

THIS IS THE TEXT OF AN ESSAY IN THE WEB SITE “*THE DISCOVERY OF GLOBAL WARMING*” BY SPENCER WEART, [HTTP://WWW.AIP.ORG/HISTORY/CLIMATE](http://www.aip.org/history/climate). **JULY 2009**. HYPERLINKS WITHIN THAT SITE ARE NOT INCLUDED IN THIS FILE. FOR AN OVERVIEW SEE THE BOOK OF THE SAME TITLE (HARVARD UNIV. PRESS, 2003). COPYRIGHT © 2003-2009 SPENCER WEART & AMERICAN INSTITUTE OF PHYSICS.

The Public and Climate

Already in the 1930s, many people noticed that their weather was getting warmer. Few connected this with human activity, and still fewer feared any harm. Gradually scientists, aided by science journalists, informed the minority of educated people that modern civilization might cause global warming, sometime far in the future. In the early 1970s, the question began to concern a wider public. By then most people had come to fear planet-wide harm from technology in general. Now an onslaught of droughts suggested we were already damaging the climate. The issue was confused, however, when experts debated whether pollution would bring global warming or, instead, an appalling new ice age. By the end of the 1970s, scientific opinion had settled on warming as most likely, probably becoming evident around the year 2000—that is, in a remote and uncertain future. Some scientists nevertheless went directly to the public to demand action to avert the warming, and a few politicians took up the issue. During the hot summer of 1988, a few outspoken scientists, convinced by new evidence that rapid climate change might be imminent, made the public fully aware of the problem. Scientific discussions now became entangled with fierce political debates over scientific uncertainty and the costs of regulating greenhouse gases. It was not until around 2005 that American media reported clearly that scientists had resolved the controversy, while films and ominous weather events gave citizens a better idea of what global warming might mean. The majority of Americans (except on the political right) had moved gradually to a vague feeling that some kind of action should be taken. Stronger worries had grown among people in most other countries, and among many thoughtful policy-makers in the United States itself.

This essay deals mainly with the United States, but until the late 1990s opinions were generally similar in other industrialized nations. The response of American policy-makers is covered in an essay on Government: the View from Washington.

Since antiquity, people had speculated about the consequences of cutting down forests or draining swamps to create farmland. Renaissance and later scholars who pored over ancient manuscripts saw that deforestation, irrigation, and grazing had altered the lands around the Mediterranean. Surely these human interventions had affected the local weather? The scholars thought it plausible, and common people adopted the notion.¹

Human and Planetary Forces (1800s-1930s)

The most striking change, obvious within a single lifetime, was the conversion of Eastern North America from forest to croplands. By the early 19th century many believed the transformation

¹ The classic discussion is Glacken (1967); see also Neumann (1985).

was altering the region's climate—probably for the better. When sodbusters took over the Great Plains they were told that “rain follows the plough.”

Not everyone agreed, and the topic could always raise a lively discussion. Some experts reported that where forests were cut down, the flow of water in rivers did not rise but actually fell. Deforestation not only caused rainwater to run off rapidly in useless floods, they said, but reduced rainfall itself. European professors, alert to any proof that their nations were wiser than others, explained that the Orientals of the Ancient Near East had heedlessly converted their once lush lands into impoverished deserts.

In the latter 19th century, official commissions in several European countries studied the question of whether reforestation should be encouraged—probably the first government concern for human effects on climate, a century ahead of its time. These inquiries could not lead to action, when scientists disagreed on whether a given change in land use brought more rain or less. “It seems almost a psychological puzzle,” an expert complained in 1890, “that for one and the same country serious scientists have at every step insisted on climate changes which are mutually exclusive.... We have to admit that even today we are still far from a definite answer...”¹ The farmers and other concerned people who paid attention to these debates could readily see that science had nothing reliable to say about climate change.

Meanwhile, national weather agencies had begun to compile masses of reliable observations of temperature, rainfall, and the like. When the figures were analyzed they showed many rises and dips, but no steady long-term change. By the end of the century, scientific opinion had turned decisively against any belief in a human influence on climate. No plausible theory had been developed for how it could happen, and the evidence was against it. The idea lingered in the public mind, among the countless scientific speculations about matters of possible interest to future generations but of no immediate concern.

Whatever the local effects, few had imagined humans could affect the climate of the planet as a whole. Today, in the 21st century, “wilderness” is something we imagine as a preserve of trees and animals surrounded by the fuming machinery of civilization. Earlier people saw the world the other way around, themselves living in a village surrounded by endless expanses of wild nature. At the start of the 20th century, civilization still seemed like an enclave, a patch of hopeful technology amid wastelands only partly explored. There were barely a billion and a half humans scattered across the planet, mostly peasants relying on no energy sources but wood, wind, water and brute muscle power. If people converted a forest to plowland or rice paddies, those were local improvements, which nobody imagined could affect the planet as a whole. The atmosphere in particular was controlled by geochemical forces that were surely indifferent to any human activity

¹ Fleming (1990); Fleming (1998), ch.s 2-4; Stehr (1995); Stehr and von Storch (2000), introduction and chapter 4; the latter is a translation of Brückner (1890b), chapter 1, including “psychological puzzle” on p. 115-16 of Stehr.

These planetary forces, however, could bring devastating changes. Everyone had seen illustrations of the old ice ages, with cavemen hunting woolly mammoths through the snow. Looking farther back, scientists described a tropical age of dinosaurs basking in balmy swamps, even in regions that were now arctic. A popular theory held that the dinosaurs had perished because gradually, over millions of years, the world had become too cold for them. Or geological forces, such as a long series of volcanic eruptions, might impose a world desert like the one where the last dinosaurs lay down to die in the 1940 Disney movie *Fantasia*. Even Bible fundamentalists accepted climate change, arguing that our sorrowful world of storms and snows had replaced an originally temperate, Edenic climate. Consider, they said, how mammoths had been found frozen intact with grass in their stomachs, apparently felled when the climate changed in a single night.¹ Turning to historical times, scientists and popular writers proposed theories about how gradual natural shifts between rainy times and dry times had caused the rise or fall of ancient civilizations.

All these theories were chiefly a matter for geologists and historians of antiquity. In the foreseeable future of human society, the next few hundred years, people expected the climate to stay near its “normal” state—the state congenial to human civilization. Of course there could be deviations from the normal. From Noah’s Flood to the Dust Bowl drought of the 1930s, ideas about climate included a dose of catastrophe. But a catastrophe was by definition transient, passing away after a few years. As for long-term climate shifts of the sort that some believed had laid low Near Eastern civilizations, if such shifts existed at all they had been too gradual to be noticeable except over several generations. Anyway the climate changes that people thought about affected only this or that local region. People scarcely imagined that their own doings, so puny among the vast natural powers, could upset the “balance of nature” that governed the planet as a whole.

This view of Nature as supra human and inherently stable lay deep in most human cultures. In Western thinking this belief was traditionally tied up with religious faith: the God-given order of the universe would stand in flawless and imperturbable harmony until the Last Days. Indeed clerics might point to examples of natural regulatory mechanisms as proofs of Divine Providence. Darwin's theory of evolution shook this faith only a little. Even those who acknowledged evolution believed that changes in the planet’s inventory of living creatures must be so gradual and progressive that harmony would prevail at every stage.

Scientists too believed in the balance of nature. By the end of the 19th century, geologists had become convinced that nature operates through steady and uniform processes. They held that view all the more strongly because of vehement opposition from people who tried to explain geological features by abrupt, supernatural catastrophes like Noah’s Flood. Modern geology declared that many millions of years of Earth’s geological history showed that biological and geophysical systems had maintained an overall equilibrium.

¹ Price (1995), pp. 59, 69. Actually every arctic hiker knows how swiftly a freeze can come and how a shifting riverbed can bury the careless in permafrost.

This was a serious obstacle for G.S. Callendar when, in 1938, he presented sketchy evidence that humanity's use of fossil fuels could be causing global warming through the greenhouse effect of carbon dioxide gas (CO₂). Callendar recalled how nearly every expert on climate rejected his arguments. "The idea that man's actions could influence so vast a complex," he wrote, "is very repugnant to some."¹ What scientists did find plausible were simple hand-waving arguments that seemed to prove that emissions of CO₂, or any other human intervention, could not possibly change global climate. Since this was the answer they expected, few tried to probe deeper. When journalists reported what scientists said, the confidence in natural self-regulation not only echoed but reinforced the public's beliefs.

Human industry was in fact too small in the first half of the 20th century to noticeably affect the climate. Hardly anyone expected much greater impact during the next century or two. People did not grasp the prodigious fact that both population and industrialization were exploding in a pattern of exponential growth. Between the start of the 20th century and its end the world's population would triple, and the use of fossil-fuel energy by an average person would quadruple, making a twelve-fold increase in the rate of emission of CO₂ from fossil fuels. Yet the First World War and Great Depression led industrialized nations to worry about a possible *decline* in their populations. Their industries seemed to be plodding ahead in linear growth, that is, expanding no faster in the current decade than last decade. As for "backward" regions like China or Brazil, industrialization scarcely entered anyone's calculations except as a possibility for the remote future.²

Even if human activity could have global effects some day, was that a problem? Nearly everyone saw technology as benign. People believed that in the centuries to come, scientists and engineers would turn deserts into gardens, poverty and ignorance would decline, and everyone would become steadily happier. Typical was the attitude of Svante Arrhenius, the first scientist to suggest that sometime (thousands of years from now) we might have produced enough CO₂ by burning fossil fuels to warm the atmosphere. In a popularizing book of 1908 he wrote, "we may hope to enjoy ages with more equable and better climates, especially as regards the colder regions of the Earth, ages when the Earth will bring forth much more abundant crops than at present, for the benefit of rapidly propagating mankind."³ Callendar, when he presented his evidence that

¹ Callendar, personal notes, Nov. 1960, Schove-Callendar Collection, Climatic Research Unit, University of East Anglia, Norwich, UK, quoted by Peter Brimblecombe and Ian Langford, "Guy Steward [sic] Callendar and the increase in global carbon dioxide," paper presented at meeting of Air & Waste Management Association, San Antonio, Texas, June 1995 (paper 95-WA74A.02, available from AWMA).

² Thus Callendar in his landmark paper argued in 1938 that growing efficiency had stabilized the amount of gas production in the previous 20 years, ignoring the Depression's effects, Callendar (1938), p. 231; Plass implicitly assumed linear growth in calculating that it would take a thousand years to use up known reserves of coal and oil, Plass (1956a), p. 149; similarly in the crucial paper Revelle and Suess (1957).

³ Arrhenius (1908), p. 63.

greenhouse effect warming was already underway, likewise looked forward to it. Not only would the warmth and extra carbon help crops to grow more abundantly, he said, but “the return of the deadly glaciers [of the ice ages] should be delayed indefinitely.”¹ A Swedish meteorologist and friend of Arrhenius, Nils Ekholm, was still more sanguine. Writing in 1901 in the heyday of optimism for technology and progress, he exclaimed that “it seems possible that Man will be able efficaciously to regulate the future climate of the Earth.” Man could release natural gas, Ekholm explained, or if desired absorb CO₂ by “ruling the growth of plants according to his wants and purposes.”²

The public heard little of this. Only an educated minority of a few millions were attentive to science at all. These people might notice a rare mention of greenhouse warming buried as a paragraph or two in some popularizing article about climate. To them, as to most scientists, that was just one of the many barely plausible stories about a distant, science fiction future, a subject for crackpot speculations and outright fantasy. One example was a popular Japanese children’s tale of 1932 in which the hero set off a volcanic eruption to warm the Earth with carbon dioxide emissions.³ The vast majority of the world’s people, even educated people, suspected that rain-makers might manipulate local weather, but never imagined that we had already begun to alter the entire planet’s climate.

From Grandfathers’ Tales to Nuclear Fears (1930s-1950s)

The first hint of actual global warming came from public memory. In the 1930s, grandfathers were heard to say that when it came to weather, the younger generation had it easy. Gone were the early frosts and daunting blizzards of their own youth. The popular press began to publish articles, pointing out that in fact rivers were not freezing over as formerly and so forth. Science reporters found experts who confirmed that crops and codfish were now harvested in northern zones where they had not been seen for centuries. When meteorologists scrutinized the records, they confirmed that a warming trend was underway. As *Time* magazine put it in 1939, “gaffers who claim that winters were harder when they were boys are quite right... weather men have no doubt that the world at least for the time being is growing warmer.”⁴

Nobody was much concerned. The meteorologists thought it likely that temperatures rose and fell modestly in centuries-long cycles. The grander and slower cycle of ice ages might also be on a warming upswing (“But you can work up a cycle for anything,” as one expert told a reporter).⁵ If the 20th century happened to be a time of warming, so much the better. A typical popular article of 1950 promised that “vast new food-producing areas will be put under cultivation.” It was

¹ Callendar (1938), p. 236.

² Ekholm (1901), p. 61. Revision of a paper first published in Sweden in 1895.

³ Miyazawa (1932). My thanks to Kooiti Masuda for this information.

⁴ *Time* (1939); other examples: Kimble (1950); Abarbanel and McCluskey (1950); here and below, see also Fleming (1998), pp. 131-32.

⁵ H.T. Kimble quoted *Time* (1951).

reminiscent of old familiar theories about how ancient civilizations had risen and fallen in obedience to gradual shifts of rainfall and other regional climate changes.

Some reports were more sensational. If warming continued, new deserts might appear, and the oceans might rise to flood coastal cities—“another deluge, such as the catastrophe recorded in the Bible.”¹ People recalled also the old Euro-centric belief, repeated by some scientists, that heat is enervating. Many Europeans thought it was a scientific fact that the temperate zones inhabited by the “Caucasian race” were naturally superior for the spread of civilization. *Life* magazine warned that a warmed-up climate might make everyone as lazy as the natives of the tropics were supposed to be. And then there was the fact that sex crimes rose at the start of summer!²

As prediction, all this was plainly nothing but colorful speculation about the remote future. *Time* magazine explained that “Meteorologists do not know whether the present warm trend is likely to last 20 years or 20,000 years.” Many professional meteorologists doubted that there was in fact any world-wide warming trend. They saw only normal, temporary, regional fluctuations. In 1952 the *New York Times* remarked that thirty years from now, people might look back fondly on the mild winters of the 1950s.³

The future was all the more obscure since the cause of the supposed warming trend was unknown. Some articles mentioned the possibility of a CO₂ greenhouse effect, but they only listed it along with more widely accepted theories of climate change—erratic volcanoes, solar variations, and so forth.⁴ At times even good journalists would also report some half-baked theory of climate change advocated by someone with a Ph.D. Further speculations came from amateur meteorologists, who were not yet easy to distinguish from professionals. As one writer put it, “Everyone has his own theory—and each sounds good—until the next lad comes along with his theory and knocks the others into smithereens.”⁵ In short, the science-attentive public was well informed that climate theory was in a dismal state. That scarcely seemed to matter, if nothing we could do would change the climate anyway. It took barely a decade for public attitudes to reverse. The reversal was not because of any changes in what scientists knew about global warming. The public’s rising concern for human impacts came from far more visible connections between technology and the atmosphere.

¹ “Deluge... new food-producing areas:” Abarbanel and McCluskey (1950), p. 63; a widely read book (first printing 100,000 copies) warning of floods and drought was Baxter (1953); Baxter was disparaged e.g. by Bello (1954).

² For racist-tinged concern that heat is enervating: e.g., Huntington (1916); Sears (1953), p. 43 (note also Shapley’s preface, p. vi); Coon (1953); discussion of Huntington in Fleming (1998), ch. 8; Coughlan (1950) (condensed in Readers’ Digest, Nov. 1950).

³ “Do not know”: *Time* (1939). Thirty years hence: Editorial (probably by W. Kaempffert), *New York Times*, Aug. 10, 1952, section IV.

⁴ For example, Engel (1953).

⁵ Baxter (1953), p. 69.

One of these was a growing awareness of the dangers of atmospheric pollution. In the 1930s, citizens had been happy to see smoke rising from factories: dirty skies meant jobs. But in the 1950s, as the economy soared and life expectancy lengthened, in industrialized countries a historic shift began from worries about poverty to worries about chronic health conditions. Doctors were learning that air pollution was mortally dangerous for some people. Meanwhile, on top of smoke from coal-burning factories came exhaust from the rapidly proliferating automobiles. A “killer smog” that smothered London in 1953 demonstrated that the stuff we put into the air could actually slay several thousand people in a few days. Effects on health also became evident in Los Angeles during the 1950s. Many Americans did not take the problem seriously, however, until a deadly smog assaulted New York City in 1966. Events in New York always had a disproportionate influence on the media headquartered there.¹

Another thing that drew the public’s attention to the air was exciting news about manipulating weather. During the 1950s, the press prominently reported attempts to make rain by “seeding” clouds with silver iodide smoke. Scientists openly speculated about other technical tricks, such as spreading a cloud of particles at a selected level in the atmosphere to interfere with solar radiation. Journalists and science fiction authors explained that in a not distant future we might alter climates over entire nations to their benefit. Or perhaps to their harm. Scientists publicly warned about the approach of “climatological warfare.” Might the Russians someday inflict deadly blizzards on the United States in a truly Cold War?

It had become plausible that by putting materials into the air, humans could alter climate on the largest scale. The frequent and colorful press coverage of cloud seeding and so forth helped convince the public that it was possible for humanity to alter the climate. Even decades later, when poll-takers asked people about causes of climate change, many thought first not of industrial emissions but of technical feats such as spaceship launches and nuclear explosions.²

The astonishing advent of nuclear energy was central to the change in thinking. Suddenly nothing seemed beyond human power. To many people the news of a limitless energy source was hopeful, even utopian. For example, experts speculated that we would soon be able to use salvos of atomic bombs to control weather patterns, bringing rain exactly where it was needed. At the same time, scientists warned that a nuclear war could destroy civilization. Science fiction stories, like the widely seen 1959 movie *On the Beach*, pictured the extinction of all life by radioactive fallout, carried around the world on the winds after a nuclear war. Many among the public suspected that dust from atomic bomb tests was already affecting the weather. From about 1953 until open-air testing ceased in the mid 1960s, as opponents of nuclear armaments pointed with horror to the invisible dangers of fallout, some people blamed the faraway tests for almost any unseasonable heat or cold, drought or flood. In a magazine article laying out the evidence that

¹ For the anti-smoke movement, Stradling (1999); on air pollution and pollution in general, McNeill (2000).

² Harrison (1982), p. 737.

global temperatures were rising, the authors remarked that “Large numbers of people wonder whether the atomic bomb is responsible for it all.”¹

The new threats awoke images and feelings that most people had scarcely experienced outside their dreams and nightmares. Humans were introducing unnatural technologies, meddling with the very winds and rain, spreading pollution everywhere. Would we provoke retribution? Would “Mother Nature” pay us back for our attacks upon “her”? At the deepest level, horror movies about radioactive monsters hinted at infantile fantasies of filth and incest, attack and punishment.² Such veiled anxieties were not detectable in the sober discussions of subjects like climate change. But the public did develop a vague feeling that natural disasters followed not only scientific law but moral law—a punishment for unhallowed human assaults.

Of course, this was nothing new. Many tribal peoples attributed climate disasters, such as an unusually severe winter, to human misdeeds. Somebody’s “polluting” transgression of rules was to blame. The community was being punished because someone had carelessly bungled a ceremony, violated an incest taboo, or the like. Just so was the Flood of Noah called down upon humanity by our sins. It was not only primitive tribes, but sophisticated civilizations too, that saw the natural order as so intrinsically benign and harmonious that any severe disruption must be due to human misdeeds. Chinese dynasties were shaken when people held the corruption of the Emperor and his mandarins to blame for devastating floods; European communities until quite recently declared days of public penance as an answer to droughts.

During the 1950s, human-caused disruptions of nature all the way up to global destruction took on a veneer of scientific plausibility. As the nuclear arsenals grew, Bible fundamentalists got a wider hearing than ever for their prophecies of rivers of blood, rains of fire, and the like. Told that our depravity would bring apocalyptic wars and the end of all things, the listener might be uncertain whether the warning came from a moralizing preacher or a concerned atomic scientist.

In this mental environment, people increasingly saw the natural world itself as unreliable, quite aside from human sin or divine punishment. Immanuel Velikovsky and several other would-be scientists were writing popular books that declared that the Earth had suffered extremely swift and cataclysmic changes not long ago. The poles had shifted thousands of miles in only a few years, bringing sudden floods and ice ages—with instantly frozen mammoths as evidence. These theories deserved scarcely a moment’s attention as science. Yet with titles like *Earth in Upheaval*, *Earth’s Shifting Crust*, and *Popular Awakening Concerning the Impending Flood*, the catastrophist writings resonated with apocalyptic fears and excited widespread popular interest.³

¹ Weart (1988), p. 187 and passim; “large numbers:” *This Week*, condensed as Robbins (1956), p. 83; further references are in Hart and Victor (1993), pp. 647-48 and n22.

² Weart (1988), ch. 4, also pp. 296-99 and passim.

³ Velikovsky (1955), mammoths p. 4; Hapgood (1958), mammoths ch. 8; Brown (1948) (an example of a crank pamphlet), mammoths p. 9; for further references, see Huggett (1990), pp. 119-21.

