MR. ADLER: Folks, I guess, wanting to go outside and enjoy the scorchingly hot July Washington afternoon, I don't know if we've actually hit the record today that they were predicting, but I guess some folks decided to take advantage of it.

For the next hour, we're going to two views on what the implications are of current climate science, and whether or not we need to act right now. Moderating this session is Ben Wattenberg, who is a resident fellow at the American Enterprise Institute, and is also a host, as I believe many of you know, of the PBS weekly television series Think Tank, which is on locally, I guess, WETA at 6:00 p.m. on Saturdays. And it's certainly one of the more intellectual talking head shows around, and one that I recommend highly to people.

And now I'll turn it on to Mr. Wattenberg.

MR. WATTENBERG: Thank you, Jonathan.

About a year ago on Think Tank, we did a program on global warming. And, as fate would have it, two of our panelists were Pat Michaels and Alan Robock. It was a -- it was quite a vigorous discussion. It was one of our better programs, although that's hard to be one of our better programs, because all of our programs are wonderful. But we enjoyed that discussion, and I am delighted, I was delighted when I was asked to, in part, recreate that discussion.

Pat Michaels and Alan Robock are distinguished scientists, as you know. Their biographies are in your kit. The order of battle -- it seems to me, by the way, that the question they will be talking about, which is, must we act now to avert a climate catastrophe, is really the central policy question. I'm just looking down your agenda here. Now, I mean, this is the gut question. Do you have to do something now, or can you talk about it for another generation or two? So, it seems to me, we're right on the money on it.

We have allocated 15 minutes to each participant to give an opening statement. At least in Pat's case, I know with slides. And then we will have some back and forth, where your friendly moderator may participate, and then we will try to go to the floor for some questions. And, because we have promised to be out of here in exactly one hour, at 3:30, let's start right now with Pat Michaels.

MR. MICHAELS: If we could bring down the lights, I'd appreciate that. It's nice to be here. I feel like the vice president in the campaign of 1988, who said, I want my full 30 seconds to explain the Middle East. So, I'd like my full 15 minutes to explain global warming, which means the lights are going to have to come down even further, because no one can see the slides. Thank you.

Okay. Global warming, back in 1990, the United Nations did a silly thing. They got a group of as many scientists as they could find that they approved together, and decided to ask them what they could agree on to form a consensus. Anyone who has ever been to a faculty meeting knows what a foolhardy thing this is. But the United Nations in 1990 produced the report that served ultimately as background for the framework treaty on Climate Change Framework Convention, which, of course, why we're chatting so amiably today. It's what to do about this convention.

I thought I'd take you through where the science has evolved since the United Nations produced that report, and I will tell you at the outset that I am not surprised, and I've heard rumors that one of the big British science magazines is about to carry a large piece saying, the skeptics won. In other words, the people who said that it was not going to warm up nearly as much as the United Nations had said back in 1990, turned out to be correct.

This is the problem, this is the operative phrase from that entire 1990 United Nations' report, it says, "When the latest models of the atmosphere are run with present concentrations of greenhouse gases, their simulation of climate is generally realistic." In other words, the climate models in 1990 that were predicting an average of 4.2 degrees of warming for doubling carbon dioxide were generally realistic, i.e., right. Several scientists, not a small band of skeptics, but a very large and disconcerted group of people, thought this statement was wrong, because certainly the largest scale of climate is the planetary surface temperature. These models say that the planet surface temperature should have warmed between 1.3 and 2.3 degrees by 1990 as a result of human activity.

Here's how much it warmed. This is the northern hemisphere's temperature history from Jones and Wigley, we'll accept that everything that you're about to see in this talk is either a data set from the refereed literature or from the refereed literature. The warming was not 1.3 degrees, it was bout .6 degrees Celsius in the northern hemisphere over the last 100 years, but a large amount of the warming was before World War II, and Burt Bolin from the head of the IPCC is now on record as admitting that this warming has very little to do with the greenhouse effect, which leaves you about a maximum of about three-tenths of a degree of warming due to anthropogenic-generated activities.

Lesson number one about the greenhouse effect, you don't care whether it warms, you care how much it warms. If the warming is small, you really don't care. If the warming is large, you do. If it's primarily in the winter, you don't care very much. If it's primarily in the night, you don't care very much. If it's in the summer days, you care a lot more. So, it's not just whether it warms, it's how it warms.

Well, unfortunately, there are some problems with this record. For 1979 until now, we have satellites that have gone up, and you saw Roy Spencer's talk this morning. I will just remember that people who say that the science has settled on this issue are very unsettled by this graph. This is the global satellite temperature departure, which shows a statistically significant, I underline "statistically significant," net cooling of the global temperature. And it is a remarkable record when you compare it to what was predicted by the United Nations models back in 1990. The open circles are a very conservative estimate for the closed circles. It is what was supposed to have happened by 1990, and that is the northern hemisphere's temperature history through mid-1995 in this record, and you can see there is no change, of course.

Now, questions about the satellite have arisen, the satellite when and matches up perfectly with weather balloon measured temperatures between 5 and 30,000 feet, so that there is no doubt that all those thousands of people who have been sending up weather balloons have independently been in a conspiracy with Roy Spencer and his friends at NASA to lie, no doubt paid by the coal industry. Anyway, this really is a remarkable coincidence that they could produce this data by chance. In fact, 1 in 256,000 runs would still not get you such a correspondence.

Well, anyway the satellite data is really quite fascinating, because if we plot it out and look at where it's warming and where it's cooling, you see it's really not global warming, obviously. It's a warming of the mid- latitude land areas of the northern hemisphere. In fact, because there is a net statistically significant cooling of the whole record, it almost looks to me, as a scientist, like what's really going on here is the planet has remained in the slight cooling phase that it was in since World War II, but the greenhouse effect has done its best, and not a very good job, to try and superimpose some warming on it where you would expect to see it, which would be in the coldest air masses of the winter.

