

Chapter 27. 1987: What to Tell Decision-Makers?

A letter from Senator J. Bennett Johnston requested my testimony to the Senate Committee on Energy and Natural Resources, asking my “views on the likely pace and regional implications of the Greenhouse Effect and Global Climate Change, with specific reference to temperature changes in the nation's cities” – fingerprints of Rafe Pomerance again.

That sentence was the only instruction. It seemed to be an open license, so I prepared a list of seven topics and questions that I thought they should ask. My hope, I wrote in an introduction, was to “find an appropriate middle ground between the preference of scientists to stress all caveats in detail, and the desire of non-technical parties for an understandable practical statement of the status of scientific understanding.”

The hearing was in November 1987 – when our climate model simulations were complete for all three greenhouse gas scenarios. In a preface I noted that my testimony was based in part on climate research being carried out at GISS with colleagues I. Fung, A. Lacis, S. Lebedeff, D. Rind, R. Ruedy, G. Russell and P. Stone. My 25-page written testimony included 14 figures.

My testimony is available in the Congressional Record and from my website.¹ After discussion of each topic or question I provided a one-paragraph conclusion.

The first question was: “Are major greenhouse climate changes a certainty?” My discussion included evidence from planetary comparisons, from understanding based on theory and modeling, and empirical evidence from paleoclimate and ongoing observations.

My conclusion was: in view of the facts that (1) even conservative projections of CO₂ and trace gas growth indicate an equivalent doubling of CO₂ by the second half of the 21st century, and (2) the warmest time in the past 100,000 years was only about 1°C warmer than present, we can confidently state that major greenhouse climate changes are a certainty. However, as shown by results in the remainder of the testimony, the impacts are much less in scenarios with reduced trace gas growth rates.

Another question, intended to cover the request in Senator Johnston’s letter, asked “Will the temperature changes be significant to the man-in-the-street?”

My answer was based on simulations with our climate model, which had a sensitivity of 4°C global warming for doubled CO₂. When this equilibrium global warming was achieved, there was a dramatic impact on the number of days per year that temperature extremes were exceeded, as I showed for eight United States cities. The annual number of days with temperature reaching 100°F (38°C) increased from 19 to 78 in Dallas, Texas and from 4 to 42 in Memphis, Tennessee. The annual number of nights in which the temperature failed to fall below 80°F (27°C) increased from 4 to 68 in Dallas and from 2 to 51 in Memphis.

Policy actions could prevent such a 4°C global warming, relative to the 1951-1980 base period used for our calculations, from ever occurring. I showed the near-term progression of warming for three scenarios. Scenario A had continued exponential growth of the gases, including CFCs. Scenario B had a slow growth in emission rates that produced a nearly constant annual growth rate of the net climate forcing. Scenario C had a dramatic slowdown of emissions such that the

net greenhouse gas climate forcing remained constant after year 2000. Scenario B was described as “the most plausible;” indeed, subsequent reality matched it closely.

My conclusion was: Although there has been little quantitative research on climate impacts of greenhouse warming, it is apparent that the temperature changes predicted to result from scenarios A and B would dramatically alter the climate perceived by the man-in-the-street.

Another topic was: “Climate response time: implications for emissions policies.” The delayed response of climate to imposed forcings causes a huge problem for policymakers. By the time climate change becomes apparent to the public, additional climate change is already locked in.

I pointed out that the amount of climate change locked in is a strong function of climate sensitivity, and that the recent studies indicated a high climate sensitivity. The implication was that a large amount of warming due to gases already in the air had not yet occurred.

Heat storage in the ocean was the hallmark of delayed response, I noted, and accurate monitoring of ocean temperature was the “single measurable quantity which would be most helpful.”

My conclusion was: The finite response time of the climate system implies that there is unrealized greenhouse warming already “in the bank” or “in the pipeline.” This yet-to-be-realized warming calls into question a policy of “wait and see” regarding the issue of how to deal with increasing atmospheric carbon dioxide and other trace gases.

Friday morning, 6 November 1987, I received a call from Lynne Murphy of NASA Headquarters. My testimony, scheduled for Monday three days hence, was not approved.