The widespread forebodings about the planet's fate made it easier for scientists to conceive theories of climate catastrophe and get a hearing. By far the best-publicized theory was offered in 1956 by two respected scientists, Maurice Ewing and William Donn. They argued that a warm spell could melt the Arctic Ocean's ice pack and trigger processes that would bring an ice age. Popularizations, such as a widely read article on "The Coming Ice Age" by freelance journalist Betty Friedan, speculated that flooded coasts and other calamities might soon arrive.¹ The publicity brought Ewing dozens of letters over the next several years from amateur enthusiasts of climate studies, as well as from cranks with elaborate ice-age theories of their own.² Careful science journalists warned that scientists saw no more in the Ewing-Donn theory than an interesting unproved speculation. But most writers agreed that significant climate change was possible.³

Ewing and Donn's theory sounded like a rational version of ancient myths of climate catastrophe. There had always been something deeply buried in human consciousness that resonated with the Nordic myth of Fimbulwinter—the future time when three years without a summer would herald the doom of men and gods. And something resonated with the annihilating world-flood described not only in the Bible but in the folklore of many peoples. Images of an end of the world in ice, in flood or in (nuclear) fire were no longer confined to the spheres of fable and religion. Underwritten by scientists, the images were leaking into sensible everyday conversations.

Suspicious of a Human-Caused Greenhouse (1956-1969)

Now that it seemed plausible that human technology could alter the planet as a whole, journalists found it easier to suggest that the greenhouse effect of CO₂ from fossil fuels was a possible cause of global warming. Evidence that the world had been growing a bit warmer had become strong enough to convince most meteorologists. In a 1955 news conference, the head of the U.S. Weather Bureau said that a significant general rise in average temperature (3.6°F, that is, 2°C) had been seen in the previous fifty years.⁴ During the 1950s, thorough newspaper readers could repeatedly run across small items with anecdotes of warming, such as crops and codfish flourishing hundreds of miles north of their former ranges. Easier to visualize were stories of mountain glaciers retreating. (That turned out to be confusing, however, since mountain glaciers advance and retreat erratically, depending less on global temperature than on purely local variations in snowfall.) On a larger scale, in 1959 the *New York Times* reported that the ice in the

¹ Friedan (1958), also published condensed in *Reader's Digest*.

² Folder "Ice Age Fan Mail," preliminary box 52, Maurice Ewing Collection, Center for American History, University of Texas at Austin..

³ "Unproved speculation:" Cowen (1960), pp. 186-89, who also put any ice age centuries in the future. Another example: "the beginning of the next glacial era might still be breathing down our necks," but "Much time and study and additional evidence will be necessary before even an informed guess can be made:" Andrist (1960).

⁴ F.W. Reichelderfer at WMO Congress, *New York Times*, May 18, 1955.

Arctic Ocean was only half as thick as it had been in the previous century. Still, the report concluded, “the warming trend is not considered either alarming or steep.”¹

The respected oceanographer Roger Revelle took the lead in suggesting that trouble might lie ahead. When he calculated that a rise in the level of CO₂ was likely, Revelle took pains to talk about global warming with science journalists and government officials. He said that humanity was inadvertently undertaking a huge “experiment” on the atmosphere, and the phrase was quickly picked up by others. Revelle meant “experiment” in the traditional scientific sense—a useful logical exercise, with the rise of CO₂ offering a fascinating opportunity for the study of geophysical processes. But the word “experiment” increasingly reminded ordinary people of nuclear bomb tests, or even Frankenstein at work on his monster.

Revelle himself at times warned that the experiment might bring serious problems. Testifying to Congress in 1957, he was one of the first to use another new and potent metaphor. “The Earth itself is a space ship,” he said. The ventures into space that began with the Soviet launching of *Sputnik* in 1957 were pushing many people toward seeing the planet as if from outside, as a whole. For Revelle, it meant we had better keep an eye on the spaceship’s air control system. Noting that climate had changed “quite abruptly” in the past, perhaps bringing the downfall of entire civilizations in the ancient world, he warned that the rise of CO₂ might turn Southern California and Texas into “real deserts.”² A few newspapers carried accounts with headlines like, “Fumes Seen Warming Arctic Seas,” and reported Revelle’s prediction that the Soviet Union could become a “great maritime nation” within as little as fifty years. It was in a newspaper account of Revelle’s scientific work that the phrase “global warming” was published for the first time and “climate change” for almost the first time although neither phrase would become common until the late 1970s.³

¹ Helmut Landsberg reported in the *New York Times*, Feb. 15, 1959.

² United States Congress (85:2) (1957), pp. 104, 105, 106; one popular writer who took up the “experiment” term (quoting the Woods Hole oceanographer Columbus Iselin), was Robert C. Cowen, “Are men changing the Earth’s weather?” *Christian Science Monitor*, Dec. 4, 1957, see Cowen (1960), pp. 181-82; the “spaceship earth” trope was popularized a decade later by Buckminster Fuller, see Jasanoff (2001), p. 319.

³ “Fumes Seen,” Lloyd Norman for Chicago Tribune Press Service, as seen in *Washington Post*, March 19, 1956. Phrases first published (“a large scale global warming, with radical climate changes may result”: *The Hammond Times* (Indiana), Nov. 6, 1957, from the Global Warming Newspaper Archive, <http://www.globalwarmingarchive.com/>. Only one earlier relevant use of “climate change” is found there, from 1952. The archive shows only scattered uses of “global warming” (and little more for “climate change”) into the 1970s, with a significant rise for “global warming” after 1975. The publication that brought the phrase into widespread use was probably Broecker (1975) (titled, “Climatic Change: Are We on the Brink of a Pronounced Global Warming?”), although a Sept. 1976 statement by M.I. Budyko that “a global warming up has started,” as quoted by the Soviet news agency TASS, was more widely reported.

Another scientist the media noticed was the physicist Gilbert Plass, whose own work had convinced him that CO₂ would warm the planet. In a 1959 *Scientific American* article he boldly predicted that global temperatures would rise something like 3°F (1.7°C) by the end of the century. Plass, thinking as a scientist, only remarked that this would allow a conclusive test of the CO₂ theory of climate change. But the magazine's editorial staff connected his ideas with the public's growing concern about pollution, printing a photograph of coal smoke belching from factories. The caption read, "Man upsets the balance of natural processes by adding billions of tons of carbon dioxide to the atmosphere each year."¹ The lesson was clinched by news in mid 1961 that meticulous measurements by C.D. Keeling had detected an annual increase of CO₂ in the atmosphere.²

Most people did not see anything ominous. "There would seem to be every reason for producing as much carbon dioxide as we can manage," one popularization had concluded back in 1957. "It is helping us towards a warmer and drier world."³ In any case none of it would happen until the 21st century, which seemed very distant indeed from the 1950s. The subject was scarcely noticed by anyone outside the science-minded minority who happened upon the reports, which were mostly buried in the back pages of newspapers or dropped into a news magazine as a brief paragraph.

After all, nothing here was certain, not even the recent warming trend. In 1961, a Weather Bureau expert announced that since about 1940 the world had in fact been cooling. Just around the time scientists had started to become convinced that there was a long-term warming trend, it had reversed, although the random fluctuations were so great that it had taken two decades for the reversal to become plain. (It didn't help that in the world's media capital, New York City, unusual warm spells happened to continue through the 1950s and 1960s.) For most of the 1960s and into the 1970s, science popularizations were dismally confused. A magazine might one year predict a tropical world with cities drowned by rising oceans, and the following year warn of cities overwhelmed by gigantic glaciers. It was uncomfortably obvious that experts could not agree about the actual trend of climate change, let alone its possible causes. "Man may be changing his weather...," an environmental study group warned; "through his inadvertent action he may be driving the atmosphere either to a disastrous ice age—or as bad—to a catastrophic melting of the ice caps... Despite firm predictions by some ecologists, we do not know the answers."⁴

The one unchallenged fact was Keeling's measurement of the amount of CO₂ in the atmosphere. His curve rose year by year through the 1960s. The rise impressed scientists who reviewed

¹ Plass (1959); Plass's 1953 calculation of a somewhat more gradual rise was carried earlier in the media in small notes, e.g., the climate may be "getting about 1-1/2 degrees hotter per century," *Newsweek* (1953).

² *New York Times*, Sept. 11, 1961.

³ Cook (1957), p. 121.

⁴ Council on Environmental Quality (1970), pp. 1043, 1046.

climate issues on behalf of various committees. A pioneer was the private Conservation Foundation, which sponsored a 1963 conference on climate. The scientists issued a report warning of “potentially dangerous atmospheric increases of carbon dioxide.”¹ In 1965, the issue rose to a high level of government, when a panel of the U.S. President’s Science Advisory Committee decided that the potential for global warming was a matter of serious national concern. But their report mentioned it only as one brief item among many other, more troubling environmental problems.²

These reports gave notice that some knowledgeable people were beginning to worry about how humans might be altering the atmosphere. The anxiety was only partly provoked by developments in climate science. Equally important was the historic shift of attitudes about how technology might affect the natural world. Utopian hopes dissolved as the nuclear arms race hurtled onward. The vague, almost mythological anxieties of the 1950s were reinforced by specific and immediate fears, voiced in shrill public debates and mass demonstrations against nuclear weapons tests. Exquisitely sensitive instruments detected radioactive fallout from the explosions half a world away—the first recognized form of global atmospheric pollution. By the early 1960s, many in the public looked with dread on plausible future scenarios. It was easy to imagine a post-nuclear war world like what a science fiction story portrayed later in the decade: the atmosphere so wrecked that horrible and uncanny storms perpetually swept the discolored skies.³

The lesson of fallout was that the world’s air was no longer pristine, not anywhere. Science writer Rachel Carson recalled that she used to think “the clouds and the rain and the wind were God’s,” but now she knew otherwise. In her 1962 book *Silent Spring* she warned that agricultural pesticides such as DDT and other chemical pollution, drifting around the world like fallout, could endanger living creatures not just in the neighborhood of the polluter, but everywhere.⁴ Meanwhile scientists reported that the increasingly despised urban smogs could no longer be attacked as just a local problem, for the pollution measurably dimmed the skies a thousand miles downwind.

These influences and many others brought a new generation of social critics onto the public stage. The “conservationists” of an earlier generation had fought against local harms, the toxic river, the razed forest or stinking air in their own vicinity. That was the immorality of fouling one’s own neighborhood. Now the moral lesson was still more severe. As poor farming practices had apparently aggravated the Dust Bowl, as ancient civilizations had destroyed their lands

¹ Conservation Foundation, *Annual Report for 1963*, pp. 19-20, see Conservation Foundation (1963).

² President's Science Advisory Committee (1965).

³ Zelazny (1969). Later made into a B movie (1977, directed by Jack Smight). Based on a novelette that I read in 1967 in *Galaxy* magazine—I remember some of the scenes vividly even now.

⁴ Carson quoted in Graham (1970), p. 14; on all this, see Weart (1988), pp. 323-25.

through overgrazing, so now human carelessness and greed seemed to endanger the entire global environment. Rejecting the traditional admiration for technology, the new “environmentalists” exclaimed that human activities threatened all life on Earth.

A new view was growing of the Earth as a system, an interlocking and fragile whole. Presumably this view was somehow connected with improved intellectual understandings. For one thing, discussion of the “population explosion” was teaching people the fierce power of exponential increase. Experts and public alike began to foresee trouble as the rise in the number of humans not only multiplied on itself, but was multiplied again by advances in technology. The quantity of materials and energy that each individual used was redoubling even faster than the number of individuals.¹ People were coming to think in global terms not only about population growth but also about its intricate relationship with the planet’s stock of chemicals and other resources.

Analyzing such a tangle seemed impossible. Nevertheless a few people at the Massachusetts Institute of Technology, the world center of enthusiasm for computer modeling, attempted to construct global resource models. Environmental issues like greenhouse warming were in the back of their minds (we will see that one of the instigators, Carroll Wilson, was meanwhile organizing landmark conferences on climate change). Their trail blazing 1972 book on *The Limits to Growth* proclaimed that the limits were strict. The computer said that exploding population would use up all available food and minerals, and if somehow we avoided that, we would eventually choke in our own polluting exhaust. The book sold millions of copies worldwide, deeply impressing thoughtful people with its calculation of “the predicament of mankind.” For most of the public, and policymaking elites too, it was not only the first time they had faced up to the finite capacity of the planet, but also the first time they had seen a scientific analysis of the global physical and economic system.²

Meanwhile scientists showed how widespread harm might be wreaked by modest quantities of materials, and not only radioactive fallout or DDT. Meteorologists calculated, and explained to science reporters, that a modest addition of ordinary dust or gases to the atmosphere might trigger serious and unpredictable changes. It was just now, in the mid 1960s, that climate science—one of the few fields that tried to model an entire planetary system—became acutely aware of feedbacks and the mathematics of chaos. New models of the atmosphere interacting with oceans and ice raised the possibility of huge and sudden upheavals. It is not clear how far these intellectual developments affected public opinion, since most people scarcely heard of them. There may have been as much influence in the other direction. While models of an unstable climate had scientific roots stretching back into the 1950s, scientists may have been encouraged to develop the models when their thinking expanded along with the shift of public opinion toward seeing global disruptions as plausible.

¹ E.g., Ehrlich and Holdren (1971).

² Meadows et al. (1972); Edwards (2000a).

Scientific ideas of any sort meant less to the public than technological coups, and not just the bomb tests. Likewise impressive was the photograph that an astronaut took from lunar orbit in 1968. Here was our small blue sphere, decorated with lacy whirls of cloud, floating like an oasis in endless black space. Astronauts and cosmonauts declared with an almost mystical insistence that from their high viewpoint, national boundaries became invisible as a global perspective opened up.¹ The photographs, compared with even the most scientifically informed earlier paintings, showed weather systems that were far more elaborately organized, more delicate and more ravishingly beautiful—a planet to cherish.

Threats of Climate Disaster (Early 1970s)

The first Earth Day, held in 1970, marked the emergence of environmentalism into powerful political action. New public attitudes supported bitter attacks on authorities, especially in government and industry. They were the villains held responsible for pollution and many other problems. To the new breed of environmentalists, almost any novel technology looked dangerous. As one example, the press revealed that the U.S. military in Vietnam had engaged in a massive cloud-seeding program, trying to bog down the Communist army with rains. The military was now widely despised, and in the eyes of many around the world, this attempt at climate modification was malignant. Where once people had held utopian hopes for the ways humanity would modify the environment, either deliberately or as a side-effect of “progress,” now such “interference” seemed ignorant, reckless, and perhaps wicked. In every democratic industrial nation, citizens pressed their government to enact environmental protection laws. Governments gave way, taking steps to reduce smog, clean up water supplies, and the like. Meanwhile bureaucracies improved the organization (and in some cases the funding) of research on the atmosphere, along with every other element of the environment.

The new attitudes affected scientists along with everyone else. Some experts were getting worried about climate change, and made deliberate efforts to stir up other scientists and the public. Especially important was a “Study of Critical Environmental Problems” organized in 1970 at the Massachusetts Institute of Technology. The organizer was Carroll Wilson, a dynamic science policy entrepreneur who had earlier managed the U.S. Atomic Energy Commission. Under his expert leadership, some 40 scientists deliberated for a month over desertification, pollution of the air and oceans, and other harms. In their concluding conference report, as the first item in a big list of potential problems, the scientists pointed to the global rise of CO₂. The risk of global warming, they declared, was “so serious that much more must be learned about future trends of climate change.”² The media paid some attention, although they mostly overlooked global warming among more immediate pollution threats.

¹ The influence of the Apollo pictures of Dec.1968 (Earthrise over the Moon, by William Anders) and Dec.1972 (the Whole Earth) cannot be proven but many have testified to it. Like all great symbols the Whole Earth was exploited for diverse purposes, see Garb (1985); Jasanoff (2001), pp. 316-17; Maher (2005); for astronauts, White (1987).

² SCEP (1970), p. 12; see also Matthews et al. (1971); Kellogg (1987), pp. 120-22.

Wilson followed up the MIT study by organizing a meeting of experts in Stockholm. This “Study of Man’s Impact on Climate,” focused tightly on climate change, was a landmark in the development of awareness. The group concluded with a ringing call for attention to the dangers of humanity’s emissions of greenhouse gases and particle pollutants. Their widely read report gave as its epigraph a Sanskrit prayer: “Oh, Mother Earth... pardon me for trampling on you.”¹ Another example of the new tone was a deliberately provocative 1971 book titled *Impingement of Man on the Oceans*. “The shocking reality,” said the author, “is that the hour is fast approaching when the people of the Earth will have exhausted nature’s ability to adjust to the complexities of human attack.”²

Contemplating the relationship between science and society, some people would say that the judgment of scientists bent under the pressure of the mass prejudices of the day. Others would say that public opinion responded intelligently to new scientific facts. Both views go too far in separating scientific from popular thought. In regions like North America and Europe, where the public was relatively well educated and informed, the views of scientists and public tended to evolve together.

Not everyone adopted such thinking. Many still felt, as the veteran meteorologist Joseph Smagorinsky had declared in 1969, that “our physical environment must be considered an enemy to humanity until we master it.”³ But the rhetoric and attitudes of the environmental movement spread rapidly, not only among the general public but also among climate researchers. Smagorinsky himself worried in 1972 that we were standing “at the threshold of a possible crisis which could have as much of an impact on man as his invention of war.”⁴

Climate was now seen as one of the planet’s vulnerable spots, and many people expected that whatever we did to it would be for the worse. For example, in 1969 (Feb. 20) the *New York Times* reported that greenhouse warming of the Arctic Ocean might make the pole ice-free within a decade or two. The resulting climate change would turn much of the United States and Europe from breadbaskets to deserts. On the other hand, the *Times* article continued, some scientists held there was a cooling trend. That too could be blamed on humanity. Increased dust and other aerosols, stirred up by agriculture and industry, might bring destructive cold spells.

Science reporters were especially impressed by a 1972 warning from the oceanographer Cesare Emiliani. His ground-breaking research on past climate cycles had persuaded him that in the natural course of events the present “amiable climate” should give way, within the next few thousand years, to a new ice age. But the prediction, Emiliani explained, might be confounded by human interference such as deforestation and pollution, for the climate was extremely unstable. “We may soon be confronted with a runaway glaciation,” *Time* magazine quoted him as

¹ Wilson and Matthews (1971), p. v.

² Hood (1971), p. v, “provocative” p. vi.

³ Smagorinsky (1970), p. 25, from a talk at an August 1969 conference.

⁴ McIntyre (1972), p. 37.

saying—or perhaps instead a “runaway deglaciation” that would flood our coastal cities.¹ The most common scientific viewpoint was summed up by a scientist who explained that the rise in dust pollution worked in the opposite direction from the rise in CO₂, so nobody could say whether there would be cooling or warming. In any case, “We are entering an era when man’s effects on his climate will become dominant.”²

Climate pronouncements like this were no longer always hidden in the back pages. In the early 1970s, the public learned that climate change could be an urgent problem. What aroused them was a spectacular series of disasters. In 1972, drought ravaged crops in the Soviet Union and several other regions; this caught attention around the world when the Soviet government made massive grain purchases and prices rose sharply. Also in 1972 the Peruvian fisheries collapsed because of an El Niño event, while the Indian monsoon failed (and again in 1974). Meanwhile droughts struck the Midwestern United States too, severely enough to show up repeatedly on the front pages of newspapers and in television news programs. In 1974 world prices of food soared to a level never seen before. Most dramatic of all, years of drought struck the African Sahel and reached an appalling peak in 1972, threatening millions with starvation, bringing on mass migrations and hundreds of thousands of actual deaths. Television and magazine pictures of sun-scorched fields and emaciated refugees brought home just what climate change could signify.

Climate scientists did not know what caused any of this, but some publicly suggested that humans were partly responsible. Looking at the disaster in Africa in particular, they speculated that our pollution of the atmosphere was changing global weather patterns. Or perhaps overgrazing of the semi-arid Sahel had started a vicious cycle, where the barren ground reflected more sunlight, altering the winds so as to cause further desertification. Whatever the cause of the disasters, they undercut the public’s traditional belief that weather conditions would never get far from their old accustomed pattern. Climate scientists had already been moving away from that during the past decade. People increasingly understood that there existed no such a thing as a “normal” climate, and many began to worry that permanent shifts were underway.³

The rise in attention can be seen in the popular articles in American magazines listed in the *Readers’ Guide to Periodical Literature* under the rubric “Global temperature change.” The articles put interviews of climate scientists alongside the recurring news of droughts and other weather disasters. In the mid 1970s, the number exploded from roughly three articles per year to more than twenty.⁴ That was still a low level compared with many other issues that agitated the public. But it was enough so that well-read people would be generally aware of climate change as a public issue.

¹ *New York Times*, Jan. 27, 1972. Quote: Time (1972).

² G.S. Benton, chair of Johns Hopkins Dept. of Earth & Planetary Sciences, to 1970 National Academy of Sciences symposium, *New York Times*, April 30, 1970.

³ Henderson-Sellers and Robinson (1986), pp. 10-11.

⁴ My counts. A sharp increase in coverage in magazines and newspapers in the mid 1970s is also reported by a qualitative survey, Harrison (1982), p. 737.

This was not brought about by any deliberate public relations campaign. Nearly all scientists felt their job was to pursue research and publish it in technical journals. Anything important would presumably come to the attention of science journalists and policy-makers. For really important problems, the scientists could convene a study group (like the “Study of Man’s Impact on Climate” held in Stockholm in 1971) and issue a report. Experts like Revelle were more than willing to explain their ideas when asked, and they might even make an effort to come up with quotable phrases for reporters. On request they would give a talk on the state of climate science or write it up for a magazine like *Scientific American*, which reached, not exactly the public, but the part of the public that was well educated and interested in science. This mild part-time activity was fairly effective, for science journalists did notice and amplify anything that could make a good story.

As usual, news media drew attention to the worst dangers. Various journalists reported that scientists suspected the weather fluctuations could be the harbinger of another ice age. To be sure, most articles made it clear that the top scientists frankly admitted uncertainty. Many scientists believed that cooling was no more likely than global warming, or than no particular change at all. *Newsweek* explained, in a direct quote from a National Academy of Sciences report, that “Not only are the basic scientific questions largely unanswered, but in many cases we do not yet know enough to pose the key questions.” Yet there was one thing that nearly all experts agreed on, news reports explained. As *Time* put it, “the world’s prolonged streak of exceptionally good climate has probably come to an end—meaning that mankind will find it harder to grow food.”¹ When rising population crashed against the increasingly erratic weather, the world might face widespread famine, even warfare over the dwindling food supply.

