Government: The View from Washington, DC

Following the Second World War, the United States Federal government funded many kinds of research, much of it connected to Cold War concerns, and some of this happened to relate to climate change. During the 1960s, the government created major agencies for space, atmospheric, and ocean science, and in the 1970s, as public concern for the environment mounted, the agencies increasingly supported research targeted directly at climate change. But climate scientists were too few and disorganized to push through a unified national research program. Their budgets, divided among different agencies, would rise for a few years and then stagnate. During the 1980s, the funding and the science itself came under attack. The scientific question of whether climate change might be a threat got caught up in political battles between environmentalists and anti-government conservatives. During the early 21st century, vehement opposition to regulation of greenhouse gases became obligatory for Republican Party politicians, who blocked legislative action and fought to delay and undermine regulations promulgated by Democratic administrations. However, essential government funding continued for climate research and for the development and early deployment of low-emission technologies. In 2022 Democrats finally passed a substantial bill aimed at reducing emissions, but more would eventually be needed. (This essay describes relations between the United States federal government and science, touching only briefly on policy debates. For developments on the international level see the essay on International Cooperation.)

I think it is no exaggeration to say that climate change is the biggest problem our civilization has ever had to face up to in its 12,000 years, because it requires a collective response. — *David King (Chief Science Adviser to the UK Govt.)*[1]

During the first half of the 20th century, it would have been hard to find any institution that gave a penny specifically to support research on climate change. The work was donated by individuals, mostly university professors who were paid more for their teaching than for research, let alone for any particular subject of research. The most important greenhouse effect work in the entire half-century was done by a complete amateur, the engineer G. S. Callendar, in his spare time.

[1] Quoted in *Science* **318** (2007): 1863

National meteorological services like the United States Weather Bureau, driven especially by the needs of military and civilian aviation, did spend large and increasing sums to observe the atmosphere.[1] But this treasury of data was compiled for daily forecasts and was seldom used for basic research. The few climatologists that national agencies supported were hired only to compile dull statistics of average weather conditions.

Around mid century some meteorologists began to call for a more vigorous research effort. In 1953, a government advisory committee reported that the entire Weather Bureau needed new, young blood. Modest research that a few outstanding individuals had undertaken before the war had suffered a "slow, almost lingering death." The committee warned that climatology, starved for funds, was scientifically moribund.[2] Their report led to the appointment of a new climatology chief, Helmut Landsberg, who brought an improved "esprit de corps" and an important expansion. His group&!s main job, however, was still routine processing of data on past climates . Another report presented in 1957 complained that climate research remained a stepchild at the Bureau, inadequate in scope, with climatologists mostly "relegated to a mere housekeeping function."[3] While climate studies languished at the Weather Bureau, however, a flood of new Federal money began to push the field forward in other institutions, even though their missions were remote from weather research.

Cold War Organizations and Climate Research (1950s)

From the late 1940s into the 1960s, many of the papers cited in these essays carried a thought-provoking footnote: "This work was supported by the Office of Naval Research." The ONR&!s work is a well-known chapter in the history of American science. In 1945, as the war effort wound down and scientists worried about where they would find support, the United States Navy decided to fund basic research. The other military services soon followed. Their support reflected a recognition among some officers that they would need scientists for many purposes. The war had been shortened, if not decided, by radar, the atomic bomb, and dozens of other scientific devices barely imagined a decade earlier. Who could guess what basic research might turn up next?

Besides, scientists who made famous discoveries would bring prestige to the nation in its global competition with Communism—in the Cold War, winning opinion came before winning territory. Scientists&! glory would also reflect on the officers who were on good terms with them. More important, ready access to a stockpile of skilled brains might be vital in some future emergency. So there was reason to support good scientists regardless of what questions they

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[1] For rise of weather services: Nebeker (1995), p. 87.

[2] United States (1953), pp. 4-7, 24, 36.

[3] National Academy of Sciences (1957), "housekeeping" p. 4, "inadequate" p. 14, "esprit" p. 15.

chose to pursue.[1] Still, some fields of science were more equal than others in the long-term advantages they might provide to the United States. Nuclear physics in particular (think of bombs and submarine reactors), and solid-state physics (think of electronics and metallurgy) could count on especially generous support.

