

Primary Source: Excerpt of “[Climate Surprises](#)” the May 8, 1989 Hearing Before the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation of the United States Senate

Statement of Dr. James Hansen, Director, Goddard Institute for Space Studies, National Aeronautics and Space Administration, New York, NY

Dr. Hansen

Thank you. My testimony is based on research carried out with my colleagues at NASA Goddard Institute for Space Studies located at Columbia University. But the opinions I express represent our scientific conclusions, not necessarily NASA policy.

Since 1958 the international geophysical year when Keeling began to make accurate measurements, atmospheric carbon dioxide has increased 11 percent, nitrous oxide about 7 percent, methane 30 percent, and the chlorofluorocarbons by a factor of 20.

We know the infrared properties of these gases, so we can compute the radiative heating of the earth’s surface which they cause. It is 1.1 watts per meter squared.

Now, this small light bulb which I have here which I took off our Christmas string at home has a power of 1.1 watts. So, the heating of the earth due to the gases added in the past 30 years is equivalent to having a bulb like this shining down on every square meter of the earth’s surface, day and night, year after year and getting brighter each year.

Now, at first glance, it is not obvious whether this heating is important. But consider that the earth absorbs 238 watts per meter squared. So, just the gases added in the last 30 years are one half of 1 percent of the energy that we get from the sun, and in 50 years it will be 2 percent of the energy we get from the sun if we continue along a path of business as usual for trace gas growth rates.

This amount of heating is important. It affects the temperature on the surface, the evaporation from the ground and the temperature and evaporation on a global scale affect the winds, the cloud cover and the rainfall and in turn these affect the oceans—the ocean circulation. That is why we need global models, because we need to analyze the interactions and feedbacks of the entire climate system.

One of the things that we learn from the models, by the way, is that this initial small forcing is magnified by feedback processes which we believe to be in the range of a factor some place between 1.5 and 4.0.

Now, the first point that I want to stress is the value of using models to study basic climate processes, as opposed to making predictions for Des Moines, Iowa or any other specific location. Models are not capable of accurate local climate predictions, but they can be used to help us understand some of the regional implications of global warming.

An example which we are beginning to study is shown on my first viewgraph. This shows—my first viewgraph, if it does appear—

Senator Gore

The overhead projector just broke down, I am informed, so I am sorry about that. We will try to get it fixed.

Dr. Hansen

Well, you can find in my—

Senator Gore

We saw an OMB official near the projector.

This is a transcribed excerpt of the May 8, 1989 Hearing Before the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation.

The full senate hearing transcription can be found [here](#).

Dr. Hansen

The figure which I was going to show is included in my formal testimony. It is a color plate in that testimony and what it shows is areas of brown and green, where brown is used to represent dry areas and green, wet areas.

What we find in our climate modeling is that the large-scale warming which all of the models obtain causes an increased frequency of both extreme droughts and extreme wet situations in the model. This result, an increase of both hydrologic extremes, is one which we believe must survive as the models become more and more realistic, because it originates in a straightforward way from the greenhouse surface heating and the increased temperatures.

The location of wet and dry regions fluctuates from year to year, but increased rates of evaporation cause both increased rainfall and drought intensification. Now, one implication of this result, if it is correct, is that as the greenhouse effect increases droughts will become more frequent at most low latitude and middle latitude land areas.

Although the expected pattern of the drought intensification may change as key elements in the climate models are improved, such as the ground hydrology, the moist convection in clouds and the model's resolution, we believe that it is very unlikely that this basic result will be altered and we believe that there is a potential for scientific consensus during the next several years if this approach of looking at the basic processes is pursued broadly.

Now, the second point that I want to make concerns climate surprises, which you asked us to speculate on. Surprises can be either pleasant or unpleasant. The potential unpleasant surprise which I worry about is the possibility that there could be some near-term regional manifestation of the greenhouse effect analogous to the Antarctic hole in the ozone depletion and in particular, could we suddenly have much more frequent regional droughts as opposed to the gradual transition suggested by climate models?

I have two reasons to suspect that possibility. First, there seems to be an association of drought with high temperatures and northern hemisphere temperatures are now near the levels of the 1930s, a time of frequent severe drought. Second, our climate model has a positive cloud feedback in drought regions, reduced low-level cloud cover which leads to more sunlight coming in and higher temperature and more evaporation.

But this cloud feedback is weak in our model and I sometimes wonder if the cloud feedback is not more accurately described by John Steinbeck. I was going to show on my next viewgraph a quote from *Grapes of Wrath* in which, just picking out a few phrases from that paragraph, he said the clouds that had hung in high puffs were dissipated. The sun flared down, the clouds appeared and went away and in a while they did not try any more.

Well, if his description of clouds is more accurate than the crude cloud simulation in our model, then our present model underestimates the rate at which droughts can potentially intensify. To evaluate this issue we need to put realistic cloud physics into the models and we need good observations of the clouds in both drought regions and nondrought regions.

