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The search for an explanation of the apparent lack of dramatic and damaging global warming

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Introduction

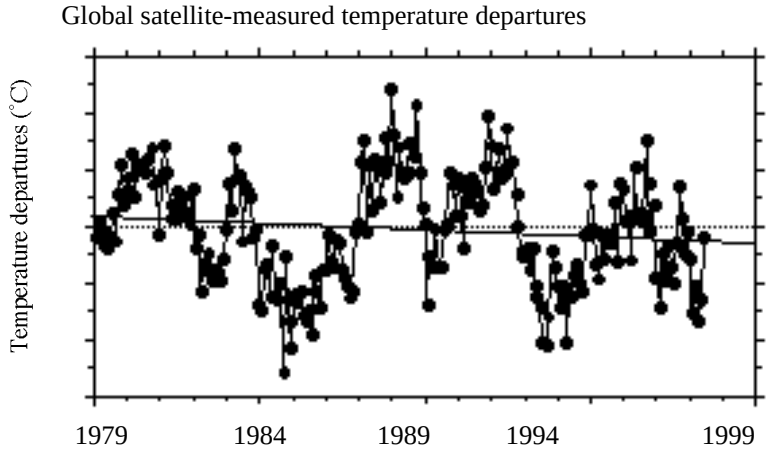
Any argument for an expensive and potentially disruptive policy to reduce greenhouse gas emissions based upon forecasts of global warming requires strong scientific backing. This is particularly true when attempting to legislate global warming policy in major energy-exporting nations such as Australia, and large per-capita energy consuming countries such as New Zealand and the United States.

Figure 1 leaves little doubt that the science is sorely lacking. It is the satellite-sensed global temperature history that begins in 1979. While it is not a measure of ground temperatures, it very faithfully reproduces global mean temperatures measured between 5000 and 30000 feet by weather balloons. This history shows a statistically significant net *cooling* when averaged over the 18.5 year period of record. As noted in the July 19, 1997 issue of *New Scientist,* 'This is not what is predicted by the computerised climate models on which all estimates of global warming depend' (Pearce 1997).

Yet, on June 27, 1997, President William Clinton told the United Nations: 'The science is clear and compelling: we humans are changing the global climate.'

How can these facts coexist? Is there, as the United Nations stated in 1995, 'a discern[i]ble human influence on global climate,' even thought the satellite shows no warming? It is my thesis that all of the above are correct. The problem is that the human influence has been so small as to compel a reduction in the forecasts of future warming. And, further, the type of climate change that has been observed is hardly alarming.

Figure 1: **'The science is clear and compelling: we humans are changing the global climate' – US President Clinton, 26 June 1997**



Background

In 1990, the First Scientific Assessment of the United Nations Intergovernmental Panel on Climate Change (IPCC) stated that 'when the latest atmospheric models are run with the present atmospheric concentrations of greenhouse gases, their simulation of climate is generally realistic on large scales.'

Five years later, the succeeding IPCC assessment stated that, 'when increases in greenhouse gases only are taken into account … most [GCMs] produce a greater mean warming than has been observed to date, *unless a lower climate sensitivity is used* (italics added) … There is growing evidence that increases in sulfate aerosols are partially counteracting the [warming] due to increases in greenhouse gases.'

Thus the new consensus might be paraphrased as follows: 'either it is not going to warm up as much as earlier indicated, or something, like sulfate aerosols, is hiding the warming.'

The sulfate hypothesis is under increasing scientific challenge. Hansen et al. (1995) reported that the direct radiative effect of sulfates was too small to account for the lack of observed warming. Further, the magnitude of the indirect (cloud enhancement) cooling effect is highly speculative, as Hansen et al. (1997) argued that a 'semi direct' heating of the lower atmosphere by aerosol absorption may minimise the indirect cloud effect. Most recently, Hobbs (1997a) reported that air samples from the eastern US showed a predominance of soot (carbon) that should have created a net warming.

