to be much more specific.
(3) **Q** And the IPCC report is not intended by its authors to be used in the way a primary source would be used; is that correct?
(6) **A** Of course not.
(7) **Q** For what purpose is it intended by its authors to be used?
(9) **A** For policy guidance.
(10) MR. WIRTSCHAFTER: No further questions.
(12) THE JUDGE: Okay. Who would like to be next? Ms. Sasseville. RECROSS-EXAMINATION
(15) BY MS. SASSEVILLE:
(16) **Q** To what extent do scientists rely on tertiary sources in their research?
(18) **A** Very little. I mean normally not at all.
(19) MS. SASSEVILLE: Thank you, no further questions.
(21) THE JUDGE: Anyone else? Ms. Hedman. RECROSS-EXAMINATION
(23) BY MS. HEDMAN:
(24) **Q** Dr. Lindzen, were you present during the Conference of the Parties in Berlin?

PAGE 47
(1) **A** No.
(2) **Q** And isn't it the case that you filed your testimony prior to the meeting in Berlin, the Conference of the Parties, that occurred at the end of April and early May?
(6) **A** Yes.
(7) MS. HEDMAN: No further questions.
(8) MS. ZIBELMAN: I have a follow-up question. RECROSS-EXAMINATION
(11) BY MS. ZIBELMAN:
(12) **Q** Dr. Lindzen, you testified in response to a question from Mr. Wirtschafter that the IPCC is used for policy guidance. To your knowledge is the IPCC intended to be used by state public utility commissions to set environmental costs for state utilities?
(18) MR. WIRTSCHAFTER: I object to the friendly redirect or friendly cross here.
(20) THE JUDGE: Well --
(21) MS. ZIBELMAN: I don't know if it's friendly or not, it's a follow-up.
(23) THE JUDGE: Just a moment, just a moment. I think it's a legitimate thing, you can answer the question.

PAGE 48
(1) THE WITNESS: It's formally stated that it is to advise essentially international parties. And it was formally started in connection with the plans for Rio. I don't think they ever intended it for Minnesota specifically though.
(7) THE JUDGE: Okay. Is there anything further for this witness? Ms. Hedman. RECROSS-EXAMINATION
(10) BY MS. HEDMAN:
(11) **Q** Dr. Lindzen, can you cite an IPCC document that indicates that its use is for making international policy?
(14) **A** I can't give you a direct citation here, I'd have to look, but one would have to go back to '88 to find the documents creating the IPCC and I don't have those here.
(18) THE JUDGE: Okay. Anything further for the witness? Thank you. (Break taken.) (Whereupon, Exhibits 57 and 58 were marked for identification by the court reporter.)
(24) THE JUDGE: Let's go on the record. Ms. Zibelman has a housekeeping item that she

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PAGE 49
(1) would like to raise before we begin with the next witness. It shouldn't take too long.
(3) MS. ZIBELMAN: Your Honor, the issue that I'd like to raise is I have not yet seen the additional surrebuttal filed by the Environmental Coalition with the two new witnesses. And I am concerned that these witnesses may be putting in, because of their backgrounds, information that we would not have seen if Dr. Whitelaw had testified. What I'd like is an opportunity, if need be, to respond to that through additional testimony by our witnesses, and I would propose if it's short that we just ask leave to allow us to elicit it on the stand or file short additional surrebuttal. But the concern relates to the fact that I don't know what these witnesses will be saying, if they're supplementing essentially the direct and rebuttal by adding in new information that they have that he wouldn't have had, we have been deprived then of our opportunity to file surrebuttal to Dr. Whitelaw and I think we should be given that opportunity.
(24) THE JUDGE: Ms. Hedman, I wasn't certain whether the surrebuttal that was filed by these

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PAGE 50
(1) two witnesses was in lieu of Whitelaw's filing or whether they would have filed separately anyway even if Whitelaw had been available.
(4) MS. HEDMAN: They would not have filed separately. This was testimony which they were participating in preparation of for surrebuttal on behalf of the Environmental Coalition, it would have been filed anyway.
(9) THE JUDGE: It seems to me that we don't know if there's a problem yet and so there's no point in doing anything until we do know whether there's a problem. So I think we just wait and see whether there is a problem. I'm a little bit leery of having testimony come in which has not been prefiled just because it raises questions about surprise and that kind of thing, but let's wait and see if there's a problem, first of all.
(18) MS. SASSEVILLE: Your Honor, I'm sorry that I wasn't there and this perhaps wasn't discussed in-depth, but if Dr. Whitelaw isn't dead, I mean why can't he be subpoenaed to appear here? Presumably you have a contractual relationship with him and he has an obligation to appear. And it puts, it not only puts us at a disadvantage, of course it's putting you at a

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PAGE 51
(1) disadvantage. And has that been explored?
(2) MS. HEDMAN: I've taken every step I can to work things out, it's not possible.
(4) THE JUDGE: I don't -- I mean we can't say really until these people appear and are cross-examined, but I don't know that it's going to be that much of a problem. I think we'll have to wait and see what the situation is. All right. I believe, Mr. Glaser, the next witness is yours. You may call him.
(11) MR. GLASER: Yes. We call Dr. Patrick Michaels to the stand PATRICK J. MICHAELS, after having been first duly sworn, was examined and testified on his oath as follows: DIRECT EXAMINATION
(17) BY MR. GLASER:
(18) **Q** Dr. Michaels, would you state your name for the

record, please?
(20) A Patrick J. Michaels.
(21) Q And would you state your business address, please?
(23) A Department of Environmental Sciences.
(24) Q And do you have in front of you a document entitled Rebuttal Testimony of Dr. Patrick J.

PAGE 52
(1) Michaels that has been marked as Exhibit 57?
(2) A Yes.
(3) Q And does this exhibit consist of your rebuttal testimony and exhibit that consists of your resume?
(6) A Yes.
(7) Q Have you made any changes to this exhibit?
(8) A Yes, I have. Would you like me to detail them?
(9) Q Yes, please.
(10) A On page 10 there are two typographical mistakes. In the table labeled Net Temperature Change, under the subhead Globe, Century, after the number 0.50 there is a bullet, a typographical bullet that should not be there. And immediately beneath that, under the subhead Century, category Northern Hemisphere, there is a one plus, that is a typographical error, it should read 0.40 only.
(18) Q And have you indicated these changes in writing on the exhibit in front of you?
(20) A Yes, I have.
(21) Q And have you initialed those?
(22) A Yes, I have.
(23) Q And do you also have an exhibit in front of you entitled Surrebuttal Testimony of Dr. Patrick J. Michaels?

PAGE 53
(1) A Yes, I do.
(2) Q And that is identified as Exhibit 59?
(3) A 58.
(4) Q 58, I'm sorry.
(5) A Yes.
(6) Q And were Exhibits 57 and 58 prepared by you?
(7) A Yes, they were.
(8) Q And if I asked you the questions in those two exhibits today now that you're under oath would you give me the same answers?
(11) A Yes, I would.
(12) MR. GLASER: Your Honor, I move admission of these two exhibits into evidence.
(14) THE JUDGE: All right. Is there any objection to 57 or 58?
(16) MS. FREESE: Your Honor, we would like to preserve our opportunity to make motions to strike some of this testimony after the hearing consistent with our motions for Dr. Lindzen's testimony.
(21) THE JUDGE: All right. Anything else? Then 57 and 58 are received subject to that possibility.
(24) MR. GLASER: And Dr. Michaels is available for cross-examination.

PAGE 54
(1) THE JUDGE: Who would like to go first?
(2) MS. FREESE: Your Honor, I'm prepared to proceed.
(4) THE JUDGE: All right. CROSS-EXAMINATION
(6) BY MS. FREESE:
(7) Q Dr. Michaels, good morning.
(8) A Good morning.
(9) Q Let me start with a question regarding your surrebuttal on page 2. At the very end of that page you state, referring to the period from 4,000 to 7,000 years ago, that textbooks published in the 1970s referred to this era as the climatic optimum?
(15) A Yes.
(16) Q Regarding the term climatic optimum, that simply means that it's the warmest period; is that correct?
(19) A No, it means, the textbooks in that era generally refer to this as the climatic optimum because it accompanied the ascendants of agriculture in civilization.
(23) Q I have some questions, Dr. Michaels, regarding natural variability, in climatic natural variability of temperature change. The IPCC 1990

PAGE 55
(1) report states that natural variability of the climate system could be as large as the changes observed to date over the past century which they characterize as a global mean temperature increase of .3 to .6 degrees centigrade. Leaving aside whether their estimate of the amount of warming over the past century is correct, do you agree that natural variability of climate over a century could be in the range of .3 to .6 degrees centigrade?
(11) A Yes.
(12) Q What is your best estimate of natural variability?
(13) A That is a very, very difficult question. It may require me to digress a little bit. If we look at climate records over the last 1,000 years, it's probably plus or minus about 1.2 degrees Celsius. If we look back 4 to 7,000 years ago we see excursions of two degrees on the global scale, much larger excursions on the local scale, and then when we go back to the glaciations the numbers get much larger than that.
(22) Q How about if you go back a century?
(23) A It depends upon the century.
(24) Q The last one.
(25) A That's not representative of all the centuries.

PAGE 56
(1) We see, for example, in -- as in the period roughly, I think about 13,000 years ago and then probably around 11,000 years ago, we see repeated excursions in the climate. This is from a paper by Lehman, L-E-H-M-A-N, and Keitwin, K-E-I-T-W-I-N, of I believe plus four, plus or minus four to five degrees in 40 years. So that's a very large range of natural variability that has been observed.
(10) Q Would you agree, Dr. Michaels, that it is possible that an even greater enhanced greenhouse effect is being hidden by natural variability?
(13) MR. GLASER: I object. There's no foundation for what is meant by "even greater enhanced greenhouse".
(16) MS. FREESE: I can rephrase that.
(17) THE JUDGE: Okay.
(18) BY MS. FREESE:
(19) Q Let's assume hypothetically that a .3 to .6 degrees centigrade warming has occurred in the past century and let's assume hypothetically that that entire warming could be attributed to enhanced greenhouse effect. Would you agree that it is even -- that it is possible that an even greater enhanced greenhouse effect is being hidden

PAGE 57

(1) by natural variability?
(2) **A** It is possible.
(3) **Q** Would you agree that it is possible that an even greater enhanced greenhouse effect is being hidden, I assume you would then, by a combination of natural variability and other human factors?
(7) **A** It is possible.
(8) **Q** You'd agree, wouldn't you, that the earth will undergo some warming as a result of the increase in anthropogenerated greenhouse gases?
(11) **A** Yes, I do.
(12) **Q** You state on page 24 of your testimony, beginning on line 23, that the warming trend of the last century is taking place at a rate far below that required to meet the forecast of 4.2 degrees centigrade for a doubling of effective carbon dioxide within a relative time frame. The most conservative estimate is that GCMs are off by a factor of two. When you say GCMs are you referring again to the GCMs that forecast warming of 4.2 degrees centigrade?
(22) **A** I'm referring to the suite of models there that was the background for the IPCC '90 report, that's correct.
(25) **Q** So using your conservative, a conservative

