

# ***An Inconvenient Truth*: blurring the lines between science and science fiction**

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Published online: 19 March 2008  
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**Abstract** Al Gore's movie *An Inconvenient Truth* gives a variety of unusually biased interpretations of the state of climate science and global warming theory. These cover a wide range of natural events and processes which could potentially be impacted by global warming, but which the movie misrepresents as clear examples of the human influence on climate. A few examples include the mixing up of cause and effect in his graphical portrayal of temperature and carbon dioxide variations over hundreds of thousands of years; the repeated depiction of ice calving from glaciers as a sign of global warming; the implication that Hurricane Katrina was the fault of humans; and the particularly extreme view that the Greenland ice sheet will melt, flooding coastal cities worldwide. Ultimately, all of these are related to the widespread perception that scientists have uniquely tied global warming to anthropogenic greenhouse gas emissions. The real inconvenient truth is that science has no idea how much of recent warming is natural versus the result of human activities.

**Keywords** Carbon dioxide · Climate · Glacier · Global warming · Hurricane · Sea level rise · Severe weather

## **Introduction**

Former-Vice President Al Gore's movie *An Inconvenient Truth* offers a particularly extreme interpretation of the state of global warming science. While the movie does a good job of explaining the basic theory behind manmade greenhouse warming, it misinterprets a variety of observations of weather and climate processes in ways that misleadingly suggest a dangerous human influence on global climate. As a result, by the end of the movie the viewer is left with the mistaken impression that humans are drastically altering a wide variety of weather and climate processes. In contrast, the true state of the science is much less dramatic, and much less certain, than Mr. Gore makes it out to be.

A number of the following arguments I present will not support the supposed scientific "consensus" that exists on the subject of global warming. This consensus usually refers to the specific activities of the U.N.'s Intergovernmental Panel on Climate Change (IPCC). As such, my views can be considered a counterbalance to Mr. Gore's interpretations, in the opposite direction.

## **Global temperatures and carbon dioxide**

One of the most compelling graphics in Mr. Gore's movie is a huge prop covering a stage that has ice-core based temperature and carbon dioxide estimates over

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hundreds of thousands of years. The temperature and CO<sub>2</sub> curves look very similar, with ups and downs approximately tracking each other. Mr. Gore interprets this behavior in terms of a specific cause and effect relationship, i.e. when CO<sub>2</sub> levels rise, so do temperatures.

He then shows on the same graphic how CO<sub>2</sub> concentrations in the last 50 years have risen well above those at anytime previous on the graph, and also how temperature has also begun to skyrocket. The inescapable conclusion seems to be that global temperatures will continue to rapidly rise in response to the increasing CO<sub>2</sub> concentrations.

But there are at least three serious problems with this interpretation. First, most if not all of the studies of these ice core-based relationships between temperature and CO<sub>2</sub> suggest that the temperature changes *preceded* the CO<sub>2</sub> changes, by at least several hundred years. This suggests the possibility that the temperature changes caused the carbon dioxide changes, rather than the other way around as is the claim for global warming theory. While the IPCC offers one possible scenario that accommodates this inconvenient fact, it is also possible that the extra CO<sub>2</sub> was released by the ocean during warming. As addressed below, the extra CO<sub>2</sub> itself might have had little influence on the temperatures. After all, we know that ocean circulation changes associated with El Niño and La Niña have a huge effect on how much extra CO<sub>2</sub> shows up at monitoring stations each year (Keeling et al. 1994; Behrenfeld et al. 2006).

The second problem with the graphical presentation in the movie is that the older data are considerably smoothed in time, whereas our most recent measurements over the last 100 years have very high time resolution. As a result, a very recent 30 year period of warmth shows up as a strong peak, while any such peaks 100,000 years ago would be mostly smoothed out. This exaggerates the signature of the recent measurements compared to the older ones.

