Are Human Activities Causing Global Warming?

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I. INTRODUCTION

Continuing controversy over the extent of human influence on climate change suggests that a review of the latest findings on global warming written for a general audience will contribute to a wider understanding of this critical issue. Previous analyses of the global warming problem by the Marshall Institute have concentrated on the validity of climate models, the climate record as revealed in temperature observations, and the lack of a greenhouse signal in the temperature record to date. This report summarizes some results discussed in earlier reports, but its focus is on new facts related to the global warming issue as it has been discussed over the last 12 months.

The study begins with a review of evidence relating to claims that 1995 was the warmest year on record, and that anthropogenic global warming has caused and will cause a greater frequency of severe storms and extreme weather events, including blizzards and hurricanes.

The remainder of the report concerns statements by the UN Intergovernmental Panel on Climate Change (IPCC) that for the first time it is now possible to discern in the temperature record a significant human influence on climate.

This most recent Marshall Institute review of scientific evidence on climate change confirms the earlier conclusion that predictions of an anthropogenic global warming have been greatly exaggerated, and that the human contribution to global warming over the course of the 21st century will be less than one degree Celsius and probably only a few tenths of a degree. Spread over a century, a temperature rise of this magnitude will be lost in the noise of natural climate fluctuations.

II. SIGNS OF GLOBAL WARMING CAUSED BY HUMAN ACTIVITIES

According to computer models of climate change, the average temperature of the earth's surface should have increased by approximately 1°C in the last 100 years, in response to the increased concentration of anthropogenic greenhouse gases in the atmosphere. A temperature rise of approximately one-half degree has been observed, but most of that rise occurred before 1940 while most of the greenhouse gases produced by human activities entered the atmosphere after 1940. (See Section V.) Thus, anthropogenic greenhouse gases can only account for a small part of the observed half-degree rise — at most a few tenths of a degree. This amount of global warming is considerably less than had been predicted to result from human activities. Recent work suggests that the cooling effect of atmospheric pollution can account for the apparent absence of global warming due to man-made greenhouse gases.[1] Section V discusses recent theoretical analyses leading to this conclusion.

An increase in the earth's average temperature would be the most direct manifestation of the climate impact of anthropogenic greenhouse gases. In view of the nonappearance of the predicted temperature increase, it has been suggested that signs of the climate impact of the anthropogenic greenhouse gases may be sought in other weather and climate phenomena, such as the occurrence of exceptionally hot years in the recent climate record, or an increase in the frequency of occurrence of hurricanes and other extreme weather events. Evidence bearing on these effects is discussed below.

1995: Warmest Year on Record?

On January 2, 1996, the British Meteorological Office (UKMO) and the University of East Anglia announced that 1995 had been the warmest year on record. The

1. Mitchell, J.F.B., T.C. Johns, J.M. Gregory and S.F.B. Tett, *Nature* 376, 501-504 (1995).

global warming implications in this finding led to a considerable amount of press comment, e.g.,

> "'95 Is Hottest Year on Record As the Global Trend Resumes"
> — *New York Times, 1/4/96*
>
> "Hottest year heralds global warming"
> — *New Scientist, 23/30 December 1995*

According to the UKMO the global average surface temperature for 1995 was 0.04°C — 1/25 of a degree — warmer than the average temperature for the previous record-breaking year, 1990. However, a NASA team's analysis of global temperature observations finds 1995 to be *cooler* than 1990 by about 0.01°C. Moreover, throughout the 1980-1995 period, the NASA analysis differs from the UKMO results by an average of 0.1°C — substantially greater than the difference that is supposed to make 1995 the warmest year. The year-to-year fluctuations in each temperature analysis also average 0.1°C. These facts suggest that the temperature difference that forms the basis for the UKMO announcement is not significant. That conclusion is supported by the satellite temperature measurements, released later in January, which indicate that 1995 was only the eighth warmest year in the last 17 years (the period for which satellite measurements have been available). The temperature for 1995 is precisely in the middle of the temperature range for the last 17 years. Far from being unusually warm, 1995 was an ordinary year in the satellite record.

The Warm 1980s and 1990s

The 1980s and 1990s to date have been a warm 1 1/2 decades with a temperature increase of approximately 0.2 - 0.3°C from 1980 to the present. Over the last 17 years the temperature has been increasing at the rate of 0.17°C/decade according to

surface measurements, and 0.09°C/decade according to satellite data.[2] Is this very recent warming trend caused by anthropogenic greenhouse gases?

Trends of the order of 0.1 - 0.2°C/decade are within the range of natural variability and occur frequently in the climate record. In themselves, they provide no indication of a human influence on climate. From 1890 to 1900, for example, the temperature rose at the rate of 0.2°C/decade — somewhat greater than the rate of temperature increase measured between 1980 and 1994. From 1900 to 1910 the temperature fell at the rate of 0.2°C/ decade. Between 1910 and 1940 the temperature rose approximately 0.15°C/decade for a total increase of nearly 0.5°C.

All these warming and cooling trends in the half century prior to 1940 must have been mainly the product of natural factors in the climate system, since no significant anthropogenic influence on climate existed in that early period. In particular, as noted earlier, the half-degree warming between 1910 and 1940 occurred too early for carbon dioxide and other anthropogenic greenhouse gases to have played any significant role. The 1990 *IPCC Scientific Assessment* concurs:[3] "The rather rapid changes in global temperature seen around 1920-1940 are very likely to have had a mainly natural origin." But if natural forces caused the half-degree temperature rise between 1910 and 1940, they could also have caused the temperature rise of 0.3°C observed in the 1980s and 1990s. Contrary to statements by some scientists that have been reported in the press, the recent temperature rise in the 1980s and 1990s provides no evidence of a global warming due to human activities.

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2. These values have been adjusted to include an estimate of the transient cooling caused by the eruption of the Mt. Pinatubo volcano in the Philippines. See Jones, P.D., *Geophys. Res. Ltrs.* 21, 1149-1152 (1994).
3. *Climate Change: The IPCC Scientific Assessment*, Houghton, J.T., G.J. Jenkins and J.J. Ephraums, eds., p. 233, Cambridge University Press (1990).

III. EVIDENCE FROM THE RECORD OF ANCIENT CLIMATES

The geologic record reveals that major changes in the atmospheric concentration of carbon dioxide have occurred during the earth's history. A comparison with evidence for temperature changes occurring at the same time can yield information on the sensitivity of the earth's climate to CO_2 changes, and the planet's probable increase in carbon dioxide concentration expected in the next century. This empirically based determination of the temperature rise resulting from carbon dioxide increases could have greater validity than the theoretical estimates derived from computer models of the earth's climate, which are subject to major uncertainties because of difficulties in estimating cloud and water-vapor feedbacks.

Unfortunately for the usefulness of this approach to the global warming problem, the earth's climate record indicates that other significant factors in climate change frequently come into play simultaneously with the changes in CO_2 levels. These factors can add to the warming effect of an increase in CO_2, thus making the climate sensitivity to carbon dioxide changes seem greater than it really is; or they can subtract from the warming effect of the added CO_2, making the climate sensitivity to higher CO_2 levels seem smaller than it really is. Reliance on the paleoclimate record for clues to the magnitude of a future greenhouse effect may lead to seriously misleading results.

For example, in the Ordovician, 440 million years ago, the CO_2 concentration was as much as 10 times present levels. Using the IPCC's best estimate of a global warming of 2.5°C for the equilibrium response to a doubling of CO_2, the temperature in the Ordovician should have been approximately 8°C above today's levels. The lower limit of the range of IPCC estimates — a warming of 1.5°C for doubled CO_2 concentration — would have led to a warming of approximately 5°C in the Ordovician for this level of CO_2 concentration. However, the climate in the Ordo-

vician did not agree with either of these estimates. The geologic record reveals that during the Ordovician the earth was in the grip of a major ice age, with temperatures 5 - 10°C *below* today's levels.[4]

Crowley and Baum have shown the low temperatures in the Ordovician ice age may be explained as a result of the proximity of the South Pole to the continental mass which is now a part of Africa.[5] Their analysis confirms that other factors — in this case, the altered geography in the Cretaceous — acting simultaneously with an increase in CO_2 can swamp the warming effect of the added CO_2. In general, these other factors are not fully understood; in some cases their existence may not be even be suspected. As a consequence, it may be impossible from the record alone to disentangle the temperature response to CO_2 changes.

In addition to episodes such as the Ordovician ice age — in which CO_2 increased but temperature did not — the climate record also reveals instances in which temperatures increased but CO_2 did not. An example is the warmest period of the current interglacial, in the mid-Holocene, ca. 4,000 BCE, when temperatures were 1 - 2° above today's levels,[6] and about the same as the warming predicted by climate models for the end of the 21st century. However, the concentration of CO_2 at that time was approximately equal to that of the preindustrial era, i.e., 25% *below* today's levels.[7]

These examples indicate that large errors in forecasting climate can result from the assumption that changes in CO_2 concentration are one of the main driving forces in climate change. It is not possible to assume that temperature changes in

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4. Crowley, T.J. and S.K. Baum, *J. Geophys. Res.* **96**, 22,597-22,610 (1991).
5. Crowley, T.J. and S.K. Baum, *J. Geophys. Res.* **100**, 1093-1101 (1995).
6. Lamb, H.H., *Climate, history and the modern world*, Methuen, London and New York (1982).
7. Ref 3, p. 202.

the paleoclimate record have been caused largely or entirely by one factor — a change in the concentration of CO_2.

IV. SEVERE STORMS AND GLOBAL WARMING

"Blizzards, Floods & Hurricanes: Blame Global Warming."
— *Newsweek, 1/22/96*

It has been suggested that greenhouse warming will increase the frequency and severity of violent storms and extreme weather conditions. Both the recent climate record and the history of past climate changes going back a thousand years indicate that this suggestion has no foundation in fact. The climate history of the past millennium demonstrates that cold — and not warmth — is associated with greater storminess.

The warmest conditions in the last thousand years on both sides of the Atlantic occurred in the 10th - 12th centuries, when the temperature was approximately 0.5°C warmer than today[8] and comparable to the temperatures predicted by the climate models for the 2030 - 2050 period. Yet that was a period of benign climate in Europe and North America, when vineyards flourished in England and the southern regions of Greenland were free of ice and farmed by Norse settlers. Those relatively warm centuries are known as the Medieval Climatic Optimum.

In the 13th century the climate began to cool as the earth slid into a centuries-long cold period called the Little Ice Age. Temperatures in the depths of the Little Ice Age were 0.5 - 1°C cooler than today. The Little Ice Age lasted through the 17th and 18th centuries and into the 19th, when a recovery began and a climb to higher temperatures that appears to be still continuing. With the advent of colder weather

8. Lamb, H.H., *Climate: Present, Past, and Future*, Vol. 2, Methuen, London and New York (1972-1977).

in Europe starting in the 13th century, the severity and frequency of storms increased dramatically in the area around the North Sea. More than 100,000 people died in flooding of the North Sea by storms in 1421 and 1446; a storm in 1570 resulted in the deaths of over 400,000 people. The number of severe floods on the North Sea coast in the last 1000 years seems to have been greatest in the early 1400s and late 1600s; about three times as many disastrous floods occurred then as in the warmer 20th century.