I was unaware of the approval process. I do not know whether my 1982 and 1986 testimonies were subjected to this approval process. Perhaps a person learns about the process only when testimony is disapproved.

I was told that the White House Office of Management and Budget (OMB) wanted changes to many statements in the testimony. These changes were located throughout the testimony. The changes were substantial, in my opinion, diluting and distorting my conclusions.

Instead, I suggested some clarifications that I was willing to make. Interactions with whoever it was at OMB went via Lynne. By mid-afternoon there was still no response from OMB. I was getting angry as I waited. I had worked hard on the testimony, and I knew it was good.

Late in the afternoon I told Lynne that I was going home, and so was my secretary. That evening I got a call at home from Lynne. OMB insisted on essentially all of their changes. Stubbornness is one characteristic that I seemed to have inherited from my mother. I would be damned if I would make any of their changes. We had an impasse.

Out of the blue, Lynne said that of course I had “the right to testify as a private citizen,” if we could not get OMB to agree on the testimony. I doubt that employees in NASA’s Office of Congressional Affairs are encouraged to make that suggestion to a scientist.²

Later Friday evening Lynne told me that she got “approval” of OMB for me to testify as a private citizen. She had the 50 copies of my testimony shipped back to my office.

Sunday morning I went to my office and replaced the front page on all 50 copies of the testimony. I changed my address from NASA to 33 North Pleasant, Ridgewood, New Jersey. [We had just moved. Thanks to Anniek's work to improve the South Irving house, we could sell it and move to a larger house with more than an acre of land and a big red barn.]

Before leaving my office I wrote a note to my supervisor, Jim Trainor: "Jim, This is the testimony I'm giving to the Senate Energy Committee Monday. OMB decided Friday evening that they would not approve it. They wanted changes in every section which diluted and distorted what I was saying, so I could not make the changes. Lynne Murphy got them to agree to let me testify as a private citizen and returned the copies to me over the weekend, but I was obviously unable to get the Committee advance copies as they requested. I don't understand the basis by which OMB can censor scientific opinion." I sent the note by express mail. Trainor would receive it while I was in Washington for the testimony. I did not call him, because I was concerned that he might ask me not to testify.

Chairman Johnston must not have been present for the hearing, because I scratched "Mr. Chairman" as the first words of my oral testimony and instead read: "Senator Wirth, Senator Murkowski, thank you for the opportunity to testify. Before I begin I would like to state that, although I direct the NASA Goddard Institute for Space Studies, I am appearing here on the basis of my scientific credentials; the views that I present are not meant to represent in any way agency or administration policy."

Tim Wirth of Colorado was a Democrat and Frank Murkowski of Alaska a Republican. They had in front of them my written testimony with my home address. I expected the strange beginning to my testimony to at least elicit dialogue, if not consternation. But not one peep.

Two issues cried out for discussion. First, why did the White House try to reduce, so thoroughly, the degree of confidence in human-made climate change and its importance to the public?

Second, on what basis is OMB allowed to alter the expressed opinion of scientists? I asked that question of NASA Congressional Affairs and was told that it was to assure that any testimony of government employees is "consistent with the Administration's budget request to Congress."

What? Science is altered to fit the budget? It made no sense. Yet I was to learn later that both political parties use OMB and Offices of Public Affairs to filter the information that government scientists present to the public.

It was my own fault. I could have asked the Chairman to include that topic in the agenda, or I could have explicitly raised the issue during my testimony. I missed an opportunity.

Rafe, the staffer who organized the hearing, and I went into a smaller room after the hearing. Rafe wanted to talk about next steps – another hearing – but I was grumpy. Testimony preparation was a lot of work. Interest seemed to be minimal. Only two Senators had attended, and media coverage was much less than for the ozone and climate hearing a year earlier.

One reason for lack of interest, I argued, was the cool season. I did not want to testify again unless it was in the summer, when the public and lawmakers might pay more attention.

Senator Tim Wirth had the same thought. He scheduled the next hearing for 23 June 1988.

