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Global warming: How skepticism became denial

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Abstract

The conversation on global warming started in 1896, when a physical chemist estimated that the mean global temperature would rise several degrees if the level of carbon dioxide in the atmosphere was doubled. The topic eventually became one of the most passionate in the history of science. The author points out that climate experts were initially strongly skeptical of the theory of global warming; it took a variety of evidence to gradually convince them that warming due to human emissions was likely. The public, however, was guided away from this conclusion by a professional public relations effort, motivated by industrial and ideological concerns. Deniers of the scientific consensus avoided normal scientific discourse and resorted to *ad hominem* attacks that cast doubt on the entire scientific community—while disrupting the lives of some researchers. The author points out that scientists have failed to mount a concerted public relations campaign to defend their position. When trust is lost, he asserts, a determined effort is needed to restore it.

Keywords

climate change, climategate, denial, global warming, greenhouse effect, history, skeptic

Is the science community hopelessly corrupt? That is the conclusion many would draw from a letter that senior physicist Harold Lewis (2010) sent last October to the American Physical Society. He accused the Society of promoting a "pseudoscientific fraud," namely "the global warming scam, with the (literally) trillions of dollars driving it, that has corrupted so many scientists. . ." The underlying issue was whether humanity was causing the temperature of our planet to rise—a question that indeed put at stake trillions of dollars, although one might wonder how much of this money went to scientists. The climate question had led not only Lewis but other senior scientists to hurl accusations of bias that increasingly overshadowed the actual scientific findings. It was an unprecedented attack on the trust that is the very core of the relationship between science and society. How did we get into such a situation?

Every novel scientific idea must scale a wall of skepticism. First it must overcome the resistance of scientists who found the older ideas plausible. Changing the consensus of the experts is only a beginning, however; the public has yet to be convinced. That may never be completed if the new idea contradicts

widely cherished assumptions about the natural world. There is yet another barrier if the idea seems to attack established interests such as a religion or an industry. Then doubt is reinforced by denial: concerted efforts to represent the scientific consensus as false. Nothing shows this process so clearly as the history of the idea that human emissions of greenhouse gases must inevitably produce a global warming.

Beginnings: Skepticism prevails

It took a century to accumulate enough evidence to convince climate experts that human activity would warm the planet. The starting point was a famous 1896 paper written by the Swedish physical chemist Svante Arrhenius. He estimated that doubling the level of carbon dioxide in the atmosphere would raise the mean global temperature by several degrees. At the time that Arrhenius's paper was published, there were many theories about what forces regulate climate. And to those few scientists who paid attention to such theories, the level of carbon dioxide seemed as plausible as any. To be sure, Arrhenius's calculation had omitted many crucial effects. For example, a warmer atmosphere would carry more moisture, and wouldn't that make for more clouds, which would reflect more sunlight and thus counteract the additional carbon dioxide? Thus, from the outset, strong skepticism ruled the field, as is normal among scientists (for full history and references, see Weart, 2008).

The initial skepticism changed to outright rejection in 1900. New experiments seemed to show that the part of the infrared spectrum that carbon dioxide affected was "saturated"—that is, the carbon dioxide and water vapor that were already in the atmosphere blocked radiation so thoroughly that adding more gas could make no difference. Henceforth, most scientists considered Arrhenius's idea decisively refuted.

But there was a flaw in this refutation: The greenhouse effect acts most crucially high in the atmosphere, where additional traces of carbon dioxide and water vapor both make a big difference as they intercept radiation. However, decades passed before this flaw was recognized. After all, there were other reasons to reject a prediction of global warming. In particular, nearly all of the carbon dioxide in the terrestrial system is dissolved in the massive oceans, which hold 50 times more carbon than the atmosphere does. Thus, whatever gas humans added to the atmosphere would sink into the deeps.

That argument reflected deeply held beliefs about the natural world. The vast climate system of atmosphere, ocean, rock, and ice was self-regulating, maintaining its temperature and chemical composition over millennia. This grand equilibrium seemed far beyond anything mere humans could affect. The oceans' regulation of carbon levels, and the presumed correlation between temperature and an increase of cloud reflection, were examples of benign mechanisms maintaining a durable "balance of nature." This worldview, which emphasized and yearned for continuity and stability, thus reinforced the specific arguments that anthropogenic global warming was impossible. Or at least unlikely: Arrhenius's idea continued to be cited in climate textbooks, if only to argue against it. With no generally accepted theory of how climate might change,

good scientists would keep all possibilities in mind, however odd. Skepticism can work both ways.