PAGE 58
(1) estimate, the observational record would support warming predictions of 2.1 degrees centigrade?
(3) **A** No. I do need to elaborate on that statement, if I could. We have three sets of observed records that are in fact independent sets of observed records. And they give us a very, I think, consistent answer with respect to the greenhouse issue. If we look, for example, at the shortest of these records, the MSU satellite record, it actually shows a net cooling, it begins in 1979. However, if you adjust that record as Spencer and Christy did for volcanism, and it was a somewhat debatable adjustment, one gets a warming in it of about .09 degrees per decade. That's about, that's between a factor of three and four beneath the warming predicted to have occurred during that period by those models. Another record that we have is something called the radiosonde record. Radiosonde, R-A-D-I-O-S-O-N-D-E. That record is valid globally back to 1958 and is a highly calibrated record because these are the instruments that go up in the weather balloons twice a day and set the computer for the daily weather forecast. This

PAGE 59
(1) record shows a decadal warming of about .11 degrees Celsius per decade, which again --
(3) **Q** I'm sorry, could I just ask you, this shows what kind of warming?
(5) **A** Decadal.
(6) **Q** Decadal?
(7) **A** Decadal of about .11 degrees per decade which is a factor of about three underneath the warming predicted by the referred suite of models. The last record that we have is the so-called ground based temperature record, the surface based temperature record which has a lot of problems associated with it. It shows a warming of roughly half a degree. But much of that warming, about, let's say a half or so, maybe a little more, occurred before there was much of a change in the greenhouse effect. So if we discount that, we come up with a warming that is between a factor of three or four beneath the trend projected by those models. So what we have here are three independent sources of data. All putting us in the same ballpark, which is centering around a factor of three.
(25) **Q** Which gets me back to your testimony on pages 24

PAGE 60
(1) and 25, my question, which I still don't understand your response to, is if you're saying, as you do on page 24, that the most conservative estimate is that GCMs are off by a factor of two, could we then say that the most conservative estimate would be that if the GCMs predicted half as much warming as they do they'd be on track?
(8) **A** That's allowing, that is -- implied in that statement is that the observed record is in fact missing somehow a large portion of the projected greenhouse enhancement. And at the same -- at the other end, perhaps the observed record would be in error by an equal or opposite amount, you'd be up to a factor of four. The point is that the observed record shows three and there are three independent ways of demonstrating this.
(17) **Q** The observed record shows that they are overestimating by a factor of three?
(19) **A** Correct.
(20) **Q** And when you say "they" you're talking about the GCMs?
(22) **A** The suite --
(23) **Q** You're talking about the GCMs that predict in the range of 4.2 degrees?
(25) **A** That's the average of that suite.

PAGE 61
(1) **Q** Dr. Michaels, you explain, beginning on page 15 of your testimony, line 4, that you do not believe that the effective sulfate aerosols emitted into the air by industrial activities can explain what you call, quote, the failure of the warming forecast, unquote. Isn't it true that in 1992 you hypothesized in the bulletin of the American Meteorological Society that in the Northern Hemisphere the presence of sulfates in the air may actually produce a negative forcing, that is cooling effect, equal to the warming effect caused by CO2?
(13) **A** I have two papers in the bulletin there. I want to make sure. You must have a copy of that paper, tell me what page it is on?
(16) **Q** This is the paper beginning on 1563.
(17) **A** Correct. I see it.
(18) **Q** And you're answering correct to my earlier question?
(20) **A** No, I now have the paper. My answer to your -- excuse me. My answer to your question is that that was stated as a hypothesis and in the conclusion to the paper I will quote, it said, "If this is the course the earth has embarked upon," et cetera, et cetera, "that course is not

PAGE 62
(1) consistent with an increase in sulfate aerosol."
(2) **Q** So you're concluding in this paper that your hypothesis is wrong?
(4) **A** It was a hypothesis. In a scientific paper one sets up a hypothesis, it's not my hypothesis.
(6) THE JUDGE: But to answer the question, did you conclude that the hypothesis was incorrect?
(9) THE WITNESS: It was not sufficiently explanatory.
(11) BY MS. FREESE:

(12) **Q** Do you not also conclude in that paper at the bottom of page 1575, "I believe that both the observed and theoretical evidence for mitigation of greenhouse warming by anthropogenerated particulates serves to partially explain several disparate measurements that seemed counter what would be observed in a simple greenhouse enhancement"?
(20) **A** The operative word is partially.
(21) **Q** Let's explore that then. In your view what effect -- in your view how do you define partially in that sentence?
(24) **A** Sulfate aerosols do not explain the behavior of the climate in a spatial sense. In fact, the

PAGE 63
(1) behavior of the observed climate in several important areas is opposite to what one would expect from a sulfate greenhouse interaction.
(4) **Q** You're referring to your 1994 study?
(5) **A** In part. I'm referring -- in part I'm referring to that.
(7) **Q** My question, Dr. Michaels, is in your view now how much of a cooling effect do you believe that sulfate aerosols have had?
(10) **A** I can't give you that number. I never attempted to calculate that number.
(12) **Q** In your view do they have no effect on the -- have they had no cooling effect?
(14) **A** I think it is a fair statement to say that our understanding, our, meaning the scientific understanding of the magnitude of the sulfate response is very cloudy, to use a double entendre. Clouded, excuse me.
(19) **Q** And can you state that there is some cooling effect from sulfate aerosols?
(21) **A** I do not know, though perhaps you could help me. A paper that directly measures cooling from sulfate aerosols.
(24) **Q** Do you know what the IPCC's view on the cooling effect of sulfate aerosols is?

PAGE 64
(1) **A** Yes. It is that they have very, very little confidence in their ability to estimate it.
(3) **Q** Is their assumption, however, that there is some cooling effect?
(5) **A** Again, there is a recent report on radiative transfer, I believe, in the atmosphere, by IPCC, and twice in their report, and only twice so far as I can tell, they rate their confidence in their ability to quantify the cooling effect of sulfates. The highest confidence that they ascribe to that ability is, quote, low. The median confidence is between low and very low.
(13) **Q** That is to quantify the effect?
(14) **A** To correctly quantify the effect.
(15) **Q** How about to determine whether it has a cooling effect or no effect?
(17) **A** I believe that they do say they exert a cooling effect. But I caution you that in science, a qualitative statement is essentially a meaningless statement.
(21) **Q** Do sulfate aerosols in the stratosphere from volcanoes lead to cooling?
(23) **A** They should. The effect is much less subtle. One knows what happens when the sun goes behind a cloud.

PAGE 65
(1) **Q** I'm sorry, I'm not sure I understand your answer to that. Isn't it fairly well established that sulfate aerosols from volcanoes lead to a cooling of the mean global temperature?
(5) **A** That's not the same question you just asked.
(6) **Q** Perhaps you would answer that one then?
(7) **A** The first or the second?
(8) **Q** The second.
(9) **A** I would think the first is the more appropriate question, if I could. The second question is much more difficult. And I could explain why.
(12) **Q** Let's try to answer both.
(13) THE JUDGE: Let's start with the first question.
(15) THE WITNESS: The first question, what line am I looking at? Here we go, I've got it. "Do sulfate aerosols in the stratosphere from volcanoes lead to cooling," that's the first question.
(20) BY MS. FREESE:
(21) **Q** Okay.
(22) **A** The answer to that is yes.
(23) **Q** Okay.
(24) **A** The key word is stratosphere.
(25) **Q** Why is that the key word?

PAGE 66
(1) **A** Because aerosol from volcanoes does not reside in the troposphere very long.
(3) **Q** But you're not suggesting that the cooling does not occur on the surface?
(5) **A** The cooling occurs because the aerosol is in the stratosphere.
(7) **Q** And the cooling is felt on the surface?
(8) **A** Correct.
(9) **Q** Isn't it the case, Dr. Michaels, that in your 1992 article you cited as evidence for the hypothesis that sulfate aerosols are having a cooling effect, the works of several scientists, including Mayewski, M-A-Y-E-W-S-K-I, et al?
(14) **A** M-A-Y-E-W?
(15) **Q** M-A-Y-E-W-S-K-I. Who had demonstrated that the amount of sulfate humans are putting into the air in the Northern Hemisphere is equivalent to the amount put in from the Tambora Volcano. T-A-M-B-O-R-A, which was associated with a short-term cooling of one to two degrees centigrade?
(22) **A** That's correct.
(23) **Q** And just to be clear, before I leave this point, you have not ruled out the possibility that the presence of such pollutants has had a cooling

PAGE 67
(1) effect on the planet?
(2) **A** Nor have I ruled out the observation that it clearly does not explain the temporal behavior of climate during the greenhouse enhancement.
(5) **Q** So your answer is no?
(6) **A** I said --
(7) **Q** You have not ruled out the possibility?
(8) **A** Right. But I also add the second statement as answer to your question.
(10) THE JUDGE: It would save, I think, a little time and extra questions if you could try to start out answers like that with the words, no, but I also want to point out such and such. That way those of us who are not trained in this area know that the basic answer is no in addition to whatever else you want to say.
(17) THE WITNESS: Thank you.
(18) BY MS. FREESE:

(19) Q You testified beginning on page 17 of your rebuttal that there is evidence of increasing cloudiness particularly in North America and particularly since 1950. In 1992, again that article I referred you to, you suggested that the industrial pollutants were creating the low leveled cloudiness; is that correct? You

PAGE 68

(1) hypothesized?
(2) A Yes.
(3) Q Have you ruled out this possibility now?
(4) A As I concluded -- no, as I concluded in the 1992 paper, however, that effect does not sufficiently explain the disparity between forecasts of the current climate and the current climate.
(8) Q But it partially explains it?
(9) A It could.
(10) Q And just to be clear on this then, you leave open the possibility that whatever increased cloudiness you observed could have been caused by industrial pollution?
(14) A I have to answer no to your question because you used the word whatever. There are -- there is evidence for cloud increases that could not have been caused by sulfate aerosols.
(18) Q Okay. So some of the increased cloudiness you could not attribute to these aerosols?
(20) A Correct.
(21) Q But some you could?
(22) A You couldn't rule them out is the correct answer.
(23) Q Are you aware of what the IPCC view is on this subject?
(25) A I believe I am.

PAGE 69

(1) Q Do they agree with you?
(2) A I think they do. Can I elaborate on that answer?
(3) THE JUDGE: Yes.
(4) THE WITNESS: I have to say I must elaborate on that answer. I think we are in agreement inasmuch as we both say that the confidence in the quantitative estimate of the effect of sulfate aerosol varies between a low and very low.
(10) BY MS. FREESE:
(11) Q Are you in agreement that some of the increased cloudiness can be attributed to sulfate aerosol?
(13) A With the confidence level between low and very low.
(15) Q Is the hypothesis that -- which I would attribute to you based on your testimony -- that warming will be, any warming would be manifested as warmer nights and cooler days something that is accepted by the IPCC?
(20) MR. GLASER: Excuse me. Let me just jump in. When you say any warming, could you please be more specific?
(23) MS. FREESE: Perhaps I could unpack that question into two.
(25) MR. WITHAM: Your Honor, I also have an

PAGE 70

(1) objection on the same question. She keeps referring in her questions to the IPCC. As Dr. Lindzen testified, the IPCC is not a person, it's a series of documents, and to clarify her questions I think she should be referring to which document she's referring to or meaning when she refers to the IPCC.
(8) THE JUDGE: Can you refer to documents as the '90 or '92 or '94, that kind of thing, are you prepared to do that?
(11) MS. FREESE: I may be able to. If it would work I'd prefer to refer to them as a body of work and then if there is a distinction that comes up between the different drafts then the witness could identify that distinction for us.
(16) THE JUDGE: Okay.
(17) BY MS. FREESE:
(18) Q Do you hypothesize that any enhanced greenhouse effect would be manifested as warmer nights and cooler days?
(21) A I have hypothesized that. That will serve as my answer.
(23) Q Is that the working hypothesis of the IPCC?
(24) A That depends on which IPCC report you're referring to.

