Understanding Visual Exhibits in the Global Warming Debate

By

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The specter of hotter summers, melting icecaps, and rising coastlines lurks near the surface of every discussion of environmental policy taking place in the world today. As Michael Franc has written, “Weather used to be the ultimate safe topic for conversation. That was before climate change came along.”¹ Even the Vatican has hosted a conference on climate change.²

Due in part to a recent U.S. Supreme Court decision,³ politicians and the voters who elect them will be called upon to make some difficult decisions regarding carbon-based emissions and the environmental and economic consequences of their regulation. No one should doubt the importance of basing those decisions on solid information. Unfortunately, solid information can be difficult to come by.


³ In Massachusetts v. EPA, 127 S. Ct. 1438, 549 U.S.__ (2007), the U.S. Supreme Court identified carbon dioxide as a pollutant within the scope of the Clean Air Act. Thus, the highest level of the judiciary has determined the executive branch needs to begin making decisions regarding global warming. Debates within the legislative branch are ongoing. For background on Massachusetts v. EPA, see Jonathan H. Alder, “Standing in the Hot Seat: Climate Change Litigation,” 8 Engage 62 (2007).

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Global warming involves science, economics, and politics. Each of these areas has its own complexities, and there are many difficult issues and sub-issues. Moreover, special interests on both sides of the debate can make the case more difficult to understand rather than easier.4

There are many scientists, of course, who question the capability of humans to change the atmosphere significantly. The leading theory is that carbon-based emissions have contributed to a recent (past 100 years) increase in atmospheric carbon dioxide (CO2). The theory further holds that this atmospheric carbon dioxide has led to an increase in global temperatures and will continue to cause temperatures to rise throughout the twenty-first century.5 If we are to avoid catastrophic global climate change, the theory holds, it will be necessary to dramatically reduce carbon emissions, probably by imposing significant limits on industry and transportation.

There are many scientists, of course, who question the capability of humans to change the atmosphere significantly.6 NASA’s top administrator, Michael Griffin, speaking on National Public Radio, said he doubted global warming is “a problem we must wrestle with,” and that it is arrogant to believe “we need to take steps to make sure that [the climate] doesn’t change.”7

One problem with the global warming theory is that there is no way to use the scientific method to test the link between carbon dioxide and temperature levels at an atmospheric scale.8 A scientist cannot emit carbon dioxide into some atmospheres and leave others as an experimental control. We have only one atmosphere to work with and we are dependent on it for our lives. The scientist is left with environmental modeling—sort of reverse engineering. This involves looking at changes that have taken place and trying to figure out why they happened. This is a recognized way to try to understand the world, but it is far less certain than experimentation based on the scientific method.

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8 The scientific method is based upon repeatable experimentation that can prove or disprove a hypothesis. See Morris R. Cohen and Ernest Nagel, An Introduction to Logic and Scientific Method (2002). Karl Popper, one of the most influential philosophers of science of the twentieth century, described the scientific method as “proposing bold hypotheses, and exposing them to the severest criticism, in order to detect where we have erred.” Karl Popper, “Replies to my critics,” in The Philosophy of Karl Popper (P.A. Schilpp, ed. 1968).
There are some things in the climate change debate on which there is widespread agreement. Average global temperatures have increased by about one degree Celsius over the past 100 years. During the second half of that period, carbon emissions from human activity increased significantly, and the amount of carbon dioxide in the atmosphere has increased from about 280 ppm to 380 ppm, or from approximately 0.03 percent of the atmosphere to 0.04 percent of the atmosphere. Whether this amount of a “trace gas” actually could lead to a global temperature increase is where much of the modern debate is focused.  

With a lack of traditional science, partisans on both sides, and enormous consequences depending on popular opinion and political will, it is important that people understand the evidence in the debate over global warming. Unfortunately, most people do not have the time, desire, or ability to undertake an independent study of the issues. Recognizing this, advocates have “packaged” their evidence with charts, graphs, and other visual exhibits designed to have maximum impact with minimal effort on the part of the public. These displays, while appearing to present hard facts, are often misleading.

