

# The Global Warming Debate

A Layman's Guide to the Science and Controversy

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## 9. Hansen's '88 Scenarios

### *Oracle or charlatan? (case study)*

In 1988, NASA Climate Scientist James Hansen published the results of three model scenarios based on possible future emissions of greenhouse gases. Over the past two decades, controversy has surrounded their accuracy.

### Background

In 1987<sup>[1]</sup> and 1988, Hansen testified before Congress about human caused global warming. The '87 testimony took place in November and went largely unnoticed. Recognizing that the public tends to doubt global warming when it is cold outside (see section 4), another hearing was scheduled, this time for June. Timothy Wirth (D-Colorado), then chairman of the Senate Energy and Natural Resources Committee selected June 23<sup>rd</sup>, historically the hottest day of the year in Washington DC. The night before the hearing, committee staffers opened all the windows in the hearing room to make sure the air conditioning wasn't working properly. Not surprisingly, the hearing was appropriately hot.

### Testimony<sup>[2]</sup>

Hansen testified that the temperatures of 1988 to that point were 0.4 ° warmer than the 1950 to 1980 average. He said, "The probability of a chance warming of that magnitude is about 1 percent. So, with 99% confidence we can state that the warming during this time period is a real warming trend."

As in the '87 testimony, the centerpiece of Hansen's '88 testimony was the results of three model scenarios, projecting low, medium, and high amounts of warming, depending on future emissions of greenhouse gases.

He also spoke more broadly about the signs of an enhanced greenhouse effect, such as:

- \* Cooling stratosphere
- \* More warming over land and sea ice than ocean
- \* More warming over high latitudes (poles) than low latitudes
- \* More warming in the winter than in the summer

All of these have been observed, except warming of the South Pole (see next section). He summarizes:

*Altogether, the evidence that the earth is warming by an amount which is too large to be a*

*chance fluctuation and the similarity of the warming to that expected from the greenhouse effect represents a very strong case, in my opinion, that the greenhouse effect has been detected, and it is changing our climate now.*

Addressing the possibility of more extreme weather such as heat waves, he testified that the enhanced greenhouse effect would likely increase the probability of hot summers in Washington DC from the normal one-out-of-three chance to between 55 and 70% during the '90s. He also pointed to the model's tendency to predict warmer temperatures in the Southeast and Midwest US.

He concludes: "I would like to stress that there is a need for improving these global climate models, and there is a need for global observations if we're going to obtain a full understanding of these phenomena."

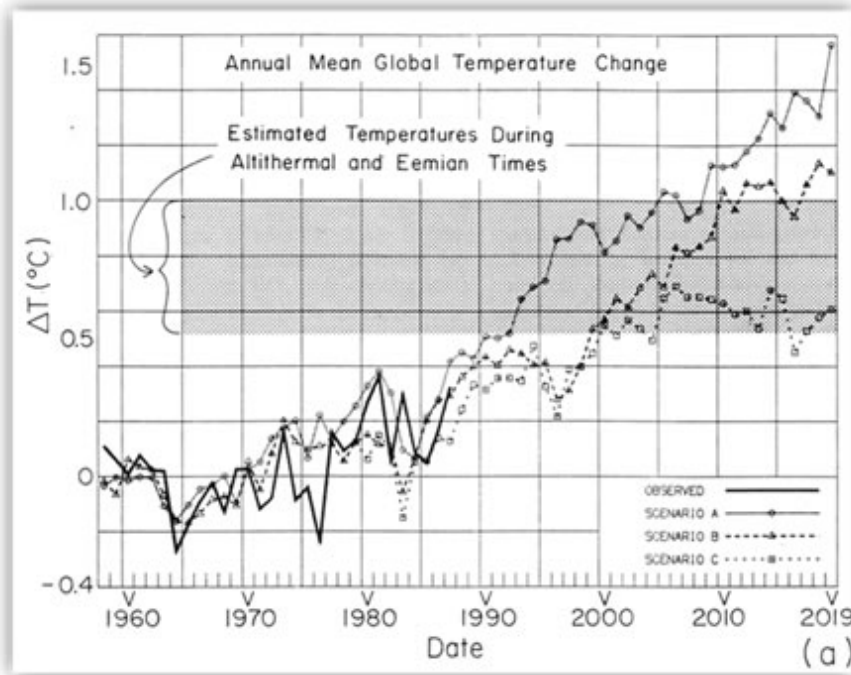
By the time the summer was over, a historic heat wave had killed 5,000-10,000 people in the US and caused \$40 billion in drought related damages. 1988 went on to be the warmest year to that point. The public finally took notice.

