

TESTIMONY OF PATRICK J. MICHAELS TO THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT, COMMITTEE ON SCIENCE AND TECHNOLOGY, U.S HOUSE OF REPRESENTATIVES, NOVEMBER 17, 2010

Thank you for inviting my testimony. I am a Senior Fellow in Environmental Studies at the Cato Institute and Distinguished Senior Fellow in the School of Public Policy at George Mason University. This testimony represents no official point of view from either of these institutions and is tendered with the traditional protections of academic freedom.

My testimony has four objectives

- 1) Demonstration that the rate greenhouse-related warming is clearly below the mean of climate forecasts from the United Nations Intergovernmental Panel on Climate Change (IPCC) that are based upon changes in atmospheric carbon dioxide concentrations that are closest to what is actually being observed,
- 2) demonstration that the Finding of Endangerment from greenhouse gases by the Environmental Protection Agency is based upon a very dubious and critical assumption,
- 3) demonstration that the definition of science as a public good induces certain biases that substantially devalue efforts to synthesize science, such as those undertaken by the IPCC and the U.S. Climate Change Science Program (CCSP), and
- 4) demonstration that there is substantial discontent with governmental and intergovernmental syntheses of climate change and with policies passed by this House of Representatives.

“Climate change” is nothing new, even climate change induced by human activity. What matters is not whether or not something so obvious exists, but to what magnitude it exists and how people adapt to such change.

For decades, scientists have attempted to model the behavior of our atmosphere as carbon dioxide and other greenhouse gases are added above the base levels established before human prehistory. The results are interesting but are highly dependent upon the amount of carbon dioxide that resides in the atmosphere, something that is very difficult to predict long into the future with any confidence. It is safe to say that no one—no matter whether he or she works for the government, for industry, or in education—can tell what our technology will be 100 years from now. We can only say that if history is to be any guide, it will be radically different from what we use today and that therefore projecting greenhouse gas emissions so far into the future is, to choose a word carefully, *useless*.

One thing we are certain of, though, is that the development of future technologies depends upon capital investment, and that it would be foolish to continue to spend such resources in expensive programs that will in fact do nothing significant to global temperature.

Fortunately, despite the doomsaying of several, we indeed have the opportunity to not waste resources now, but instead to invest them much further in the future. That is because the atmosphere is clearly declaring that the response to changes in carbon dioxide is much more modest than what appears to be the consensus of scientific models.

### **Testimony Objective #1: Greenhouse-related warming is clearly below the mean of relevant climate forecasts from the IPCC**

Figure 1 shows the community of computer model projections from the IPCC's "midrange" scenario. Observed changes in atmospheric carbon dioxide concentrations correspond closer to this one than to others. You will note one common characteristic of these models: they predict warmings of a relatively constant rate. This is because, in large part, the response of temperature to changes in atmospheric carbon dioxide is logarithmic (meaning that equal incremental increases produce proportionally less warming as concentration increases), while the increase in carbon dioxide itself is a low-order exponent rather than a straight line. This combination tends to produce constant rates of warming.

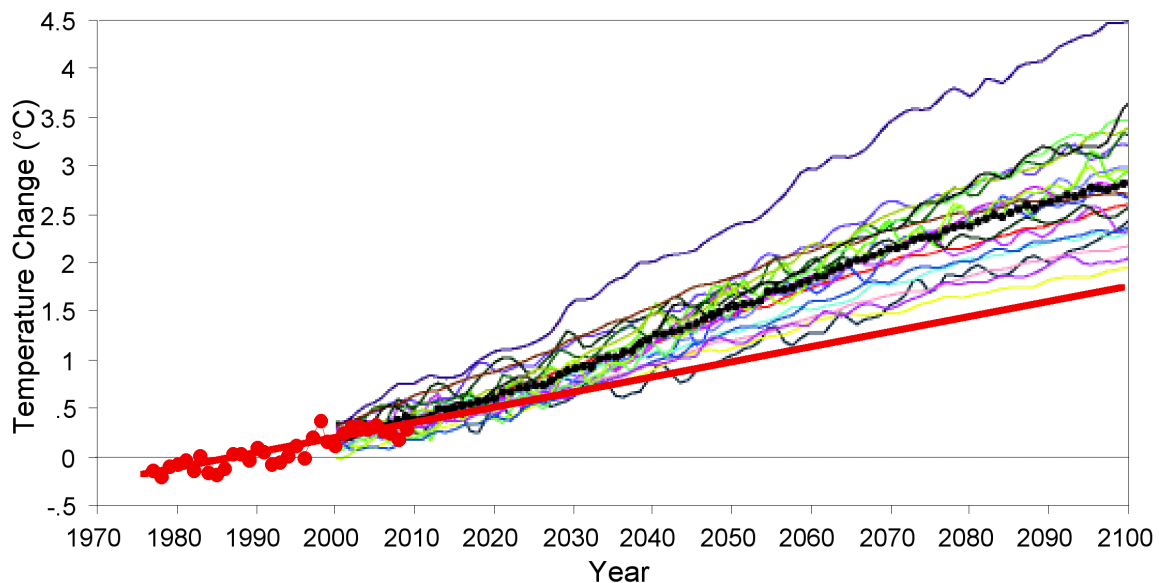


Figure 1. Projected temperature rise over the course of the 21<sup>st</sup> century from climate models used in the IPCC's *Fourth Assessment Report* (colored lines) running a 'midrange' emissions scenario, with observed temperatures superimposed (red circles).