Environmental activists may be tempted to exaggerate their case in order to convince the public and politicians of the validity of their scenarios. This was illustrated in a statement made by climatologist Stephen H. Schneider, one-time adviser to Vice President Al Gore and author of the book Global Warming: Are We entering the Greenhouse Century? (1989). Schneider said that in order to reduce the risk of potentially disastrous climatic change, “we have to get some broad-based support, to capture the public’s imagination. That, of course, entails getting loads of media coverage. So we have to offer up scary scenarios, make simplified dramatic statements, and make little mention of any doubts we might have.”

The manipulation of visuals—bar and line graphs, pie charts, even photographs—has proven to be a highly effective way “to offer up scary scenarios” ... and it is easily done. This report explains how visuals can be manipulated by, among other techniques:

- changing the appearance of graphs by adjusting baselines (minimums) and maximums on the vertical axis,
- selectively reporting data on, for instance, a time line appearing on the horizontal axis of a chart,

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9 Oxygen and nitrogen make up 99 percent of the atmosphere. Other atmospheric gases are known as “trace gases.” See Ronald J. Rychlak, “Trace Gases, Equal Footing, and the Public Trust: Ownership of Coastal Properties after the Greenhouse Effect,” in Long Term Implications of Sea Level Change for the Mississippi and Alabama Coastlines (Conference Proceedings) (1990). Water vapor is probably the atmosphere’s main greenhouse gas. According to one study, in clear sky conditions, water vapor contributes 60 percent of the greenhouse effect; carbon dioxide 26 percent; ozone, 8 percent; and methane and nitrogen oxide, 6 percent. T.J. Kiehl & Kevin Trenberth, “Earth’s Annual Global Mean Energy Budget,” Bulletin of the American Meteorological Society 78, no. 2: 197-208 (1997).

Graphics can easily mislead ... and all too often in the global warming debates, that too has been their purpose.

Manipulating Visuals to Control Their Impact

The easiest way to understand how a graph can be manipulated is to capture a simple line graph from the Internet and paste it into a graphic program like PowerPoint. Once the graph is in PowerPoint, it can be stretched, squeezed, smashed, pulled, and otherwise manipulated. The axis labels may become distorted, but they can be replaced.

One could take a fairly simple bell curve, for example, with a gradual and even slope on both sides. (See Figures 1.)

By extending the horizontal axis the designer can create a graph with a more gradual slope. (See Figure 2 on following page.) By contrast, by changing the grid so that the vertical axis is comparatively longer than the horizontal axis, slope will be much steeper on each side of the bell. (See Figure 3.)

Each of these graphs will reflect the same data, but they will convey different visual images to the casual observer. The differences can be even more dramatic when working with graphs that are less symmetric than a bell curve.

As long as the changes maintain the integrity of the data, the resulting graph is not actually incorrect, even though various versions of the graph may present very different visual pictures of the data.

Visual differences in bar graphs can be magnified, without rendering the graph inaccurate, simply by modifying the baseline. For instance, consider the difference between Figure 4 and Figure 5 on the following page.
These bar graphs both depict the comparative number of people from three towns who attended a fair during a relevant time period (55,000 attendees from Oxford, 60,000 from Memphis, and 50,000 from Carmel). The bars in Figure 4 provide a reasonable visual depiction of the numbers. Figure 5, however, collapses the axis so that the first 50,000 people are depicted in the same space as the next 2,000 people. This emphasizes the visual impact of the numbers above 50,000 and significantly magnifies the difference in attendance levels.

The same effect could be attained by setting the baseline at some point other than zero. In Figure 6, for instance, the baseline is set at 48 and the visual difference between the various bars is even greater.

The differences in the visual impact of different charts and graphs are not random or accidental. Graphs like these are prepared for one reason: to create a visual impact. People who design them carefully consider color, size, labeling of the axis, and other factors with the objective of creating a persuasive visual image.

The differences in layout can render an exhibit either informative or misleading. For that reason, court proceedings subject exhibits to a determination of whether they are probative or merely prejudicial. Federal Rule of Evidence 403 provides: “Although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury, or by considerations of undue delay, waste of time, or needless presentation of cumulative evidence.”

See Id. at 119 (noting that in most cases, probative value is the more important determination).
In political debates, like the one over global warming, there is no such standard or evaluation. Advocates frequently refer to charts and graphs that are at least potentially misleading.

**Misleading Visuals in the Global Warming Debate**

One of the most common global warming graphs is seen in Figure 7. This line graph combines several features that tend to maximize its visual impact.

