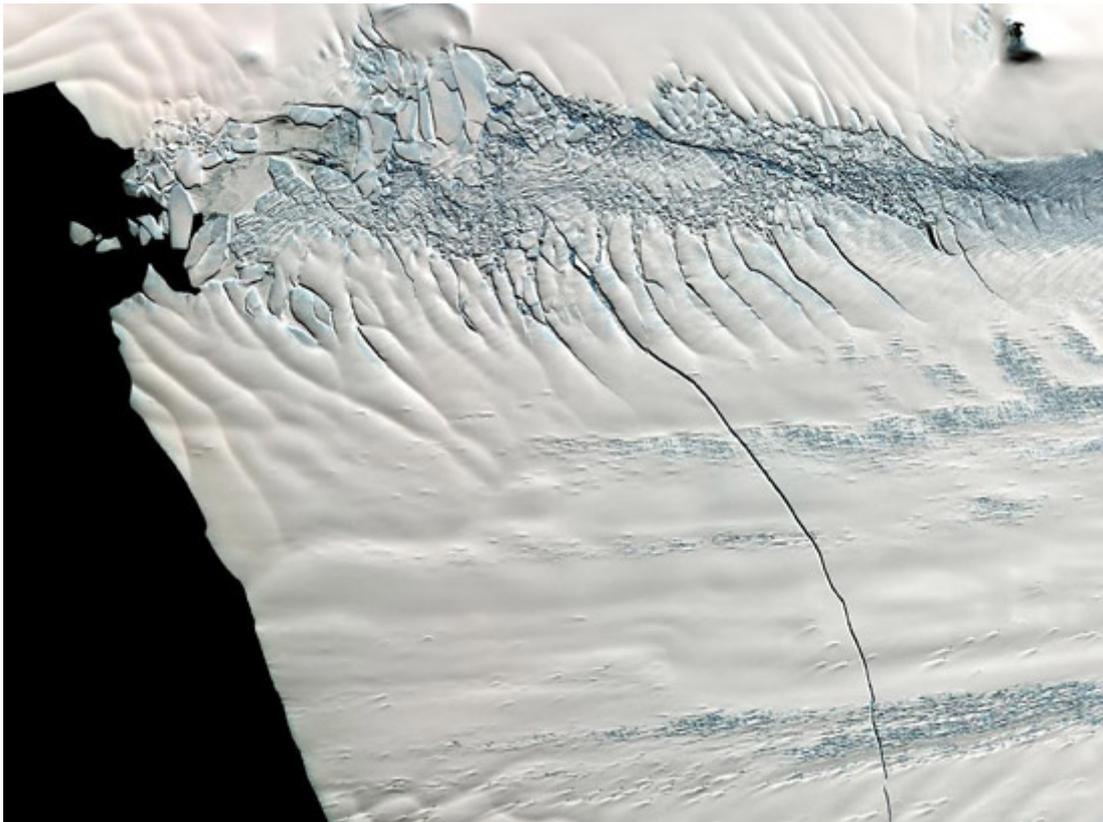


# How We Know Global Warming is Real and Human Caused:

BY DONALD R. PROTHERO

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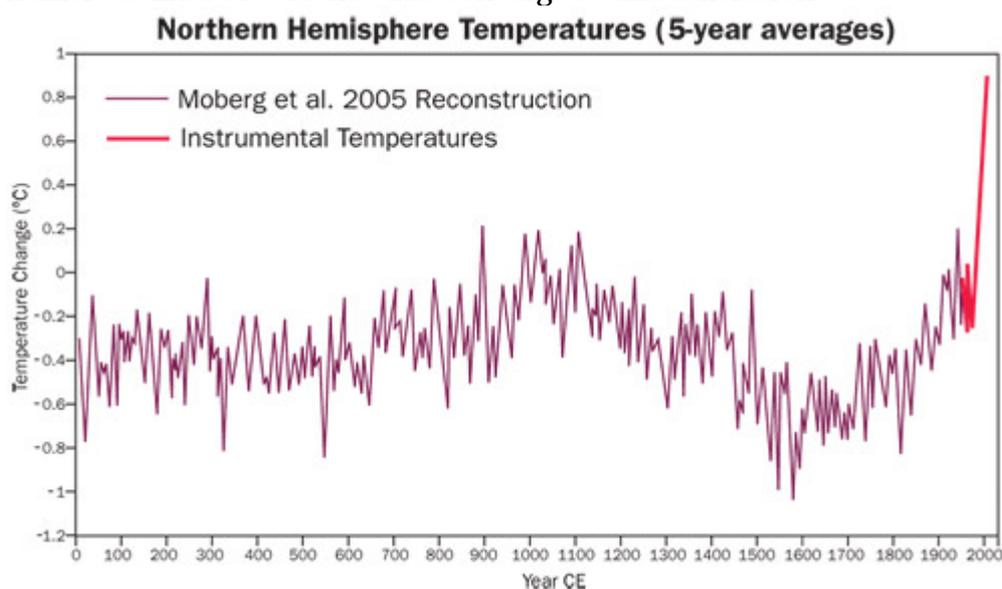
## Pine Island Glacier (photo shown above)