Hurricanes and Tornadoes

A comparison of weather conditions in the Medieval Climatic Optimum and the Little Ice Age suggests that the general level of storminess will decrease, rather than increase, in a warmer climate. But can global warming cause an increase in the frequency and severity of the most violent storms — hurricanes and tornadoes? Meteorological records contain evidence bearing on this question. Figure 1 (p. 9) shows the dependence of the yearly number of hurricanes in the North Atlantic on the temperature of the Northern Hemisphere at the time each hurricane occurred.[9] There is no indication of a trend toward an increase in the number of hurricanes with increasing temperature. Figure 2 (p. 9) shows the relation between the yearly number of tornadoes in the U.S. and the U.S. average temperature, again with no indication of a positive trend.[10]

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9. *Hurricanes*: National Climatic Data Center, NOAA. *Temperature*: Jones, P.D., T.M.L. Wigley and K.R. Briffa, *Trends '93*, ORNL/CDIAC-65, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, TN, p. 603-608.
10. *Temperature*: Karl, T.R., D.R. Easterly, R.W. Knight and P.Y. Hughes, *Trends '93*, ORNL/CDIAC-65, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, TN, p. 689 and updates. *Tornadoes*: National Climatic Data Center, NOAA.

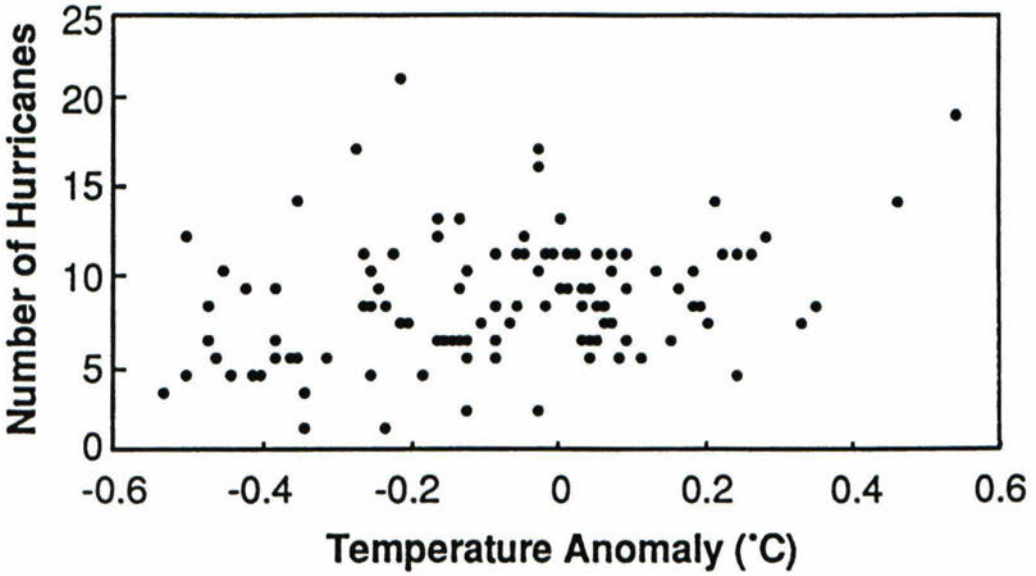

Fig. 1. Yearly number of North Atlantic hurricanes vs. Northern Hemisphere average temperature 1886 - 1995. (Source: ref. 9)

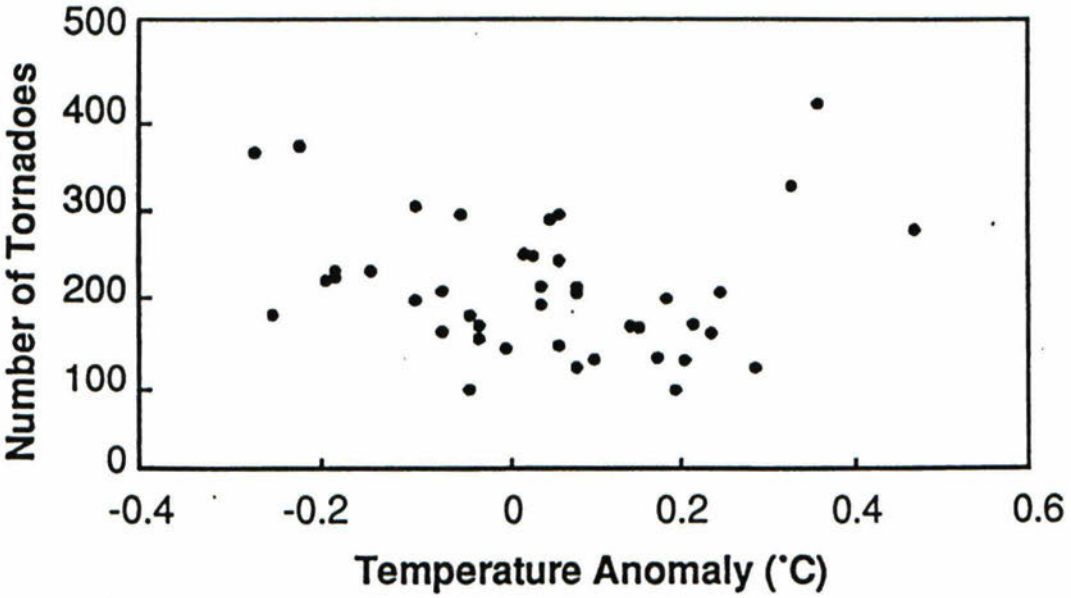

Fig. 2. Yearly number of tornadoes vs. U.S. average temperature 1953 - 1994. (Source: ref. 10)

Heavy Rains

The National Climatic Data Center has analyzed the number of heavy rains from 1910 to 1990. The records indicate that heavy rains, with accumulations greater than two inches over 24 hours, have increased in frequency over that period. The increase is modest: one additional heavy rain every two years.[11] Does this change constitute evidence for global warming due to human activity?

A change in the pattern of rainfall in the 1910-1990 period is not surprising, since there was a global warming of approximately one-half degree since 1910. A warmer earth means more evaporation and more condensation, and thus more and/or heavier rain. However, granting that global warming may change rainfall, the key question is: *Was the global warming caused by human activities?* Since, as noted earlier, most of the half-degree global warming occurred before 1940, while most of the CO_2 and other anthropogenic greenhouse gases entered the atmosphere after 1940, we can be certain that most of the half-degree warming was the product of natural factors and not the result of human activities. Therefore, these natural factors in climate change are the cause of heavier rainfall.

Severe Cold

It has been suggested that a global warming caused by human activities is responsible for the extremely cold weather that afflicted the eastern and southern U.S. in January 1996. However, the opposite is true; if the anthropogenic greenhouse effect has any appreciable impact on climate, it must be such as to make winters milder, not colder. The reason is that the warming effect of carbon dioxide and other greenhouse gases, as noted below in the discussion of Arctic temperature changes (Section VIII), is particularly effective at high latitudes; that is, the green-

11. Karl, T.R., R.W. Knight and N. Plummer, *Nature* 377, 217-220 (1995).

house effect warms the Arctic considerably more than the globe as a whole. When cold weather develops in the U.S., it is usually because cold polar air masses have moved southward. Because the warming due to the greenhouse effect is greatest at high latitudes, in and near the Arctic, these polar air masses are warmer than they would otherwise be, and the cold snap that develops over the U.S. is milder. If the warming caused by greenhouse gases has any significant impact on U.S. winters, the impact must be such as to make the winters milder.

Blizzards and Snowstorms

"Blame Global Warming for the Blizzard."
— *New York Times, 1/14/96*

The heavy snowfalls accompanying the cold weather of January 1996 have also been attributed to an anthropogenic global warming. This suggestion is based on the reasoning, again, that higher temperatures lead to more evaporation of water and a higher moisture content in the atmosphere, and thus to heavier snows when the warm, moist air encounters cold air masses moving southward from the polar regions.

However, observations indicate that the opposite is true, at least on the eastern seaboard, which was the site of much of the heavy snowfall in January 1996. Figure 3 (p. 12) shows, for the representative eastern seaboard state of Virginia, the number of inches of snow that fell in January and February for the years from 1927 to 1987, vs. the average temperature in January and February for the corresponding years.[12] The lines mark normal snowfall and temperature. Figure 3 demonstrates that, as intuition would suggest, heavy snowfalls occur when temperatures are low, and not when

12. *Virginia Climate Advisory*, Vol. 11, No. 4, p. 13.

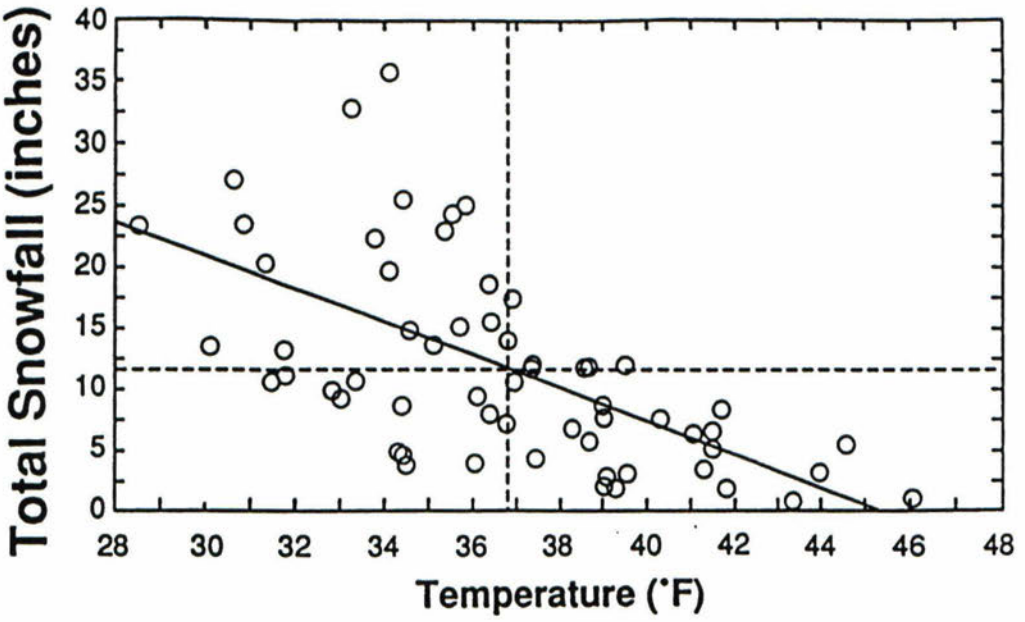

Fig. 3. Total snowfall in January and February vs. average January/February temperature for the period 1927 - 1987. The dotted lines indicate average snowfall and temperature in those months.

the weather is relatively warm. Note that the upper-right quadrant of the chart is empty: the heaviest snows *never* occur when the temperature is relatively high.