Revival of the theory

In 1956 the physicist Gilbert N. Plass, using greatly improved spectroscopic data and theories and the new electronic calculators, laid to rest the "saturation" argument. Adding carbon dioxide to the upper layers of the atmosphere, he showed, would block additional heat radiation from leaving the planet. However, his calculation said nothing about whether clouds would change and reflect more sunlight. And anyway wouldn't the oceans absorb all of humanity's emissions? Not according to a calculation that Roger Revelle published with Hans Suess in 1957. Seawater was a buffered solution, they pointed out; adding a little carbon dioxide would alter its acidity enough to make it harder for more to dissolve. Revelle encouraged Charles David Keeling to measure the global carbon dioxide level directly. After barely two years of work, Keeling announced in 1960 that the level was indeed rising. The prediction of global warming could no longer be dismissed as fallacious.

Of course that did not quell the skepticism that is in the bones of every scientist. Most thought the matter was, at best, something worth investigating... by somebody else. Even Plass, Revelle, and Suess turned to other topics, leaving Keeling the sole scientist of the day to devote his entire career to the greenhouse question. Over the next decade the "Keeling Curve," which measured the carbon dioxide level, climbed year after year, demonstrating that human activity was indeed great enough to change the atmosphere noticeably.

Others meanwhile began to work out how the planet's climate system operated. By the early 1970s a few groups had separately created computer models that bore a rough resemblance to reality. Their work attracted wide attention when devastating droughts around the world brought the question of climate change before the public. Were the disasters caused by the trash that humanity was throwing into the air—not only greenhouse gases but smoke, smog, and dust from farmland? Noting that in the natural course of events the planet was due to settle over the course of the next few thousand years into an ice age, a few scientists speculated that pollution would block sunlight and accelerate the process. But nobody made a confident prediction, and most felt the whole matter was altogether uncertain. Many meteorologists still believed in a balance of nature; as one leader of the field declared, "The climatic system is so robust... that man has still a long way to go before his influence becomes great enough to cause serious disruption" (Mason, 1977).

By the late 1970s scientists found good reasons to dismiss the theory, never widely credited, that pollution would bring a rapid global cooling. Meanwhile, computer modelers began to experiment with climates different from the present state. When they increased the level of carbon dioxide, the model atmospheres warmed up. Several experts predicted that an anomalous global temperature rise would become perceptible around the start of the twenty-first century.

However, computer modeling was a new mode of research, mistrusted by

many, with a potential yet to be demonstrated. President Jimmy Carter's science adviser asked the National Academy of Sciences to report on the matter, and a committee was duly formed. The group studied complex three-dimensional computer models developed by teams under Syukuro Manabe and James Hansen, along with a variety of simpler models that calculated in only one dimension (for example, averaging the atmosphere over all latitudes and longitudes). All the models warmed up from one to several degrees Celsius when the carbon dioxide level was doubled. The committee reported in 1979 that they had tried, but had been unable, to find any natural mechanism that would prevent this warming from happening (National Academy of Sciences, 1979).

Academy reports are typically so careful and conservative that they are thought to represent a consensus of the scientific community. This report, however, represented only a consensus of the tiny band of experts who had studied the issue intensively. Other scientists reserved judgment on a conclusion that was based, after all, on nothing more than the newfangled computer modeling. That changed after 1980, thanks to cores drilled in the Greenland and Antarctic ice caps. This meant that the level of carbon dioxide and the temperature could be measured back through the last ice age. The measurements showed that low levels of the gas had always correlated with low temperatures, high levels with high temperatures. It was a dramatic confirmation, totally independent of theory and computers, of Arrhenius's speculation that carbon dioxide and global temperature are linked.