PAGE 71

(1) Q Is it the working hypothesis of any IPCC report?
(2) A Let me explain. In 1990, I reviewed the 1990 report and in my review I pointed out the propensity for night warming and little, if any, day warming. That review never, not one word of that appeared in the 1990 report. In the most recent versions of IPCC, and I am going to have to check a reference here, if you don't mind. IPCC 1992 reports a reduction in the range of daily temperature. That means that has been detected, and I want to be precise on this, if you'll give me a moment. That has been detected primarily as a rise in the night temperatures with little change in the day.
(15) Q Did you find the page there in looking for that?
(16) A Well, actually what I'm looking at is a reference to IPCC '92 which is IPCC '95. They did not give the page number.
(19) Q Okay. Just one minute, Your Honor. Directing your attention to page 29 of your rebuttal testimony.
(22) A Excuse me, I'm a little overloaded up here with information. Yes.
(24) Q You show in your chart, the top portion, that in about 1950 the amount of CO2 emissions began to

PAGE 72

(1) increase steeply; is that correct?
(2) A Correct.
(3) Q And in the Northern Hemisphere, based on the second part of the chart, temperatures do not go up dramatically at that time, but rather they go down for a few years before they start to come up again?
(8) A There's no net change in the temperature that's statistically significant in this representation in the Northern Hemisphere.
(11) Q Looking at just a portion from 1950 --
(12) A Correct.
(13) Q -- forward, between the beginning and the end, I presume you would say there was no significant net change?
(16) A Right. This is the ENSO, E-N-S-O, corrected record, yes.
(18) Q But recognize there is a general dip in temperatures until, say, the '80s, and then it appears to go back up again?
(21) A The point of the illustration is that every observed Northern Hemisphere temperature after the carbon emissions take off, falls beneath the warming that was established before it did.
(25) Q Do you hypothesize in your 1982 article that the

PAGE 73
(1) difference between what happens in the Northern Hemisphere and the Southern Hemisphere after 1950 appears to be associated with the onset of world industrialization after 1950?
(5) MR. GLASER: Could you give him a cite to the 1982 article that you're referring to?
(7) MS. FREESE: Page 1574. Did I say '82? I meant '92. It's the article we discussed earlier.
(10) THE WITNESS: Okay. What column are we in here, left or right?
(12) BY MS. FREESE:
(13) Q Left column in the very beginning of that page, in fact part of the sentence is on the previous page.
(16) A Correct.
(17) Q Now, looking again at page 29, isn't it true that you would not expect global mean temperatures to immediately go up in response to increased CO2 due to, among other factors, the ocean lag or the theory that the oceans would delay the onset of atmospheric warming?
(23) A No. That's not correct.
(24) Q So you're saying that you would, if warming were to occur in response to CO2, you would expect a

PAGE 74
(1) line that began to rise as soon as CO2 began to rise?
(3) A It would not be a line, it would not be smooth. Climate has certain noise associated with it. However, you are bringing up one of the real problems with the entire greenhouse issue. And that is the following: That when we change the radiation, say five watts per meter squared, when volcanic ash gets into the stratosphere, we see a rather quick effect, an immediate effect on the global temperature. It maximizes at approximately 18 months after the radiation change. Here we have a change in the down welling radiation, via the greenhouse effect, conceptually estimated at 2.5 watts per meter squared and we don't see that type of behavior. We don't see the same type of response. That question has never, ever, been resolved as to why the two would behave differently.
(20) Q Are you suggesting then, Dr. Michaels, that because the earth cools off quickly after a volcano, the earth should warm up equally quickly in response to greater CO2 emissions?
(24) A It depends upon the rate of change.
(25) Q The rate of change?

PAGE 75
(1) A The rate of change in the forcing. But the subject of delay has been more an attempt to try and sort of fit the earth's behavior to a model and to try and account for the lack of warming rather than the other way around.
(6) Q You do not believe, then, that there is a theoretical basis for the idea of an ocean lag?
(8) A Oh, most certainly. Most certainly there is.
(9) Q That there should be some lag based on theory?
(10) A Correct. However, there are experiments that one can perform where the oceanic influence should be minimized. Suppose we had, for example, a situation where there was little advection, A-D-V-E-C-T-I-O-N, from the oceanic region and the atmosphere were allowed to radiate outward, given, given -- pardon me. Period, radiate outward, period. Such a situation occurs in the high latitudes during polar night. One would expect to see substantial warming in that situation and yet when Jonathon Kahl, K-A-H-L, looked at surface temperatures during polar winter, precisely during the period in which you, to which you are referring, namely 1950 onward, he found no net warming of the winter, in fact, he found a cooling.

PAGE 76
(1) MS. SASSEVILLE: Your Honor, would you ask the witness to define advection?
(3) THE WITNESS: Lateral motion.
(4) MS. SASSEVILLE: Thank you.
(5) BY MS. FREESE:
(6) Q For the record then, let's get back to your view on ocean lag. Do you agree that there should be some lag?
(9) A Yes. But when the ocean would not be influencing the climate. If our understanding were the understanding that is given by transient, remember that word? By the way, you asked a question, do you want to know what transient means?
(14) THE JUDGE: Sure.
(15) THE WITNESS: It doesn't mean at the bus station. A transient climate model is one in which the change in the atmospheric's, atmosphere's radiative characteristics are changed gradually, to save on computer time, most of the early models changed it all at once. But at any rate, back to where I was, if I could. Let me pick up on my last sentence, if I could. Where transient models predict large warming to have occurred, happens to be, I should

PAGE 77
(1) correct and say the largest, happens to be precisely in the areas where there is very little ocean influence on that type of temperature and it is precisely those areas where we do not see the large forecast winter warming, where in fact Kahl, K-A-H-L, in Nature Magazine, found a cooling in the winter.
(8) BY MS. FREESE:
(9) Q In nature, for the group as a whole, you would agree that the earth will have -- I'm sorry. That the ocean will have an effect of slowing down any warming that would result from CO2?
(13) A Where it has an effect it would have an effect. Where it --
(15) Q How about --
(16) A Where it doesn't have much of an effect it shouldn't.
(18) Q How about on average?
(19) A The planet, planetary climate doesn't behave -- I'm sorry. Referring to planetary climate to averages, discounts the fact that there are different radiative regimes for different times and seasons. If you want me to say on the average, if we'd averaged all the numbers up, if we added all the apples and the oranges, would I

PAGE 78
(1) get apple/oranges? Yes.
(2) Q The predictions of the models are global mean averages, correct? They're in those terms?
(4) A The predictions of the model are summations of grid point, latitude, longitude calculations. If we go much further I think we're going to be adding apples and oranges, but let's proceed.

(8) Q And the number of 4.2, for example, that is a global mean average that you characterize as being the predictions of the GCM models?
(11) A Yes. Yes. And I think it is because of the addition of the polar apples and the oceanic oranges in part that explains why it didn't warm as much as was projected. And further, that the sulfates don't explain it.
(16) Q Dr. Michaels, if the atmosphere warms will the oceans warm?
(18) A Yes.
(19) Q Will some of the heating of the atmosphere be drawn off to raise ocean temperatures?
(21) A You could characterize it that way.
(22) Q What is the characteristic circulation time of the oceans?
(24) A I'm not an oceanographer, I don't want to give an answer that may not be precise.

PAGE 79
(1) Q Would you agree that since the relationship between the atmosphere and the oceans is not well understood, this relationship is thought to be the source of possible climatic surprises in the future. That is, a sudden warming that will explain a lack of observed warming?
(7) MR. GLASER: I'm going to object on the grounds that that's vague. I'm not sure what is thought to be, or thought by anybody, who, the IPCC?
(11) MS. FREESE: Let me be more specific, Your Honor.
(13) BY MS. FREESE:
(14) Q Dr. Michaels, did you state in 1992 in the article that we were referring to earlier, that since the relationship between the atmosphere and oceans is not well understood, this relationship, quote, is thought to be the source of possible climatic surprises in the future. That is, a sudden warming that will explain the lack of observed warming?
(22) A I would answer by quoting from the National Academy of Sciences' report.
(24) Q Could you first answer that question?
(25) MR. GLASER: The question is not coming

PAGE 80
(1) up clearly for me. You're asking him did he -- you're asking him to confirm that his 1992 article said what you're quoting here?
(4) MS. FREESE: That's my first question.
(5) MR. GLASER: Does the witness have the --
(7) THE WITNESS: Say it again. I'm sorry.
(8) BY MS. FREESE:
(9) Q Maybe I could just give you a reference. Page 1565 of your 1992 article.
(11) A Yes.
(12) Q First column, second full sentence, you conclude here, do you not, that, or you at least state the relationship between deep ocean circulation and climate is very unclear and is thought to be a source of possible climatic surprises in the future. That is, a sudden warming that will explain a lack of observed warming.
(19) A That statement is a clearly hypothetical statement.
(21) Q That is, you think it's possible but not proven?
(22) A It was in reference to the National Academy of Sciences' report that said that no credible claim could be made that this type of event is eminent, dot, dot, dot, although none could be precluded.

PAGE 81
(1) I mean that statement is, is just to draw attention to this hypothesis and to say that nobody can say anything about it.
(4) Q I hesitate to belabor this point, but I'm still a bit confused on what effect you would expect, quite apart from surprises, the ocean to have on affecting the rate of warming from CO2. Let me ask you --
(9) A I suspect in San Francisco where the wind blows from the west off the massive Pacific Ocean that it would have some, it would have a much greater effect than it would have in the high latitude polar winter. So it depends on where you are and that's the problem with this issue. That's why your question is so very difficult to answer.
(16) Q Given how much of the planet is covered by ocean, is it fair to say that the climate of the entire planet is affected by the presence of those oceans, though in varying degrees?
(20) A Yes.
(21) Q If you were looking at, looking for a greenhouse signal, in other words, evidence that enhanced greenhouse effect is occurring, and you saw CO2 emissions rising steeply, would you expect -- let me strike that last "would you expect".