This graph has been put together so as to dramatize a one degree change in temperature over 125 years. Normally, such a small fluctuation over such a long period of time would be barely visible on a graph. In this case, however, both the baseline and the top line have been set so the graph fills the available space. Notice that despite the large visual impact of this graph, it actually shows a fluctuation only from -0.4 to +0.6.¹³

Moreover, the use of an annual mean as well as a five-year mean gives us a broader line (or grouping of lines) that seems to fill the graph. Even the placement of the key, within the axes and on the graph, adds to the visual impact.

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¹³ This figure is used on the Wikipedia “global warming” Web page, as well as on numerous other Web sites. See <http://en.wikipedia.org/wiki/Global_warming>. Global warming advocates could, of course, make their case seem even more dramatic by using the Fahrenheit scale, which would show a fluctuation of about two degrees. The problem would be that this scale, if put on a properly labeled axis, would show even less fluctuation (roughly two degrees over a 70 degree spread instead of one degree over a 20 degree spread).
The use of an annual mean as well as a five-year mean gives us a broader line (or grouping of lines) that seems to fill the graph.

The person who constructed Figure 7 did another thing that also magnifies its visual impact. A quick Internet search will reveal numerous graphs and charts that track average global temperatures as part of the global warming debate. The overwhelming majority of them begin the time line (the bottom axis) at 1860 or 1880. This is the tail end of the so-called “Little Ice Age.”

From about 1200 until about 1880, the Earth was unusually cool. Graphs that start at 1880 or 1860 actually begin in the final years of this Little Ice Age. Since the Earth was coming out of an unusually cold period, temperatures were rising. This contributes to the visual impact of the graph, even though that part of the temperature increase cannot legitimately be attributed to carbon emissions from human activity (which did not become significant in any meaningful way until around 1940).

By flattening the graph so as to more realistically reflect a fluctuation of one degree Celsius, then extending the graph above and below the line so as to show a possible range from zero to 22 degrees, we can construct a new graph, as shown in Figure 8. This new graph accurately reflects the same data as Figure 7, but the visual image created by the two graphs is quite different.

**Figure 8**

**A More Accurate Temperature Trend Graph**

One seems to depict a serious threat with wildly fluctuating temperatures. The other shows a barely noticeable increase in temperatures. Figure 8 may present a more accurate reflection of

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changes in global temperatures, but it certainly does not have the same ability to persuade that Figure 7 does.

Figure 9 shows the same kind of manipulation has taken place with graphs depicting carbon dioxide concentrations. This is a fairly common line graph showing the increase in atmospheric carbon dioxide concentration from about 270 parts per million to 370 parts per million over the past 1,100 years. When the graph is presented in color, the most dramatic increase, which took place over the past 50 years, is depicted in red.

One might wonder why this graph goes back 1,100 years when the issue being debated is the impact of carbon emissions from human activity, which only became significant over the past 50 or so years. The answer is because this presents a more dramatic visual impact. The 1,100-year time line magnifies the visual impact of the increase in carbon dioxide levels over the past 50 years—the red part of the graph.

Consider the other aspects of the graph that went into magnifying the visual impact of that part of the graph. For one thing, the graph is based on the seemingly high “parts per million” scale, rather than on an “atmospheric percentage” scale. After all, an increase from 270 ppm to 370 ppm is much more impressive than an increase from 0.03 percent to 0.04 percent.

Moreover, the top and bottom of the graph have been collapsed. The baseline begins at 260 rather than at zero, and the top is at 380, very near the highest point reached by the line. As such, and with explanatory notes placed inside the field of the graph, the visual impact is significantly magnified. Finally, lest the focus be directed away from where the author intended, the last 50 years of the line are colored red.

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15 This graph is taken from a Canadian natural resources Web site, <http://adaptation.nrcan.gc.ca/posters/wa/wa_06_e.php>. Similar graphs can be found on numerous Web sites.

16 One might also question why a graph that goes back 1,100 years is labeled as covering the past 1,000 years.
For comparison purposes, let us look at Figure 10. This graph shows actual measurements of carbon dioxide concentrations over the past 50 years. This is the red part of Figure 9—the part that seems to turn up so dramatically. Yet here, while we certainly can see an upward trend in carbon dioxide levels, it is far less threatening.