In mid-October 2011, NASA scientists working in Antarctica discovered a massive crack across the Pine Island Glacier, a major ice stream that drains the West Antarctic Ice Sheet. Extending for 19 miles (30 kilometers), the crack was 260 feet (80 meters) wide and 195 feet (60 meters) deep. Eventually, the crack will extend all the way across the glacier, and calve a giant iceberg that will cover about 350 square miles (900 square kilometers). This image from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument on NAS's Terra spacecraft was acquired Nov. 13, 2011, and covers an area of 27 by 32 miles (44 by 52 kilometers), and is located near 74.9 degrees south latitude, 101.1 degrees west longitude. (Image Credit: [NASA/GSFC/METI/ERSDAC/JAROS, and U.S./Japan ASTER Science Team](#))

**O**n January 27, 2012, the *Wall Street Journal* ran an [Opinion Editorial](#) written by 16 people who deny the evidence of human-induced climate change. Most of the authors of the editorial were not climate scientists; one of two actual climate scientists of the group, Richard Lindzen, is a notorious global warming denier who also denies that smoking causes cancer. Predictably, the Rupert Murdoch-owned *Journal* refused to run a statement by 255 members of the National Academy of Sciences, although a “Letter to the Editor” by 38 of the world’s leading climate scientists<sup>1</sup> did manage to get published there. The letter pointed out the numerous lies, mistakes, and fallacies in the editorial, along with a scathing rebuke by climate scientist Kevin Trenberth, whose remarks were quoted out of context to make them seem the opposite of what he actually said. As the Trenberth et al. letter pointed out, the 16 authors of the editorial were so far out of their depth in discussing the topic that they were the “climate-science equivalent of dentists practicing cardiology.” And as if to answer the editorial, the earth sent a resounding message in reply. On Feb. 2, 2012, an 18-mile crack appeared in Pine Island Glacier in Antarctica (see photo above and sidebar for details), a prelude to the calving off an iceberg 350 square miles in area, one of the largest icebergs ever seen.<sup>2</sup>

### Converging Lines of Evidence

How do we know that global warming is real and primarily human caused? There are numerous lines of evidence that converge to this conclusion.



**Figure 1.** The Moberg et al. (2005) plot (updated from the Mann et al., 1999, plot) of the last 2000 years of earth’s average surface temperature, which shows over 800 years of relative stability followed by the rapid warming of the past two centuries, giving it the shape of a “hockey stick.” The slight warming trend of the Medieval Warm Period can also be seen (data from 900–1200 A.D.) and is nowhere near the magnitude of the warming in the past century. (Click diagrams to enlarge them.)

1. **Carbon Dioxide Increase.** Carbon dioxide in our atmosphere has increased at an unprecedented rate in the past 200 years. Not one data set collected over a long enough span of time shows otherwise. Mann et al. (1999) compiled the past 900 years' worth of temperature data from tree rings, ice cores, corals, and direct measurements of the past few centuries, and the sudden increase of temperature of the past century stands out like a sore thumb. This famous graph (see Figure 1 above) is now known as the "hockey stick" because it is long and straight through most of its length, then bends sharply upward at the end like the blade of a hockey stick. Other graphs show that climate was very stable within a narrow range of variation through the past 1000, 2000, or even 10,000 years since the end of the last Ice Age. There were minor warming events during the Climatic Optimum about 7000 years ago, the Medieval Warm Period, and the slight cooling of the Little Ice Age from the 1700s and 1800s. But the magnitude and rapidity of the warming represented by the last 200 years is simply unmatched in all of human history. More revealing, the timing of this warming coincides with the Industrial Revolution, when humans first began massive deforestation and released carbon dioxide by burning coal, gas, and oil.
2. **Melting Polar Ice Caps.** The polar icecaps are thinning and breaking up at an alarming rate. In 2000, my former graduate advisor Malcolm McKenna was one of the first humans to fly over the North Pole in summer time and see no ice, just open water. The Arctic ice cap has been frozen solid for at least the past 3 million years and maybe longer<sup>3</sup>, but now the entire ice sheet is breaking up so fast that by 2030 (and possibly sooner) less than half of the Arctic will be ice covered in the summer.<sup>4</sup> As one can see from watching the news, this is an ecological disaster for everything that lives up there, from the polar bears to the seals and walruses to the animals they feed upon, to the 4 million people whose world is melting beneath their feet. The Antarctic is thawing even faster. In February–March 2002, the Larsen B ice shelf—over 3000 square km (the size of Rhode Island) and 220 m (700 feet) thick—broke up in just a few months, a story typical of nearly all the ice shelves in Antarctica. The Larsen B shelf had survived all the previous ice ages and interglacial warming episodes for the past 3 million years, and even the warmest periods of the last 10,000 years—yet it and nearly all the other thick ice sheets on the Arctic, Greenland, and Antarctic are vanishing at a rate never before seen in geologic history.
3. **Melting Glaciers.** Glaciers are all retreating at the highest rates ever documented. Many of those glaciers, especially in the Himalayas, Andes, Alps, and Sierras, provide most of the freshwater that the populations below the mountains depend upon—yet this fresh water supply is vanishing. Just think

about the percentage of world's population in southern Asia (especially India) that depend on Himalayan snowmelt for their fresh water. The implications are staggering. The permafrost that once remained solidly frozen even in the summer has now thawed, damaging the Inuit villages on the Arctic coast and threatening all our pipelines to the North Slope of Alaska. This is catastrophic not only for life on the permafrost, but as it thaws, the permafrost releases huge amounts of greenhouse gases and is one of the major contributors to global warming. Not only is the ice vanishing, but we have seen record heat waves over and over again, killing thousands of people, as each year joins the list of the hottest years on record. (2010 just topped that list as the hottest year, surpassing the previous record in 2009, and we shall know about 2011 soon enough). Natural animal and plant populations are being devastated all over the globe as their environment changes.<sup>5</sup> Many animals respond by moving their ranges to formerly cold climates, so now places that once did not have to worry about disease-bearing mosquitoes are infested as the climate warms and allows them to breed further north.