Chapter 28. 1988: Mother Earth Speaks

The planet seemed to conspire with us. Nature, science and politics aligned on 23 June 1988. We had an opportunity to draw attention to the threat posed by climate change.

Mother Earth was the star. Mid-America was searing in heat, and the discomfort was amplified by a drought of biblical proportions. The Mississippi River dried up -- riverboat paddlewheels ground to a halt. A bubble of hot Midwestern air expanded to encompass the nation's capital, where the temperature exceeded 100°F (38°C). Global temperature was at a record level.

Our climate simulations were complete. Our paper³ describing the results, including examples of how extreme temperatures would increase in American cities, was submitted, refereed, and accepted for publication in the *Journal of Geophysical Research*.

Politicians must have been focused on the Presidential election. Early favorite Michael Dukakis crashed and burned from his own missteps in the face of negative campaign ads and President Reagan's eviscerating depiction of him as an invalid. Attention was diverted. Political censors fell happily asleep at the switch. My testimony passed through NASA and OMB untouched.

I called Rafe Pomerance the day before the Senate hearing. I wanted to be sure that there was good media coverage because, I said, "I'm going to make a pretty strong statement."

I put down the phone and started writing my "oral" testimony. A "just in time" preparation strategy allows more things to get done, but it is also risky. I assumed that composing my remarks would be easy, because my three main conclusions were simple and clear.

I wrote on a tablet of white lined paper, printing initially in large, dark square letters that would be easy to read. The first conclusion was that Earth was warmer in 1988 than at any time in the history of instrumental data. I noted, referring to my first graph, that the four warmest years in the past century all occurred in the 1980s. Also the rate of warming in the last 25 years was the fastest in the record, and 1988 to date was so warm that it would probably break the prior record.

It was hard to work on the plane. When I got to my hotel in Washington, the evening before my testimony, I had finished one page. I commenced work on my second conclusion, namely that we could ascribe the global warming to the greenhouse effect with a high degree of confidence.

I should not have tried to get the Yankee game on the radio, while lying on the bed and writing. It was hard to catch announcer's words over the static from the distant New York station. The Yankees had lost two in a row to the Detroit Tigers, both in the Tigers' last at bat. Now, having fallen out of first place, the Yankees needed this last game in the series to reverse their slide.

Global temperature is "noisy," fluctuating a lot from year to year. The atmosphere and ocean are dynamical fluids that, in effect, slosh about rather chaotically. The standard deviation, the typical amount that the temperature fluctuates annually about its 30-year average, is 0.13°C.

When we wrote our 1981 *Science* paper, with observational data up to 1980, global warming in the prior century was 0.4°C. In the 1980s global temperature increased another 0.2°C. The warming rate was accelerating.

Our new study focused on the period since 1958, when accurate CO₂ measurements began. Expected warming for the observed greenhouse gas increase, if climate sensitivity was 3°C for doubled atmospheric CO₂ as indicated by paleoclimate data and the Charney study, was almost 0.2°C per decade based on simple models. Our global three-dimensional model concurred.

Natural climate forcings were small. Solar irradiance measurements, initiated in the late 1970s, showed that solar climate forcing was small. The Mt. Agung volcanic eruption in 1963 and El Chichón in 1982 had detectable cooling effects, but the effects lasted only a few years.

By 1988 observed warming in the prior two decades was 0.4°C, three times the standard deviation. The chance of such warming as an unforced fluctuation was less than one percent, so I could say with 99 percent confidence that it was a real warming trend, not “noise.”⁴

Furthermore, I had “insider” information: global warming at the observed rate was expected because of increasing greenhouse gases. Therefore, I could say, with a high degree of confidence, that there was a cause and effect relationship between increasing greenhouse gases and observed global warming.

Other characteristics of the observed temperature change also carried a signature of the CO₂ greenhouse effect. For example the stratosphere, the atmosphere above a height of about 10 miles, was cooling, while the lower atmosphere and the surface were warming.

“In all of these cases,” I wrote, “the signal is at best just beginning to emerge, and we need more data.” And further: “There are certainly other climate change factors involved in addition to the greenhouse effect.”