**Figure 10**

**Measurements of Carbon Dioxide Concentrations in the Atmosphere**

So we have two graphs. Neither one is technically incorrect, but they present us with very different visual images. Those images, of course, are the result of conscious decisions made by the people who prepared the graphs.

Why are the two graphs so different? Primarily because Figure 10 has a zero baseline, is spread over only the relevant years, and extends well above the top of the line itself.

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17 Figure 10 is taken from JunkScience.com.
**Visuals Are Not the Whole Story**

It is important to remember the limits of charts and graphs. They do not present the whole story. For instance, in the motion picture *An Inconvenient Truth*, former Vice President Al Gore uses two graphs—one depicting the increase in atmospheric carbon dioxide and a similarly shaped one depicting the increase in average temperatures—to contend carbon emissions are causing global warming.

Congressman Joe Barton (R-Texas) challenged Gore when he appeared before Congress:

> In your movie, you display a timeline of temperature and compared to CO2 levels over a 600,000-year period as reconstructed from ice core samples. You indicate that this is conclusive proof of the link of increased CO2 emissions and global warming. A closer examination of these facts reveals something entirely different. I have an article from *Science* magazine which I will put into the record at the appropriate time that explains that historically, a rise in CO2 concentrations did not precede a rise in temperatures, but actually lagged temperature by 200 to 1,000 years. CO2 levels went up after the temperature rose. The temperature appears to drive CO2, not vice versa. On this point, Mr. Vice President, you’re not just off a little. You’re totally wrong. That would suggest higher temperatures add to the carbon dioxide levels in the atmosphere, not that carbon dioxide emissions increase temperatures.  

There are counter-arguments supporting Gore’s case and rebutting Barton. The point here, however, is that visual exhibits are intentionally created or selected in order to advance a particular viewpoint.

Figure 11 on the following page, from the U.S. Environmental Protection Agency’s Web site, is similar to the image used in the movie. In Figure 11, as in the movie, the lines are on the same graph, but they are not superimposed on the same axis; the carbon dioxide line is kept above the temperature line.

Perhaps that is because if they were placed on the same axis, the resulting graph would look like Figure 12, which looks like temperatures usually move before carbon dioxide concentration levels, not after them.

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Figure 11
Superimposing Graphs on Different Axes

Figure 12
Superimposing Graphs on the Same Axis
Figure 11, like the graphs in *An Inconvenient Truth*, shows there is a correlation between temperatures and atmospheric carbon dioxide, but correlation alone does not prove causation. A different global warming theory, that solar activity is responsible for the increased temperatures, contends these increased temperatures are responsible for the increased carbon dioxide levels, not the other way around.20

There are several interesting correlations that are not causally related. For instance, there used to be a very strong correlation between the Superbowl and the stock market. If the NFC won, the market would go up. If the AFC won, the market was set for a bad year. This correlation has weakened in recent years, but it remains an interesting anomaly.21

A more serious situation came up in the early days of AIDS, when doctors thought this new disease was related to the use of nitrate inhalants, not a virus.22 A current issue involves an apparent correlation between childhood vaccines and the onset of autism.23

In the global warming debate, one graphic designer, intent on illustrating that correlation does not prove causation, created a humorous chart showing a correlation between global warming and a decrease in the number of pirates in the world.24

### Visuals Are Only as Good as the Data They Present

So far, we have talked about different ways evidence can be presented so as to create strikingly different visual images. We have assumed the data being presented are legitimate. One of the

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21 See “Hedge Funds Consistency Index, Correlation and Non-Correlation.” <http://www.hedgefund-index.com/d_correlation.asp> (noting the correlation is not a good basis for prediction of future markets)


most famous global warming graphs, however, has come under close scrutiny due to the method used to develop the data.

Figure 13 purports to show average temperatures in the northern hemisphere over the past 1,000 years. The upturn at the end—the part of the graph representing the most recent years—is what gives this graph its name: the hockey stick graph. It was prominently featured in a 2001 report issued by the Intergovernmental Panel on Climate Change (IPCC).

The hockey stick graph was put together by three scientists: Michael Mann, Raymond Bradley, and Malcolm Hughes. Since temperatures from long ago had not actually been recorded, the scientists used tree rings, corals, ocean and lake sediments, cave deposits, ice cores, bore holes, and glaciers to infer the climates of the distant past.