Physical geoscience was one of the privileged fields. As historian Ron Doel has pointed out, military officers recognized that they needed to understand almost everything about the environments in which they operated, from the ocean depths to the top of the atmosphere. In some fields such as oceanography, another historian noted, "operational data and basic research results were often the same thing." Considering the complex interconnectedness of all things geophysical, the military services were ready to sponsor every kind of study. For good practical reasons, then, the U.S. government supported geophysical work in the broadest fashion. If purely scientific discoveries happened along the way, that would be a welcome bonus.[2]

Meteorology was especially favored. Weather has been crucial in warfare since antiquity. During the Second World, the armed forces had seen meteorologists provide life-or-death information for everything from bombing missions to the Normandy Invasion. After the war, military agencies joined civilian ones in fostering research that might eventually improve weather prediction. The work ranged from better data-collecting networks to laboratory studies of radiation to attempts to model weather on digital computers.

Beyond the daily forecast, some experts had visions of deliberately altering the weather. New schemes to help farmers by "seeding" clouds with silver iodide smoke, in hope of making rain, caught the public&!s attention. Government officials and politicians also took heed.[3] From the late 1950s forward, the U.S. government was pressed to fund meteorological studies in hopes that the nation might improve its agriculture with timely rains. A nation that understood weather might also obliterate an enemy with droughts or endless snows. By the mid 1950s a few scientists, particularly the brilliant mathematician and nuclear bomb expert John von Neumann, were warning that "climatological warfare" could become more potent than nuclear war itself.[4]

Von Neumann spoke from inside knowledge. He was hard at work applying electronic computers to meteorology. His group was initially located at the U.S. Army&!s Aberdeen Proving Grounds, and the Air Force too supported computer weather research. Von Neumann told yet another sponsor, the ubiquitous ONR, that his efforts had a dual goal: not only to predict daily weather changes, but to calculate the general circulation of the entire atmosphere, which might someday show how to deliberately change a region&!s climate.

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[1] Sapolsky (1990); Mukerji (1989), pp. 52 ff., see passim for government funding in general; Weir (2001).

[2] I thank Ron Doel for his draft, "Military constitution of the environmental sciences in America, 1945-1965," 1996. Also Doel (1997); Hamblin (2002), quote p. 26; Hamblin (2013).

[3] Lambright and Changnon (1989).

[4] von Neumann (1955).

Questions about long-term climate change over the planet as a whole were *not* a favored field of inquiry. To be sure, evidence that the Arctic was getting warmer caught the eye of officers in the Pentagon. Among other strategic considerations, the thickness of the ice mattered for the missile-bearing nuclear submarines that lurked beneath. The officers saw this as a question of monitoring natural changes. Why pay for research about, say, the global effects of increased carbon dioxide gas (CO_2), when that was expected to bring a shift of climate only with the passing of centuries, or more likely never? So it was only by chance that certain research projects funded by government agencies turned out to be useful for the study of greenhouse effect warming.[1]

An example was the development of radiocarbon dating, which later became a key to working out the history of past climates. The pioneers in the delicate study of radioactive materials were a group of Manhattan Project veterans at the University of Chicago. They drew on parallel work underway at Chicago on the detection of fallout from atomic bomb tests. In this as in almost all American non-military research, something like half the support was indirectly related to Cold War military demands. Of course that left half the support to come from other sources. A good part of the funding for radiocarbon dating was simply the basic salaries and lab space that universities gave their professors. Other support came from philanthropic foundations interested in archeology, and from corporations that worked to improve radiation instruments as a commercial enterprise.

In many other areas of apparently pure science, without Cold War funding the research would have advanced far more sluggishly or not at all. For example, military agencies supported theoretical and experimental studies of the way infrared rays passed through the atmosphere, because the problem was important for heat-seeking missiles and other weaponry. One physicist doing such work was Gilbert N. Plass. He carried out theoretical calculations in association with an experimental group at Johns Hopkins University, funded by the ONR, that was gathering data on how pressure and temperature affected infrared spectral lines. According to his later recollection, Plass learned about climate change only because he read broadly about topics in pure science. He happened upon the discredited theory that changes in the amount of CO_2 in the atmosphere could explain the ice ages, and took to studying the infrared absorption of CO_2 as a sideline, not far from his regular work.