PAGE 82
(1) Would you consider it evidence that warming will not occur if there were not an immediate warming in response?
(4) MR. GLASER: I'm going to have to object to that one. We got a lot of negatives in there. Could I just ask you to rephrase that?
(7) THE JUDGE: Well, I think it's -- I think he can answer it. Unless he's confused, but --
(10) THE WITNESS: People have accused me of that, but I think I understand the question. What I would do is I would go fishing where the climatic fish are supposed to be. Namely, in a dry place at night with very little wind. And need I elaborate on why I would look there? I ask that as a subquestion.
(17) BY MS. FREESE:
(18) Q A dry place, you mean a place far from oceans?
(19) A A place where the mean atmospheric humidity were low.
(21) Q Okay. I don't understand why you would go there.
(22) A Because the radiative response to greenhouse gases is logarithmic. And water vapor and carbon dioxide have something called an overlap. So that where there is very little water vapor, if one

PAGE 83
(1) changes the carbon dioxide, the net radiative effect is large. And furthermore, if we could find a place where there wasn't very much other air, if you will, blowing in, that would be a nice experimental ground. And further, if we looked at night, when there's no incoming solar, and the only process that's going on is the earth is reradiating out long wave radiation, that's where the fish are. That's where one would look. I know we talk about the fingerprint, that's the body. And the problem is that one sees little, if any warming, under those circumstances, and Jonathon Kahl actually found a winter cooling. So what that tells me, and that's what you're really asking, is that our understanding is, from a modeled point of view, is tragically flawed.
(18) Q Is your testimony that if in such a place there is not

immediate warming in response to increased CO2, that that is evidence that CO2 will not later cause warming?
(22) A One would have to devise a hypothesis, observationally based, to explain this very peculiar finding which is well-known. I believe those hypotheses are being formed, though I don't

PAGE 84
(1) believe they have been adequately tested.
(2) Q Can you describe, Dr. Michaels, model response at the surface for a double CO2 for just the CO2 component if you include the water vapor overlap?
(5) A Could you phrase that question more specifically? That's a very broad question. Are you asking me to draw you a map?
(8) Q We'll move on to another point. You have been both a reviewer and contributor to the IPCC process, correct?
(11) A Correct.
(12) Q In the course of your reviews and contributions did you express to the IPCC authors the views you have presented in your testimony in this proceeding?
(16) A That answer is most certainly true, but I can't, chapter and verse, tell you what we may have forgotten or not. I do not have my review loaded on this computer, unfortunately.
(20) Q You state on page 21 of your testimony, line 25, you begin there with the statement that you are compelled to agree with the statements of your colleagues that, quote, there has been an unfortunate politicization of science in the IPCC process, unquote. In response to an MPCA

PAGE 85
(1) information request asking you for evidence of this politicization, you cite to the Bohmer Christiansen article in Nature which your colleague Dr. Lindzen testified about earlier, correct?
(6) A That was a partial answer. It was a very, very large question.
(8) Q That was the answer you provided to us earlier?
(9) A Correct.
(10) MR. GLASER: Well, I need to point out that the answer that was provided was subject to an overall objection to discovery requests that they were very broad, that we could not in time provide complete answers, that we were going to do the best that we could in the time that we had. And that's also a part of the discovery response.
(17) THE JUDGE: All right.
(18) BY MS. FREESE:
(19) Q In your own words, Dr. Michaels, could you describe what you understand to be the politicization identified by Bohmer Christiansen?
(22) A I need to look at my response there. I think it's in here, excuse me. Do you remember what question that was, what question number?
(25) Q 60, perhaps. Let's try 60. Yes, it is.

PAGE 86
(1) A Yeah, okay. What Bohmer Christiansen refers to in her article at the time, and we have the spelling on that from before, no? I hope it's right. B-O-H-M-E-R, C-H-R-I-S-T-I-A-N-S-E-N. I do not have her article in front of me, but my recollection is that she noted that the IPCC was a process that must have interacted with the political sphere because, and I think I am texturally stating what she said properly, and I could stand corrected, that the politicians, if you will, policy makers, kinder word, demand an answer. And once an issue is obviously complicated, judging from our conversation over the last hour, requires discreet answers for use in the political process. That is de facto evidence that the process must be politicized.
(17) Q Have you ever been to a plenary session of the IPCC?
(19) A No.
(20) Q Dr. Michaels, on page 5 of your resume -- actually I think that might be a wrong page, let me check it. It is the wrong page. Page 15 of your resume. You list the sources of your financial support over $10,000. Could you identify which of those research projects involved global warming?

PAGE 87
(1) A 19 -- I'm sorry, the answer is going to be somewhat extensive. 1986, '88, $140,000, Commonwealth of Virginia.
(4) Q That was a global warming research project?
(5) A It turned -- it was a project on air stream trajectories and we discovered in the process, it was that there was -- in our final report we said that there was quite a remarkable relationship between what we found and some of the trajectory patterns that we had been paid to look at with respect to the climate change issue. That was in fact -- in fact the referee publication that came from that, I think, concluded that we had found something quite interesting. It might be boring to you, but it related to the global warming issue. So that's Commonwealth of Virginia, 140 K. Cypress Minerals, 40,000.
(18) Q How did that relate to global warming?
(19) A You know, with all due respect, you're going to think I'm not telling you the truth. I'm trying to remember directly what came out of that project, and please don't tell the grantor. I'm sure we were looking at regional temperatures in some way. Anonymous, 50 K.
(25) Q What was that project?

PAGE 88
(1) A That was general research support on climate change.
(3) Q General?
(4) A Research support.
(5) Q So whatever research you were doing at the time --
(6) A I think, for example, I would guess that the 1992 paper that you refer to is from there. Edison Electric is to support graduate students to keep up with the global warming literatures and essentially is a training grant. Western Fuels is to do research on global climate change. And the German was day/night, I'm sorry, nighttime cooling rate work which is in the process of publication, I think if I talked about the results, which I'd love to, we'd probably be busting into Friday, but too bad.
(17) Q Would you translate the German for us?
(18) A I can't. Don't ask me. I don't know, can you?
(19) Q Is it the German Coal Trade Association?
(20) A Beats me. Peter, do you speak German?
(21) Q Who did you get this money from?
(22) A It was work through a scientist by the name of Gerth Vaber (phonetic).
(24) Q And you don't know the nature of the organization?
(25) A It's a, I mean it is a German energy-related

PAGE 89

company. But please don't ask me for a direct translation.
Q That's fine. Do you publish a journal called the World Climate Review, a quarterly review of issues concerning global climate change?
A No longer.
Q No longer? You formerly did?
A Yes.
Q And how long did you publish that?
A A little less than three years.
Q Who funded it?
A Western Fuels Association.
MS. FREESE: I have no further questions.
THE JUDGE: All right. Who would like to be next? Ms. Hedman. CROSS-EXAMINATION
BY MS. HEDMAN:
Q Dr. Michaels, I'm Susan Hedman and I represent the Environmental Coalition.
A Good morning.
Q To follow up on that last question that Ms. Freese asked you, I was also curious about the publication that you headed that was funded by Western Fuels. I didn't see any mention of that

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PAGE 90

on your CV or in your introductory statement. Am I correct in noting that that was omitted?
A Well, that is the -- if you look in the CV, financial support, the one there that says 1992, 1993, Western Fuels, it says Research on Global Climate Change, I believe if you look at the University of Virginia contract it may be titled Research Publication on Global Climate Change. That is, again, an I think, but probably correct.
Q With respect to your work at the University of Virginia, I note you're an associate professor, are you tenured?
A No. I can't be. Not on the line I'm on anyway.
Q On page 2 of your testimony I note that you are a senior fellow at the Cato Institute. Would you disagree if I characterized that as a neo-conservative organization?
A Yes, I would.
MR. GLASER: Wait, wait, I'm going to object to that as vague. I don't know what we mean by neo-conservative organization. And I'm not sure what this witness's characterization of the organization, what that means in terms of evidence in this proceeding.
THE JUDGE: Well, I think it's a

PAGE 91

legitimate -- I would overrule the objection. I don't think it's vague, I think you can answer the question. I think you did answer the question, didn't you?
THE WITNESS: Well, I hope I don't get in trouble here with the, quote, authorities, but Cato was a rather vociferous supporter of L. Douglas Wilder who is the former Governor of Virginia and I think would be characterized, and I hope I don't step on any toes here, as a very liberal democrat.
BY MS. HEDMAN:
Q In its natural resources program doesn't the Cato Institute fund seminars and publications that advocate the expansions of the use of the takings clause?
A I am unaware that Cato has a natural resources program. Do they?
MR. MILLER: I object to that. I mean I don't think we need a response from Ms. Hedman on that.
THE JUDGE: The objection is sustained.
THE WITNESS: Sorry, I goofed, my apologies.
BY MS. HEDMAN:

PAGE 92

Q Doesn't the Cato Institute fund publications and seminars advocating the expansion of the takings clause?
A I know absolutely nothing of Cato's funding.
Q On takings?
A On anything.
Q Presumably you know the funding of your work?
A Cato doesn't fund me. My remuneration from Cato is zero dollars and zero zero cents.
Q What is your role at the Cato Institute?
A They said when I go up to Washington if I wanted to use a computer and some office space I would be perfectly welcome. And they have this room in their new building for visiting fellows, I think there are three of us, I believe.
Q Do you happen to know if Terry Anderson is one of the fellows?
A Is he?
Q I'm asking.
A I thought, and I might be wrong, I thought that the fellows were myself, an ecologist who wrote Visions on the Land, do you remember who that is? And P.J. O'Rourke, the humorist, are the fellows. It's not Terry Anderson. Whoever wrote Visions on the Land.

PAGE 93

Q Doesn't Visions on the Land deal with, in part, with privatizing the national parks?
A I've never read Visions on the Land.
Q Going to page 7 of your CV. About the middle of the page you have a 1994 publication about U-B radiation?
A Yes.
Q Does that appear in Science or Science News?
A Science.
Q Was that an --
A I believe it was -- Science News, one does not publish in Science News, that's a -- well, I'm trying to be charitable. A summary sheet that serve for the journals and I believe they did, believe me, and I would not, I guess I am not supposed to say I would not testify to, but I think that they did reference it.
Q And did that study relate to a reanalysis of data by James, collected by James Kerr and C. Thomas McGelroy (phonetic) up in Byron, Canada?
A Specifically your answer, or your question, I might not be able to answer in the affirmative because what it was was an analysis of data that they had somehow not analyzed.
Q Are you familiar with the statements that they

PAGE 94

made in Science News regarding your article?
A No. Science News is not -- it comes in my mailbox but it's one of those things that oftentimes is not read.
Q So do you recall, if I showed you a copy of that article might it refresh your memory?
A The Science News article?
Q Yes.
A Sure.
MR. WITHAM: Objection, Your Honor. I don't think

there's foundation yet that he's even read the article, so I don't think she's refreshing his memory about anything.
(14) THE JUDGE: It's my recollection of his testimony -- let me just take a look here -- was that he wasn't familiar with it at all.
(17) THE WITNESS: This article is not about global warming, Your Honor, I should mention that.
(20) THE JUDGE: Okay. Well, just a moment. How do you know it's not about global warming?
(22) THE WITNESS: The Science article that I wrote was not about global warming.
(24) THE JUDGE: Oh, the Science article.
(25) THE WITNESS: I believe this is what

PAGE 95
(1) she's referring to.
(2) MS. HEDMAN: I'm exploring this area simply because of the rejoinder related to Mr. Michaels' methodological approaches.
(5) MR. GLASER: But the only rejoinder that you have is something that's reported in something that's not a primary source publication, it's some sort of news summary that is going to report on something somebody says and the witness says he hasn't seen it before. We're not dealing with global warming, I really think it's time to get on to global warming here.
(13) THE WITNESS: There was --
(14) MR. GLASER: Wait, wait, there's no pending question.
(16) THE JUDGE: Okay. We've got an objection. Do you want to say anything else, Ms. Hedman, about it?
(19) MS. HEDMAN: No, Your Honor.
(20) THE JUDGE: I'm going to sustain the objection.
(22) BY MS. HEDMAN:
(23) **Q** Do you recall, in preparation of your article for Science, the one we're discussing, that you only used winter data as opposed to the total data