## Three scenarios[3]

The three scenarios that Hansen presented remain embroiled in controversy to this day.

The first of the scenarios was initially presented in 1984, and the others were completed over subsequent years. All three were first published together in a 1988 paper. The scenarios were computed on a 1970s era mainframe with the tiniest fraction of computing power compared to what is common today. Of particular interest is that it used a simplified ocean, excluded anthropogenic aerosols, and its calculated climate sensitivity for doubled CO<sub>2</sub> was 4.2 °, versus the current best estimate of 3 ° (see section 7).

In the 1988 testimony Hansen said, "We have considered several scenarios because there are uncertainties in the exact trace gas growth in the past and especially in the future."



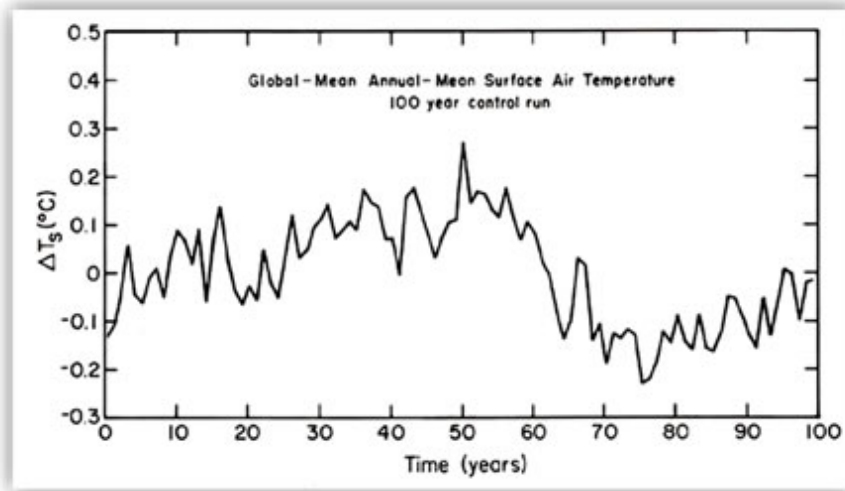
The black line represents the global temperature anomaly as calculated from meteorological stations on land. The top line is scenario A, which Hansen described as “business as usual.” It did not include any volcanic eruptions, which act to cool the planet. It also included the effects of additional and poorly measured trace gases. Scenario A’s greenhouse emissions increased 1.5% per year.

Scenario B is the middle graph. It included volcanic eruptions in 1995 and 2015. Of course, we don’t know when volcanoes are going to erupt in the future, but we do know that they will erupt sometime. The greenhouse gas emissions grow linearly. In the 1988 paper, which was attached to his written testimony, scenario B was described as “perhaps the most plausible of the three cases.”

Scenario C is the bottom graph. It also includes volcanic eruptions in 1995 and 2015. The growth of the greenhouse gas emissions is also linear, although at a slightly lower rate than scenario B. After the year 2000, the growth of these gases flat lines. Hansen described this scenario as “draconian measures.”

So Hansen bracketed expected warming with high and low scenarios. The testimony was based on outcomes projected by scenario B.

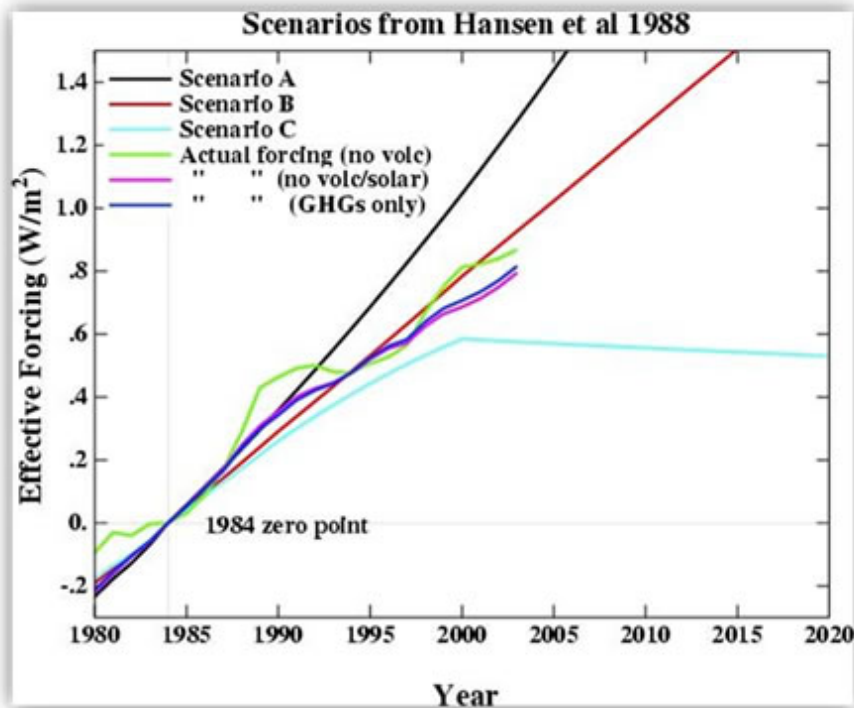
The calculated temperature anomalies for each scenario are in relation to the model’s 100 year control run, where all forcings were fixed at 1958 levels.