Leaving Hopkins, Plass continued his research using a computer at the University of Michigan, also on ONR funds. Before he could finish his analysis, he moved on to join a group of scientists at the Lockheed Aircraft Corporation in southern California. In his new job he was calculating the transmission of radiation through the atmosphere to answer questions directly related to weapons. Meanwhile he wrote up his results on greenhouse warming—"in the evening," as he

[1] On a secret Pentagon briefing by Ahlmann, see Doel, (2002), p. 545. Probably there was classified climatological warfare work that has not come to light, and which contributed to the openly published developments. See Institute for Advanced Study, Proposal to establish Meteorology Project, May 8, 1946, published as Appendix A to Thompson (1983), p. 766; for further references, see Weart (1997).

later recalled, entirely separate from the military research for which he was now employed. The results turned out to be crucial for reviving the moribund greenhouse effect theory.[1]

There were many similar cases. Studies of deep ocean circulation interested the ONR, because naval officers worried about disposing radioactive bomb debris and nuclear reactor wastes in the ocean depths. The information also happened to be crucial for understanding how much CO_2 the oceans could absorb, and thus the prospects for greenhouse effect warming. The Navy and other services lent logistical support for stations in Antarctica, mainly to gain experience in case they ever had to fight there. The logistics happened to be invaluable for studies that required a pristine environment, such as monitoring CO_2 levels in the atmosphere. The Air Force Cambridge Research Center in Massachusetts had an entire Geophysics Research Directorate which funded, among many other projects, laboratory and field studies of weather patterns that surprised everyone with crucial hints about how rapidly climate could change. In short, the military scattered so much money about that there was enough for studies that nobody connected with any practical issue. When scientists put together some of the results, they began to suspect that there was a genuine risk that burning fossil fuels could bring on global greenhouse warming. The U.S. military had bought an answer to a question it had never thought to ask.

A more complete story of Cold War support for one key development is told in a supplementary essay on Roger Revelle&!s Discovery.

By the end of the 1950s, the U.S. government—or rather, the few and scattered people in Congress and the bureaucracy who took any interest in weather science—had become vaguely aware that there was a risk of unwanted climate change. This awareness was largely the doing of a highly respected oceanographer, Roger Revelle. As soon as his studies of CO_2 convinced Revelle that the oceans probably would not absorb all the gas that human industry was producing, even before publishing the results he took the matter to both government officials and journalists. When a committee of the National Academy of Sciences produced a “First general report on climatology to the Chief of the Weather Bureau” in 1957, it picked up a metaphor that Revelle had begun to use: “In consuming our fossil fuels at a prodigious rate, our civilization is conducting a grandiose scientific experiment.”[2] Meanwhile Revelle came before a Congressional committee to testify that the rise of CO_2 might bring severe climate shocks within the next century.

New Research Organizations (1957-1970)

Revelle had come to Washington to promote a general boost in funds for all of geophysical science. It was his part in a world-wide campaign that geophysicists had mounted to win a really big pot of money for their research, a campaign that reached fruition in the International

[1] The Lockheed group split off soon after Plass joined it to found an independent Systems Research Corporation. Interview of Plass by Weart, 14 March 1996, AIP.

[2] National Academy of Sciences (1957), p. 8.

Geophysical Year of 1957-1958. The U.S. National Committee responsible for IGY plans had called groups of experts together in early 1956. As one minor part of their work, the experts devised a modest program of climate research. Among other things, the committee set aside some IGY money to temporarily support a program of measurements of the concentration of CO_2 in the air.[1] Other climate studies got similar important benefits.

Although the IGY officially ended in 1958, its success gave research a lasting impetus. Above all (literally above all) were the Soviet *Sputnik* and other satellites. Nominally built for geophysical research and launched under IGY auspices, in reality the satellites were meant chiefly to gather military intelligence. To the American public, *Sputnik* was a frightening demonstration of vulnerability to nuclear-armed missiles, and seemed to show a Russian lead in science and technology. The "crisis," as some called it, drove the government to boost funding for all areas of science.