PAGE 96
(1) attempted to be collected by Kerr and McGelroy?
(2) MR. GLASER: Your Honor, I'm going to object to this on the grounds of relevance. This article does not have to do with global warming, it has to do with an entirely different subject and I just don't see the relevance.
(7) THE JUDGE: Do you want to respond?
(8) MS. HEDMAN: Only that, again, I'm offering this for the purpose of an example of a commentary on Mr. Michaels' methodological approaches.
(12) THE JUDGE: Okay. And this is the article entitled Increasing Ultraviolet-B Radiation: Is there a Trend?
(15) MS. HEDMAN: It's the rejoinder that followed in Science News.
(17) THE JUDGE: But that's the article we're talking about?
(19) MS. HEDMAN: Yes.
(20) THE JUDGE: Does that have anything to do with global warming?
(22) MS. HEDMAN: Well, to the extent that when we talk about global warming and the greenhouse effect we're also concerned about holes in the ozone layer and increases in radiation. I

PAGE 97
(1) think it is relevant.
(2) THE JUDGE: Well, I'm going to sustain the objection.
(4) BY MS. HEDMAN:
(5) **Q** Mr. Michaels, Dr. Michaels, I believe you were in the room earlier when I was cross-examining Dr. Lindzen regarding the various issues and degrees of certainty related to the global warming question; is that correct?
(10) **A** I did step out, yes, and I may or may not have been there, I don't know. Go ahead.
(12) **Q** Were you active, an active participant in the Clinton administration's Office of Science and Technology policy working group on climate modeling?
(16) **A** Working group on climate modeling? What group do you mean?
(18) **Q** I mean the -- I guess the formal name was the Forum on Global Change Modeling.
(20) **A** I was at the meeting for one day.
(21) **Q** Okay. Again, I'm not wishing to cross-examine you on the document that was produced out of that process, but for purposes of clarifying the record, I would like to and will be taking each of the natural and physical science witnesses through

PAGE 98
(1) these various points so we can identify where the specific disagreement is of uncertainty.
(3) MR. GLASER: Objection for the same reason that this was excluded this morning or earlier this morning. There's no document that's been identified in the record to ask him to comment on statements that were made in something that might or might not be a draft, this is not appropriate.
(10) MS. HEDMAN: Again, I'm not trying to get the document in, I just think it's a very useful set of issues and probabilities and he can say whether he agrees or disagrees with the statement, not with the document itself.
(15) THE JUDGE: I think it's a legitimate process and she can do it.
(17) MR. GLASER: Your Honor, can we just clarify, then, that there's nothing in this questioning that is meant to bring this document into evidence or give any evidentiary weight to the statements that are in the document whatsoever?
(23) THE JUDGE: Yes, I think I went through that already with Dr. Lindzen.
(25) MR. GLASER: All right.

PAGE 99
(1) MR. MILLER: I don't think Ms. Hedman needs with each witness then to make a statement that my next series of questions is going to relate to this document. If she just wants to ask her questions she should do it.
(6) MS. HEDMAN: Your Honor, in the case of Mr. Lindzen and Dr. Michaels, they did participate in the process, I thought it would expedite the questioning if I --
(10) MR. GLASER: I think it has to be very clear that the witness is to ascribe no weight at all to the questions that are being asked in terms of characterizing the results of that process.
(14) THE JUDGE: Just a second. Ms. Hedman, I don't think it's necessary to refer to the document. They'll figure it out.
(17) BY MS. HEDMAN:
(18) **Q** I'm going to ask you a series of questions and ask you whether you would agree with the questions. The first is to ask whether you would agree that something is virtually certain, in giving your earlier testimony that is necessary to quantify something for it to have meaning in your eyes. Let's

say that virtually certain means a 100 percent or near 100 percent probability, 99

PAGE 100

(1) percent probability. And I would ask you whether or not you would agree that it is virtually certain that the increase in carbon dioxide concentration and ozone depletion that is currently occurring will cause large stratospheric cooling?
(7) **A** You're asking me to make a probabilistic statement.
(9) **Q** I'm asking you whether or not --
(10) **A** You said probability.
(11) **Q** -- it's virtually certain --
(12) **A** And then you said probability.
(13) **Q** No, I'm not --
(14) **A** The nature of probabilities is something that requires --
(16) MR. GLASER: Can I ask the witness to wait? Let's get a question framed here first.
(18) BY MS. HEDMAN:
(19) **Q** I'm simply asking whether or not you believe that that is virtually certain if virtually certain means 99 percent likely to occur?
(22) **A** And restate the question in its entirety, I'm sorry, and I don't mean to be -- please accept that.
(25) **Q** Whether or not you agree that you're virtually

PAGE 101

(1) certain that the increases in carbon dioxide concentrations and ozone depletion that are currently documented will cause large stratospheric cooling?
(5) **A** Again, the operative word is large. We have stratospheric data which I have here. And I would say, I would answer your question that the former, the change in greenhouse effect, would be associated with a drop in stratospheric temperature. I would be very careful on the ozone to not misplace my chickens and eggs. Because it is often stated that the stratosphere ozone loss was a result of a result. I don't -- of a drop in stratosphere temperature, not causative. And stratosphere temperatures vary, by the way, an awful lot, and we have not very good measurements of them.
(18) **Q** But you would agree that there is association between what you term the greenhouse effect and stratospheric cooling?
(21) **A** I think there should be an association between the two, yes.
(23) **Q** Now I'm going to ask you about a number of statements and ask you whether you agree that it's very probable. And since the next series or

PAGE 102

(1) statements I'm going to ask you about are whether they are probable, which I would take to be more than 50 percent, just for the sake of argument let's say we're talking about very probable meaning about a midpoint there, about 75 percent chance that they're true, or you'd have a 75 percent level of certainty and you can use that as a rough gauge. Would you agree that it is very probable that if no changes occur in the current rate of emissions growth that global mean surface temperature warming will increase from about half a degree to two degrees over the period 1990 to 2050?
(15) **A** Probability estimates are based upon sample size. It is not a -- one cannot make a sign a scientifically based probability to that question because we do not have multiple sample size.
(19) **Q** So you're telling me that between being virtually certain and the -- that something is true and something virtually certain is something that's false, there's no way we can talk about the continuum of certainty in between?
(24) MR. GLASER: I'd like to ask for a clarification here. Are you redefining very

PAGE 103

(1) probable? Before you said 75 percent, is that still what you mean by very probable in this question?
(4) MS. HEDMAN: I'm willing to work with the witness on a definition. I'm trying to work with him because in his earlier testimony he indicated he gave a number, he said he couldn't work with just concepts. I'm offering this, if you have a way that we could work with very probable --
(11) THE WITNESS: That is precisely the problem. Not to use the word "prob" too many times. I mean fragment. I don't know how to answer your question in terms of probability. When we ask the question what's the chance, what's the probability I'm going to walk outdoors and get hit by a car, that's based upon a known number of observations of people walking out the door and a known number of observations of people getting hit by cars.
(21) BY MS. HEDMAN:
(22) **Q** That's correct, that's a measurement of risk. I'm asking you about a certainty.
(24) **A** In this case they're one in the same.
(25) **Q** Well, let's explore that point.

PAGE 104

(1) THE JUDGE: Well, okay, but if the witness is unwilling to answer the question the way you framed it he can say I can't answer it and we can move on.
(5) BY MS. HEDMAN:
(6) **Q** I'd like to explore the witness's claim that risk and uncertainty are synonymous. In the case of temperature change, would you agree with me that there might be two components in thinking, in the simple sense, thinking about temperature change, one component of the model might be inputs which we cannot quantify or do not know at this point, and that those might be termed uncertain inputs?
(15) **A** Are you asking me are there uncertainties?
(16) **Q** Are there uncertainties?
(17) **A** Yes.
(18) **Q** And distinct from that, might there be things that we can quantify and do know, for instance, you know, because of Boyle's law we know certain things about the relationships between temperature and pressure, that we can assign a certain probability that something is going to occur with the raise --
(25) **A** But the naughty problem with the issue about which

PAGE 105

(1) we are speaking is that the uncertainties and the certainties interact.
(3) **Q** Is it your testimony that the --
(4) **A** Would you like -- I'd be happy to elaborate on that. We've been talking about it for the last hour and 15 minutes.
(7) **Q** I guess I'd like to have you elaborate on specific aspects of it. Let's take this concept of uncertainty and risk and go back to the question of if we continue at the current rate of emissions, whether global mean surface temperature

warming will increase half a degree to two degrees over the period from 1990 to 2050?
A I don't agree with the range that you have given. I have testified and I maintain that the record, rather, that independent and internally consistent records steer one toward the lower value and away from the upper value. If you asked me a half a degree I'd be much more comfortable with that.
Q So you might say that you believe that a half a degree is very probable?
A No. I said I would be more comfortable with that.
Q Meaning that you are somewhat more certain that that number is correct?

PAGE 106
A Based upon what we have been speaking about, and I just want to clarify, you were saying one-half a degree in what period of time?
Q 1990 to 2050.
MR. GLASER: Is this temperature?
THE WITNESS: Yeah, global average.
MR. GLASER: Global mean temperature?
MS. HEDMAN: Global mean surface temperature.
MR. GLASER: Increase from 1990 to 2050?
MS. HEDMAN: Yes.
MR. GLASER: For a doubling of CO2?
MS. HEDMAN: For the current rate of emissions increase.
MR. GLASER: Do you understand the current rate of emissions increase?
THE JUDGE: If you could answer for the record, please? Don't just nod your head.
THE WITNESS: I'm thinking. I do that, I think, unfortunately I'm giving it away that I'm thinking, you can tell how often I'm not. I am, and I'm going to choose my words carefully here. Please understand that. I am very uncomfortable with anything above the bottom

PAGE 107
portion, meaning the 0.5 of that range. And I think that one could construct an argument that it's possible it would be underneath that, so, but had you phrased your question, you know, do you think that .5 degrees is a reasonable limit or reasonable target, I'd have to say I'm not uncomfortable with that. But I caution you that that number is virtually irrelevant because it doesn't matter at that level really what the magnitude is, it's how it expresses itself. And we continue to see in the record this propensity for the night rather than the day, et cetera, et cetera. You know the rest of the story.
BY MS. HEDMAN:
Q You're making that distinction. I would like to stick to the question of whether the reason you are more, to use your word, comfortable, with half a degree is because you are somewhat more certain that it is right?
A That's much more consistent with the facts rather than the forecast facts. That is why I am more comfortable with it.
Q And do you mean that by saying that, that because it's not a forecast, rather it's based on historical data, you're saying that you can have a

PAGE 108
greater degree of certainty?
A With the -- again, we have gone over this, we seem to be going back and back over the same territory. Given the failure of the atmosphere to conform spatially, S-P-A-T-I-A-L-L-Y, to the patterns of warming that were forecast, one is -- the patterns, not, we're not even discussing magnitude, pattern is more important than magnitude.
Q That's your contention, yes.
A It's not my contention, that's science. Given that failure, one is left to rely upon data more than models. I'm reminded of Egor Sykorsky (phonetic), the aeronautical engineer who had a famous statement in a graduation speech, he said, "Ladies and gentlemen, sometime in your life you will confront a situation where the facts and the theory do not coincide. I urge you to pay attention to the facts." And that's what we must do.
Q Aren't facts used to develop theories?
A No, the way -- you must understand, if I could, what a model is in science. A model is a hypothesis. All these things really should be not GCMs, but GCHs. A series of interacting

