REVIEW OF THE *2001 U.S. CLIMATE ACTION REPORT*

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INTRODUCTORY COMMENT

The *2001 U.S. Climate Action Report* (USCAR) is, in general, more balanced than analogous compendia, such as the Third Assessment Report of climate change recently published by the United Nations Intergovernmental Panel on Climate Change (IPCC) , or the U.S. National Assessment (USNA) of climate change.

However, certain portions of USCAR, particularly Chapter 6, rely heavily on the USNA or the 2001 report of the National Academy of Sciences (which itself relies heavily on the USNA). Whatever originates from the USNA is highly flawed because the USNA is based upon a true miscarriage of science: it is based upon two models for future projections of climate that perform worse than a table of random numbers when applied to recent climate. The producers of the USNA, mainly the U.S. Global Change Research Program, have ignored this glaring problem, even as it is well-known that they were aware of it. Further, the USNA is based upon a selection of the two most extreme climate models for U.S. temperature and precipitation, for which there is no scientific defense.

Consequently the quality of large sections of the USCAR has been fatally impaired by the acceptance of the nonscientific USNA. This applies mainly to Chapter 6, *Impacts and Adaptation*. These sections—and mainly Chapter 6—need either to be re-written, or a prominent note needs to be appended detailing the tragic flaws in the USNA.

It is hoped that these comments will force a re-opening of the USNA process, which was headed by the U.S. Global Change Research Program (USGCRP) with a specific investigation into how such a document could have been published, when USGCRP and the associated scientists knew that it was based upon models that simply did not work. As it stands, it is the blackest of marks upon U.S. Environmental Science in recent decades, and the historical credibility of our considerable efforts in this science are at stake. The blatant disregard of science in the USNA (and therefore in the USCAR) will not be noted today or next week. But, in coming decades, academic research carried out in a more dispassionate atmosphere than exists today will surely uncover these flaws and the attempts to cover them up. A responsible Agency would expose them NOW. This review affords that opportunity.

My main comments are directed at Chapter 6; however, there are a few others included below.

SPECIFIC COMMENTS

CHAPTER 1

Page 4, lines 10-11: For the last three decades, the amount of GDP produced per unit energy has increased, not just in the 1990s. This is an established long-term trend owing to financial pressures to reduce production costs. There is no reason to assume, as this does in lines 15-16, that the 1990s are an anomaly. Change this paragraph to accommodate reality.

Page 7, lines 1-5. As noted above and below, the USNA is fatally flawed. As this is the first reference to it, there should be a footnote regarding the central problem, or Chapter 6 should be re-written using more primary scientific literature rather than the USNA.

CHAPTER 2

Page 18, lines 28-29. In, general, as long as adequate moisture is maintained, warmer ecosystems are more diverse ecosystems. This needs to be noted.

CHAPTER 3

Page 10, lines 20-24. There is no Table 3-6 in my report. GWPs are highly suspect because the residence time of carbon dioxide is largely overestimated. Here IPCC is at some variance with a large body of literature indicating a residence of 50-100 years, not the >100 assumed by IPCC and this report. A footnote concerning this would be appropriate here.

CHAPTER 4

Page 13, lines 16-25. The PNGV has NOTHING to do with the two commercially available automobile hybrids, because they were developed independently by Toyota and Honda. Let's tell the truth: the PNGV has NOT resulted in a commercially available domestic hybrid, largely because there turns out to be very little market for them, as Honda will attest, having sold only 8,000 in two years.

CHAPTER 6

Page 1, line 23. There is no statistically significant increase in drought frequency or areal magnitude as measured by the Palmer Index in the last 100 years. There is an increase in the area of the country that is wet as measured by the same index. Change the text to reflect the truth: There is an increase in wet conditions but no increase in dry conditions.

Page 1, lines 23-24. The study referred to here, by Karl, describes increases in rain events that are not likely to have produced significant flooding. The increase in high-intensity rainfall works out to less than one inch per year, averaged nationally. This calculation can be readily deduced from his 1995 *Nature* paper. If you're going to assert a change, at least show how little it has been.

95th percentile 24-hour precipitation in the U.S. is approximately 1.3 inches (based upon a preliminary analysis of U.S. HCN data from 1900 through 1987). That is *not* intense. Even using the two-inch threshold, 11% of the 34 inches of average annual national rainfall comes from that category, or 3.74 inches. As Karl et al. showed in *Nature* in 1995, the increase in this class was from 9% to 11%. That works out to 2% of 34 inches, or 0.68 inches *per year*.

Page 1, line 25. Parmesan's butterfly study shows a large decline in frequency in a grid cell that is actually *cooling* (!), with major expansions in the northern part of the range, which is warming. In Europe, she finds a large expansion of range, implying increased biodiversity. She never checked the weather data for Southern California, which is available from the IPCC nor did she comment on the range expansion, nor is the writer of this paragraph in the USCAR familiar with these truths.

OVERALL USE OF THE USNA AS BACKGROUND

The essential problem with the USCAR is that it is based upon the USNA. That report is based largely on two climate models, neither one of which, when compared with the 10-year smoothed behavior of the lower 48 states (a very lenient comparison), reduces the residual variance below the raw variance of the data. The one that generates the most lurid warming scenarios—the Canadian Climate Centre (CCC) Model—produces much larger errors than are inherent in the natural noise of the data. That is a simple test of whether or not a model is valid (see attached Figures 1 and 2)—and both of the models used in the USNA fail. All implied effects, including the large temperature rise, are therefore based upon a multiple scientific failure. The USNA's use of those models and that approach is a willful choice to disregard the most fundamental of scientific rules. (And that they did not find and eliminate such an egregious error is testimony to grave bias). For that reason alone, the USCAR should be withdrawn from the public sphere until it becomes scientifically based.