A question of policy

Through the 1980s more and more researchers began to take the matter seriously and undertake their own investigations. A large conference of experts in Villach, Austria in 1985 affirmed that global warming was a problem so severe that governments should consider policies to restrict emissions of all greenhouse gases. This still represented a consensus only of the scientists, now a few hundred, who were most deeply involved with climate—and most of them understood that future warming was not yet thoroughly proved. A healthy skepticism continued to prevail even within the small community of computer modelers. Yet all but a few could agree that anthropogenic global warming, while not certain, was a serious risk and ought to be addressed. Meanwhile, as predicted, the mean global temperature was rapidly rising, and in a pattern that pointed straight at the greenhouse effect.

In 1988 a major international conference of scientists in Toronto concluded that anthropogenic climate change posed a major risk for the security of many nations. Sea levels would rise, uprooting millions of refugees; heat waves would harm agriculture and perhaps bring famines; the damage might provoke deadly conflicts. The conference report called on the world's governments to set specific targets for rapidly reducing greenhouse gas emissions. That same summer saw another series of severe droughts and other dismaying climate news, culminating in Hansen's widely publicized claim that it was virtually certain that global warming was underway. A poll taken at this time found that more than half of

American adults had heard or read about the greenhouse effect, a remarkably high level for a scientific phenomenon. Most of these citizens thought they would live to see climate changes. Other polls found that a majority felt the greenhouse effect was "very serious" or "extremely serious." Fewer than one-fifth said they worried "not at all" about global warming or expressed no opinion.[1]

In short, by 1989 the scientific community had formed a rough consensus, which the public knew and largely accepted. As with many surprising scientific findings, a few experts dissented. But out of everything published on climate change in the peer-reviewed scientific literature, hardly any articles denied that it was likely (Oreskes, 2004).

The establishment of broad agreement on global warming was not a revolution like some developments in geophysics (for example, plate tectonics), but it did overturn older assumptions that the climate was self-regulating and beyond human power to change. The adherents of this older model were not so much defeated as isolated and left behind by a steady, relentless accumulation of evidence.

In response to this paradigm shift, politicians were pressed to adopt the appropriate policies. But the idea of new taxes and regulations was anathema to the fossil fuel industries and their allies in other industries, whose profits might be lowered; the idea equally repelled people who, for ideological reasons, opposed any government regulation. Corporations and wealthy individuals already had experience in developing mechanisms to influence the public on such issues. Conservative think tanks and corporate publicists had worked out tactics in battles over the health effects of cigarettes, chemical pesticides, and other issues involving science, money, and ideology. Their basic strategy was to create doubt. It was not necessary to disprove the scientific consensus; it would suffice to raise enough questions to convince the public that there was no consensus (Hoggan and Littlemore, 2009; Michaels, 2008; Oreskes and Conway, 2010).

In 1989 one of these conservative institutions, the George C. Marshall Institute, issued an anonymously authored "report" attacking the consensus view on climate change. Endorsed by Frederick Seitz, an aging but still respected physicist with no background in meteorology, the report skillfully presented a variety of skeptical arguments. The arguments were taken up by the Global Climate Coalition, which was formed in 1989 by major fossil fuel and other industrial corporations. Over the following decades the Coalition and other organizations would spend tens of millions of dollars supporting lectures and writings by a few skeptical scientists, producing slick publications and videos that were sent to journalists, and advertising directly to the public.

The criticism fit well with the visceral distrust of environmentalism that right-wing political commentators were propagating. The political dimension was stressed by conservative institutions such as the Cato Institute, Competitive Enterprise Institute, Heritage Foundation, and many others. They sponsored pamphlets, press releases, public lectures, and books, all arguing that claims of global warming were a "scare tactic" worked up for selfish purposes by power-seeking bureaucrats and radicals. Nobody needed to worry about global warming, for it was

all nothing but "junk science" (Jacques et al., 2008; McCright and Dunlap, 2003; Oreskes and Conway, 2010; Union of Concerned Scientists, 2007).

Many journalists presented the issue as if it were a quarrel between two comparable groups of scientists. A study of US newspapers found that through 1994, climate scientists who were highly respected by their peers were cited substantially more often than the skeptics associated with conservative think tanks, but after 1995, as the campaign to cast doubt grew more active, newspapers cited the two groups about equally. Reporters were seeking an artificial balance by matching each "pro" scientist with an "anti," although there were far more of the former (Boykoff and Boykoff, 2004; McCright and Dunlap, 2000).