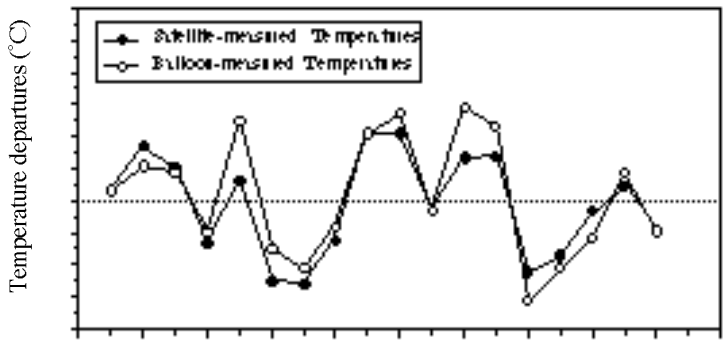
Here we argue that the multiplicity and internal inconsistency of the attempts to explain the lack of planetary warming leads inexorably to the default argument: the planetary surface temperature is simply not as responsive to small changes in the natural greenhouse effect as it was once thought (modelled) to be.

Observed climate change

Historical records of surface and free atmosphere temperature are well documented. The IPCC surface history has a warming of approximately 0.6°C in the last 100 years, but at least half of that warming was prior to major changes in the greenhouse effect, or pre-1940. Everything else being equal, that leads to a maximum contribution of the enhanced greenhouse effect of 0.3°C. Based upon this, interpolation of upwelling-diffusion equilibrium models of Wigley and Raper (1987), as given in the first IPCC compilation, *would yield an equilibrium warming of 0.8°C for doubled carbon dioxide.*

As noted above, weather balloon temperature anomalies in the 5000–30 000 foot layer and satellite readings show a remarkable annual correspondence since the two records became concurrent in 1979 (figure 2). Through 1996, both showed no warming trend

Figure 2: **Temperatures measured by the MSU (closed circles) match up nearly perfectly with temperatures by weather balloons in the 850–300mb layer (open circles)**

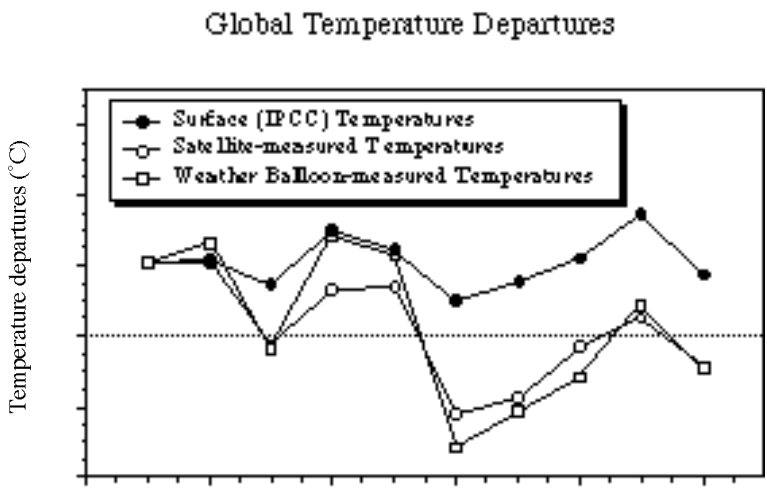


whatsoever. None of the three temperature histories (and they are the only three that exist), surface, satellite, or radiosondes in the analogous level to the satellite, show any net warming in the last decade (figure 3).

While there has been no overall warming in these records, regional patterns of warming are present. The pattern is particularly amplified when seasonal differences are examined. The difference in temperature trends (winter minus summer) in the MSU data shows that the warming has been predominantly occurring in the coldest anticyclones — over Siberia in the wintertime. The IPCC data, which has sufficient coverage since the mid-1940s over most of the northern hemisphere, shows a similar pattern of relative (winter minus summer) warming over a large part of northern Eurasia and northwestern North America, which are the source regions for the coldest anticyclones.