Perhaps this was not just bad luck. “We have broken into the places where natural energy is stored and stolen it for our own greedy desires,” a journalist declaimed. “Our tampering with the delicate balances of nature can cause major dislocations... and many people intuitively and logically conclude that some great natural law is about to catch up with us.... A few see in such catastrophes the just hand of divine judgment and retribution against materialist sinners...”²

A leader in stirring public anxiety was the respected climate expert Reid Bryson. Scarcely any popular article on climate in the 1970s lacked a Bryson quote or at least a mention of his ideas. His big worry was the increase in smoke and dust, not only from industry but also from lands laid waste by deforestation and slash-and-burn agriculture. Already in the late 1960s, he had gone to the public to warn that such pollution was probably bringing on global cooling.³ He explained that like the smoke from a huge volcanic eruption, the “human volcano” could cause disastrous shifts in weather patterns. His claims were forcefully stated and unequivocal, backed up by an argument that the droughts in Africa and India already showed how air pollution was halting the rain-bringing monsoons. (Three decades later scientists were still unsure about that, although

¹ harbinger: *Time* (1974a); Academy report: *Newsweek* (1975); *Time* (1974b), p. 83.

² Ponte (1976), pp. 234-35.

³ Bryson (1967).

they suspected that pollution had in fact contributed to the deadly African drought.) Journalists quoted Bryson's warnings that the effects of human interference "are already showing up in rather drastic ways," as *Fortune* magazine reported in 1974. We faced unprecedented dangers, the magazine declared, perhaps "a billion people starving."¹

Most climate experts thought Bryson went too far, at least as reported in the media. "There has been much hand-waving of late," the respected climatologist William Kellogg complained in 1971, "and the 'prophets of doom' have taken the spotlight of public attention. Virtually none of these people who speak of the 'doom' of our earthly environment are scientists..." He insisted that our planet had "a remarkably stable life-support system" and that "the natural sources of contamination... still far outweigh all of man's contributions, taken on a global scale."

Yet the majority of climate experts were beginning to worry. Kellogg himself confessed to a "haunting realization that man may be able to change the climate of the planet Earth." A 1974 study by leading figures, convened by the National Academy of Sciences, concluded that "there is a finite probability that a serious worldwide cooling could befall the Earth within the next 100 years." The shift, moreover, could be "rather sudden."² Another official (or official-sounding) endorsement came in 1976 with the publication of a secret 1974 report by the Central Intelligence Agency. The report's authors, relying on Bryson's theory, gave dire warnings that impending cooling could bring economic dislocation and perhaps even wars. "There would be increasingly desperate attempts on the part of powerful but hungry nations to get grain any way they could. Massive migrations, sometimes backed by force, would become a live issue...", Climate scientists publicly attacked the CIA report as "sloppy" and full of "patent nonsense" (Bryson himself had to spend a good part of the next year explaining to people that he wasn't responsible for what it said). However, news accounts went on to say that nearly all scientists did admit that severe climate variations were possible.³

News of these reports and studies was still relegated to a few paragraphs on the inside pages of the better newspapers or in the science-and-culture section of news magazines, reaching only the more alert citizens. This limited but important audience, if they happened to open to the right page on the right day, might notice a significant discovery. Strong new evidence showed that the coming and going of ice ages followed a rhythm set by predictable astronomical variations of the Earth's orbit around the Sun. Projecting the orbital variations forward, several experts calculated

¹ Alexander (1974), quote p. 92; current thinking on the drought: Rotstayn and Lohmann (2002).

² Kellogg (1971), pp. 123, 131; GARP (1975), p. 189, from App. A (pp. 186-90) by J. Imbrie, W.S. Broecker, J.M. Mitchell, Jr., J.E. Kutzbach. *New York Times*, Jan. 19, 1975, p. 31.

³ Central Intelligence Agency, "Potential implications of trends in world population, food production, and climate," OPR-401, Aug. 1974, published as Appendix II to Impact Team (1977), quote p. 200. News of the report was first published in the *New York Times*, May 1, 1976, p. 2; scientists quoted: U.S. News & World Report (1976); Bryson, personal communication, 2002.

that we were now in the descending part of the natural cycle, with the onset of the next ice age probably scheduled to come within the next few thousand years. (It would be a couple of decades before more accurate calculations showed that the next scheduled ice age was not due for tens of thousands of years.) A few scientists argued that it would be prudent to make preparations for the possibility that cooling would begin to get serious within the next century or two. After all, journalists pointed out, weather records revealed widespread temperature declines since the 1950s. (Later studies would find the cooling had come only in the Northern Hemisphere, and particularly in the much-watched North Atlantic region. It didn't help that the 1970s brought especially cold weather to the world's media capital, New York City.)

Popular articles occasionally summarized the scientific debates. The respected oceanographer James Hays, for example, told the elite *Saturday Review* audience that within a few centuries "it may very well get cold enough to allow great glaciers thousands of feet thick to cover North America as far south as Long Island." While acknowledging that other scientists predicted that greenhouse warming could cancel out the natural trend toward the next ice age, Hays warned that more pollution, by blocking sunlight, "could tip the balance" and bring on the ice age even faster. Members of the public who wanted to read more about all this could find a book-length popularization of the ideas of Bryson and like-minded scientists in *The Cooling*. The journalist author warned that "we could possibly witness the beginning of the next Great Ice Age. Conceivably,... we would see mass global famine in our lifetimes, perhaps even within a decade." That compressed into a decade glacial processes that scientists expected must take hundreds if not thousands of years. It went far beyond what even Bryson had suggested (he provided a preface to the book, but used the opportunity to warn that it was neither scientifically accurate nor balanced). Most reviewers rightly dismissed *The Cooling* and a few similar publications as mere sensationalism, if they noticed them at all.¹

The startling images of a sudden ice age in popular media scarcely reflected the scientific literature, where articles were published only after review by other experts. In those journals, during the 1970s only a few papers projected that the world might freeze within a century or two. Many more authors foresaw not global cooling but global warming, and still more weighed the pros and cons but insisted that it was impossible to make any prediction until much more work was done. This understanding was reflected in the few more-or-less "official" pronouncements by bodies that presumed to speak for a consensus of scientists. The World Meteorological Organization in 1976 addressed the "controversial statements on climatic change...issued in recent years by various bodies and individuals..." Their own statement acknowledged the possibility of rapid climate changes caused by human activities, including aerosol pollution, but the only possibility they noted specifically was "a long-term warming" from CO₂. And a lengthy study by the U.S. National Academy of Sciences that concluded in 1977 scarcely bothered with worries about cooling. The report focussed on global warming from CO₂ emissions, warning of

¹ Hays (1973), quotes p. 29, 32. Ponte (1976), p. xiv.

the risks of rising seas, failures of agricultural and marine production, and so forth—while admitting that much more research was needed before anything could be said for certain.¹

Still, Bryson's group had found evidence that climate really could change severely in the course of only a few decades. Journalists promptly reported this to the public, and trotted out the old theory of Ewing and Donn about the sudden onset of an ice age (not overlooking the tale of mammoths found buried in permafrost with grass in their stomachs). Some scientists "even believe the glaciers could return within our lifetime," exclaimed a science writer in the *Saturday Evening Post*. This was more scientific nonsense, and Bryson remarked indignantly, "I am probably the most misquoted climatologist in the United States."²

In truth, scientific opinion was shifting toward the idea that small perturbations could trigger sudden climate change. Abstract theoretical studies were showing how a complex system of feedbacks like climate could even lurch all on its own, unpredictably. The *Saturday Evening Post* article correctly cited studies from lake sediments and ice cores that hinted that severe cold could descend in as little as a century.³ A slower global warming seemed more likely to many experts. A few scientists, however, suggested that if global warming was underway it might release a mountainous surge of ice from Antarctica. By cooling down the oceans that could bring an ice age, perhaps within decades.

The ideas seemed plausible to Nigel Calder, a respected British science journalist, who featured them in a two-hour television feature about weather that was broadcast in 1974. One short but memorable segment warned of a possible "snowblitz" set off by an Antarctic ice surge, or directly by global warming or pollution, or just by pure chance. Entire countries could be obliterated under layers of snow, said Calder, and billions would starve. The new ice age "could in principle start next summer, or at any rate during the next hundred years." This was the first time the threat of abrupt climate change appeared as the subject of a major television presentation.⁴ But it was an isolated case, and it did not reach beyond the minority who watched educational shows on public television. Climate change was not yet a topic of widespread public discussion.

¹ Peterson et al. (2008) discuss all this in detail. World Meteorological Organization, Press Release and WMO Statement on Climatic Change, WMO/No.319 (June 18, 1976), copy kindly provided by John Mabb. National Academy of Sciences (1977).

² "Within our lifetime," Wolkomir (1976), p. 50. "I am a little touchy about this point," Bryson added. Bryson testimony, May 26, 1976, United States Congress (94:2) (1976), p. 211.

³ Mammoths frozen "swiftly in their tracks," Impact Team (1977), p. 19; trigger ice age: Rasool and Schneider (1971); for lake sediments Wolkomir, *op. cit.*, quotes David W. Folger, and for ice cores C. Langway, p. 78.

⁴ "The Weather Machine," BBC-television (a co-production with the U.S. Corporation for Public Broadcasting and WNET), first aired 20 Nov. 1974, expanded in a book: Calder (1975), quote p. 134; he based the "snowblitz" idea on Lamb and Woodroffe (1970); see also Brooks (1925), pp. 90-91.

Atmospheric Scientists and Industrial Policies (Latter 1970s)

A few scientists thought the prospects of a calamity were so serious that they must make a personal effort to address the public directly. Bryson wrote a book titled *Climates of Hunger*, published in 1977. Drawing on his group's historical researches, he described how native American societies had been destroyed by the sudden onset of prolonged droughts, far worse than anything known in recent centuries. A better-documented historical case, noted by many writers, was the "Little Ice Age" that had chilled the North Atlantic region from the 15th through the 18th century. Starvation had loomed as crops failed in the dank summers, the Thames at London and the Baltic Sea had frozen solid in winter, while advancing glaciers had crushed entire villages in the Alps and Viking colonies in Greenland had collapsed.¹ Bryson warned that such disasters could hit our own civilization unpredictably and swiftly.²

Another climatologist who worked hard to warn of a possible climate calamity was the young Stephen Schneider. He and his journalist wife wrote a popularizing book, *The Genesis Strategy: Climate and Global Survival*. Insisting that climate could change more quickly and drastically than most people imagined, they advised the world to devise policies to cushion the shocks, such as building a more robust agricultural system. As Joseph had advised Pharaoh in the Book of Genesis, we should prepare for lean years to follow fat ones.³

A few experts stirred public interest with ideas of still more drastic action: enormous global engineering projects to deliberately bend the climate to our will. Most scientists dismissed the ideas, but not because they sounded like science fiction. It seemed only too plausible that humanity could alter the climate. However, our knowledge was so primitive that any intervention might only make things worse.

Some scientists criticized Bryson, Schneider, and others who spoke directly to the public. The time spent writing a book and going about the country delivering public lectures was time away from doing "real" science. Worse, most scientists felt that any definite statement about climate change was premature. After all, nobody had in fact published a serious prediction of an imminent ice age or runaway global warming in a peer-reviewed scientific journal.⁴ The whole subject was so riddled with uncertainties that it seemed unfit for presentation to the scientifically naive public. Experts whose profession demanded accuracy were upset by the shortcuts some colleagues took when explaining things in lay language. They particularly disliked the blunt and colorful statements, inevitably imprecise, that were necessary to catch the public's ear. Since

¹ Fagan (2000).

² Bryson and Murray (1977).

³ Schneider and Mesirov. (1976), esp. chap. 3; Kellogg and Schneider (1974); Hammond (1976); Glantz (1977).

⁴ In addition to Peterson et al. (2008) (see note above), see discussions in the blogs of RealClimate, <http://www.realclimate.org/index.php?p=94> and W. Connolley, <http://www.wmconnolley.org.uk/sci/iceage>.

debate over the likelihood of severe climate change had become a salient public issue, any statement might be dragged into the media arena. Reporters were quizzing experts at scientific meetings and telephoning them with urgent questions about one or another discovery that was about to be published. Climate science professionals, accustomed to life in a quiet academic backwater, found the change both gratifying and disturbing.

Many of the experts felt that the climate controversy was inflated by a few irresponsible scientists and sensation-seeking journalists, agitating for no good reason. As the Director-General of the United Kingdom Meteorological Office explained in a 1976 lecture, the official message was, “no need for panic induced by the prophets of doom.” With other meteorologists, perhaps the majority, he insisted that “the climatic system is so robust, and contains so much inherent stability through the presence of negative feedback mechanisms, that man has still a long way to go before his influence becomes great enough to cause serious disruption....”¹ In fact the public showed no signs of panic nor even much anxiety. The traditional belief in the benign “balance of nature” was still widely held. Warnings of a future climate calamity sounded no different from the countless other future threats that newspapers had been trumpeting for a hundred years.

We don’t know the public’s response for sure, since nobody took a poll. But a largely indifferent attitude is suggested by the very lack of polling, or any other distinct reaction by the experts who kept their finger on the public pulse. Politicians, even better attuned to public feelings, did show some desultory reactions. A few bills dealing with climate were proposed in the U.S. Congress, and the administration undertook a mild reorganization of climate research. But most politicians showed little interest in the topic.

Yet climate change was becoming a political issue, if only in the narrow sense that policies were at stake. At professional meteorological conferences, debates over technical questions such as the rate of CO₂ buildup became entangled with debates over how governments should respond. In some meetings scientists addressed the policy issues formally in papers and working groups, struggling with questions far beyond their professional expertise. How much should reliance on fossil fuels be reduced, if at all? Should the destruction of tropical forests be a main target for reform? How much money and effort should be spent on averting climate change, amid the struggle to feed the world’s poor? With demands for equity rising and centralized government threatening freedom, what policies were desirable? Or even politically feasible? Which was more dangerous—to exclaim about the worst possible harms, and give science a reputation for sensationalism, or to offer cautious scenarios, which might delay action until it was too late? Was it even proper for a scientist to speak, as a scientist, on social questions?²

¹ B.J. Mason, speaking mainly about aerosols and ozone. He admitted that greenhouse warming could become significant in 50-100 years. Gribbin (1976); Mason (1977).

² Stumm (1977), articles by A.M. Weinberg and R. M. Rotty, pp. 225-39, by H. Brooks, pp. 241-52, report by A. Nir et al., pp. 312-22, and *passim*.

The different approaches showed up in exchanges like the following, at a 1972 symposium where scientists argued over intractable calculations on how much CO₂ was emitted during deforestation. “I guess I am rather conservative...,” one expert remarked. “I really would like to see a better integration of knowledge and better data before I would personally be willing to play a role in saying something political about this.” A colleague replied, “To do nothing when the situation is changing very rapidly is not a conservative thing to do.”¹

Unable to agree even whether the world was likely to get warmer or colder, the scientists did unanimously agree that the first step must be to redouble the effort to understand how the climate system worked. Calls for research always came naturally to researchers, but from the early 1970s onward, climate scientists issued these calls with increased frequency and passion. Even in technical articles in professional journals, many authors now went out of their way to state that an increased research effort was urgently needed. Interviewed by journalists, most climate scientists said they required far more data and analysis. In other words, governments should put up more money. As one meteorologist put it, “public opinion is being alerted and thus politicians may be able to act.”²

Not only more funds, but better organization seemed necessary. Individual scientists were backed up by official committee reports pressing these issues. In particular, around 1974 American scientists made a concerted effort, both in public and behind the scenes among officials, to urge their government to found a National Climate Program. That would give them both unified direction and sharply increased funding. Gathering data and organizing research on climate change, one expert explained, “should be regarded as an important aspect of national defense, or, more accurately, of defense of the entire planet against a common threat.”³ Scientists also pushed for heightened international efforts. In the absence of a truly global public opinion, this action tended to be mostly hidden within conferences and in the corridors of bureaucracies.

A few people began to look beyond the corridors of research policy and publicly demanded immediate changes on a broader scale. Environmental activists were already attacking overgrazing, smog emissions, and so forth because of the damage in their neighborhoods. Such bad practices might alter the climate as well. But this only added one more item to the list of arguments against specific practices. During the 1970s, only a few people speculated that it might be wise to impose serious changes on industry and agriculture for the special purpose of reducing their impact on climate. That was a world away from practical politics, rarely suggested even as an abstract future goal.

An example of the auxiliary part played by climate worries came up during a controversy that gathered around itself much of the political attention that could be spared for the atmosphere. This was a public debate that began in 1970 over the U.S. government’s plans to subsidize a fleet

¹ Reiners and Olson at 1972 Brookhaven Symposium in Biology, Reiners (1973), p. 327.

² Bert Bolin in McIntyre (1972), p. 253.

³ Barrett and Landsberg (1975), p. 79.

of supersonic commercial airplanes. The transports would inject large amounts of water vapor and chemical aerosol particles into the stratosphere, and some scientists warned that this could have damaging effects on global climate. The public's main worries, however, were that the fleet would be intolerably noisy, damage the high ozone layer that protected them from skin cancer, and waste taxpayers' money. Under pressure from the entire list of objections, in 1971 Congress cancelled the project, perhaps the first time in American history such a major technological initiative was defeated by public pressure invoking environmental arguments.¹

Pursuing the new concern for the stratosphere, in 1974 two scientists noticed that certain obscure gases produced by industry (nicknamed "CFCs") lingered in the atmosphere. Some would drift up to the stratosphere where, the scientists discovered, ultraviolet rays would activate them in a process that destroyed ozone. The high, thin layer of ozone blocks the Sun's ultraviolet rays, so removing this layer would cause an increase of skin cancers, and perhaps bring still worse dangers to people, plants, and animals.

CFCs were the propellents in aerosol sprays: every day millions of people were adding to the global harm as they used cans of deodorant or paint. Science journalists alerted the public, and environmentalists jumped on the issue. Chemical industry groups fought back with public relations campaigns that indignantly denied there was any risk whatsoever. Unconvinced, citizens bombarded government representatives with letters and boycotted spray cans. A survey showed that nearly three-quarters of Americans had heard about the issue. In 1977, the U.S. Congress added restrictions on the spray can chemicals to the new Clean Air Act.²

Climate change was nowhere to be seen in the spray can controversy. But the threat to the ozone layer sent a stinging message about how fragile the atmosphere was, how easily human activity might damage it. And how unexpectedly. Except for the chance circumstances that had stimulated studies of high-altitude airplanes, the danger from spray can propellants might have gone unnoticed for quite a few more years.

The ozone story added to the shapeless fears that human activity was somehow endangering the entire planetary atmosphere. The majority of citizens found it hard to distinguish among the various materials, whether airplane and automobile emissions, agricultural chemicals, or industrial pollution from either traditional smokes or bizarre new substances. Many scarcely distinguished among climate change from greenhouse warming, ozone damage from CFCs, and health threats from automobile tailpipes and power plant smokestacks. It was enough to feel that an eerie toxic smog threatened the entire planetary environment.

Scientific results continued to trickle in. None of the new studies was especially striking or definitive, but there was a significant overall tendency. It seemed that climate could indeed be more delicately balanced, more subject to swift changes, than scientists had supposed. An

¹ Horwitch (1982), pp. 318-20.

² Gribbin (1988); also Dotto and Schiff (1978); Roan (1989), see p. 58.

example of the claims that briefly caught the public eye were studies that suggested that severe droughts in western America followed a cycle, driven by changes in the number of sunspots. It was a reminder that the climate might be sensitive to all sorts of small and unexpected influences. That was driven home to scientists by new data on ancient climates, observations of disturbingly large annual shifts in the amount of snow cover in the Arctic, and novel theoretical models that showed how such changes might make the climate system flip abruptly from one state to another. This idea of runaway climate became terribly vivid to both scientists and the public when space probes brought news of a hellish furnace atmosphere on Venus and a permanent ice age on Mars.

Meanwhile new studies convinced an increasing number of scientists that, given a choice between warming and cooling, it was the greenhouse effect that would dominate sooner or later. Theoretical work on aerosols suggested that human smog and dust might not cool the atmosphere very much after all. At most, the increased pollution might bring a mild cooling that would only temporarily mask greenhouse warming. Other studies suggested that the greenhouse effect might already be changing the weather. Computer models, although still provisional, tended to agree that the rising level of CO₂ would bring a degree or so of warming within decades. Any statement that invoked supercomputers commanded strong respect from the public, and from most scientists too.

Climate experts were quick to explain the new findings. A well-respected geochemist, Wallace Broecker, took the lead in 1975, warning in an influential *Science* magazine article that the world might be poised on the brink of a serious rise of temperature. “Complacency may not be warranted,” he said. “We may be in for a climatic surprise.”¹ In 1977, the National Academy of Sciences weighed in with a major study by a panel of experts who warned that temperatures might rise to nearly catastrophic levels during the next century or two. The report, announced at a press conference during the hottest July the nation had experienced since the 1930s, was widely noted in the press.²

Science journalists, by now closely attuned to the views of climate scientists, promptly reflected the shift of opinion. Media talk of a ruinous new ice age continued through the winter of 1976-1977, which was savagely cold in the Eastern half of the United States. But that was the end of it. From 1978 on, nearly all articles on climate in the *New York Times* were oriented toward greenhouse warming. In the *Readers' Guide* listing of U.S. popular articles, warnings about

¹ Broecker (1975), reported in *New York Times*, Aug. 14, 1975, p. 24. Influence of Broecker on a member of the President's Council of Economic Advisers is reported in *New York Times*, June 3, 1977, IV p. 13.

