

Response to Questions from Associated Press about the Film “An Inconvenient Truth”

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1. Did you read the book, see the movie, both or neither? And did you consult with Vice President Gore on it?

I have seen the movie and scanned the new book. I also have read “Earth in the Balance,” his first book. I had nothing directly to do with either the movie or the new book, though I have on occasion during the Clinton-Gore Administration and since answered questions (in writing) about the science and suggested (and sometimes summarized) useful items to read, data sets that might make good figures, etc. And since the movie I have helped the Gore team answer some of the questions that have arisen about it.

2. What is your general impression of the movie/book as it relates to just the science?

My overall impression of the movie and the book is very positive—a wonderful communication of the science, and I think the movie gives a valid impression of the importance and urgency of the issue. As a scientist, I would have liked to have heard the lecture start to finish without interruption, but I realize that would be hard to present as a commercial product and so the director added in all the highlights about his life to add more dramatic effect. I think it is thus a bit hard to tell if there is carryover between the two aspects; might these personal inserts focusing on his enthusiasm and commitment be causing people not to hear as carefully as they should the qualifications that are included in his presentation regarding a number of topics?

Another issue for scientists in evaluating the film arises because we also work in a tradition of evidence building up over the years to give greater and greater understanding (and generally, but not always, leading to less and less uncertainty); for us, this process is typically continuous and cumulative. On the other hand, the public and politicians (and the legal system) view things as mainly two-sided, yes or no, liberal or conservative, guilty or not guilty, act or don't act. The movie is out to make the point that, in this context, we have crossed over from perhaps not knowing enough to act to knowing enough to act, citing what I agree is very strong evidence up against some rather weak arguments of the skeptics. His talk presents the interpretation of the science in the context of a policymaker concerned about the public's interests, in contrast to the tendency of scientists to generally not want to say something assertive until we have two-standard deviations of significance (so 20 to 1 odds in our favor, and, even more than that, because we also want two standard deviations of significance that no other explanation is possible, so another 20 to 1 odds in our favor). The scientific approach to dealing with uncertainties is fine for building a really solid scientific pyramid of knowledge, but it does not represent how society does act or could act or even should act—the public and those in business and government would only very seldom decide to do anything with such high confidence requirements—our society would not work.

Thus, as a public servant, in the broadest sense, Gore has interacted with the scientific community, learned what we have learned and how well we think we know the science, and then made the translation for the public based on his perspective as a policy maker and decision maker (something we scientists often don't know much about). In reacting, we scientists therefore need to be very cognizant of the framework he is operating in and the one we are using ourselves to make sure we are not imposing our rigid scientific decision-making framework on what is really a translation of the science into the relative risk or likelihood framework more generally used by the public and decision makers. With all of this in mind, I reiterate my initial reaction—I think he has done exceptionally well in presenting the significance of the science to the public in the framework that is typically used by society in its decision-making process.

3. Was it an accurate portrayal of the science, as you know it?

Overall, and in recognition that this is a presentation of the science to the public, I think the movie, and what I have looked at of the book, give an accurate portrayal of the science and its significance. As a scientist, there are a few things that I would have liked to see a bit tighter or changed slightly, but they are quite minor, and far, far fewer and less significant than the shortcomings in speeches by the typical politician explaining an issue. Gore, in my view, is accurate on all the key conceptual issues, and does not make errors typical of many politicians, as, for example, the many politicians who claim a tax cut will more than make up for lost revenue by encouraging growth—now that is a fundamental conceptual error, and Gore does not have any of those.

And just to provide an anecdote regarding his interest and knowledge about the issue: about ten years ago, I did get to attend a gathering where VP Gore met with an audience of mainly businessmen about the results of IPCC's [Intergovernmental Panel on Climate Change] Second Assessment Report. My role at the meeting was mainly to hold up his one chart (of the Vostok ice core record, that then unfolded to the much higher projected CO₂ levels—a chart the USGCRP [U.S. Global Change Research Office] office that I led at the time had helped the OSTP [White House Office of Science and Technology Policy] to get made for him). The VP spoke on the science for half an hour based on that one chart, and I heard only one slight technical slip concerning the units of the ocean overturning. He then took questions and did very well in addition. He has learned the science—and understands it.

4. Was anything inaccurate? If so what?

The slip-ups that I noticed in the movie were quite limited and subtle (and I may be wrong on some of these as I have not seen a transcript of the film). For example, he shows an ice core and indicates it is from Antarctica and shows evidence of a change due to the Clean Air Act amendments in the US; the core was actually, as I understand it, from Greenland—and on his visit to see the core, the scientist had shown him cores from both the Antarctic and Greenland Ice Sheets. Inconsequential misstatement.