The third point that I want to make is a pleasant one. It also is illustrated on a viewgraph. I will have to tell you what was one that viewgraph. It shows the production of CFCs were increasing about 10 percent a year for decades until 1974, when concern emerged about the possible impact of CFCs on the ozone layer.

If that growth rate had been maintained, the greenhouse effect of CFCs would now exceed that of carbon dioxide, which was shown on a bar graph on my third viewgraph and it is in my written testimony. But the environmental concerns of consumers and Congress caused a dramatic change in CFC production growth rates.

I think both consumers and Congress deserve credit for that action, which greatly reduced both the present and the future greenhouse effect and the ozone problem and that graph also illustrates very

clearly the impact of breaking from a path of exponential growth of emissions. It is not necessary to eliminate emissions in order to have a very large impact on future greenhouse climate forcing.

My final point concerns what is needed to develop the understanding and the modeling capability for a greenhouse climate change. In my personal opinion, the primary need is brainpower. Observational hardware and large computers are important components in a balanced research program, but their effective use is critically dependent on the existence of appropriately trained and supported manpower which does not now exist.

An appropriate analogy, I believe, is the brainpower requirement which existed in the 1960s, when the United States developed a space science capability. Then, the government supported hundreds of traineeships at top graduate schools, also post-doctoral scientists and research at universities and government laboratories.

The challenge in the earth sciences now is at least as great as that of the space sciences in the 1960s. We must begin to attract and support more of the best and brightest students if we want to achieve the understanding and predictive capability for global change.

Thank you.

Senator Gore

Thank you very much. We are going to hold off on questions. I have a number of things to pursue with you, but let us get the other two statements and then we will ask questions of all three witnesses.

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Excerpt of Question Portion

Hearing Before the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation
United States Senate

Senator Gore

Now we will have questions of the three witnesses on this last panel.

I would like to start with you, Dr. Hansen.

In your statement you respond to our request for information on our scientific understanding of global climate models and our effort to determine which effects are pretty well understood and which effects are subject to change as we learn more about the models.

You respond by saying, among other things, that as the models improve and more evidence becomes available, it is not very likely that scientists will change their conclusion that increases in greenhouse gases will intensify drought in the middle and low latitude land areas, like the Midwest of the United States.

I am puzzled that you also say on that same point on page 4 of your statement that you want to stress that you do not really believe that and that as the computer models evolve, that conclusion will very likely evolve and should not be regarded as reliable.

I think I know the answer to the question I am about to ask you, but why do you directly contradict yourself in the testimony you are giving about this scientific question?

Dr. Hansen

Let me first rephrase exactly what we said in that regard because when I discussed this with my scientific colleagues, the slight rephrasing makes a difference.

What I said was we believe it is very unlikely that this overall conclusion drought intensification at most middle and low latitude land areas if greenhouse gases increase rapidly, will be modified by improved models. Now, that is what I believe, and that is what I wrote.

The last paragraph in that section which seems to be in contradiction to that was not a paragraph which I wrote. It was added to my testimony in the process of review by OMB, and I did object to the addition of that paragraph because in essence it says that I believe that all the scientific conclusions that I just discussed are not reliable, and I certainly do not agree with that.

In fact, the point I was trying to make in that section is that we are trying to pursue an approach of looking at certain processes where the conclusions will not be sensitive to the model details.

Now, the way that added paragraph is written, it implies that every time a model is rerun you will get a different answer, and that of course, if you looked at the exact climate in Des Moines, Iowa, you rerun the model with a different parameter, it is going to be a little different. But I was trying to focus on those broad conclusions which I think in my opinion will not be modified, and those include the large-scale warming and the drought intensification of most middle and low latitudes and increased intensity of extreme wet events, and those were the things that we focused on.

Now, a couple of things I want to clarify here in the preface to my testimony. We state that the testimony represents my scientific opinion, my scientific conclusions, not government policy, or a consensus of the scientific community.

So, I think with these qualifications I do not believe that the science aspects in the testimony should be altered. But, my only objection is being forced to alter the science.

I have--as a government employee I certainly can and do support what the policies are, and I do not object to review of the policy statements.

Senator Gore

So, the statements which were changed by OMB were not statements about policy. They were statements about the scientific data, correct?

Dr. Hansen

That is right.

Senator Gore

Did you object when OMB forced you to put these words in the first person into your statement? They instructed you to use the pronoun "I" and to follow it with conclusions which were not yours but theirs about the scientific evidence, correct?

Dr. Hansen

Well, I did try to get them to compromise on wording. For example, the "not reliable" is what I particularly is what I particularly objected and was unable to get them to change that.

I did notice this first person "I," and that is a little disturbing, but I did not actually try to get them to change that. They might have been willing to change that pronoun.

Senator Gore

Well, were there other parts of your testimony which they forced you to change?

Dr. Hansen

The number of changes as these things go is actually not that large, but there was at least one other one which I think is worth mentioning. That was concerned with they--they added a sentence which

says one point that remains scientifically unknown is the relative contribution of natural processes and human activities to the growth of trace gas climate forcings.