4. **Sea Level Rise.** All that melted ice eventually ends up in the ocean, causing sea level to rise, as it has many times in the geologic past. At present, sea level is rising about 3–4 mm per year, more than ten times the rate of 0.1–0.2 mm/year that has occurred over the past 3000 years. Geological data show that sea level was virtually unchanged over the past 10,000 years since the present interglacial began. A few millimeters here or there doesn't impress people, until you consider that the rate is accelerating and that most scientists predict sea level will rise 80–130 cm in just the next century. A sea level rise of 1.3 m (almost 4 feet) would drown many of the world's low-elevation cities, such as Venice and New Orleans, and low-lying countries such as the Netherlands or Bangladesh. A number of tiny island nations such as Vanuatu and the Maldives, which barely poke out above the ocean now, are already vanishing beneath the waves. Eventually their entire population will have to move someplace else.<sup>6</sup> Even a small sea level rise might not drown all these areas, but they are much more vulnerable to the large waves of a storm surge (as happened with Hurricane Katrina), which could do much more damage than sea level rise alone. If sea level rose by 6 m (20 feet), most of the world's coastal plains and low-lying areas (such as the Louisiana bayous, Florida, and most of the world's river deltas) would be drowned. Most of the world's population lives in coastal cities such as New York, Boston, Philadelphia, Baltimore, Washington, D.C., Miami, Shanghai, and London. All of those cities would be partially or completely under water with such a sea level rise. If all the glacial ice caps melted completely (as they have several times before

during past greenhouse episodes in the geologic past), sea level would rise by 65 m (215 feet)! The entire Mississippi Valley would flood, so you could dock your boat in Cairo, Illinois. Such a sea level rise would drown nearly every coastal region under hundreds of feet of water, and inundate New York City, London and Paris. All that would remain would be the tall landmarks, such as the Empire State Building, Big Ben, and the Eiffel Tower. You could tie your boats to these pinnacles, but the rest of these drowned cities would be deep under water.

### Climate Deniers' Arguments and Scientists' Rebuttals

Despite the overwhelming evidence there are many people who remain skeptical. One reason is that they have been fed lies, distortions, and misstatements by the global warming denialists who want to cloud or confuse the issue. Let's examine some of these claims in detail:

- **"It's just natural climatic variability."** *No, it is not.* As I detailed in my 2009 book, [\*Greenhouse of the Dinosaurs\*](#), geologists and paleoclimatologists know a lot about past greenhouse worlds, and the icehouse planet that has existed for the past 33 million years. We have a good understanding of how and why the Antarctic ice sheet first appeared at that time, and how the Arctic froze over about 3.5 million years ago, beginning the 24 glacial and interglacial episodes of the "Ice Ages" that have occurred since then. We know how variations in the earth's orbit (the Milankovitch cycles) controls the amount of solar radiation the earth receives, triggering the shifts between glacial and interglacial periods. Our current warm interglacial has already lasted 10,000 years, the duration of most previous interglacials, so if it were not for global warming, we would be headed into the next glacial in the next 1000 years or so. Instead, our pumping greenhouse gases into our atmosphere after they were long trapped in the earth's crust has pushed the planet into a "super-interglacial," already warmer than any previous warming period. We can see the "big picture" of climate variability most clearly in the EPICA cores from Antarctica (see Figure 2 below), which show the details of the last 650,000 years of glacial-interglacial cycles. *At no time during any previous interglacial did the carbon dioxide levels exceed 300 ppm, even at their very warmest.* Our atmospheric carbon dioxide levels are already close to 400 ppm today. The atmosphere is headed to 600 ppm within a few decades, even if we stopped releasing greenhouse gases immediately. This is decidedly *not* within the normal range of "climatic variability," but clearly unprecedented in human history. Anyone who says this is "normal variability" has never seen the huge amount of paleoclimatic data that show otherwise.