The *Sputnik* anxieties brought a particularly big raise to the National Science Foundation, which Congress had established back in 1950 with a modest budget to support fundamental scientific research. By 1959, the NSF&!s funding had jumped more than tenfold. Meanwhile military officers&! interest in supporting basic science waned, and during the 1960s, Congress decided that the armed forces should stick closer to their immediate needs. The NSF with its fattened wallet took over much of the support of basic climate research from the military agencies.

Still, military funding remained important for many activities. For example, the bases that the U.S. Navy had set up in Antarctica during the IGY remained indispensable during later decades for research on the potentially fateful interactions between ice sheets and global warming. Other nations funded similar if smaller programs. For example, the Soviet Union likewise established a half-military, half-scientific presence in Antarctica. Without this logistical base, the Russians and their French partners could never have drilled through the ice cap to get crucial data on past glacial periods.

During the 1960s, scientific technology proved its importance not only in Cold War activities but in all areas of economic life. Coupled with rising prosperity, the promise of benefits prompted nearly all nations to expand their funding of science. Atmospheric science got its share of the new budgets. Meanwhile university departments of meteorology proliferated, driven by a demand for trained staff. The rapidly spreading air transport industry needed meteorologists, and so did the still more rapidly spreading television weather shows, not to mention the military weather services. Private meteorological services also began to burgeon, as the cash value of forecasting increased in step with its precision. Still, the rise of meteorology was no faster than other areas of university science, driven by their own mushrooming practical demands.[2] Equally rapid expansion benefitted other fields of geophysics where research relevant to global warming might be found.

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[1] Keeling (1960); see Weart (1997).

[2] Houghton (1996).

In the early 1960s, Federal officials decided to target the atmospheric and ocean sciences for a special boost. Scientists and bureaucrats who were dedicated to ocean research, and who had never gotten much National Science Foundation money, had already begun a lobbying effort in the late 1950s. Their warnings that the nation was lagging behind its rivals evoked all the *Sputnik* worries, and Congress at last gave NSF substantial funds for oceanography research.[1] Meanwhile others sought to brush away the Weather Bureau cobwebs. The key idea came from the physics community. To build and run their gigantic particle accelerators, physicists had put each instrument in the hands of a consortium of research universities. Imitating this model, in 1960 Congress established a National Center for Atmospheric Research with 14 universities as initial NCAR members (dozens more joined over the following decades). The funding came through the National Science Foundation. The NSF got a good boost in its meteorology research budget not only to support NCAR but also to build up university groups.

In 1965, the government enacted a still grander reorganization, bringing the Weather Bureau together with several other science agencies in a new agency named the Environmental Science Services Administration (ESSA). Federal funding for meteorological research jumped sixfold (in constant dollars) in the decade 1958-1967. Then it leveled off, and for the next two decades support barely kept ahead of inflation. But the gain was permanent for people like the computer modelers who had helped to set up NCAR. Their work was a line item in NCAR&!s budget from the beginning, so the costly computer studies of climate went forward as a matter of course.[2]

Ocean scientists had an initiative of their own. Support for their field was even more divided than support for the atmospheric sciences, scattered among small and disorganized programs that dealt with everything from offshore oil to fisheries. A group of leaders, noting the ample funds given to the National Aeronautics and Space Agency (NASA), lobbied for a "wet NASA." A presidential commission was organized in 1968 to address the issue, and it surprised everyone by recommending that ocean programs be integrated with atmospheric ones. The commission was in tune with recent thinking, seeing the seas and air in a unified way. They were concerned about "modification of weather and ocean conditions by interference with natural environmental processes," and called for monitoring of the entire "global air-sea envelope."[3] Prodded by marine interests in Congress, President Richard Nixon&!s administration supported the idea. In 1970, the various marine research, technology, and administrative programs were folded together with ESSA into a new organization, the National Oceanic and Atmospheric Administration (NOAA). The hopes for a top-ranked independent agency like NASA were not entirely fulfilled, however, for NOAA was created as only one of the many agencies within the Department of Commerce.[4]

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[1] van Keuren (2000).