The control run shows that even when a scenario is “unforced,” there are still substantial swings in temperature. Just as in reality, the models create natural variability due to the ebb and flow of energy between the atmosphere and ocean. These fluctuations temporarily add to or take away from warming that would occur if human forcings were the only factors driving temperature. Hansen’s statement of a 1% likelihood of temperatures being as warm as those observed in 1988 without an enhanced greenhouse effect is based on the probability of an unforced control run producing a random fluctuation of temperature that high.

## Hansen’s forcings

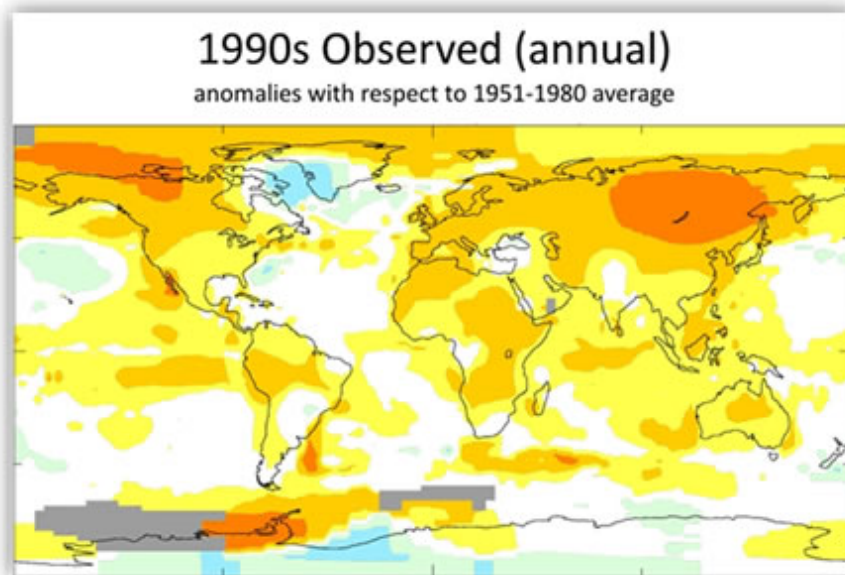
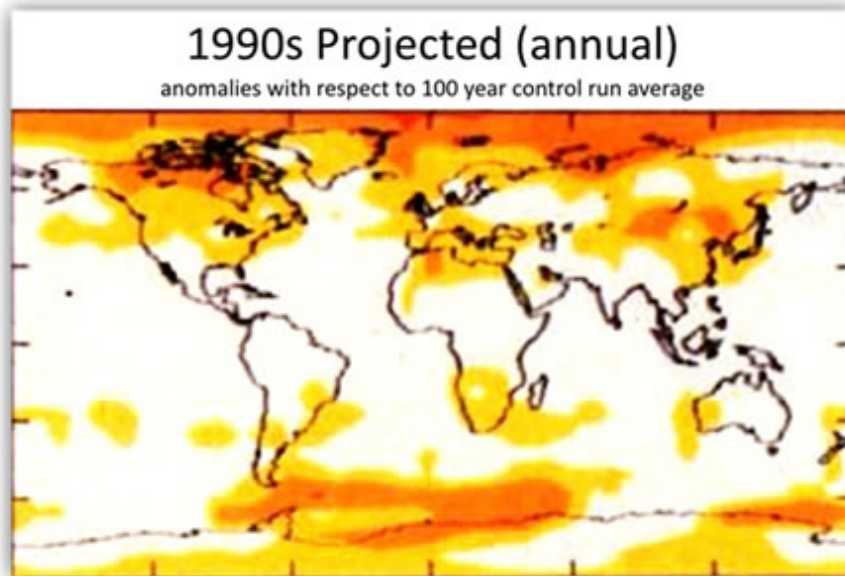
Now that over 20 years have passed since these scenarios were first designed, we can compare estimates of actual forcings to what was projected.[\[4\]](#)



The combined forcings, shown in green, have most closely followed scenario B, shown in red. Even if Hansen had not chosen scenario B as the most plausible, the model should be judged based on the accuracy of this scenario, since the forcings that went into it most closely match reality.