There are good physical reasons for that, by the way. I let the cat out of the bag a couple of minute ago. The greenhouse effect carbon dioxide changes have the greatest effect on temperature where the atmosphere is very dry at the surface, and that happens to be in the coldest air masses on the planet. So what you would really expect to see would be a warming of the coldest air masses, which would be here in Siberia and Northwestern North America, and not much else. And I'll show you some remarkable data on that in a second.

This is the satellite temperature record, by the way, but aerially weighted, or by latitude band, and you can see something quite striking. This is the zero line here. This is the temperature trend in degrees Celsius per decade. This isn't global warming at all. It's a warming of latitude band 25, 30, 35, 40, and 45 degrees north, and nothing else. The rest of it shows either negative or cooling.

Now, I made the statement that the warming is primarily -- what warming you see is primarily winter warming. Let's get away from the satellite records. The problem is, the satellite doesn't see absolutely down to the surface of the planet. The reason that I show you the correspondence between the satellite data and the 5 to 30,000 foot temperature is, when you get into the very cold air masses in the winter, the satellite doesn't see -- it just sees the top of the very cold air masses. It doesn't see the bottom of them.

What I'm going to do now is, I'm going to take the land surface record, the one that shows the warming, and subtract the temperature change in the summer from the temperature change in the winter around the globe so that you can see. The redder it is, the more the winter coldest temperatures have warmed up. This is quite remarkable. You see the one blob here in Siberia where the coldest, most obnoxious air mass that we know of originates, and its weaker cousin in Northwestern North America. So what you have here is not global warming really, what you have is a warming that is primarily a warming of the obnoxious air masses on the face of the planet where people live.

And, by the way, I have not read this one in the newspaper yet, but we have three measures of temperature. The satellite measured temperatures, the surface measured temperatures, and the balloon measured temperatures in the last decade, none of them, none of the only three records that we have show any warming. So what happened is that the coal industry must have bought all the guys that took the surface temperature in the last 10 years, too, I guess.

Anyway, after this carping by this small band of skeptics, the United Nations finally came around. And, in its new volume said, "When increases in greenhouses only are taken into account, most climate models produced a greater mean warming than has been observed to date, unless a lower climate sensitivity is used, there is growing evidence that increases in sulfate aerosols" -- these are particles that go out with the other emissions -- "are partially counteracting the warming."

The translation of this statement is very simple, either it's not going to warm up very much or something is hiding it. And, you can bet the sociology of science is that everybody is going to try very much to find something hiding the warming rather than having to write the letter to President Gore in the year 2001, Dear President Gore, we were sorry, we goofed, we overestimated the warming. Didn't know that much about it. Thanks for the frequent flyer miles. Hope you get your carbon tax. Yours truly, the consensus of scientists. P.S., sure has been good for research, hasn't it?

Well, anyway, this is a sulfate aerosol concept. You put these things in along with the greenhouse effect and it counters the warming. This is the paper that was, I think, the signal paper that pointed this out. It appeared on the Fourth of July last year by Ben Santer, et al. It ran from 1963 through 1987, and Bob Balling called me up on the Fourth of July when it came out and said, Michaels, have you seen this paper. I said, it's the Fourth of July, Bob, do you know how much illegal ordinance I have to blow up? This better be important. And I said, there's something wrong with those dates.

The fifth of July, I went to work and looked at the upper air data from 1958, when it starts, through 1995, when it stops, in the region where there is the most warming in this paper. Hold on to your hats, folks. This is the data from 1963 through 1987, and there is the rest of the data. You know, in debate it is often supposed to be a good idea to accuse your opponents of consorting with sheep, so that they have to say they don't. When this graphic got passed around in literature, all I heard was, not us. That's because the sulfate argument is really not a very good argument as it was based in this paper, at any rate.

This is the model that was used which has both warming from the greenhouse effect and cooling from sulfates. And you can see where it predicted it would cool are the regions of blue, and the satellite data, warming, warming, warming. Not a very good thing.

Well, anyway, I will then proceed to just hit two things, and I will be done, Ben. I would like to read you a little bit about the new United Nations report. This is one of my favorite sentences. It says, "Warmer temperatures will lead to prospects for more severe droughts and/or floods in some places and less severe droughts and/or floods in others." When I asked Tom Karl (?), who wrote that, what person wrote this, he said, a person didn't write it, it was written by a committee.

And so, I'd like to show you what the United Nations says will happen as a result of global warming. This is now diagram this sentence, "More intense wet periods, more intense dry periods, more intense wet and dry periods, less intense wet periods, less intense dry periods, and less intense wet and dry periods." So, in other words, whatever happens, unfortunately and this is the administration's strategy, whatever happens will be blamed upon global warming, including cold temperatures that happened in February of 1996.

Well, I'll finish with a little one-minute diatribe on how federal climatologists don't really tell you the truth, and how your government is trying to mislead you. Everybody saw the press release in January, that extreme rainfall has increased by 20 percent over the United States. This press release was timed to come out right during the California flood that was prepared a couple days after the news stories. In fact, Tom Karl at NCDC, National Climate Data Center, told me that.

Now, here is the data that went into that. What it was, was rainfall data from around the United States for storms that produced two inches or more in 24 hours. Now, I had never heard that a rainstorm of two inches in 24 hours is intense or extreme, but that's the level of rhetoric that's applied to this issue. If you ask the folks who wrote this paper if there is an increase in rainfall of storms of three inches or more in 24 hours, they will tell you, no. So it's rainstorms between two and three inches in 24 hours. By the way, everybody out there would like one of these right now. It would probably do wonders for Virginia agriculture. So I'm not so sure that at two inch rainstorm is all that bad in the summer.

Well, anyway, the percent of rain falling in the United States as a result of these storms has changed over the course of the century. It's changed 1-2 percent, not 20 percent. How did they get 20 percent? Well, you see, the average amount of rainfall that falls across the U.S. from storms of more than two inches is 10 percent. In other words, 10 percent of all rain comes from storms with two inches or more. It changed from 9 percent in 1910, to 11 percent by 1950, before the greenhouse effect had changed very much. They took the 2 percent, divided it by 10 percent, and said, that's 20 percent. Can we please have a carbon tax, we're wrecking the climate.