The various models just produce different quasi-constant rates. Divining future warming then becomes rather easy. Do we have a constant rate of warming? And if so, then we know the future rate, *unless the functional form of all of these models is wrong*. And if

this is wrong, scientists are so ignorant of this problem, that you are wasting your time in soliciting our expertise.

How does the observed rate of global temperature increase compare to what is being projected? For that, we can examine the behavior of literally hundreds of iterations of these models. For time periods of various lengths, some of these models will actually produce no significant warming trend (as has been observed since 1996), or even a short-term interval of cooling.

Figure 2 gives us the mean and 95% confidence limits of the midrange family of IPCC models as well as temperatures observed by the Climate Research Unit at the University of East Anglia. (More will be said on this history below). It is quite apparent that the observed rates of change are below the mean value forecast by the IPCC.

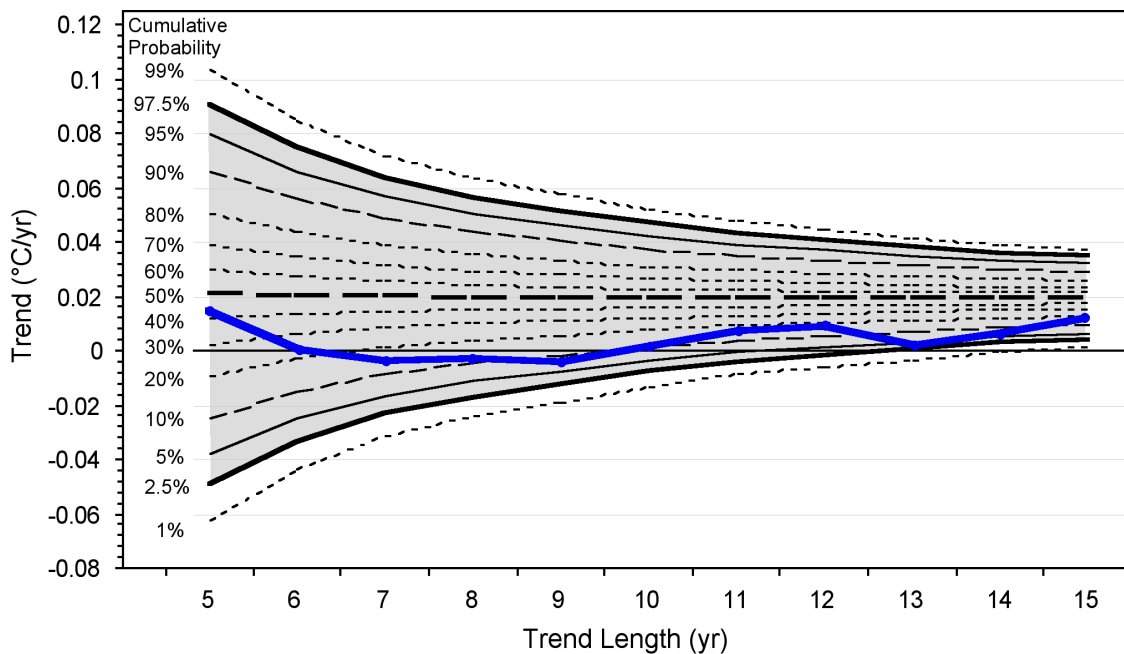


Figure 2. Range of climate model probabilities of surface temperature trends (gray shading) overlaid with the observed surface temperature trend from the Climate Research Unit (blue line) (data through September 2010).

An additional and important discrepancy between the models and reality extends into the lower atmosphere as well. In the lower atmosphere, climate models expectations are that the degree of warming with increasing greenhouse gas concentrations should be greater than that experienced at the surface, with the lower atmosphere warming about 1.4 times faster than the average surface temperature. Despite claims that observations and models are in agreement (Santer et al., 2008), new analyses incorporating a large number of both observational datasets as well as climate model projections, clearly and strongly demonstrate that the surface warming (which itself is below the model mean) is significantly outpacing the warming in the lower atmosphere—contrary to climate model expectations. Instead of exhibiting 40% more warming than the surface, the lower atmosphere is warming 25% less—a statistically significant difference (Christy et al., 2010).