## Regional changes [\[5\]](#)

Hansen's 1988 paper provides regional projections for the 1990s. In his written testimony, he says that climate models are "not yet sufficiently realistic to provide reliable predictions of the impact of greenhouse warming on detailed regional climate patterns" but that "such studies help focus the work needed to develop improved climate models and to analyze observed climate change."

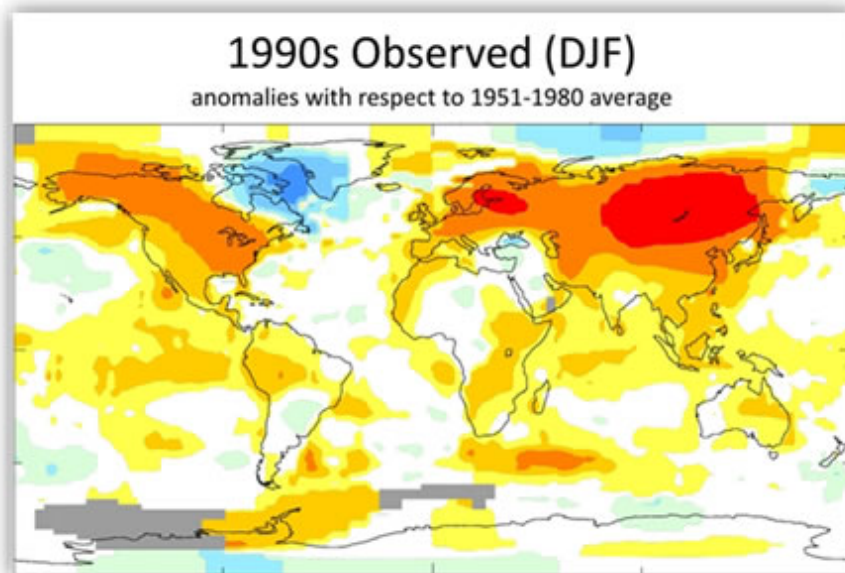
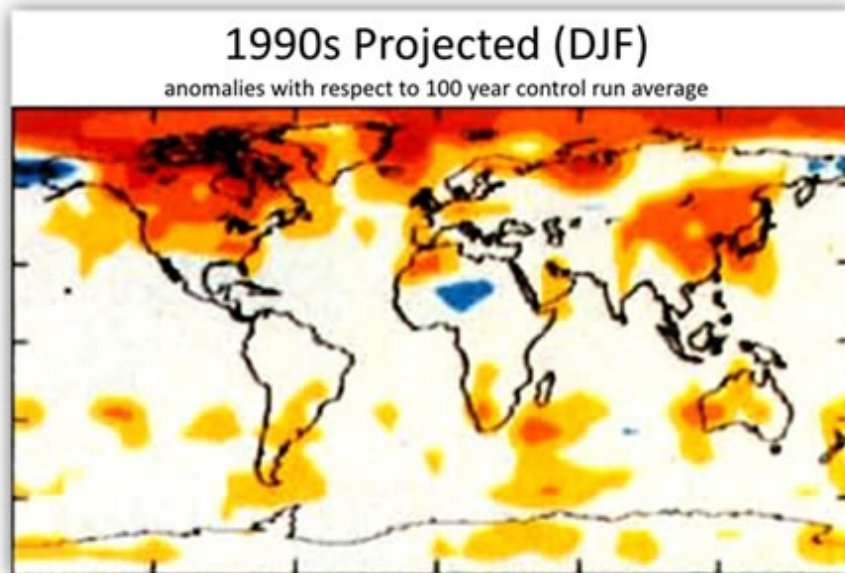


Above are the modeled anomalies for scenario B during the '90s. Red areas are warmer than the average temperature during the control run, and blue areas are colder than the control run. In contrast, the observed anomalies are in relation to the 1951 to 1980 mean. The intensity of the colors has not been made consistent between the model results and the observations, so bear that in mind. Also note that the grey areas in the observations indicate that there are no thermometers in those regions so we cannot calculate the anomaly.