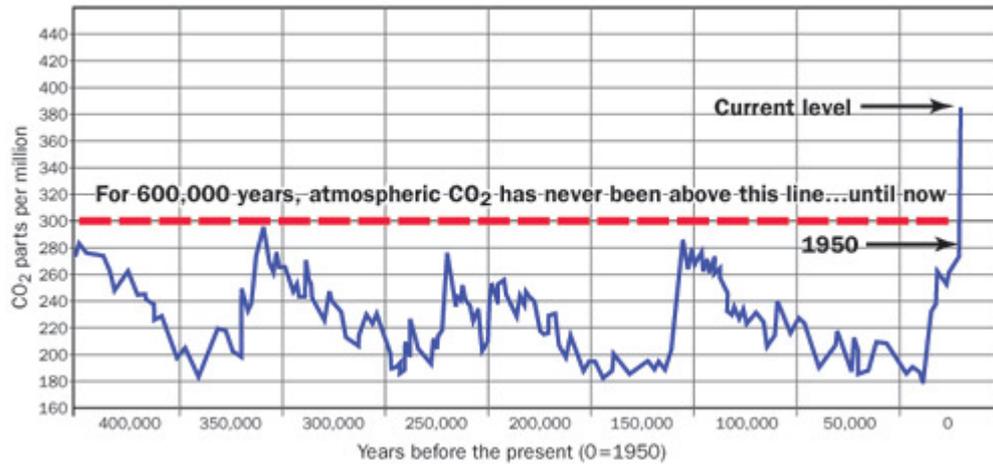


Figure 2. The climate record from EPICA core from Antarctica. It shows the normal range of climate variability over the past 650,000 years (450,000 years shown here) and the last 6 glacial-interglacial cycles. At no point in any previous interglacial was the carbon dioxide level higher than 300 ppm, or the temperatures so high, yet we are almost to 400 ppm today. This is ironclad evidence that our present episode of warming is not “normal fluctuations.”

- “It’s just another warming episode, like the Mediaeval Warm Period, or the Holocene Climatic Optimum” or the end of the Little Ice Age.”** *Untrue.* There were numerous small fluctuations of warming and cooling over the last 10,000 years of the Holocene. But in the case of the Mediaeval Warm Period (about 950–1250 A.D.), the temperatures increased by only 1°C, much less than we have seen in the current episode of global warming (see Figure 1). This episode was also only a local warming in the North Atlantic and northern Europe. Global temperatures over this interval did not warm at all, and actually cooled by more than 1°C. Likewise, the warmest period of the last 10,000 years was the Holocene Climatic Optimum (5000–9000 B.C.) when warmer and wetter conditions in Eurasia caused the rise of the first great civilizations in Egypt, Mesopotamia, the Indus Valley, and China. This was largely a Northern Hemisphere-Eurasian phenomenon, with 2–3°C warming in the Arctic and northern Europe. But there was almost no warming in the tropics, and cooling or no change in the Southern Hemisphere.<sup>7</sup> To the Eurocentric world, these warming events seemed important, but on a global scale the effect is negligible. In addition, neither of these warming episodes is related to increasing greenhouse gases. The Holocene Climatic Optimum, in fact, is predicted by the Milankovitch cycles, since at that time the axial tilt of the earth was 24°, its steepest value, meaning the Northern Hemisphere got more solar radiation than normal—but the Southern Hemisphere less, so the two balanced. By contrast, not only is the warming observed in the last 200 years much greater than during these previous episodes, but it is also *global and bipolar*, so it is not a purely local effect. The warming that ended the Little Ice Age (from the mid-1700s to the late 1800s) was due to increased solar radiation prior to 1940. Since 1940, however, the amount

of solar radiation has been dropping, so the only candidate for the post-1940 warming has to be carbon dioxide.<sup>8</sup>

- **“It’s just the sun, or cosmic rays, or volcanic activity or methane.”** *Nope, sorry.* The amount of heat that the sun provides has been decreasing since 1940<sup>9</sup>, just the opposite of the denialists’ claims. There is no evidence (see Figure 3 below) of increase in cosmic radiation during the past century.<sup>10</sup> Nor is there any clear evidence that large-scale volcanic events (such as the 1815 eruption of Tambora in Indonesia, which changed global climate for about a year) have any long-term effect that would explain 200 years of warming and carbon dioxide increase. Volcanoes erupt only 0.3 billion tonnes of carbon dioxide each year, but humans emit over 29 billion tonnes a year<sup>11</sup>, roughly 100 times as much. Clearly, we have a bigger effect. Methane is a more powerful greenhouse gas, but there is 200 times more carbon dioxide than methane, so carbon dioxide is still the most important agent.<sup>12</sup> Every other alternative has been looked at, but the only clear-cut relationship is between human-caused carbon dioxide increase and global warming.

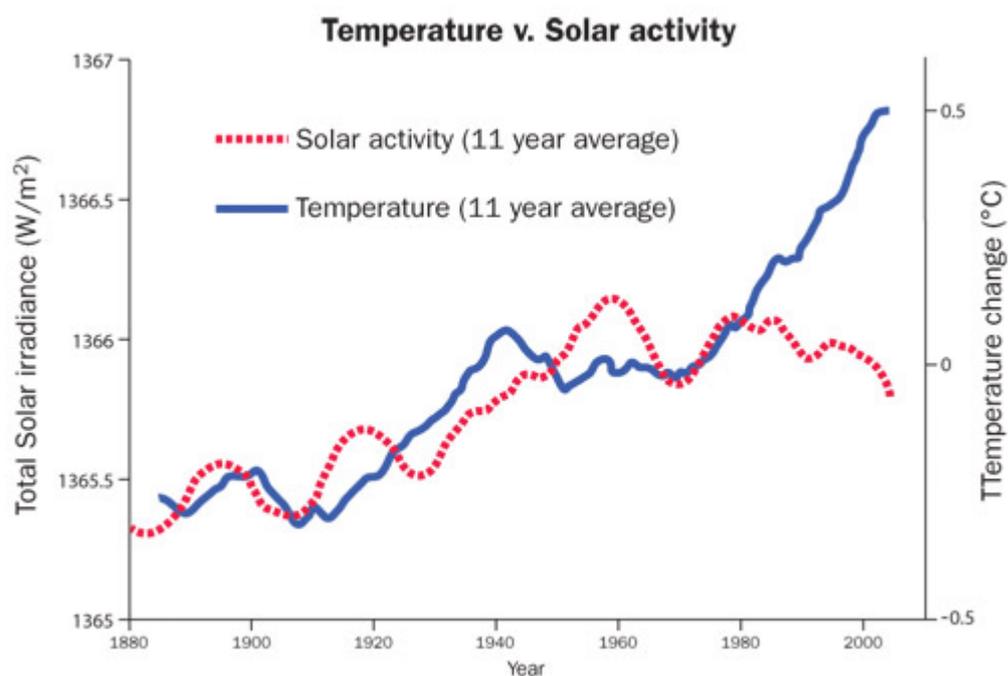
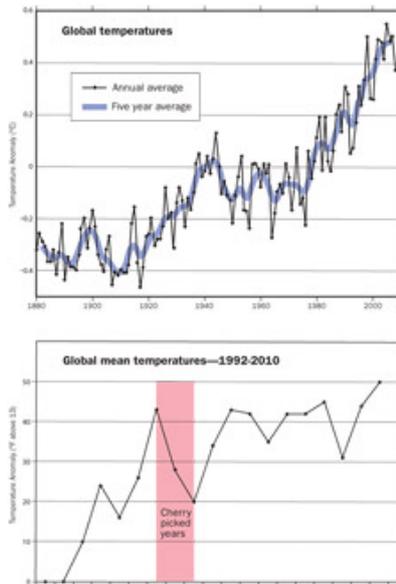