Now, suppose we had told the truth? The amount of rainfall coming from storms of less than two inches has declined, perhaps as a result of human activity, from 91 percent of all rain to 89 percent of all rain. That's how this issue gets exaggerated.

Thank you very much.

(Applause.)

MR. WATTENBERG: I'm working under the general proposition, Pat, that your answer to the question, must we act now to avert a climate catastrophe is no.

MR. MICHAELS: No.

MR. WATTENBERG: Right, okay.

For another perspective, Alan, why don't you go ahead. Thank you, we're right on time.

MR. ROBOCK: Thank you for inviting me here. I am a scientist. I'm a professor at the University of Maryland. I have a statement out there. I don't get any money from any interest group. I don't have -- I don't represent anybody except for myself. I'm part of the international scientific community. I participated in the IPCC report. So I'd just like to give you my perspective on what the science is and what we should do.

The IPCC conclusion for 1995 was that the balance of evidence suggests that there is a discernible human influence on global climate. So this is the balance of evidence, not unambiguous proof. And the report also points out that our ability to quantify the human influence is currently limited because there's so much natural variability still in the climate system. We're trying to find a small signal among normal, natural inter-annual climate changes, and because also, we're -- the models are not perfect. We're uncertain about exactly how the climate system works. And these uncertainties include the magnitude and patterns of long-term variability.

So, what is this balance of evidence? What is the evidence? Why do we think that we've seen a human impact on climate? First of all, it's gotten warmer. Pat spent a lot of time showing the last 20 years, but that's much too short a time scale to really look at for this problem. We have to look at a much longer time scale, because there are natural fluctuations in the climate system that can take place on inter-decadal time scales. There can be changes of ocean circulation. There can be energy which can go in and out of the oceans. And, in the North Atlantic Ocean, for example, scientists have identified 40 and 50 year oscillations in the ocean circulation that can also impose climate changes of about the same magnitude that we see. So, El Ninos can come and go, and some year can have more intense ones, which also have a large impact on climate.

Volcanic eruptions can cool the climate for a few years. The figure Pat showed for -- based on Ben Santer's work showed cooling after the data Ben used, and that's because there was the huge Mount Pinotuba volcanic eruption just after that. We understand that. That is what climate models predict, and that's what the climate system did. So, if we use the most recent climate models to include all the causes of climate change, greenhouse gases, aerosols, volcanic eruptions, ozone depletion, solar variations, El Nino, then they do a good job at reproducing the climate change of the past 100 years. And it would be -- and nobody has figured out how to explain the warming of the last 100 years without some other cause of climate change, most likely greenhouse warming.

But, even though the warming of the last 100 years is definitely a detectable climate change, that doesn't say what caused it. It could have been caused by something else. And so, you use a model, you put in all these different causes of climate change and see what comes out. And the most reasonable thing is that it was caused by greenhouse warming.

But you can't prove it to a statistical certainty because there's so much natural variability. There is a very small chance that natural variability could have caused this. The group at Princeton University NOAA Geophysical Fluid Dynamics Lab has tried to test this by doing a 1,000- year run with a climate model without any greenhouse gases changes, no volcanoes, no aerosols, no solar variations and use this as a model of the natural variability of the climate system, because we don't know what this system would have done without all these other inputs. We only have one Earth, we can't reproduce the experiment in the real world, so we use models. And, in their model, they never got such a large warming in the whole 1,000 years.

And, it's like a six significant -- six standard deviation difference. So it's statistically certain that this warming is not caused by natural variation, if their model is a good model of the climate system, and it includes the ocean.

What else do we see? The stratospheric temperatures have been decreasing. The Spencer and Christy data do a wonderful job of showing that in the last 20 years, with the exception of a few warming events after El Cajon (?) and Pinotuba volcanic eruptions. How do you explain this large cooling of the stratosphere? My own research shows that you don't get warming of the surface and cooling at the stratosphere at the same time in natural variations. The logical -- the most reasonable assumptions based on other climate models is, it's based on ozone depletion and increased greenhouse gases, increased carbon dioxide.

Sea level is rising, and it's been observed to be rising. Sea level isn't falling, sea level is rising. What causes that? Thermal heating of the ocean and melting of glaciers on land. Although, the latest models show that in the future, Greenland will probably melt more than increase it's snow, but Antarctica, as the climate warms, there will more snow, but there won't be much melting. And so they sort of balance out. And on these two major ice sheets, there won't be much of an impact on sea level rise. But still, glaciers on land will melt, and the ocean itself will warm up and get thicker.

So, and glaciers are melting. All around the world the last couple hundred years, the glaciers are melting. Another thing is that surprises are possible. We're talking about gradual smooth climate change which the models get. What if there's a surprise? What if something that nobody understood and nobody predicted happens?

The ozone hole is a good example of that. Rowland and Molina predicted that Freons would cause ozone depletion in 1974 in their famous paper, and they got the Nobel Prize in chemistry two years ago. But they weren't smart enough to predict the ozone hole, nobody predicted it. Nobody predicted that all of a sudden all the ozone over Antarctica would disappear for a month in October and spring in the southern hemisphere. And now, we've figured out what causes this. It's caused by heterogeneous chemical reactions. That means, the Freons are reacting on polar stratospheric clouds which weren't even well observed before. Now, we've figured it out after the fact. But nobody predicted it ahead of time.

What might the climate system do that we aren't clever enough to figure out? Wally Broecker has suggested in the past there have been rapid shifts of ocean circulation where the gulf stream doesn't head toward England but heads in a different direction, and you can get this rapid overturn of the ocean. Are we warming climate to a level above which some unknown, some threshold, where all of a sudden there's going to be a rapid change? Nobody knows, but it's possible.

What would be the impacts of this warming that's predicted by climate systems? Well, I won't go into much detail about that. I agree with Pat, there is not much evidence currently that big storms, or droughts or floods are caused by climate change now. They're part of the natural variability of the climate system. They've happened in the past. They'll happen in the future.

