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Satellite Data Supports Global Warming Trend

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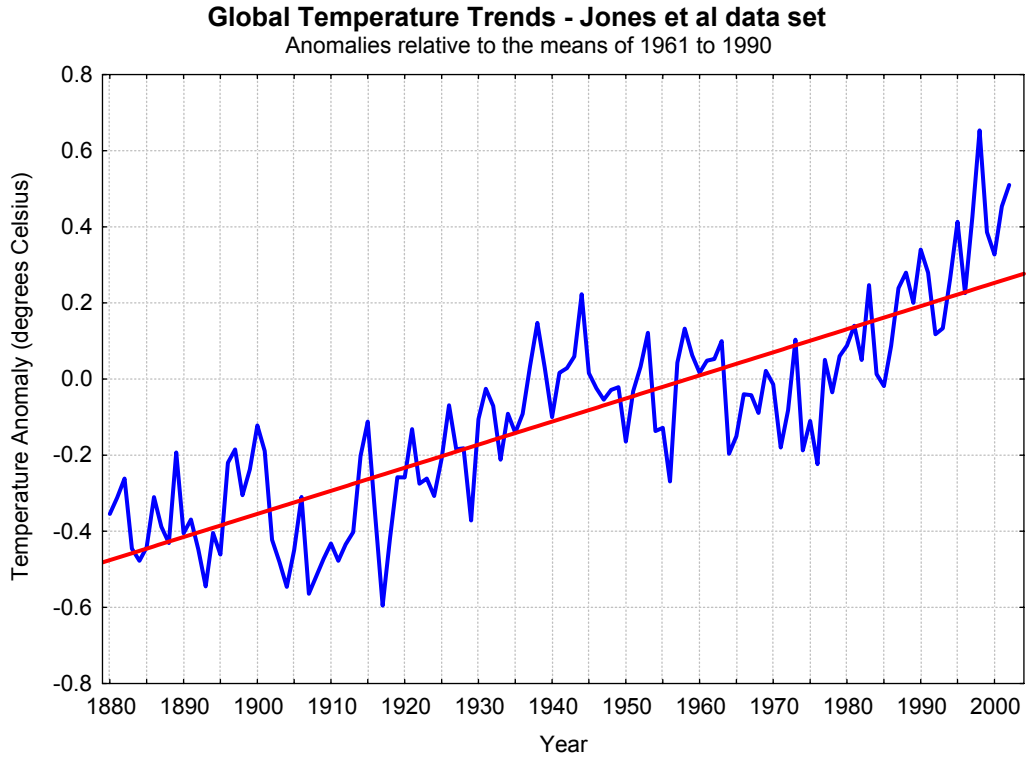
One of the quandaries in the analysis of air temperature trends has been the failure of satellite temperature readings to show any upward trend. Both terrestrial and balloon readings show a statistically significant upward trend. With the release of 2002 data for the satellite readings, it is now highly likely that the satellite time series also shows a warming trend. This removes the main plank in the case of those who have depended on satellite data to contend that global warming is not happening.

There is a highly statistically significant upward trend in the terrestrial global temperature data[1] (Chart 1).

Chart 1



Over the entire period, there is a statistically significant upward trend of 0.6 degrees Celsius per century. For the period from 1975, the upward trend is a statistically significant 2.0 degrees per century.

There was a period of cooling between the mid-1940's and the mid-1970's. The more rapid rate of increase since the mid-1970's has been observed in Australia, USA and elsewhere and is probably due to reduced concentrations of sulfur dioxide in the atmosphere[2].