FIGURES

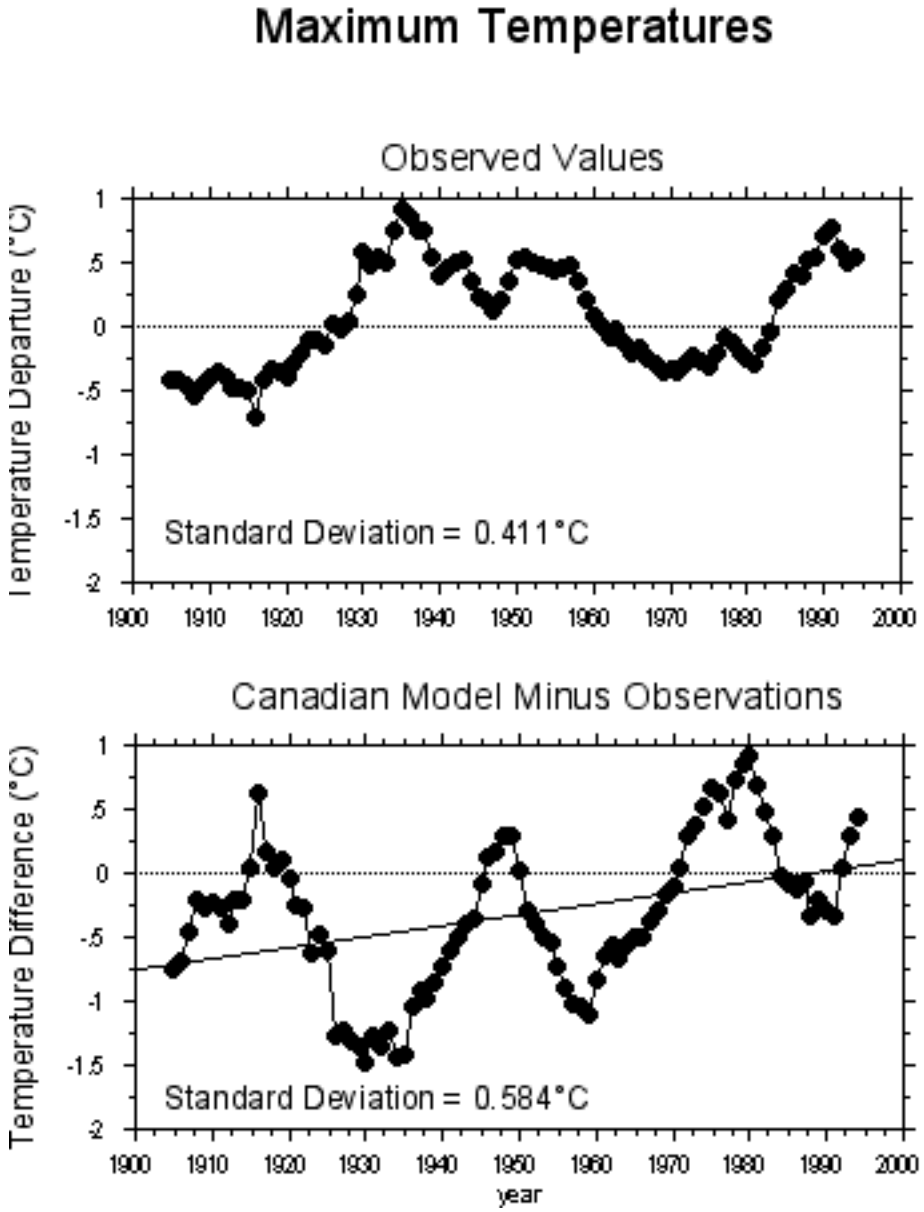

Figure 1.
TOP: Observed 10-year smoothed averaged maximum temperature departures from the recent climatological mean over the lower 48 states. BOTTOM: Predicted minus observed averaged maximum temperature departures for the CCC model the USNA used. The residual error standard deviation is actually larger than the standard deviation of the observed data, which is *prima facie* evidence for a scientifically invalid model.

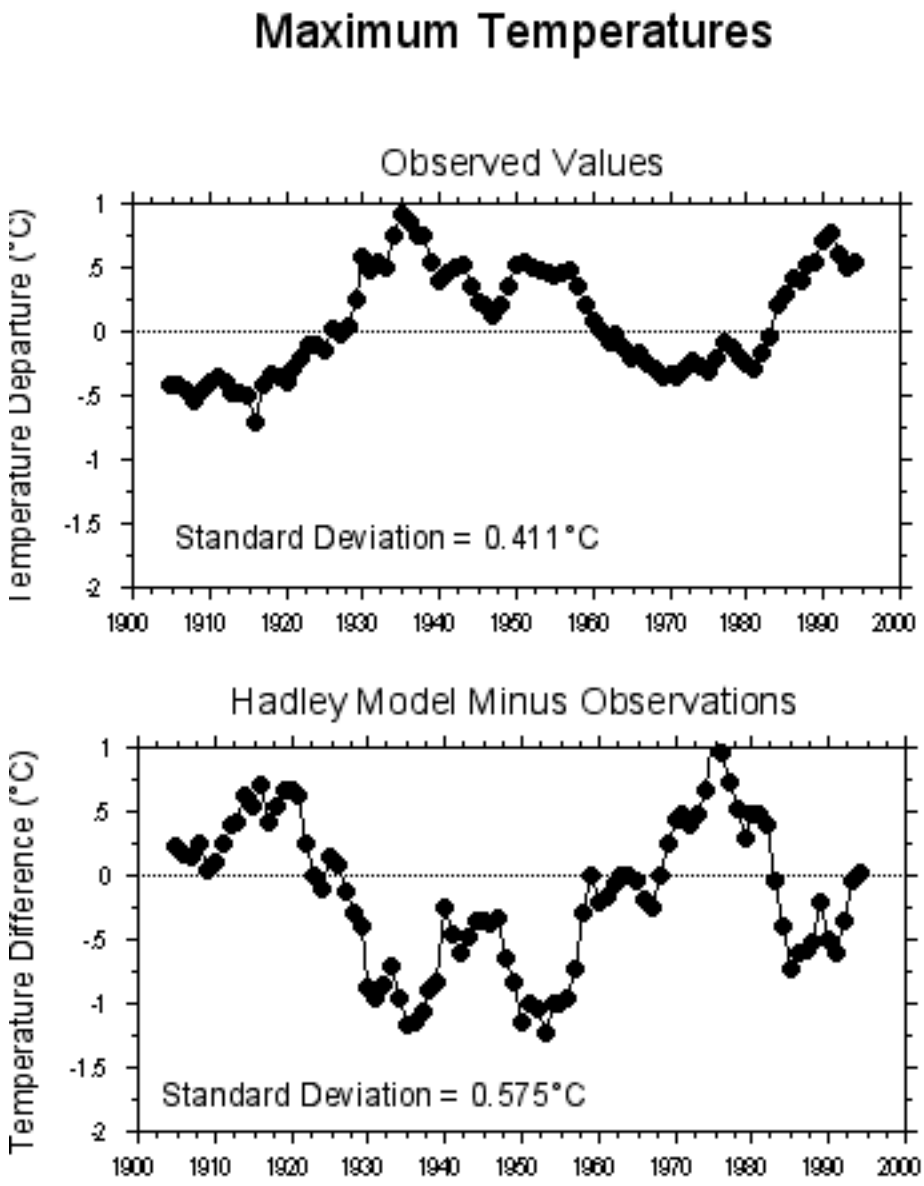

Figure 2. Same as Figure 1, this time for the Hadley model the USNA used. The model error may be the same as the CCC's, but at least it doesn't have the obvious trend bias.