Precipitation has been increasing in the mid- latitudes over the last 100 years, as Pat showed some data from. So where is this mid-latitude drought that's predicted? Well, it hasn't warmed up enough. But, models show that in the future the atmosphere will be warm enough, it will hold more water and that will compensate the increased precipitation and the net result would be drought.

So there's a possibility of more violent storms, forest declines, pest outbreaks, winter skiing and snowboarding won't be as good, increased human mortality from heat, a lot of possible, but unproven consequences. So what should we do? Policy -- now, I'm an expert in meteorology, I'm a climate scientist. So this is more my opinion, based on my scientific knowledge and my political knowledge, the second of which is not as good as my first one. And Fred Smith said this morning, logic is for losers. So I can't help but think that way, so I'm not going to stop now.

The basic question we have to address is would slower climate change be better for humans than rapid climate change, because climate's going to change. It's going to warm no matter what we do. All the greenhouse gases we've put in over the past -- our lifetimes are still there, most of them. And so it takes a long time, and they'll be there for a long time. And the climate system is slow to respond. So all the greenhouse gases which are there now will warm the climate in the future, no matter what we do, even if we stop putting them in now. So there's a long time lag in the system. So it's going to warm anyway.

The most we can hope to do, I think, is to sort of slow it down a little bit. So would slower climate change be better than rapid change? Do we have to act now or can we wait for a while and let it change for a while and then can we act in the future, when we have better understanding of the science and also better technology to deal with the mitigation. And is there some threshold that we must avoid that would result in a vastly greater harm to society? If we let it go along will we -- at some point the danger be much larger. Those are the questions that we have to answer in order to decide what to do. And the problem is, we don't know the answers to these questions. And I don't think we will for a while.

Must we act now, or will continued change be okay? I don't know. Is there some threshold? I don't know, possibly. Would slower climate change be better than rapid change? The changes predicted is going to be -- let's take the IPCC figure, two degrees Celsius by 2100. At the last great ice age the -- when there were mile thick ice sheets covering North America, the global climate was only about five degrees Celsius colder than it is now. So we're predicting that it will go half the way in the other direction, to a temperature warmer than ever before experienced by not only anybody on the planet, but any members of our species, in the past couple-million years. And it will be at a rate faster than climates ever changed before.

So the question is, will this rapid climate change -- will we be able to adapt to it, or will it be harmful, or should we try and slow it down? If we don't know, I think in the -- because of caution we should act as if the answer is yes. What should our -- if we wait until we've detected a climate change for sure, we can't go back and take all the greenhouse gases out of the atmosphere. So prudence dictates that we shouldn't do this uncontrolled experiment, an environment impact statement written on putting greenhouse gases in the atmosphere would never have passed muster. But, we're doing it inadvertently. We're doing it because we want to do other things. We want to heat out houses and cook. We're not doing it because we want to pollute the planet.

What should the response be? What do I think? I think it should be three things. It should be adaptation. It should be improved knowledge and it should be mitigation. Adaptation means that no matter what happens the planet will warm and we have to deal with it. And one way to deal with it is to do more studies of how it will change, what will the patterns be, so that we can adapt in a better way and plan for it. Because we don't understand the climate system well enough, we need better data, better models, better computers, more trained scientists and engineers, to address the problem. This would be a good investment for society. Right now the U.S. Global Change Research Program has $1.8 billion, $1.1 billion is for hardware, for satellites, mainly for NASA, and about 700 million is in research funding. That's barely adequate to answer all these pressing questions.

With mitigation, that's what most people focused on today, should the U.S. actually put a carbon tax on or reduce carbon dioxide emissions? Well, again, this is really an opinion. Some people say, that well, we should wait until we understand, until we know better what to do. The problem is, people will always make that argument. Ten years from now people will make exactly the same argument. Well, we don't know everything, let's wait, let's wait, and we'll have better technology in the future. That's always the case.

I think we should start now to try and figure out how to deal with it and start doing some research on it. Let's try some small things first that can help. If we don't begin, we'll never get to that point. And I think it's actually an opportunity for American industry to develop the energy efficient technology that will be needed, not only by us, but by the whole world.

The real problem, as has been pointed out already, is China and India, with these huge populations. They all want to have a refrigerator and a car and live like us. If they used the same technology we use, they'll put tremendous amounts of CO_2 in the atmosphere, much more than we will. So I think any action by the U.S. and the other developed countries should be as an example to the world. If we don't do anything, nobody will ever do anything. If we do something, as we have in many other issues, set the standards for the world, in environment protection, in morality and how to treat people, and democracy, other countries follow. So as an example to the world, we can begin slowly to take actions that will be good for us and for the rest of the planet in the long run.

Thanks.

MR. WATTENBERG: Those were two very convincing cases, I must say. I'm going to ask each of the panelists from their seats, with the mikes live there, to offer no more than a five minute rebuttal. And then I'll have a few questions and then we'll go to the floor.

MR. MICHAELS: Okay. Then I'm going to have to ask you to put the slide button up there, because there are two slides that I left out that I prepared for rebuttal.

MR. WATTENBERG: Okay. Come up here.

MR. MICHAELS: It will just take a second. Al, you can come up here, too, after I'm done, and yell at me from here. Okay. If you don't mind. My question to you is, so what. The point of the matter is that the climate -- we don't care whether there's a discernible human influence on the climate or not. What you care about is how and how much of a discernible human influence there is on the climate.

I'd like to show you, just as an example of that, the most recent models, if we can turn down the lights for a second, on climate change. This was published by Mitchell and Johns, and what we're doing now to create large climate change is we're putting greenhouse effect changes in it that are wrong. This model has a greenhouse effect, carbon dioxide concentration at about 900 parts per million by the year 2050. According to the United Nations, it should ride along this line here, which would produce a warming of about 1.7 degrees by the year 2100. This model correctly captures four-tenths of a degree of warming of the last century, or so it says, which leaves you a net warming of 1.3 degrees Celsius, primarily in the winter and primarily at night.