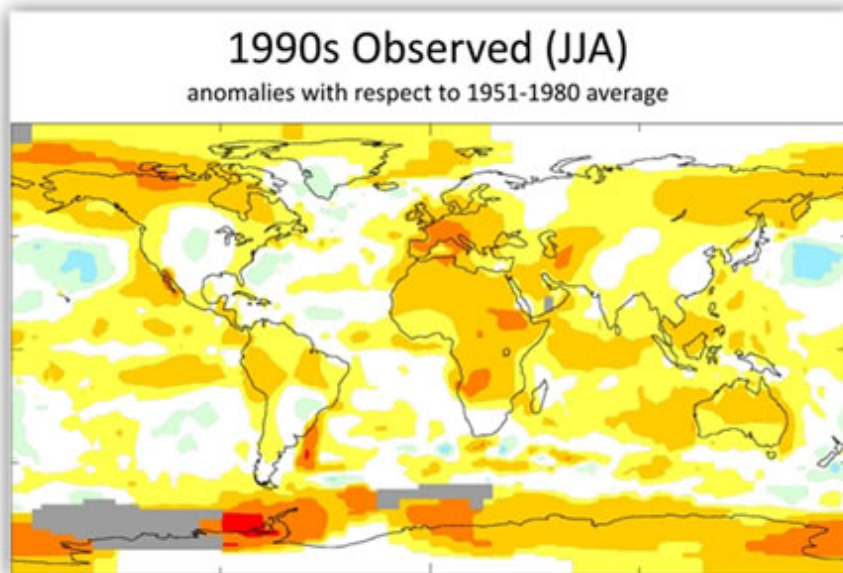
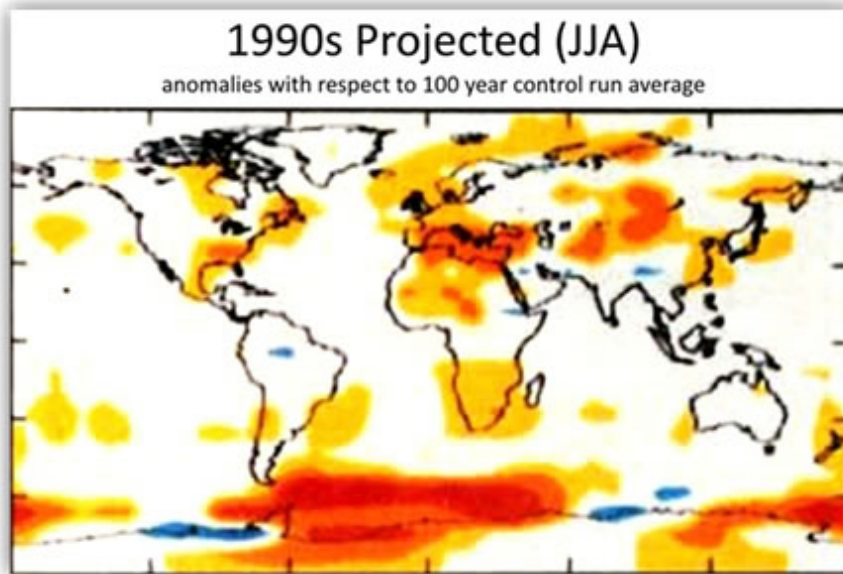
In general we can conclude that scenario B did a reasonable job forecasting the climate during the 1990s, although many details do not match. This is for two reasons. The first is due to natural variability, which the model does not attempt to predict. More significantly, other differences are due to shortcomings of the model, especially those relating to the simplified ocean.

Most of the warming is over land, and thus most of it is over the northern hemisphere. In the southern hemisphere, the strongest anomalies are on the Antarctic Peninsula. However, the interior of Antarctica

cooled slightly, which is a definite shortcoming of the model, which we will discuss in an upcoming section.



For the northern hemisphere winter (Dec-Jan-Feb), our conclusions are much the same. The strongest anomalies are over northern hemisphere continents, although there was cooling in the Arctic Ocean and the waters to the west of Greenland due to changes in the North Atlantic Oscillation.