The third problem with Mr. Gore's graph is related to the fact that CO<sub>2</sub> is a relatively minor atmospheric greenhouse gas. His graph might make it look like the CO<sub>2</sub> concentration is skyrocketing, but if you double or triple a very small fraction, it is still a very small fraction. To be specific, only 38 out of every 100,000 molecules of air are carbon dioxide—and it takes a full 5 years of anthropogenic greenhouse gas

emissions to increase that number by one, to 39 out of 100,000.

As a result of its relatively minor role, it has long been known that the direct warming effect of a doubling of the carbon dioxide, which will occur sometime late in this century, would only be 1°C or less. In contrast, over 90% of our current greenhouse effect (which warms the surface of the Earth by an average of 33°C) is not due to CO<sub>2</sub>—it is mostly due to water vapor and clouds. So, it is the response of the climate system to the warming tendency caused by the extra CO<sub>2</sub> in terms of *feedbacks* that are of greatest concern—and of greatest uncertainty.

Weather processes, especially rain and snow systems, govern most of the Earth's greenhouse effect through their control over water vapor and clouds. While all climate models change vapor and clouds in ways that amplify the small amount of direct warming from the carbon dioxide, recent evidence suggests a natural thermostatic control mechanism might be at work in the real climate system. Observational evidence for such a mechanism has only recently been revealed (Spencer et al. 2007).

Precipitation processes determine how much water vapor will be allowed to reside in the atmosphere in the face of continuous evaporation. The troposphere's air is continually recycled through these systems. Even the exceeding dryness of the air sinking over the world's deserts was desiccated by precipitation systems, possibly thousands of miles away.

Precipitation systems also, directly or indirectly, control the temperature profile of the global troposphere, even in regions remote from any precipitation activity. The temperature profile, in turn, exerts strong control over cloud formation everywhere on the planet.

And guess which part of the climate system we understand the least? Precipitation systems.

### Extreme events

A persistent misrepresentation occurring throughout the film is that every dramatic weather event is somehow connected to global warming. Here I will address only a few of these events.

## Calving of icebergs from glaciers

The film makes it look like the world's glaciers shrinking, calving, and melting are all the result of humans. I have actually talked to an adult who, after watching Mr. Gore's movie, was convinced that ice did not calve off of glaciers before humans caused it to happen.

Of course, as long as snow falls on glaciers, they will continue to slowly flow downhill. If they reach low enough altitudes, the fringes melt. If they reach the sea, ice breaks off and dramatically crashes into the ocean. The real question is this: Are these natural processes speeding up? And even if they are speeding up, can we blame humans? These are very difficult questions to answer. There is considerable evidence that many of these glaciers have been receding since at least the late 1800's, before humans could have been responsible. As they recede, some glaciers are revealing tree stumps, carbon dated to be several thousand years old, indicating a relatively recent period when the glaciers were even smaller than they are today (Koch 2006). How is it that a smaller glacier thousands of years ago was due to natural climate variability, but a receding glacier now is entirely due to humans?

## Hurricanes

The record 2005 hurricane season was widely blamed on anthropogenic global warming. After viewing *An Inconvenient Truth*, one would think that Hurricane Katrina was humans' fault. But the most dramatic thing about the 2005 tropical cyclone season across the global ocean basins was the large number of hurricanes that made landfall in the U.S.

While sea surface temperatures were indeed above normal in the tropical Atlantic and Gulf of Mexico during 2005, the number of hurricanes that formed was much greater than could be explained by increased temperature alone. Low wind shear and a generous number of "seedlings" coming off of Africa are also necessary. It appears that 2005 was a case of a near-perfect co-alignment of the several ingredients needed for an active hurricane season. But the fact is that Category 4 and 5 hurricanes have always occurred, and always will occur.

And we now have the 2006 and 2007 Atlantic hurricane seasons which were both relatively quiet. It

is not even obvious that 2005 was a record season for the number of named tropical cyclones, since before the age of satellites some storms would certainly have been missed. Thus, 1933 might well have been a more active season than 2005.