Here is the new National Center for Atmospheric Research model. In order to achieve large numbers, it increased the carbon dioxide effectively at 1 percent per year. Everybody who studied this knows the intrinsic rate of effective greenhouse effect, including CO2 and the other gases, is .7 percent per year. This gives a warming of 1.5 degrees, on out to the year 2100. And it doesn't have any sulfate cooling in it, which Al will say will probably knock it down another three-tenths of a degree or so. That leaves you at 1.3 degrees. If you take the observed warming of the 20th Century and say it was all due to the greenhouse effect, and run it in a very simple climate model, called an upwelling diffusion model, it gives you 1.3 degrees of warming.

Nature is trying to tell us something here, Al. It's trying to tell us, that while there will be a human influence on the climate, it's not going to be very much, and nature is going to ask us the real question, how much money do you want to spend to stop this pernicious warming of the coldest nights in the winter, the lengthening of the growing season and the greening of the planet. Thank you.

MR. ROBOCK: Pat was saying that in order to achieve the desired result -- I don't think that's the way science works. And if you read the climate change 1995, this is the summary for policy makers, you'll see that there is a whole range of scenarios that people have used to put into their models. Pat's right if you put in less greenhouse gas in the future, if you predict human behavior, that they will have less greenhouse gases, then the climate will not warm as much. Indeed, that's true.

But, there's been a whole range of scenarios applied and with different scenarios you get different answers. That's the whole way to do it. If you can't predict human behavior, you ask the question what if. What if we put in a lot of greenhouse gases, how much will it change. What if we put in less. And this is research that can help in adaptation in guiding us as to how much is safe to put in.

So these new studies which he showed, show what you'd expect. If you put less greenhouse gases in, you don't get as much warming. So the question is not which scenario did you choose and which one is right, because it's very difficult to predict human behavior. The question is, how can we understand this system so that we can take actions that will produce human behavior that's not dangerous for us.

MR. WATTENBERG: Is this on?

Pat, it seems to me as if you are both saying that there will be some rise in temperature over time. You're arguing magnitudes. What is the problem with, as Alan says, starting slowly and doing little things, experimentally. That's all I heard him say. I haven't been here for the whole conference. What would be -- what's your beef?

MR. MICHAELS: Well, I would argue that I think we should believe our greener friends, who keep telling us that the energy efficient technologies are around the corner and will become much more efficient. Obviously you can buy a heck of a lot more of a much more efficient, less expensive technology in the year 2020 than you can in the year 1997. In fact, if we -- unfortunately, if you do the small things and the incremental things, you're not going to have any effect on the climate, if you believe the climate models of gloom and doom. And if you don't believe the climate models of gloom and doom, ask yourself the question, why you're doing anything anyway.

MR. WATTENBERG: If instead of it happening by the year 2100, whatever the year that you guys all agree on, it's going to happen by the year 2200 or 2300, and if the remedies are minimal and experimental, and incremental, why are you so concerned?

MR. MICHAELS: Your conditions to the question are inappropriate. The remedies are not incremental, inexpensive, et cetera. You have to reduce emissions by 60 to 80 percent, if you believe it's a serious problem. And, furthermore, I don't think it's -- you want to talk about morality, I don't think it's real moral of us to plan the energy structure of a society 250 years from now, considering what plans would have been made, as Al said, if we had put an environment impact statement in for the fossilization of the global economy, which only resulted in everybody living twice as long as they do, and living a very nice life.

MR. WATTENBERG: Alan, let me ask you a question.

MR. ROBOCK: You think we live twice as long because of CO_2 in the atmosphere?

MR. MICHAELS: No, because of the society that we created with the energy structure that we have, obviously.

MR. WATTENBERG: Excuse me. Alan, let me ask you a question. My understanding is that the climate projections done by the United Nations group are based in part upon population projections, made by the U.N. And that they are using data from 1990 or 1992, when this whole round of experimentation roughly began. Since that time, we have seen dramatic, truly dramatic declines in fertility rates around the world.

MR. ROBOCK: In three years?

MR. WATTENBERG: In the last six years, dramatic changes, to a point -- I mean, I'll just give you some -- I write about demographics. The model, as I understand it, that is being used by the United Nations, calls for a top out of population at about 11-1/2 billion people. And in point of fact, many demographers looking at the new data say you're talking about a top out between eight and nine billion people, at which point population will decline. Now, that's an enormous difference. It's an extra three billion people. On a base of 11 billion, you're talking 25 to 30 percent difference. And then a population decline.

Now, if that is baked into the cake, which I happen to think it is, how significant would that be, in terms of your calculations?

MR. ROBOCK: Well, you're asking me to accept a prediction of demographers for how the world is going to change in the next 100 years and then put that into a climate model. As I said before, in it you can choose any scenario you want and you'll get an answer based on that scenario. I'm not a demographer, but I don't know that -- and I don't know how well they can predict future climate -- future population, which depends on -- on climate, depends on political acts, depends on all kinds of things.

MR. WATTENBERG: It depends also on the number of potential child bearers there are, and those are sinking very rapidly. Those people already are born. I mean, it's one of the better prognosticative sciences, demography.

MR. ROBOCK: Yes, but, you know, you look at how many people -- how many women of child bearing age there were in the former Soviet Union and how many children they had, compared to the same number of women in China and in the United States, in all cases they reduced the number of children for different reasons. In China, because of a government dictate, in the U.S. --

MR. WATTENBERG: But, there's not a country in the world now, to my knowledge, where fertility is going up. And just about every country in the world, maybe with a couple of exceptions, it's going down.

MR. ROBOCK: All right. You're right. If you agree that all of a sudden, now we are sure of the demographic projections and they are much lower than we thought before, then they'll -- and you have to also factor in how much energy they'll use, and if they'll use energy at the same rate that other people would have used, then there will be less climate change. That's true.

MR. WATTENBERG: Okay. We still have about 15 or 20 minutes to take some questions from the floor.

MR. ROBOCK: Could I just say one thing?

MR. WATTENBERG: Please.