MODEL SELECTION PROBLEMS

Then there is the problem of model selection in the USNA. As shown in Figure 9.3 of the Third Assessment of the United Nations Intergovernmental Panel on Climate Change, the behavior of virtually every General Circulation Climate model (GCM) is the production of a linear warming, despite assumptions of exponential increases in greenhouse forcing. In fact, only one (out of, by my count, 26) GCMs produces a substantially exponential warming—the CCC model. Others may bend up a little, though not substantially, in the policy-relevant time frame. The USNA specifically chose the outlier with regard to the mathematical form of the output. No graduate student would be allowed to submit a

thesis to his or her committee with such arrogant bias, and no national committee should be allowed to submit such a report to the American people.

Even worse, the CCC and Hadley data were decadally smoothed and then (!) subject to a parabolic fit, as the caption for the USNA's Figure 6 makes clear. That makes the CCC even appear warmer because of the very high last decadal average.

One of the two models chosen for use in the USNA, the Canadian Climate Center (CCC) model, predicts the most extreme temperature and precipitation changes of all the models considered for inclusion. The CCC model forecasts the average temperature in the United States to rise 8.1°F (4.5°C) by the year 2100, more than twice the rise of 3.6°F (2.0°C) forecast by the U.K. model (the second model used in the USNA). Compare this with what has actually occurred during the past century. The CCC model predicted a warming of 2.7°F (1.5°C) in the United States over the course of the twentieth century, but the observations show that the increase was about 0.25°F (0.14°C) (Hansen, J.E., et al., 1999: GISS analysis of surface temperature change. *Journal of Geophysical Research,* **104**, 30,997–31,022), or about 10 times less than the forecast. If the observed ratio continues into the future, the U.S. temperature increase by the year 2100 will be less than 1°F and hardly noticeable. The CCC forecast of precipitation changes across the Unites States is nearly as extreme. Of all the models reviewed for inclusion in the USNA, the U.K. model predicted more than twice the precipitation change than the second most extreme model, which was the CCC model. The CCC model itself forecast twice the change of the average of the remaining, unselected models. Therefore, along with the fact that GCMs in general cannot accurately forecast climate change at regional levels, the GCMs selected as the basis for the USNA conclusions do not even fairly represent the collection of available climate models.

Why deliberately select such an inappropriate model as the CCC? Tom Karl, a NOAA scientist, told me that that the reason the USNA chose the CCC model is that it provides diurnal temperatures; this is a remarkable criterion given its base performance. Consider the logic: *Because we want to include the minute detail of diurnal temperatures, let's select the most extreme climate model in existence, in terms of exponentiality.*

Thus the USCAR is driven by a model that 1) doesn't work over the United States; 2) is at functional variance with virtually every other climate model. It is simply impossible to reconcile this skewed choice with the rather esoteric desire to include diurnal temperatures. This reviewer leaves it to everyone else to speculate on the obvious reason.

It is clear that reliance on the USNA in the Climate Action Plan gravely compromises the validity of Chapter 6. It is therefore necessary to write some type of disclaiming footnote showing that the models used there are not valid and are an extreme selection.

Page 4, lines 18-21. The models in figure 6.2b are worse than random numbers (see above). It is scientific malpractice to use them. I choose my words carefully here. If a physician prescribed medication that demonstrably did not work, he would lose his

license. If this continues in the report, critics will probably write nasty op-eds that will discredit the entire process.

Pages 5-29. These are based heavily on the US National Assessment. APPENDIX 1 contains comments on the National Assessment. These were by-and-large unanswered when they were submitted; consequently, they apply as well to the Climate Action Report.

Appendix 1. Comments on the U.S. National Assessment

NOTE: Pages 5-29 of chapter 6 of the 2001 Climate Action Report are based largely upon the U.S. National Assessment. What follows are largely-unanswered criticisms of the Assessment. They are equally applicable to the Climate Action Report because of its uncritical use of the 2000 National Assessment.

August 11, 2000
Overview—U.S. National Assessment of the Potential Consequences of Climate Variability and Change

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USNA Overview—General Comments

My comments focus largely on the Overview Document, as that is what most people will read. Because the Overview claims to accurately represent the Foundation Document, these same comments should apply generally to the entire U.S. National Assessment of the Potential Consequences of Climate Variability and Change (USNA).

The USNA is by far the most misleading publicly funded report on climate change ever produced in this nation. It is so misleading, so misstated, and so ignores or underplays so many facts that it is truly difficult to formulate a comprehensive commentary. I know I am hardly alone here, having read some of satellite guru John Christy and greenhouse firebrand Kevin Trenberth's early public comments. (Christy called it "an evangelistic statement about a coming apocalypse [and] not a scientific statement about the evolution of a complicated system with significant uncertainties." And Trenberth characterized it as a "classic example of misuse and abuse of climate models.")

Indeed, every conversation I have had with practicing scientists who are not associated with the report has brought forth highly negative comments about it. Yesterday (August 9), I returned from the annual meeting of the American Association of State Climatologists (I am past president of AASC). There were roughly 100 scientists present. I can honestly state that *not one* positive comment was tendered to me about the

USNA, out of literally dozens made. If the report is published in anything like its current form, I predict it will provoke a public examination of how and why the federal science establishment could become so amoral with respect to accepted scientific ethics.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

The essential problem with the USNA is that it is based largely on two climate models, neither one of which, when compared with the 10-year smoothed behavior of the lower 48 states (a very lenient comparison), reduces the residual variance below the raw variance of the data. The one that generates the most lurid warming scenarios—the Canadian Climate Centre (CCC) Model—produces much larger errors than are inherent in the natural noise of the data. That is a simple test of whether or not a model is valid (see attached Figures 1 and 2)—and both of those models fail. All implied effects, including the large temperature rise, are therefore based upon a multiple scientific failure. The USNA's continued use of those models and that approach is a willful choice to disregard the most fundamental of scientific rules. (And that they did not find and eliminate such an egregious error is testimony to grave bias). For that reason alone, the USNA should be withdrawn from the public sphere until it becomes scientifically based.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Even though the models fail at the national level, much of the USNA Overview is devoted to "regional" assessments. Traditionally, in science, when models for the future fail, we fall back on known reality. As examples of this alternative, more rational, assessment, we include as separate attachments individual state summaries of climate change for the Northeast (New York), Southeast (Florida), Midwest (Illinois), Great Plains (Texas), West (California) and Pacific Northwest (Washington). These are included as Appendices C through H.