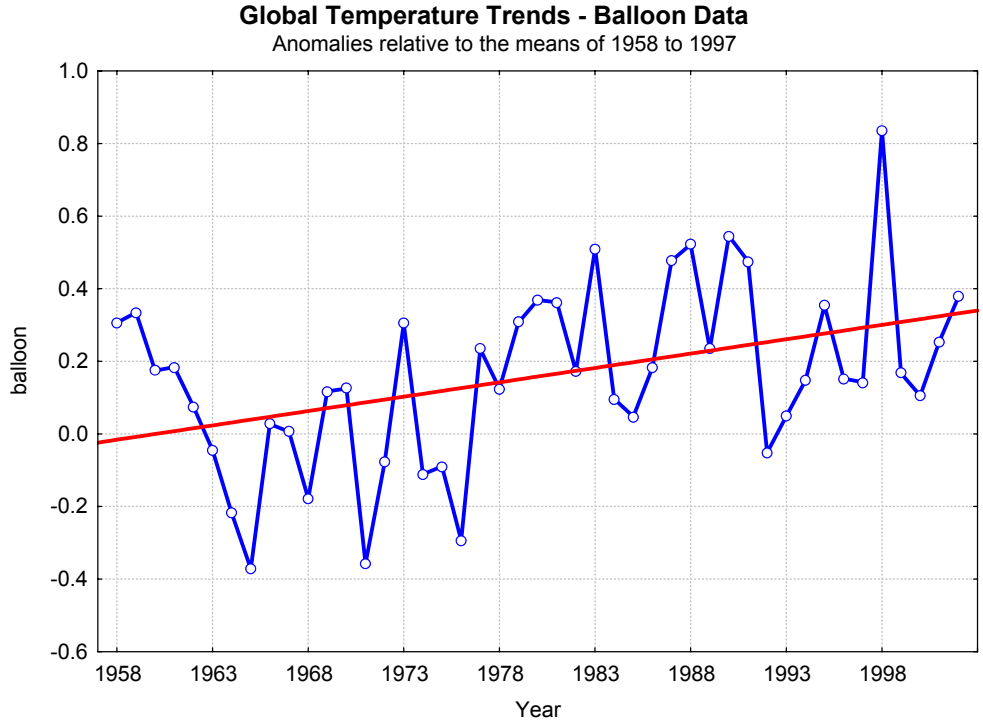
Sulfur dioxide is emitted by coal-burning power stations. The direct impact of sulfur dioxide particles in the atmosphere is a cooling effect. Short wave solar radiation is scattered back to space leading to a cooling tendency which is larger than the warming effect due to absorption of long wave reflected radiation by soot particles. Action to reduce sulfur dioxide emissions was initiated in the 1970's, in order to reduce the health impact of this pollution and to reduce acid rain. In the USA, the EPA reports a 39% reduction between 1980 and 2000, while in Britain a reduction of 76% has been achieved between 1980 and 2000.

The impact of increasing sulfur dioxide pollution until the 1970's was a net cooling and since then the decline in pollution has tended to warm the atmosphere. This has masked the impact of global warming caused by carbon dioxide, making it difficult to make reliable predictions about future warming.

There are many influences on temperature, including sulfur dioxide, methane and carbon dioxide emissions, El Nino and other ocean cycles, the sun's output and the sunspot cycle, variations in the earth's orbit and albedo (reflectivity) amongst possibly others.

The Upper-Air Radiosonde (Balloon) temperature data set[3] provides a measure of temperature over a vertical area of the lower troposphere (roughly 5000 - 30,000 feet). This time series, which started in 1958, shows a statistically significant upward trend of 0.8 degrees Celsius per century (Chart 2). For the period 1965 to 2001, the trend is 1.2 degrees per century.