Figure 3. Plot of solar energy input to the earth versus temperature of the last century. The two tend to track each other until the last 30 years, at which time the earth warmed dramatically even as solar input went down.



**Figure 4a.** The plot of global mean temperature over the past century, showing the yearly data (solid black lines) and the smoothed curve using a 5-year rolling average (blue line). Clearly, the trend has been dramatically increasing, and individual data points from one year do not tell the whole story. The anomalous El Niño warm year of 1998 is one of those outliers.

**Figure 4b.** A detailed plot of the past 20 years of global mean temperatures, showing how anomalous 1998 was. If you cherry-pick 1998 and the two years that followed it, it appears that climate is cooling. However, if you pick any two points other than 1998–2000, or any rolling average, it is clear that climate is warming. Indeed, most of the years from 2002 and on are as warm or warmer than 1998, so any claim that “it has been cooling since 1998” is a lie. The short-term cooling of the 2008 La Niña year can also be seen.

- “The climate records since 1995 (or 1998) show cooling.”** *That’s a deliberate deception.* People who throw this argument out are cherry-picking the data.<sup>13</sup> Over the short term, there was a slight cooling trend from 1998–2000 (see Figure 4 below), because 1998 was a record-breaking El Niño year, so the next few years look cooler by comparison. But since 2002, the overall long-term trend of warming is unequivocal. This statement is a clear-cut case of using out-of-context data in an attempt to deny reality. All of the 16 hottest years ever recorded on a global scale have occurred in the last 20 years. They are (in order of hottest first): 2010, 2009, 1998, 2005, 2003, 2002, 2004, 2006, 2007, 2001, 1997, 2008, 1995, 1999, 1990, and 2000.<sup>14</sup> In other words, every year since 2000 has been in the Top Ten hottest years list, and the rest of the list includes 1995, 1997, 1998, 1999, and 2000. Only 1996 failed to make the list (because of the short-term cooling mentioned already).
- “We had record snows in the winters of 2009–2010, and in 2010–2011.”** *So what?* This is nothing more than the difference between *weather* (short-term seasonal changes) and *climate* (the long-term average of weather over decades and centuries and longer). Our local weather tells us nothing about another continent, or the global average; it is only a local effect, determined by short-term atmospheric and oceanographic conditions.<sup>15</sup> In

fact, warmer global temperatures mean *more moisture* in the atmosphere, which increases the intensity of normal winter snowstorms. In this particular case, the climate denialists forget that the early winter of November–December 2009 was actually very mild and warm, and then only later in January and February did it get cold and snow heavily. That warm spell in early winter helped bring *more moisture* into the system, so that when cold weather occurred, the snows were worse. In addition, the snows were unusually heavy only in North America; the rest of the world had different weather, and the global climate was warmer than average. And the summer of 2010 was the hottest on record, breaking the previous record set in 2009.

- **“Carbon dioxide is good for plants, so the world will be better off.”** *Who do they think they’re kidding?* The people who promote this idea clearly don’t know much global geochemistry, or are trying to cynically take advantage of the fact that most people are ignorant of science. The Competitive Enterprise Institute (funded by oil and coal companies and conservative foundations<sup>16</sup>) has run a series of shockingly stupid ads concluding with the tag line “Carbon dioxide: they call it pollution, we call it life.” Anyone who knows the basic science of earth’s atmosphere can spot the deceptions in this ad.<sup>17</sup> Sure, plants take in carbon dioxide that animals exhale, as they have for millions of years. But the whole point of the global warming evidence (as shown from ice cores) is that the delicate natural balance of carbon dioxide has been thrown out of whack by our production of too much of it, way in excess of what plants or the oceans can handle. As a consequence, the oceans are warming<sup>18</sup> and absorbing excess carbon dioxide making them more acidic. Already we are seeing a shocking decline in coral reefs (“bleaching”) and extinctions in many marine ecosystems that can’t handle too much of a good thing. Meanwhile, humans are busy cutting down huge areas of temperate and tropical forests, which not only means there are fewer plants to absorb the gas, but the slash and burn practices are releasing more carbon dioxide than plants can keep up with. There is much debate as to whether increased carbon dioxide might help agriculture in some parts of the world, but that has to be measured against the fact that other traditional “breadbasket” regions (such as the American Great Plains) are expected to get too hot to be as productive as they are today. The latest research<sup>19</sup> actually shows that increased carbon dioxide inhibits the absorption of nitrogen into plants, so plants (at least those that we depend upon today) are *not* going to flourish in a greenhouse world. Anyone who tells you otherwise is ignorant of basic atmospheric science.
- **“I agree that climate is changing, but I’m skeptical that humans are the main cause, so we shouldn’t do anything.”** *This is just fence sitting.* A

