of 500,000 people. A city with a growing population generally increases its area. A temperature station inside the city would be little affected by the expansion of the suburbs. However, a temperature station located just outside a city would be greatly affected by the city expanding around the station. This effect is shown in the following diagram.



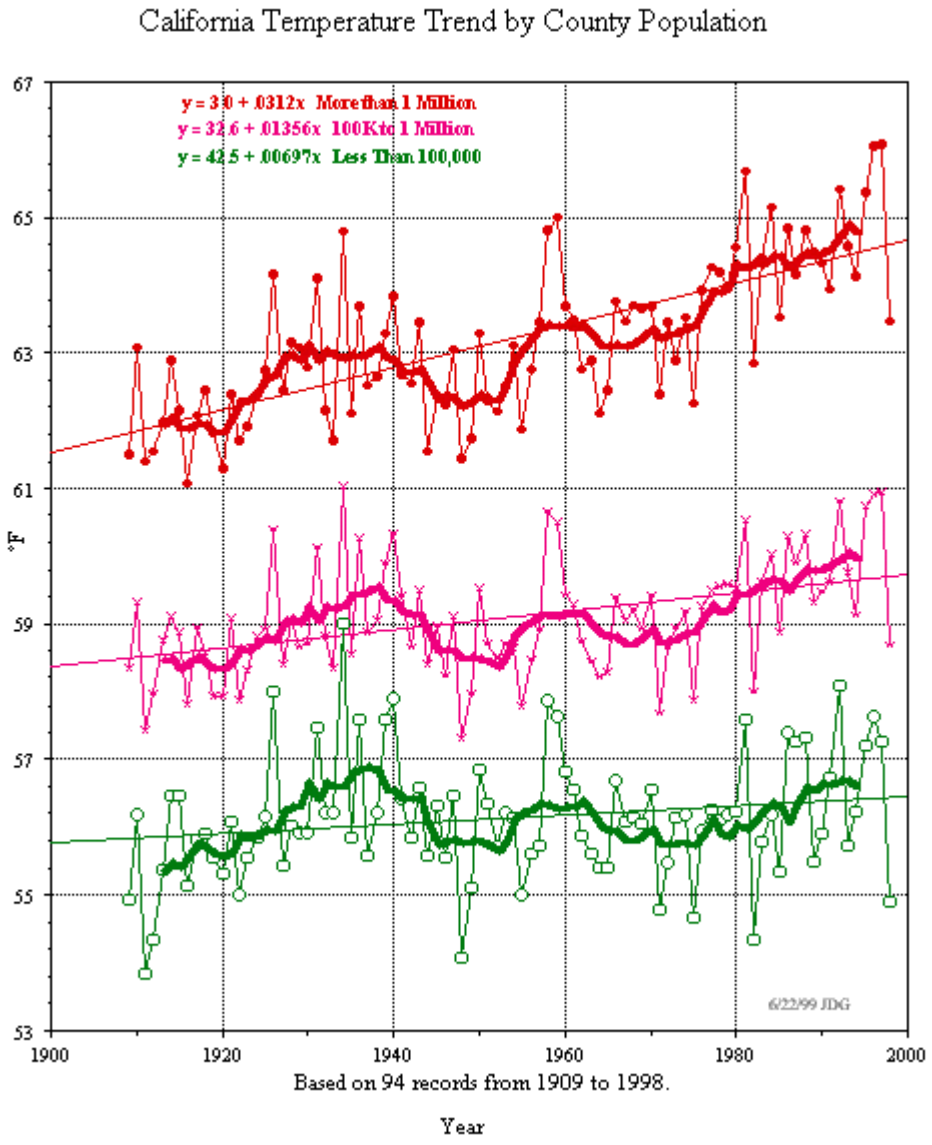


A hypothetical urban station is shown located in a city and a rural station is located outside the city in the year 1920. By 1960, the city has grown out to the rural station. The city growth has little affect on the urban station, but a much larger affect on the rural station. By 2000, the rural station is completely surrounded by the city, so it has the same temperature as the urban station. As indicated in the graph, the unadjusted rural temperature trend is much greater than the urban station trend. According to the GISS urban adjustment procedure, the urban station trend is increased to match the rural station trend by reducing the past temperatures.

A proper urban correction algorithm would reduce the warming trends of both stations to make an adjusted temperature record represent what would have happened if nobody lived near the stations.

There are two types of contamination of temperature data; changes due to urbanization and changes due to poor maintenance of stations and quality control. Many stations are situated in unsuitable locations, such as near parking lots and air conditioner exhausts.

Numerous studies indicate enhanced warming in urban areas. For example, here is a graph showing the temperature trends in Californian counties with various populations. Note that the trend with the high populations is 4.5 times greater than the trend with the low populations.



Ross McKitrick and Patrick Michaels published a paper in December 2007 that shows a strong correlation between urbanization indicators and the "urban adjusted" temperatures, indicating that the adjustments are inadequate. The conclusion is: Fully correcting the surface temperature data for "non-climatic effects reduce the estimated 1980-2002 global average temperature trend over land by about half."[3]

Dutch meteorologists, Jos de Laat and Ahilleas Maurellis, showed (2006) that climate models predict there should be no correlation between the spatial pattern of warming in climate data and the spatial pattern of industrial development. But they found this correlation exists, and is statistically significant. They also concluded it adds a large upward bias to the measured global warming trend.[4]

These studies convincingly show that the urban corrections fail to correct for the effects of urbanization, but do not indicate why the corrections fail.

The audit of GISS urban adjustments by Steve McIntyre shows why the corrections fail. Governments around the world intend to spend billions of dollars based on the belief that the temperature indexes are properly corrected for the effects of urbanization. The Canadian government plans to spend $2 billion to sequester just 0.7% of its CO_2 emissions.

The GISS urban correction algorithm needs to be changed to eliminate the urbanization temperature effects. Only then can the science of climate change be put back on the right track.

Satellite data is free of urbanization effects and provide truly global coverage continually. Previous problems with satellite drift affecting temperature calculations have been corrected. Newer satellites have station keeping capability and do not drift. The satellite data is much superior to land measurement. The satellite global temperature trend from 2002 to May 2008 is a decline of 0.25 Celsius per decade, significant global cooling for over 6 years.

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References:

1. “GISS analysis of surface temperature change”, by J. Hansen et al, 1999, Journal of Geophysical Research, Volume 104.
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3. “Quantifying the influence of anthropogenic surface processes and inhomogeneities on gridded global climate data”, by R. McKitrick and P. Michaels, December 2007, Journal of Geophysical Research, Volume 112. http://www.uoguelph.ca/%7Ermckitri/research/jgr07/M&M.JGRDec07.pdf
4. “Further evidence for influence of surface processes on lower tropospheric and surface temperature trends”, by Laat de, A.T.J., Maurellis, A.N., International J. of Climatology, 26, p. 897-913, 2006. http://www.knmi.nl/~laatdej/2006joc1292.pdf

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