PAGE 109
equations --
Q Hypotheses.
A That's correct. And one can reject hypotheses based upon data.
Q And they can be rejected with very -- or accepted with varying degrees of certainty?
A Accepting a hypothesis is much different. It's much easier to falsify --
Q To set up --
A -- than to verify.
Q To set up an all --
A And that is precisely what I did in that 1994 paper. It was a formal mathematical model to test the hypothesis, whether the pattern, not the mean, but the pattern, resembled the forecast.
Q So your testimony does not address the null hypothesis, a null hypothesis relating to mean temperature?
A No. No.
Q Let's move on to the --
MR. GLASER: Off the record. (Discussion held off the record.)
BY MS. HEDMAN:
Q Let's move on to the next one, and again, the reason I'm doing this is in the hopes of

PAGE 110
clarifying where the differences are for the record.
A Differences?
Q The differences in views of the various experts that will be testifying in this proceeding, so bear with me, I'd like to go through this, this list. Would you agree with the statement that it is very probable that if the current emission rates continue, the global mean precipitation will rise?
A Can I ask a question, a procedural question off the record?
THE JUDGE: On the record.
THE WITNESS: Okay. Is it appropriate for me to refer to previous testimony today?
MS. SASSEVILLE: Yes.
THE WITNESS: Dr. Lindzen testified in response to that question that the hypotheses that storminess would increase

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(20) BY MS. HEDMAN:
(21) **Q** I'm asking -- actually --
(22) **A** Precipitation comes from storms.
(23) **Q** Actually, if I recall his response, his response was simply no because he didn't agree with the prior statement which he took to be --

PAGE 111

(1) **A** The evidence --
(2) **Q** We can go back and check the record, if you'd like.
(4) **A** Sure.
(5) THE JUDGE: Well, no. I'd just rather have you answer the question, please, without characterizing what Dr. Lindzen said. It just leads to disputes. Please, if you can just answer the question.
(10) THE WITNESS: My apologies.
(11) THE JUDGE: Okay. If you can just answer it on your own.
(13) THE WITNESS: I'm used to faculty meetings. Okay. I'll answer the question now then.
(16) THE JUDGE: Okay.
(17) THE WITNESS: Some types of precipitation should increase, some types should decrease, the jury is out as to what the net effect ultimately will be.
(21) BY MS. HEDMAN:
(22) **Q** And relating to your earlier testimony about patterns, I take it that in some areas you would expect to see increased precipitation, in other cases, in other areas, perhaps, decreases in

PAGE 112

(1) precipitation?
(2) **A** We have to couch this discussion in terms of statistical significance. Those are the rules of science. And I will answer your question by saying that it will take a long time, given the noisiness of precipitation data, to see any signal in this.
(8) **Q** Is it you're saying that there is a great deal of uncertainty regarding this?
(10) **A** A great deal of noise. No, noise is not uncertainty, noise is random behavior. It's a difference, it's really not all that subtle between the two.
(14) **Q** Let me ask you whether or not you would agree that it's very probable that if current rates of emissions growth continue that the Northern Hemisphere sea ice will diminish?
(18) **A** No.
(19) MR. MILLER: Your Honor, I'm going to object to this question. Northern Hemisphere sea ice will diminish by what, a gram, a ton? You know, I think the question is so vague that she's got to ask something a little bit more focused for him to give a response.
(25) THE JUDGE: Do you want to respond?

PAGE 113

(1) MS. HEDMAN: My response would be that often scientists can only, in their hypotheses, hypothesize a sign plus or minus. Here diminish would be a minus sign to whatever you're testing.
(5) THE WITNESS: A statistically significant fashion, that's the rule we usually play by.
(8) THE JUDGE: I'd allow him to answer it.
(9) THE WITNESS: The answer is, in my mind, is that the jury is again out. We see evidence in the historical record during the so-called, the climatic optimum, which we mentioned way back in the beginning of this testimony, that the snowfall rates in the high latitudes were increased. It is not clear whether the net change under this scenario would be positive or negative. And that, the opinion on that changes really from almost from year to year depending upon what the latest findings are. I'm going to answer and say that I believe the jury is still out on that.
(21) BY MS. HEDMAN:
(22) **Q** And would you agree that it is very probable that wintertime warming will occur in arctic land areas?
(25) **A** Theoretically, yes.

PAGE 114

(1) **Q** And would you agree that it's very probable that the rate of the rise in global sea level will increase at the current rate of increase if the current rate of CO2 emissions continues?
(5) **A** There has been no change in the rate of sea level rise for the last 100 years. So do you mean to say do I agree it's probable that what has happened, meaning I believe it's two and a half to three inches, please don't hold me to that, but I think that's the number, of sea level rise in the last 100 years, that that trend would continue? The answer is yes.
(13) **Q** So you're assuming that there have been -- in your answer to this question you're assuming there are no -- there has been no change in sea level?
(16) **A** No, there has. In sea level rise it's been a couple of inches. And I would agree with your statement, yes, that would continue.
(19) **Q** Okay. Finally, would you agree that it is very probable that prolonged forcing from solar variability would be insignificant compared to the effects of greenhouse gas emissions?
(23) **A** If?
(24) **Q** If carbon emissions continue to increase at the current rate?

PAGE 115

(1) **A** Yes.
(2) **Q** And then I have a final series of questions which I'll simply ask you whether you agree that it's probable, and let's take that to mean that you think it's slightly more true than untrue, you're slightly more comfortable than uncomfortable, however that works best. Would you agree that it is probable that dryness will be on the rise during the summer period in the Northern Hemisphere, midlatitude continental area, if the trends we discussed earlier continue?
(12) **A** We don't have any scientific information that allows us to make that determination. So I must answer based upon science, the answer is I don't know. The models are equivocal, the data is noisy.
(17) **Q** And would you agree that it's probable that high latitude precipitation would rise if the emission trends continue?
(20) **A** Based upon the work over thousands of years ago, I would say that it's likely that the high latitude snowfall would increase. I don't know about high latitude rainfall.
(24) **Q** And would you agree that it's probable that warming will be slower in the Antarctic and North

PAGE 116

(1) Atlantic ocean regions than elsewhere?
(2) A No.
(3) Q And then finally, would you agree that short-term cooling will result from transient explosive volcanic eruptions?
(6) A Yes, if we have volcanic eruptions.
(7) MS. HEDMAN: Thank you. I don't have any further questions.
(9) THE JUDGE: All right. Off the record. (Discussion held off the record.) (Break taken.)
(12) THE JUDGE: All right. We're now resuming after a break. Who would like to be next?
(15) MR. WIRTSCHAFTER: I will go.
(16) THE JUDGE: Okay. CROSS-EXAMINATION
(18) BY MR. WIRTSCHAFTER:
(19) Q Good afternoon, Dr. Michaels.
(20) A Good afternoon.
(21) Q My name is Joshua Wirtschafter, I represent the Department of Public Service. On page 23 of your testimony you stated that science effect does not work by static consensus?

PAGE 117

(1) A Yes.
(2) Q By that do you mean that the state of scientific knowledge is always in flux?
(4) A It depends upon the issue that we're talking about. The state of scientific knowledge is not in flux about the earth being round, but it is in flux about the earth's climate.
(8) Q So in complex questions like the earth's climate there will always be a state of flux within scientific knowledge?
(11) A I would never say always in science. It could be somewhere, 100 years from now, we'll live in what I would view as an undesirable world where we knew everything about the weather, that could happen.
(15) Q You wouldn't expect that to happen --
(16) A Soon.
(17) Q -- for decades. And until that happens there will always be observed phenomenon that do not, the predominant theories of the day; would you agree?
(20) A Yes, but theories are modified in light of disparate observations, and if I could I'll draw you what I think is a poignant example of that on the issue of global warming.
(24) Q That's all right, you can do that on redirect. In the on-line transcript at page 1484, that you can

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PAGE 118

(1) reach by hitting J, at line 13.
(2) A Okay.
(3) Q You mention that policy makers require discreet answers. Could you explain what you mean by discreet answers?
(6) A Yes. John Houghton said that when they wrote the policy maker summary for the 1990 report, that they recognized that there was a great deal of what I would call balanced uncertainty. And that he chose to write the executive, or the policy maker summary, in a way that corresponded, and I'm using his words, and we can find these back in the papers if we have to, in a way that corresponded more to a weather forecast than a scientific document, I believe is the correct word, end quote.
(17) Q Could you explain what you mean by discreet answers?
(19) A That they wanted a document that was less equivocal than reality. Or I'm sorry, less equivocal than the state of science was. The policy makers -- excuse me, I'm sorry. I'll rephrase that. That policy makers desire a document that is less equivocal than the state of science on this issue.

PAGE 119

(1) Q And why is that?
(2) A You'd have to ask a policy maker, but I suspect that it is difficult to formulate policy in an environment of factual conflict.
(5) Q Do you believe that policy making usually requires making decisions based on the predominant theories of the time?
(8) MR. GLASER: I'm going to object to that as beyond the scope of the testimony. The witness is testifying as a scientist, not as a policy witness.
(12) MR. WIRTSCHAFTER: The witness has testified about how he thinks science should be used in policy making.
(15) MR. WITHAM: I also object because I think the phrase "predominant theories" is vague.
(17) THE JUDGE: I'm going to sustain the objection.
(19) MR. WIRTSCHAFTER: On what grounds is that?
(21) THE JUDGE: I am going to sustain it because I don't think he, what he believes the policy makers in this situation are going to do, meaning the situation of our proceeding in Minnesota, is irrelevant. He's in no position to

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PAGE 120

(1) know.
(2) BY MR. WIRTSCHAFTER:
(3) Q On page 1481 of the on-line transcript, at line 11. You were having a discussion with Ms. Freese about where one would find evidence of global warming and at that line you use the phrase "our understanding". What did you mean when you said "our understanding" in that context?
(9) MS. SASSEVILLE: Where is this?
(10) THE WITNESS: I'm going to have to back up a line or two, if you don't mind.
(12) BY MR. WIRTSCHAFTER:
(13) Q That's fine.
(14) A Yes. I think, the context of this discussion was that we were referring to the concept of going fishing where the climate fish were. And it was that if one was going to find a substantially enhanced warming, one would look for it in a dryer environment at night and in the winter. Because of our understanding of the absorption characteristics of greenhouse gases, and the fact that there's very little mixing from the ocean to high latitude dry winter environments. So our understanding would say, well, this should be where a dramatic warming would be quite evident

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PAGE 121

(1) and our reality doesn't even conform to that understanding.
(3) Q So when you say "our understanding," do you mean something like the predominant views of the majority of scientists' work in global warming?
(6) A Yeah.
(7) Q So I take it you think it does make sense to talk about the existence of, of this understanding of the -- of the predominant views of the scientists working on global warming?
(11) MS. ZIBELMAN: Objection, Your Honor, it's vague. In

what context is he referring to? I'm referring back to the earlier question that he asked that was objected to and sustained. It makes sense --
(16) THE JUDGE: Well, no, no, no. I think the witness was about to start out by answering the question in a way that suggests what you're getting at. If the witness believes he can answer it he can answer it. You can answer the question.
(22) THE WITNESS: Our understanding or the strength of a paradigm, if you will, depends upon the nature of the phenomena. For example, if we had between me and you a tube, in which we passed