MR. ROBOCK: I saw Pat a couple of weeks ago, where we both testified at a Senate hearing. And I saw for the first time this book, which is not -- the point of view of which is not represented here at this meeting today. It's called -- it's from the World Resources Institute. It's The Cost of Climate Protection, by Repetto and Austin. And what they did is they took all these different economic models and compared a large set of them, and looked at the assumptions that went into them. And they found that the results, whether you predict a bad or a good effect on the economy, depends a lot on what assumptions went into it.

And when they classified them according to the assumptions, only six assumptions were important and all the models got basically the same results when they used the same assumptions. And when they assumed efficient economic responses, joint implementation, revenues recycled effectively, and the benefits of averting air pollution damages, and the benefits of averting climate change damages, then reduction of use of CO_2 is actually good for us. It's not -- good for our economy. It's good economically.

And the impact of air pollution, local air pollution, is much larger than the impact of climate change. So there are things you can do which help us -- you know, if we just want to solve the air pollution problem, will it solve the climate change problem at the same time and have a lot more benefits related to visibility. Go outside today, see if you can see across the Potomac River. You can't because of all that haze there from burning fossil fuels, from the sulfates. And when that comes out of the atmosphere it comes out as acid rain and destroys the monuments here. So if you want to work toward solving that problem, that will also work in the same direction as solving the problem with CO_2.

MR. MICHAELS: Very nice unpaid commercial announcement for the World Resources Institute. I would suggest that it's very interesting what you say, that what you get depends upon the assumptions that you put into your models. And you made a statement that scientists would never assume things that they knew were wrong in a climate model. Well, in fact, the climate model that I showed you, by Taylor and Penner, that tries to match the greenhouse effect and sulfates with the observed climate, has a greenhouse effect change to date, meaning a net change in radiation, of 1-1/4 watts per meter squared. You know it's 2-1/2 watts per meter squared, the entire community knows that, and if you put that number in, you get a model that doesn't work. So tell me about it some time.

MR. WATTENBERG: Why don't you tell him about it right now?

MR. MICHAELS: Why did they use the wrong number? Why did they use the wrong number?

MR. ROBOCK: There's two types of assumptions that go into models. One is how you build the model itself, what parts of the climate system you put in. They all include basic laws of conservation of energy, conservation of mass, conservation of moisture. And they try and represent the physical processes, like ocean circulation, the winds, the clouds, as well as they can. Probably the weakest part is the cloud models, as was pointed out earlier. The other set of assumptions -- that's how you build the model. The other set of assumptions is the boundary conditions, the forcing, how do you -- what -- how do you -- what do you tell this -- what scenario do you use for this model to get it to react and predict the climate. And that's what Pat is talking about. What scenario do you use for greenhouse gases in the future and --

MR. MICHAELS: No, it was the present. Why did they use the wrong number? I asked Joyce Penner in the House, as a matter of fact, and she twisted on her feet for 45 seconds before answering. And Fred Singer was there. We were just interested in the changes in the greenhouse effect that would result from carbon dioxide only, not the other greenhouse gases, which is nuts, because you want to know how the climate was supposed to have changed.

MR. ROBOCK: I wasn't sure your -- so, the point Pat's making is that --

MR. MICHAELS: They used the wrong number. The models can't be that good.

MR. WATTENBERG: Why don't you let Alan go.

Go ahead, Alan.

MR. ROBOCK: The point Pat's making is that, carbon dioxide, which we've been talking about today, is not the only greenhouse gas that humans produce and put into the atmosphere. It's only about half of the warming is produced by CO_2. The other comes from methane, nitrous oxide, Freons and some other trace gases. We've already decided to stop putting Freons in the atmosphere, because they destroy ozone. So that takes away their global warming potential. But, a lot of climate models didn't have the detailed radiation calculations to include the specific effects of each of these different gases. So the -- the easiest calculation to do was to just put in more CO_2, so it gives the same equivalent warming as CO_2, plus all the greenhouse gases. And that's what they did in this case.

MR. MICHAELS: Okay.

MR. WATTENBERG: All right. Stop. Just hang on. I mean, when I'm getting lost, I assume that everybody else is getting lost. Let's have some questions.

Fred Singer, and if you could please identify yourself. And do we want people to go up to the microphone or not?

Everybody knows who Fred Singer is. And these are supposed to be questions or very short speeches.

MR. SINGER: Thank you. I want to ask a question. My question, isn't it important to gain perspective on this issue when you have a debate? And by this I mean, we cannot rely on models to gain perspective, you have to look at data, you have to look at the atmosphere itself. And one way to do this is to look at the past, see what's happened in the past, and draw some conclusions from this.

Now, Alan has made three points, which I think are important. He has pointed out that in Princeton the modelers ran a model for 1,000 years to see what sort of natural fluctuations would occur in the atmosphere. I think that's impossible. You can't run a model and use it to determine what the natural fluctuations are. But, never mind.

MR. ROBOCK: I don't understand. What do you mean it's impossible?

MR. WATTENBERG: That they're not natural, they're artificial, because they're a model.

MR. SINGER: They're what you put in the model, obviously. And I will come -- I will comment on this in a minute. Then he asked about surprises in the climate system. That's always an interesting question. And finally, he asked the question, isn't it better to have a slower rate of change of climate than a faster rate of change. To gain perspective on this, we can look at the past. Two-hundred million years ago the carbon dioxide content of the atmosphere was about 500 percent higher than what it is today. That was during the dinosaur time. The climate was somewhat warmer, but was actually well behaved. Nothing untoward has happened. The ice ages have come and gone. The climate has fluctuated. But, most important, there have been fluctuations of climate during recorded human history. I am familiar now with the work of Keigwin, from the Woodshole Institute - published in Science last year. Who showed that the climate changed naturally by over two degrees – by two and a half degrees, in fact – over the timeframe of only decades. That’s published in the literature. At the same time we have publications by Paul Mayewski using ice core data showing that these changes occurred worldwide. These are not isolated events.

MR. WATTENBERG: Right.

MR. SINGER: So, we have in the recorded human record large climate changes, climate fluctuations, larger and faster than anything predicted by the IPCC. But we don't have anything in the recorded history showing that this affected human beings in some untoward way.

MR. WATTENBERG: But it might have affected dinosaurs adversely?