The hockey stick graph replaced a different graph that had represented scientific “consensus” that past temperatures were higher than those of the 1990s. That graph, shown in Figure 14 on the following page, had appeared in the IPCC’s 1995 report.

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25 This version of the popular graph was taken from the Middlebury College Web page <http://www.middlebury.edu/about/pubaff/news_releases/2006/news632761361369665320.htm>.


28 Intergovernmental Panel on Climate Change, Climate Change 1995, Figure 22.
In June 2005, the U.S. House Energy and Commerce Committee became concerned about allegations that the scientists who came up with the hockey stick graph (who had received federal funding) withheld adverse statistical results and that the results depended on questionable indicators. The committee sent questions to Mann and his co-authors about verification statistics and the algorithm they used. When the measurements were called into question, Mann responded by saying he would not be “intimidated” into disclosing the algorithm by which he obtained his results.

A similar attitude was expressed by climate researcher Phil Jones, who said to climate change skeptic Warwick Hughes: “We have 25 or so years invested in the work. Why should I make the data available to you, when your aim is to try and find something wrong with it?”

In February 2006, the National Academy of Sciences (NAS) appointed a panel of 12 eminent academics involved in climate science to evaluate the science behind the hockey stick graph. They eventually returned a 155-page report on the graph and the science behind it. They found

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30 Id.

many serious errors in methodology and observed that little confidence could be placed in its
temperature reconstructions before 1600, and even less confidence in the conclusions that “the
1990s are likely the warmest decade, and 1998 the warmest year, in at least a millennium.” 32

The NAS panel conceded Mann’s reconstruction was “plausible” but said it was impossible to
have confidence in it. 33 The 2007 report by the IPCC downplayed reliance on the hockey stick
graph, though it had been a centerpiece of the group’s earlier report. 34

The visual image created by the authors of the hockey stick graph had serious repercussions that may have
influenced international policy to an extent not justified by the actual evidence.

At a news conference announcing the NAS findings, panelist Kurt Cuffey was asked whether any lessons could be learned from
these developments. He said the prominent use of the hockey stick graphic by the IPCC sent “a very misleading message.” 35 He said
the over-selling did not come from the “science community,” but from the “interaction of part of the science community
with the broader public discourse and in particular with the way the [Mann et al.] reconstruction
was used by the IPCC in the 2001 report.” 36

This has led some commentators to ask a very serious question:

But haven’t we been told that the IPCC is the “science community?” If a knowledgeable observer such as Cuffey distinguishes the two, blaming the IPCC while defending the “science community,” shouldn’t we be trying to figure out exactly how the IPCC process ended up
sending out a “very misleading message?” And if the process has not been fixed—and there is no
evidence that it has—how do we know that the IPCC won’t send another equally “misleading”
message in the upcoming Fourth Assessment report? 37

In other words, the visual image created by the authors of the graph had serious repercussions
that may have influenced international policy to an extent not justified by the actual evidence.
There is no telling how much damage such a graph can do in a debate that is so highly influenced
by public perception.

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32 McIntyre and McKitrick, supra note 29; Richard Monastersky, “Climate Science on Trial: How a single
scientific graph became the focus of the debate over global warming,” Chronicle of Higher Education,
September 8, 2006.

33 McIntyre and McKitrick, supra note 29. These same concerns apply to the spike at the end of the graphs
in Figures 11 and 12.


35 McIntyre and McKitrick, supra note 29.

36 Id.

Which Data to Present, Which Graph Format to Use?

One point that animates many global warming arguments is the amount of carbon dioxide (CO2) emissions that come from the United States. This would seem to be a fairly indisputable fact, but it isn’t—especially when it comes to depicting the amount graphically.

For instance, if the sole question relates to the absolute amount of CO2 released into the atmosphere, the United States releases more CO2 than any other nation except China. But it may be more fair to take population into consideration and look at emissions on a per-capita basis. Considered this way, the United States is at the top of the list.

If, rather than per-capita emissions, we consider geographic area (which might be justified due to the greater transportation needs of a country with lower population density), Holland is far and away the largest emitter, with France, Germany, Japan, and several other countries well above the United States.