And further, the climate models are faring little better with oceanic temperature changes. There again, they project far more warming than has been observed. In a much-publicized paper published in *Nature* magazine in 2006 (by authors Gleckler, Wigley, Santer, Gregory, AchutaRao, Taylor, 2006), it was claimed that by including the cooling influence of a string of large volcanic eruptions starting in 1880, that climate models produced a much closer match to observed trends in ocean warming than when the models did not include the volcanic impacts. Further, it was claimed that volcanic eruptions as far back as Krakatoa in 1883 were still significantly offsetting warming from human greenhouse gas emissions. However, a soon-to-be-published paper by one of the *Nature* paper's original authors, Jonathan Gregory, shows that the influence of volcanoes was greatly exaggerated as the original climate models assumed that no major volcanic eruptions had occurred prior to Krakatoa. In fact, episodic major eruptions are an integral part of the earth's natural climate. Gregory shows that had climate models been equilibrated with more realistic natural conditions, that the long-term impact of volcanoes since the late 19<sup>th</sup> century would be greatly minimized. In that case, the apparent match between model simulations and observations of oceanic heat content that was noted by Gleckler et al. would deteriorate, leaving climate models once again over-responsive to rising levels of greenhouse gases.

I caution you that analyses of climate models can be highly dependent upon the time period chosen. There was a major El Nino event in 1998, which is the warmest year in the instrumental histories. Thus any analysis beginning in this year will show little warming. On the other hand, if one studies the last twenty years, there is a major volcano at the beginning of the record (Pinatubo in 1991), so any analysis beginning then will show anomalously large warming trends.

An example of the time dependency of model validation can be seen in one of the most famous papers ever published on this subject, by Santer et al. (1996). It was clearly rushed to print by *Nature* magazine in order to provide a scientific justification for the Second Conference of the Parties to the United Nations Framework Convention on Climate Change, held in Geneva a mere few days after its publication. The findings were reported in virtually every major newspaper on the planet in this politically sensitive timeframe.

The analysis shows a remarkable fit between the observed three-dimensional changes in the atmosphere and what was projected by models between 1963 and 1987. But, indeed, this three-dimensional history actually begins in 1957, and, for the purposes of this paper, clearly ends in 1995, not 1987.

The major match for this record results from the substantial warming of the southern hemisphere compared to the northern (Figure 3). Indeed the time evolution of southern hot spot is striking from 1963 through 1987. But, when all of the data are used, the warming trend completely disappears.<sup>1</sup>

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<sup>1</sup> The attitude displayed in the famous "climategate" emails has a long provenance. This finding was shown in an invited presentation to the American Meteorological Society annual meeting in 1997. A