MR. SINGER: Well, actually, they did very well until they were hit by an asteroid. Now, that was not predicted by any model. That was one of the great surprises.

MR. WATTENBERG: Alan.

MR. ROBOCK: Actually, they weren't hit by the asteroid. It was the climate changes induced by the asteroid that changed their environment so much. I'd like to know where this one paper you bring up that says there were two degrees change in a couple of decades and it didn't affect humans. So, if you could show that a couple degree change Celsius, likes like 4 degree Fahrenheit change in a couple of decades, wouldn't affect humans, or the eco-system or sea level, then I would agree with you, but I don't think it's possible for it to change that quickly without having any impact.

About the climate model and natural fluctuations, what do we mean by natural fluctuations? How well can we forecast the weather? We can forecast the weather pretty well now a couple days in advance. Today's weather was very well forecast yesterday and the day before. It was very hot today. It was well forecasted. These are the same models that we use to predict the climate. But if we go a couple of weeks into the future, you can't predict the weather. You can't tell on a particular day what the weather is going to be. The reason is because the atmosphere has instabilities. It has storms which grow. You've heard of the flopping of the butterfly wings that can -- the small storms can grow into large storms, and we can't predict those well into the future.

So there's a certain amount of noise, and a certain amount of variability generated just by the energy in the atmosphere of storms growing and decaying. And that's what I mean by natural fluctuations. And these can sometimes transport a lot of energy to the pole and warm it up, can sometimes transport less. And they introduce a natural background, inter-annual climate change. Some years are warmer than others. Some are -- some regions are warmer, some are colder. And that's natural. That's not caused by anything put into the atmosphere. It's just the way the atmosphere behaves. And the climate model that I'm talking about included those natural fluctuations as modeled as best we can by the models.

MR. WATTENBERG: And now, just hold on a minute, now, if we are going to have full scale questions, rebuttals, and re-rebuttals, we're going to be out of business real quick. So, Pat, I'm going to ask you to confine your re-rebuttal to be exceptionally brief.

MR. MICHAELS: Extremely brief. I'm exceptionally brief, and probably brief of mind.

First of all, the planet was one to two degrees warmer today than it is today four to seven thousand years ago. That accompanied the rise of human beings, and the rise of civilization.

MR. ROBOCK: Yes, but it changed gradually.

MR. MICHAELS: Please. Five hundred years ago, we were in the little ice age and the glaciers were all down the mountains in Europe, and people held bazaars on the Thames River. Human beings seem to do quite well. But let's talk about the meat. You said two degrees was really going to affect human beings. Last I heard, human beings evolved in Africa. And you have to take where human beings live, if that's what's going to affect human beings. When all the human beings lived in Africa, not all that long ago, would you allow the temperature in which they lived was a little bit warmer than two degrees C above the current temperature?

MR. WATTENBERG: Don't answer that yet. I will give you my favorite debater's trick is, the next time you get a question, toss in the answer to that.

Ma'am, right over there.

Q: (Off mike) -- I now work with the Nuclear Energy Institute. I'd like to bring this to Kyoto a little bit. We talk as if there are some sort of very benign, helpful, charitable, let's all get together and be friends measures that we're about to take. But we're actually embarking on the possibility of signing a treaty that will become the law of the land that will then impose restrictions that will have to be implemented either through further statutes, law of the land, or regulations using the treaty as authority, or those additional statutes, such as the Clean Air Act, as authority. And, as we all know, when you pass statutes and you pass regulations, you impinge on some level of behavior that people prior to the implementation of those statutes and regulations thought they were free to engage in, in this country, and that often takes away certain economic rights, or certain economic expectations, or certain behavioral expectations or other things. So we're not really, when we talk about Kyoto, as opposed to the current voluntary, let's do joint implementation and let's do this on a project basis. When we talk about Kyoto, we are talking about engaging in what you could call an international command and control regulatory scheme.

And my question comes down to whether --

MR. WATTENBERG: I'm glad you got to the question, because that was the outside limit of the short speech parameter, which I just wanted everybody to know.

Q: Oh, I could have sworn I was within Dr. Singer's parameters there.

MR. WATTENBERG: Go ahead.

Q: My question is, in all this talk about what we do know or don't know, or whether there's a discernible influence, is it a discernible adverse influence, is anything that the climatology or the science producing do we feel is actually a sufficient evidentiary basis to begin changing the nature of behaviors and freedoms, as opposed to whether it's sufficient to talk about or give money to scientists, or all the other semi-benign things? Do we really think from sort of a due process standpoint, is the evidence we're talking about sufficient to start taking away rights?

MR. WATTENBERG: All right. That seems to me a question that could be answered either in less than 20 seconds, or in more than 20 hours, so you've got less than 20 seconds. You may each deal with that.

MR. MICHAELS: If we changed the -- if we went halfway towards effectively changing the natural carbon dioxide greenhouse effect, all we could show at best was three-tenths of a degree of warming. All we could show with warming in the coldest air masses. And the thing that we were putting in the planet into the atmosphere made plants grow better. That's all we can show. And I would say you have a very, very bad case against regulation.

MR. WATTENBERG: Alan?

MR. ROBOCK: I just wanted to address the issue of people living in lots of different climates on the planet today. I mean, people live in the tropics, people live in high latitudes, people live in areas where the temperature is much larger, difference is much larger than two degrees. So what's the problem? I mean, people move to Florida to get a warmer climate. They like it warmer when they retire. So what's the problem?

MR. WATTENBERG: Alan, now, you took my advice by answering the previous question, which is wise. And now, the questioner now was asking, in effect, in a court of law, is there something evidentiary?

MR. ROBOCK: Okay. The issue is the rate of change of climate, not the absolute value. Can we deal with a very rapid rate. I'm not a lawyer, but if you were trying to prove beyond a shadow of a doubt that we've seen the human impact on the climate system, the answer is, no, we haven't. And, if you want to prove beyond a shadow of a doubt that if there were climate change it would be terrible for us, we can't prove that either. So you can't -- but you can't -- so you can't deal with it that way. If you wait until you can prove it, it will be far too late to do anything about it.