Then there is the problem of model selection. As shown in Figure 9.3 of the Third Assessment of the United Nations Intergovernmental Panel on Climate Change, the behavior of virtually every General Circulation Climate model (GCM) is the production of a linear warming, despite assumptions of exponential increases in greenhouse forcing. In fact, only one (out of, by my count, 26) GCMs produces a substantially exponential warming—the CCC model. Others may bend up a little, though not substantially, in the policy-relevant time frame. The USNA specifically chose the outlier with regard to the mathematical form of the output. No graduate student would be allowed to submit a thesis to his or her committee with such arrogant bias, and no national committee should be allowed to submit such a report to the American people.

Even worse, the CCC and Hadley data were decadally smoothed and then (!) subject to a parabolic fit, as the caption for the USNA's Figure 6 makes clear. That makes the CCC even appear warmer because of the very high last decadal average.

One of the two models chosen for use in the USNA, the Canadian Climate Center (CCC) model, predicts the most extreme temperature and precipitation changes of all the models considered for inclusion. The CCC model forecasts the average temperature in the United States to rise 8.1°F (4.5°C) by the year 2100, more than twice the rise of 3.6°F (2.0°C) forecast by the U.K. model (the second model used in the USNA). Compare this with what has actually occurred during the past century. The CCC model predicted a warming of 2.7°F (1.5°C) in the United States over the course of the twentieth century,

but the observations show that the increase was about 0.25°F (0.14°C) (Hansen, J.E., et al., 1999: GISS analysis of surface temperature change. *Journal of Geophysical Research*, **104**, 30,997–31,022), or about 10 times less than the forecast. If the observed ratio continues into the future, the U.S. temperature increase by the year 2100 will be less than 1°F and hardly noticeable. The CCC forecast of precipitation changes across the Unites States is nearly as extreme. Of all the models reviewed for inclusion in the USNA, the U.K. model predicted more than twice the precipitation change than the second most extreme model, which interestingly, was the CCC model. The CCC model itself forecast twice the change of the average of the remaining, unselected models. Therefore, along with the fact that GCMs in general cannot accurately forecast climate change at regional levels, the GCMs selected as the basis for the USNA conclusions do not even fairly represent the collection of available climate models.

Why deliberately select such an inappropriate model as the CCC? I heard from one senior NOAA scientist that the reason the USNA chose the CCC model is that it provides diurnal temperatures; this is a remarkable criterion given its base performance. Consider the logic: *Because we want to include the minute detail of diurnal temperatures, let's select the most extreme climate model in existence, in terms of exponentiality.*

The USNA's high-end scenarios are driven by a model that 1) doesn't work over the United States; 2) is at functional variance with virtually every other climate model. It is simply impossible to reconcile this skewed choice with the rather esoteric desire to include diurnal temperatures. This reviewer leaves it to everyone else to speculate on the obvious reason.

Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Mike MacCracken told me a different reason for the use of the CCC: that the USNA wanted an example of a plausible worst-case scenario. My own and others' analyses cast considerable doubt on plausibility, but nonetheless the USNA may have been so blinded by its lack of scientific diversity (more on that below) that no one actually noticed the tremendous errors CCC was making or its exponential singularity.

Which leads to the problem of symmetry. Even if they didn't choose the CCC specifically for its heat, the USNA leaders *had* to know that it was *the* hot exponent (and if they did not know that, then why were they in a leadership position?). Even a cursory surf of the Net reveals that plenty of decent scientists out there had also already noticed. To mitigate against bias (or at least cover themselves) they also could have included an analogously cold model, such as the NCAR CCM3, with a more realistic greenhouse change. (Using the observed effective CO2 exponent for the last two decades, the NCAR model gives a 21st-century global warming of a mere 1.4°C, with a substantially lower value in the dreaded summer.)

Why on God's getting-greener earth didn't the USNA do so, at least for the sake of their own credibility? They could have used the Hadley and CCC models for the diurnal changes and still used, say, the cold NCAR for all the other comparisons. But they didn't. And whether or not that omission was intentional (I believe it was), it leaves the appearance of tremendous, unremitting bias.

Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

I strongly believe it is necessary either to redo the entire report or to simply destroy it and reconstitute a credibly diverse oversight panel. The new report should not use any model that cannot replicate the smoothed U.S. behavior of the last 50 years: If a model can't replicate past and current climate, when there has been "a discernible human influence on global climate," why should we trust its future scenarios? Left as is, the USNA report will be branded the worst excess to date in government reports about global warming. And that's saying something, considering the competition.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

The USNA's choice of emissions scenarios is suspect. The USNA follows on the IPCC's Third Assessment, insisting upon using 1% per year increase in effective carbon dioxide concentration for this (the 21st) century. Historically, the exponent has *never* been 1% per year. Hansen (Hansen, J.E., et al., 1998: A common-sense climate index: Is our climate changing noticeably? *Proc. Nat. Acad. Sci.* **95,** 4113–4120.) demonstrated that in recent decades the incremental forcing has been at the low end of the scenarios (he had it at about 0.4% per year). My best calculation—easily more logical than assuming what has not happened—is about 0.6% per year assuming no sulfate cooling, but around 0.4% using more standard sulfate assumptions (which are not likely to be true). Splitting the difference gives about 0.5% per year, which is half the value assumed in the USNA. This has dramatic effects upon the exponential CCC model, to say the least! (Plot it out yourself for fun).
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Finally, we come to the subject of bias in the selection of USNA participants. There are plenty of knowledgeable climatologists, including or excluding this reviewer, who have scientific records that equal or exceed those of many of the USNA's participants and managers. They would have picked up the model problem at an early point *and would not have tried to sweep it under the rug*. Where is Bob Balling? Where is Dick Lindzen? Where are Pielke Sr., Weber, or Spencer? Where are the dozens of critics who were at the recent AASC meeting?

They are not on the list of participants. Indeed, not one of the well-known skeptics about gloom-and-doom is on the list. The fact is that they would likely have interjected substantial comment into the document that would have precluded the disastrous Assessment that ultimately resulted. Lack of courage on the USNA's part is now its own reward.