PAGE 122
(1) carbon dioxide and had infrared energy measurement at one end of the tube and at the other, you and I would conclude that carbon dioxide absorbs in the infrared. That is almost like saying the earth is round. However, we would have a difficult time concluding from that or drawing from that very real physical fact that, let us say, the dryness of a point on the earth would increase or decrease. In other words, our understanding is, or the robustness of our understanding is a function of the variable that we are describing.
(12) BY MR. WIRTSCHAFTER:
(13) **Q** I take it your use of the word paradigm is taken from the ideas put forth by Thomas Kuhn in the structure of scientific revolutions, is that what you mean by paradigm? Is that sort of the working theories of the scientific community?
(18) **A** I mean what he says and also a paradigm is a structure, a referential structure. You don't need Thomas Kuhn to have a paradigm.
(21) **Q** Do you think within the community of global warming scientists there is a dominant paradigm at the present time?
(24) **A** Depends upon the -- again, in answer to your previous question, it depends upon the nature of

PAGE 123
(1) the phenomena. Again, if we wanted, if -- perhaps the word you should use is unshakeable, strong. There is a strong paradigm that CO2 absorbs in the infrared. When we take that and a series of interacting differential equations, some of which are only partially parametrized, and put in solar values that we know aren't real, and heat fluxes that we know aren't occurring, in order to simulate the transient behavior of climate as that known phenomena that you and I just proved in our little mental laboratory, when we do all those things to make that simulation, we come up with a very weak paradigm, indeed, and in fact we come up with conflicting results. So is there a paradigm as to whether one can reliably estimate regional climate change, such as in the state of Minnesota, in a greenhouse scenario, the answer is that one can't. There is no paradigm of reliable estimation for, as we call it, a grain size such as this state. If we were in Virginia it would be commonwealth.
(22) THE JUDGE: Let me suggest that it's really going to speed things up if you --
(24) THE WITNESS: Go back to yes and no.
(25) THE JUDGE: -- try to answer the

PAGE 124
(1) question as briefly as possible and only use examples when necessary. It really just invites people to question you on the examples.
(4) THE WITNESS: Yes, Your Honor, my apologies.
(6) MR. WIRTSCHAFTER: I have no further questions.
(8) THE JUDGE: Who would like to be next?
(9) MS. SASSEVILLE: I would, I have just two questions.
CROSS-EXAMINATION
(12) BY MS. SASSEVILLE:
(13) **Q** The first one is just if you could clarify for me, Dr. Michaels -- I'm Katie Sasseville, I represent Otter Tail Power Company. I'm not sure I understood what your conclusion is about the effect of changing ocean temperatures on land temperatures because it seemed to be counterintuitive to my experience of climatic differences on land masses that are close to oceans. For example, in Juneau, Alaska it's clear that the Japan current has a warming effect and in Door County, Wisconsin it's clear that the Great Lakes have a warming effect. Could you explain simply the difference between those observations

PAGE 125
(1) and what you were saying?
(2) **A** What I was saying is that, that in fact areas that are oceanically influenced, such as the west coast of continents, would be expected to have a climate that corresponds very closely to the oceanic temperature. Places that are more continental, I don't mean that in the cultural sense, I mean more in the North Dakotan sense.
(9) THE JUDGE: To draw a clear distinction.
(11) THE WITNESS: All right. Never laugh at your own jokes. Places that are more continental see less of an influence, direct influence, from the ocean's temperature. So that today, if you and I were going to look for changes, climate changes related to the greenhouse effect, we'd like to look in a continental area, North Dakota being a fine example, again, under, probably under nighttime clear conditions.
(21) BY MS. SASSEVILLE:
(22) **Q** Thank you.
(23) **A** That work is in progress.
(24) **Q** Then I just have one other question. It was about a possibility raised by Ms. Freese and there were

PAGE 126
(1) enough negatives in it, so I'm just not clear. But she asked you about the masking possibility or the hiding possibility that natural variability in temperature could have on a potential greenhouse effect. And my question is, is that scenario that she was talking about the same thing as saying that without the greenhouse related warming, whatever that level might be, natural variability over the last 20 years could have otherwise resulted in cooling and precipitation changes that would be harmful to agricultural production in this area?
(13) MR. GLASER: This area means Minnesota?
(14) MS. SASSEVILLE: And North Dakota, the upper great plains.
(16) THE WITNESS: The answer to that, in the hypothetical, is yes. In the reality, between 1930 and 1970 in southern Minnesota, the mean temperature fell a statistically significant 1.3 degrees. I don't know if anyone has ever ascribed an economic or ecological effect to a fall of that magnitude in that time in Minnesota.
(23) BY MS. SASSEVILLE:
(24) **Q** Okay.
(25) **A** But what, it does say that regional climate

PAGE 127
changes quite a bit, naturally.
MS. SASSEVILLE: Okay, thank you. I have no other questions.
THE JUDGE: Okay. Mr. Witham.
MR. WIRTSCHAFTER: I take it that Mr. Witham is doing the redirect for the parties sponsoring?
THE JUDGE: No.
MR. WITHAM: I have one question.
MR. WIRTSCHAFTER: He is one of the parties sponsoring Dr. Michaels.
THE JUDGE: Oh. Mr. Witham is part of your coalition?
MR. GLASER: He did cosponsor.
MR. WITHAM: I'll withdraw my question. It was a question I could hardly resist, but I won't ask it.
MR. GLASER: I think it had to do with the North Dakota statement.
THE JUDGE: Ms. Heitkamp, you know we tried. Is there any other cross-examination? All right. Seeing none, what about redirect? REDIRECT EXAMINATION
BY MR. GLASER:

PAGE 128
Q Dr. Michaels, in response to questions by Ms. Freese, you testified about sulfates and some of the questions were concerning whether anthropogenically emitted sulfates were retarding expected warming. And I believe your testimony was that you believe that sulfate emissions were insufficient to explain the failure of actual warming to be of the magnitude predicted by the models. And then you also talked about volcanoes that emitted sulfur and that you could see a detectable cooling as a result of certain volcanoes. I wonder if you could just explain your testimony generally about the difference between man-made emissions and volcanic emissions and the effect on temperature?
A If it's a volcanic aerosol from an explosive volcano, and there are two different types of volcanoes, there are volcanoes that ooze and volcanoes that explode. Explosive volcanoes can put these sulfate particulates and other particulates up into the stratosphere. There is very little air exchanged normally between the surface and the stratosphere, two known mechanisms are nuclear explosions and volcanic explosions, to

PAGE 129
get a lot in there at once. When anything gets into the stratosphere it resides a long time. The volcanic aerosol in the stratosphere resides roughly an average of a year and a half, that's a half-life, some of it lasts much longer. So that it has a substantial amount of time, if you will, to veil the atmosphere, and it does so, if not globally, over a large portion, usually much more than one hemisphere or one-half of the planet. The anthropogenerated aerosol lies in the troposphere, in particular in the bottom of the troposphere, in the bottom, about, on the average, the bottom 7,000 feet of the atmosphere. And its lifetime is only, on the average, a few days. It is not distributed as evenly as the volcanic aerosol and, therefore, should leave a much less even, but nonetheless very detectable climate signal which would include, because they are so relatively pristine, a rather large warming at the poles. They couldn't be hiding things at the poles. And we don't see that. Because we don't see that that leads one to question the efficacy of man-made aerosol as the explanatory agent. And that was the conclusion of my 1992 paper, which I should add has another paper in the

PAGE 130
same journal that followed on to precisely your question. And it was there that we pointed out that there were other mechanisms that might in fact explain some of the lack of warming.
Q Yeah. Could you, the 1992 paper, can you say what the name of that paper is for the record, please?
A The title was "Global Warming: A Reduced Threat?"
Q Okay. And can you just very briefly state your hypothesis and your conclusion of that paper since we had so much discussion on it?
MS. FREESE: Your Honor, it's not clear to me whether this is within the scope of my cross-examination or not.
MR. GLASER: We certainly had a number of questions --
THE JUDGE: Are we talking about the first paper or second paper? It's my understanding if we assume that the one Ms. Freese was asking about is the first paper, are you now asking about the second paper?
MR. GLASER: No, I'm asking about the first paper.
THE JUDGE: All right. Do you understand that?

PAGE 131
THE WITNESS: Yeah. I should point -- I'm sorry. The usual scientific practice is if one writes a letter about a paper, and the author of that paper responds to that letter in the same journal, that they are considered one in the same paper. And that's what we're talking about here.
THE JUDGE: Okay. I guess what I'm interested in is sticking with what Ms. Freese asked you.
THE WITNESS: I think I can do that. At the risk of being wordy I will list the hypotheses, recognizing the clock.
BY MR. GLASER:
Q I just want an overall, and again, recognizing the clock, since we had so much discussion about this, just generally what was the hypothesis of the paper and your conclusions?
A The hypothesis of the paper, the hypotheses were that we would see night warming and that if it were -- if it related to an increase in cloudiness.
Q If what were?
A I'm sorry, that was a misstatement. Night warming related to an increase in cloudiness. And that the paper said, yes, we do see those two things.

PAGE 132
The paper then asks the question in hypothetical form, is the cloudiness increase a result of a change in sulfate aerosol? And the paper concluded that sulfates were insufficient to explain the change in cloudiness and, therefore, are insufficient to explain night warming, muted day warming and, therefore, insufficient to explain the disparity, that since has been alluded to in the literature in many many citations between the model forecasts and the real temperature.
Q And there was a question from Ms. Hedman about whether your testimony did or did not address mean temperatures; do you recall that?
A Yes.
Q And my question is, I'm not sure if the record was

clear on that, does your testimony address mean temperatures?
A In part it does. I may have misspoke there.
Q And can you explain for us why patterns of climate are more important than -- would they be patterns in which temperature increases express themselves more important than the overall magnitude of the temperature increases?
MS. HEDMAN: Objection. The question is

PAGE 133
vague. Important and more important than what?
THE JUDGE: Could you explain it, more important in --
MR. GLASER: Sure.
BY MR. GLASER:
Q Dr. Michaels, do you recall testifying about patterns of temperature increases?
A Yes.
Q Can you explain to us, do you believe that patterns of temperature increases are important in discussing greenhouse predictions?
A They are of absolute importance because it's the pattern of climate that determines the patterns of our ecosphere. And, therefore, the logical test of a forecast of global warming would be, are the patterns that are forecast to have evolved the ones that did evolve. I think that's much more important from the ecological point of view than the mere question of global temperature. And that's why, in earlier testimony, I stated that mean temperature may not be as important as the way temperature changes.
MR. GLASER: May I have one minute, Your Honor?
THE JUDGE: Yes.