Science historians would point out that Professor Revelle did not prompt the first CO₂ measurement in the atmosphere; what he prompted was the first sampling of air from locations

around the world, and it was actually Harry Wexler, the head of the Weather Service at the time, who prompted and actually funded the start of the long-term monitoring program by David Keeling on Mauna Loa—so Revelle did play a very important role in stimulating observations (and in 1965 he chaired the panel on this issue that prepared a quite insightful appendix for the report of the President’s Scientific Advisory Council), but Revelle was not the very first to urge CO₂ be measured in the atmosphere. Slight misstatement.

If my quick notes are right, the movie seemed to also give the impression that the CO₂ measurement was done by balloon—it is done by flask. Again, inconsequential—and maybe a mistake in how the video was patched together rather than in what Gore said.

I also got the impression from the film that he said the Clinton-Gore team got a carbon tax passed in 1993. Actually, they proposed it but later had to drop it to get their bill passed—but they made a good try at it.

There were likely other minor misstatements—but not conceptual inaccuracies.

5. Was anything over-hyped, over-dramatized or taken out-of-context? If so, what?

The one thing I noticed was that it was not made adequately clear how long it might take for the various areas to be flooded. Now, this should not be too surprising as scientists don’t have this pinned down either. IPCC’s projected range goes up to about 0.9-meter rise during the 21st century. A number of papers since that report suggest that more rapid change than the IPCC indicated is quite possible, especially given new findings on how rapidly about half of Greenland seemed to deteriorate entering the Eemian interglacial. The movie’s animation of the impacts of sea level rise seemed to show the flooding effects of a several meter rise, which IPCC (2001) indicates as a possibility over several centuries. Based on more recent research, however, a number of scientists suggest this could occur in a few centuries, and some, like Jim Hansen, seem to think the change could occur even more rapidly, although it is not completely clear if by this he means the commitment to this much rise or this much actual rise during the 21st century.

Now, it also needs to be said that it is not just sea level rise that is the issue in flooding of low-lying lands—the issue is how far the waves on top of the sea level rise will reach—and this effect causes impacts much sooner than just the sea level rise itself. If one thought just about the impacts of the rise itself, New Orleans was safe for a century or so; counting the waves and the storm, New Orleans was inundated last year. The Metro East coast regional study that was done as part of the US National Assessment brought to light the expected tidal surge height for NY City in the event of a category 3 hurricane at high tide—and it is over 20 feet—without sea level rise. So, in actuality, for current conditions and a quite plausible worst-case hurricane situation, one could have much more inundation of NY right now than the movie was showing for what could happen over this century or longer as a result of sea level rise. In fact, the November/December issue of the magazine of the NY Academy of Sciences has an article describing a proposal for storm surge barriers to protect the key parts of New York from short-term, storm-related sea level rise of at least as much as the Gore movie showed, because NYC is currently so vulnerable.

So, is what Gore says over-hyped? Well, I wish there could have been a bit more explanation and context on that topic, but then, if I had my way, the movie would have been at least twice as long—in my view, he raised a very important concern.

6. Did it portray the consensus of scientists accurately? If not, how so?

So, what does “consensus” mean? I heard two pollsters talk the other day and in their surveys of the American public on climate change they found that 60+% of Republicans agreed climate change was a threat to future generations and 80+% of Democrats agreed. They then said that there was a clear consensus that the American public thinks that the climate change threat is real. A later question they asked was whether their views would change if there were a consensus among the scientific community on the science. I could not help but ask how it was that the IPCC assessments of 1990, 1995, and 2001, which were unanimously adopted by the nations of the world, did apparently not represent a consensus of the scientific community, especially when also backed by the endorsements of all the major national academies of science in the world. It seems that the definition of “consensus” varies by field, just as the decision-making framework does, with unanimity or near unanimity expected from the scientific community, even including those scientists who in many cases have not really embedded themselves in the literature nor been required to put together a coherent assembly and analysis of scientific knowledge (and even including, somehow, CEI’s [Competitive Enterprise Institute] lawyers with their ExxonMobil support, who are often quoted as the contrary view in papers on the science of climate change). The skeptics tend to pick out one aspect where there is perhaps not full agreement and fail to recognize that observations as well as models have shortcomings (witness the recent MSU [Microwave Sounding Unit] report’s findings of shortcomings in the observational techniques, etc.)—and that our best understanding must be based on a coherent integration of the many, many studies into a comprehensive synthesis—and this is what the IPCC assessments (and others) do.