In sum: Both the recent climate record and the climate history of the last 1000 years demonstrate no connection between a warm global climate and an increased frequency and violence of storms. Storminess appears to be linked to cooler, rather than warmer temperatures. The most benign conditions have prevailed in times of elevated global temperatures.

V. CLIMATE IMPACT OF ATMOSPHERIC POLLUTION

As noted in Section II, it has been clear for some time that the earth is not warming as much as greenhouse theories had predicted. According to the climate model simulations of the greenhouse effect, carbon dioxide and other greenhouse gases added to the atmosphere in the last century should already have increased the

average temperature of the earth's surface by about one degree Celsius.[13] The observations show an increase of approximately a half-degree over that period, suggesting, as noted earlier, that the calculations are exaggerating the greenhouse warming by a factor of two.

Exaggerated Estimates of Global Warming

The actual overestimate of man-made global warming must be considerably greater than a factor of two, because most of the half-degree rise occurred prior to 1940, whereas most of the CO_2 and other greenhouse gases entered the atmosphere after 1940.[14] Anthropogenic greenhouse gases cannot be the cause of a warming which occurred before these gases entered the atmosphere. It follows that the greenhouse effect can only be responsible for at most a few tenths of a degree out of the observed half-degree rise. The computer simulations of climate, which estimate a warming of approximately one degree due to the greenhouse effect in the last 100 years, apparently have overestimated the greenhouse warming to date by a factor of three or more.

Why does it matter whether the warming caused by the greenhouse effect over the *last* 100 years has been one degree, or one-half degree, or one-quarter degree? Isn't the important question how big the greenhouse effect will be in the *next* 100 years?

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13. Mitchell, J.F.B., R.A. Davis, W.J. Ingram and C.A. Senior, *J. Clim.* 8, 2364-2386 (1995).
14. The concentration of CO_2 in the atmosphere has increased by 20 - 25% in the last hundred years, and increases in other greenhouse gases, such as methane, have increased by the equivalent of another 20 - 25% rise in CO_2. Overall, there has been a greenhouse gas increase equivalent to approximately a 40 - 50% rise in the concentration of CO_2 in the atmosphere in the last hundred years. Most of that increase has occurred in the last fifty years.

The reason these global warming overestimates for the last 100 years are important is that the same climate models which have exaggerated the warming in this century are the source of the predictions of a harmful global warming in the next century. When the global warming forecasts are corrected for the three-fold exaggeration, the predicted warming in the next century drops to a few tenths of a degree. Spread over a century, a temperature increase as small as this will be lost in the noise of natural climate fluctuations.

An Explanation for the Absence of Anthropogenic Global Warming

Why has the predicted global warming due to increasing CO_2 concentrations failed to appear? A plausible explanation is that the warming effect of the greenhouse gases is as large as the climate models estimate, but has been masked by the cooling effect of atmospheric pollution. The burning of fossil fuels — oil, coal and natural gas — releases sulphur compounds into the atmosphere, where these compounds form small particles called sulphate aerosols. The sulphate aerosols create a haze that partly screens the earth from incident sunlight and tends to cool the planet. Recent calculations with the climate models confirm that when the cooling effect of the aerosols is combined with the warming effect of carbon dioxide and other greenhouse gases, the predicted temperature rise comes closer to temperature changes actually observed in recent decades. (The report by the IPCC Working Group I notes, "This agreement does not, however, constitute identification of an anthropogenic effect on climate and may be serendipitous.")

An example of the improvement gained by adding the effect of aerosols is shown in Figure 4 (p. 15), adapted from a report by the British Meteorological Office (UKMO),[1] which compares the observed global average temperatures (solid curve) with temperatures computed assuming greenhouse warming only (dash-dot curve)

or greenhouse warming plus aerosol cooling (dashed curve). The chart confirms that allowing for the cooling effect of aerosols improves the agreement between the observations and the computed global average temperatures for the last three decades.

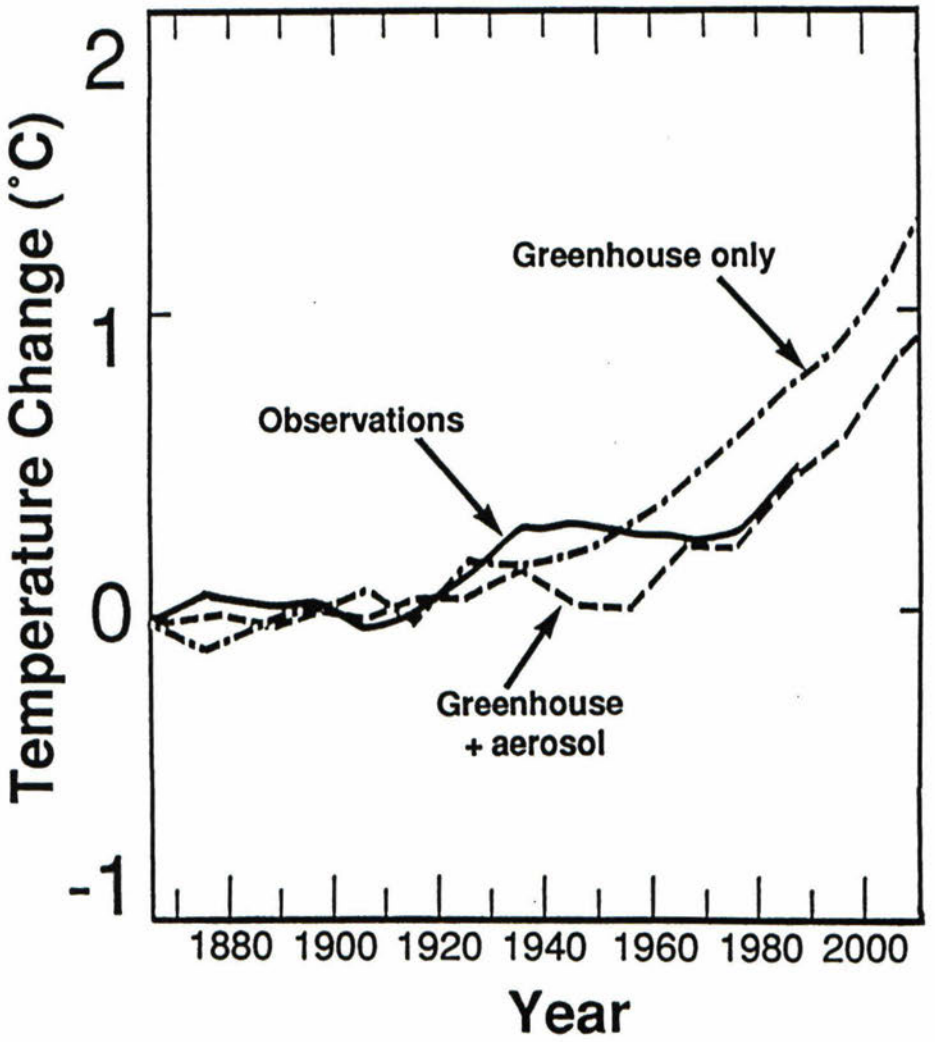

Fig. 4. Changes in global average temperature, computed from a climate model assuming greenhouse gases only (- — - —) and greenhouse gases plus aerosols (— — —), compared with observed temperatures (——). Adapted from Mitchell et al., ref. 1.

Unresolved Discrepancies

However, while aerosols improve the agreement with observation in recent decades for the *globally* averaged temperature, in some regions of the globe the

inclusion of aerosols worsens the agreement. These regions include the heavily industrialized and densely populated areas of the U.S. and Europe, which are intense sources of aerosols and consequently are cooled by them to a greater degree than the globe as a whole. Figures 5 (a) and (b), also adapted from the UKMO report, show that in North America and Europe the agreement between the observed and calculated temperatures, which was fairly satisfactory without the aerosols, is poor when they are included in the climate computations because these regions are now too cool.

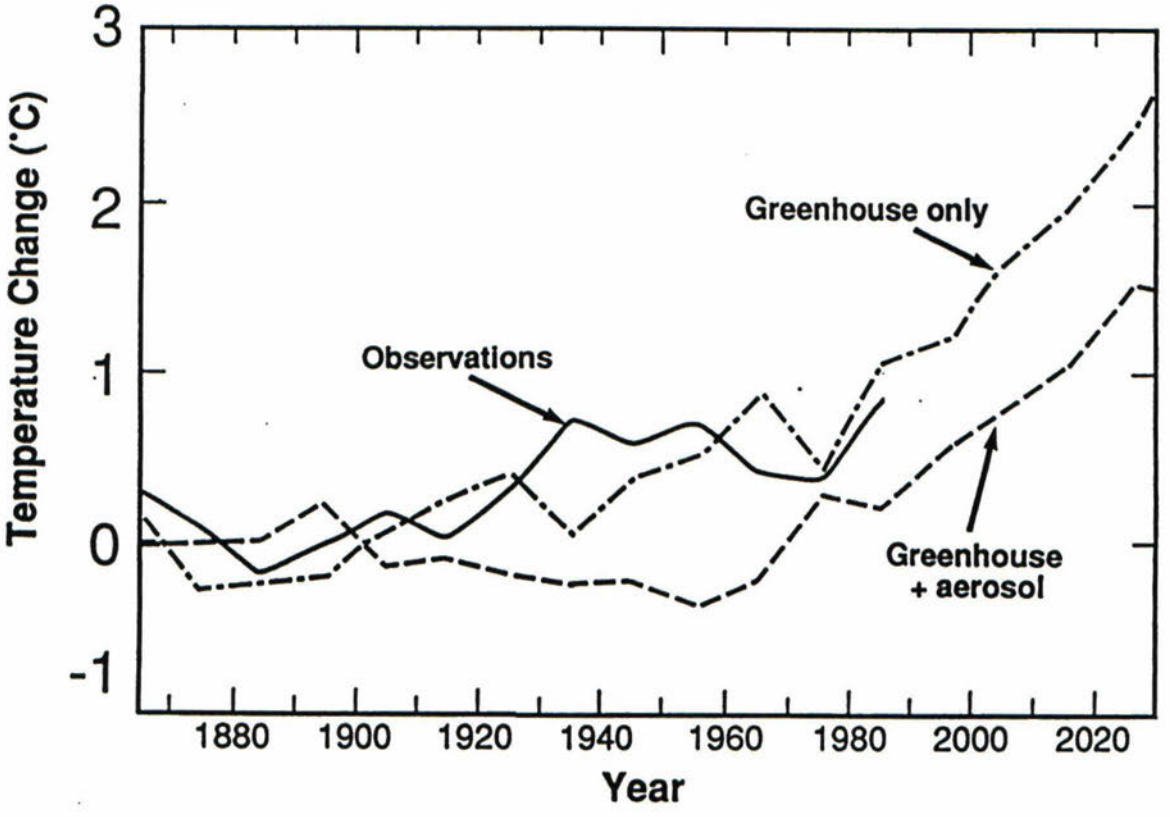

Fig. 5(a). Same as Fig. 4, for North America.