“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.”

I was on the third page already, my writing was getting scrunched and tight, and I was mixing long-hand with printing. The testimony was getting too long. The Senators will not cut me off, I thought, it is too important. But I had more to write. So I scratched some explanations.

The Yankees lost in extra innings, again. Steinbrenner surely would go berserk. Why did I hang on these games? Was it not clear that both the Yankees and Don Mattingly were sinking fast?⁵

My eyes drooped and I could not think well. I decided to sleep. Better to get up early. I would not need breakfast. I had a raisin bagel with me – I always take raisin bagels on my trips – and I could get coffee at NASA Headquarters, where I had to attend a meeting in the morning.

The next morning I started a clean 4th page, for a fresh beginning on my 3rd conclusion: global warming was already large enough to affect the probability of extreme events such as an unusually hot summer. The idea is simple. Take the 30-year period 1951-1980 to define the normal climate that people expected. At each location around the world we define the 10 coldest summers as “cold summers.” The 10 hottest ones are in the category “hot summers,” and the middle 10 are the “average” or “normal” climate, so during that 30-year period there was about a 33 percent chance that a given year would fall within the temperature range defined as “hot.”

Greenhouse warming by CO₂ and other trace gases was changing the odds. I wrote: “In the late 1980s the probability of a hot summer is somewhere in the range 40-60%,” but I put this in parentheses. If the Chairman asked me to speed up, I would skip statements in parentheses.

I started a fifth page. I would finish it at NASA Headquarters. I arrived a few minutes late, but the scientists, about 30 of them, were still finding seats at a long table or in chairs along the wall.

Ichtiaque Rasool, Chief Scientist in NASA Earth Sciences, announced that he had approval for a \$2,000,000 per year research program for early detection of global climate change. I wanted to appear involved in the meeting before I tuned out to work on my testimony, so I piped up “Are you sure you are not missing a zero?” Two million dollars was chicken feed to NASA. Twenty million could cover observations, high-speed computers, and research and analysis.

Rasool ignored my comment and continued with the meeting, and I resumed writing. But when Rasool stated that “no respectable scientist” would say that the human-made global warming signal had already been detected, my head jerked up and I said “I don’t know if he’s respectable or not, but I know a scientist who is about to make that assertion.” Several scientists turned to look at me, but Rasool did not take the bait.

At the coffee break I asked David Rind about atmospheric dynamics in our model. Was there a reason why the Midwest and Southeast U.S. often had extreme summer heat in our model runs? He noted that the ocean off the East Coast tended to warm less⁶ than the land, which could cause high pressure along the east coast and thus circulation of warm air north into the Midwest or southeast, but he included appropriate caveats about model shortcomings.

David’s suggestion was fine, but I should not have commented on dynamics. Our model did not explicitly include ocean dynamics or allow ocean dynamical effects to change as climate changed. Atmospheric dynamics in our eight-by-ten degree model was adequate for poleward heat transport, but not for reliable analysis of a specific regional climate feature. The Senators would not notice or understand a comment on dynamics, but it would turn out to be a cause of irritation and outrage for certain fellow scientists.

At lunch break, I rushed out and hailed a cab. The ride to the Dirksen Senate Building was short – no time to rehearse the testimony. That was o.k. – I had planned to read it anyway.

However, I thought of a summary statement, intended for the media. On a separate page I wrote “it is time to stop waffling so much and say that the evidence is pretty strong that the greenhouse effect is here and is affecting our climate now.” I put this page behind the five numbered pages. I might be able to use it during the give-and-take discussion, after the formal testimonies.

In the hearing room, a staffer pulled me aside and took me to speak with Senator Wirth. Wirth had read my statement and wanted to make me the first witness. Of course, I agreed. People would be paying more attention at the beginning.

At least half a dozen Senators were present. They knew media would be present, providing the chance for a sound bite that would get on television or in the newspapers.