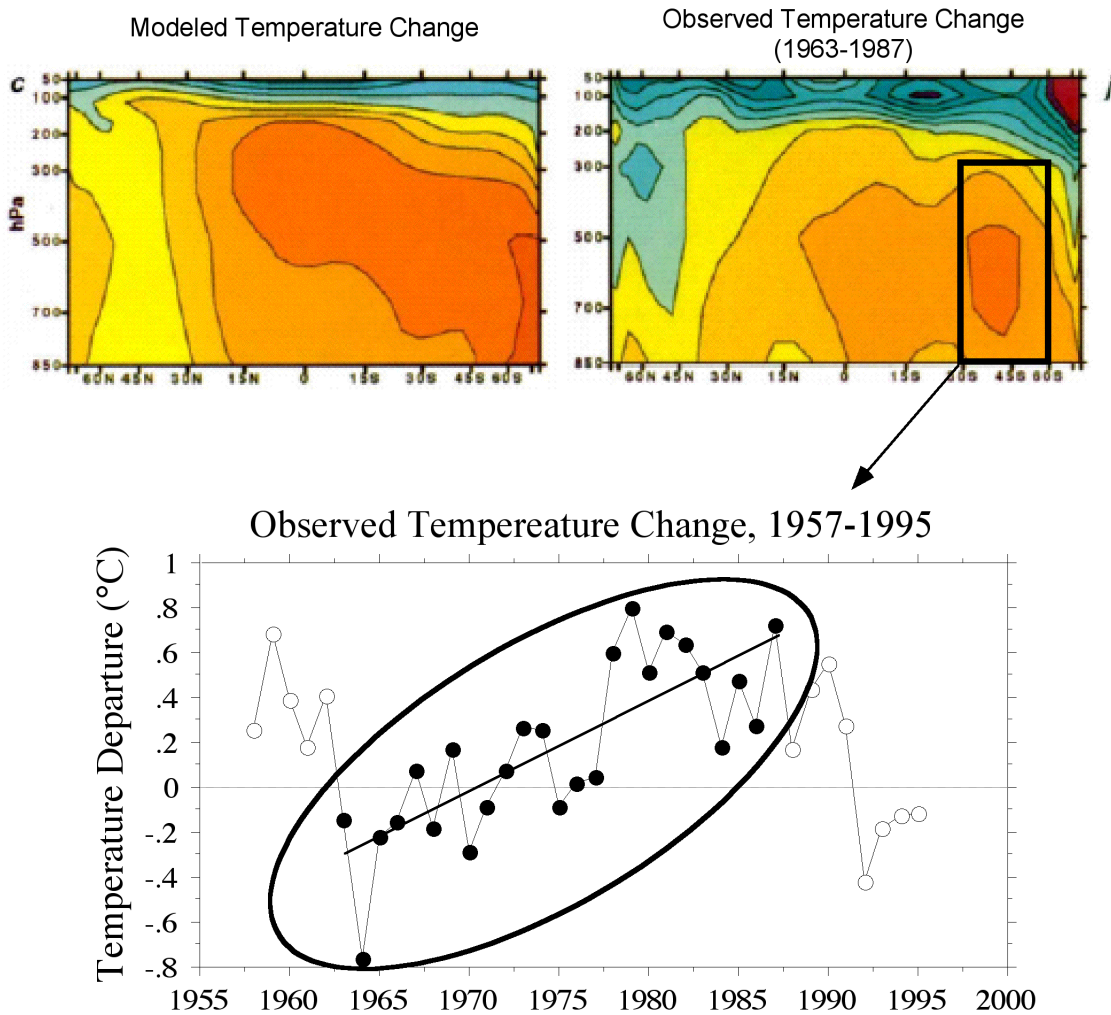


Figure 3. Modeled (upper left) and observed (upper right) temperatures changes throughout the atmosphere. Time series of temperatures in the region of the highlighted box in the upper right panel, 1957-1995. Filled circles: 1963-1987; Open circles, 1957-62 and 1988-95. Use of all the available data clearly changes the result.

Nonetheless, the Geneva conference marked the turning point in international climate change policy. It was agreed there that at the next conference, in Kyoto, that the nations of the world would adopt a binding protocol to reduce carbon dioxide emissions. The resultant Kyoto protocol demonstrably did nothing about climate change and was an historic, expensive failure that led to the ultimate failure in subsequent policy that took place in Copenhagen last December.

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scientist whom I had held in high esteem, Tim Barnett of Scripps Institute of Oceanography, in the discussion after its presentation, threatened to asphyxiate me with the microphone cord “if I ever gave it again”.

**Testimony Objective #2: The Finding of Endangerment from greenhouse gases by the Environmental Protection Agency is based upon a very dubious and critical assumption**

The reluctance of the Senate to mandate significant reductions in carbon dioxide emissions has resulted in EPA taking the lead in this activity. Consequently it issued an “endangerment finding” on December 7, 2009. The key statement in this Finding is adapted from the Fourth Assessment Report of the IPCC and from the CCSP:

*Most of the observed increase in global average temperatures since the mid-20<sup>th</sup> century is very likely due to the observed increase in anthropogenic GHG [greenhouse gas] concentrations. [italics added]*

Here the EPA gives us a very testable hypothesis. “Most” means more than 50%. “Very likely”, according to the IPCC and CCSP, means with a subjective probability of between 90 and 95 %. “Since the mid-20<sup>th</sup> century” means after 1950. So, is more than half of the warming since 1950 a result of “the observed increase in anthropogenic GHG concentrations?”

Figure 4 is a plot of observed global surface temperature since 1950 from the Climate Research Unit of the University of East Anglia. Note that its linear behavior is quite striking, with a warming trend of 0.70°C.