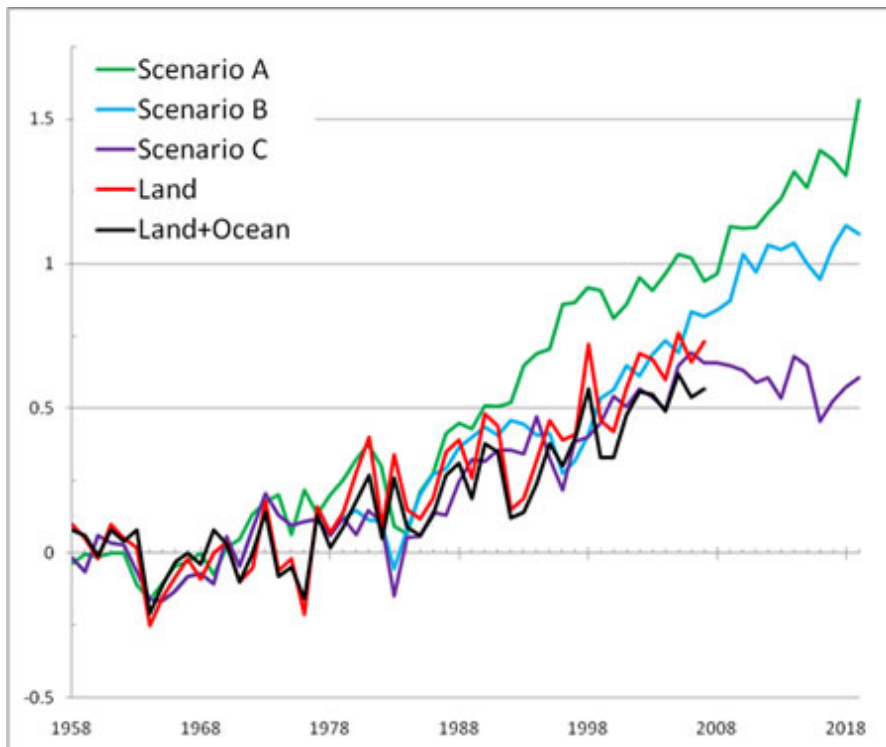
Finally is the Northern Hemisphere summer (June-July-Aug), which shows the strongest anomalies near the Antarctic Peninsula and on the perimeter of Antarctica. Hansen had noted the tendency for the models to predict increased temperatures in the Southeast United States during the summer, but only a slight warming was observed.

Clearly, these results are far from perfect, but they match the general predictions of anthropogenic global warming.

## Temperature anomalies from 1984 to 2007 [\[6\]](#)

For these scenarios, the dividing line between the past and the future was in 1984. We now have 24 years of observations to compare to the “future” scenarios.





For this time period, scenario A, shown in green, calculated  $0.37^{\circ}$  per decade of warming. Scenario B, shown in blue, calculated  $0.25^{\circ}$  per decade of warming. Scenario C, shown in green, calculated  $0.24^{\circ}$  per decade. If you recall, scenario B and scenario C are quite similar until the year 2000 when scenario C's "draconian measures" kick in, and modeled temperatures don't begin to diverge until around 2006.

Observations tell us that temperatures on land, shown in red, have been warming at  $0.24^{\circ}$  per decade since 1984. This was the original comparison made in 1988, and matches closely with scenario B. However, since 1988, NASA and other organizations have devised temperature indexes that more accurately represent the temperature of the whole world, including oceans. Thus the inclusion of the land+ocean index shown in black. The land surface warms faster than the ocean, so including the ocean surface acts to decrease warming. The land-ocean index shows warming of about  $0.21^{\circ}$  per decade since 1984. Finally, there was an actual volcanic eruption: Mount Pinatubo in 1991.

We can conclude that although scenario B matches warming over land, it exceeds warming over the land and ocean by about 21%. However, given natural variability, this is still within the expected range. Over longer time periods, we would expect the model to overestimate warming due to its calculated climate sensitivity of  $4.2^{\circ}$ , which is higher than our current best estimate of  $\sim 3^{\circ}$ .

## “21% is a lot!”

Is a 21% overestimate from 1984 and 2007 “a lot”? And does this conclusion change if we compare scenario B to the other analyses of temperature?

As mentioned in section 4, skeptics consider the satellite measurements of the lower troposphere to be the most accurate method of measuring global temperatures. Recall that the UAH satellite temperature series, long used by skeptics to “prove” that little or no warming was occurring, corrected an error in 2005 that

resulted in a 40% increase in the calculated warming trend. Significance is in the eye of the beholder.

How well does Scenario B agree with each temperature analysis as of January 2008?[\[7\]](#)

Analysis	Rate of Warming since 1984*	Scenario B over estimate**
Scenario B	0.25	-
RSS 3.1	0.23	6%
HadCRUT3v	0.21	18%
GISTEMP	0.21	21%
UAH 5.2	0.20	22%

\*Rate of warming for each temperature series based on monthly data. Rate of warming for Scenario B based on annual averages.