Greenhouse theory is consistent with this observation, inasmuch as the water vapor–carbon dioxide overlap is a considerable portion of the carbon dioxide absorption

Figure 3: **Surface, satellite-measured, and wather balloon records (5000–30 000 ft) all show no warming in the last decade**



spectrum, and these airmasses are virtually devoid of water vapor. Small changes in the absorption in these wavelengths have a logarithmically decreasing effect on temperature as the carbon dioxide concentration increases.

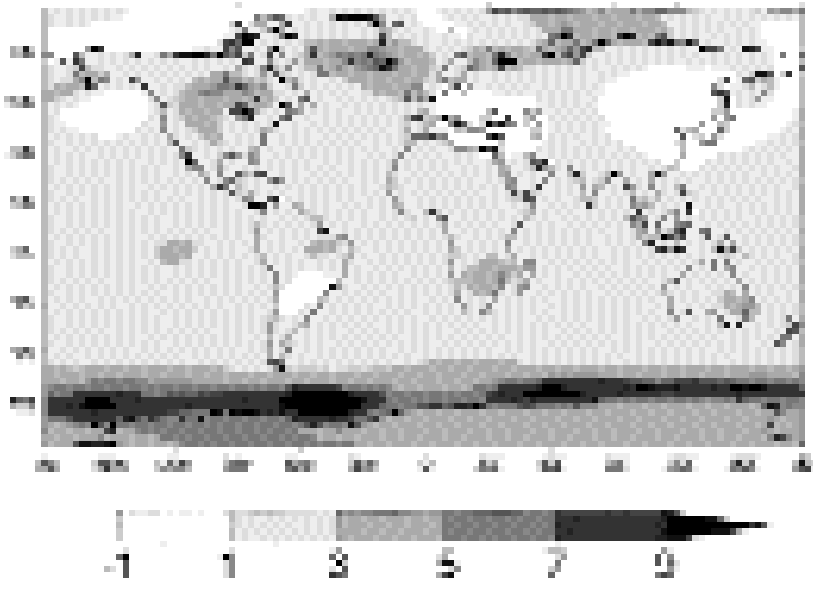
Attempts to explain the small observed warming

Mitchell et al. (1995) argued that, without sulfate aerosols, modelling results indicate that the planetary mean temperature should have risen between 1.3°C and 2.3°C as a result of the greenhouse enhancement. The observed surface rise of 0.6°C in the last 100 years, and the lack of any warming in the MSU, rather blatantly demonstrate the disconnection between observations and forecasts.

The sulfate explanation has been prominently championed by Wigley (1989), Hansen and Lacis (1990), Taylor and Penner (1994) and most recently by Santer et al. (1996). The Taylor and Penner (1994) model used a positive greenhouse forcing of 1.26 watts/m^2, while the generally accepted value is approximately 2.45. Further, the negative forcing from sulfate aerosol, of –0.9 watts, is much lower than most other estimates. The combined net forcing (greenhouse + sulfate) is only 0.3 watts, far beneath any estimate extant at the time of publication. Since then, the further reduced estimates of sulfate cooling, as noted above, made this model even more unrealistic.

Even allowing for this large sulfate cooling, using a linear estimation of the temperature change combined with a forcing of 2.45 watts/m^2 yields an equilibrium warming solution that is clearly unrealistic (figure 4), especially over the Southern Ocean.

Figure 4: **Equilibrium temperature change estimated from the Taylor and Penner greenhouse + sulfate model when the accepted greenhouse forcing of 2.45 watts/m^2 is used**



Santer et al. (1996) was especially controversial (Michaels and Knappenberger 1996). However, this study is often cited as the definitive evidence for the sulfate + greenhouse hypothesis. The controversy grew because the portion of the troposphere that showed the most dramatic warming during the study period (1963–87) was found to show no change whatsoever when the entire (1958–95) radiosonde record was used (figure 5).