² National Academy of Sciences (1977); reported: e.g., *New York Times*, July 25, 1977, p. 1, and *Business Week* (1977).

climate were more or less evenly divided between heating and cooling up to 1977, but then articles about global warming took over almost completely.¹

As an example of the change, in 1976 the *U.S. News & World Report* described (with strong qualifications) the theories that the world would be getting cooler. The very next year the same magazine reported that “The world may be inching into a prolonged warming trend that is the direct result of burning more and more fossil fuels...” The ice-age theories, said the article, “are being convincingly opposed by growing evidence of human impact.”² Similarly, in 1976 *Business Week* had explained both sides of the debate but reported that “the dominant school maintains that the world is becoming cooler.” Just one year later, the magazine declared that CO₂ “may be the world’s biggest environmental problem, threatening to raise the world’s temperature” with horrendous long-term consequences.³

The change in press coverage was not due to any obvious change in the weather—the winter of 1978-79 was the coldest on record for the United States. Nor was there any single scientific revelation, for amid the complexities of geophysics no individual finding could ever be decisive. But several research results published in the mid 1970s (perhaps especially from computer models) swayed the opinions of scientists. In early 1978 the *New York Times* reported that a poll of climate scientists found them evenly divided on whether there would be warming, cooling, or no particular change. But the balance among the handful of top experts had shifted strongly toward the likelihood of warming. In the scientific journals, where articles are published only after critical review by scientist peers, a few articles had appeared in the early 1970s that projected cooling in future centuries. These papers had always been outnumbered by articles that either predicted warming or said it was premature to make any prediction. After the mid 1970s, the papers predicting global warming predominated and became increasingly numerous. The views represented in the scientific literature migrated, with the usual exaggeration and simplification, to science journalists.⁴

In all this the journalists conveyed two important points to the public. One of these points would be obvious to anyone who read just the headlines and titles of the various articles: scientists remained uncertain and divided about what would really happen. The other point crept in on a deeper level. It was put explicitly in a 1977 *Readers’ Digest* article where the author, after emphasizing the disagreement among experts about whether the planet would get too hot or too cold, stated his principal conclusion. “All scientists agree that a new factor has entered the game of climate change, a ‘wild card’ never there before—man himself.”⁵

¹ My counts based on titles (for a given article the titles are all that most of the public reads). A compilation of cooling scare quotes includes items from 1971 and especially from 1975 to 1977 and none later, Bray (1991).

² *U.S. News & World Report* (1976); *U.S. News & World Report* (1977).

³ *Business Week* (1976); *Business Week* (1977).

⁴ Poll: *New York Times*, Feb. 18, 1978, p. 9. Journals: Peterson et al (2008).

⁵ Matthews (1977), p. 92.

Not only future weather, but weighty questions of present policies were at stake. The worries about climate change became entangled in debates about fuel supplies. The “oil crises” of 1973 and 1979, when gasoline became shockingly expensive or even unobtainable, aroused a keen public interest in energy policy. Environmentalists were mobilizing public opinion to block nuclear power. But their preferred technology of solar power was a long way from being cheap enough (or even environmentally friendly enough) to fuel the nation. The remaining alternative was a rapid boost in coal burning. Experts, including a minority of environmentalists, pointed out that coal might be worse than nuclear power because of its polluting emissions, including greenhouse gases. Some officials in the government energy establishment called for intensive study of global warming, in case the threat turned out to be severe. “If the CO₂ problem looks big enough,” one of them promised, “we’ll make changes—and fast.”¹

These arguments only reached limited circles in government and industry, scarcely penetrating public consciousness. The sense of urgency about climate change was dwindling away. It had never been very strong, even during the droughts and famines of the early 1970s. By the end of the decade, the collapse of doom-filled claims about an imminent ice age, replaced by uncertain speculations about possible future warming, left little for the media to bite into. The widely reported debates over the speculations of a few scientists, added to confusion about whether even the observed temperatures were falling or rising, convinced many people that the science was too foggy to be worth much attention. Moreover, the basic climate concern of “food security”—the dread of famine that haunted everyone from grandmothers to policy makers—sank out of view for the first time in human history. In the 1970s, the biotechnology “green revolution” burst upon farmers. By the end of the century, world food prices would decline in real terms by some 70%. Neither famine nor anything else relating to climate change seemed immediately worrisome. The topic settled down as a mildly interesting public issue, far less urgent than many others.

Breaking into Politics (1980-1988)

As the 1980s began, the question of global warming had become prominent enough to be included for the first time in some public opinion polls. A 1981 survey found that more than a third of American adults claimed they had heard or read about the greenhouse effect. That meant the news had spread beyond the small minority who regularly followed scientific issues. When pollsters explicitly asked people what they thought of “increased carbon dioxide in the atmosphere leading to changes in weather patterns,” nearly two-thirds replied that the problem was “somewhat serious” or “very serious.”

Most of these people, however, would never have brought up the subject by themselves. Only a small fraction of Americans understood that the risk of global warming was mainly due to carbon dioxide gas from fossil fuels. Meanwhile a survey of Canadians found that people divided about

¹ P.C. White of ERDA, quoted *Business Week* (1977). My own serious awareness of the greenhouse effect began ca.1980 when I began to study pro- and anti-nuclear power arguments; see the brief mention at Weart (1988), p. 338.

equally among those who thought climate change was due to some kind of industrial pollution, those who blamed nuclear tests, and those who pointed to space exploration. (The last was no anomaly, for a good many Americans surveyed in the 1990s still imagined that nuclear power and the space program contributed to global warming.) Most people suspected the issue was something they ought to be concerned about, but among the world's many problems it did not loom large. Even those who worried most about pollution were seldom concerned with global affairs, directing their dismay at the oil spill or chemical wastes that endangered a particular neighborhood.¹

Among climate scientists, concern continued to rise in the early and mid 1980s. Computer models of the climate were rapidly improving and winning the trust of experts. The modelers now said they were quite confident that a global warming of a few degrees would come within the 21st century. To an ordinary citizen, a change of a few degrees might sound trivial. But the scientists understood that it was serious, and science journalists passed along their predictions of sea-level rise and other problems. (Later research confirmed the predictions. For example, a 2004 study estimated that a rise of 3°C sustained over centuries would suffice to melt the Greenland ice cap and put the world's coastal cities deep under water.) "Gloomsday Predictions Have No Fault" was how *Science* magazine summarized the report of one authoritative review panel. The report was noticed even by the *New York Times*, although only deep on an inside page.²

Studies of ancient ice, from deep holes drilled in Greenland and Antarctica, backed up the models. For they showed that over past glacial cycles, temperatures and the CO₂ content of the atmosphere had gone up and down together in close synchrony. Meanwhile, British and American groups announced that the global warming trend, after pausing between 1940 and the mid-1970s, had resumed with a vengeance. On average the world was hotter in 1980, 1981, and 1983 than in any years as far back as good records went (to the mid-19th century). Russian climate scientists in particular were convinced that global warming was already manifest and urged their foreign colleagues to acknowledge it.³

When their scientific findings met with public indifference, more and more climate scientists around the world concluded that they should work to influence government policy. Along with

¹ 38% had heard, half ignorant: Opinion Research Corporation poll, May 1981, USORC.81MAY.R22. 5% Not at all serious, 16% Not too serious, 28% Somewhat serious, 37% Very serious, 24% Don't know: Opinion Research Corporation poll, April 1980, USORC.80APR1.R3M. Data furnished by Roper Center for Public Opinion Research, Storrs, CT. Canadian survey (10% nuclear, 12% people/pollution/urbanization, 14% space exploration): Harrison (1982), p. 731. For 1990s surveys and a valuable general discussion see Thompson and Rayner (1998), pp. 270-73.

² Wade (1979); *New York Times*, Nov. 5, 1979, p. IV:16. These refer to National Academy of Sciences (1979); the conclusion was reinforced by National Research Council (1982). Greenland: Gregory et al. (2004).

³ Russians: see Weiner (1990), p. 101.

the traditional scientists' goal of extracting more funds for their own field of study, most weather experts had come to feel that knowledge of climate change would be vitally important for our civilization. Some went further than urging governments to support research. Convinced that the world faced severe global warming within their children's lifetime, they felt called upon to pressure the world's governments to take active steps to reduce greenhouse gas emissions.

These concerns were reinforced and complicated by the ties that some scientists found with other environmentalist issues. An outstanding example was the distinguished biologist George Woodwell, who was a founder and board member of both the National Resources Defense Council and the World Wildlife Fund. Like many biologists and environmentalists, Woodwell decried the destruction of virgin tropical forests. He worried that changes in human use of land could be so socially disruptive "as to be equivalent to the drastic changes in the human condition that a warming of the climate might lead to."¹ The proliferating slash-and-burn peasants who cleared new fields were driving countless species toward extinction, arousing public sympathies for a battle to "save the rainforests." Activists who linked destruction of tropical species with greenhouse warming could make better headway on both issues. Magazine and television images of landscapes going up in smoke began to catch the public eye. Here at last was an immediate, visible connection of CO₂ emission with ruined nature (even though the scientific connection to global warming was far from certain). Scientists associated with the Environmental Defense Fund, the World Resources Institute, and similar groups began to issue reports and lobby Congress about global warming.²

The great majority of scientists remained politically inactive. They felt they were doing their job by pursuing research, building up the solid evidence that would tell governments what to do. "I really don't have that much talent to try to influence politicians," one climate scientist explained. "It's much better using my talent, staying as anonymous as possible here, and try to publish a paper... Because once you start getting in the political arena,... you lose credibility."³ These scientists might answer a phone call from a reporter but they did not offer the confident and snappy answers that journalists wanted. If pressed to offer policy guidance, they preferred to work in government-sponsored study panels and answer questions posed by administrators. Wouldn't official reports by government science agencies, national academies, and international conferences eventually convey information about what actions were appropriate?

A few scientists felt the world would take too little action on climate change, and too late, unless they personally took the initiative to stir up the public directly. These scientists had to learn some tricks. A Senator might brush off an academic who came to speak with him or his staff, but the Senator paid attention if he saw the scientist on television. Scientists were generally uncomfortable talking with the media. Experience showed how journalists might grab a simple phrase, ignoring the details and qualifications that were inseparable from an accurate scientific

¹ Woodwell (1978), p. 34, see p. 43.

² Ingram and Mintzer (1990).

³ Manabe, interview by Weart, Dec. 1989.

account. A few scientists struggled to get a hearing by deliberately wielding public relations techniques, such as crafting approximately accurate but juicy “one-liner” statements that journalists could pick up. Colleagues who had a rigid sense of scientific precision were disgusted. One respected scientist publicly accused his colleagues of publishing “fiction” instead of sound science, speculating that “some of us feel compelled to emphasize the worst case in order to get the attention of the decision makers who control the funding.”¹

There was indeed an ethical dilemma here, as Stephen Schneider pointed out when other scientists criticized his approaches to the public. It was not easy “to find the balance between being effective and being honest,” he admitted. “But promoting concern over the negative connotations of the greenhouse effect in this media age usually means offering few caveats and uncertainties—at least if you want media coverage. Twenty-second spots on national television programs... do not afford time for hedged statements; and if one is going to influence the public, one simply has to get into the media.”²

To get a reasonably accurate story to the public, the essential people were professional science writers. There were only a few hundred of them scattered about the world, spending most of their time writing up medical news and other topics remote from geophysics. But many of them were thoughtful people who took their responsibilities seriously. They worked to maintain a symbiotic relationship with leading scientists, each side seeking respect and understanding even as they openly used the other for their purposes.

When it came to deciding what scientific developments were news, American journalists tended to take their cues from the *New York Times*. The editors of the *Times* followed the advice of their veteran science writer, Walter Sullivan. A lanky and amiable reporter, Sullivan had frequented meetings of geophysicists ever since the International Geophysical Year of 1957, cultivating a set of trusted advisers in many fields. On the subject of climate, he began listening to scientists like Schneider and, in particular, James Hansen, conveniently located at a NASA institute in New York City. Hansen was energized by his group’s computer studies, which showed that warming was likely. In 1981, Sullivan persuaded his editors to feature a story about climate change, based on a scientific article that Hansen had sent the reporter a few days ahead of its publication in *Science* magazine. For the first time the greenhouse effect made page one of the *New York Times*. Sullivan threatened the world with global warming of “almost unprecedented magnitude,” disrupting agriculture and possibly causing a disastrous rise of sea level. The newspaper followed up with an editorial, declaring that while the greenhouse effect was “still too uncertain to warrant total alteration of energy policy,” it was “no longer unimaginable” that a radical policy change might become necessary.³

¹ Rasool et al. (1983); the stimulus was Hansen et al. (1981), or perhaps the related newspaper report (see below, Sullivan).

² Schneider (1988a), p. 114; see also Schneider (1989a), ch. 7; Nelkin (1987).

³ Sullivan, “Study finds warming trend that could raise sea levels,” Aug. 22, 1981, p. 1, and editorial, Aug. 29, 1981, p. 22, reporting on Hansen et al. (1981). The *Washington Post* also

This was just one example of a process that brought the perils of climate change into newspapers, magazines, and even occasionally television in the early 1980s. The stories usually rested upon statements by leading scientists including Schneider, Broecker, Nobel Prize winner Melvin Calvin and others. Politicians, ever alert to shifts in what the public was worrying about, took notice.¹

The fossil-fuel industries, and other business interests, saw that worries about greenhouse gases might lead to government regulations, following the example of restrictions on smog and spray-can chemicals. Concern also grew among political conservatives, who tended to lump together all claims about impending ecological dooms as left-wing propaganda. When environmentalist ideals had first stirred, around the time of Theodore Roosevelt, they had been scattered across the entire political spectrum. A traditional conservative, let us say a Republican bird-watcher, could be far more concerned about “conservation” than a Democratic steelworker (more recently, at the far end of the traditional Left, Communist nations were the planet’s most egregious polluters). But during the 1960s, as the new Left rose to prominence, it became permanently associated with environmentalism. Perhaps that was inevitable. Many environmental problems, like smog, seemed impossible to solve without government intervention. Such interventions were anathema to the new Right that began to ascend in the 1970s.

By the mid 1970s, conservative economic and ideological interests had joined forces to combat what they saw as mindless eco-radicalism. Establishing conservative think tanks and media outlets, they propagated sophisticated intellectual arguments and expert public-relations campaigns against government regulation for any purpose whatever. On global warming, it was naturally the fossil-fuel industries that took the lead. Backed up by some scientists, industry groups developed everything from elaborate studies to punchy advertisements, aiming to persuade the public that there was nothing to worry about.

The message was easily accepted by many among the public, including some who felt deep sympathy for the natural world. Many still found it incredible that mere human industry could seriously interfere with the awesome planetary forces, seeing these as simply an “environment” that happened to contain and sustain living creatures. Others had finally abandoned that viewpoint, only to take up James Lovelock’s radical “Gaia hypothesis.” Named (in the spirit of the times) after the Greek Earth-goddess, this hypothesis held that the atmosphere was a “contrivance” maintained by the biosphere. There was real scientific content in the idea. But supporters, pushing ahead to assert that life on Earth necessarily and automatically maintains an atmosphere suitable for itself, gave a spuriously scientific gloss to the snug old confidence in the Balance of Nature. (However, some suspected that Gaia would defend “her” balance simply by eliminating humanity itself.)

carried an editorial. Hansen, interview by Weart, Nov. 2000, AIP.

¹ Among other sources for this section, I draw on a talk given by J. Jensen in April 1991..

The most comforting ideas came from a respected scientist, Sherwood Idso, who published arguments that greenhouse gas emissions would not warm the Earth or bring any other harm to climate. Better still, by fertilizing crops, the increase of CO₂ would bring tremendous benefits. His book, *Carbon Dioxide: Friend or Foe?* came down entirely on the side of Friend. In his opinion, the increase of CO₂ “is something to be encouraged and not suppressed.”¹ Along the way Idso attacked the “scientific establishment” for rejecting his theories. His scientific and popular publications stirred vehement controversy.

As environmental and industrial groups and their scientific fellow-travelers hurled uncompromising claims back and forth across a widening political gulf, most scientists found it hard to get a hearing for more ambiguous views. “Our instincts are to fight scientifically fair and to openly admit uncertainty, even when unscientific weapons are deployed,” a climate scientist remarked. “This mismatch often leads to an amplified sense of ‘scientific’ controversy.”² Journalists in search of a gripping story tended to present every scientific question as if it were a head-on battle between two equal and diametrically opposite sides. Yet most scientists saw themselves as just a bunch of people with various degrees of uncertainty, groping about in a fog.

After Ronald Reagan became President in 1981, environmental issues of every kind became a useful tool for opponents of the Republican administration. Reagan and his supporters could be counted on to embarrass themselves with a see-no-evil approach to any industrial activity. The greenhouse effect question now became strongly polarized along political lines. You could usually guess whether someone thought global warming was likely to happen, if you knew what they thought about any sort of government environmental regulation.

The fires of public interest were stoked by Congressional hearings (promoted especially by Albert Gore, who had taken an early interest in the topic). Still more newsworthy was a controversy that broke out in 1983 when the Environmental Protection Agency (EPA) issued a report declaring that the future temperature rise could be catastrophic. As the *New York Times* noted in a front-page story, the EPA report was the first time a Federal agency had declared that global warming was “not a theoretical problem but a threat whose effects will be felt within a few years.” Within decades, the *Times* suggested, the sea level might rise and food production could suffer. That frankly contradicted a soothing report that the National Academy of Sciences had issued just days earlier. According to this report, as Sullivan summarized it in a *Times* editorial, “the greenhouse effect is for real but we can live with it.”

Reagan administration officials, pointing to the Academy’s reassurances, criticized the EPA report as “alarmist.” Here was a tale of battling perspectives, just what journalists needed to make a lively story. It even got onto national television. In the offices of NOAA, the federal agency responsible for climate science, a scientist recorded that “phones have been ringing all

¹ Idso (1982); popularized as unproven but possible by a science journalist, Gribbin (1982), ch. 9; “encouraged” Idso (1984), p. 22; see also Idso (1989).

² Mahlman (1998), p. 97.

over the country.” One historian has suggested that it was this controversy that first pushed climate change into full public view, “transforming the issue from one of scientific concern to one of political controversy.” Certainly it was largely political skirmishing that prompted popular magazines and newspapers to report on the greenhouse effect repeatedly during the early 1980s.¹

Far greater attention went to other atmospheric changes. Air pollution remained a problem in many cities, and now it was joined by dire warnings about “acid rain.” During the 1970s, scientists had begun to report that rain carrying sulfates emitted by power plants and other industries was devastating fish and forests, and even the paint on houses, in certain vulnerable regions. Coal-burning industries quieted local protests by building their smokestacks hundreds of feet high, but that only spread the damage more widely. In the 1980s, the problem stirred extensive political controversy and even international recriminations. Images of moribund stands of trees and decaying statues, attacked by sulfuric acid derived from smokestacks thousands of miles upwind, argued that industrial emissions could be a problem for everyone, everywhere. The excellent environmentalist slogan, “Think globally, act locally,” was no use when power plants half a continent away sickened your neighborhood lake.² Some environmentalists proclaimed that acid rain would eventually damage the entire planet. And this was not the worst global threat.

In 1980, scientists announced a new theory for what had killed off the dinosaurs tens of millions of years ago: an asteroid had struck the Earth and clouded the atmosphere for years, freezing plants and animals. The theory fascinated the public, perhaps less because it addressed dinosaurs than because it addressed extinction. That struck a resonance with deep-set fears of nuclear war, which had revived around the time Reagan took office. As one scientist remarked, the asteroid theory “commanded belief because it fit with what we are prepared to believe... Like everyone else... I carry within my consciousness the images of mushroom clouds.” The idea of global extinction caused by a blast coming from the sky, he said, “*feels* right because it fits so neatly into the nightmares that project our own demise.”³

On Halloween 1983, a group of respected atmospheric scientists held a press conference to make a carefully orchestrated announcement about a different climate catastrophe. They had come to fear that soot from cities torched in a nuclear war might blacken the atmosphere as much as an asteroid strike. Years of cold and dark might jeopardize the survival of all humankind. Didn’t that prove that launching a nuclear attack, even if the other side never fired back, would

¹ Philip Shabecoff, “E.P.A. Report Says Earth Will Heat Up Beginning in 1990’s,” *New York Times*, Oct. 18, 1983, p. 1. Walter Sullivan, “How to Live in a Greenhouse” (editorial), *ibid.*, Oct. 23, 1983, p. IV:18. “Alarmist:” presidential adviser Keyworth, quoted *New York Times*, Oct. 21, 1983, p. 1. Phores: Elliott (1977-89), Oct. 24, 1983 entry. Oreskes (2008b), p. 113.

² McKibben (1989), p. 37.

³ Levenson (1989), p. 32.

be literally suicidal? So maintained a group of well-known experts, including West Europeans and Russians as well as Americans, and most prominently Carl Sagan—a chief spokesperson for the group because his fame, much more as an astronomy popularizer than as an atmospheric scientist, could attract television cameras. The scientists' aim was frankly political. They meant to reinforce a public movement that was just then calling on the United States to reduce its inventory of bombs. Meanwhile the announcement added another layer to public imagination of calamitous global climate change.

Scientific discussions of climate catastrophe from an asteroid strike or nuclear war are described more fully in a supplementary essay on Wintry Doom.