lot of reasonable skeptics deplore the “climate denialism” of the right wing, but still want to be skeptical about the cause. If they want proof, they can examine the huge array of data that directly points to humans causing global warming.<sup>20</sup> We can directly measure the amount of carbon dioxide humans are producing, and it tracks exactly with the amount of increase in atmospheric carbon dioxide. Through carbon isotope analysis, we can show that this carbon dioxide in the atmosphere is coming directly from our burning of fossil fuels, not from natural sources. We can also measure oxygen levels that drop as we produce more carbon that then combines with oxygen to produce carbon dioxide. We have satellites in space that are measuring the heat released from the planet and can actually see the atmosphere get warmer. The most crucial proof emerged only in the past few years: climate models of the greenhouse effect predict that there should be cooling in the stratosphere (the upper layer of the atmosphere above 10 km (6 miles) in elevation, but warming in the troposphere (the bottom layer of the atmosphere below 10 km (6 miles), and that’s exactly what our space probes have measured. Finally, we can rule out any other culprits (see above): solar heat is decreasing since 1940, not increasing, and there are no measurable increases in cosmic radiation, methane, volcanic gases, or any other potential cause. Face it—it’s our problem.

### Why Do People Deny Climate Change?

Thanks to all the noise and confusion over the debate, the general public has only a vague idea of what the debate is really about, and only about half of Americans think global warming is real or that we are to blame.<sup>21</sup> As in the debate over evolution and creationism, the scientific community is virtually unanimous on what the data demonstrate about anthropogenic global warming. This has been true for over a decade. When science historian Naomi Oreskes<sup>22</sup> surveyed all peer-reviewed papers on climate change published between 1993 and 2003 in the world’s leading scientific journal, *Science*, she found that there were 980 supporting the idea of human-induced global warming and *none* opposing it. In 2009, Doran and Kendall Zimmerman<sup>23</sup> surveyed all the climate scientists who were familiar with the data. They found that 95–99% agreed that global warming is real and that humans are the reason. In 2010, the prestigious *Proceedings of the National Academy of Sciences* published a study that showed that 98% of the scientists who actually do research in climate change are in agreement with anthropogenic global warming.<sup>24</sup> Every major scientific organization in the world has endorsed the conclusion of anthropogenic climate change as well. This is a rare degree of agreement within such an independent and cantankerous

group as the world's top scientists. This is the same degree of scientific consensus that scientists have achieved over most major ideas, including gravity, evolution, and relativity. These and only a few other topics in science can claim this degree of agreement among nearly all the world's leading scientists, especially among everyone who is close to the scientific data and knows the problem intimately. If it were not such a controversial topic politically, there would be almost no interest in debating it, since the evidence is so clear-cut.

*Reality must take precedence over public relations, for Nature cannot be fooled.*

—Richard Feynman

If the climate science community speaks with one voice (as in the 2007 IPCC report, and every report since then), why is there still any debate at all? The answer has been revealed by a number of investigations by diligent reporters who got past the PR machinery denying global warming, and uncovered the money trail. Originally, there was no real “dissenters” to the idea of global warming by scientists who are actually involved with climate research. Instead, the forces with vested interests in denying global climate change (the energy companies, and the “free-market” advocates) followed the strategy of tobacco companies: create a smokescreen of confusion and prevent the American public from recognizing scientific consensus. As the famous memo<sup>25</sup> from the tobacco lobbyists said “Doubt is our product.” The denialists generated an anti-science movement entirely out of thin air and PR. The evidence for this PR conspiracy has been well documented in numerous sources. For example, Oreskes and Conway revealed from memos leaked to the press that in April 1998 the right-wing Marshall Institute, SEPP (Fred Seitz's lobby that aids tobacco companies and polluters), and ExxonMobil, met in secret at the American Petroleum Institute's headquarters in Washington, D.C. There they planned a \$20 million campaign to get “respected scientists” to cast doubt on climate change, get major PR efforts going, and lobby Congress that global warming isn't real and is not a threat.

The right-wing institutes and the energy lobby beat the bushes to find scientists—*any* scientists—who might disagree with the scientific consensus. As investigative journalists and scientists have documented over and over again,<sup>26</sup> the denialist conspiracy essentially paid for the testimony of anyone who could be useful to them. The day that the 2007 IPCC report was released (Feb. 2, 2007), the British newspaper *The Guardian* reported that the conservative American Enterprise Institute (funded largely by oil companies and conservative think tanks) had offered \$10,000 plus travel expenses to scientists who would write negatively about the IPCC report.<sup>27</sup>

We are accustomed to the hired-gun “experts” paid by lawyers to muddy up the evidence in the case they are fighting, but this is extraordinary—buying scientists

outright to act as shills for organizations trying to deny scientific reality. With this kind of money, however, you can always find a fringe scientist or crank or someone with no relevant credentials who will do what they're paid to do.