[2] Mazuzan (1988); Hart and Victor (1993), p. 650; Fleagle (1992a), p. 307; Fleagle (1994), p. 124; for NCAR see Easterbrook (2023).

[3] Commission on Marine Science (1969) (chaired by Julius Stratton), quotes pp. 197, 182.

[4] Wenk (1972), ch. 8.

From the beginning, NOAA was one of the world&!s chief sources of funding for basic climate studies. For example, one of its units constructed what were arguably the most important of all computer models of climate. But the agency was created by rearranging programs without adding new money. Insofar as NOAA had any central focus, it followed the original impetus to develop economically important marine resources such as fisheries. The atmospheric sciences were left mired in ambiguity. As one observer reported, through the next decades there were "serious programmatic gaps... stemming from the agency&!s complex history and resulting confusion as to its central mission." An example was the important Landsat satellite program, NOAA&!s best bet for monitoring overall global change. This program was designed to study land surfaces rather than clouds, and it was "treated as an orphan" through its first three decades. As for observational systems aimed directly at meteorology, they were designed mainly to aid daily weather prediction rather than to gather and retain the data needed for monitoring long-term climate change.[1]

The Nixon administration created another significant agency related to atmospheric science in 1970, the Environmental Protection Agency (EPA). This was the year of the first Earth Day, marking the point when the public in the United States (and soon after, many other nations) began urgently pressing their governments to pay attention to environmental harms. Congress funded NOAA and EPA largely in obedience to this growing public concern, which was directed less at possible future global troubles than at visible nearby evils like filthy rivers and choking city air. The EPA was created to deal with human health risks such as smog, not climate issues, and had only minor funds to give to global warming research.[2] Practical near-term thinking also motivated pollution-control laws such as the Clean Air Act (passed in 1970 and strengthened in 1977). This viewpoint made sense to scientists, who mostly put "environmental" questions in the category of immediate practical problems, separate from abstract speculations about climate change.[3]

Rising Concern about Climate Change

It was no wonder if nobody was devoting much effort to mobilizing funds for climate change studies—who would feel responsible for the task? The planet&!s climate is not organized along the lines of government agencies. Nor does it fit with the standard academic scientific disciplines ("Nature is ignorant of the ways our universities are organized," as one scientist remarked). Key problems in the field, such as the study of how carbon moves among the atmosphere, the oceans, and the biosphere, fell between stools. No institution had a budget line devoted to these problems.[4] There was no institutionalized field of "climate change science." There was only a variety of individual scientists in a medley of fields, studying everything from computer models

[1] Fleagle (1994), pp. 114, 116 (data), 118. Landsat was reorganized in a 1992 Act of Congress.

[2] Fleagle (1994), pp. 128-131.

[3] Hart (1992), pp. 29-32.

[4] "Ignorant": Weyl (1968), p. 60; Hart and Victor (1993), p. 650.

of weather to glaciers to sunspots—specialists who may never have heard of one another. So there was no community to lobby for funds, organization or policies.

Scientists who wanted funds for global warming research had adopted a strategy so traditional that they probably did not think of it as a strategy at all. They had worked hard to build up individual scientific institutions, academic and international as well as Federal, in their respective fields. In each institution, elite scientists would be in charge, directing research funds as they thought best. The result was that climate change studies, fragmented among many organizations, received a fairly reliable but modest fraction of various research budgets. Nobody made a special effort to create a unified climate studies program, the kind of strong and independent institution that could fight for a big lump of funds.[1] After all, scientists in the 1950s and 1960s saw global warming as only one of a thousand interesting questions, something that would not be a problem for many decades if ever, nothing at all to do with current government policies.