Other scientists questioned the scientific reasoning, and the Reagan administration heaped scorn on its critics. Even before the scientific study was published, government scientists among the authors felt pressure to keep a low profile. The pressure backfired. Forbidden to include the words “nuclear war” in the title of their paper, one of them came up with an evocative phrase—“nuclear winter.” Sagan and others answered their critics in sharp partisan debate. From the outset, a person's views on the climate scientists' predictions could usually be guessed from the person's views about nuclear disarmament. Newspapers, magazines, and even television gave the battle close attention. From this point on, computer calculations of the effects of dust and the fragility of the atmosphere were inescapably entangled in high national politics.¹

While these issues were being thrashed out to exhaustion, public interest in global warming flagged. Around 1984 the coverage of the issue, as measured by numbers of books and magazine and newspaper articles, dropped back.² The spell of unusually bad weather in the early 1970s was fading from memory, and exclamations about an imminent catastrophe waned. Besides, the Clean Air Act plus the ban on ozone-destroying chemicals suggested to the public (as politicians intended) that the most urgent dangers were well in hand. Anyway the news media rarely sustain a high level of anxiety about any topic for more than a few years. Editors dislike publishing article after article on the same subject in the absence of striking new events, for repetition quickly bores the public.

The attention of the minority who continued to worry about planetary doom likewise turned to other problems. Such movements, including fears of nuclear war, tended to rise and fall in decade-long cycles. Back in the mid 1960s, when Cold War tensions had dwindled, many committed activists had turned from their grueling campaign against nuclear weapons to spend their energies on environmentalist causes. Now, with the Reagan administration trumpeting its anti-Soviet belligerence, many activists turned their attention from the environment back to the

¹ Badash (2001) (Turco's term "nuclear winter" on p. 87); also Poundstone (1999), pp. 292-319; Schneider (1988b).

² Magazines and newspaper article counts: Ingram et al. (1990). Books: my counts from the Library of Congress catalog, under “climate” call number QC981, which includes both popular and technical works. 1975-77: 73 books. 1979-81: 97. 1983-1985: 71.

Cold War. The “nuclear winter” controversy was a milestone in the transition to agitation for a “nuclear freeze,” a halt in production of nuclear weapons.¹

Fears of climate change could not hold a candle to fears of nuclear war, nor even to the mounting public concern about peaceful nuclear reactors with their risks of explosions and radioactive wastes. Climate change did include some of the factors that are effective in rousing public anxiety. People are not particularly afraid of risks that seem familiar and within their personal control, feeling only too little anxiety as they smoke or race a red light. Climate change offered less comfortable risks. Dread of the unknown was fostered by a feeling that great forces were at work, operating in a hidden fashion, mysterious even to scientists. Worse, the threat was something new, and growing, and far beyond anyone’s personal control. However, nuclear energy had similar factors in at least equal strength, plus many more hooks digging into people’s minds. Uncanny rays and poisons, menacing authority figures (mad scientist, belligerent general, cold-blooded corporate executive), images of Hiroshima, above all the actual existence of nuclear missiles that might at any moment descend on your home—when such things came back to mind, they easily displaced abstract worries about a few degrees of warming in the next century.²

Although climate arguments faded from the news, they had left a residue in the public mind. The idea that nuclear war might bring global environmental disaster had been familiar for decades as a science fiction scenario. From the start it had brought to mind far older tales—the Ice-Winter at the world’s end in Nordic myth, intertwined with the Bible’s apocalyptic rain of fire. Scientific calculations of “nuclear winter” and other devastation now made it hard to dismiss such visions as fantasy. We cannot observe the deep levels beyond logic where ideas connect in the minds that make up the public, but we can guess at what was happening there. Probably for many people the dread connected with nuclear war, a complex of images and attitudes covering the entire range from politics to paranoia, became loosely associated with feelings about climate change. The idea that humankind itself might trigger global atmospheric change—as if in punishment for our transgressions against the natural order—was looking more than ever like a sober possibility.

This attitude was nailed down in 1985 when a British group announced their discovery of a “hole” in the ozone layer over Antarctica. The discovery could have been made years earlier if scientists had been more on the lookout for ways that a small human production of chemicals could ravage the atmosphere. The apparent culprit was again CFCs, banned from American spray cans but still widely produced around the world for a variety of functions. Inevitably a new controversy began, for again industrial interest groups automatically denied that any of their products could be hazardous. Reagan administration officials reflexively backed the industries against hostile environmentalists.

¹ Weart (1988), pp. 262-69, 299-302, 323-327, 375-87.

² Ungar (1995), includes discussion and references on dread factors and waves of public concern; Weart (1988), *passim*.

This time the denials were short-lived. Within two years experts were convinced. For the public, television showed colorful maps displaying the lack of ozone. A few scientists warned that the same chemicals that destroyed ozone could add to global warming, but that was mostly overlooked. The immediate threat was the ozone destruction, which would increase skin cancers and bring many other biological harms. But many members of the public got ozone depletion confused with global warming, as if the two problems were one. Ignorant of the science, the majority only sensed obscurely that atmospheric changes were looking more dangerous.

The public took a strong interest in the “ozone hole,” forcing a political response. The outcome was an international agreement, forged in Montreal in 1987, to gradually halt production of ozone-destroying substances. If the agreement was enforced, and if it was extended as industry produced new chemicals, that would settle the ozone problem. It would only slightly retard global warming, but the agreement proved that the world could take effective action against an atmospheric threat—if the threat was sufficiently convincing, immediate, and well publicized.

The Summer of 1988

While the public was assimilating the lesson of the ozone hole—the fact that human activity could change elements of the atmosphere both seriously and quickly—scientists were assimilating the latest research. A new breed of interdisciplinary studies was showing that even a few degrees of warming might have harsh consequences, both for fragile natural ecosystems and for certain agricultural systems and other human endeavors. Gradually experts were discovering that even a degree or two of warming might devastate many of the world’s coral reefs, that tropical diseases would invade new territory, and so forth. Still more troubling, it seemed that the entire climate system could change more rapidly than most experts had suspected. A mere couple of decades might bring a shocking surprise. In particular, the circulation of water in the North Atlantic might shift abruptly, which would bring not warmth but severe cooling to the region.

These research findings began to show up sporadically in articles addressed to the science-attentive public. Broecker in particular issued warnings, as when he wrote in *Natural History* magazine that we had been treating the greenhouse effect as a “cocktail hour curiosity,” but now “we must view it as a threat to human beings and wildlife.” The magazine’s editors went even beyond that, putting a banner on the cover that read, “Europe beware: the big chill may be coming.” Might global warming bring a change in ocean currents that would, paradoxically, make London as cold as Labrador? (Broecker was annoyed, for in fact he had given little sustained thought at that time to whether human activities might cause damaging changes in ocean currents.)¹ The notion that a climate catastrophe might descend swiftly was now on the world’s public agenda.

¹ Another example: James Gleick, “Instability of climate defies computer analysis,” *New York Times*, March 20, 1988. Broecker (1987b), quote p. 82; on annoyance Broecker (1991), p. 88.

The idea was not widely heeded, even by the small minority of people who read about such matters. The risk that global warming would bring, for instance, an oceanic change that could freeze Europe, was just one small item among many futuristic concerns. Far more was written about the potential threat of radioactive wastes from nuclear power plants, the perils of genetically modified plants, the remote but exciting possibility of bombardment by a giant asteroid, and so forth.

The most visibly outspoken climate expert was James Hansen. In 1986 and 1987, he created a minor stir among those alert to the issue when he testified before a Congressional committee. He insisted that global warming was no vague and distant possibility, but something that would become apparent within a decade or so. His group of climate modelers claimed that they could “confidently state that major greenhouse climate changes are a certainty.” In particular, “the global warming predicted in the next 20 years will make the Earth warmer than it has been in the past 100,000 years.”¹

News reporters gave only a little attention to Hansen’s November 1987 Congressional testimony, and they did not quote Broecker’s January 1987 statement at all, as newspapers filled their columns with stories of a severe winter storm. A report a few months later that the 1980s were proving to be the hottest years ever recorded did make it into the *New York Times* (March 29) but only on an inside page. As the summer of 1988 began, global warming remained below the threshold of public attention. Roughly half the American public were not even aware of the problem. Those who had heard about warming mostly saw it as something that the next generation might need to worry about, or might not.

A shift of views had been prepared, however, by the ozone hole, acid rain, and other atmospheric pollution stories, and by a decade of agitation on these and many other environmental issues, and by the slow turning of scientific opinion toward stronger concern about global warming. Only a match was needed to ignite the worries. This is often the case for matters of intellectual concern. No matter how much pressure builds up among concerned experts, some trigger is needed to produce an explosion of public concern.

The trigger came in the summer of 1988. Already by June, heat waves and drought had become a severe problem, drawing public attention to the climate. Many newspaper, magazine, and television stories showed threatened crops and speculated about possible causes. Hansen raised the stakes with deliberate intent. “I weighed the costs of being wrong versus the costs of not talking,” he later recalled, and decided that he had to speak out. By arrangement with Senator Timothy Wirth, Hansen testified to a Congressional hearing on June 23. He had pointed out to Wirth’s staff that the previous year’s November hearings might have been more effective in hot

¹ The 1986 hearings, held by Republican Senator John Chafee, “transformed the priority of the greenhouse issue, making it more important in policy decisions” according to Pomerance (1989), pp. 262-63; quotes: Hansen et al. (1987), prepared for testimony to the United States Senate Committee on Energy and Natural Resources, 9 Nov. 1987.

weather. Wirth and his staff decided to hold their next session in the summer, although that was hardly a normal time for politicians who sought attention.¹

Their luck was good. Outside the room, the temperature that day reached a record high. Inside, Hansen said he could state “with 99% confidence” that a long-term warming trend was underway, and he strongly suspected that the greenhouse effect was to blame. Relying not only on his computer model work but also on elementary physical arguments, he warned that global warming was liable to bring more frequent storms and floods as well as life-threatening heat waves.²

Talking with reporters afterward, Hansen said it was time to “stop waffling, and say that the evidence is pretty strong that the greenhouse effect is here.” Some news reports confused Hansen’s assertions, reporting that he was virtually certain that the greenhouse effect was the cause of the current droughts.³ The story was no longer a scientific abstraction about an atmospheric phenomenon: it was about a present danger to everyone from farmers to the owners of beach houses.

The timing was right, and the media leaped on the story. Hansen’s statements, especially that severe warming was likely within the next 50 years, got on the front pages of newspapers and were featured in television news and radio talk shows.⁴ Many climate experts, innately repulsed by the inaccuracies and exaggerations of the public arena, felt Hansen had gone too far beyond what the scientific evidence justified. Some respected scientists publicly rebuked him.⁵ The problem, however, lay not so much with his explicit statements as with his combative tone and the way the media reacted to it.

¹ Pool (1990), quote p. 672. Also Hansen, interview by Weart, Nov. 2000.

² Hansen (1988); Hansen et al. (1988) gives the scientific basis, predicting global temperatures in the 1990s would be indisputably above 1950s levels. In 2000 Pat Michaels claimed that time had shown Hansen’s 1988 prediction of temperature increase was exaggerated by 450%, a claim later picked up by novelist Michael Crichton and others. In fact Hansen had presented three scenarios, including a worst-case one (no volcanic eruptions to hold down temperature, accelerated emissions, etc.) and two more likely ones. Michaels et al. spoke only of the worst-case scenario and did not mention Hansen’s predictions of what was likely, which have turned out to be correct.

³ Philip Shabecoff, “Global Warming Has Begun, Expert Tells Senate,” *New York Times*, June 24, 1988, p. 1. See Hansen, interview by Weart, Nov. 2000, AIP, and Stevens (1999), pp. 131-33; Weiner (1990), pp. 87-97.

⁴ E.g., Howard Koppel’s “Nightline” ABC-TV. The following day (24 June) I heard worries voiced by a number of callers to a radio talk show (Jim Althoff, WKING). Hansen was mentioned or quoted more than twice as often as anyone else on the issue during 1985-1991 according to Lichter (1992).

⁵ Criticism by scientists: Kerr (1989b); Kerr (1989a); Bolin (2007), p. 49.

The story grew as the summer of 1988 wore on. Thanks to the heat and drought, reporters descended unexpectedly upon an international conference of scientists held in Toronto at the end of June. Their stories prominently reported how the world's leading climate scientists declared that atmospheric changes were already causing harm, and might cause much more, demanding vigorous government action to restrict greenhouse gases. Meanwhile the heat waves and droughts continued, the worst since the Dust Bowl of the 1930s, devastating many regions of the United States. Old people died in cities, shops ran out of air conditioners, many communities imposed water rationing, there were fears of a new Dust Bowl, and the level of the Mississippi River fell so low that barge traffic was paralyzed. On top of that came "super hurricane" Gilbert and the worst forest fires of the century. Cover articles in news magazines, lead stories on television news programs, and countless newspaper columns offered dramatic images of sweltering cities, sun-blasted crops, and Yellowstone National Park aflame.

Reporters asked, were all these caused by the greenhouse effect? Simply from endless repetition of the question, many people became half convinced that human pollution was indeed to blame for it all. The images triggered the anxieties that had been gradually building up about our interference with weather. As one scholar who studied these events put it, "Whether regarded as a warning signal or a metaphor of a possible future, the weather unleashed a surge of fear that brought concentrated attention to the greenhouse effect."¹

News reports often failed to explain that scientists never claimed that a given spell of weather was an infallible reflection of global warming. Schneider, who also testified in Congressional hearings and was often quoted, suggested that "the association of local extreme heat and drought with global warming took on a growing credibility simply from its repeated assertion." He worried that the media exaggerations would bring the public to dismiss climate science as unreliable when the next cold, wet season arrived.² But Schneider, Hansen, and their fellows could only be pleased that the issue had at last gotten into the spotlight. "I've never seen an environmental issue mature so quickly," an environmental advocate remarked, "shifting from science to the policy realm almost overnight."³

The number of articles on climate listed in the *Readers' Guide*, which had held steady since the mid 1970s, took a quantum leap upward. Between spring and fall of 1988 the number of articles listed abruptly tripled, and over following years remained at the new level. The number of American newspaper articles on global warming jumped tenfold in 1988 over what was published in 1987 (which was already well above the negligible number published a decade earlier) and continued to rise in following years.⁴ For the first time, global warming showed up

¹ Ungar (1992), p. 491 and passim.

² Schneider (1988a), p. 113.

³ Michael Oppenheimer quoted in *New York Times* 8/23/88 as quoted in Stevens (1999), p. 133.

⁴ My counts of *Readers' Guide*. Annual number of articles about global climate change printed in major U.S. newspapers (*Los Angeles Times*, *New York Times*, *Christian Science*

repeatedly in the most widely read of all American media, the comic strips. In the second half of 1988 the problem got a mention in such highly popular, and normally scarcely topical, strips as “Kathy,” “Calvin and Hobbes,” “Little Orphan Annie” and even “Dick Tracy.” Their creators could take it for granted that readers understood their clever remarks about warming.

A killing heat wave in China, a ghastly flood in Bangladesh, and spectacular episodes of ocean pollution in Europe gave climate worries a global reach. The Toronto meeting, and many other avenues of communication among environmentalists and scientists, helped spread concern internationally. In Germany, to take one case, a subgroup of the German Physical Society had already prepared attitudes with a 1986 report carrying the dramatic title, “Warning of the Impending Climate Catastrophe.” Although most scientists quickly backed away from the apocalyptic tone, from then on the phrase “*Klimacatastrophe*” permeated Germany’s media and public consciousness. Attention mounted steadily through 1988 and into the early 1990s.¹

In September 1988 a poll found that 58% of Americans recalled having heard or read about the greenhouse effect. It was a big jump from the 38% that had heard about it in 1981, and an extraordinarily high level of public awareness for any scientific phenomenon. Most of these citizens recognized that “greenhouse effect” meant the threat of global warming, and most thought they would live to experience climate changes.² In other polls, a majority of Americans said that they thought the greenhouse effect was “very serious” or “extremely serious,” and that they personally worried “a fair amount” or even “a great deal” about global warming. Fewer than one-fifth said they worried “not at all” or had no opinion.³

Monitor, Washington Post, Wall Street Journal) was zero in 1979-1980, rising to roughly two per newspaper per year through 1987, then from 1987 to 1988 jumped to some twenty per newspaper. Ingram and Mintzer (1990), p. 4; see also Trumbo (1996), p. 276; Wilkins (1993), pp. 75-76 (newspaper stories rose from 73 in 1987 to 574 in 1990); between 1986 and 1990 there was a fivefold jump in climate change articles in three German news publications, O’Riordan and Jäger (1996), p. 27; see Beuermann and Jäger (1996), p. 192; Ungar (1995), pp. 446-47.

¹ Weingart et al. (2000).

² 1988: Kane, Parson poll for *Parents Magazine*, USKANE.88PM7.RO98 and R11, data furnished by Roper Center for Public Opinion Research, Storrs, CT. By 1989, another poll found that 79% of the public had heard of the greenhouse effect: survey of public by Research Strategy/Management Inc., ‘Global Warming and Energy Priorities,’ Union of Concerned Scientists, 11/89, as reported in W. Kempton, “Global Environmental Change,” 6/91.

³ Sept. 1988 poll of voters by Market Opinion Research found 53% considered the greenhouse effect “Extremely serious” or “Very serious” and another 25% “Somewhat serious.” USMOR.ATS9.R11. May 1989 Gallup poll, worries on various issues: 35% Great deal about global warming, 28% Fair amount, 18% Only a little, 12% Not at all, 7% No opinion. USGALLUP.051589.R3J. Data furnished by Roper Center for Public Opinion Research, Storrs, CT.

Politicians could not overlook such strong public concern—nor could they overlook the heat in the capital city itself, where the summer of 1988 was the hottest on record.¹ Congress saw a flurry of activity as some 32 bills dealing with climate were introduced.² Whether or not attention could be sustained at such a high level, global warming had finally won a prominent and enduring place on the public agenda.

Now that nuclear war concerns were fading as the Soviet Union decayed, people striving to reform the world could redirect their energies toward environmental issues. The environmental movement, which had found only occasional interest in global warming, now took it up as a main cause. Groups that had other reasons for preserving tropical forests, promoting energy conservation, slowing population growth, or reducing air pollution could make common cause as they offered their various ways to reduce emissions of CO₂. Greenpeace, the Environmental Defense Fund, the Sierra Club, and many other organizations made reduction one of their top priorities.³ Adding their voices to the chorus were people who looked for arguments to weaken the prestige of large corporations, and people who wanted to scold the public for its wastefulness. For better or worse, global warming became identified more than ever as a “green” issue. In principle it could have been viewed instead as a technical problem of global engineering (how should we manage the planet’s climate?). But pollution and weather disasters brought in high economic stakes and potent imagery. Global warming was no longer just a research question, but a subject of hostile political maneuvering.

In the long perspective, it was an extraordinary novelty that such a thing became a political question at all. Global warming was invisible, no more than a possibility, and not even a current possibility but something predicted to emerge only after decades or more. The prediction was based on complex reasoning and data that only a scientist could understand. It was a remarkable advance for humanity that such a thing could be a subject of widespread and intense debate.

Discourse had grown more sophisticated in many ways. That may have been partly because of the steady accumulation of knowledge, and also because the public in wealthy countries had become better educated (a larger fraction of young people was now going to college than had gone to high school at the start of the century). Furthermore, stable times encouraged people to plan farther into the future than in earlier eras. So too, perhaps, did the unexpected addition of decades to the average lifespan.

The debate was also made possible by the new relationship that had grown between people and the atmosphere, indeed with all nature. Global warming, along with the ozone hole and acid rain and smog, had obscurely entangled the atmosphere in politics. The winds and clouds had taken

¹ The seven days of temperatures 100°F or higher exceeded anything seen before or in the following decade. Doe (1999).

² Ingram and Mintzer (1990), p. 4. N.b. The lower Congressional activity count cited in my “government” essay is based on Balco’s simple computer word search.

³ Sarewitz and Pielke (2000), pp. 57-58.

on (as one observer later mused) “a vaguely sinister cast... It was perfect weather for postmodernists: inescapably self-referential.”¹ In an influential *New Yorker* magazine article and book, nature writer Bill McKibben announced “The End of Nature.” In 1900, nature had surrounded our towns and fields. People saw it partly as a nurturing setting for humanity, and partly as a savage “outside” to be tamed and civilized. By the 1970s, more and more people had come to see nature the other way around, as a preserve surrounded by civilization. Now the preserve itself had been overrun.

It was not just that our pollution invisibly invaded the atmosphere. The feeling of contamination by radioactive fallout and acid rain was bad enough, yet those seemed like reversible additions, superimposed upon the old natural system. The greenhouse effect was different, McKibben declared, for “the *meaning* of the wind, the sun, the rain—of nature—has already changed.” Now every cloud, every breeze, bore the imprint of human hands. The taint was not only around us but within us. People bowed to sadness and guilt as we realized that we had “taken a hammer to the most perfectly proportioned of sculptures.”²

After 1988

After the flood of global warming stories in the summer of 1988, media attention inevitably declined as more normal weather set in. It is typical of topics in the news that unless they regularly produce something new and exciting, they will not linger for long near the top of the list of concerns. Even for a potential danger, readers will become discouraged or simply bored when nothing immediate is done, and editors will look for something novel to cover. It was still less likely that interest in climate change would remain high when weather is notoriously fickle—the winter of 1989 was a particularly cold one. The climate change story also lacked an interesting enemy, a devil (other than ourselves) to blame for the world’s woes.³ But even if an issue is no longer in the forefront of everyone’s mind, it can remain present. Although press coverage of global warming sank after its peak in the summer of 1988, it now fluctuated around a much higher average level than in the early 1980s.⁴

The issue had entirely caught the attention of one vital section of the public—the scientific community. It is impossible to judge how far scientists altered their research plans because of aroused public interest. Scientists were far more aware than the general public of how the scientific findings of the past decade, the supercomputer calculations and ice core measurements and data on rising global temperatures, had raised the plausibility of greenhouse warming models. At a minimum, the big step up in public interest suggested that anyone studying the topic would get a better hearing when requesting funds, recruiting students, and publishing.

¹ Burdick (2001).

² McKibben (1989), quotes p. 48, 86.

³ Ungar (1992), pp. 493-94.

⁴ Trumbo (1996).