I’ll thus take your question to be: Does the movie accurately portray the presentation of the science in the IPCC assessments? Generally yes, but there has been a lot of new information learned since the IPCC Third Assessment Report (e.g., on trends in hurricane intensity, the accelerated melting back of Arctic sea ice, the intensifying deterioration of the edges of the Greenland Ice Sheet, etc.) and Gore’s presentation of the science has been updated to account for these, drawing from what are the really highly reviewed and high quality papers by leading scientists. On a number of these issues, scientific understanding is in relatively rapid transition, and he has carefully worked to be at the cutting edge of scientific findings. In addition, given that he is really aiming to get at the public significance of the findings and to be identifying the risks the public is taking, his presentation is based on thoughtful consideration of where the science appears to be headed. In my view, he is quite consistent with the views of key leading and highly involved scientists (with whom he has over the years made many contacts), even if these views have yet to receive full endorsement by the very broad scientific community.

Each of the specific areas mentioned above is an example of this. With respect to hurricane intensity, there are observed trends indicating this and model results predicting this, and while there are problems in each (data problems with hurricanes, coarse resolution in global models, etc.), theoretical arguments also make clear that there will be more energy and water vapor available in the atmosphere to cause more intense hurricanes, so a very strong case can be made

for this happening. Indeed, there are still issues to work out concerning long-term trends and supposed natural variations, but no way do these contradict the indications that hurricanes will become more intense (after all, they are strongest during the times the oceans are warmest, etc.). With respect to retreat of Arctic sea ice, observed retreat is occurring a bit faster than the IPCC set of models is projecting—and some finer scale models are starting to explain why. For Greenland, the edges are clearly deteriorating rapidly, and the question is how much buildup might be compensating atop the ice sheet. Recent satellite trends indicate that the overall mass is decreasing. In addition, the rate of sea level rise has been higher over the last decade than over the last century, and paleoclimatic evidence is suggesting that the loss of about half of the Greenland Ice Sheet took place in a few centuries going into the last interglacial (the Eemian) and that sea levels were even higher than this amount of ice can account for. So, in my view, while he is ahead of the IPCC (2001) presentation of the science, he has done this very responsibly.

7. Did it portray the issue of global warming and hurricanes accurately? If so, how so? If not, how not?

This is covered to some extent above. On the rate of warming and the increase over the last few thousand years and on the increase indicated based on the Vostok core (so back 650,000 years or so), I think he presented that very fairly. He used to just unfold a plot of the Vostok results, and now he goes up in a hydraulic lift, but, yes, I think it is fairly done. Indeed, there are still some questions about periods of past warmth in particular regions (e.g., the early 20th century in the North Atlantic was warm, but it is clear from other evidence that this warmth was not Arctic-wide, as is the current warmth; the Medieval Optimum, which was another period of unusual warmth in the North Atlantic basin was warm, but paleoevidence indicates that there was not simultaneous hemispheric warmth. Scientists are working out the details (e.g., see the NRC report on the “hockey stick”), but I think that the movie provided a fair portrayal of the significance of scientific understanding for the public.

On the question of hurricanes, the theoretical arguments that more energy and water vapor in the atmosphere should lead to stronger storms are really sound (after all, storm intensity increases going from pole toward equator), but determining precisely how human influences (so including GHGs [greenhouse gases] and aerosols, and land cover change) should be changing hurricanes in a system where there are natural external (solar and volcanoes) and internal (e.g., ENSO, NAO [El Niño-Southern Oscillation, North Atlantic Oscillation]) influences is quite problematic—our climate models are just not good enough yet to carry out the types of sensitivity tests that have been done using limited area hurricane models run for relatively short times. So, the search has been on for very unusual trends. The NOAA [National Oceanic and Atmospheric Administration] hurricane community has taken the view that if one has not proven human influences in a statistically rigorous way (they tend to look for a simple trend over the century, even though it is not clear that this should be how the human signal will show itself), and then conclude that the variations not appearing as a simple trend are natural; more properly, they should be saying that the variations are an as yet unexplained combination of natural and human influences. Investigators outside NOAA are finding interesting trends and showing that they seem to be correlated with trends in such variables as SST [Sea Surface Temperature] in key regions, the changes of which almost certainly are due to human-induced changes in the climate,

though having enough data to get all the statistics right is often problematic. The article by Anthes et al. (and I am a co-author) in the May issue of the Bulletin of the American Meteorological Society summarizes what we believe is plausible, if not yet proven, basis for the relationship, whereas the Pielke et al. response focuses on the fact that we have not yet proven our plausibilities.