Maybe some were asked to participate and refused (I could understand why, given the lynch mob—a phrase I choose carefully—of fellow participants they would face). But they could have been entreated. In any event, they are starkly absent. So instead we have a terrible report suffering from a fatal flaw that cannot be fixed without slimming down the remaining material to the size of a *Reader's Digest* article. More than anything, the USNA is a lesson in what is wrong with the way we do global warming science and a pitiful tribute to the political gods to whom science has bent.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

USNA Overview—Specific Comments

Page 3:
Probabilities: Probabilities are generated by repeated sampling. The USNA uses (mainly) two models on one country over one century. These statements are scientifically devoid of content and therefore should not be made.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 4:
First sentence is extremely misleading. This relates also to the maps of U.S. temperature change. Provide a time-series graph *here, not later,* of U.S. National Temperatures, seasonal and annual—*not smoothed*—and alter the text. Delete the word "now" in the first sentence and substitute the truth: Our climate has changed at the current rate twice in the 20th century—in the 1920s/1930s and in the 1990s.

The related color graphics are rhetorically biased with the use of lurid "hot" colors for very small temperature changes. I suggest you delete the maps in favor of regional graphs as per above. There is no need to editorialize as these maps do. What's worse, doing so misleads the public.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

"Precipitation…mostly due to heavy downpours" is based upon Figure 5—which shows a 4% increase in precipitation at the 95–100 percentile class.

95th percentile 24-hour precipitation in the U.S. is approximately 1.3 inches (based upon a preliminary analysis of U.S. HCN data from 1900 through 1987). That is *not* a "heavy downpour." Even using the two-inch threshold, 11% of the 34 inches of average annual national rainfall comes from that category, or 3.74 inches. As Karl et al. showed in *Nature* in 1995, the increase in this class was from 9% to 11%. That works out to 2% of 34 inches, or 0.68 inches *per year*. These are facts that you must specify, and facts that require you to delete the florid rhetoric about "heavy downpours." Finally, I understand that USGS has submitted a public comment that the result in Figure 5 is easily generated from random numbers. How do you respond? (You could say that the CCC and Hadley models are no better than random numbers over the United States, so this, too, is OK!).
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 4, sentence two:
"These trends are most apparent over the past few decades." *A graph*—such as Figure 3 from the Foundation document—of U.S. annual or seasonal temperatures would show that the changes in the early 20th century are very similar. But then, Figure 3 from the Foundation document is itself misleading. The right axis is tremendously inflated in order to create the impression of large change. Also, the changes shown in the 1930s are not at all different from what appears in the end of the record, so the statement about recent decades is wrong and misleading.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Foundation Document, Figure 3 (cross-reference):

Figure 3 is misleading. The right axis is tremendously inflated in order to create the impression of large change. Also, the changes shown in the 1930s are not at all different from what appears in the end of the record, so the USNA's statement about recent decades is wrong and misleading.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 4, sentence 3:
"The science indicates…" is another falsehood. The science, given by Figure 9.3 of the IPCC Third Assessment, clearly shows that once greenhouse warming starts, under the emissions scenario the USNA uses, the rate is *constant* (much more on this below and the scientifically *indefensible* use of the CCC model for the United States.) Every reader gathers from this text that the warming of the 20th century was caused by humans and that as a result of human activity, it will accelerate. If you had accurately told the story of the early 20th-century warming (by using graphs) and a more comprehensive suite of models, everyone would have realized the truth, which you really must say: "The best available science indicates that warming of the 21st century is likely to be of the same rate as that observed in recent decades." That is, if you mean to imply that the warming of recent decades is anthropogenic, which you clearly do. If you do not, then why mention it at all? And how does a reader—scientist, policymaker, or lay person—then distinguish the anthropogenic from other warming in the 21st century?
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 4, sentence 4:
"Scenarios examined in this Assessment…" As you will see below, the large warmings in the CCC are produced by a model that is worse than merely assuming the mean for the 20th century. It is invalid and consequently invalidates virtually the entire USNA as it stands. Read on below to see why.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 4, paragraph 2:
The Rocky Mountain Alpine statement is invalid because CCC and Hadley *do not work* over the United States for the last century; see below. The statement about southeastern ecosystems is invalid for same reason. The last sentence is difficult to support. Primary productivity tends to rise with temperature as long as rainfall is sufficient. That is known in USNA parlance as "sustained bounty," which is likely therefore to increase. That also affects the "pull quote" on page 5.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 4, paragraph 3, sentence 1:
It is well known that GCMs are inappropriate for regional analyses. So why are they used to define "potential impacts"? Kevin Trenberth is right—the USNA is a "misuse and abuse of climate models."
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 4, paragraph 3:
Sentence on heat index. If you can't estimate maximum temperature (see below) how can you estimate heat index with any scientific validity? Can't be done. Remove.
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Page 4:
"These changes will, at minimum…in cities." Age-adjusted heat-related mortality has been dropping in cities as a result of technological adaptation; see enclosed Appendix A, based upon CDC data. That occurs even as urban temperatures increase because of heat island effects. Why will greenhouse warming alter this process of adaptation? Note that "discomfort" and death are highly correlated, which means that technology is making cities *more* comfortable in spite of warming. This passage is yet another example of the USNA's disregard for facts in an attempt to paint a lurid picture.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 6, pull-quote, paragraph 2:
"Large increases or decreases in crop yields…" An examination of major crop yields in the 20th century reveals massive increases in yield—fivefold for corn, for example, from 10 to 30 bushels/acre for soybeans (as American agriculture adapted to the new crop). The pull-quote from paragraph 2 is therefore profoundly misleading to a public that does not know the true background noise; and the USNA makes no attempt here to educate them with the whole truth.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 6, pull-quote, paragraph 3:
The very same argument applies to forests. As virtually all of the forested areas of the lower 48 states are likely to be managed and harvested next century (the present administration notwithstanding), arguments about productivity become specious at best and certainly are misleading at worst.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 7, key finding 1:
The high temperature estimates come from a model that *does not work* and must therefore be removed from the USNA. See below.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 7, key finding:
Regional impacts. Given that the GCM community itself believes the current suite of models (including the ones used) are inappropriate for regional estimates, how can you make this statement? Please delete in light of the state of our science.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 7, key finding 5:
"Falling prices and competitive pressure…." In general, agricultural commodity prices have been falling for the last 70 years as a result of competitive pressure. That is not new,

has little to do with anthropogenic climate change, and benefits us, the consumers. This is a typical example of the inflammatory and incomplete rhetoric that characterizes the USNA.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 7:
"Surprises expected." No one "expects" surprises. That's why they're "surprises"! This empty statement means only that we do not understand climate change—no more, no less—and should call into question virtually all of the USNA's major conclusions.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 8 (Intro):
"…in the last 10,000 years." That's because that was the end of the last glaciation. The USNA could at least be candid and discuss the profound natural instability of our climate—on the scales of civilization—having nothing to do with human cause.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