For whatever reason, climate research topics now became far more prominent in the scientific community itself. Prestigious general-science journals like *Nature* and *Science*, and popularizing magazines like the *New Scientist*, had published perhaps one or two significant climate articles per year in the early and mid 1980s. Now they began to publish one almost every week. The higher level was sustained over the following years. This was probably a main reason why the general press, whose science reporters took their cue from scientists and their journals, continued to carry numerous articles on climate change.

In the specialized scientific journals themselves, citations to topics like “greenhouse gases” and “climate modeling” had held fairly steady at a low level through the mid 1980s, but after 1988 they rose spectacularly. References to the subject continued to rise ever higher through the 1990s. Citations to climate change in social-science journals began to soar at the same time.¹ Meanwhile scientific conferences proliferated, ranging from small workshops to highly publicized international events, so numerous that nobody could attend more than a fraction.

Environmentalist organizations continued to make global warming a main focus, carrying on with sporadic lobbying and advertising efforts to argue for restrictions on emissions. The environmentalists were opposed, and greatly outspent, by industries that produced or relied on fossil fuels. Industry groups not only mounted a sustained and professional public relations effort, but also channeled considerable sums of money to individual scientists and small conservative organizations and publications that denied any need to act against global warming.² This effort followed the pattern of scientific criticism and advertising that industrial groups had used to attack warnings against ozone depletion and acid rain (not to mention automobile smog, tobacco smoke, etc.). Although those campaigns had been discredited after a decade or two, fair-minded people were ready to listen to the global warming skeptics.

It was reasonable to argue that intrusive government regulation to reduce CO₂ emissions would be premature, given the scientific uncertainties. Conservatives pointed out that if something did have to be done, the longer we waited, the better we might know how to do it. They also argued that a strong economy (which they presumed meant one with the least possible government regulation of industry) would offer the best insurance against future shocks. Activists replied that action to retard the damage should begin as soon as possible, if only to gain experience in how to restrict gases without harming the economy. They argued hardest for policy changes that they had long desired for other reasons, such as protecting tropical forests and removing government subsidies that promoted fossil fuel use.

The topic had become still more politicized. A study of American media found that in 1987 most items that mentioned the greenhouse effect had been feature stories about the science, whereas in

¹ Chambers and Brain (2002). The authors point out that this may partly reflect a greater likelihood of putting terms like “climate change” in the titles of papers that dealt with narrow problems.

² Gelbspan (1997), esp. ch. 2.

1988 the majority of the stories addressed the politics of the controversy. It was not that the number of science stories declined, but rather that as media coverage doubled and redoubled, the additional stories moved into social and political areas.¹ Another study similarly found that before 1988, some three-quarters of the articles on climate change in leading American newspapers described the problem and its causes, whereas by the early 1990s, more than half of the far more numerous articles focused on claims about proposed remedies or on moral judgments. Before 1988, the journalists had drawn chiefly on scientists for their information, but afterward they relied chiefly on sources who were identified with political positions or special interest groups.² Meanwhile the interest groups themselves, from environmentalists to automobile manufacturers, increasingly advertised their views on global warming.

Both scientific and political arguments were thoroughly entangled with broader attitudes. Public support for environmental concerns in general seems to have waned after 1988. Along with the natural exhaustion of all movements once they have achieved some of their goals, the ignominious collapse of Soviet Communism greatly increased the confidence of those who opposed government intervention in economic affairs. Actually it was in the Soviet Union, more than anywhere, that unrestricted pollution had shown that the horrifying predictions of environmentalists could come true. People who sought to restrict greenhouse gases, however, could not shake loose from the association of restrictions with over-centralized command of the economy.

Many believed that only good could come of whatever the triumphant free-market economy produced, including greenhouse gases. A few scientists sustained the old argument that the “enrichment” of the atmosphere by CO₂ would be a positively good thing for agriculture and for civilization in general. Some thought global warming itself would be all for the better. Russians in particular, in their bleak winters, looked forward to an improved climate. At the end of 1988, the senior Russian climatologist Mikhail Budyko told an international conference of scientists that global warming would make tundra regions fertile—an argument received, an American scientist recalled, like “swearing in the church.” (Budyko did agree however that whatever the effects of global warming in the 21st century, over the longer term it could well be dangerous.)³

The main argument offered against regulating greenhouse gases was simply to deny that warming was likely to come at all. A few scientists insisted that the statistics of record-breaking heat since the 1970s were illusory. The most prominent of these skeptics was S. Fred Singer, who retired in 1989 from a distinguished career managing government programs in weather satellites and other technical enterprises, then founded an environmental policy group. He got financial support from conservative foundations and fossil fuel corporations. Among other objections, Singer argued

¹ Wilkins and Patterson (1991), pp. 169-70.

² Trumbo (1996), pp. 278-29; see also Wilkins (1993), p. 78.

³ McGourty (1988). Budyko spoke even more strongly about the benefits in my 1990 interview with him, AIP, and I have heard other informed Russians say global warming would be a good thing for their country.

that all the expert groups had somehow failed to properly account for the well-known effects of urbanization when they compiled global temperature statistics.¹ Other skeptics pointed to analysis of satellite data that failed to show warming (debate continued all through the 1990s before studies demonstrated that the satellite instruments a poor measure of surface warming). Some conceded that global temperatures had risen modestly, but held that the rise was just a chance fluctuation. After all, for centuries there had been gradual drops and rises of average temperature around the North Atlantic, in particular. Why couldn't the next decades experience a cooling? They entirely disbelieved the computer models that predicted warming from the greenhouse effect. All of these arguments had at least some validity, and the citizen with a taste for science could pick up the ideas from occasional semi-popular articles.

Especially well founded were the doubts about computer model predictions. Different models gave different predictions for just how a given locality would be affected by global warming (or at any rate by "global climate change," the more general phrase that cautious writers were adopting). Still, all the models agreed pretty well on the projected *average* warming. The main trend turned out to faithfully confirm the predictions of old and simple hand-waving arguments. Yet when critics (like the respected meteorologist Richard Lindzen) set a strict scientific standard, demanding solid proof that no crucial effect had been left out, the modelers had to admit that many uncertainties remained and they had much work to do.

The science remained ambiguous enough to leave scientists, like everyone else, susceptible to influence from their deepest beliefs. The wish to personally preserve and improve the world, often a strong motivation for those who chose scientific careers, was not restricted to supporters of environmental regulations. Journalists remarked that the scientific critics of global warming were mostly strong political conservatives, deeply opposed in principle to extensions of government power. Their intense skepticism about global warming could seem, as one journalist noticed, to grow less from research than from a "distaste for any centralized government action" and an almost "religious" faith that humanity would not be laid low.² Conservatives in return advised that the most strident official and scientific warnings about global warming seemed designed to promote government action, not only on behalf of the environment but on behalf of empowering bureaucracies and climate researchers themselves. Yet no scientists claimed that their chief concern was political. What would ultimately matter was whether global warming was truly a menace.

The technical criticism most widely noted in the press came in several brief "reports"—not scientific papers in the usual sense—published between 1989 and 1992 by the conservative George C. Marshall Institute. The anonymously authored pamphlets came with the endorsement of Frederick Seitz, former head of the National Academy of Sciences, an ageing but still highly admired scientist whose expertise had been in solid-state physics. The reports assembled a well-

¹ On Singer see, e.g., Lancaster (1994); Stevens (1999), ch. 14; Singer (1998). His Science and Environmental Policy Project is at <http://www.sepp.org>.

² "distaste": Royte (2001).

argued array of skeptical scientific thinking, backed up by vocal support from a few reputable meteorologists. Concerned that proposed government regulation would be “extraordinarily costly to the U.S. economy,” they insisted it would be unwise to act on the basis of the feeble global warming theories and data.¹

Opponents of regulation made sure that the technical uncertainties described in the Marshall Institute reports and elsewhere became widely known. In 1989 some of the biggest corporations in the petroleum, automotive, and other industries created a Global Climate Coalition, whose mission was to disparage every call for action against global warming. Operating out of the offices of the National Association of Manufacturers, over the following decade the organization would spend tens of millions of dollars. It supported lectures and publications by a few skeptical scientists, produced slick publications and videos and sent them wholesale to journalists, and advertised directly to the public every doubt about the reality of global warming.² The criticism fitted well with the visceral distrust of environmentalism that right-wing political commentators were spreading. The scientific criticism particularly influenced President George H.W. Bush’s administration. Enough of the public was likewise sufficiently impressed by the skeptical advertising and news reports, or at least sufficiently confused by them, so that the administration felt free to avoid taking serious steps against global warming.

Scientists noticed something that the public largely overlooked: the most outspoken scientific critiques of global warming predictions did not appear in the standard scientific publications, the “peer-reviewed” journals where independent scientists reviewed every statement before publication. The critiques tended to appear in venues funded by industrial groups, or in conservative media like the *Wall Street Journal*. Most climate experts, while agreeing that future warming was not a proven fact, found the critics’ counter-arguments dubious, and some publicly decried their reports as misleading “junk science.”³ Other experts, Hansen for one, exclaimed that “wait and see” was no way to deal with the “climate time-bomb.” Going beyond calls to limit greenhouse gas emissions, he concluded that “governments must foster conditions leading to

¹ The conservative political connections of the Marshall group (Seitz, William Nierenberg and Robert Jastrow) had been shown earlier when they lent their names to support of President Reagan’s anti-missile program (“Star Wars”) even as many other respected physicists attacked the scheme as technologically infeasible. The first and most important Marshall report emphasized the argument that recent warming was due to solar activity, which was expected to diminish and cool the Earth in later decades. Seitz et al. (1989); Seitz (1990); “costly”: Seitz (1992), p. 28; on this and similar criticism see Stevens (1999), ch. 14, and Hertsgaard (2006).

² Union of Concerned Scientists (2007). See also information on the Coalition compiled by the Center for Media & Democracy, Madison, WI, online at <http://www.prwatch.org/>, in particular http://www.sourcewatch.org/index.php?title=Global_Climate_Coalition.

³ “junk”: Roberts (1989).

population stabilization.”¹ On several points open conflict broke out between some scientists, with acrimonious and personalized exchanges.²

To science journalists and their editors, the controversy was confusing, but excellent story material. The American media gave climate change substantial coverage through the late 1980s and early 1990s, notably in the *New York Times*, which still largely set the agenda for other American media. News magazines published many stories, although television gave only light coverage. Many reporters took a skeptical view of the administration’s position. Outside a few deeply conservative media like the *Wall Street Journal* and right-wing talk radio programs, journalists tended to accept that greenhouse warming was underway. Following the usual tendency of the media to grab attention with dire predictions, a majority of the reports suggested that the consequences of global warming could be cataclysmic, with devastating droughts, ferocious storms, waves attacking drowned coastlines, the spread of deadly tropical diseases. The worst consequences were expected for certain vulnerable developing nations, but as usual the American media gave little attention to the rest of the world. Many stories optimistically suggested that technological progress would solve the problem. Journalists did not often emphasize that citizens might have to make hard choices between conflicting values.

Seeking the excitement of conflict, as was their wont in covering almost any subject, some reporters wrote their stories as if the issue were a simple fight between climate scientists and the Republican administration. The ideological dimension was stressed by conservative think tanks (the Cato Institute, Competitive Enterprise Institute, Heritage Foundation, Hoover Institution, etc.) which increasingly sponsored pamphlets, press releases, public lectures and so forth, arguing that global warming was not really a problem at all. It was just “junk science,” they claimed, a “scare tactic” worked up for selfish purposes by power-seeking bureaucrats and radical environmentalists.

Many journalists responded by presenting the issue as if it were a quarrel between two diametrically opposed groups of scientists. Reporters often sought an artificial balance by matching “pro” with “anti” scientists, one against one. A study of major U.S. newspapers found that up to 1994, climate scientists who were highly respected by their peers were cited considerably more frequently than the skeptics associated with conservative think tanks, but after 1995, as the conservatives grew more active, newspapers cited the two groups about equally.³

When scratch surveys sought the real opinions of climate scientists, most of them revealed mixed feelings. A modest majority believed that global warming was very probably underway. It was only a small minority who insisted there was no problem, while at least as many insisted that the

¹ Hansen and Lacis (1990).

² See, e.g., Lancaster (1994) and references therein.

³ Lichter (1992); Wilkins (1993); also Anderson (1992). Think tanks and newspaper counts: McCright and Dunlap (2003), see also McCright and Dunlap (2000). Here and below I also use my own observations of popular media, publicity by private groups, and scientific publications and meetings.

threat was acute. Amid the publicized controversy, it was hard to recognize that there was in fact a consensus, shared by most experts—global warming was quite probable although not certain. Scientists agreed above all that it was impossible to be entirely sure. The media got that much right, for most reports in the early 1990s emphasized the lack of certainty.

Recognizing the need for a better representation of what scientists did and did not understand, climate scientists and government bureaucrats formed an Intergovernmental Panel on Climate Change (IPCC). The IPCC's committees managed to forge consensus views that almost every expert and official could accept, and published them as definitive reports. The first IPCC report, released in 1990, rehearsed the usual ambiguous warnings about the possibilities of global warming. This was nothing exciting or surprising, and the report got hardly any newspaper coverage.¹ Yet scientific opinion was shifting, although so gradually that it would take a special event to make that appear as "news."

An opportunity came with the second IPCC report, issued late in 1995. The somnolent public debate revived on the news that the panel had agreed that the world really was getting warmer, and that the warming was probably caused at least in part by humanity. Although many scientists had been saying that for years, this was the first formal declaration by the assembled experts of the world. It was page-one news in many countries, immediately recognized as a landmark in the debate. (Other warnings from the panel, such as the possibility of climate "surprises," were less noted.)² Better still for reporters, the report stirred up a nasty controversy, for a few critics cast doubt upon the personal integrity of some IPCC scientists. The principle target, a main author of the report, remarked that he had to spend the better part of the following summer dealing with journalists and e-mails. On each side, some people were coming to believe that they faced a dishonest conspiracy, driven by ideological bias and financial self-interest.³

Even more newsworthy was the international Kyoto Climate Conference, scheduled for December 1997. Here was where governments would make real economic and political decisions on the use of fossil fuels. The administration of President Bill Clinton made a bid for public support for a treaty, holding a well-publicized conference of experts on climate change in October. Editors saw a story line of conflict developing as they anticipated the Conference. News reports were further stimulated by advertising campaigns and other intense public relations efforts, funded by environmental organizations on the one hand, by the Global Climate Coalition

¹ The *New York Times* put the news on p. 6 (May 26, a Saturday).

² "Unlikely to be entirely due to natural causes" was the phrase quoted from a preliminary draft, by William K. Stevens in the *New York Times*, Sept. 10, 1995, p. 1, see also Nov. 18, p. 1. The less dramatic final negotiated statement ("the balance of evidence suggests that there is a discernible human impact") was more widely noted than the scientific report, which said, "the observed warming trend is unlikely to be completely natural in origin," IPCC (1996), p. 5.

³ B. Santer, responding to an attack that began with an op-ed by F. Seitz in the *Wall Street Journal*, June 12, 1996. See Edwards and Schneider (2001); Masood (1996); Stevens (1999), ch. 13; Bolin (2007), pp. 128-130; Lahsen (1999).

of industrial corporations on the other. Television stories dealing with global warming jumped from a mere dozen in July-September to well over 200 in October-December. Surveys conducted around the time of the meeting found about ten percent of the American public saying they followed the global warming news “very closely,” a substantial fraction for such an issue (for more exciting stories, the fraction could be several times higher). Most of the news items asserted that global warming was underway, with barely a tenth including any expression of doubt. Yet after the Conference, the wave of attention faded away as quickly as it had come, leaving almost no change in public opinion overall.

However, a detailed survey found movement beneath the surface. Asked whether global warming was happening, the gap between strong Democrats (who mostly agreed with President Clinton that it was a problem) and strong Republicans (mostly skeptical) had widened. The main result of all the effort was only to further politicize the issue.¹

...and After Kyoto

Many climate scientists were taking a more unequivocal or even activist stance. A much smaller number of skeptics opposed them. Some of these skeptics argued publicly that the 20th century's global warming (if it existed at all) had come only because the Sun had temporarily turned more active. During the 1990s they produced some fairly plausible data and theories on why global warming either was not happening, or was not caused by humans. Most other experts found these arguments weak. A historian of science who reviewed nearly 1000 abstracts of technical articles, published in peer-reviewed scientific journals between 1993 and 2003, found that "none of the papers disagreed with the consensus position." (The media would cite this study repeatedly over the next decade, and the author was even invited to testify to a Congressional committee, a rare use indeed of historical expertise.) In the minds of nearly all scientists, or at least those not connected financially to the energy industries, the case for human-caused (“anthropogenic”) global warming was as well proven as anything in geophysics.²

The editors of *Nature* magazine remarked in 2000 that “The focus of the climate change debate is shifting from the question of ‘will there be climate changes?’ to ‘what are the potential consequences of climate change?’” Even some of the remaining skeptical scientists would admit, if pressed, that the greenhouse effect would make itself felt eventually. Some went on to claim that this would bring net benefits. Others retreated to the position that in any case it made no

¹ 9% closely followed the U.S. global warming policy debate in November and 11% the Kyoto conference in December, according to Pew Research Center for the People & the Press, “Public Attentiveness to News Stories: 1986–2006,” <http://people-press.org/nii/bydate.php> (accessed 5/07); Krosnick et al. (2000), TV counts p. 241, doubts in 15 percent of newspaper stories and 8 percent of television, p. 242, politicization p. 253; Mahlman (1998), pp. 101-103.

² Study of papers: Oreskes (2004). U.S. Senate Committee on Environment and Public Works, Dec. 6, 2006.

sense to regulate emissions, for the only reasonable policy, as one prominent critic insisted, was “to adapt to climate change.”¹

As the international consensus of scientists became clear, some business leaders began to think that it was only prudent to plan for the contingency that restrictions would some day be imposed on greenhouse gas emissions. Moreover, public opinion might turn against their business if it took the wrong stand on global warming. Executives in the insurance industry began to worry that climate change itself might hurt their profits, for in fact their payouts for storms, droughts and floods were increasing at a surprising rate. Pressed by environmentalist groups as well as by general public opinion, prominent corporations pulled out of the Global Climate Coalition. By 2000 many publicists were abandoning the claim that there was no global warming problem, and shifting to claims about the most business-friendly way to address it. More efficient use of fossil fuels, alternative energy sources (not forgetting nuclear), and changes in forestry and agriculture all held promise for improving profits while reducing emissions. Other corporations persisted in denial. The largest of these, ExxonMobil, continued until 2007 to spend millions of dollars on false-front organizations that amplified any claim contrary to the scientific consensus²

In between episodes of debate, the issue occupied little of the public’s attention. Television weather news, the only place where much of the public might get climate information on a regular basis, preferred to avoid the issue altogether. It was too complex, too hard to connect with the day’s local events, too highly politicized, and perhaps too depressing for what were basically entertainment programs. As one reporter put it, global warming was “not the kind of bad news people want to hear in a weather forecast.”³ Most politicians likewise saw little to gain by stirring up the issue. In the absence of manifest public concern, why devote time to such an issue (especially if it went against short-term business interests)? Even Gore mentioned global warming only briefly during his run for the presidency in 2000.

¹ Admission: e.g., Singer (1998), p. 71. The admission that warming will come is implicit in the book, but he said it explicitly in a throwaway remark in a physics dept. colloquium I attended at the University of Maryland, College Park, 24 Nov. 2000. Prominent critic: Michaels and Balling (2000). Nature (2000).

² Union of Concerned Scientists (2007), p. 2. Greenpeace International posted documentation at <http://www.exxonsecrets.org/>. Shortly after publication of the UCS study, Exxon, now under a new CEO, announced it had cut its ties with the Competitive Enterprise Institute, a linchpin of the publicity and lobbying. The retired CEO, Lee Raymond, later endorsed a call for companies to mind their greenhouse emissions (*New York Times*, July 19, 2007). In May 2008 an Exxon spokesperson confirmed that the corporation was also cutting off other groups, like the Marshall Institute and the Institute for Energy Research.

³ Seabrook (2000), p. 53. According to one weather report producer, angry responses from viewers who doubted the risk from global warming made him “hesitant to do more on the air. We hate to run things that turn off viewers.” Linda Baker, “Just Say It’s Sunny,” *Salon.com* (viewed April 4, 2004; no longer online).

Science reporters would occasionally find a news hook for a story. The press took mild notice when experts announced that 1995 was the warmest year on record for the planet as a whole, and when 1997 broke that record, and when 1998 broke the record yet again. The impact was muted, however, since these figures were averages, and the warming happened to be most pronounced in remote ocean and arctic regions. Some smaller but important places—in particular the U.S. East Coast, with its key political and media centers—were not experiencing the warming that was becoming evident in many other regions.

Reports of official studies by government or international panels each had their day in the limelight, but rarely more than a day. Stories made more of an impression if they dealt with something visible, as when ice floes the size of a small nation split off from the Antarctic ice shelves.¹ Other chances to mention global climate change came in stories about heat waves, floods, and coastal storms, especially when the events were more damaging than anything in recent memory. Citizens who attended more closely would see stories about shifts in the range of species, from birds and butterflies to insects pests and diseases. The concerns were largely parochial. Media in the United States would scarcely notice a record-breaking heat wave or flood that stirred up fears of global warming in Germany, and vice versa.²

In fact, weather is so variable that any one of the widely reported incidents might have had nothing to do with global warming. Yet for symbolically conveying what scientists knew, the incidents could be truer than any dry array of data. For example, when tourists who visited the North Pole in August 2000 told reporters that they had found open water instead of ice, news stories claimed that this was the first time the Pole had been ice-free in millions of years. That was dead wrong—yet by many measures the Arctic Ocean icepack was in fact thinning rapidly. Similarly, a few years later, the announcement that the fabled snows of Kilimanjaro were vanishing turned the mountain into a renowned icon of global warming. A few critics argued that the main cause was a drought that brought less snow, but the general lesson was still correct—there was no doubt that nearly all of the world's mountain glaciers and icecaps were shrinking, and the only plausible explanation was global warming.³

Most journalists continued to pursue their ideal of “unbiased” coverage by writing “balanced” stories that presented both sides of an issue. That put them in the odd situation of including, in a story that might describe years of research by teams with dozens of experts, a contrary response

¹ E.g., *New York Times*, March 2, 1995, p. 16.