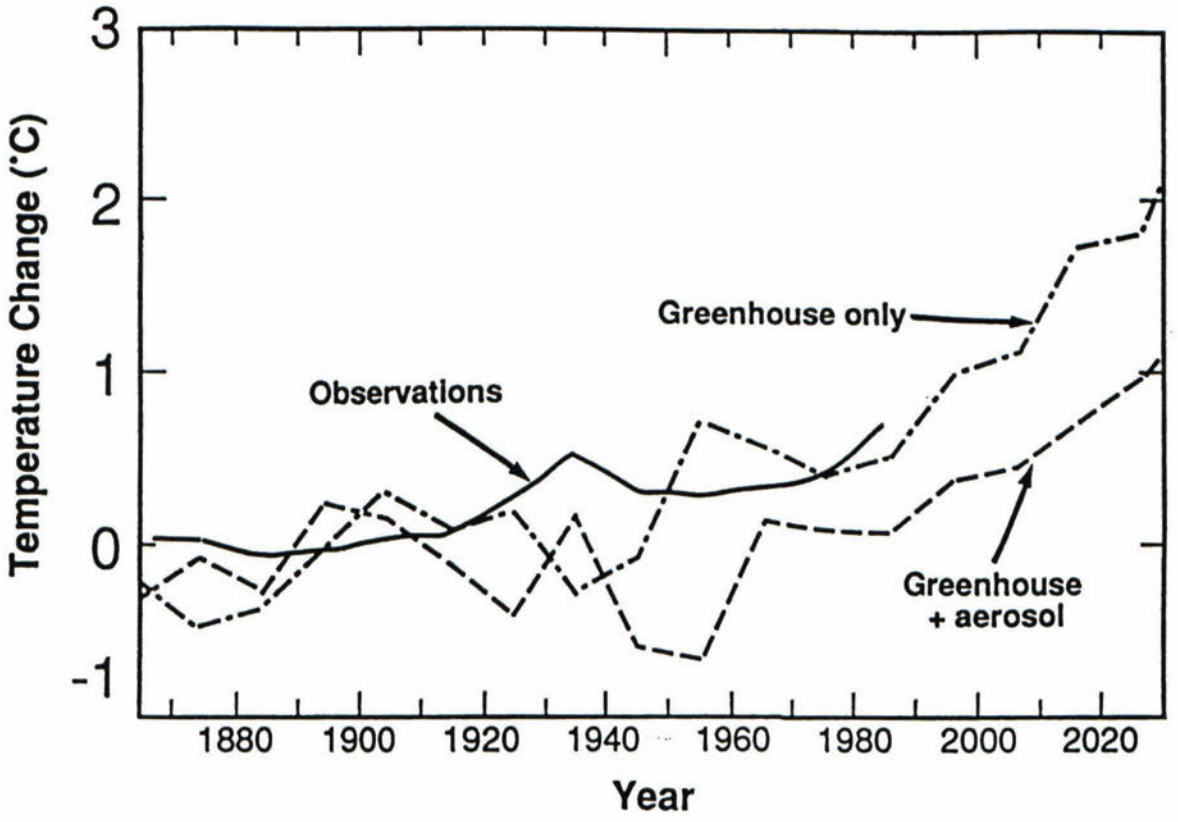

Fig. 5(b). Same as Fig. 1, for Europe.

VI. RECENT RESULTS ON REGIONAL PATTERNS OF TEMPERATURE CHANGE

Globally averaged temperatures are a relatively crude measure of climate change and do not reveal much information regarding the separate impact of the greenhouse gases and the aerosols. While it is useful to supplement the study of the global averages by looking at a few particular regions of interest, such as North America and Europe, a still more sensitive test of the climate impact of the greenhouse gases and aerosols results from a study of the comparison of the compiled and observed temperatures for every region on the entire globe. Since the greenhouse gases and the aerosols each place their own fingerprints on the climate in the form of a distinctive pattern of regional temperature changes, a comparison between the

observed and computed patterns of regional change may also enable us to estimate their separate contributions.

Analysis of Regional Temperature Patterns

Mitchell et al.[1] have undertaken an analysis of the regional patterns of temperature change produced by greenhouse gases and aerosols. The initial year chosen for the analysis is 1860. The surface of the earth is first divided into blocks of area 15 degrees on a side (approximately 1500 kilometers at the equator). The first in the series of numerical experiments is a control run in which the average temperature is computed in each block, assuming no change in greenhouse gases and no aerosol cooling.

In the next experiment, the calculations are carried out from 1860 to the present, assuming the appropriate changes in the concentration of greenhouse gases but still no aerosol cooling. They are repeated again with constant greenhouse gas concentrations, but with aerosol concentrations increasing with time according to observation.

Finally, the calculations are repeated assuming increasing concentrations of both greenhouse gases and aerosols. The gradually evolving patterns of regional temperature change relative to the control run are then compared with the observed patterns of temperature change for each of the three experiments — greenhouse only, aerosols only, and greenhouse + aerosols.

Figure 6 shows the results for the calculated regional patterns of temperature change for the case of aerosols and greenhouse gases combined, compared with temperature observations going back to 1860. The comparison is expressed in terms of the spatial correlation, R, which indicates the extent to which warm and cool regions in the observations are matched by similarly warm and cool regions in the

computations. R is defined to equal 1 if the correspondence between the observed and computed temperature patterns is perfect. A value of R close to zero signifies no similarity between the two patterns of regional temperature change.

From 1860 until approximately 1960, R fluctuates around zero — i.e., there is essentially no correlation between the observed and computed regional patterns of temperature change. Between the 1960s and 1980s, R increases to a peak value of 0.3.

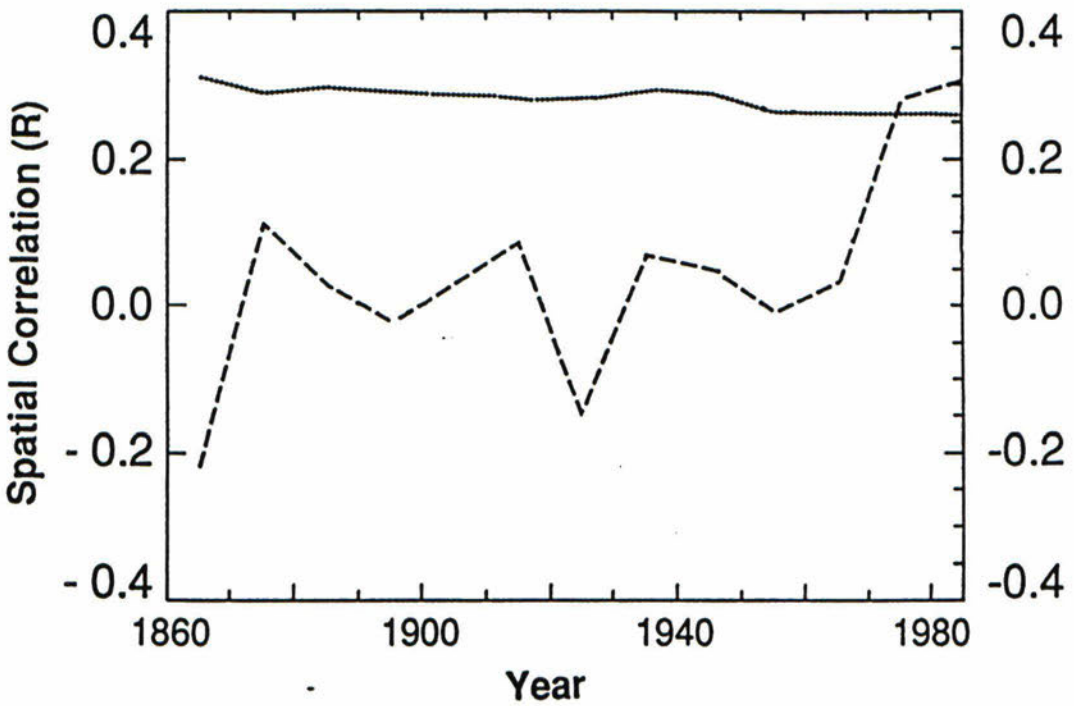

Fig. 6. Regional correlation between computed and observed decadal patterns of temperature change relative to the 1860-1990 mean, for the case of greenhouse gases + aerosols (adapted from ref. 1). The dotted line is the 10% (one-tailed) level of significance, based on climate model estimates of the natural variability of climate.

The increase in R since 1960 has been interpreted by Mitchell et al.[1] to be a combined greenhouse and aerosol signal gradually rising out of the background of natural climate variations in recent decades, as both the greenhouse gases and the aerosols increase in concentration and climate impact.

Similar results have been obtained by Santer et al.[15] In their analysis, R begins to increase in the 1950s and rises to values in the neighborhood of 0.3 in the 1980s. Figure 7, adapted from reference 15, shows the correlation coefficients for the fall season, which display the increase in R clearly. The average value of R from Fig. 7 for the period 1953 - 1993 is 0.17. The upward trend in R is 0.006/yr for the interval 1942 - 1993. On the basis of climate model estimates of natural climate variability, Santer et al. estimate a probability of less than 5% that this upward trend is the result of natural climate fluctuations.

Santer et al. give no estimate of the statistical significance of the R values themselves in Figure 7. Assuming the values of R are significant, Figure 7 also suggests the gradual emergence of a combined greenhouse/aerosol signal in the temperature record.

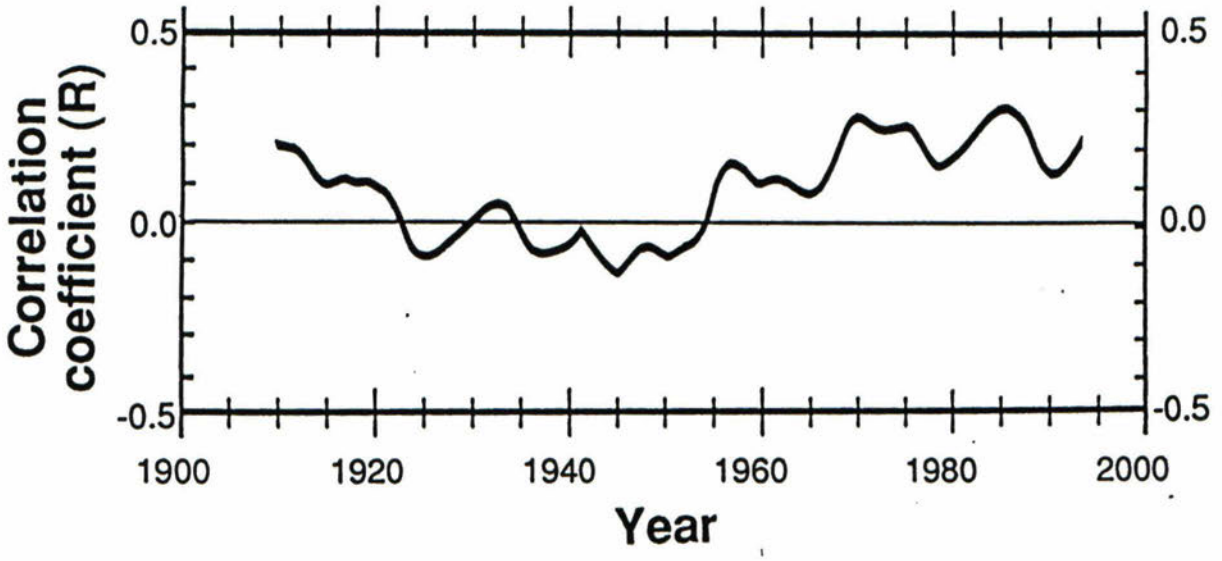

Fig. 7. Correlation coefficients between observed and computed regional patterns of temperature change, for greenhouse gases plus aerosols, and for the fall season (September/October/November) (adapted from reference 15).