In my view, Gore, considering the risks to society, has rightly concluded that there is a strong indication that hurricane intensity is being affected by human-induced climate change, and that it is more important to raise this likelihood than waiting until everything is absolutely pinned down. I would say that is what responsible politicians and the public should be doing, so I think he is accurately portraying the significance of current scientific understanding.

8. Have you read the Crichton book? If so, how would you compare the way the two handled and portrayed the science of global warming?

I have not read the full Crichton book; I have, however, read his appendix that summarizes his views on climate change and I heard him speak on climate change at the National Press Club about a year ago. In my view, Crichton is being very irresponsible, basically taking the notion that if you cannot explain and predict everything perfectly, then nothing should be believed. For example, the criterion he stated at the Press Club for believing model results was (as I understood it) that the models had to correctly predict the trends and fluctuations at all of the world's measuring stations (he had arbitrarily picked out 6 that did not show warming as counter evidence to the global warming projections) for each of the next ten years (and whether he meant this on a daily, monthly, seasonal, or annual basis was not clear—it almost sounded as if he meant at least as fine as monthly). He showed no understanding of the chaotic nature of the weather and climate, internal variability, short versus long-term influences, etc. He is trained as a medical doctor, and his requirement would be the equivalent of saying I won't believe in any cancer treatment until the doctors can accurately predict the day-by-day or month-by-month status of every cancer patient for ten years into the future. It was an absurd argument.

He also showed no understanding of how science assembles the collection of observations and analyses, drawing on fundamental conservation laws of energy, etc. (of course, medicine does not have such laws—so maybe that is his problem), into a coherent picture of how the Earth is functioning (and how this matches how the planets are functioning, etc.) and so develops a paradigm for Earth system behavior that incorporates theory, observations, results of field and laboratory studies, paleoclimatic records, and so on. At the Press Club, he basically seemed to presume that his 2 years of inquiry made him into a qualified Earth system scientist—as some of our community has said, would he subject himself to a brain operation by someone who did the level of study and analysis he exhibited (or even to listen to their analysis). Truly, an arrogant attitude on his part—if I had been quicker, I would have borrowed from the quip by former VP candidate Lloyd Bentsen and said, “Mr. Crichton, I have known many leading climate scientists, and you are not one of them.”

Gore's arguments, on the other hand, are based on decades of interactions with leading scientists, and he does not claim to be an expert in their place, but instead listens to and comes to understand their findings, understanding issues concerning scientific uncertainties, natural

variability, conservation laws, and so on. He then does the translation of the significance of the scientific findings for the public. Sure, not everything is completely known. I would venture that, however, if people gave Gore twice as long, he could fill the time with further high quality discussion of the issues (and he has done this in hour long question periods following some of his talks). Fundamentally, Gore is intimately connected with the scientific world, and Crichton is off in a fictitious world of his creation.

9. Do you think viewers/readers will take home an accurate perception of climate change and the science of climate change? And what is that perception they should take home?

I think viewers will take home an accurate impression of the issue of climate change and an accurate perception of the urgency of dealing with this issue in a responsible way. The talk and the movie are not really designed to make the public into scientists as scientists look in detail at a much wider set of information and findings. Instead, the film is designed to give the audience a sense of how the key scientific findings have come together to indicate how rapidly human influences are altering the global climate and the types of impacts this is having and further change is likely to have. People typically have an awful lot on their mind, and stuffing their heads with details of lots of scientific findings is not really likely to happen or be productive—what is needed is an overall impression of the urgency of the problem and enough evidence being presented to show that his conclusions of importance and immediacy are based on solid scientific information (and the movie demonstrates a lot of this). Thus, Gore's talk presents enough detail to make him into a credible spokesperson in the minds of his audience—a status that none of the skeptic senators or other such officials (like the President) have achieved. If the movie can then make clear that the issue is important and that action is needed, and this means personal to global action, then I think Gore's outreach efforts have achieved what they should and can expect to do. For those who want to learn more about the scientific details, he points to where more information can be found—and the truly curious with a technical bent can pursue further inquiry. In my view, those that do so will find that Gore has quite accurately portrayed the understanding and sense of urgency held by the leading scientists in the area.

10. What did you think of the movie from a non-science perspective?

I liked the movie very much. I would only add that now that attention has been gotten, what is needed is a sequel that provides a path to making the changes, covering both what is easy and what will not be so easy. The movie does mention at the end and intertwined with the credits a lot of steps that can be taken, but I think what is needed next is a movie showing that we can have a society where we get the energy based services we need in ways that will not degrade the environment—basically, that we as a society can live sustainably on the planet, that lays out the steps and the sacrifices, and then the ultimate benefits of doing this, for us, for the world, and for our grandchildren and theirs.