² Ungar (1995), p. 453.

³ John Noble Wilford, “Ages-old icecap at North Pole is now liquid, scientists find,” *New York Times*, Aug 19, 2000, p. 1. Lonnie Thompson’s report from Kilimanjaro made the front page of the *New York Times*: Andrew Revkin, “Glacier Loss Seen as Clear Sign of Human Role in Global Warming,” Feb. 19, 2005. Thompson later produced evidence that Kilimanjaro’s icecap was indeed melting in an unprecedented way. Glacier National Park, rapidly losing its characteristic feature, served as another, indisputably accurate icon. In a world survey, “For the period from 1900 to 1980, 142 of the 144 glaciers retreated:” Oerlemans (2005).

by one of the few scientists who still denied that human activity was bringing global warming (or “climate change,” a phrase some promoted as sounding more neutral and less worrisome). Publicists for conservative and fossil-fuel organizations worked hard to give an impression that these contrarian scientists were a large and important minority.

For example, Seitz and the Marshall Institute circulated a petition, accompanied by a contrary review formatted to look like an article printed in the *Proceedings of the National Academy of Sciences*, and claimed to have gathered 15,000 signatures. The Academy took the unprecedented step of announcing that it was not associated with the activity of its former president, and inspection showed that very few of the signatures belonged to people who had any expertise in the science of climate change. But it is often enough to publicize an idea, however wrong, to leave many people convinced that there must be something to it. An analysis of news reports published between 1988 and 2004 in four influential American newspapers found that more than half of the articles gave roughly as much attention to the contrarians as they did to the view accepted by the IPCC and all the other rigorous scientific panels (skepticism about the IPCC’s findings and the IPCC itself was represented even better in editorial pages). On television during 1995-2004, more than two-thirds of the news reports “balanced” the opposing views as if they had equal support in the scientific community. The contrarian scientists quoted in reports frequently had financial ties to corporate lobbying groups, a fact the reporters often failed to mention. The veteran environmental journalist Ross Gelbspan bitterly accused his colleagues of being duped, bought out or intimidated by fossil-fuel interests.¹

If so, it was largely an American phenomenon. In most other industrialized nations, oil companies and their right-wing allies had less policy influence. And it was only in the United States that they worked hard to push their view of climate change upon the media. Journalists elsewhere rarely quoted contrarians, and climate change never became an intensely polarized political issue outside the United States.

In the American media, after the Kyoto meeting more attention went to the political controversy than to the scientific evidence. In these policy discussions, three-quarters of the articles in the four leading U.S. newspapers “balanced” scientists’ calls for strong action against the energy-industry’s view that only voluntary action, if any, was needed. Gelbspan called this “stage-two” denial of the climate threat—people admitting that there might be a problem, but ignoring or

¹ “While global warming has catastrophic connotations attached to it, climate change suggests a more controllable and less emotional challenge,” etc. Memorandum to Republican image-makers ca. 2002 by strategist Frank Luntz, p. 142, online at <http://www.luntzspeak.com/graphics/LuntzResearch.Memo.pdf>. The memo was reported by Jennifer Lee in the *New York Times* March 2, 2003. The Marshall/Seitz petition was signed by many who were not scientists at all. See e.g., Bolin (2007), p. 155; William K. Stevens, “Science Academy Disputes Attack on Global Warming,” *New York Times*, April 22, 1998. Newspapers covered: *New York Times*, *Washington Post*, *Wall Street Journal*, *Los Angeles Times*, in Boykoff and Boykoff (2004). Editorial pages: Wilkins (1993), p. 79. TV news covered: ABC, CBS, NBC, CNN, in Boykoff (2008). Gelbspan (2004), p. 83, see chap. 4.

rejecting effective solutions.¹ Public understanding nevertheless kept up with the main points of the evolving scientific consensus. Polls in the 1990s found that roughly half of Americans thought global warming was already here, and many of the rest thought it was coming. Fewer than one in eight asserted that it would never happen. Many citizens now believed that the scientists who publicly cast doubt on global warming were unreliable, and had a vague idea of what the greenhouse effect meant. But most did not consider themselves well informed—quite rightly (for example, many well-educated adults still confused the ozone hole with global warming). An increasing number of people suspected that they were personally seeing global warming in their daily lives, in the latest record-breaking drought or strangely balmy winter. Even Alaskans, quick to scoff at environmentalist positions, began to worry as the permafrost supporting their roads softened and dog-sled racers complained that it was getting too warm for their huskies.²

When the IPCC issued its third report in 2001, concluding that it was “likely” that greenhouse gases were bringing a sustained warming, it scarcely seemed like news. Brief stories in the chief media focused, needless to say, on the report’s worst-case scenario—a threat that future temperature rise might be more dire than previous IPCC reports had suggested. Even that drew only modest attention.³ Also widely overlooked were warnings, buried deep in the report, of a small but disturbing risk that climate might change abruptly.

If the computer predictions were wrong, it might be that they were not too radical but too conservative. New evidence of past climate shifts was persuading many experts that large changes could strike in the span of a decade or less. One plausible mechanism was a reorganization of the global system of ocean circulation. Journalists and a few scientists suggested that global warming could bring the Gulf Stream to a halt, paradoxically freezing Europe even as other places grew too hot. A close look at this specific scenario eventually showed it would violate elementary principles of oceanography. But the experts who studied the system of ocean currents and winds knew their understanding was incomplete, and they worried

¹ Boykoff and Boykoff (2004), p. 134. See also Mooney (2005), pp. 252-253. Gelbspan (2004), p. 83. Paul D. Thacker, “Climate skeptics in Europe? Mostly missing in action,” *SEJournal* Summer 2006, online as Society of Environmental Journalists: SE Journal excerpts, http://www.sej.org/ub/SEJournal_Excerpts.htm (accessed 7/18/06). According to a survey of major newspapers in New Zealand, Finland and the US ca. 2000, “The U.S.’s media states that global warming is controversial and theoretical, yet the other two countries portray the story that is commonly found in the international scientific journals.” Dispensa et al. (2003), p. 74.

² E.g., Bostrom et al. (1994); Read et al. (1994); Kempton (1991), and see Gallup and other references cited below. I heard some of these stories on visits to Alaska. “Greenhouse-effect skeptics become believers,” Juneau Empire Online (www.juneau.online), March 18, 2001. Also, e.g., Charles Wohlforth, climate.weather.com/blog/9_10806.html

³ One news magazine gave a cover story, Shute (2001), but others (like the *New York Times*) put it in back pages. The impact was blunted partly because some conclusions had been leaked piecemeal in advance.

about possible instabilities. “The climate system is an angry beast,” Broecker said whenever he got a public platform, “and we are poking at it with sticks.”¹

A National Academy of Sciences panel reported in 2001 that “The new paradigm of an abruptly changing climatic system has been well established by research over the last decade.” They added that “this new thinking is little known and scarcely appreciated in the wider community of natural and social scientists and policy-makers.”² Stories about the risk of sudden climate shifts did show up occasionally in newspapers and magazines, sometimes exaggerated into claims about a threatened collapse of civilization. People scarcely noticed, for the stories lay amid the usual journalistic noise—warnings of future disasters from falling asteroids, runaway genetic manipulation, and a hundred other conceivable threats. To most people, climate change still meant an evolution over slow decades if not centuries. Perhaps the scientists had gone a step beyond what ordinary people were prepared to believe. As a geologist remarked (on why people failed to prepare for great earthquakes), “To imagine that turmoil is in the past and somehow we are now in a more stable time seems to be a psychological need.”³

Political controversy raised a flurry of media attention in 2001-2002 after the new president, George W. Bush, made it clear that he would never impose the limits on CO₂ that the previous administration and the rest of the world had agreed upon at the Kyoto meeting. Europeans loudly expressed dismay, and many American publications joined in the criticism, Editorials scolded the policy as a surrender to business interests. So it was, and yet Bush’s approach was not far from what a majority of the American public and Congress wanted. To be sure, most people thought something should be done about global warming—but not if that would mean spending money or changing anything much.⁴

The conservationist writer Bill McKibben lamented that global warming “hasn’t registered in our gut.” It wasn’t just that the issue was a scientific one, although for many people that was enough to repel thought. Andy Revkin, a *New York Times* science reporter who led the pack in announcing global warming news, explained that “It’s a century-scale story, and newspapers are dealing with a day or an hour kind of scale... to get them to think about something important that may happen three generations from now, in terms of its full flowering, is almost impossible.” People whose interest normally focused on a local crime or scandal could scarcely grasp a phenomenon that operated on a planetary scale. If you did accept climate change as something that could affect your own community in your own lifetime, you might feel obliged to change

¹ This particular version of the quote is from the Desert Research Institute Newsletter, Spring 1999, at <http://newsletter.dri.edu/1999/spring/Broecker.html>. The earliest I’ve noticed was, “far from being self-stabilizing, the Earth’s climate system is an ornery beast which overreacts even to small nudges,” Broecker (1995).

² National Academy of Sciences (2002), p. 1 (draft published in 2001).

³ Eldridge Moores, in McPhee (1998), p. 605. For the media in this period see Boykoff and Boykoff (2007).

⁴ Scolded: e.g., Time (2001), including polls.

your pattern of consumption, and perhaps some political opinions. For many people, this was enough to raise mental barriers to further consideration. One way to resolve the dissonance between personal predilections and scientific statements was to deny that we needed to do anything about climate change.¹

Global warming was beginning to resemble nuclear war, which many people had met with simple denial. This potent psychological mechanism was well illustrated by a child who demanded that her father turn off a television documentary about climate change because it scared her. In any case most people, scarcely understanding the causes of climate change, could not name specific practical steps to forestall it. Citizens were more likely to scrupulously eschew spray cans, which in fact no longer used CFCs, than to improve the insulation of their homes, even though the lower fuel expense would repay their investment within a few years.²

A 1998 study using focus groups dug deeper, catching what had probably been the general feeling of Americans since 1988, and perhaps long before. Most felt confused, believing the scientific community had not reached a consensus. While the great majority of citizens said they thought global warming was underway, few felt really sure of that. Some people hoped that new technologies would somehow fix any problems. Others despaired of all technology and vaguely foresaw a general apocalyptic environmental collapse. Few thought their own personal efforts could make any difference.

Many people in these focus groups were convinced that not only climate changes but all environmental harms were the fault of social decline—a rising tide of selfishness, gluttony and corruption. (In one week of unusual warmth during November 1989, I heard two people separately say that the Earth was paying us back for the harm we humans were doing to it.) People saw a generalized “pollution,” the material and moral evils intertwined. Some, including prominent scientists, wondered if we had invited divine retribution. Most Americans believed they were personally powerless to halt the moral deterioration, and therefore saw the problem of

¹ McKibben (2005). Much work on “cognitive dissonance” theory provides evidence for this mental mechanism “Century-scale,” Andrew Revkin on “Living on Earth,” National Public Radio, Sept. 10, 2004.

² Poll of voters by Mellman Group for World Wildlife Fund, 9/97 (http://panda.org/climate_event/poll.htm) and Gallup polls of general public 11/97, 4/99, 4/01, 3/02, etc. (I saw these on Gallup’s Website, <http://www.galluppoll.com/>, but they are now available only for a price.) For analysis, see Kempton (1991); Bostrom et al. (1994) (spray cans); Read et al. (1994). Non-U.S. polls: O’Riordan and Jäger (1996), using a 1995 report by W. Rudig; also Bord et al. (1998); see also Stamm et al. (2000) and other articles in the same issue. There are many other polls from this period; see <http://www.pollingreport.com/enviro2.htm> and, e.g., http://www.americans-world.org/digest/global_issues/global_warming/gw1.cfm. Child’s denial: White (2005); on nuclear denial cf. Wearth (1988), esp. pp. 149-51.

global warming as insoluble. Anxious and baffled, “people literally don’t like to think or talk about the subject,” the authors of the study concluded. “Their concern translates into frustration rather than support for action.”¹

The world’s image makers had failed to come up with vivid pictures of what climate change might truly mean. Nothing happened like the response to the risks of nuclear war and nuclear reactors in earlier decades, when hundreds of novels and movie and television productions, some by top-ranking authors or directors, had commanded the world’s attention. Global warming did show up in several substantial science-fiction novels and the 2001 Stanley Kubrick/Steven Spielberg movie “AI,” which set its final scenes in a future drowned city. In most of these works, however, global warming was merely incidental background, only one of many evil consequences of a civilization fallen into decay.²

After 2002 some more-substantial works began to appear. *Oryx and Crake* (2003), by the leading novelist Margaret Atwood, portrayed a future world where global warming was one of several technological causes of ruin. In one scene the protagonist looked out over the wrecks of buildings half submerged in the ocean. Also widely noted was a huge and unsettling mural by the painter Alexis Rockman, “Manifest Destiny” (2004). It showed a scene much like Atwood’s, a future Brooklyn half submerged, given over to tropical wildlife and jungle. However, Atwood’s novel featured global warming as only one of many harms of technology, less central than artificial manipulation of organisms (an issue that had long preoccupied Rockman too). Her story resembled hundreds of earlier tales of a Last Man in despair after the collapse of civilization, for example wandering amid the wreckage of a city after a nuclear war. Rockman acknowledged links to illustrations of bombed cities and to still earlier 19th-century paintings of elegiac

¹ Immerwahr (1999); summary in Showstock (1999); here I also draw upon Thompson and Rayner, pp. 270-73; on pollution, see Wearth (1988), pp. 188-190; an early, widely read statement of climate concern connected with a call for “a simpler life” was McKibben (1989).

² For nuclear productions see Wearth (1988). Examples of science fiction based on devastating climate change are Ready (1998), well-meaning but scarcely noticed; Turner (1989), a story of civilization collapsing under the pressures of war and economic forces as well as global warming (noted fairly widely for its literary quality); and by two of the field’s major authors, Silverberg (1994), emphasizing the greed, stupidity and ambitions that were bringing vast destruction through ozone as well as global warming, and Sterling (1995), where colossal storms mingle with stormy political conspiracy. Global warming was one of the background problems related to overpopulation in the pioneering environmentalist film *Soylent Green* (1973). The polar ice caps melted to set the scene for a highly touted and financially disappointing action movie, “Waterworld” (1995, directed by Kevin Reynolds, starring Kevin Costner and Dennis Hopper). The Hugo-award-winning Robinson (1994) may be the most outstanding science-fiction work of the ’90s that included disastrous global warming (sea-level rise speeded up by methane eruptions, which I discuss in the essay on Rapid Climate Change)—but only in the background.

vine-covered ruins. In such productions, global warming was only an example and manifestation of inexorable social evolution, another civilization laid low by its own pride and greed.¹

No panel of climate scientists ever suggested that global warming could destroy our entire civilization, but the idea was spreading in public consciousness, especially among groups already inclined to worry about environmental harms. Through the 1990s, as researchers dug up (sometimes literally) ever more data on past climates, archeologists came to suspect that certain ancient civilizations had collapsed during prolonged periods of drought—actually laid low by a climate change. Widely read articles and books prophesied that the same Biblical fate would befall us unless we awoke and changed our ways.²

Abstract forebodings of doom became vivid scenes of cataclysm in “The Day After Tomorrow,” a special-effects spectacular from a popular movie director. Along with a novel by a leading science fiction author that also appeared in the spring of 2004, it was the first fictional work centered on global warming to reach a wide public. Both included authorities denying any possibility of danger, a familiar plot element in science-fiction disaster fables. The new works continued in that mode, beginning with real scientific concerns about changes in ocean circulation and stretching to cataclysms beyond anything that scientists thought was possible, notably an instant ice age. While critics worried that such horrific phantasms would only push audiences toward despair and denial, surveys in the United States, Britain and Germany found that people who saw “The Day After Tomorrow” became a bit more more receptive to political action to forestall climate change. The movie, a great commercial success worldwide, was seen by roughly a tenth of all American adults and generated ten times as much media coverage as the IPCC’s 2001 report. Even that was not enough to measurably shift American public opinion as a whole.³

¹ Atwood (2003), start of ch. 5. For Rockman see, e.g., Stevens (2004); Weart (2005). [Disclosure: by an odd coincidence, my daughter Kimi was one of Rockman’s assistants while this painting was made.] Rockman has since done several other paintings in this genre. Yannick Monget painted Paris and other cities ruined by climate change, see Grousseau (2006) and http://www.yannickmonget.com/Site%20Officiel%20_%20004%20Presse.htm. I review the “last man” and “ruined cities” themes in Weart (1988), pp. 19-20, 220-221. The masterpiece of the genre is Max Ernst’s superb “Europa nach dem Regen” (“Europe after the Rains,” 1942), which uses the titular climate change as a metaphor for the destructive forces of war and politics.

² E.g., Diamond (2004) (paperback reprint Penguin, 2005); Kolbert (2005).

³ Robinson (2004) was the first volume of a trilogy; the second volume, Robinson (2005), featured a sudden freeze in Washington, DC. “The Day After Tomorrow” (2004) was directed by Roland Emmerich, his third summer “blockbuster” movie in which New York City was wrecked (respectively by aliens and Godzilla). Its receipts put it among the top 100 all-time U.S. movies. Critics: e.g., Anthony Lane, the *New Yorker* movie critic, wrote (June 7, 2004, p. 103), “The very silliness of ‘The Day After Tomorrow’ means that global warming will become, in the minds of moviegoers, little more than another nonspecific fear about which they must uncomprehendingly fret.” U.S. response: Leiserowitz (2004). Germans surveyed, unlike Americans, grew *more* skeptical about climate change after seeing the movie, perhaps because it violated what they

Political cartoonists managed to come up with a few realistic and effective images in direct reference to immediate political choices. They might comment on a bill before Congress, for example, with a sketch of a withered desert landscape under a scorching sun. Television similarly showed parched crops or smog-shrouded cities. Calls for action against the threats of rising sea level and worsening storms got a visible face in television clips of advancing waves and hurricanes, and in political cartoons that showed buildings half underwater, whirling tornadoes, or both together. These were strong images, but limited by their familiarity. After all, drought, flood and storm images had long been associated with ordinary weather problems. A pair of communications experts explained, “in the absence of a symbol for the greenhouse effect, the media ... is limited in its interest and its impact.”

More-specific images appeared as actual climate changes began to show up. People who paid attention to the topic would see then-and-now photographs of receding mountain glaciers or images of northern houses sinking into the melting permafrost. On television and in magazines, picturesque Alaskan natives and Pacific islanders described their fears about changes they saw in the ocean. No report on climate seemed complete unless it showed a block of ice breaking from a glacier to plunge into the sea; the exotic image became a self-contained symbol of global warming. Starting around 2005 an even more popular icon emerged, turning up frequently even in cartoons—the polar bear, said to be threatened with extinction. There were scattered reports of children frightened by such images. “My son is convinced,” a mother reported, “that in his lifetime he will see the world thawed, warmed, and thoroughly cooked.”¹

It is doubtful whether any of these images meant much to adults who were not already concerned about global warming. As one critic complained when reviewing a show of artistic paintings on climate change, “a far more compelling case” was made by the plain graph of the rise of global temperature. Graphs, however, impressed only the more data-minded type of person. Nobody had produced a significant novel or movie that showed, in realistic human form, the travails that climate change might realistically bring upon us—the squalid ruin of the world’s mountain

already understood fairly well, but they became more concerned about the risk of *abrupt* climate change. Reusswig et al. (2004). Contrariwise, British film viewers became slightly more concerned about climate change but reduced their belief that climate change would bring extreme events, perhaps because they now identified that as fantasy, Lowe et al. (2006).

¹“In the absence,” Wilkins and Patterson (1991), p. 176. See, e.g., Weber (2006) for an introduction to the important literature on how people judge or misjudge risks. Viewers of Gore’s “Inconvenient Truth” movie were especially impressed by an animation of an exhausted polar bear who could not find an ice floe to rest on. It was reported that bears were in fact drowning, Simonite (2005). Children: Allegra Goodman, “The Dark Dreams of Global Warming,” Boston Globe Sept. 8, 2008, http://www.boston.com/bostonglobe/editorial_opinion/oped/articles/2008/09/08/the_dark_dreams_of_global_warming/; similarly, John Stossel, “Man vs. Nature: Challenging Conventional Views About Global Warming,” ABC News, Oct. 19, 2007, <http://abcnews.go.com/2020/Stossel/story?id=3751219>

meadows and coral reefs, the impoverishment caused by crop failures, the invasions of tropical diseases, the press of millions of refugees from inundated coastal regions.¹

In the early years of the new century, polls in the United States showed an outright decline in concern for global warming. Since the late 1980s, a large majority of Americans had told poll-takers that they personally worried about global warming, but the fraction who claimed they worried about it “a great deal”—roughly a third—declined in the early 2000s, and by 2004 a bare majority in the United State expressed any worry at all about global warming. This was in parallel with a dwindling concern about all environmental issues. West Europeans meanwhile grew *more* concerned, especially when a terrible heat wave assailed the continent in the summer of 2003, bringing huge crop losses, forest fires, and tens of thousands of excess deaths. Comparable calamities might have happened in earlier times, perhaps during the so-called “Medieval Warm Period,” but the 2003 heat wave surpassed anything in the historical record and was quite likely made worse by greenhouse warming. That made a gripping story, although it still lacked the concentrated symbolic heft of a Hiroshima or Chernobyl. The divergence of West European from American opinion created diplomatic friction as President Bush rejected any steps to control emissions, or even negotiations about it.