Prothero discusses the latest findings in geology and paleontology, providing an insider's view of the profession. His detailed, first-person narrative allows readers to experience the personalities, the debates, the controversies, the development of new scientific techniques, and the latest scientific findings as they happened. This book is a valuable, no-nonsense, must-read for anyone interested in paleontology or geology, or anyone considering entering those fields. [ORDER the hardcover](#)

The NCSE satirized this tactic of composing phony “lists of scientists” with their “Project Steve.”<sup>28</sup> They showed that there were more scientists named “Steve” than their entire list of “scientists who dispute evolution.” It may generate lots of PR and a smokescreen to confuse the public, but it doesn't change the fact that *scientists who actually do research in climate change are unanimous in their insistence that anthropogenic global warming is a real threat.* Most scientists I know and respect work very hard for little pay, yet they still cannot be paid to endorse some scientific idea they know to be false.

The climate deniers have a lot of other things in common with creationists and other anti-science movements. They too like to quote someone out of context (“quote mining”), finding a short phrase in the work of legitimate scientists that seems to support their position. But when you read the full quote in context, it is obvious that they have used the quote inappropriately. The original author meant something that does not support their goals. The “Climategate scandal” is a classic case of this. It started with a few stolen emails from the Climate Research Unit of the University of East Anglia. If you read the complete text of the actual emails<sup>29</sup> and comprehend the scientific shorthand of climate scientists who are talking casually to each other, it is clear that there was no great “conspiracy” or that they were faking data. All six subsequent investigations have cleared Philip Jones and the other scientists of the University of East Anglia of any wrongdoing or conspiracy.<sup>30</sup>

Even *if* there had been some conspiracy on the part of these few scientists, there is no reason to believe that the entire climate science community is secretly working together to generate false information and mislead the public. If there's one thing that is clear about science, it's about competition and criticism, not conspiracy and collusion. Most labs are competing with each other, not conspiring together. If one lab publishes a result that is not clearly defensible, other labs will quickly correct it. As James Lawrence Powell wrote<sup>31</sup>:

Scientists....show no evidence of being more interested in politics or ideology than the average American. Does it make sense to believe that tens of thousands of scientists would be so deeply and secretly committed to bringing down capitalism and the American way of life that

they would spend years beyond their undergraduate degrees working to receive master's and Ph.D. degrees, then go to work in a government laboratory or university, plying the deep oceans, forbidding deserts, icy poles, and torrid jungles, all for far less money than they could have made in industry, all the while biding their time like a Russian sleeper agent in an old spy novel? Scientists tend to be independent and resist authority. That is why you are apt to find them in the laboratory or in the field, as far as possible from the prying eyes of a supervisor. Anyone who believes he could organize thousands of scientists into a conspiracy has never attended a single faculty meeting.

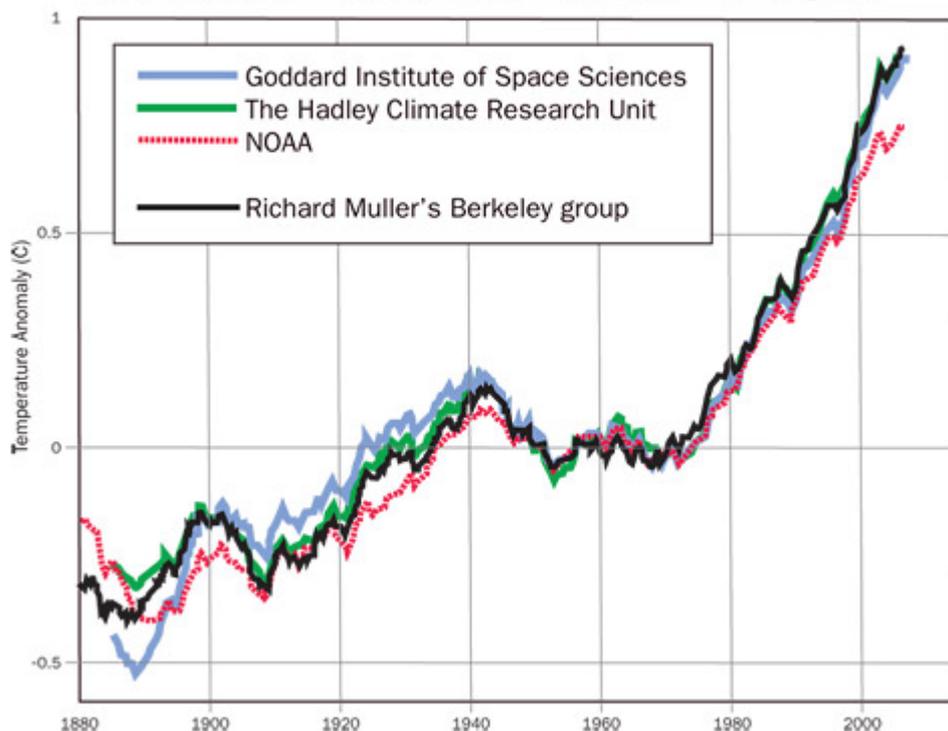
There are many more traits that the climate deniers share with the creationists and Holocaust deniers and others who distort the truth. They pick on small disagreements between different labs as if scientists can't get their story straight, when in reality there is always a fair amount of give and take between competing labs as they try to get the answer right before the other lab can do so. The key point here is that when *all* these competing labs around the world have reached a consensus and get the same answer, there is no longer any reason to doubt their common conclusion. The anti-scientists of climate denialism will also point to small errors by individuals in an effort to argue that the entire enterprise cannot be trusted. It is true that scientists are human, and do make mistakes, but the great power of the scientific method is that *peer review weeds these out*, so that when scientists speak with consensus, there is no doubt that their data are checked carefully.