From skepticism to denial

The most prominent "anti" campaigner was retired physicist S. Fred Singer. Among other objections, Singer insisted that the warming seen in global temperature statistics was an artifact of urbanization. He should have known that on the contrary, the "urban heat islands" that make cities warmer than the surrounding countryside had been factored into calculations for half a century; further, urbanization, of course, could not explain the rapid warming seen in the Arctic, the oceans, etc. Singer and other skeptics raised countless other questions. If the world was in fact warming, wasn't that because of increased solar activity? Or a natural cycle involving ocean currents? It would take a hundred pages to detail the arguments. All were carefully considered by climate scientists, and definitively answered. But the refutations did not silence the small band of skeptics nor the conservative and corporate publicists who drew on these efforts.

Since people like Singer were highly selective in their use of data, and appeared to draw important personal financial support from conservative foundations and fossil fuel corporations, many of their opponents felt they were merely liars for hire. However, what appears to be deliberate cherry-picking of data may be an extreme case of "cognitive bias," a phenomenon well-known in science as in daily life. This means that when people with a strong conviction are presented with a variety of information, they will cling to the parts that confirm their bias, and ignore or reject as unreliable everything else. Another force at work is "cognitive dissonance." If people are deeply engaged in a certain behavior (such as defending a particular view), they are likely to find anything that is incompatible with that behavior (such as contradictory evidence) simply too disturbing to accept.

In any case, the self-styled skeptics were not proceeding in a normal scientific manner. Scientists continually test their beliefs, seeking out all possible contrary arguments and evidence, and finally publish their findings in peer-reviewed journals, where further attempts at refutation are encouraged. But the small group of scientists who opposed the consensus on warming proceeded in the manner of lawyers, considering nothing that would not bolster their case, and publishing mostly in pamphlets, books, and newspapers supported by conservative interests. At some point they were no longer skeptics—people who would try to see every side of a case—but deniers, that is,

people whose only interest was in casting doubt upon what other scientists agreed was true.

Very few experts among the deniers continued to act as skeptics, publishing articles in the peer-reviewed literature. The only one of these with an important record of accomplishment was Richard Lindzen of MIT. Reaffirming the traditional belief in a self-correcting natural balance, Lindzen pointed out that nobody could prove that clouds in the tropics would not become thicker and reflect more sunlight as the region got warmer, and thus prevent further warming. The modelers could only reply that their established assumptions about clouds worked very well. Until somebody managed to make a model that could reproduce something at least vaguely like the present climate, and that did *not* warm up when carbon dioxide was added, the modelers would stick by their conclusions. (Eventually observations by Clement et al. (2009) showed that warming did not tend to increase tropical reflection of sunlight.)

Personal attacks

As the deniers found ever less scientific ground to stand on, they turned to political arguments. Some of these policy arguments were straightforward, raising serious questions about the efficacy and expense of proposed carbon taxes and emission-regulation schemes. But leading deniers also resorted to *ad hominem* tactics.

A red line was crossed in 1996 with accusations of deliberate dishonesty. The occasion was the second report of the Intergovernmental Panel on Climate Change (IPCC), with its key conclusion that a human impact on climate was already discernible. The fossil fuel industry public relations apparatus and its allies in right-wing organizations could not let that stand, and they launched a variety of reports, letters to the editor, and the like claiming that the conclusion was false—by intent. Their principal target was Ben Santer, a main author of the report. Among other attacks, an op-ed by physicist Frederick Seitz in the *Wall Street Journal* accused Santer of blatant "corruption," falsely claiming that Santer had fraudulently altered the report's conclusions in order to "deceive policy makers and the public."

Such a public smear of one leading scientist by another was unprecedented in the history of science. Santer remarked that he had to spend the better part of the following summer dealing with journalists and e-mails; the pressure reportedly contributed to his divorce. On each side, some people were coming to believe that they faced a dishonest conspiracy, driven by ideological bias and naked self-interest (Bolin, 2007; Edwards and Schneider, 2001; Lahsen, 1999; Masood, 1996; Oreskes and Conway, 2010; Santer, 2010; Seitz, 1996; Stevens, 1999).

This battle even found its way into popular culture when Michael Crichton's *State of Fear* became a best-selling thriller in 2004. The plot revolved around a fantasy that fear of global warming was a deception propagated by evil conspirators and their dupes. Crichton played upon a theme popular on the right wing: The scientific establishment was arrogant and untrustworthy, corrupted by a lust for fame and political power on behalf of liberalism. The novel, and many non-fictional works around that time, demonstrated

that the attack was no longer just against the climate science community: It was open warfare against science itself (see e.g., Mooney, 2005).