Despite the efforts of the contrarians, science reporters and their editors slowly came to realize that the scientific debate over climate change was essentially over. They began to feel they should explain the situation straightforwardly, even at risk of angering part of their audience. Coverage of climate change in major American newspapers, after declining in the mid 1990s, began to climb back. In 2004 the American public could read extensive cover-story articles in respected journals like *Business Week* and *National Geographic*, stoutly declaring that global climate change was truly a serious and immediate problem. Meanwhile several books and dozens of well-maintained Websites attempted to explain the situation. Far more widely noticed, however, was a best-selling thriller, *State of Fear*. The author, Michael Crichton, built his plot on the fantasy that fear of global warming was a deception propagated by evil conspirators and their dupes. As in his earlier novels, Crichton played upon a theme beloved of right-wing populists—the scientific establishment was arrogant, wrong-headed and untrustworthy, if not actively corrupt.²

¹ “More compelling,” referring to “the Hadley Centre’s horrifying J-curve,” Richard Hamblyn, “Message in the Wilderness,” *Times Literary Supplement* no. 5389, July 14, 2006, p. 18.

² Newspaper coverage: Boykoff and Boykoff (2004), figs. 2, 4, see also Boykoff and Boykoff (2007). Carey (2004); Appenzeller (2004) (a giant 74 pages). *Nat’l Geographic* editor Bill Allen wrote in his editorial that “some readers will even terminate their memberships,” but he couldn’t look himself in the mirror if he didn’t print the article. He later told a reporter that some readers did indeed cancel. An especially well-received book was Speth (2004). For other books and Websites see my links page, <http://www.aip.org/history/climate/links.htm>. At year-end Crichton (2004) was no. 3 on the *New York Times Book Review* best-seller list and no. 2 worldwide in sales on Amazon.com. For an analysis of Crichton’s errors see <http://www.realclimate.org/index.php?p=74>. Earlier Crichton books criticizing scientists

This was in line with a proliferation of Websites and blogs that vehemently denounced the scientific consensus on global warming. Some were posted not by paid lobbyists but by independent contrarians, passing around plausible-sounding arguments supported by scraps of anomalous data. There are always anomalies at the research front, of course. But when scientists resolved a problem, typically within a few years, the contrarians fastened on a newer one, while the old arguments stubbornly lived on among the Web's countless niches. The contrarians had constructed what one neutral observer called an "alternative universe" where "basic findings of mainstream science are rejected or ignored."¹

Some of the statements on the Web, radio talk shows, newsletters and other media began to resemble the typical American diatribe against wicked elites. Such arguments also began to show up in West Europe, Japan, and especially Russia, but Americans were the most prone to openly distrust scientists. Populist American politicians were often more scornful of intellectuals than were policy-makers in other advanced nations, and more responsive to pressure from oil and related corporations. Remarkably, the science-fiction novelist Crichton got an appreciative hearing as a "climate expert" on visits to Congress and the White House. Such antics widened the divide between the United States and most other nations, and helped maintain polarization over the issue at home.

But outside Washington, important groups were shifting their stance. One turning point was a 2002 meeting in Oxford, England, where leaders of evangelical church organizations convened with scientists who shared their religious beliefs. Devout Christian scientists such as John Houghton, a lay preacher and co-chair of the IPCC's 2001 report, convinced some church leaders that they were called upon to protect God's creation from greenhouse warming. In February 2006, a group of important American evangelical leaders issued a statement calling for government controls on emissions, backed up by television and radio advertisements.²

Business leaders also began to speak out forcefully. Some European firms, notably oil giant BP under the farsighted John Browne, had already decided (as he put it in 1997), that "it falls to us to take precautionary action now." Starting around 2005, a growing number of leading American corporations like General Electric and Wal-Mart pledged to limit their emissions. *Business Week* called 2006 "the year global warming went from controversial to conventional for much of the corporate world." Some executives "spoke of a personal awakening," the magazine reported. An environmental consultant agreed that "Suddenly CEOs were expressing genuine concern about the issue." He repeatedly heard variations on the story of a CEO's daughter who came home from college and said, "Dad, we can't be that stupid." For example, the conservative owner of the Fox News media empire, Robert Murdoch, announced in 2007 that his corporations would feature the battle against climate change in all their shows, and would strive to reduce their own emissions. An appalling drought in his native Australia was one influence, but still more was "my son James, who... converted me." (Polls did not find young people much more concerned about

included *The Andromeda Strain* (1969) and *Jurassic Park* (1991).

¹ Ruddiman (2005), p. 187, see ch. 18.

² Evangelical appeal: <http://www.christiansandclimate.org>; Kintisch (2006); Haag (2006).

global warming than their elders, so these are probably cases where family dynamics brought views that were now mainstream to a resistant minority.)

Executives who remained skeptical felt pressure from many directions. Promising to fight climate change would improve their corporate image, and it would also be (as Murdoch put it) “a huge morale builder” among their own staff. More directly, some major corporations were hit with lawsuits for the damage their emissions were causing, and more of the same might be feared. Meanwhile powerful investors, from state pension funds to Wall Street giants like Goldman Sachs and JP Morgan Chase, began to weigh global warming risks before investing in a company. After all, business magazines like *Fortune* were warning of imminent “droughts and floods not seen since ancient times.” Most important, legal restrictions on emissions seemed inevitable. As the *Wall Street Journal* reported, “The global-warming debate is shifting from science to economics... The biggest question going forward no longer is whether fossil-fuel emissions should be curbed. It is who will foot the bill for the cleanup.” A wise corporation would take the lead in discussing just which business operations should be taxed or regulated. If you’re not at the table, the *Journal* remarked, you’re on the menu.¹

Political leaders sensed how the wind was blowing. Not only were corporations pressing them for decisions so they could make business plans, but calls for action on climate lifted public approval ratings. And it was getting harder to argue that action was unwise. The IPCC’s fourth assessment, issued in early 2007 and widely reported in the media, announced what most people already knew from the media or their own experience—stresses from global warming were now apparent around the world. The scientists were confident that worse was to come. Meanwhile a team of British economists calculated that these impacts might be as harmful as a great depression or world war, but they could be staved off at modest cost. Even some staunch Republican leaders, like California governor Arnold Schwarzenegger, pushed their states or cities to curb their

¹ “It falls to us...,” Browne, speech at Stanford University, May 19, 1997, at http://www.gsb.stanford.edu/community/bmag/sbsm0997/feature_ranks.html and other Websites. Jim Carlot, “J.P. Morgan Adopts ‘Green’ Lending Policies,” *Wall Street Journal*, April 25, 2005, p. B1; Aston and Helm (2005); Michael Barbaro and Felicity Barringer, “Wal-Mart to Seek Savings in Energy,” *New York Times*, Oct. 25, 2005, p. C1; Linden (2006), p. 136; “the year global warming,” *Business Week* (2006); and other articles in these and other business media. For David Crane, an energy CEO who read up on climate change and “realized it was a moral issue,” see Whitford (2007), p. 76. “Dad,” Adler (2007), p. 48; Murdoch: Amanda Griscom Little, “The Greening of Fox,” *Salon.com*, at www.salon.com/news/feature/2007/05/17/murdoch.

Some polls show more concern among young people, some less, some little age difference; e.g., HSBC Climate Confidence Index 2007 (London: HSBC, July 2007), 20 pp., at http://www.hsbc.com/1/PA_1_1_S5/content/assets/newsroom/hsbc_ccindex_p8.pdf; Pew Center, “A Deeper Partisan Divide Over Global Warming,” 5/8/08, <http://people-press.org/reports/display.php3?ReportID=417> Jeffrey Ball, “New Consensus: In Climate Controversy, Industry Cedes Ground,” *Wall Street Journal*, Jan. 23, 2007 (p. 1).

greenhouse gas emissions. A surprising number of political units pledged they would meet the Kyoto goals.

One important reason for the change was the disastrous summer of 2005, the worst Atlantic hurricane season on record, capped by Hurricane Katrina's devastation of New Orleans. Attention to climate change in the American press climbed to the highest level ever. "Are We Making Hurricanes Worse?" asked the October 3 cover of *Time* magazine. Probably so, the editors concluded. Scientists were in fact divided on that, and vigorously debated whether global warming had raised the risk to New Orleans at all. This was another case where an event that was not really a clear sign of global warming nevertheless taught an accurate lesson, for it was certain that rising sea levels would eventually lift storm surges over the existing levees. But what really mattered was the imagery. The half-submerged buildings of science fiction, the "environmental refugees" that experts had been foreboding for decades, now filled Americans' television screens in real time.

Meanwhile scientific reports on surprising changes in ocean currents and ice sheets spurred fears that the world might soon pass what many had begun to call a "tipping point"—a point where calamitous climate change would become unavoidable.¹ "Suddenly and unexpectedly, the crisis is upon us," declared a reporter in 2006. Another mused that "global warming has the feel of breaking news these days." Reporters admitted that they had leaned over backward too far in granting "equal time" to the dwindling remnant of contrarians. As one of them put it, "journalists increasingly have assessed the weight of the evidence and explained who was behind the opposing views." In November 2005 alone, PBS public television stations, the Turner Broadcasting System, and even the right-wing Fox News Channel all ran specials stating plainly that global temperatures would rise, and a much larger audience saw movie idol Leonardo DiCaprio explain the problem on the Oprah Winfrey Show. The Weather Channel added reports on climate change as a "niche" market. In the spring of 2006, people could see a thorough analysis of the danger in two widely read books by top science journalists, a week-long series of reports on ABC television and radio, and a special issue of *Time* magazine ("Be worried," the cover advised. "Be *very* worried.")²

¹ The term "tipping point," popularized in 2000 in a book of that title by Malcolm Gladwell, was popularized for climate by, *i.a.*, Lindsay and Zhang (2005) and Kluger (2006), see also Kluger (2005); *New York Times*, Sept. 28, 2005; Juliet Eilperin, "Debate on Climate Shifts to Issue of Irreparable Change," *Washington Post* page one lead, Jan. 29, 2006—the same day the *New York Times* led with a story of administration attempts to silence James Hansen's warnings (see essay on "Government"). Gabrielle Walker reported in 2006 that "In 2004, 45 newspaper articles mentioned a 'tipping point' in connection with climate change; in the first five months of this year, 234 such articles were published." (*Nature* **441**, p. 802)

² "Unexpectedly" and *Time* cover, Kluger (2006), p. 35, part of special report, pp. 34-42; "Breaking news," Andrew Revkin "Meltdown," *New York Times* (Week in Review) April 23, 2006; "journalists... assessed," Carey (2007), p. 92. "Global Warming: The Signs and the Science," PBS (South Carolina ETV and Stonehaven Productions), Nov. 2, 2005; "Earth to America!" starring many well-known figures, Turner Broadcasting System (TBS), Nov. 20,

The greatest media attention of all went to a shoestring-budget documentary film. Since 1990, Al Gore had occasionally told the global warming story in a convincing illustrated lecture, and in the gloomy days after his defeat in the 2000 election, his wife persuaded him to take it up again. Honed before many hundreds of audiences, Gore's presentation was converted into a film titled "An Inconvenient Truth." In the year following its May 2006 opening, it garnered the third highest box-office receipts of any documentary in history. Meanwhile an associated book reached the top of the best-seller list. Critics pointed out a few points where Gore had been misleading (he showed a sea level rise without explaining it would take centuries, and used images of hurricanes without noting that their relationship to global warming was conjectural). But scientists generally gave the film high marks for explaining a complex subject with accuracy and grace. The film by itself could not do much to shift American public opinion as a whole. But it did strongly impress the sort of people who saw documentaries, including key policy-makers.¹

Poll-takers found that people around the world were rapidly becoming more aware of global warming and more concerned about it. In the United States, concern about global warming climbed back up to the level where it had stood in 1989. This was not simply a response to Hurricane Katrina and other matters in the media, but part of a general revival of concern about all environmental issues. In fact, when asked to name problems facing the nation, Americans would think of pollution of drinking water, the ozone hole, or the destruction of tropical forests

2005; "The Heat Is On," Fox News Channel, Nov. 13, 2005 (see following note); "Global Warming 101" with Leonardo DiCaprio, Oprah Winfrey Show, Oct. 28, 2005. Books: Among Amazon.com's 200 top-selling books in March 2006 were Flannery (2006) and Kolbert (2006), the latter previously published in the *New Yorker* [Kolbert (2005)]; some commentators hoped one or the other would serve like Rachel Carson's *Silent Spring* (1962), which spurred action against pesticides and environmental pollution in general. Also, for example, *Vanity Fair* "Green Issue," no. 549, May 2006; ABC reports on "Good Morning America," "Nightline," "World News Tonight," ABC news radio, etc., week of March 16, 2006.

¹ "An Inconvenient Truth," dir. Davis Guggenheim, Participant Productions, 2006, and illustrated book, Gore (2006). Origins: Pooley (2007), p. 37. Publicity included many radio and television interviews and magazine cover stories. I saw the talk in the early 1990s, where Sen. Gore illustrated the soaring of CO₂ in the atmosphere by standing on a chair. The book spent four weeks at the top of the *New York Times Book Review* bestseller list and was on the list for 38 weeks. After the film was widely seen, U.S. public opinion turned modestly in Gore's direction, but perhaps only as part of a general shift toward environmentalism: Saad (2007). There is anecdotal evidence from several sources on the influence of Gore's presentation on elites. For example, the first Fox News documentary (see preceding note) "was approved after environmentalist Robert F. Kennedy, Jr. reportedly 'dragged' Fox News Chairman Roger Ailes to a lecture by former Vice President Al Gore, 'kicking and screaming'." Randy Hall and Marc Morano, CNS News, Nov. 9, 2005, <http://www.cnsnews.com/ViewSpecialReports.asp?Page=%5CSpecialReports%5Carchive%5C200511%5CSPE20051109a.html>. Florida Governor Charlie Crist, pushing emissions reduction in 2007, "said the movie influenced his views deeply," Joe Follick, Gainesville *Sun*, July 4, 2007, <http://www.gainesville.com/article/20070704/LOCAL/707040342/-1/news>.

ahead of global warming. This contrasted with Europe, where climate change generally ranked top among environmental worries.

As often happens with such issues, after the wave of attention surged forward it receded: the number of media reports on global warming fell almost as fast during 2008 as it had risen during 2006. Polls of Americans in 2009 found that they had grown a bit less concerned about global warming. And the ranks of the skeptics had grown to a near-majority. That was partly because polemicists of every stripe leaped on any new scientific finding that seemed to support their position. Good scientists took their time; they understood that when you stood at the frontier of what was known, no finding could be trusted until it had been verified and set alongside other findings. The news media, however, inevitably featured the latest findings, which were inevitably unreliable (the oceans were warming! ...no, they were cooling! ...oops, they really were warming!). Scientists themselves, and citizens who followed the science news with care, paid more attention to the accumulating weight of confirmed evidence. And this weight was moving steadily in the wrong direction—in the range of possibilities the IPCC had warned about, the worst was coming to pass. For example, the summer ice covering the Arctic Ocean was shrinking remarkably swiftly, by 2007 exposing seas that experts had expected would be ice-bound for decades more. But many citizens, scarcely aware of the laboriously developed pronouncements by the IPCC, scientific societies, the world's chief academies of sciences and other authoritative bodies, saw the entire discussion of global warming as nothing more than partisan political posturing.¹

International polling found that almost everywhere in the world, a majority of the population had heard of global warming. Of these people, in most nations a quarter to half felt “a great deal” of concern about it, substantially higher than just a few years earlier. Educated people in most developing nations expressed more concern about climate change than their counterparts in the industrialized world, and more commitment to action. The United States still lagged behind most of the world, with fewer than a fifth of its citizens expressing strong concern, only slightly more than a decade before. (After all, as a comparison of newspapers in the United States and the United Kingdom showed, the rise in stories in the American media, although steep, did not match the explosive growth of attention on the other side of the Atlantic.) Around the world polls found

¹ Media studies by Robert Brulle and by Maxwell Boykoff & Mara Mansfield, reported in <http://www.yaleclimatemediaforum.org/2008/12/2008-year-long-fall-off-in-climate-coverage/> and discussed by Andrew Revkin, New York Times blog, Dec. 5, 2008, <http://dotearth.blogs.nytimes.com/2008/12/05/back-to-media-trance-on-climate/>. Gallup, Pew Research Center and Rasmussen Reports polls, summarized and discussed by Revkin Jan. 22 and March 11, 2009, <http://dotearth.blogs.nytimes.com/2009/01/22/obamas-urgency-on-warming-meets-cool-public/> and 3/11/09, <http://dotearth.blogs.nytimes.com/2009/03/11/gallup-rising-sense-of-climate-hype/>

Sea ice: e.g., Andrew C. Revkin, “Analysts See ‘Simply Incredible’ Shrinking of Floating Ice in the Arctic,” *New York Times*, Aug. 10, 2007. For data see US National Snow & Ice Data Center, http://nsidc.org/data/seaiice_index/

resentment against the United States, which had put much more CO₂ into the atmosphere than any other nation yet refused to take responsibility for it.¹

In all countries, even though majorities claimed to worry about global warming, most people still saw the problem as distant and abstract. Climate change felt remote not only in years but in geographical and emotional distance. To people in the developed world, global warming was not so much a problem for folks like themselves as for Pacific island natives and polar bears. One study concluded that most Americans still “lacked vivid, concrete, and personally-relevant affective images of climate change, which helped explain why climate change remains a relatively low priority...issue.”

Smaller groups (each perhaps 5-10% of the public) took stronger views. On one side stood people alarmed by what they saw as an imminent, even disastrous, threat to their own way of life and perhaps all creatures on the planet. On the other side stood people who dismissed it all as a myth if not a deliberate hoax, concocted by self-serving intellectuals and journalists.

If you guessed that a member of the first group leaned politically to the left, and a member of the second group to the right, you would usually be correct—at least in the United States, for the issue remained more politically polarized there than elsewhere. A 2007 Gallup poll found that the average level of worry about the impacts of global warming among Republicans was 34%, compared with 59% among independents and 75% among Democrats. In the following year, Republicans grew *less* convinced that humans were causing global warming. This political divide lay along a line that more generally separated people according to their feelings about authority, individual responsibility, risk-taking and other personal issues. But it also depended on national political circumstances and history (in the United Kingdom, Conservatives in the tradition of Margaret Thatcher criticized the Labor government for doing too *little* about global warming). Each side found confident endorsement of its views in its favorite media, where exaggerated pronouncements served to attract and retain an audience by conforming to that audience’s prejudices.²

¹ U.S. polls by Gallup, <http://poll.gallup.com>; details available only for a fee, but summaries of these and similar results from many other polls are easily found on the internet, see <http://www.pollingreport.com/enviro.htm>. Pew Research Center for the People & the Press, global attitudes survey, spring 2006, <http://pewglobal.org/reports/display.php?ReportID=252>; ; HSBC Climate Confidence Index 2007 (London: HSBC, July 2007), 20 pp., at http://www.hsbc.com/1/PA_1_1_S5/content/assets/newsroom/hsbc_ccindex_p8.pdf. Results are often inconsistent among polls: it is important to make comparisons only within polls asking exactly comparable sequences of questions and among comparable populations (for example, surveys in the developing world usually reached only the more affluent). US/UK newspapers study by Maxwell T. Boykoff, online at http://www.2007amsterdamconference.org/Downloads/P-AC2007_Boykoff.pdf

² Leiserowitz (2005), and especially Leiserowitz (2006), “lacked vivid” p. 55. Also Lorenzoni and Pidgeon (2007) Ereaut and Segnit (2006); Saad (2007). Gallup: see preceding note. See also Pew Research Center for the People & the Press, Jan. 2007 poll at

Some observers worried that the major media had swung too far, promoting a language of crisis and looming catastrophe that fitted poorly with the gradual nature of the actual problem. But only a small minority of citizens seemed paralyzed by what they saw as a catastrophe beyond human control. Indeed, only a minority saw global warming as a serious and immediate challenge at all. Many who expressed concern were satisfied with small symbolic steps, if any. To launch actions on a scale large enough to arrest the tremendous and increasing flux of greenhouse gases into the atmosphere, bold leadership was necessary. Some farsighted individuals in business, government and other influential fields did recognize that they had a responsibility to offer such leadership, and an opportunity. “A tipping point appears to have been reached...,” concluded the head of an international polling group in 2006. “The reality and impact of climate change has been internalized by most citizens, suggesting that well-designed political and corporate initiatives to reduce the problem will likely receive substantial support.”¹ However, a determined fraction of the public remained unconvinced about global warming, while most of the rest gave the problem a lower priority than more immediate issues. Only mild initiatives were politically feasible in the leading nations. It hardly seemed to matter that an overwhelming majority of scientists insisted that half measures would not suffice, in face of what they increasingly regarded as one of the most severe long-term risks that world civilization had ever faced.

*What can people do about global warming, and what should we do?
See my Personal Note and Links.*

Related:

Government: The View from Washington, DC

The Modern Temperature Trend

Rapid Climate Change

Supplements:

Wintry Doom

Rising Seas

Reflections on the Scientific Process

<http://pewresearch.org/pubs/282/global-warming-a-divide-on-causes-and-solutions> and April 2008 poll at <http://people-press.org/report/417/a-deeper-partisan-divide-over-global-warming>. There is growing evidence that “hierarchically arranged groups... tend to perceive industrial and technological risks as opportunities and thus less risky, whereas more egalitarian groups tend to perceive them as threats to their social structure.” Weber (2006), p. 111. This may extend to individual personalities with respect to their concerns about authority vs. fairness, etc. See Haidt (2007).

¹ “Tipping point,” Doug Miller, Globescan, Inc. press release, April 24, 2006, http://www.globescan.com/news_archives/csr_climatechange.html (Accessed 1/26/07)