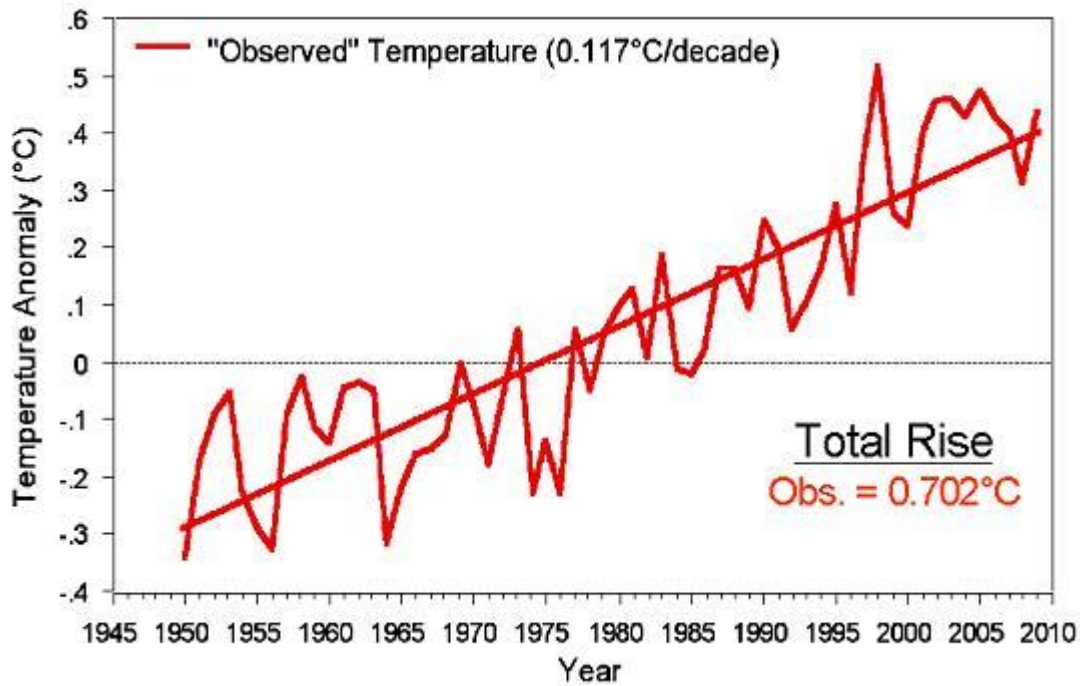


Figure 4. Annual global average temperature history from 1950 to 2009 (source: U.K. Hadley Center).

Thompson et al., writing in *Nature* in 2008, noted that sea-surface temperatures were measured too cold between the mid-1940s and mid-1960s. Accounting for this lowers the surface warming trend from 0.70 to 0.55°C; see Figure 5.

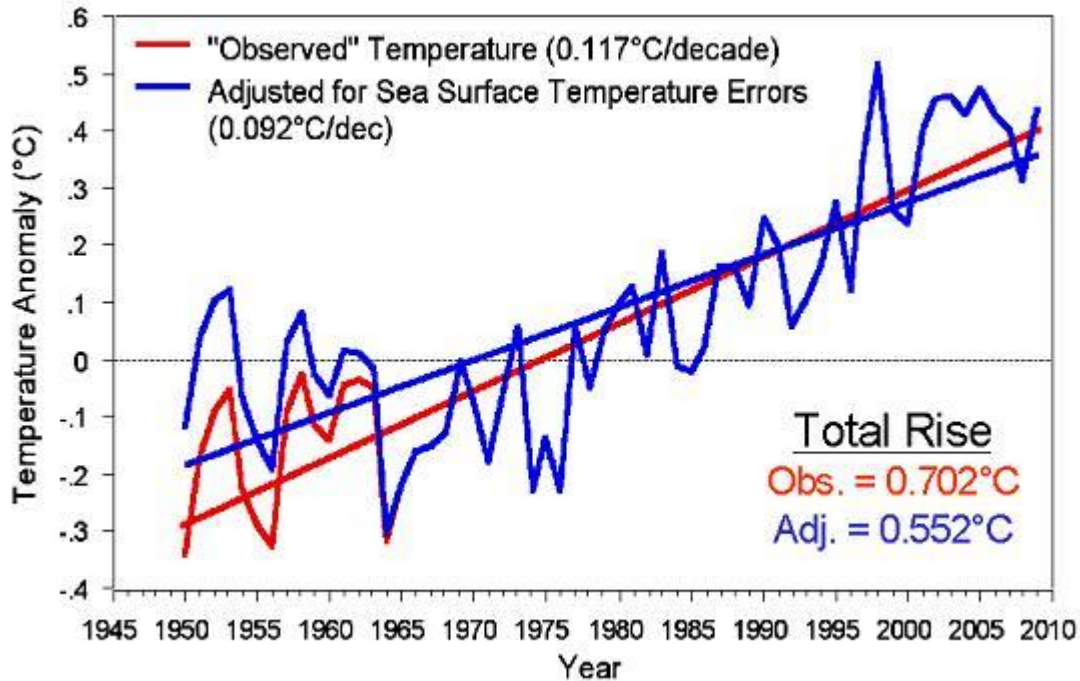


Figure 5. Annual global average temperature history from 1950 to 2009 (source: U.K. Hadley Center) and adjusted annual global average temperature to remove SST errors (Thompson et al., 2008).

Late in 2007, Ross McKittrick and I published an analysis of “non climatic” trends in surface temperature data. While the global effect was not as large as some erroneous reports have stated, we found that approximately .08°C of the warming trend was a result of these factors. We were looking at effects that could only occur over land, and Thompson et al. was concerned with the ocean, so these two adjustments are obviously independent, additive, and not from GHG changes. The remaining warming is now 0.47°C (Figure 6).