J. Bennett Johnston, Louisiana, Chairman of the Committee on Energy and Natural Resources, went first and uttered a one-liner that got in the news: “We have only one planet. If we screw it



Fig. 28.1 Hansen testifying on 23 June 1988

up, we have no place else to go.” He followed with some insightful commentary, presumably prepared by his staffers: “The greenhouse effect has ripened beyond theory now. We know it is fact. What we don’t know is how quickly it will come upon us as an emergency fact, how quickly it will ripen from just simply a matter of deep concern to a matter of severe emergency.”

Johnston then turned the chairmanship of the hearing over to Senator Timothy E. Wirth of Colorado, who stated: “The Energy Committee must move aggressively to examine how energy policy has contributed to the greenhouse effect and the kinds of changes in energy policy that may be needed to reverse the trend of increased emissions of carbon dioxide...”

Senator Dale Bumpers of Arkansas made an emphatic statement that proved prescient, indeed, it sounded like an instruction to all the media in attendance: “Dr. Hansen is going to testify today to what...ought to be cause for headlines in every newspaper in America tomorrow morning.”

Doubtless I was tense, but I was confident, because I could read the testimony and I knew that I could answer their questions. I wanted my three conclusions to be unambiguous, so I began:

Mr. Chairman and committee members, thank you for the opportunity to present the results of my research on the greenhouse effect, which has been carried out with my colleagues at the NASA Goddard Institute for Space Studies.

My principal conclusions are: (1) the earth is warmer now than at any time in the history of instrumental measurements, (2) the global warming is now sufficiently large that we can ascribe with a high degree of confidence a cause and effect relationship to the greenhouse effect, and (3) in our computer climate simulations the greenhouse effect is already large enough to begin to affect the probability of occurrence of extreme events such as summer heat waves.

Microphones were fixed on the table, making it impractical for me to place my charts on the projector and speak into the mic. So I asked Suki Manabe if he would put my charts on the projector. Suki was a decade my senior and a more accomplished scientist, but he readily agreed.

My oral testimony was probably 12-15 minutes.⁷ Senator Wirth then had the other scientists give their testimony before opening up for discussion. The other panel members were Michael Oppenheimer, George Woodwell, Suki Manabe, Dan Dudek and Bill Moomaw.

Discussion following the presentations raised several points. There was agreement that a specific drought or other meteorological event cannot be blamed on the greenhouse effect. However, the probability and severity of such events increase in a hotter world.

My assertion of 99 percent confidence astonished some Senators. Senator Wirth said that he agreed with the 99 percent assertion, based on his reading of studies and meeting many people in this research field. However, he seemed to anticipate scientific backlash to my testimony, as he pointed out that programs such as energy conservation, alternative energy sources and reforestation should take place regardless of the degree of confidence in the climate assessment.

The Senators needed to rush to a vote on the Senate floor, but Senator Domenici took over as the presiding Senator, because he wanted to continue discussion about policy, chiding the other Senators, to laughter of the audience, that he could still “run there and get there.”

Senator Domenici raised the issue of incrementalism. Is an appropriate policy, at least in early stages, incremental diminution of the problem via steps such as improved energy efficiency. He seemed to get agreement on the incremental approach from the scientists who focused on policy.

Senator Domenici foreshadowed a great policy failure. Incrementalism, accompanied by strategic long-term vision and action, made sense. But incrementalism as an excuse to avoid clear policy implications of the science, sentenced future generations to climate disasters. Nevertheless, once the reality of the climate threat was recognized globally, the policy choice recommended by the United States and accepted by the global community was incrementalism.

As the hearing adjourned at 4:15 p.m., I realized that I had not used my “waffling” comment. Several reporters waited in the back of the room. Phil Shabecoff of the New York Times asked what global temperature rise was needed to confirm the human-made greenhouse effect as cause. This was my opportunity. I said that there was no “magic number” for that, but “it is time to stop waffling so much and say that the evidence is pretty strong that the greenhouse effect is here.”⁸

The next day, Friday morning, that quote – along with our graph of global temperature from 1880 to 1988 – was prominent in Shabecoff’s front-page article in the New York Times, which was headlined “Global Warming Has Begun, Expert Tells Senate.”