15. Santer, B.D., K.E. Taylor, T.M.L. Wigley, J.E. Penner, P.D. Jones and U. Cubasch, *Clim. Dyn.* 12, 77-100 (1995).

Similar results are obtained for the summer season, although not for the winter and spring months.

The increasing correspondence in recent decades between the observed and computed patterns of regional temperature change is cited in IPCC reports as a significant part of the evidence for a detectable human influence on climate.[16]

VII. CLIMATE IMPACT OF GREENHOUSE GASES AND AEROSOLS

Which mechanism — greenhouse gases or aerosols — is primarily responsible for the improvement in the agreement between observed and computed regional temperature patterns?

Figure 8 shows the regional pattern correlation for the computation with aerosols alone and no greenhouse gas increase, again adapted from reference 15. As in the case of the aerosols and greenhouse gases combined, Fig. 8 also indicates an

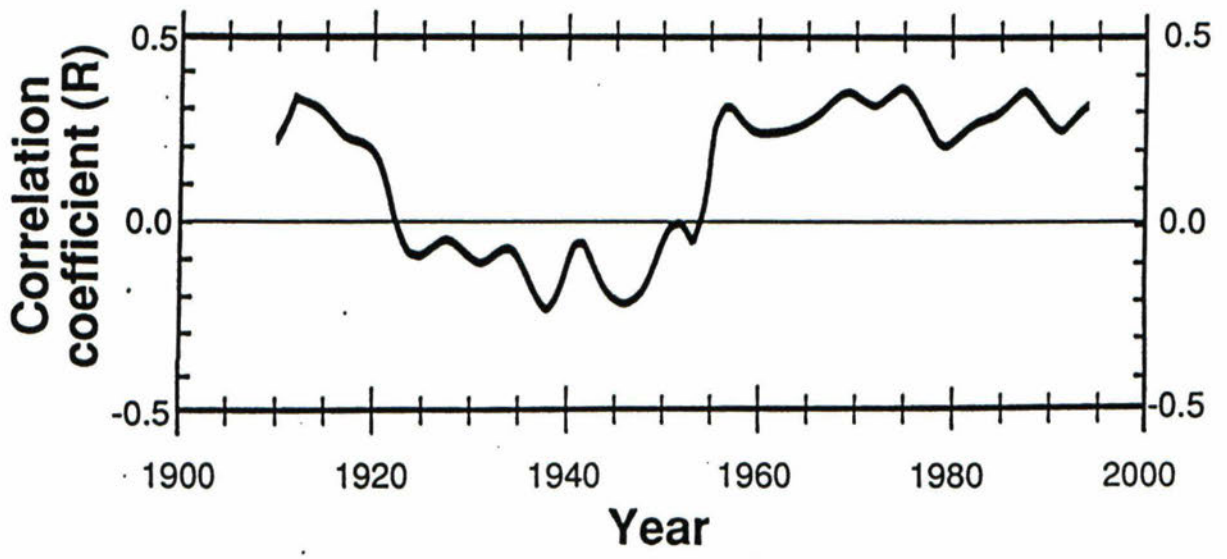

Fig. 8. As in Figure 7, for aerosols only.

16. Summary for Policymakers of the Contribution of Working Group I to the IPCC Second Assessment Report 1995.

increase in R, beginning in this case in the 1940s. For this case, the average value of R for the period 1953 - 1993 is 0.29. The upward trend in R for the 1942-1993 period is 0.009/yr.

Comparison between these results for the case of aerosols only, and the corresponding mean values of R and trend in R for the case of aerosols combined with greenhouse gases, leads to a significant result. Inclusion of the greenhouse effect in the temperature calculations makes the agreement with the observed regional temperature patterns somewhat poorer than in the case of the aerosols alone. Thus aerosols, and not the greenhouse effect, are the cause of the improved agreement between observed and computed regional temperature patterns in recent decades.

Again, assuming that the values of R and the changes in R are significant, the IPCC conclusion that "geographical patterns of temperature change provide important evidence for a discernible human influence on climate" is an accurate assessment of the evidence. However, the human influence in question is almost entirely that of the aerosols.*

The IPCC conclusion was widely misunderstood to imply observational confirmation of a global warming caused by human activity, e.g.,

> "Experts Confirm Human Role in Global Warming"
> *New York Times*, 9/10/95

> "Global warming 'jury' delivers guilty verdict"
> *New Scientist*, 12/9/95

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* The climate models also predict a cooling of the stratosphere as a result of the increased concentration of atmospheric CO_2. This prediction is confirmed by radiosonde and satellite observations and has been cited as an additional item of evidence for the climate impact of anthropogenic CO_2. However, stratospheric cooling may be understood simply as a consequence of the fact that CO_2 is an efficient radiator in the infrared. It conveys no direct information regarding the amount of warming of the surface and lower atmosphere that would result from the addition of CO_2 to the atmosphere.

However, examination of the regional pattern studies which were factored into the IPCC analysis leads to the contrary conclusion: the studies prove that the anthropogenic global warming produced by an increase in the concentration of greenhouse gases has been too small to have a detectable impact on temperatures.

The conclusions to be drawn from the studies of regional patterns of temperature change are the same as those derived earlier from the analysis of globally averaged temperature changes: (1) the greenhouse effect has had a negligible impact on global climate, and (2) the warming effect of the greenhouse gases is substantially smaller than the climate models have predicted.

VIII. ARCTIC TEMPERATURE CHANGES

The accuracy of the climate models can be further tested by examining their predictions at high latitudes in the Arctic zone. All climate models predict that the warming caused by the greenhouse effect will be particularly intense in the Arctic. This prediction of a large Arctic warming makes Arctic temperature measurements a particularly sensitive test of the accuracy of the greenhouse predictions.

Predictions of Arctic Warming Compared with Observations

The climate models predict that the Arctic should have become 1 - 2°C warmer in the last 50 years.[17] However, surface temperature measurements in the Arctic for the last 40 years show that temperatures in the Arctic *decreased* by

17. Manabe, S., R.J. Stouffer, M.J. Spelman and K. Bryan, *J. Clim.* 4, 785-818 (1991).

approximately 1.5°C in that period.[18] Satellite data for the last 17 years also show a cooling in the Arctic. (Figure 9) [19]

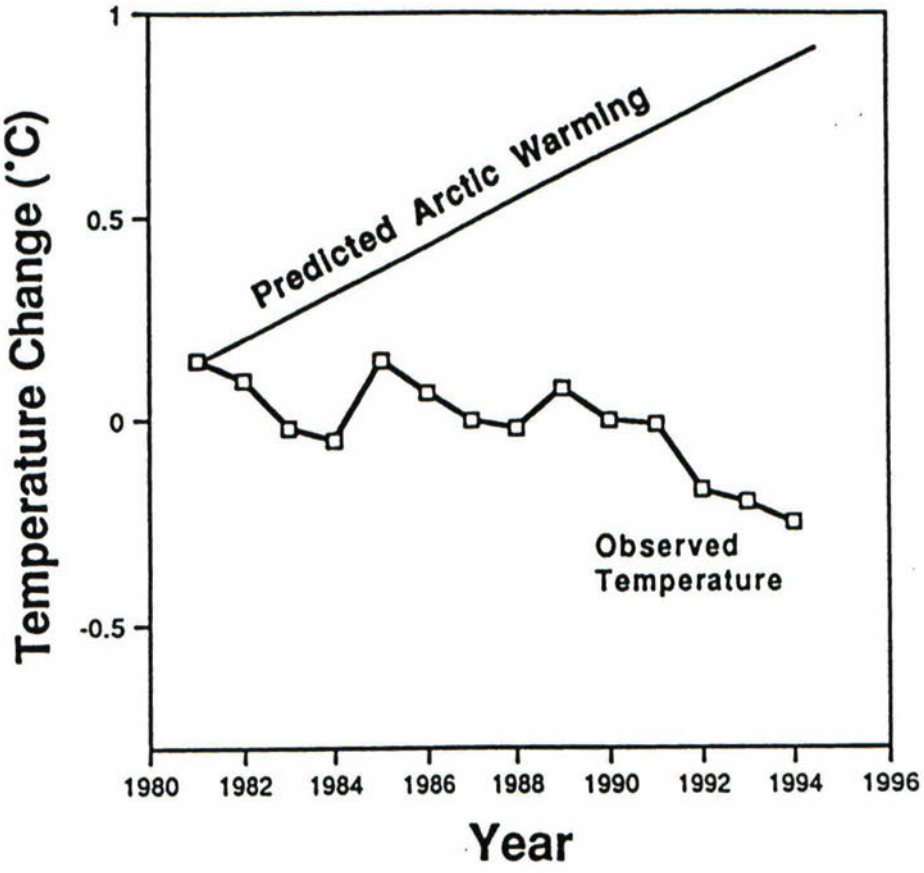

Fig. 9. Satellite measurements of annual average Arctic temperature for the latitude band 67.5N - 82.5N vs. greenhouse predictions. (Source: ref. 19)

Cooling by aerosols cannot explain this very large error in the predictions, since the concentration of aerosols in the Arctic is roughly 10 times smaller than at lower latitudes.[1]

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18. Kahl, J.D., D.J. Charlevoix, N.A. Zartseva, R.C. Schnell and M.C. Serreze, *Nature* 361, 335-337 (1993).
19. *Satellite observations*: Earth Science System Laboratory, University of Alabama at Huntsville; *predicted warming*: Stouffer, R.J., S. Manabe and K. Bryan, *Nature* 342, 660 (1989).

It was concluded above, on the basis of the comparison with globally averaged temperature data, that theoretical estimates of the greenhouse effect must be decreased by at least a factor of three to bring them into better agreement with global averages. A three-fold reduction in the computed Arctic warming would reduce the predicted Arctic temperature rise in the next century from 1 - 2°C to roughly 0.3 - 0.7°C. This range of Arctic temperature increases is still considerably greater than the measured values, which indicate that the Arctic has not warmed at all. It appears that a three-fold reduction in climate model predictions is not adequate to bring the computed Arctic values into line with observation, and a further reduction in the predicted warming is required.

This result implies that the temperature increase produced in the next century by anthropogenic greenhouse gases will be less than one degree, and probably no more than a few tenths of a degree.

IX. PENALTY FOR DELAY ON LIMITING CO_2 EMISSIONS

As the previous discussion indicates, significant new results on global warming are still accumulating. The general trend over the past five years has been toward a reduction in the magnitude of the global warming predictions. In view of the potential importance of the global warming phenomenon, it may be prudent to allow the process of collecting evidence on global warming to continue for some time before policy decisions are reached on CO_2 emission limits and possible mitigation measures.