See comment above on the misleading use of "heavy downpours."
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 9:
"Extreme events." The picture of a Category 4 or 5 hurricane here is remarkably misleading. There is *no* evidence for an increase in these as greenhouse gases have gone up and only very conflicting modeling studies. Remove this rhetorical device.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 10, paragraph 2:
Very misleading. The actual change in greenhouse forcing is more than 50% because of non-CO2 emissions. But noting this would make people wonder why their lives are so good—which is clearly why you haven't told the whole truth here. Please change to reflect the whole truth.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 11, Figure:
Related comment: Figure on page 11 is equivalently misleading and should show the massive change in effective CO2 concentration—although it would prompt the obvious question as to why all of the awful things in the USNA don't add up to anything worse than the Dow at 11,000 and doubled life span in the last century. Ancillary note: Do you think all that generated wealth is just going to sit around and commit suicide with climate change? Or maybe does it predispose us to massive and profitable adaptation?
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 11, paragraph 1. The year 1975 is a low point in the record, *as everyone knows.* The text should acknowledge this fact.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 11:
Where's the MSU here? It clearly doesn't have the trend that the surface record does, and the NRC report clearly indicates a problem. Nor can this discrepancy be reconciled; see attached Appendix B, which was recently accepted for publication in *Geophysical Research Letters.* A more honest USNA would note this problem rather prominently.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 11, paragraph 2:
As noted by everyone, there is no increase in the rate of sea-level rise. How does that square with exponential increases in greenhouse gases and the very warm last third of the 20th century?
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 11, paragraph 3:
"According to the IPCC…discernable cause of *the* (emphasis added) climate changes observed in the 20th century…" A phenomenal distortion of what IPCC said and meant! Your text implies *all* climate changes—but in fact, even the much-derided fingerprint analyses focus on stratospheric cooling and high-latitude warming in the late 20th century.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 12, paragraph 4:
Everyone acknowledges that the models are inappropriate for regional analyses "assessments." So remove all of the maps, please.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 14, paragraph 1:
Those decisions based upon weather forecast probabilities are based upon real models whose probable errors are tested by repeated analyses. As noted in below, neither the lurid CCC model nor the midrange Hadley model works over the United States. The "probabilities" in the USNA are merely subjective assessments and not true probabilities at all, and should be noted as such.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 14, paragraph 2:
"Changes are likely to accelerate." *Only* the CCC model produces substantially accelerating change. All of the others are linear or very nearly so. Therefore, if you mean to say that the observed climate changes in the last third of the 20th century were caused by greenhouse changes, then the rate of change is already defined *unless the USNA believes only the CCC and no other model.*
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 14, paragraph 4:

As noted in my "General Comments," the rms error between both the CCC and Hadley predictions and observed 10-year smoothed U.S. temperatures are greater than the rms error of the observed data! The models thus fail the simplest of tests—they are WORSE THAN NO MODEL. As noted in these comments, that fact alone argues that the report should either be destroyed or be completely rewritten around this sad scientific reality.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 14:
As my general comments noted, this choice of the two "base" models is both biased and asymmetric. Please explain as per the general comments.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 15, Figure:
Here we see a figure with several other models. This *one place* where the USNA uses several models does not fix the fact that the rest of the report is largely based upon two, and does *not* provide sufficient evidence for claiming that the USNA used a broad spectrum of models.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 15, Multiple Model Picture caption: The assumed increase in effective CO2 is almost certainly wrong. The USNA follows on the IPCC's Third Assessment and insists upon using 1% per year increase in effective carbon dioxide concentration for this (the 21st) century. Historically, the exponent has *never* been 1% per year. Hansen (Hansen, J.E., et al., 1998: A common-sense climate index: Is our climate changing noticeably? *Proc. Nat. Acad. Sci.* **95,** 4113–4120.) demonstrated that in recent decades the incremental forcing has been at the low end of the scenarios (he estimated around 0.4% per year). My best calculation—easily more logical than assuming what has not happened—is about 0.6% per year, assuming no sulfate cooling, but around 0.4% using more standard sulfate assumptions (which are not likely to be true). Splitting the difference gives about 0.5% per year, which is half the value the USNA assumes. That has dramatic effects upon the exponential CCC model, to say the least! (Plot it out yourself for fun).
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 16, figure caption:
"The observed temperature…." This is totally misleading about the CCC. Again, the essential problem with the USNA is that it is based largely on two climate models, neither one of which, when compared with the 10-year smoothed behavior of the lower 48 states (a very lenient comparison), reduces the observed rms residual error below the raw error of the data. The one that generates the most lurid warming scenarios—the Canadian Climate Centre (CCC) Model—also has a clear warm bias.. This simple test shows that neither model is valid (see attached Figures 1 and 2). All implied effects, including the large temperature rise, are therefore based upon a multiple scientific failure. The USNA's continued use of those models and that approach is a willful choice to disregard the most fundamental of scientific rules. (And that they did not find and

eliminate such an egregious error is testimony to grave bias). For that reason alone, the USNA should be withdrawn from the public sphere until it becomes scientifically based. The Hadley model (see attached Figure 2) provides no improvement over the raw data and, although not as bad as CCC, is still not validated over the United States and therefore cannot be used.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 15, pull-quote:
Every model on the previous page is smooth. The pull-quote means that every model is wrong. If you are going to base an assessment on models, just do it and be consistent about it instead of inserting this canard about discontinuities.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 15, last paragraph: At least you could attempt some semblance at balance by noting that some models project an increase in El Niño, which would *reduce* the frequency of Atlantic hurricanes. The one-sided nature of the USNA is particularly transparent here.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 17:
"Surprises." No model the USNA uses has surprises. Therefore this word is inappropriate.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 18, figure:
The use of a very warm color (yellow) to denote "no change" is a clear attempt at rhetorical bias.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 19:
If a model does not work for max temp for the 20th century then it is unreliable in the next century. But Heat Indices are based upon maximum temperatures. Therefore these results are not based upon accepted scientific practice and should be removed from the USNA.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 20:
Neither model has ever demonstrated an ability to reproduce the spatial patterns of precipitation change over the CONUS in the 20th century. Yet the USNA clearly attempts to relate the observed increase in precip to greenhouse changes, which makes it incumbent upon a greenhouse model to reproduce these changes. Because they can't, they are clearly inappropriate for estimating future changes.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 20:
Same as above, except for soil moisture. This is not based upon accepted scientific norms of reproducibility and must therefore be removed for ethical reasons.

Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 25:
The sentence about the two opposite ecosystem responses is sufficient to trash virtually this entire section. Suggest you do that.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 25:
If you can't predict max temp, you can't predict evaporation, which means you can't predict ecosystems, which should be sufficient to trash section of the report. I suggest you do that.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 34, pull-quote:
Logic: A) The 1930s drought was a surprise. It occurred without much change in the greenhouse effect and is similar to many droughts documented in the prehistoric record by many paleoclimate researchers. B) It was about as dry as it could get in the summer of '34. C) There may be climate "surprises" in the future. D) But because they can't be any worse than '34, how can they be differentiated, in terms of causation, by greenhouse increases? The answer is that they can't. So stop conflating the two.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 35, figure:
What do you mean "extreme events"? It is pretty obvious that there will be decreased extreme cold from greenhouse warming. *Prove* that there is a net increase in extreme events, in toto, or drop this nonsense.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 36:
Model does not work for the United States as a whole—yet now it is applied to regions! This alone should be sufficient cause to trash the entire regional section of report, which itself is the vast majority of the text of the Overview document. Too bad, but I suggest you do that. This portion invalidates the entire exercise through page 83.

As an alternative, the USNA could have used data-based state or regional summaries. We include, as separate appendices (see Appendices C through H) to these comments, state reports for the Northeast (New York), Southeast (Florida), Midwest (Illinois), Great Plains (Texas) West (California) and Pacific Northwest (Washington). Another appendix, Appendix I, provides a reality-based analysis of the science of climate change, and portions of that text should be included in any revised USNA (should the decision be made to continue publication of this document, despite it's pervasive flaws).
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 79:
Where's the sea-level rise in the Pacific?
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 98:
See comments on heat index. This is purely and simply not based upon accepted scientific guidelines and ethics. Sorry to be so blunt.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 98:
Please see attached paper (Appendix A), which demonstrates that U.S. heat-related deaths are declining as a result of technology (the same technology that emits dreaded greenhouse gases!).
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 100:
Please demonstrate that weather-related mortality has increased as temperatures have risen this century. Of course, you cannot, because it hasn't, even though low-level ozone may have increased. Obviously this section is erroneous and irrelevant.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 101:
Please demonstrate that mortality in the United States is increasing because of El Niño. Again, you cannot. As Changnon showed in BAMS last year, the big 1997–1998 El Niño resulted in a net saving of U.S. lives.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 104, paragraph 2:
The "conveyor belt," while logical, is a nonverified construct. Also please note that the rate of sea-level rise has been constant for the last 100 years despite exponentially increasing GHG concentrations. Finally, if in the IPCC's words, "the balance of evidence suggests a discernable human influence on global climate," and the functional form of virtually all models (with the notable exception of the CCC—which doesn't work over the United States) says warming occurs at a constant rate, once established, *which the IPCC says it is*, then the rate of sea-level rise must be constant, too—as it has been. You need to note this, whether or not you want to.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 105, illustration:
Too bad this wonderful theoretical construct has never really been documented! Would it be too much to ask for you to note this?
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 108:
El Niño and those *cute* sea lion pups: El Niños have been quite frequent for at least much of the last 100 million years. Do you think that the biota aren't adapted to them? The writers of the USNA seem to be among the most Zenless people! Please note that the lack of El Niño is likely to be a greater biological threat than *more* El Niños.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 111:
It is very clear that there has been a dramatic increase in forested land in the southeast United States since 1900. There isn't much data before then, so the constant dashed lines must be USNA's attempt at subtle humor, right?
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 113, figure:
The little blue dots over Virginia are another grab at a chuckle, right? You can't be serious—using models that don't work at the level of the entire United States (see above) to model county-by-county vegetation type.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 115, figure:
This report just gets funnier! The figure on page 115 supposes that we understand the forces that create timber demand for the next 50 years.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 115:
Contrast my comment about page 115 with the text in the pull-quote, "…if new technologies and markets are recognized in a timely manner."
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Page 116, paragraph 1:
How many times does it have to be said? The CCC does not work nationally, so it cannot be applied locally to Southwestern Kansas. I am sorry but it appears you have to scrap all references to model-based scenarios.
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Appendix 1, cover picture:
Could you be any more lurid or suggestive about bad things coming from climate change than to show a Cat 4 hurricane off the East Coast? I think not!
Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

Pages 132–134:
CENR, the USNA Assessment Team, the "Independent[!] Review Board" of the "President's[!!] Council…" is about as large a collection of pro-greenhouse scientists, largely federal employees, and pork-barrel administrators as one could find (There are a couple of exceptions—Sally Ride rode the Space Shuttle, no doubt qualifying her as a global warming expert). You really had to *search* to put together this team. How many of these individuals suffer professional harm if the truth be told—that this is an overblown issue? The answer is "many," and they would be condemned to finish their lives in the hell of the Formerly Important. Let's face it, the USNA didn't have the courage to bring in anything but lightweight opposition, which is why the so-called independent review board was so blind that it couldn't even see that the model errors were larger than the variance of the observed data over the United States. "You got what you paid for."

Patrick J. Michaels, Ph.D., Professor of Environmental Sciences, University of Virginia