But the lead article on the front page of our New Jersey newspaper, The Record, was “George Fires Billy – Again!” The Wednesday night extra-inning loss to The Tigers caused Steinbrenner to fire Billy Martin for the fifth and final time. The front page also had an article titled “Pollution raised risk of drought,” with subhead “NASA expert blames ‘greenhouse effect’.”

The Shabecoff article portrayed accurately the message I meant to convey. It was an exception. Most stories – including television newscasts – said that I ascribed the drought to the greenhouse effect. Widespread misimpressions were probably unavoidable, given the massive ongoing heatwave and drought. I minimized interviews after the hearing, but when invited to go on a popular Sunday morning news program, I saw an opportunity to clarify the message.

I already had a set of large dice for that purpose. One die was for the climate of 1951-1980, the most recent three complete decades, which NOAA took to represent the climate that people expected to see. This “normal” climate die had two white sides for near average temperatures, two blue sides for cool summers, and two red sides for summers notably hotter than average.

The other die, for end-of-century climate, had four red sides, one white side and one blue side. Climate change, global warming, was loading the climate dice enough that people should notice the change by the end of the century from the increased frequency of extreme hot events.

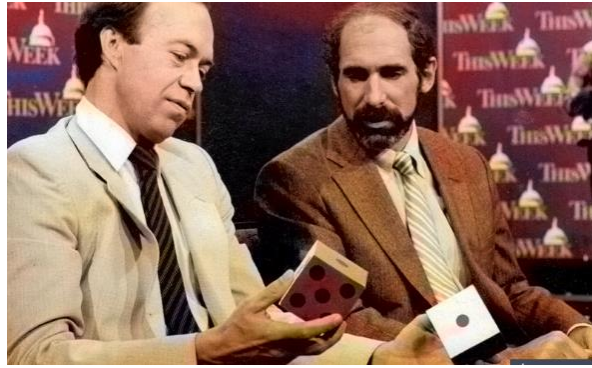


Fig. 28.2 Hansen and Oppenheimer on This Week news program, Sunday 26 June 1988

That night, when we were in bed, Anniek told me that she thought she had breast cancer, and was waiting for laboratory confirmation. The doctor had given her that opinion two weeks earlier, but she did not tell me, so as to avoid upsetting me before the Senate testimony.

From a friend we learned of a doctor at Columbia Presbyterian Hospital, supposedly among the nation's best in treating breast cancer, at least among those who specialized in surgery. We were fortunate to get an early appointment.

He provided the latest data on breast cancer survival rates and assured us that Anniek's odds were good because her cancer had been discovered early. My maternal grandmother had died from breast cancer when my mother was 13. Anniek's sister-in-law got breast cancer when her children were young, but she did not succumb to the disease until her children were adults. We did not expect Erik and Kiki to be subjected to such trauma, yet the first thought that enters one's mind is how to reduce the chances to the absolute minimum. Anniek scheduled a double mastectomy. The surgeon provided affirmation, saying that he and his wife had decided on that course, if his wife should ever develop breast cancer.

After we got home, we read articles about breast cancer and its treatments. George Schuyler, my sister Lois' brother-in-law, ran annual meetings of the Radiological Society of North America. George put us in contact with a New York University professor who was a leading expert in radiation treatment of breast cancer. He assured us that, in a case such as Anniek's, there was no discernable difference in survival rate between mastectomies and conservative minimal surgery to remove the cancerous lump followed by treatment with radiation and chemotherapy. Anniek chose that course. The small cancerous lump and some lymph nodes that proved to be cancer-free were removed and she has been cancer-free ever since.

The episode, especially Anniek's withholding of information until after my testimony, was a sobering reminder of all her efforts that aided my career. My priorities changed temporarily, but, once the crisis was over, the effect faded and life mostly reverted back to what it had been. I focused on research and tried to avoid the time-consuming distraction of interviews and politics.

I wanted especially to avoid media hoopla. Even if I prepared beforehand, I found it difficult to string together sensible sentences, especially during television interviews. I almost forgot the "waffling" line, even though I had it written on a piece of paper. Why not leave it to others who were talented at communication. Michael Oppenheimer and Steve Schneider said they were happy to do interviews, if I preferred to divert requests to them. I was glad to do that.