It is instructive to use recent, lower estimates of sulfate cooling. Hobbs et al. (1997) implies a global effect of approximately –0.25 w/m^2, resulting in a net greenhouse–sulfate forcing of approximately 2.2 w/m^2. Assuming again that one-half of the observed warming (0.3°C) is from greenhouse changes, either the sensitivity to greenhouse changes is much lower than current estimates of 1°C/watt/m^2, or the thermal lag of the ocean is enormously long.

However, Schlesinger and others have argued that e-folding times for ocean heating are on the order of 40 to 60 years. The relatively small observed warming that can be ascribed to greenhouse changes would then yield a lower sensitivity (assuming a 1950 net forcing of 40 per cent of the total net; 0.4 * 2.2 = 0.9w/m^2). At 1°C/watt/m^2 sensitivity, this implies a warming of about 0.8°C plus a nearly equal increment for the increase since 1950, or a total of roughly 1.6°C. *The implication is that, unless sulfate aerosols are exerting a much greater effect than is now thought, the sensitivity is about 25 per cent of the previously accepted value.* This would reduce warming projections for doubled carbon dioxide from a mean equilibrium value of nearly 4°C down to 1°C, assuming a continuation of small sulfate cooling.

Interestingly, this rather simple calculation is not appreciably different from two recent general circulation model results. Mitchell and Johns (1997) and the National Center for Atmospheric Research (as described by Kerr 1997) have two new models that, when adjusted for the median emission scenarios from IPCC (1995), produce, respectively, 1.7°C and 1.3°C of warming to the year 2100.

Unfortunately, neither of these results were published with realistic changes in the anthropogenerated greenhouse effect (we let the readers speculate as to why this might have occurred). Mitchell and Johns (1997) uses 859 ppm effective carbon dioxide by the year 2050, and NCAR increases the forcing at 1 per cent per year. IPCC gives the most likely 2050 value at approximately 604 ppm, and it is well known that the increase in combined forcing from all greenhouse gases is not in excess of 0.7 per cent per year (and probably somewhat less).

Figures 6 and 7 give the results as published and adjusted for the more realistic greenhouse changes. It is noteworthy that the NCAR result is achieved without sulfate cooling. Clearly the implied sensitivity is much less than 1°C/watt/m^2. Assuming the 50 year ocean lag and mid 21st Century enhanced forcing of 4.5 watts/m^2 again implies a sensitivity of approximately 25 per cent of the previously accepted value.

Figure 5: **Observed warming in Santer et al. (1996) from 1963 to 1987 (top). The highlighted region in the Southern Hemisphere shows the strong observed warming. The entire temperature history over the same region from 1957 to 1995 shows no significant warming trend (bottom). However, the period that was chosen for study by Santer et al. (filled circles) warms dramatically.**