A recent analysis by Wigley, Richels and Edmonds[20] estimates the additional global warming that would result from a delay of as much as 25 years before action is

20. Wigley, T.M.L., R. Richels and J.A. Edmonds, *Nature* **379**, 240-243 (1996).

taken to limit worldwide CO_2 emissions. Wigley et al. take the goal of such action to be a stabilization of CO_2 concentration in the atmosphere at approximately twice the preindustrial CO_2 concentration, or 550 parts per million by volume (ppmv). They conclude that there is little difference between immediate (1995) emission cuts and initiation of cuts in 2020. Peak emissions are approximately 9 billion tons/year (GT/yr) for the case of immediate cuts, vs. 12 GT/yr for a business-as-usual policy — i.e., no cuts in CO_2 emissions — to 2020 and heavy cuts thereafter. Both scenarios lead to the same stabilized CO_2 concentration of approximately 550 ppmv. The penalty for a 25-year delay in action is an additional global temperature rise of 0.2°C in 2100. A 0.2°C rise distributed over a century would be insignificant.

It seems clear that even if fears of anthropogenic global warming were realized — a concern which finds no support in the scientific data — there is no significant penalty for waiting at least two decades before taking corrective action to reduce global CO_2 emissions.

APPENDIX. ACCURACY OF SATELLITE TEMPERATURE MEASUREMENTS

Because of their nearly complete coverage, the temperature data acquired by satellites add important information to the database of surface temperature measurements used in estimating the size of the greenhouse effect. The surface temperature measurements are sparse over the three-quarters of the earth's surface covered by oceans, and provide essentially no coverage of the polar regions. Coverage of the southern oceans is particularly poor. The satellite measurements provide coverage of all oceans as good as their coverage of land areas. They also survey the polar regions to within 4° of the Poles. The complete satellite global temperature survey includes 99% of the earth's surface and is repeated every four days.

The satellite data agree extremely well with ground-based temperature readings wherever the ground-based coverage is good. In Europe and North America, where surface temperature measurements are numerous and reliable, the correlation coefficient between satellite and surface measurements for the last 17 years is 0.95 — close to perfect agreement.[21] Figure 10 (p. 28) shows the close agreement between the satellite and surface measurements with respect to year-to-year changes in globally averaged temperature.

The correlation coefficients noted above are not sensitive to long-term trends in the globally averaged data. However, fairly good agreement is also found between the satellite data and other sources of temperature measurement in respect to long-term trends. For the period 1979 - 1993, after adjustment for the transient cooling caused by the volcanic eruption of Mount Pinatubo in the Philippines, the satellite value for the global temperature trend is 0.09°C/decade, compared to

21. Christy, J.R, R.S. Spencer and R.T. McNider, *J. Clim.* **8**, 888-896 (1995).

0.10°C/decade from the radiosonde balloon measurements and 0.17°C/decade from the surface temperatures. [2]

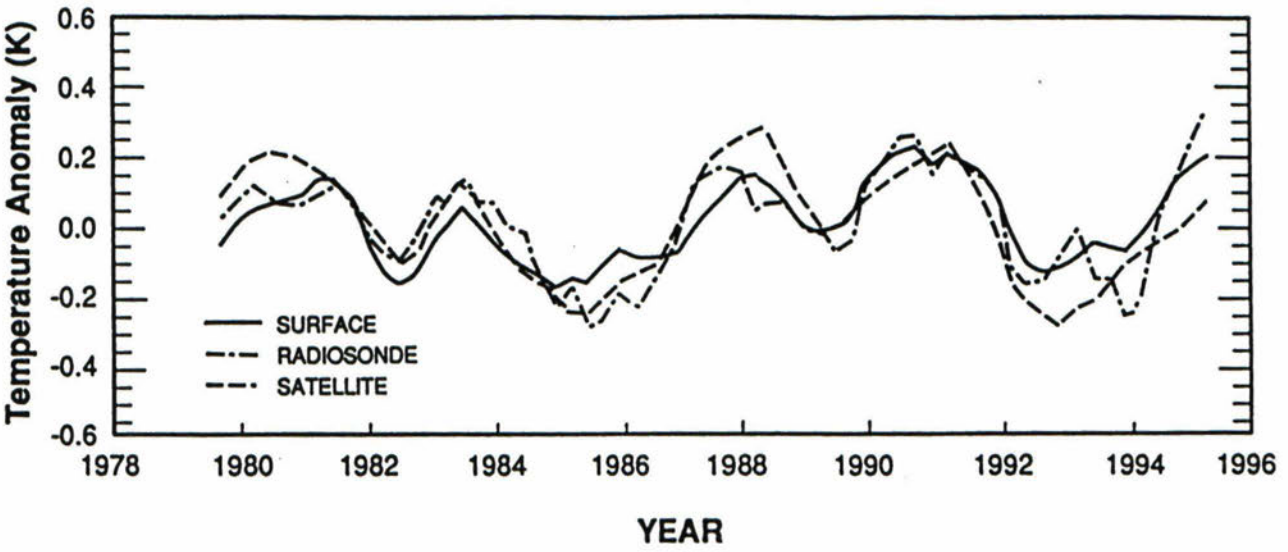

Fig. 10. Comparison of globally averaged temperatures from satellites (— — —), radiosonde balloons (— . — . —) and surface stations (——), courtesy A. Arking. Surface: Hansen, J. and S. Lebedeff, *Geophys. Res. Ltrs.* 15, 323-326 (1988). Radiosonde: Angell, J.K., *J. Clim.* 1, 1296-1313 (1988) plus updates. Satellite: J.F. Christy, Earth and Planetary Science Laboratory, University of Alabama at Huntsville.

Information on the Marshall Institute

The George C. Marshall Institute provides scientific and technical advice on matters that impact public policy. Decisions in virtually all areas of public concern are increasingly shaped by developments in science and technology. The Marshall Institute is dedicated to providing balanced reports on the technical developments underlying these policy issues. The Institute is supported by grants from private foundations and individual donors and receives no government or industry funding.

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John H. Moore, member of the Board of Directors, is former Deputy Director of the National Science Foundation and Professor of Economics at George Mason University. He served as Associate Director of the Hoover Institution. Dr. Moore holds degrees in both chemical engineering and economics.

William Nierenberg, member of the Board of Directors, served for 21 years as Director of the Scripps Institution of Oceanography. He also served as first Chairman of the NASA Advisory Council and as a member of the Defense Science Board. Dr. Nierenberg is a member of the Global Climate Subcommittee of the Advisory Board to the Environmental Protection Agency.

Chauncey Starr, member of the Board of Directors, is President Emeritus of the Electric Power Research Institute. Dr. Starr was Dean of the UCLA School of Engineering and Applied Science and is past President of the American Association for the Advancement of Science. His awards include the National Medal of Technology, the Atomic Energy Commission Award and the Pender Award.

Sallie Baliunas, Chairman of the Science Advisory Board, is staff astrophysicist at the Harvard-Smithsonian Astrophysical Observatory and Deputy Director of the Mount Wilson Institute. Dr. Baliunas is a member of the Editorial Board of *Solar Physics* and recipient of the Newton Lacey Pierce Prize of the American Astronomical Society.

Jeffrey Salmon, Executive Director, was Senior Speechwriter to three Secretaries of Defense. Dr. Salmon was Managing Editor of the journal *Comparative Strategy* and a Senior Fellow at the National Defense University.

The Washington Times

PAGE A22 / *FRIDAY, SEPTEMBER 12, 1997* ★

There's no credible evidence of human influence on global warming

Cord Meyer's Aug. 29 commentary on global warming, "Climate, technology and trepidation," is more misleading than enlightening. From start to finish, his piece is inaccurate.

He begins with the oft-repeated but false statement that 2,500 scientists make up the Intergovernmental Panel on Climate Change (IPCC). In fact, the IPCC includes government officials, social scientists, environmentalists, corporate employees and trade-association staff members, many of whom have no bona-fide credentials in the field of climate science.

Mr. Meyer goes on to suggest that extreme weather and higher insurance claims are related to fossil fuel use when, in fact, the IPCC made no such connection.

The IPCC did find that during the past century, average surface temperatures around the globe have increased about one-half degree Celsius, that the majority of the temperature increase occurred prior to the increase in emissions of greenhouse gases and that there is no credible evidence of increased frequency or severity of weather events related to increases in carbon dioxide or other greenhouse gases.

Mr. Meyer underscores the need for continued development and diffusion of energy-efficient technologies, but he fails to note that the product of current U.N. climate negotiations will be a treaty that, depending on what terms are selected, could require Americans to reduce energy use by 25 to 30 percent over very few years. There are no new technologies that can replace so quickly that much energy produced from fossil fuels. The only way to achieve that goal would be a large energy tax or some form of energy rationing.

Readers also would not have known that in the United States, consumption of energy per unit of gross domestic product has improved by a third since 1974. This improvement is a significant step toward lowering greenhouse gas emissions. Also, American business is investing billions of dollars a year in search of even more efficient ways to operate.

WILLIAM F. O'KEEFE
Chairman
Global Climate Coalition
Washington

4888681

DRAFT

Notes and Comments from a Congressional Briefing Held on June 13th, 1997, Entitled "Truths, Myths and Impacts of Global Warming" by Tony Socci

On Friday, June 13th I attended a Hill briefing sponsored by the National Center for Policy Analysis, on "Truth, Myths and Impacts of Global Warming". Needless to say the speakers represented a collection of climate science skeptics and skeptics of the economics of climate mitigation.

My overall impression was that the assembled group of people never got around to identifying any so-called myths although they created a few of their own as they went along, in addition to having created a few straw dogs which they then proceeded to knock over. The economic tales of woe were also extremely one-dimensional in that all that was taken into consideration were some aspects of the cost of climate mitigation, mostly in the form of carbon taxes.

The moderator for the event was Sterling Burnett of the National Center for Policy Analysis

The opening statement was made by Dennis Fitzgibbons, Deputy Director, Minority Staff House Commerce Committee.

Two scientists/meterologists spoke on "The Truths of the Science", Norman Macdonald, Consulting Meteorologist who spoke on "The Observational Evidence of Global Warming", and Robert Balling, Jr., AZ State University, who spoke on "Greenhouse Warming: The Other Consensus."

"The Impacts on the Economy" were addressed by Eugene Trisko, Attorney for the United Mine Workers of America (The Impact on Jobs), Fran Smith, President, National Consumer Coalition (The Consumer Losses), and Karen Kerrigan, President, Small Business Survival Committee (The Economic Hardship on Business).

And finally, "The Myths of the Global Warming Treaty" were addressed by Jonathan Adler, Competitive Enterprise Institute (Why the Treaty Isn't Green).

Comments:

Dennis Fitzgibbons stated that opinions of congressional members on the issue of global warming were largely unformed yet and that it was difficult to get a handle on the issue of global warming because there was nothing of substance to grab onto. He also conveyed that Congressional members did not want any impending climate treaty to adversely affect America's competitiveness, nor were they receptive to developing countries having no

binding obligations under a climate treaty.