Now, I was able to get them to change, the last part of that sentence to say “non-CFC climate forcings,” because it is very clear that CFCs have to natural source. But, you know, even in the case of the growth of carbon dioxide and methane, it is pretty clear to scientists that in fact they are rising because of anthropogenic emissions.

I agree that the sentence is a scientifically correct sentence, but I would not have added that myself if I had not had it put in there for me.

Senator Gore

Well, every scientist that testified here today and every reputable scientist that I know of in the field supports your conclusion that is primarily a human-caused phenomenon and that is probably not an act of God that we have had nothing to do with.

OMB forced you to say well, maybe, we are not a significant cause of this at all that if it may be just forces of nature operating without a significant contribution from what we are doing.

Now, back to the first change that they forced you to make, A lot of farmers last year and a lot of other people began to wonder whether or not the unprecedented drought and heat wave had anything to do with the global warming which many of us have discussed for years.

The scientists have now concluded that while it is impossible to say that any given year is a direct result of a global climate trend, it is now possible to say with some certainty that the earth will warm because of what we are doing and specifically that there will be intensified drought because of this trend.

The Bush Administration is acting as if it is scared of the truth. They are acting as if they do not want the best scientists in the administration to come to Congress and give us the best knowledge that you can glean from the data.

If they forced you to change a scientific conclusion, it is a form of science fraud by them. If they forced negotiators in Geneva to pretend that we need to know before we act, that also is fraudulent. And if they substitute this kind of do-nothing policy for the promises of then-candidate George Bush, that, too, is fraudulent.

It seems to me that they have got a decision to make. Are they going to let scientists come up here and tell us the truth? Are they going to recognize the truth and then make the changes in policy required to respond to this emerging crisis? Are they going to keep the campaign pledges which they used in television commercials all over this country? And is this administration going to be committed to environmental protection or not?

These are the questions which come as a result of what has happened here. Let me just put it into its starkest form. They say in Geneva that no action is justified because we need more study, and then they say here in this hearing, do not tell the Congress what the studies are showing. Cover it up with a lot of vague denials that it was any reliability, and that is what they have ordered you to do.

I want to commend your courage in being candid in response to my questions about your personal opinion really is about the scientific evidence. I appreciate that a great deal.

Dr. Mahlman, have you ever--

Dr. Hansen

Excuse me, could I respond?

Senator Gore

Yes, please respond by all means.

Dr. Hansen

You mentioned truth. We have to be careful to distinguish between truth and opinion.

Senator Gore

But truth is formed by the assessment of data. Our understanding of the truth is never perfect, but it is formed by a candid assessment of the most objective opinions we can gather, and if the scientists who are used to dealing with uncertainties in the data are forced to color their judgments and cannot give us the most accurate assessment of the evidence that they can possibly give us, but are forced to give us some politically colored version of their studies, then it makes it all the more difficult to find out what the truth is.

You know, in the Soviet Union they used to have a tradition of ordering their scientists to change their studies to conform with the ideology then acceptable to the state. And scientists in the rest of the world found that laughable as well as tragic.

Now, we are confronted with the most difficult environmental question humankind has ever faced and we are forced out of necessity to fashion policy on the basis of science that is incomplete and as we gain more information, we find more justification for toughening the actions.

I think we know enough already and a lot of other people believe that. But the Administration does not want us to act. They want to sit still and do nothing, and as the evidence becomes clearer and clearer, they become more and more afraid of the scientists coming up here and telling us how much closer they are to certainty about what is going on.

I interrupted you. Please go ahead.

Dr. Hansen

I do want to clarify that one thing specifically with regard to droughts. You heard Jerry say that he put it in a category of two to one, I believe, two out of three that we are going to get more extensive midcontinental droughts.

My opinion is it is much more probable than that because of the kind of studies which I briefly described here, some of which have not even been published yet, and they are included to some extent as an attachment to my testimony.

But at this time it is not--it is certainly not appropriate to describe this as truth. We do not know that. But in my opinion, it is very likely that droughts will intensify at low and middle latitudes as the greenhouse warming proceeds.

And all I am saying is when we have a qualification at the beginning of the testimony that says the opinions represent our scientific conclusions and not policy and not a consensus of the scientific community, then I should be able to say what my opinions are.

Senator Gore

Well, let me just say one other thing, Dr. Hansen. That you have shown such remarkable courage in being candid under these circumstances. I just wanted to tell you that if they attempt any kind of retribution in return for candor, they will have on their hands the Congressional equivalent of World War III. This subcommittee--I think I can speak for an awful lot of my other colleagues, too--will go as far as necessary to protect your ability to say what is on your mind where scientific conclusions are concerned.

We want to try to find the truth, and the only way we have to get it is to get the best scientists and ask them to give us their best conclusions. And we appreciate it. We will go to the mat for you, I can guarantee that.