A few people did notice implications for their present concerns. When Edward Teller told an assembly of scientists in 1957 that rising CO_2 levels might eventually melt back the polar ice caps and inundate the world&!s lowlands, he had a personal stake as a nuclear expert. These were years when many people in government and industry, including Teller, were enthusiastically promoting the building of nuclear reactors. Some of them noticed that the risks of greenhouse warming could give minor reinforcement to their arguments for weaning humanity from dependence on coal and oil. Recognizing an attack on fossil fuels, a scientist working for Shell International Chemical Company publicly denied that "our furnaces and motor car engines will have any large effect on the CO_2 balance."[2] From time to time on through the 1960s, nuclear power advocates would mention greenhouse warming in passing as a future drawback of fossil fuels. That may have helped maintain awareness of the greenhouse issue in policy circles.[3]

Foreseeing weightier issues was not impossible. Two reporters who spoke with scientists in 1957 sketched out some striking implications of the greenhouse effect. If it ever became certain that CO_2 was warming the planet, they wrote, we would see "a type of control regulation, law, interstate compact, and international agreement which could scarcely help clashing with some of our cherished notions of free enterprise. Industry, which might blossom in some directions...would be hamstrung in others.... Further, in view of the global nature of the problem, ordinary international agreements might prove inadequate for effective regulation." But an international regime that imposed actual penalties would be "sure to foster great heat and controversy."[4] The reporters were far ahead of their time. For decades, hardly anyone else would

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[1] Hart (1992), pp. 17-22; Hart and Victor (1993).

[2] Teller: see references in the essay on Impacts. Matthews (1959), p. 646; on promotion of nuclear reactors, see Weart (1988), Weart (2012).

[3] The issue was brought up in hearings of the U.S. Congress&!s Joint Committee on Atomic Energy. See Clinton Anderson, interview by Ron Doel, August 1995, transcript, AIP.

[4] Phil Yeager and John Stark, "Mystery of the Warming World," *Washington Sunday Star*, 26 Jan. 1958, p. A26, copy seen in clippings file, Roger Revelle Papers, SIO..

raise these grave questions. After all, as the *New York Times*&!s science writer remarked in a 1956 article on the prospects for global warming (Oct. 26), "coal and oil are still plentiful and cheap... and there is every reason to believe that both will be consumed by industry so long as it pays to do so."

Through the 1960s, a modest level of official interest was sustained by new scientific findings. Most telling was C.D. Keeling&!s measurements of the level of CO_2 in the atmosphere, a curve that dramatically rose year after year. The idea that the government should actually do something about this—if only to sponsor climate research more systematically—first arose in 1963, when Keeling and a few other experts met in a conference sponsored by the private Conservation Foundation. Their report warned that the doubling of CO_2 projected for the next century could raise the world&!s temperature some 4°C (more than 6°F), bringing serious coastal flooding and other damage. The government should give the subject more consistent attention, they believed, and more money. Decrying the lack of continuity in greenhouse gas research, the group recommended that Keeling&!s program for monitoring CO_2 levels (whose funding was threatened) be continued. Above all, they called on the National Academy of Sciences to create a committee to look into the whole question of atmospheric change.[1]

A more complete story of the vicissitudes of support for one key development is told in a supplementary essay on Funding Keeling and CO_2 Monitoring.

Gradually the government reacted.[2] In 1965, when the President&!s Science Advisory Committee formed a panel to address environmental issues, it included a subpanel of leading climate experts. They told President Lyndon Johnson that greenhouse warming was a matter of real concern. There could be "marked changes in climate," they reported, "not controllable through local or even national efforts." CO_2 needed attention as a possibly dangerous "pollutant." That put the issue on the official agenda at the highest level of government—although only as one item on a long list of environmental concerns, many of which seemed more pressing.[3]

The following year, 1966, the Academy answered a government request to report on how human activity could influence climate. The experts sedately said they saw no cause for dire warnings, but they did believe the CO_2 buildup should be watched closely. "We are just now beginning to realize that the atmosphere is not a dump of unlimited capacity," the report said, "but we do not

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[1] Other participants included Erik Eriksson and G.N. Plass. Conservation Foundation (1963); see also the Conservation Foundation&!s Annual Report for 1963 and Keeling (1998).