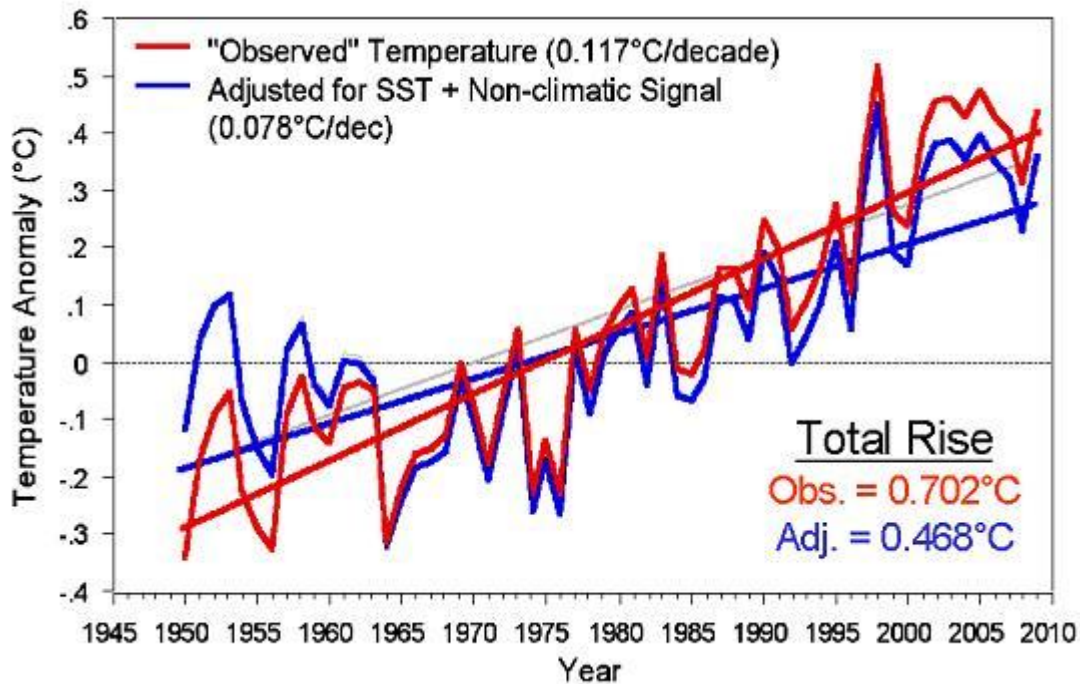


Figure 6. Annual global average temperature history from 1950 to 2009 (source: U.K. Hadley Center) and adjusted annual global average temperature to remove SST errors (Thompson et al., 2008) and non-climatic influences (McKittrick and Michaels, 2007).

In January, 2010, in an attempt to explain the lack of significant warming that has been observed since 1996, Susan Solomon published a new simulation in *Science* that took into effect the radiative consequences of changing water vapor in the stratosphere. No one really knows why this is happening, but it is not an obvious consequence of changing GHG concentrations. This additional factor drops the warming to 0.41°C; see Figure 7.



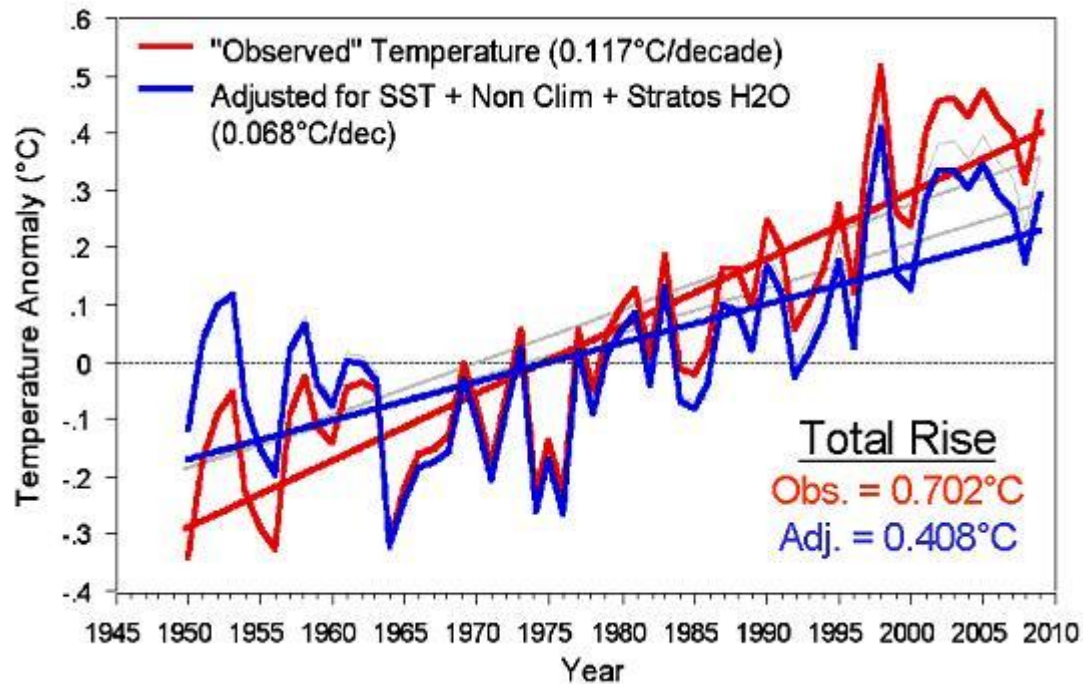


Figure 7. Annual global average temperature history from 1950 to 2009 (source: U.K. Hadley Center) and adjusted annual global average temperature to remove SST errors (Thompson et al., 2008), non-climatic influences (McKittrick and Michaels, 2007) and the influence of stratospheric water vapor increases (Solomon et al., 2010).