Wally Broecker called. He was at a meeting of the National Academy of Sciences where, Wally said, Jerry Namias was “on the warpath.” Namias was upset about my testimony, in particular the implication that the greenhouse effect had a role in the drought. When someone tried to defend my testimony, Namias shook his fist and said “I saw him say it on television!”

Jerry was referring to my comments about effects of modeled ocean temperature on atmospheric dynamics. Namias was the nation’s most respected weather forecaster. I knew he was partly right: it was a mistake to comment on atmospheric dynamics in my testimony. Such speculation detracted from my main conclusions, which I was sure were rock solid.

Broecker delivered a message: I was requested to write down a clarification of what I was trying to say in my testimony and he would read it at the Academy meeting. An admission of fault was necessary to satisfy Namias.

I refused. First, my position would not satisfy Namias, who insisted that the drought “has no connection whatever with the greenhouse effect.”⁹ I did not agree with that. Second, focus on even a minor flaw might get in the news, cast doubt on my testimony, and perhaps spoil any good produced by the testimony.

There was a real problem with my testimony, however. I did not give equal emphasis to both extremes of the hydrologic cycle. Global warming pumps up both extremes.

On the one hand, at times and places where it is dry, the warming makes heat waves and droughts more extreme and makes fire seasons longer, with fires that burn hotter.

On the other hand, a warmer atmosphere holds more water vapor. Rain, when it comes, tends to be in more extreme events. So-called “100-year floods” occur more often than once a century in a warmer world, and the largest floods are more extreme. Also, storms driven by the latent energy in water vapor or by a warm sea surface – including thunderstorms, tornadoes and tropical storms – have more fuel and thus the potential to be stronger as the planet becomes warmer.

How to make that story clear? Global warming produces stronger heat waves, droughts and a more extreme, longer fire season. That sounds logical. But it also causes heavier rains, more extreme floods and stronger storms? This total story might sound fishy to the public.

Fortuitously, in early 1989 I received a phone call from Rick Adcock, Senator Al Gore’s assistant. Could I testify at a new hearing on global warming? Ah, this was my chance. This time I would be better prepared, and things would go smoothly. So I thought.

¹ Hansen, J.E., [Prediction of near-term climate evolution: what can we tell decision-makers now?](#) Testimony to United States Senate Committee on Energy and Natural Resources, 9 November 1987, 29 pages.

² Sometime later – I believe it was May 1989, when I again had difficulty with OMB -- I asked about Lynne and was told that she was no longer with NASA. They thought she was working for “an environmental organization.”

³ Hansen, J., I. Fung, A. Lacis, D. Rind, S. Lebedeff, R. Ruedy, G. Russell, and P. Stone: [Global climate changes as forecast by Goddard Institute for Space Studies three-dimensional model](#). *J. Geophys. Res.*, **93**, 9341-9364, 1988.

⁴ My language, “99 percent confident” and “high degree of confidence,” was meant to be as a lay person would understand the phrases. Beware that formal, sometimes esoteric, definitions of confidence may include arbitrary assumptions that obscure practical interpretation.

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- ⁵ Mattingly's career peaked at age 24 in 1985, when he had 35 home runs, 145 RBIs and the Yankees won 97 games; Mantle's career also peaked at age 24 in 1956 with 52 home runs and 130 RBIs. (Mantle's second peak in 1961 was from weakened pitching with league expansion). The Yankees finished 1988 in fifth place.
- ⁶ Decades later, when climate models included ocean dynamics, we found that the ocean along the East Coast of the U.S. warmed more than average as the Atlantic Meridional Overturning Circulation began to slow down.
- ⁷ A 9-second youtube [video](#) should suffice, as I read my testimony.
- ⁸ Shabecoff, P., [Global warming has begun, expert tells Senate](#), New York Times, 24 June 1988.
- ⁹ Namias, J., [Cold waters and hot summers](#), *Nature*, **338**, 15-16, 1989.