Crichton's novel was just one example of how denial took on a life of its own in the early twenty-first century, expanding beyond the sphere of well-funded conservative think tanks and publicity experts. Websites and blogs that confidently denied the scientific consensus proliferated. Some of these were maintained by paid professionals, but others by independent citizens. They passed around plausible-sounding arguments and fragments of anomalous data. There are always anomalies at the research front, of course. Some of the arguments were valid skepticism that provoked serious research to clarify, and in a few cases correct, published results. But as soon as scientists resolved a problem, the deniers presented a new one.

Meanwhile what we may call "zombie arguments"—dead arguments raised from their graves—survived among the Web's countless niches. The old claims that the carbon dioxide spectra was saturated, that urban heat explained the observed global warming, and a hundred others, long since refuted, kept convincing novice readers that claims of global warming were nonsense. The deniers constructed what one observer called an "alternative universe" where "basic findings of mainstream science are rejected or ignored" (Ruddiman, 2005: 187, see ch. 18).

Consequences

Personal attacks proliferated. Leading researchers were assaulted with countless questions and demands for information, often disingenuous, and even investigations and lawsuits. They were insulted, slandered, and sent so many death threats that some had to take security measures. The only comparable case in science was the vilification and threats showered on prominent defenders of Darwin's theory of evolution. Even that did not reach the broad scale and public prominence of the attacks not only on individuals, but on the community of climate scientists as a whole. Some leading climate scientists found a large part of their time had to be spent not doing research, as they would have preferred, but responding to attacks and denial.

Another line was crossed in 2010 with the theft and publication of thousands of e-mails involving a few climate researchers. The media dubbed the affair "climategate," implying a scandal. Although official investigations turned up no malfeasance on the part of the climate scientists, suspicious-sounding quotes wrenched out of context were permanently embedded in the public's memory. By implication, not only were these few researchers dishonest in how they reported their research, but so were hundreds of others who had independently reported confirmatory findings.[2]

The public, and large sections of the press, found it difficult to distinguish among the sources of information. The scientific consensus announced in the IPCC's reports was growing stronger: Many experts who in 2001 were 90 percent convinced that humans were causing global warming had become 95 or 99 percent convinced by 2007. Every scientist, even perennial skeptics, agreed at least that the world had grown significantly warmer since the 1960s. Yet more than a third of the American

public now believed that "most scientists are unsure about whether global warming is occurring or not."[3] The deniers had been effective.

As a defense mechanism, denial is familiar to psychologists—for example, when somebody is diagnosed with a fatal cancer and refuses to believe it. Psychologists studying how citizens reacted to warnings of climate change found that this type of denial was common. The more harmful and costly global warming was said to be, the more some people insisted it was not a real problem (American Psychological Association, 2009).

Even among people who believed the warnings, a majority found many reasons to avoid actually doing anything. They convinced themselves that the danger was remote in time and space and would not affect them personally—let the polar bears worry about it. Or they believed, wrongly, that anything they could do to mitigate the problem would be both expensive and ineffective. They believed it was up to others to handle the problem; some trusted scientists to come up with an easy technical solution. Given this public mood, it was easy for politicians to avoid taking action that would have been unwelcome in powerful circles. It was almost as if the less doubt scientists felt, the stronger denial became everywhere else.

Once trust is lost, a determined effort is needed to restore it. The scientific community is still widely trusted, but it is losing credibility, and that will bring losses of students and funding. People who feel threatened by scientific findings have mobilized extensive, coordinated, professional efforts to defend their ideologies and their profits. The position of science will continue to deteriorate until scientists respond in kind with broad and well-organized public-relations campaigns.

Notes

1. USMOR.ATS9.R11 and USGALLUP.051589.R3J, data furnished by Roper Center for Public Opinion Research, Storrs, CT.
2. For recent denial and harassment in general, see Hansen (2009); Schneider (2009); Pearce (2010); and http://realclimate.org, passim.
3. Gallup (2010). For recent polls see: http://www.pollingreport.com/enviro.htm.

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