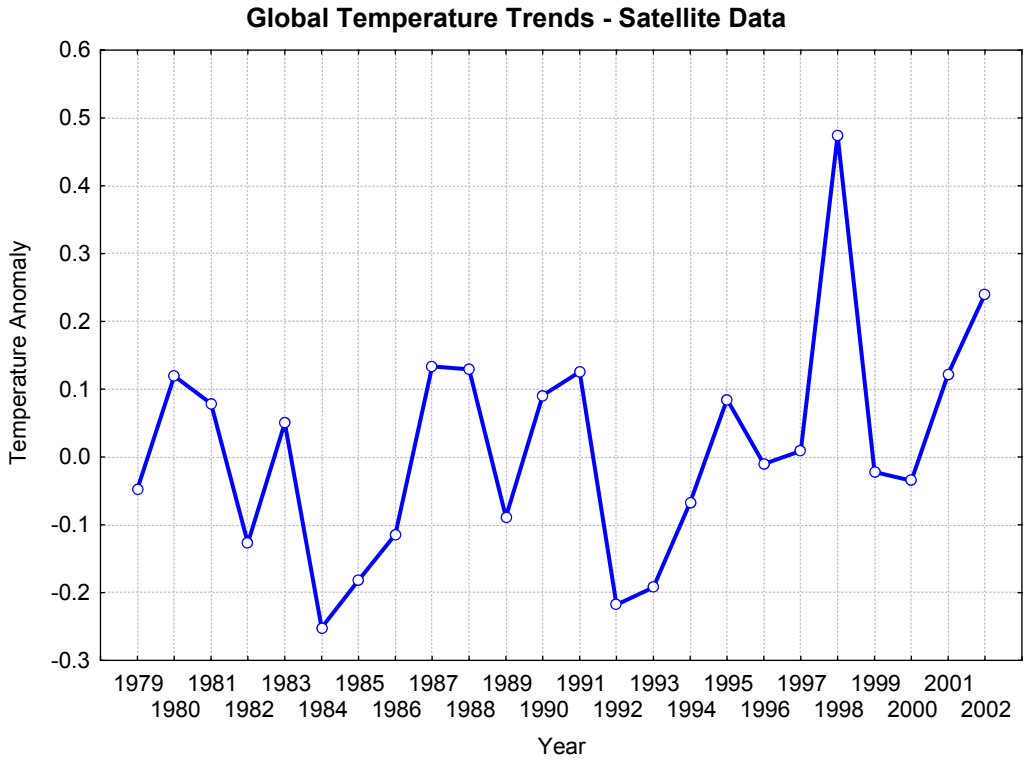
Chart 2



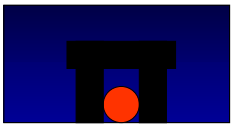
The MSU Satellite data set is a product of the NASA and the University of Alabama in Huntsville[4]. The MSU data set represent the temperatures of a layer of the atmosphere that extends from the surface to approximately 8 kilometers (5 miles) above the surface. The data are obtained from microwave sounding units (MSUs) on the National Oceanic and Atmospheric Administration's TIROS-N satellites, which relate the intensity or brightness of microwaves emitted by oxygen molecules in the atmosphere to temperature.

The satellite data set shows no significant upward trend over the period that data is available, from 1979 to 2002 (Chart 3) and especially over the period from 1979 to 1997. Despite this source of data having the shortest time series of the three sets of temperature data, the lack of an upward trend has led to some analysts doubting the accuracy of other two. However, it is highly likely that the satellite data now supports the conclusion that global temperatures are rising. It almost certainly does **not** support the case that there is **no** global warming.

Chart 3



The warmest year, 1998, occurred in the second half of the period while the coolest year, 1984, occurred in the first half of the period. If there was no global warming over the period measured, the probability of this outcome is 0.25 (there are four possible, equally likely, outcomes if these events occur randomly: both in the first half, both in the second half, warmest in the first half and coolest in the second half, coolest in the first half and warmest in the second half).



If we take this approach further, we can note that there were six years in which the temperature anomaly was 0.18 degrees or more (1984, 1985, 1992, 1993, 1998, 2002). If there was no global warming over the period measured, the probability that all four coolest extremes precede the two warmest extremes is one in fifteen (there are 15 possible arrangements), or 0.067. Thus, we can be highly confident that the satellite data does support the warming trend indicated by the longer terrestrial and balloon data.

Is it possible to explain the apparent absence of warming until 1998? There are some possible explanations. One is that the cooling observed in the terrestrial record from the mid-1940's to the mid-1970's extended for a longer period in the atmosphere above ground level. Perhaps more likely, based on the sulfur dioxide emissions, is that the atmosphere above a kilometer or so was already warmer than it would otherwise have been when satellite measurements began.