\*\*Apparent discrepancies are due to rounding.

Of all the analyses, the closest to scenario B is the RSS satellite analysis, with Hansen's scenario overshooting observed warming by 6%. As in section 4, the UAH satellite analysis shows the least amount of warming.

## Patrick Michaels' 1998 testimony

Ten years after Hansen presented his scenarios, Pat Michaels testified before Congress. Pat Michaels is the former "Virginia State Climatologist" and a CATO institute fellow, a libertarian think tank. Whenever a talk show involves global warming contrarians debating the issues, he is the one you are most likely to see. However, he now admits that global warming is a real problem but we should avoid government regulation.

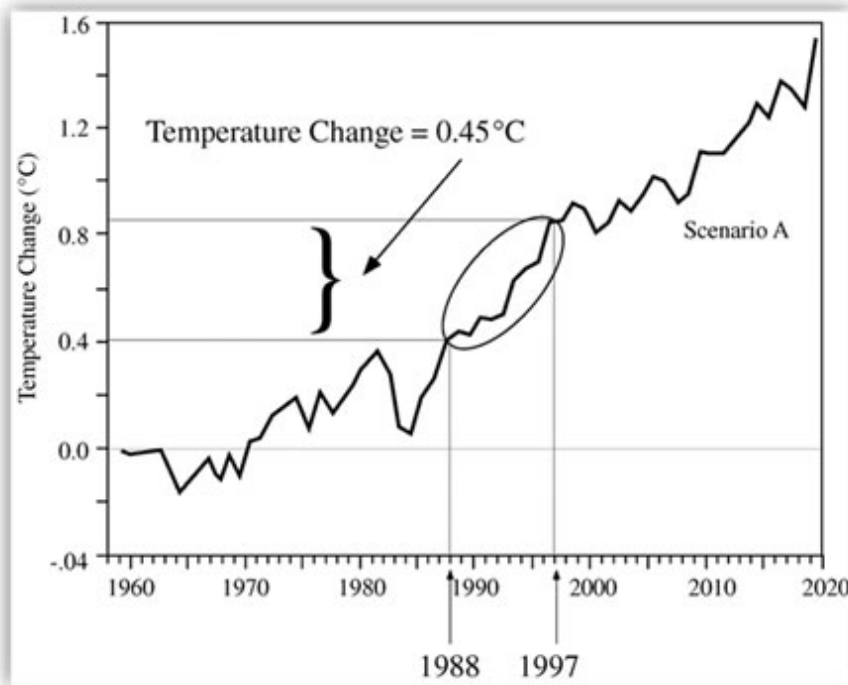
In 1998, he testified before the House Committee on Small Business, and he made these statements:[\[8\]](#)

*Hansen's model predicted that global temperature between 1988 and 1997 would rise by 0.45 °.[...] Ground-based temperatures from the IPCC show a rise of 0.11, or more than four times less than Hansen predicted.*

*The forecast made in 1988 was an astounding failure, and the IPCC's 1990 statement about the realistic nature of these projections was simply wrong.*

## "4X less?"

How did Michaels conclude that warming was 4X less than predicted?



He looked at only scenario A, and ignored the other two scenarios. He then compared the modeled 1988 and 1997 to the IPCC's official measurements for 1988 and 1997, even though models do not attempt to predict the temperature anomalies for specific years. [9]

As we've shown, a more valid comparison is to compute the rate of warming for both observations and model results over a sufficiently long length of time. Ten years after Pat Michaels testimony, we know that the rate of warming for scenario B and land-based measurements since 1984 are virtually identical. Compared to land-ocean measurements, which wasn't even the original comparison, scenario B calculated 6 to 22% more warming than observed, depending on the analysis. Expressed in Michaels' terms, the warming was between 1.06 and 1.22 times less than predicted. Put yet another way, the actual error over the last 24 years is more than 3 times *less* than what Michaels alleged back in 1998.

## Science fiction vs. science

Michael Crichton borrowed Michaels' line of reasoning for his 2004 book *State of Fear*. The late Michael Crichton is the author of *Jurassic Park* and other books and movies, and the creator of the TV show *ER*. He was a non-practicing medical doctor. In *State of Fear*, Crichton writes about power-mad activists who have concocted global warming as a means to further their own agenda. In his afterword, Crichton concludes that global warming is eugenics revisited (see the Introduction, and section 11 for the refutation).