Moreover, it might be most accurate to consider emissions as compared to a nation’s Gross Domestic Product ("GDP"). In that way we compare the emissions a nation releases into the atmosphere in light of the good things it brings to the market. Measured this way, China, South Korea, Canada, and the U.K. are all bigger emitters than is the United States.

Before a chart or graph is put together, the author must decide which of the above numbers it will depict. As a quick Internet search will reveal, almost all such graphs depict the first option—the absolute emissions figure—but not the others.

That, however, is not the end of the decision-making process. Next, the author must decide how to depict the number graphically. The logical ways to depict comparisons like this include bar graphs and pie charts.

A bar graph permits an author to present a visual comparison of the emissions from a handful of nations. Figures 4, 5, and 6 have already been used to illustrate how bar graphs can be manipulated by failing to set the baseline at zero or by collapsing the bottom part of the graph. Without doing either of those things, however, the author of a bar graph can create different visual impacts by manipulating its shape and size.

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Figures 15 and 16 are rotated on their sides to better accommodate the labels, but they both reflect exactly the same data.

It is easy to see how an elongated, lean bar graph (Figure 15) magnifies the differences as compared to a compressed, thick graph (Figure 16). Additionally, but not shown here, a three-dimensional effect on the bars can create a misleading visual impact by making it appear that a bar is at a height other than the one called for by the data.

A pie chart not only gives a visual comparison between the carbon emissions of various nations, it also shows what percentage of total emissions comes from any given nation. Figure 17 on the following page gives this visual picture, based on raw carbon emissions.

Obviously, the chart makes the point that the United States puts more absolute carbon into the atmosphere than any other nation—almost a quarter of the total emissions. Rarely, however, do we see pie charts as simple as Figure 17. More often, those who make pie charts provide a three-dimensional pie, which is more visually pleasing, but also less visually accurate.
A three-dimensional graph presenting this same information, Figure 18, magnifies the visual impact of the nations depicted in the bottom (front) pieces of the pie.  

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From the Web page of “Flex Your Power,” California’s statewide energy efficiency marketing and outreach campaign.
Because in a 3D pie chart the “side” of the front pieces is visible, they appear significantly larger than is justified by the actual numbers. When one or more pieces of the three-dimensional pie are separated from the pie, the sides of those pieces may also become visible. With careful positioning, such pieces at the top or rear of the pie can present a visual image that significantly over-states what would be justified by the statistics.

This visual impact may be easier to see in Figure 19, which compares the GDP of various nations (making a larger piece of the pie better for the nation). The United States, located at the back of the chart, seems to have a smaller GDP than justified by the numbers, while China, France, Germany, and the UK all appear to have a much larger GDP than they really do.

The amount by which the visual impact is misleading will vary depending on the tilt of the pie and the thickness of the side. The key point, however, is that when advocates want to create visual images for persuasive purposes, a three-dimensional chart allows them to create an image that does not accurately reflect the statistics that underlie it. A good rule of thumb is to be very suspicious of any graph that provides a three-dimensional view.

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40 Figure 19 is from PhysOrg scientific forums. <http://lofi.forum.physorg.com/Global-warming_8866.html>
In the global warming debates, even photographs are being used in misleading ways. One of the most common, shown as Figure 20, shows polar bears stranded on what appears to be a melting iceberg. The implication and argument, of course, is that global warming is destroying the bears’ habitat, and they are dying off.

In fact, however, polar bears are not threatened. Most populations are increasing, especially in those regions where temperatures have been on the rise. The claim that they are being killed by global warming is apparently based on a single observation of four drowned bears, without any information about the cause of the drowning. The photographs and the related arguments are simply invalid.

Other photographs that have been extensively used show retreating glaciers or diminished snow caps on mountains. Consider the comparison photographs depicted in Figure 21.

The comparison certainly suggests that much snow was lost between

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41 There are several different photographs used to advance the same argument. One can be found on the WindStar Wildlife Garden Weekly e-Magazine Web page <http://www.windstar.org/eMagazines/eMagazine98/emagazine.cfm> (noting “Greenpeace recently began running TV ads featuring adorable animated Polar Bears that slip off melting ice and drown.”).


1928 and 2004 at the Upsala Glacier, part of the South American Andes in Argentina. Of course, there is no indication of the month in which each photograph was taken. One might have been taken in the summer and the other in the winter. Even if they were taken at the same time of year, however, the photos would show only that temperatures have increased in that region. That is not the issue. The issue is why temperatures have increased across the globe. The photos provide no help when it comes to answering that question.