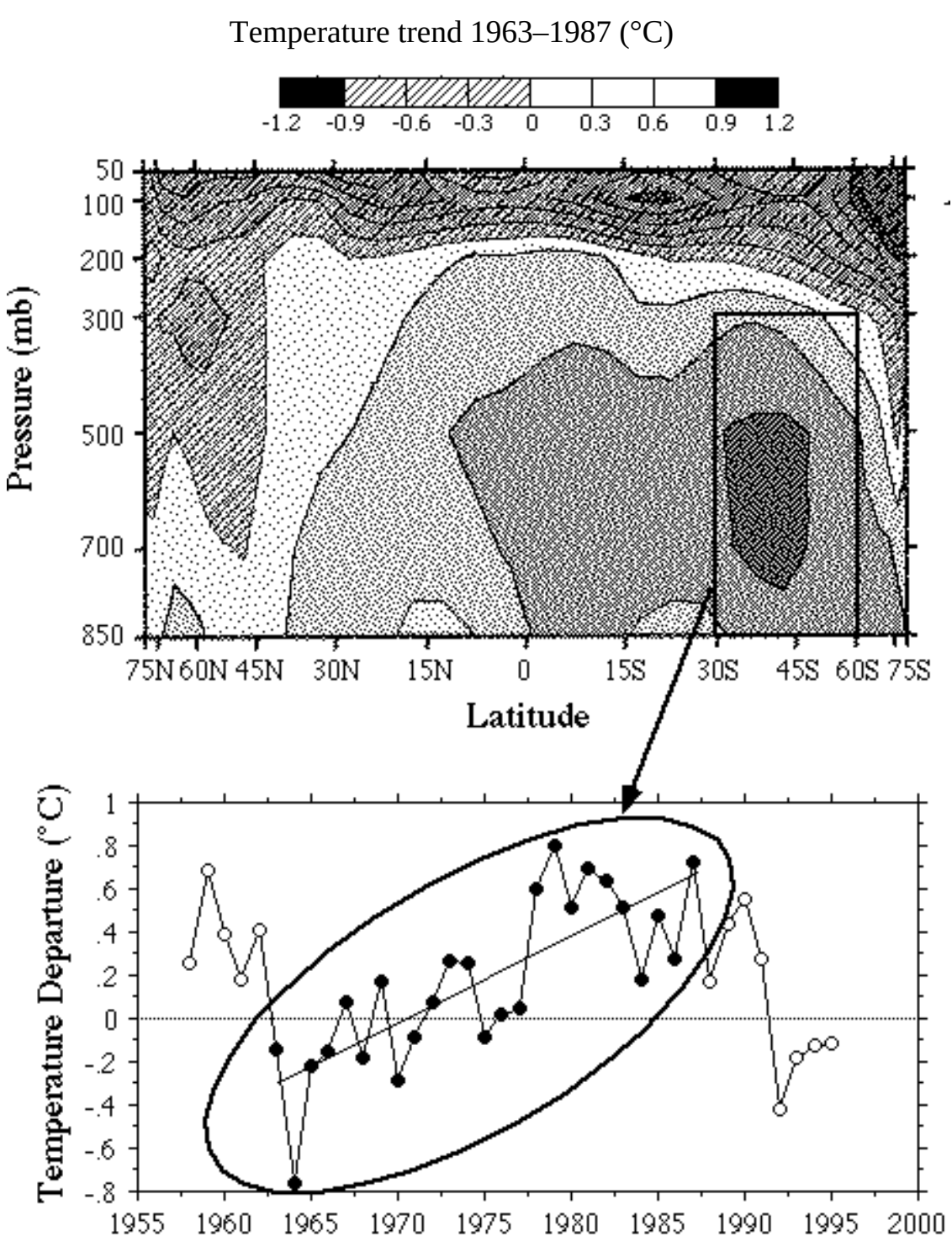


Figure 6: **Temperatures predicted by the UKMO model (Mitchell and Johns 1997). The dashed line uses an unrealistic CO_2 concentration of 859 ppm by 2050. The solid line estimates the warming if the most likely concentration, as given by IPCC (1995), is used**