On the merits of this book, he was invited by Senator James Inhofe (R-Oklahoma), then chairman of the Senate Environment and Public Works Committee, to testify before Congress. In his testimony, he used the occasion to blast the Hockey Stick (see section 5) and the IPCC. [10]

For *State of Fear*, Crichton received the American Association of Petroleum Geologists "Geosciences in Media Award" for "notable journalistic achievement in any medium which contributes to public

understanding of geology, energy resources, or the technology of oil and gas exploration.”<sup>[11]</sup> According to the AAPG's communications director, “*State of Fear* is fiction, but it has the absolute ring of truth.”<sup>[12]</sup>

President Bush liked the book so much he met with Crichton. According to commentator Fred Barnes, “the president ‘avidly read’ the novel and met the author after Karl Rove arranged it” and that Bush talked with Crichton “for an hour and were in near-total agreement.”<sup>[13]</sup>

In the introduction it says that despite being a work of fiction, “references to real people, institutions, and organizations that are documented in footnotes are accurate. Footnotes are real.”<sup>[14]</sup> So he's holding himself to a high standard, and Congress, petroleum geologists, and the President seem to agree.

## State of distortion

In the book Crichton writes,<sup>[15]</sup>

*“When Hansen announced in the summer of 1988 that global warming was here, he predicted temperatures would increase .35 °C over the next ten years.”*

*[...]*

*“Dr. Hansen overestimated by three hundred percent. The actual increase was .11 °.”*

Same idea as Michaels but different math. The book continues:

*“And ten years after his testimony, he said that the forces that govern climate change are so poorly understood that long-term prediction is impossible.”*

*[...]*

*“He, said, quote ‘The forcings that drive long-term climate change are not known with an accuracy sufficient to define future climate change. And he argued that, in the future, scientists should use multiple scenarios to define a range of possible climate outcomes.’”*

Crichton provides a citation to a paper of Hansen's from the *Proceedings of the National Academy of Sciences* (PNAS). When one character starts to object, the hero says, “Stop quibbling. He said it.”

In fact, he said it in 1988. As we recall from Hansen's testimony, “We have considered *several scenarios* because there are uncertainties in the exact trace gas growth in the past and especially in the future.”<sup>[16]</sup> Crichton ignored Hansen's other scenarios and then used Hansen's words calling on other scientists to use multiple scenarios in their projections to make it seem like Hansen was backpeddling. Hansen has always used multiple scenarios.

If only Crichton had read his own footnotes.

## Notes

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<sup>[1]</sup> (Hansen J. , 1987) Online [here](#)

[2] (Hansen J. , 1988) Online [here](#)

[3] (Hansen J. , 1988) Online [here](#) (Hansen, et al., 1988) Online [here](#)

[4] (Schmidt, 2007) Online [here](#)

[5] (Hansen J. , Greenhouse Effect and Global Climate Change: Written Testimony of James Hansen, 1988) Online [here](#). (Hansen, et al., 1988) Online [here](#). (NASA GISS) Map creation tool [here](#)

[6] (NASA GISS) Data [here](#) and [here](#). (Schmidt, 2007) Data [here](#).

[7] (Schmidt, 2007) Data [here](#). (RSS) Data [here](#). (UK Hadley Centre and Climatic Research Unit of the University of East Anglia) Data [here](#). (Christy & Spencer) Data [here](#). (NASA GISS) Data [here](#).

[8] (Michaels, 1998) Online [here](#).

[9] (Michaels, Long Hot Year: Latest Science Debunks Global Warming Hysteria, 1998) Online [here](#). This article by Michaels is a longer, more detailed version of his 1998 testimony. It contains a litany of conclusions since found to be without merit, based on such old standbys as the radiosondes and UAH satellite analysis.

[10] (Crichton, 2005) Online [here](#).

[11] (AAPG, 2006) Online [here](#). The award was called “Geosciences in *Journalism*” but was changed to “Geosciences in the Media” after some AAPG members objected.

[12] (Dean, 2006) Online [here](#).

[13] (Janofsky, 2006) Online [here](#).

[14] (Crichton M. , 2004) Eugenics discussion begins [here](#). Footnote disclaimer [here](#)

[15] Ibid [Page 273](#) of paperback.

[16] (Hansen J. , 1988) Online [here](#)

[17] (Hansen, Sato, Lacis, Ruedy, Tegen, & Mathews, 1998) Online [here](#)

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