Figure 21
How Photographs Can Mislead

Mount Kilimanjaro’s glacier, frequently used in the global warming debates, began to recede around 1880, well before the global increase in man-made carbon emissions. The researchers

44 These photographs can be found on the Time magazine Web site at: <http://www.time.com/time/magazine/article/0,9171,1176980-3,00.html>.

45 "Small changes in temperature can produce rather large changes in mountain glaciers. So can changes in regional precipitation that have nothing to do with CO2 emissions." Lewis, supra note 43, at 9.

46 Id.
behind one recent study developed “a new concept for investigating the retreat of Kilimanjaro’s glaciers, based on the physical understanding of glacier-climate interactions.” They say the new concept “considers the peculiarities of the mountain and implies that climatological processes other than air temperature control the ice recession in a direct manner. A drastic drop in atmospheric moisture at the end of the 19th century and the ensuing drier climatic conditions are likely forcing glacier retreat on Kilimanjaro.”

In his motion picture, former Vice President Al Gore uses a photograph of where the Perito Moreno Glacier, in Patagonia, Argentia, terminates and flows into Lake Argentino. This creates the impression that the glacier is literally melting away. The Perito Moreno, however, “is famous for being in a state of dynamic equilibrium, continually advancing and then unpredictably shedding ice via spectacular calving events.”

In other words, this photographic evidence supposedly showing global warming actually depicts a glacier that is continually expanding.

There are other glaciers that continue to expand, such as the Pio XI in Argentina. Of course, using photos of those growing glaciers to suggest that temperatures are not increasing would likewise be deceptive.

Similarly, global warming debates often feature photos of dark smoke billowing from industry smokestacks. Even the poster for the film _An Inconvenient Truth_ features smoke from a smokestack swirling into what appears to be a hurricane.

The global warming theory at issue, however, is focused on carbon dioxide—a clear, odorless gas that would not be seen escaping from a smokestack or exhaust pipe. In fact, “a central goal of the Clean Air Act for more than 30 years has been to make cars so clean burning that, ultimately, nothing comes out of the tailpipe except water vapor and CO2.”

Hurricane Katrina played an important role in _An Inconvenient Truth_, even though the linkage between global warming and hurricanes is very weak. According to a statement for the World Meteorological Organization developed at the International Workshop on Tropical Cyclones in

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49 See Greenpeace, _Climate Change and the Earth’s Mountain Glaciers_, May 1998.
50 Lewis, supra note 43, at 8.
November 2006, “no firm conclusion can be made” as to the relationship between global warming and hurricane activity; “no individual tropical cyclone can be directly attributed to climate change”; and the “recent increase in societal impact from tropical cyclones has been largely caused by rising concentrations of population and infrastructure in coastal regions.”

In fact, one recent study suggests that warming ocean temperatures may actually make it more difficult for hurricanes to form.

**Conclusion**

Global warming is a risk that we need to consider carefully. If we are wrong and miss the opportunity to halt or at least slow the increase in temperatures, humanity may pay a horrible price. On the other hand, if we over-estimate the role of human activity, we could divert precious resources in a futile effort while at the same time sacrificing other projects that might have significant benefits for the world.

Charts, graphs, and even photos can be misused by their creators. This can lead to confusion in a time when clarity is essential.

If we are to make wise decisions, we have to understand the evidence. Graphic exhibits can help convey a strong visual image. In fact, that is their reason for being. However, as words can be misused by an advocate, charts, graphs, and even photos can be misused by their creators. This can lead to confusion in a time when clarity is essential. In the global warming debates, that is happening with a disconcerting degree of regularity.

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52 Global Warming and Hurricanes, Geophysical Fluid Dynamics Laboratory Web page &lt;http://www.gfdl.noaa.gov/~tk/glob_warm_hurr.html&gt;


54 According to one estimate, everyone in the world could be provided with clean drinking water forever at about the same price for one year of compliance with the Kyoto Protocol. Kyoto: Costs vs. Benefits, AEI-Brookings Joint Center for Regulatory Studies, April 8, 2002 (comments of Bjorn Lomborg). &lt;http://www.aei-brookings.org/admin/authorpdfs/page.php?id=236&gt;