Finally, a powerful line of evidence that this is a purely political controversy, rather than a scientific debate, is that the membership lists of the creationists and the climate deniers are highly overlapping. Both anti-scientific dogmas are fed to their overlapping audiences through right-wing media such as Fox News, Glenn Beck, and Rush Limbaugh. Just take a look at the "intelligent-design" creationism website for the Discovery Institute. Most of the daily news items lately have nothing to do with creationism at all, but are focused on climate denial and other right-wing causes.<sup>32</sup>

If the data about global climate change are indeed valid and robust, any qualified scientist should be able to look at them and see if the prevailing scientific interpretation holds up. Indeed, such a test took place. Starting in 2010, a group led by U.C. Berkeley physicist Richard Muller re-examined all the temperature data from the NOAA, East Anglia Hadley Climate Research Unit, and the Goddard Institute of Space Science sources (see Figure 5 below). Even though Muller started out as a skeptic of the temperature data, and was funded by the Koch brothers and other oil company sources, he carefully checked and re-checked the research himself. When the GOP leaders called him to testify before the House Science and Technology Committee in spring 2011, they were expecting him to discredit the temperature data. Instead, Muller shocked his GOP sponsors by demonstrating his scientific integrity and telling the truth: the temperature

increase is real, and the scientists who have demonstrated that the climate is changing are right. In the fall of 2011, his study was published, and the conclusions were clear: global warming is real, even to a right-wing skeptical scientist. Unlike the hired-gun scientists who play political games, Muller did what a true scientist should do: if the data go against your biases and preconceptions, then do the right thing and admit it—even if you’ve been paid by sponsors who want to discredit global warming. Muller is a shining example of a scientist whose integrity and honesty came first, and did not sell out to the highest bidder.<sup>33</sup>

**Temperature data obtained by three original sources contrasted with the data obtained by Richard Muller’s Berkeley group**



**Figure 5.** Plot contrasting the temperature data obtained by three original sources (NOAA, Goddard Institute of Space Sciences, and The Hadley Climate Research Unit of the University of East Anglia) with the data obtained by Richard Muller’s Berkeley group, which was originally attempting to deny the evidence of global warming, but found that in fact the original data were correct and the planet is getting warmer.

## Science and Anti-Science

The conclusion is clear: there’s science, and then there’s the anti-science of the global warming denial. As we have seen, there is a nearly unanimous consensus among climate scientists that anthropogenic global warming is real and that we must do something about it. Yet the smokescreen, bluster and lies of the deniers has created enough doubt that only half of the American public is convinced the problem requires action. Ironically, the U.S. is almost alone in their denial of this scientific reality. International polls taken of 33,000 people in 33 nations in 2006 and 2007 show that 90% of their citizens regard climate change as a serious problem<sup>34</sup> and 80% realize that humans are

the cause of it.<sup>35</sup> Just as in the case of creationism, the U.S. is out of step with much of the rest of the world in accepting scientific reality.

It is not just the liberals and environmentalists who are taking climate change seriously. Historically conservative institutions (big corporations such as General Electric and many others such as insurance companies and the military) are already planning on how to deal with global warming. Many of my friends high in the oil companies tell me of the efforts by those companies to get into other forms of energy, because they know that oil will be running out soon and that the effects of burning oil will make their business less popular. BP officially stands for “British Petroleum,” but in one of their ad campaigns about 5 years ago, it stood for “Beyond Petroleum.”<sup>36</sup> Although they still spend relatively little of their total budgets on alternative forms of energy, the oil companies still can see the handwriting on the wall about the eventual exhaustion of oil—and they are acting like any company that wants to survive by getting into a new business when the old one is dying.

The Pentagon (normally not a left-wing institution) is also making contingency plans for how to fight wars in an era of global climate change, and what kinds of strategic threats might occur when climate change alters the kinds of enemies we might be fighting, and water becomes a scarce commodity. The *New York Times* reported<sup>37</sup> that in December 2008, the National Defense University outlined plans for military strategy in a greenhouse world. To the Pentagon, the big issue is global chaos and the potential of even nuclear conflict. The world must “prepare for the inevitable effects of abrupt climate change—which will likely come [the only question is when] regardless of human activity.”

Insurance companies have no political axe to grind. If anything, they tend to be on the conservative side. They are simply in the business of assessing risk in a realistic fashion so they can accurately gauge their future insurance policies and what to charge for them. Yet they are all investing heavily in research on the disasters and risks posed by climatic change. In 2005, a study commissioned by the re-insurer Swiss Re said, “Climate change will significantly affect the health of humans and ecosystems and these impacts will have economic consequences.”<sup>38</sup>

Some people may still try to deny scientific reality, but big businesses like oil and insurance, and conservative institutions like the military, cannot afford to be blinded or deluded by ideology. They must plan for the real world that we will be seeing in the next few decades. They do not want to be caught unprepared and harmed by global climatic change when it threatens their survival. Neither can we as a society. **S**

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