MR. WATTENBERG: All right. Anybody on your side of the room? Sir.

Q: MALCOLM ROSS, U.S. GEOLOGICAL SURVEY, Dr. Robock, I'm appalled that you use climate models instead of the facts. Do you know Herbert Lamb, in Maine, Herbert Lamb?

MR. ROBOCK: You mean Hubert Lamb?

Q: Yes.

MR. ROBOCK: Hubert Lamb, yes. I've met him once, yes.

Q: I mean, the inventor of modern climatology, and one of those beautiful research problems that have been ongoing is the ebb and flow of humanity with climate change. And you completely ignore it. You say that -- you essentially said, what you said here is, that the climate hasn't changed. Paul Nitze in an editorial in the Post last week said that climate has not changed for 10,000 years. He's with the

Environment Defense Fund. And that's sort of what you're saying now. There's been no change until just recently. And that's not so. You're not giving the history of climate change and the history of civilization.

MR. ROBOCK: No. I didn't say climate hasn't changed. Indeed, it has changed. Greenland was -- the name Greenland was, you know, people were living there a thousand years ago, and the climate was much warmer a thousand years ago. Then it got colder during the little ice age, then it's gotten warmer again.

Q: (Off mike.)

MR. ROBOCK: Well, I don't remember saying that climate hasn't changed. If that's what you understood, I'm sorry, but that's not what I meant to say. Climate has changed. What I'm saying is that the rate of change of climate in the past is predicted to increase dramatically in the next century by the effects of human pollution of the planet with greenhouse gases.

MR. WATTENBERG: Okay. The questioner at the mike. Thank you. Go ahead.

Q: I just wanted to make a marginal comment to the point that Robock made about the speed of change.

MR. WATTENBERG: Could you identify yourself, please?

Q: Yes. I'm Wilfred Beckerman. I'm speaking later on.

MR. WATTENBERG: I know who you are. Welcome.

Q: And this is a point that I would have been talking about, but they just happened to come here, about the speed of change. You see, I've just flown in from London where the temperature was about 16 Centigrade, and here it's about 34, and I find I adapted very well. There's, firstly, modern societies, you see, we have things like air conditioning. And although the plane only took about eight hours, I had time to change into a lighter shirt. So, you know, it's not like it was 100,000 years ago. We have the whole technology which makes us practically climate immune. And the speed of change story is not as if it's going to rise by 10 degrees in the next couple of years anyway. What we're talking about is a couple of degree rise over 50-100 years. The speed of change story is far exaggerated.

MR. WATTENBERG: Mr. Beckerman, do you think, if we define long-term as really long-term, I mean many centuries, that what you say may be correct, that it's a relatively small change. We know how to deal with it. We'll put on a seersucker jacket, get some air condition, et cetera, et cetera, et cetera. However, if those tendencies continue over an extended number of centuries or millennia, whatever the appropriate figure is, that we will be in the soup big time? Shouldn't we then start to say, let's begin to play around?

Q: No, because for various reasons. First of all, it's just physically impossible. I mean, one of the paradoxes of the green environmentalist case is that there is possibility to go on and on and on getting warmer. On the other hand, we're going to run out of resources. And one of them will be fossil fuel. And if you add up -- calculate how much accessible fossil fuel there is, it could never lead to an increase in the carbon concentration of the sort that would lead to a fantastic rise in temperature over the next 300 years, 400 years.

MR. WATTENBERG: Okay.

Q: So, point one. The second, point two, you would have to discount the cost of benefits. Point three, it's just beyond our imagination how much technical progress there's going to be over the course of the next few decades. It's absurd now to --

MR. ROBOCK: Because it's beyond our imagination, that means it could be less or more than we think now.

Q: So far, it's been favorable. (Laughter.)

MR. WATTENBERG: Hold it. We have -- I wanted to ask one very brief question.

MR. ROBOCK: The greenhouse warming is a result of our technology. It's an inadvertent effect that nobody predicted when we started using fossil fuels.

MR. WATTENBERG: Alan, what would the role be of nuclear power if the world decided that this was the way to go, and we doubled or tripled the percentage of nuclear power in the energy budget?

MR. ROBOCK: If nuclear power had no other adverse effects, it would be a solution to the greenhouse warming problem because it produces electricity without any greenhouse gases. I don't know if we want to get into an argument of the problems with nuclear power, but --

MR. WATTENBERG: We have fully 60 seconds. I was just curious.

MR. ROBOCK: I just happen to believe that there are a lot of unsolved problems with nuclear power. And it's something we should consider, but not something we should adopt right now.

MR. WATTENBERG: Okay. Last question.

Q: I have eight, but I'll boil it down, because things are just --

MR. WATTENBERG: You'd better believe it. Yes, go ahead.

Q: We're going to get the Elmer Fudd argument, do we shoot him now or wait until we get home. There are several problems with what was said here. One is, if we don't know, but the risk is high, we should act. Well, my father died of heart disease, and so did his father. Yet, I have no evidence of bad health in myself. Shall I have a heart transplant now and then -- just on general principles. It's the same idea.

MR. ROBOCK: You should watch how much fat you eat.

MR. WATTENBERG: Be sure to take a baby aspirin every day.

Q: I do. Yes, but you're going beyond the common sense things. I already exercise every day, thank you. But, the second question, you said the Earth will warm. Do we know the actual buffering capacity of the Earth for absorbed heat?

MR. ROBOCK: Oh, yes. The thermal capacity of the land, of the atmosphere, of the upper layer of the ocean and the deep layer of the ocean are very well know. And those are all taken into consideration in the climate model calculations.

MR. MICHAELS: How could the climate models have made such errors then?

Q: I was going to say, that is not my understanding.

MR. ROBOCK: You're talking about different forcing, not different models. Those are two differences.

MR. WATTENBERG: Ladies and gentlemen --

Q: To be fair, anyway, to be fair --

MR. WATTENBERG: Hold on. I'm sorry. I made a solemn, solemn commitment, which I do not renege on that we would be finished at 3:30. It is now 3:31. Thank you all for joining us.