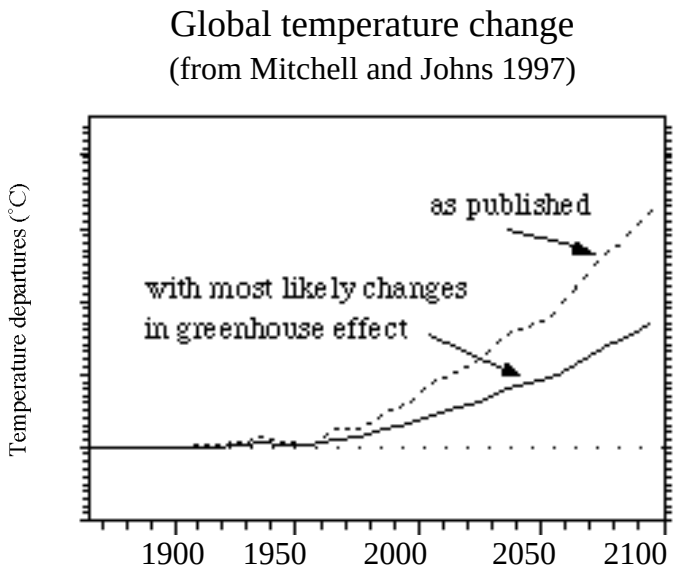
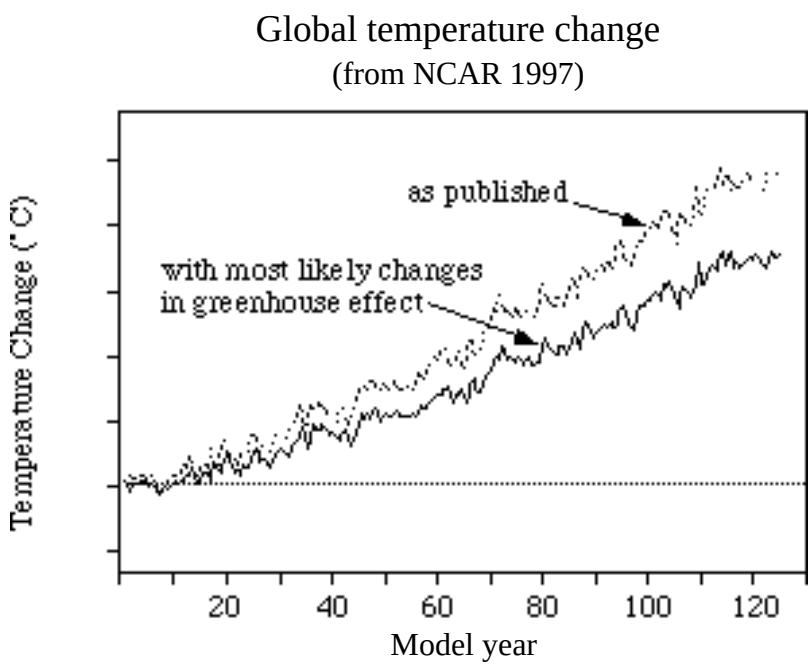


Figure 7: **Temperatures predicted by the new NCAR model. The dashed line increases effective CO_2 by 1 per cent per year, but a more realistic increase is 0.7 per cent per year. The solid line estimates the temperatures using the more realistic value. The nominal starting time is around 1965**



The solar explanation

Friis-Christensen and Lassen (1991), and more recently, Lean et al. (1995) have found some rather striking correlations between the 20th century northern hemisphere temperature history and solar activity. Lean et al. (1995) estimate that approximately one-half of the warming of the last 130 years was a result of solar forcing. In particular, much of the warming of the early 20th century, which was prior to the greenhouse enhancement, appears to be a product of solar forcing.

The solar argument again favors the concept of reduced sensitivity to anthropogenerated greenhouse gases. It leaves the same 0.3°C of warming in the last 100 years as a residual, possibly explained by greenhouse changes. This gives the same low implied and reduced estimates of overall warming that are consistent with the lowest forecasts now being generated by general circulation models with realistic greenhouse changes.

Conclusion

Remember IPCC's statement in their recent volume as noted above: 'when increases in greenhouse gases only are taken into account … most [GCMs] produce a greater mean warming than has been observed to date, unless a lower climate sensitivity is used … There is growing evidence that increases in sulfate aerosols are partially counteracting the [warming] due to increases in greenhouse gases.'

It is highly likely that most attempts will be made to explain the lack of warming with some compensating emission like sulfate aerosol. In fact, it is also likely that there will be considerable resistance to the alternative explanation — that the sensitivity was simply overestimated. Nonetheless, the balance of evidence suggests there is, at best, a very small human influence on global climate. President Clinton was correct when stated that humans change the climate. But the fact that the changes are very small, primarily in the coldest air, and likely to remain small spells the end of the greenhouse scare — at least in a world controlled by reason.

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