FIGURES

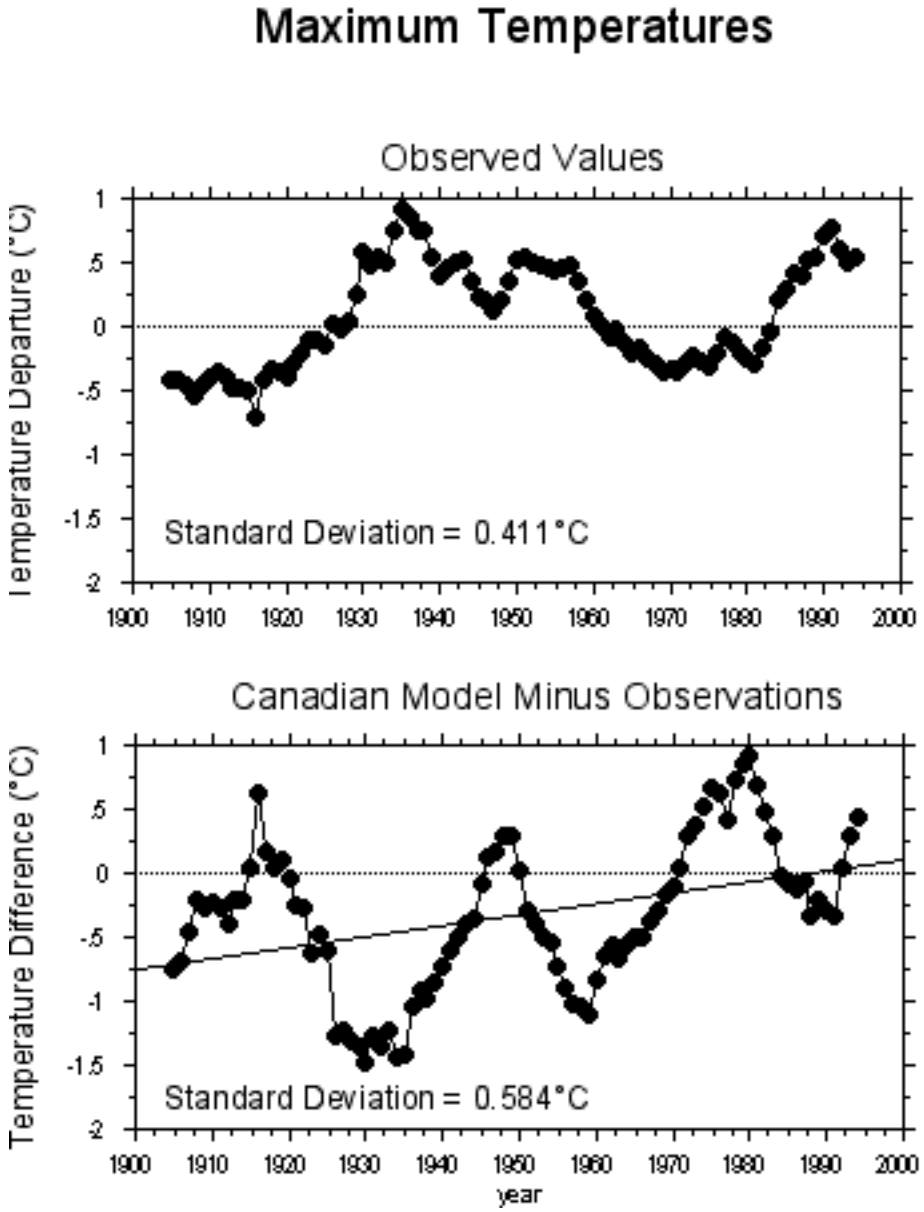

Figure 1.
TOP: Observed 10-year smoothed averaged maximum temperature departures from the recent climatological mean over the lower 48 states. BOTTOM: Predicted minus observed averaged maximum temperature departures for the CCC model the USNA used. The residual error standard deviation is actually larger than the standard deviation of the observed data, which is *prima facie* evidence for a scientifically invalid model.

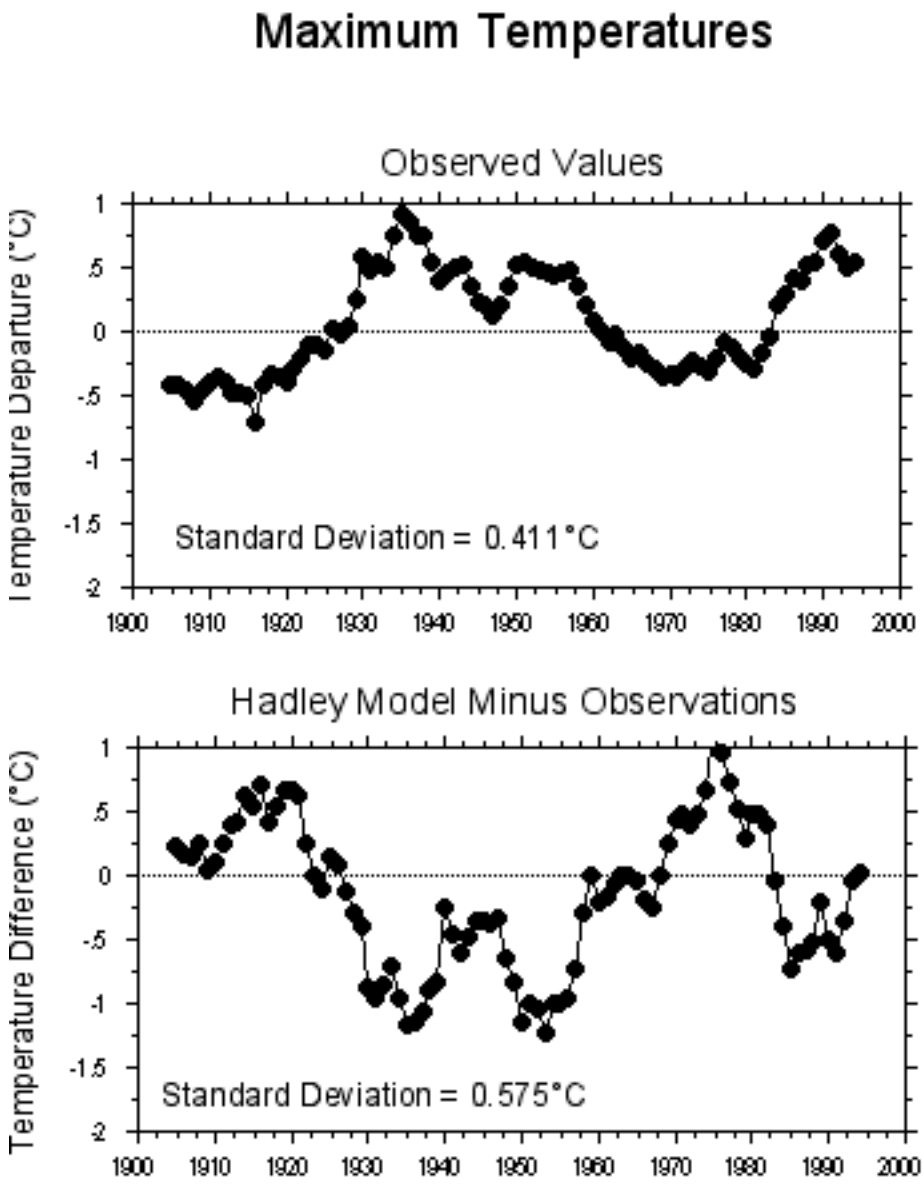

Figure 2. Same as Figure 1, this time for the Hadley model the USNA used. The model error may be the same as the CCC's, but at least it doesn't have the obvious trend bias.