Norm Macdonald, apparently a former local Washington, DC meterologist for one of the major news networks, commented that there was no observational meteorological evidence for global warming, although he did not seem to dispute that the Earth's surface temperature had risen by about 1 degree C over the past century or so. He did however, offer that there were many possible reasons for this 1 degree C temperature rise, no one of which necessitated calling upon a greenhouse effect. He pointed out to the audience that the Earth has always undergone a series of natural climate changes, ranging from ice ages to times when the climate was much warmer, implying that we might, in fact, be witnessing nothing more than natural climate variability. He also felt that changes in sun spots and sunspot activity could account for the temperature change to date, and that the sun had surely influenced climate changes in the past. Norm's final point was that climate models were ill equipped to deal with climate change since they could not handle chaotic behavior.

[MY RESPONSE]

1) I seriously doubt weather Norm Macdonald has spent any time looking for any historic meteorological or climatological observational records or data for the U.S. or anywhere else. Nor am I convinced that Norm Macdonald is at all familiar with the climatological and/or meterological research or the journals in which this research is housed. Had he done some homework he might have come upon a paper or two by Tom Karl (NOAA Climate Prediction Center). Tom's keystone paper on the observational record of climate change in the U.S., region by region, would have made it clear to Norm Macdonald that sweeping changes in temperature, precipitation, frequency and duration of precipitation events, and frequency of extreme precipitation events, in any number of regions of the U.S., had already occurred, regionally and nationally, within the last hundred years. Macdonald would have discovered that in general, parts of the western U.S. had warmed by 1-4 degrees C over the last 100 years, that precipitation within the southeastern U.S. had risen by 30%, that the Plains region had witnessed considerable drying, and that all of these observations and trends were consistent with the theory of greenhouse warming and with climate model projections of climate warming due to an enhanced greenhouse effect.

2. As Jerry Mahlman has often been quick to point out, if you agree that variations in solar output and sunspots can and do provoke significant climate changes, yet represent a climate forcing of roughly 0.3-0.5 watts/square meter, how could one then by contrast, trivialize climate changes due to the buildup of greenhouse gases, which presently represent a climate forcing of 2.5 watts per square meter? In light of this stark contrast in climate forcing, why would one then go out of one's way to ascribe the observed climate change (warming of roughly 1 degree C over the past century or more) to solar radiation, as opposed to a vastly more powerful climate driver, the present and escalating concentration of greenhouse gases? How can a small climate forcing such as solar variability be invoked for so large a climate change, while a vastly larger climate forcing, greenhouse gases, have such a negligible effect? It's like saying that one should be more concerned about getting into an automobile accident with a Volkswagen Beetle than with a Mack truck.

3. As to the matter of climate models not integrating chaotic behavior into their models, Macdonald is in error. Climate models (general circulation models) do include chaotic behavior.

Robert Balling basically assailed the credibility and reliability of climate models and climate model projections. Balling talked of the "conspiracy" to tell us that the world was warming, contesting the fact that the Earth's temperature had risen by 1 degree C over the past century or more, by calling attention to the Satellite temperature records which he claimed showed a cooling trend over the life of these records (Satellite records go back to 1979). He stated, for example, that Phoenix, AZ was not witnessing any warming, and that most of the warming that people were referring to was an urban heating effect, not global warming due to a greenhouse effect. He stated that thermometers over the last 10 years showed no warming. Balling also stated that there was a need to pursue other reasons or causes of climate warming other than greenhouse gases. He also made mention of the fact that in the1970s many scientists were expressing concerns over global cooling, implying that scientists had historically flip-flopped all over this issue of global warming and why then, should they be taken seriously now.

Balling made no reference whatsoever to the surface temperature records of climate change. Balling argued that the models were unreliable largely because they could not deal with clouds, and if they could not get clouds right they could not get precipitation right (water balance) etc.... Ergo, if they could not get those these things right, they could not make any reliable projections. Models also did not do a good job on winds.

Balling also cited the recent evidence that the growing season is now lasting longer, stating that this was, in fact, good. On the issue of hurricanes and storms Balling criticized the "apocalyptic" predictions that hurricanes and storms would increase in number and intensity, stating that there was no evidence of an increase in extreme events such as hurricanes and that hurricanes had, in fact, become less intense. Balling also called upon the influence of dust in cooling climate and offsetting any anthropogenic warming influence.

[MY RESPONSE]

1. On the issue of the Satellite temperature versus the surface temperature records of climate change:

i) The satellite temperature records of climate change and the surface temperature records are two very different measurements of two very different places.

ii) The surface temperature records are the average of all surface-based temperature monitoring stations around the globe, including ocean buoys in some locations. The satellite temperature record is a measure of the temperature of the lower atmosphere taken between 5,000 and 30,000 feet in elevation. It is not a measure of the surface temperature.

iii) Within this layer of the atmosphere from 5,000 to 30,000 feet, the temperature varies considerably vertically, thus the satellite temperature record is a highly aggregated measure of the temperature within this 25,000 foot thickness of the atmosphere, averaged over time and geographic location to produce an annual average value constituting the globally-averaged satellite temperature.

iv) For all practical purposes humans live at the surface of the Earth not between 5,000 and 30,000 feet above the surface of the Earth.

v) The satellite temperature record extends back to 1979, a period of 17 years. Most climatologists maintain that despite all else, a record of 17 years in duration is too short a period of time over which to tease out a climate signature or signal. It's simply too short a timespan to make inferences as to any climate change or any sense of the direction of that change (positive or negative).

vi) Balling stated that the satellite records showed a cooling trend. According to John Christy, one of the co-authors of the original work on the satellite temperature records, after adjusting the satellite temperature records for influences due to ozone depletion and aerosols, one finds an overall slight net warming trend in the satellite records since 1979, contrary to Balling's assertion. John Christy's comments to this effect are also recorded in a recent transcript of a Congressional hearing which took place in 1996.

Furthermore, everyone agrees that in comparing balloon records of lower atmospheric temperature over the last 17 years with the satellite records of lower atmospheric temperatures for the same period of time, there is very good agreement between the two data sets (And well they should be highly correlated data sets since the balloons and satellites are essentially measuring the same temperature over the same thickness of the atmosphere.), thus all agree that balloon records are a good proxy record for the satellite-derived temperature records. If one then tacks on to this 17-year satellite temperature record going back to 1979, the balloon records going back to the 1950's, in order to produce a longer (40-50 year record) and therefore, more climatically sensitive and credible climate record, one then sees a decided warming trend in the satellite record, consistent with the observed surface temperature record over the same period, and consistent with climate model projections.

2. In stating that thermometers over the last 10 years show no warming, it is entirely unclear as to what Balling was referring to specifically. To my knowledge, 4 out of the last 6 years are the hottest years on record. Beyond that, I seem to recall that the last 10 years represent the hottest decade on record. However, from a climate perspective, no ten-year record provides enough of a climate trend to give it climatic significance. If a 17-year satellite record is too short a period to infer a climate trend or signal, why would a ten-year record be any better?

3. That Phoenix, AZ has witnessed no warming is hardly a negation of greenhouse induced warming globally, nor does it negate climate model projections or the theory of greenhouse warming. No scientists that I know ever stated that during global warming every place on Earth would

automatically become warmer. Some regions will not warm and some might even experience cooling, for any number of reasons. Nonetheless, all of this is entirely consistent with model projections and the theory of greenhouse warming.

4. Balling's attribution of an observed global warming signal to confusion with an urban heat island effect is entirely erroneous. In calculating the globally averaged temperature record for any number of years, Wigley, Jones and others have routinely stripped out any outside influences, such as an urban heat effect, from the surface temperature records.

5. As for climate models being seriously flawed, largely due to uncertainty surrounding clouds and precipitation, and therefore, not credible, Balling is distorting the case.

i) Clouds are a large source of uncertainty in model projections. However, Balling seemed to imply that if one cannot get the clouds right in models one cannot get the precipitation or water balance right. Here Balling is mis-stating the case by setting up a syllogism loaded with straw dogs, one of which is that clouds represent all or most of the water or water vapor in the atmosphere. Clouds, in general, contain very little of the water or water vapor housed in the atmosphere, and certainly account for a minuscule portion of the global water budget.

As it turns out, most general circulation models do a good job on getting the global water balance and circulation right.

ii) In terms of precipitation, how good or bad climate models (GCMs) do in the realm of precipitation is often a matter of scale, making Balling's comments on the inability of climate model's (GCMs) to correctly characterize precipitation, misleading. Global climate models make use of large-area grid scales (40 kilometer or more) in making their global-scale calculations. At this scale of resolution one cannot, in general, get a good feel for precipitation differences locally or regionally since precipitation is generally a more regional or localized phenomenon. The models are not designed to get at the smaller-scale aspects of precipitation. However, the general circulation models do a reasonably good job in characterizing precipitation trends for broader (area-wise) regions of the world on the scale of the interior of North America, for example.

iii) Nor is it the case that models do not deal with or account for uncertainty with respect to clouds. Uncertainty surrounding clouds, as well as other uncertainties, are embodied in virtually all global climate model projections of temperature change out to the year 2100, hence the reason for the wide range of model projected temperatures of 1.5-4.0 degrees C by the year 2100. Cloud uncertainty is already accounted for in models.

6. Balling was correct in stating that the IPCC concluded that it was uncertain as to whether hurricanes and tropical storms would increase or decrease in number in a greenhouse warmed world. However, contrary to Balling's assertions of a decrease in the intensity of hurricanes and other tropical storms in a warmer world, the IPCC concluded that in a warmer world the intensity of hurricanes and tropical storms was likely to increase, not decrease.

This expectation of an increase in hurricane and tropical storm intensity is consistent in that heat (warm ocean surface temperatures) is the overwhelming driving force behind the intensity of hurricanes and tropical storms. The hotter the world becomes one would logically expect more intense hurricanes and tropical storms. This expectation and model

projection are also consistent with Kerry Emanuel's (MIT) notion of "Supercanes" (extremely intense hurricanes) in the Earth's paleoclimate record when the Earth was warmer than it was today. The driving force behind these "Supercanes" was largely elevated temperatures. Unless of course Balling was referring to the intensity of hurricanes and tropical storms being less over the past few years, he almost certainly mis-stated the case for future decreases in hurricane and tropical storm intensity, as the climate warms.

7. As for Balling's comment that scientists in the 1970s were concerned about global cooling, and are now concerned about global warming, begging the credibility of scientists as well as their understanding (or lack thereof) of climate and the direction that climate will take, it amounts to a "red herring". Yes, some scientists were, and remain to be concerned about global cooling as well. However, the important point here is the fundamental difference in timescales involved.

Most scientists agree that natural cycles of ice ages and intervening warm ages are found throughout the paleoclimate record, largely at intervals or cycles of 21,000, 40,000, and 90,000 years. These natural cycles are driven by orbitally-driven changes in the distribution of solar radiation over the surface of the Earth, operating at the periodicities cited above. The peak of the last ice age occurred roughly 18,000 years ago. Consequently, there are a number of scientists who are rightly concerned about the next orbitally-driven natural cycle of cooling which is predicted to occur sometime within the next 3,000 years (18,000 + 3,000 years = 21,000 years), one of the key orbitally-driven cycles responsible for the onset and demise of ice ages.