In 2009, Ramanathan and Carmichael reviewed the effects of black carbon—which is not a GHG—on temperature and concluded it was responsible for approximately 25% of observed warming. This now drops the residual warming to a ceiling of 0.31°C, or 44% of the original 0.70° (Figure 8). Note that this catena of results does not invoke solar variability, as estimates of its impact on recent climate vary widely (Scafetta, 2009).

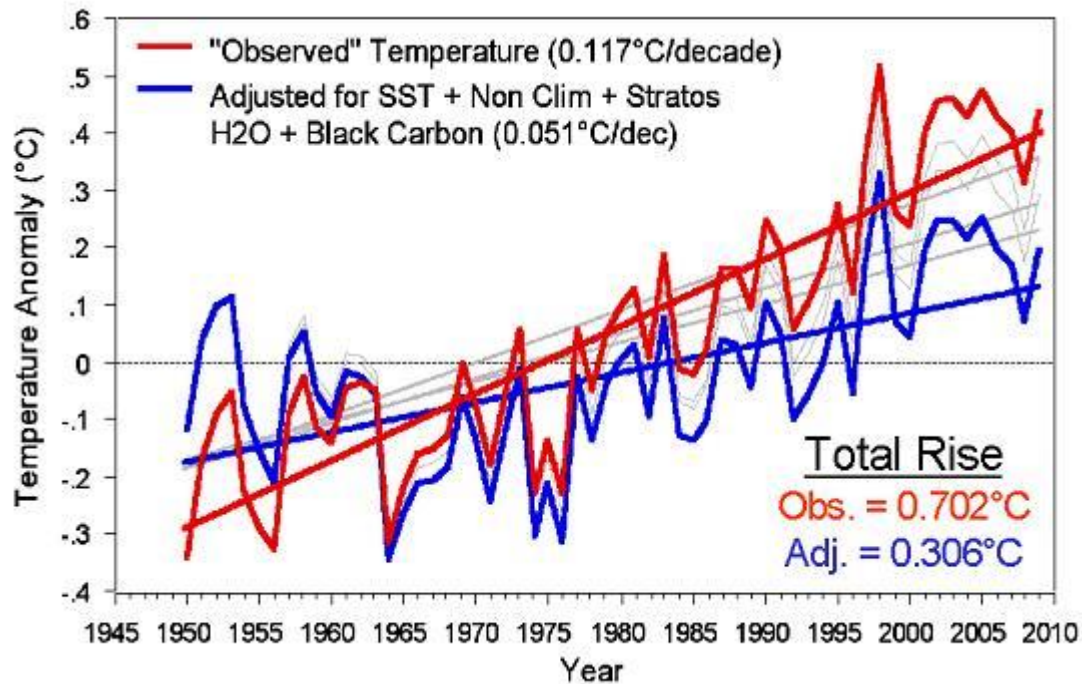


Figure 8. Annual global average temperature history from 1950 to 2009 (source: U.K. Hadley Center) and adjusted annual global average temperature to remove SST errors (Thompson et al., 2008), non-climatic influences (McKittrick and Michaels, 2007), the influence of stratospheric water vapor increases (Solomon et al., 2010) and the influence of black carbon aerosols (Ramanathan and Carmichael, 2009).

Consequently EPA’s core statement (as well as that of the IPCC and the CCSP), “Most of the observed increase in global average temperatures since the mid-20<sup>th</sup> century is very likely due to the observed increase in anthropogenic GHG [greenhouse gas] concentrations”, is not supported.

**Testimony Objective #3: The definition of science as a public good induces certain biases that substantially devalue efforts to synthesize science, such as those undertaken by the IPCC and the U.S. Climate Change Science Program (CCSP).**

Visitors to the website of *Scientific American* have been invited to participate in an ongoing survey on global warming. This survey finds—despite the general environmentalist bent of its readership—that only a tiny minority (16%) agree that the IPCC is “an effective group of government representatives, scientists, and other experts”. 84% agree, however, that it is “a corrupt organization, prone to groupthink, with a political agenda” (Figure 9). The concordance between the IPCC and the bizarre one-sidedness of the CCSP Synthesis would compel the respondents to say the same about it, if asked.