PAGE 134
(Discussion held off the record.)
BY MR. GLASER:
Q The last one, Dr. Michaels, if you could scroll up to page 1514, line 24?
A Yes.
Q And that's your answer, you were asked a question just above that and then in your answer you said that you would give an example; do you recall that?
A Yes.
Q Could you go ahead and give us that example now?
A I'm sorry, I'm missing your question.
Q The question, there's a question and then there's an answer and then you offer to give an example and then in the next question the counsel said that's all right, you can do that on redirect?
A I must be on the wrong page. What page are you on?
Q This is 1514.
A I'm on 1515. Line?
Q Go up to line 25 where the question is.
A Wait a minute. Okay.
Q You read that question and the answer?
A The theories are modified in light of disparate -- that's computerese. Oh, yes. Oh, yes. If we

PAGE 135
take a look at the 1990 IPCC report, which the process, as you know, is rather involved, when I reviewed that I said, I stated in rather extensive review that something looked to be amiss, it looked like there was a disparity between the model temperature and the observed temperature and that one of the causes could be related to sulfate aerosol. And in this report that barely appears. There is a sentence that says something like that early in the report. By the time we get to 1992 -- I should point out, that then in 1990, and this review was probably written in '89 for the 1990 report, the folks who made, who made that assertion might have been called nonconsentual, outside a paradigm. By the time we got to 1992 there is more text that states that sulfates or something may be compensating for the warming. When we get out to 1994 and '95 we see more and more of this. At the same time, tests were being done by scientists, by myself, asking the hard and quantitative question, is it sulfates or is it something else, or sulfates plus something else. And what we, I think, are going to see, probably because of the process that's associated with the production of

PAGE 136
this type of document, is now the acceptance of the paradigm of sulfate compensation, when in fact the advancing from, of knowledge, is going to be, no, that's not enough. That that doesn't explain it. So you see, you know, you see shifts in scientific, or changes in scientific consensus and when one attempts to force a consensus by making very large documents like this, almost certainly that forced consensus is behind what the state of the science really is on its forward march.
MR. GLASER: That's all that I have.
THE JUDGE: All right. Could I just ask you to do something on the electronic transcript, please? If you could go to 1514, where you were earlier, but then take a look at the question on line 18 and your answer on line 19.
THE WITNESS: Wouldn't you expect that to happen?
THE JUDGE: That's it. And I think there's some confusion there, if I'm not mistaken, and you tell me if I am mistaken, but the implication I get from that question and answer is that you expect it to happen "soon". And I don't think that that's correct based on your answer to the previous question.

PAGE 137
THE WITNESS: I think the answer was not soon.
THE JUDGE: Okay. Is not soon more consistent with your belief?
THE WITNESS: Oh, yes.
THE JUDGE: That's what I thought, yes.
MR. WIRTSCHAFTER: While we're there though, I think -- I'm not sure this is all clarified yet, just a moment.
MS. FREESE: After Mr. Wirtschafter said for decades the answer was no. And I think that's not reflected in here.
THE WITNESS: Meaning it would take longer than decades.
MS. FREESE: It would not happen for decades.
THE JUDGE: My understanding of the word soon is very, you know, reasonably soon within the next few years and that clearly is not what he was saying. All right, good. Is there any recross based on the redirect?
MS. FREESE: One point briefly, Your Honor.
THE JUDGE: Yes, Ms. Freese.
RECROSS-EXAMINATION

PAGE 138
BY MS. FREESE:

(2) **Q** Dr. Michaels, you have before you Global Warming: A Reduced Threat, your 1992 article. Would you read for us the second paragraph of the abstract?
(5) **A** An extensive body of evidence?
(6) **Q** Right.
(7) **A** Can we just enter it into the record?
(8) **Q** It's only two or three sentences.
(9) MR. GLASER: I would be willing to enter the entire article into the record. There's been so much testimony on it I'm afraid of him just reading three sentences out of it. We can put the whole thing in.
(14) THE JUDGE: I would prefer to put the whole thing in.
(16) MS. FREESE: Additional cross-examination, what I'm asking him to read from is the abstract which is generally intended to give someone the general flavor of the article for people not having time to read the whole thing.
(22) THE WITNESS: Then read the entire abstract.
(24) MS. FREESE: If you prefer, I think the second paragraph --

PAGE 139
(1) THE JUDGE: Mr. Witham?
(2) MR. WITHAM: Yes. I would move for admission of that article as Exhibit 59, I believe.
(5) THE JUDGE: Well, can we agree that the abstract is a fair summary of the article and put the whole abstract in?
(8) THE WITNESS: I actually -- I remember that when this paper went to press that I looked at the abstract and said, yeah, that's okay, but perhaps, you know, you should have added something.
(13) MR. GLASER: You don't like the abstract, do you?
(15) THE WITNESS: It's all right.
(16) MR. GLASER: You don't actually author the abstract?
(18) THE WITNESS: Yes. But I would prefer it be viewed in context of the overall article.
(20) THE JUDGE: Okay. Unless, Ms. Freese, that you believe that his summary of the hypotheses and conclusions is somehow incomplete, that's the only basis I would allow to put in the whole thing.
(25) MS. FREESE: That his summary of what's

PAGE 140
(1) in --
(2) THE JUDGE: No, he was asked about the hypotheses and the conclusion. Is that what your problem is?
(5) MS. FREESE: Yes. Perhaps I should simply ask questions based on his abstract that he can answer.
(8) THE JUDGE: Let's see if it works better.
(10) BY MS. FREESE:
(11) **Q** Would you agree there's an extensive body of evidence now indicating anthropogenerated sulfate emissions are mitigating some of the warming, and that increased cloudiness as a result of these emissions will further enhance night, rather than day, warming?
(17) **A** Yes, I agree, and the operative word is some.
(18) **Q** And would you agree that the sulfate emissions, though, are not sufficient to explain all the night warming?
(21) **A** Yes, I would.
(22) **Q** Would you agree that, however, the sensitivity of climate to anthropogenerated aerosols and the lack of previously predicted warming could drastically alter the debate of global warming in favor of

PAGE 141
(1) less extensive policies?
(2) **A** Yes, I do agree. Please remember that the third clause, in the general lack of previously predicted warming, is not written as a consequence to the second clause. Which is the sensitivity of climate through anthropogenerated aerosols. Two facts.
(8) MR. FREESE: Okay. That's all I have, Your Honor.
(10) THE JUDGE: Okay, good. Let me just see if there's any other recross. Any other recross?
(12) MS. SASSEVILLE: Just one question.
RECROSS-EXAMINATION
(14) BY MS. SASSEVILLE:
(15) **Q** You testified about the relative importance of climate patterns versus mean. Is the reason you think that patterns are more important is because two opposite patterns can have the same mean?
(19) **A** That, that's certainly one of many reasons, yes.
(20) MS. SASSEVILLE: Thank you.
(21) THE JUDGE: Okay. Any further recross? Okay. Redirect? REDIRECT EXAMINATION
(24) BY MR. GLASER:
(25) **Q** Dr. Michaels, in response to the questions that

PAGE 142
(1) Ms. Freese just asked you on her recross, do you believe her questions, the statements that she asked you to agree to or not to agree to completely summarize the findings and conclusions of the article referred to?
(6) **A** Not completely. I would always refer a person to an entire scientific article rather than to an abstract.
(9) MR. GLASER: That's all I have.
(10) THE JUDGE: Anything further for this witness? Ms. Hedman.
(12) MS. HEDMAN: One quick question related to that article.
(14) MS. ZIBELMAN: Your Honor, I mean for those of us who don't have it, it's kind of -- I would ask that we could just introduce it as an exhibit.
(18) MS. HEDMAN: It's not related to the article, I'm simply asking a question relating to Mr. Glaser's question.
(21) THE JUDGE: Well, if you're making it, I mean you can either ask for it informally, there seem to be a number of copies floating around. If you're asking for it formally, we haven't dealt -- we haven't heard enough argument on that yet to be

PAGE 143
(1) able to deal with it, I'll have to hear argument pros and cons.
(3) MS. SASSEVILLE: At this point would we be able to refer to the article in briefing?
(5) THE JUDGE: Conceptually, yes.
(6) MS. SASSEVILLE: Okay.
(7) THE JUDGE: Okay. Ms. Hedman, I think you had a question. RECROSS-EXAMINATION
(10) BY MS. HEDMAN:
(11) **Q** Just one final question relating to the role of the sulfate emissions in mitigating global warming. You do agree, don't you, Dr. Michaels, that there is a substantial body of evidence that indicates that sulfate emissions do mitigate some of the warming?
(17) **A** Yes, but the confidence in our ability to quantify that is given in most recent IPCC as maximal at low and medially

between low and very low.
(20) THE JUDGE: All right. Is there anything further for the witness? Mr. Witham.
(22) MR. WITHAM: Your Honor, I guess my motion for the admission of the article has not been addressed in the record. I would move it be admitted for the purpose of elucidating the

PAGE 144
(1) questions and answers asked and not for the proof of the matter asserted and I renew my motion for admission.
(4) THE JUDGE: Okay. So you're moving it essentially as a clarification item?
(6) MR. WITHAM: Yes.
(7) THE JUDGE: Is there any objection to that motion?
(9) MS. FREESE: No objection.
(10) THE JUDGE: All right. Hearing no objection, the motion is granted and the document will be received. Does somebody have a copy we can take?
(14) MS. FREESE: I have copies I can distribute.
(16) THE WITNESS: Again, the article in the scientific world, when there is a question, a letter --
(19) MS. HEDMAN: There's no question pending.
(21) THE JUDGE: All right. Mr. Glaser is aware of the situation, if Mr. Glaser wants to do it he can do it.
(24) MR. GLASER: I don't even know what she's handing out.

PAGE 145
(1) THE JUDGE: Let's wait and see. Why don't you hand it out, please, Ms. Freese. Thank you. (Whereupon, Exhibit 59 was marked for identification by the court reporter.)
(7) MR. GLASER: In response to the motion to introduce this exhibit into evidence, I think we do have testimony on the record and we can certainly get more testimony on the record, but this is not the complete article. That the practice is that when an article like this is written, and then there is a letter that is written in response to it, the author gets a chance to reply to the letter and the letter and reply are published and all three are documents, the initial article, the letter and the reply are considered to be all part of the same article that was written. And as long as we are putting the document in the record I think we ought to have all three documents.
(22) MS. FREESE: Your Honor, it seems to me that this letter, or rather this article, stood alone at the time that it was published. The fact that there was subsequent correspondence and a

PAGE 146
(1) follow-up response to that, I think that while it may be considered in some circles to make it all the same article, these were not published at the same time, is my understanding, and subsequent dialogue does not necessarily follow that it should be admitted along with this.
(7) MS. PETERSON: Clarification. I thought that this was being admitted for illustrative or clarification purposes on the questions and I'm not sure, I don't think any questions were asked on the letter and the follow-up response, but perhaps they were, I don't know.
(13) THE JUDGE: Ms. Freese, I think you and Ms. Hedman were the ones who focused on this article, did you ask questions about the letters or the response?
(17) MS. FREESE: No, I did not.
(18) MS. HEDMAN: Nor did I.
(19) THE JUDGE: All right. I think that the way this was introduced, for the limited purpose of clarifying the questions that were asked out of it, means that it's not introduced for the truth or falsehood, if you will, of what's contained in the article. So, therefore, I don't think the response and the subsequent follow-up article are

PAGE 147
(1) necessary for the purpose for which this is received. So I would deny your request to add more material to it.
(4) MR. GLASER: Off the record. (Discussion held off the record.) (Hearing adjourned at 1:35 p.m.)