Consequently, scientists should rightly be concerned about orbitally-driven, natural global cooling on the scale of thousands of years, while at the same time be concerned about rapidly escalating, anthropogenically-driven global warming on the scale of tens to hundreds of years. How this anthropogenically-driven rapid trend in the buildup of greenhouse gas emissions, in parallel with a sluggish, natural orbitally-driven trend toward a new ice age, will play out in the long run, is an important issue of concern. Being concerned about global cooling (on a scale of thousands of years) is not therefore, contradictory to being concerned about global warming (on a scale of tens to hundreds of years). This is hardly a measure of confusion or uncertainty among scientists, and should not be taken as such, contrary to what Balling and others would like to have the public believe.

8. As for the need to explore other possible reasons or causes of the observed climate change to date, I wonder to what extent Balling has embarked on a research program to do just that. Otherwise, I am somewhat at a loss to understand what Balling's contribution to climate science has been in terms of advancing our understanding of processes and feedbacks, or modeling. Searching for 'silver bullets" and trying to poke holes in climate models and the IPCC consensus understanding of the climate system is not what I would call being genuinely engaged in the business of scientific research. Perhaps Balling would entertain the idea of looking for other mechanisms and causes of climate change, and assess their importance and whether their effects can and are being observed.

9. Balling also made reference to the "apocalyptic" predictions of the impacts of global warming. I wonder who Balling was referring to specifically, in casting climate changes as apocalyptic? I know of no scientists that have described the impacts of climate change as an apocalypse or apocalyptic. Perhaps Balling could enlighten all of us as to who exactly is saying this. Otherwise, it's fair to conclude that this particular phraseology is part of a public relations media strategy.

10. Balling also commented on the fact that a longer growing season, as a consequence of spring arriving earlier (in the northern latitudes especially) was good, implying that even if climate is changing (warming) it's implicitly good. This notion of climate warming being inherently good and a longer growing season inherently better, is simplistic and misleading to the extreme, especially from an ecosystem perspective.

It turns out for example, that certain species of penguins in West Antarctica have been impacted indirectly by an observed 4-5 degree C warming and an earlier spring in this part of the Antarctic over the last half century. In this instance, a certain species of penguin had its breeding habitat altered or rendered unavailable at the crucial moment when recent offspring required habitat that was rendered unavailable by the change in climate and the change in the timing of the seasons. The consequence of this change amounts to no survival of offspring. The same is true for certain butterflies in the western U.S., where an observed 2-3 degree C warming has occurred over the past 100 years, altering the timing of food availability at a crucial moment in the growth of butterfly larvae such that food was no longer available for developing butterfly larvae at a crucial moment in their development. The net effect was that the butterfly larvae never reached maturity and the species is becoming extinct.

Each of these examples serve to underscore the complexity of ecosystem responses to climate warming. In addition, in each of these two examples there are a host of unknown ripple effects throughout the larger ecosystems of which these two organisms are a part. Climate warming or cooling is hardly simplistic in the way it plays out.

11. Balling's contention that dust will essentially cool off the planet in the face of any threat of global warming, is preposterous. While it is true that dust serves, in general, to cool the planet as a result of the particles reflecting sunlight back into space, dust in the atmosphere is not pervasive but localized. Thus, while one might anticipate some cooling due to dust, that cooling would largely be localized. In addition, some dust at certain levels of the atmosphere, tends to have an insulating or warming effect. Furthermore, if dust were to have acted to cool the panet down every time the planet tended to warm, there should never have been any records of past climate warming, yet the paleoclimate record is replete with episodes when the climate warmed considerably, and for long periods of time. In addition, there appears to have been more dust in the atmosphere during times in the Earth's past when the climate was much colder, during ice ages, for example. Consequently, the paleoclimate record flatly contradicts Balling's assertion.

Eugene Trisko, in discussing the impacts of binding international CO_2 emissions reductions, stated that mitigation policies could reduce the GDP by $100-$300 billion annually according to a recent report. This could spell a loss of $500.00-$1,500.00 dollars per capita if we chose emissions targets and timetables too prematurely. He stated that any binding mitigation efforts needed to be global, including responsibilities for developing countries. If developed countries alone agreed to an emissions ceiling of 450 ppm, for example, it would cost 1 million American jobs.

Frances Smith stated that the impact of climate change policies on consumers would be real, substantial and painful, and that consumers will be forced into a future of poverty that they will never be able to get over. She stated that most fuel costs would increase by 15%.

As for automobiles and auto efficiency, she stated that small cars are less safe and cannot accommodate families comfortably. Cars are now less safe due to a 500% reduction in weight to improve mileage and efficiency. According to a 1989 Harvard study she cited,

this reduction in automobile weight causes more deaths. According to her, there would be an additional 5.5% increase in mortality due to automobile accidents if we went to a 40 MPG fuel efficient vehicle.

She stated that climate change policies would have a serious impact on senior citizens with fixed incomes, and that such policies will worsen the disparity in the distribution of income in the U.S.

She stated that there were no clear federal policies on climate mitigation, no information, and no analyses to look at. She called for a clearer picture on risks. She claimed that there are lots of global warming scares that were not rooted in fact, and that conclusions regarding global warming were inconclusive. The risks of warming are speculations, and cited Fred Singer's Leipzig Declaration (a statement signed by 100 or so scientists who disagree with the conclusions of the IPCC). She quoted Congressman Dingell's comments calling the FCCC poorly conceived and badly executed.

Karen Kerrigan began by stating that new climate-related regulations on businesses would be a nightmare, and that through the FCCC the UN would be able to penalize U.S. businesses for not complying with CO_2 emissions reductions targets and timetables, while the developing world would be left untouched, giving the latter a serious economic advantage. She commented on the widespread disagreement on the issue of global warming itself and called for a go-slow attitude.

Jonathan Adler referred to the FCCC as "all pain and no gain", and that it could also cause environmental damage as well. He cited the Edmonds, Wigley, et al paper in saying that greenhouse gas reductions are not necessary until some 20 or so years down the road, and that we could afford to wait and see what happens. He stated that the cost of CO_2 reductions could reduce the GDP by 0.5 %. Slowing the rate of growth and the rate of technological development will have an acute negative effect on the economy and people in the U.S. "Wealthier is healthier." A slow down in economic growth will also result in premature mortality.

[MY RESPONSE]

The general conclusion reached by those who addressed the impacts of climate mitigation policies was economic destitution for U.S. citizens and the U.S. economy. It was clear from all of the presenters that this was a collection of exceedingly one-dimensional economic analyses (by non-economists for the most part), wherein the cost of climate mitigation was the only item in need of consideration.

i) What was left out of these presentations was balance and genuine expertise. For example, if the actual cost of climate mitigation might be on the order of 0.5% of the GDP (GDP is also projected to grow at a rate of roughly 2-3 % annually), how does that figure compare to the cost of the regional and global impacts of climate change? What would be the cost of doing nothing, or business-as-usual, compared to the cost of mitigation?

ii) There was also no allowance for fuel efficiency and the use of new and improved, cleaner energy technologies, and no recognition of the possibility that greater energy efficiency and the use of newer, cleaner energy technologies could, in fact, lead to a more robust economy that might also be more sustainable over the long haul, with side benefits such as cleaner air, lowered health care costs, and less or no acid rain damage to people, crops, forests, and ecosystems.

iii) Adler also mis-stated what Edmonds, Wigley, and others stated in their paper and elsewhere. Edmonds et al. make it very clear that in terms of climate mitigation options, one can essentially choose any one of an array of greenhouse concentration ceilings, and then embark on a pathway for reducing greenhouse gas emissions. However, in doing so Edmonds also made it clear that regardless of which greenhouse gas concentration target one selected as the ceiling, work on reducing emissions had to be initiated immediately. The sooner one got to work on reducing emissions the less extreme and less costly the reductions would be over the long haul. The longer one put off reducing emissions, the more difficult, drastic, and costly reducing emissions would be, and with less chance of success.

iv) Although Frances Smith was quick to ascribe more auto deaths to the loss of weight in cars over the years, one wonders what the impact of legal speed limits has had on deaths, as opposed to a loss in automobile body weight. There have also been advances in the use of lighter but stronger materials as well in automobiles. Consequently, this seemed to be a weak argument.

v) I found it exceedingly interesting to note that the industry lobbyists/representatives who railed against the economics of climate mitigation policies, elected to highlight their concern for how these policies would seriously adversely affect senior citizens and the economically disenfranchised (those at the low end of the widening economic gap of the haves and have-nots in the U.S.). I'm certain that the elderly and the economically disenfranchised would be surprised to hear how seemingly concerned these organizations are about their health and well being. I found this whole line of argument very hypocritical.

Final Comments

I was struck by the fact that virtually all of the scientific and economic presentations made were anecdotal in that they were presenting work done by others. One wonders why the original authors and experts were not called upon to convey their work directly, without second-and-third-hand interpretations by others.

At the end of nearly two hours of presentations before a good size audience made up mostly of Hill staff, the National Center for Policy Analysis elected to take a total of three questions from the audience, one of which was my own.

National Center for Policy Analysis

Truths, Myths and Impacts of Global Warming

Friday, June 13, 1997, 10:00 to 11:45 a.m.
1324 Longworth House Office Building, Washington, DC

Sponsored by the National Center for Policy Analysis

10:00 a.m.	MODERATOR	*Sterling Burnett* Environmental Policy Analyst National Center for Policy Analysis
10:05 a.m.	OPENING REMARKS	*Dennis Fitzgibbons* Deputy Director, Minority Staff House Commerce Committee
10:15 a.m.	Q & A	
	The Truths of the Science	
10:20 a.m.	OBSERVATIONAL EVIDENCE OF GLOBAL WARMING	*Norman J. Macdonald* Certified Consulting Meteorologist
10:35 a.m.	GREENHOUSE WARMING: THE OTHER CONSENSUS	*Dr. Robert C. Balling, Jr.* Director, Office of Climatology Arizona State University
	The Impacts on the Economy	
10:50 a.m.	THE IMPACT ON JOBS	*Eugene M. Trisko* Attorney United Mine Workers of America, AFL-CIO
11:05 a.m.	THE CONSUMER LOSES	*Fran Smith* President National Consumer Coalition
11:15 a.m.	THE ECONOMIC HARDSHIP ON BUSINESS	*Karen Kerrigan* President Small Business Survival Committee
	The Myths of the Global Warming Treaty	
11:25 a.m.	WHY THE TREATY ISN'T GREEN	*Jonathan Adler* Associate Director, Environment Competitive Enterprise Institute
11:35 a.m.	QUESTIONS & ANSWERS	*The Panelists*

We hope you will be able to join us for this important and informative environmental policy briefing. Because seating is limited, please RSVP at 202-628-6671. If you have any questions, contact Erik Rudeen.

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