## Tornadoes

Despite the movie's suggestion that severe storm and tornado events have increased in frequency, there is no convincing evidence of this. Monetary storm *damage* has dramatically increased, but this is because of an increase in wealth and storm-sensitive property. The reported number of weak tornadoes has increased, but this is believed to be the result of more people covering more land to see these weaker events, as well as our use of increasingly sophisticated weather radar systems that can continuously monitor and identify rotating thunderstorms over most of the U.S. In fact, the incidence of strong tornadoes has actually decreased since statistics began back in the 1950's.

In summary, Mr. Gore's movie made a connection between every type of extreme weather event and global warming, despite the fact that everything shown in the film can be explained in terms of natural processes.

## Sea level rise

Sea level rise deserves special mention because it is probably the single most feared result of global warming. While in the movie Mr. Gore alludes to sea level increases of twenty feet or more, even the IPCC is projecting something closer to only one or two feet. The discrepancy is mostly related to uncertainties regarding how much the Greenland and Antarctic ice sheets will shrink. But in order to know that, we would need to know more than just whether the sheets are losing more ice to the ocean—we also need to know whether any of the extra loss is being compensated for by increased snowfall on the ice sheets. Since warmer air masses typically contain more moisture, it might be expected that increased snowfall would occur over glaciers in a warmer world.

## Humans or nature?

A fundamental question regarding any climate change we see today is this: *To what extent is our*

*present global warmth due to humans?* While the movie makes it appear that all of our warmth is due to humans (and the warmth then causes more extreme weather events), there are several lines of evidence that do not support this view.

While you have probably heard about the increased summertime melting of sea ice in the Arctic Ocean, based upon thermometer measurements the Arctic was just as warm in the 1930's as it is now. The Northwest Passage opened up in 1940—just as it did in 1906—and then once again in the summer of 2007. But we didn't have satellites back then to know whether the enhanced summer melting of Arctic sea ice we see today is out of the realm of natural variability, e.g. compared to 1940 and 1906.

There are both historical records and numerous temperature proxy measurements from around the Northern Hemisphere that suggest our present warmth is not greater than that during the Medieval Warm Period, which peaked around 1,000 years ago (Loehle 2007). At that time the Vikings were farming in Greenland, but they gradually abandoned those farms as the climate cooled, coinciding with the Little Ice Age.

This humans-or-nature question exists for virtually all of the changes we see in the climate system. While an anthropogenic explanation for our current warmth is indeed a plausible one, it is by no means the only one. We know that the nonlinear fluid dynamical nature of the climate system, combined with the very large heat capacity of the ocean, can result in substantial climate fluctuations on time scales of tens, hundreds, or even thousands of years (Hasselman 1976). But since we do not understand these variations, we can't predict them.

The particularly strong warming since the 1970's, for instance, could have been contributed to by a small change in the general circulation of the atmosphere. For instance, the warming coincided with a change to more frequent El Niño events, which cause globally-averaged warmth (<http://www.cdc.noaa.gov/people/klaus.wolter/MEI/mei.html>). Changing atmospheric circulation patterns would only need to alter average cloud cover by about 1% to explain the warming over the last 30 years. Unfortunately, our satellite measurements over that period of time are not accurate or stable enough to measure such a small change in cloudiness.

I am not claiming that recent warming is entirely natural; I am simply disputing the view that it is 100% anthropogenic. There has been extreme reluctance on the part of the climate research community to investigate the possibility that any portion of our recent warming has had a natural cause.

### Concluding remarks

*An Inconvenient Truth* certainly deserves high marks for raising public awareness of the global warming issue, and for explaining the theory that increasing carbon dioxide causes a warming *tendency* of the lower atmosphere. But there are simply too many examples of irresponsible misrepresentation of the science to redeem the movie as a medium for helping the public better understand how worried the scientific community is about the threat of anthropogenic global warming.

Indeed, the oft repeated “scientific consensus” on global warming, which is echoed in the movie, can only be claimed for the *existence* of warming—not its cause. That climate modelers can only explain our current warmth by including extra carbon dioxide in their models only displays our lack of understanding of natural climate variability. While humans are certainly a plausible explanation, there are others as well—and *An Inconvenient Truth* makes no mention of any of them.

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