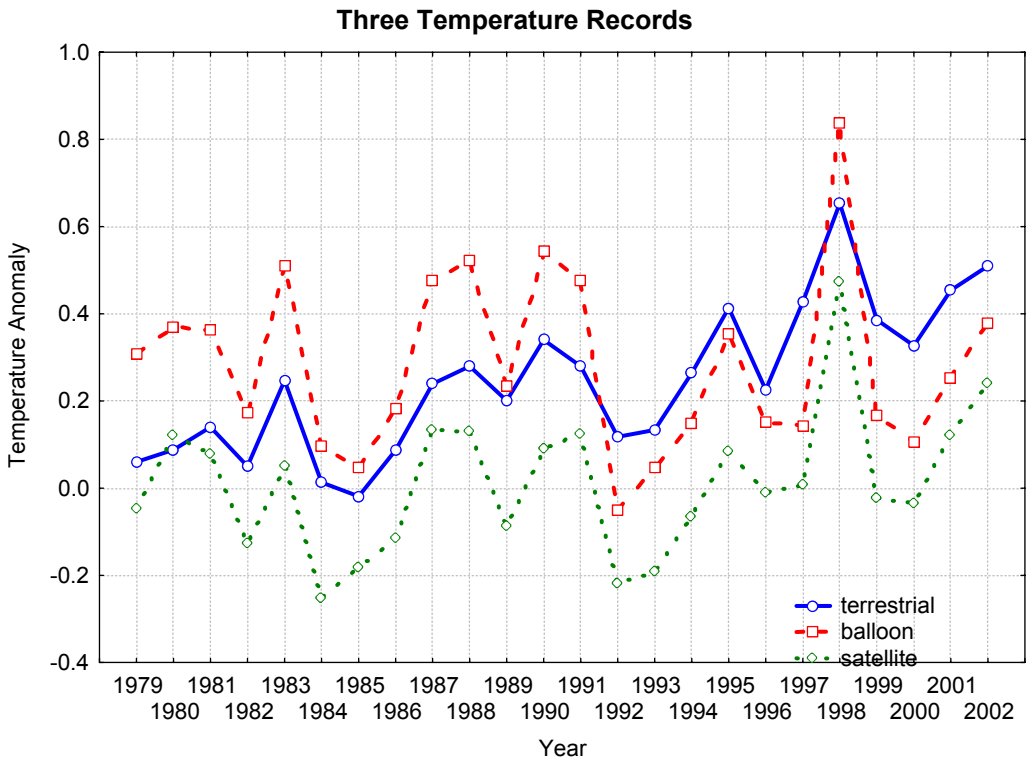
Given that sulfur dioxide emitted from power stations scatters short wave radiation back into space, such radiation would warm the atmosphere above the sulfur dioxide level twice – once on the way in and once on the way back. As the sulfur dioxide concentrations fell (after the mid-1970's, just as the satellite measurements commenced) this "double" warming effect waned. This possible explanation will be investigated further in future research.

The three temperature records for the period 1979 to 2002 are shown together in Chart 4. There is a high correlation between them. The correlation coefficients, all statistically significant, are:

- terrestrial and balloon: 0.53;
- terrestrial and satellite: 0.77;
- balloon and satellite: 0.88.

The close correlation between these temperature records provides confidence that they are all measuring the temperature with accuracy. Annual variations of all three records are synchronized. Slight variations between the three do occur and this is to be expected given the complexity of the atmosphere over the horizontal and vertical ranges measured.

Chart 4



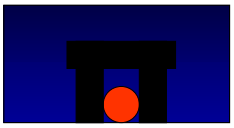
In conclusion, we are highly confident that the three temperature records are telling the same story – that the atmosphere is warming at a rate of at least 0.6 degrees Celsius per century and perhaps as high as 2.0 degrees per century. The satellite data set is the shortest and accordingly it would be expected to show the least significant trend. Our statistical analysis indicates that it too is now most likely showing a warming pattern. In addition, we have advanced a possible physical explanation for the trend discrepancy in the early period of the satellite data.

It is time to move on from harbouring doubts about whether global warming is happening. The issues that must be addressed urgently are how quickly temperatures will rise in the future; how we can mitigate the rising temperatures; and how we can adapt in the meantime.

For analysis of temperature records in USA and Australia, see our articles at www.healingforests.com/globalwarming.htm. These analyses of data for individual locations yields broadly similar results to the above analysis of global data.

References

1. Jones, P. D., Parker, D. E., Osborn, T. J. and Briffa, K. R. 1999. Global and hemispheric temperature anomalies – land and marine instrument records. In *Trends: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Ok Ridge, TN, USA.



2. See a 1999 Environmental News Network report on research conducted by Michael Schlesinger, a professor of atmospheric sciences at the University of Illinois, Urbana-Champaign.

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4. Christy, J.R., Spencer, R.W., and Braswell. 2000. MSU Tropospheric Temperatures: Dataset Construction and Radiosonde Comparisons. *Journal of Atmospheric and Oceanic Research* **17**: 1153-1170.