4. The IPCC, or Intergovernmental Panel on Climate Change is:			
		Response Percent	Response Count
an effective group of government representatives, scientists and other experts.		15.8%	1,065
a corrupt organization, prone to groupthink, with a political agenda.		83.6%	5,652
something to do with Internet protocols.		0.6%	42
		<b>answered question</b>	<b>6,759</b>
		<b>skipped question</b>	<b>2</b>

Figure 9. Only a tiny minority of respondents (16%) agree that the IPCC is “an effective group of government representatives, scientists, and other experts”. 84% agree, however, that it is “a corrupt organization, prone to groupthink, with a political agenda” (Questions 4 from a *Scientific American* on-line poll, downloaded November 12, 2010).

This stems from the very nature of modern science, which is treated largely as a public good, to be funded by taxpayer dollars. But, like other tax-supported entities, science also competes within itself for attention to its disciplines and problems. In the environment of Washington, the most emergent or apparently urgent subjects receive proportional public largesse. With regard to incentives, no scientific community ever came into this House of Representatives and claimed that its area of interest was overemphasized and that funding should be directed elsewhere. This is normal behavior.

However, an implication of this behavior is that the peer-review process is also populated by a community of incentivized individuals. The test of this hypothesis would be in fact if that literature were demonstrably biased.

Rather than use the inflammatory subject of climate change as an example, I draw your attention to the everyday weather forecast. In the US, we recast our global forecasting models twice a day, based upon three dimensional measurements of atmospheric state variables that simultaneously updated.

If the initial forecast model is unbiased, each new pieced of information has an equal probability of either raising or lowering the high temperature forecast three days from now. And, indeed, that turns out to be the case.

The same should apply to climate science if there is no incentivized bias. In fact, the “mainstream” community of climate scientists claims this is true. In their *Amicus* brief in

*Massachusetts v EPA*, the supreme court case that required the EPA to determine whether or not carbon dioxide caused “endangerment”, Battisti et al., writing as “The Climate Scientists” state:

Outcomes may turn out better than our best current prediction, but it is just as possible that environmental and health damages will be more than severe than the best predictions.

As with the EPA’s use of “most” and “mid-20<sup>th</sup> century”, “just as possible” is a quantitatively testable hypothesis. In this case, “The Climate Scientists” are stating that there is an equal probability that a new scientific finding in global warming, in amount or consequence makes future prospects either worse than previously thought or not as bad.

I examined 13 consecutive months of *Nature* and *Science* to test the hypothesis of unbiased. Over a hundred articles were examined. Of those that demonstrably had a “worse than” or “not as bad as” component, over 80 were in the “worse” category and 11 were “not as bad”.

The possibility that this did not reflect bias can be determined with a binomial probability. It is similar to the likelihood that a coin could be tossed 93 times with only 11 “heads” or “tails”. That probability is less than 1 in 100,000,000,000,000,000.

In fact, climate science holds itself apart from other quantitative fields. Both economics and biomedical science acknowledge this problem, known as “publication bias” when doing meta-analyses. It a concept is completely foreign to the dominant mainstream in my profession, in the IPCC and in the CCSP.

**Testimony Objective #4: There is substantial discontent with governmental and intergovernmental syntheses of climate change and with policies passed by this House of Representatives.**

In response to a perceived political need for mandated reductions to demonstrate our national resolve at Copenhagen, this House passed a cap-and-trade bill on June 26, 2009. The Senate never considered such legislation and it will rest when this Congress adjourns.

The survey by *Scientific American* shows the unpopularity of this approach. Figure 10 shows that only 7.5% of nearly 7,000 respondents say cap and trade was the course that should have been taken.






7. Which policy options do you support?			
		Response Percent	Response Count
a carbon tax		13.1%	887
cap and trade (a price on carbon via an overall limit on emissions paired with some form of market for such pollution permits)		7.5%	504
increased government funding of energy-related technology research and development		35.6%	2,408
cap and dividend, in which the proceeds of auctioning pollution permits are rebated to taxpayers		6.0%	404
keeping science out of the political process		67.7%	4,576
		answered question	6,759
		skipped question	2

Figure 10. Only 7.5% of nearly 7,000 respondents said cap and trade was the course that should have been taken (Questions 7 from a *Scientific American* on-line poll, downloaded November 12, 2010).

### Conclusion

I hope to have demonstrated in this testimony that observed warming rates are certainly below the mean of the most likely suite of climate models, and that the finding of endangerment by the EPA is based upon an important assumption that may not be true.

Further, science and scientists are demonstrably incentivized, as publicly funded goods, in ways that make any synthesis of the scientific literature highly susceptible to bias. Finally, an ongoing survey by *Scientific American* reveals profound distrust of scientific institutions such as the IPCC, and by extension, the CCSP, probably caused by the incentives noted above.

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