[2] For a chronicle of US government actions on climate change, listing many items not covered here, see Watanabe Ing LLP et al., "Part I of Defendants Chevron Corporation and Chevron U.S.A. Inc.&!s Answer to the First Amended Complaint," filed First Circuit [Hawaii]1CCV-20-0000380, Sept. 12, 2022, online at https://aboutblaw.com/4Tc.

[3] The panel, chaired by statistics expert John W. Tukey, had a CO_2 sub-panel chaired by Revelle and including Broecker, Craig, Keeling, and Smagorinsky. President&!s Science Advisory Committee (1965), quote p. 9, see pp. 111-31. On "pollutant" see Howe (2017), Part 3.

yet know what the atmosphere&!s capacity is." The panel&!s primary conclusion was typical of such reports—a maxim that came from the heart of scientists&! belief in their calling—More Money Should Be Spent on Research.[1]

These efforts were only minor byways in the government&!s atmospheric science work. Short-term weather prediction came first. For longer-term problems, the titles of the panels show what was on people&!s minds. The President&!s advisory group was named the "Environmental Pollution Panel," and the Academy&!s was the "Panel on Weather and Climate Modification." Asked about human influence on the atmosphere, the public would think first about smog. Next they would think about deliberate attempts to make rain (by the early 1970s, the NSF was spending almost as much on "weather modification" as on all the rest of the atmospheric sciences combined).[2] That included climatological warfare—indeed the U.S. armed forces had already begun secret attempts to bog down the North Vietnamese army with artificial rainmaking.

Research on climate change was not the particular responsibility of any government official. As the 1965 panel remarked, "no agency or program is concerned with the average condition of our environment."[3] The 1966 Academy panel added that for climate as for most environmental fields, support was "diffused among many agencies." Thus "there exists no single natural advocate in the Federal structure, nor is there a clear mechanism for making budgetary decisions." In the mid-1960s, a variety of government agencies together spent roughly $50 million a year for all aspects of meteorological research. That was not much, and climate change caught only a few percent of that.[4] Studies of the topic had to fit in as minor components of programs that had been set up to work on more immediate problems.

Perhaps the best hope of climate scientists was that a bit of the money devoted to climate modification (which mainly meant rainmaking) could be diverted toward research on... well, call it "inadvertent climate modification." The phrase was often used during this period by people concerned about greenhouse warming.[5] But defining the greenhouse effect as "inadvertent climate modification" made it sound like just one of the countless byproducts of economic progress, a sort of smog that could be handled easily by more technology. Leading experts suggested that if global warming ever became annoying, there were technical schemes, not excessively costly, that could counteract it. In short, climate change was of far less interest to the government (and the public) than chemical pollution, dying lakes, and countless other environmental problems.

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[1] National Academy of Sciences (1966), "not a dump" vol. 1 p. 10.

[2] Budget: Kwa (2001), p. 140.

[3] President&!s Science Advisory Committee (1965), p. 26.

[4] National Academy of Sciences (1966), vol. 1, quote p. 20, budget p. 16.

[5] Hart (1992).

A Federal Program for Climate Change Research? (Early 1970s)

When a group of citizens (in this case, scientists) decides that their government should do more to address some particular concern, they face a hard task. The citizens have only a limited amount of effort to spare, and officials are set in their bureaucratic ways. To accomplish anything—to bring about a new government program, in particular—people must mount a concerted push. For a few years concerned citizens must hammer at the issue, informing the public and finding allies among like-minded officials. These inside allies must form committees, draft reports, and shepherd legislation through the administration and Congress. Interests that feel threatened by change will put up roadblocks, and the whole process is liable to fail from exhaustion. Typically such an effort succeeds only when it can seize a special opportunity, usually news events that distress the public and therefore catch the eye of politicians.

In the early 1970s, a few climate scientists sought such an opportunity to mount such a concerted push. A month-long workshop at the Massachusetts Institute of Technology in 1970, and an international conference in Stockholm in 1971, put global climate change on the table as a significant policy concern. The scientists were spurred to the task by new data and calculations, which convinced them that the world&!s climate might change far sooner and more drastically than had seemed possible only a decade earlier. There was now evidence from ancient ice sheets and the seabed of abrupt climate changes in the past. A fresh look at mechanisms driving the climate system found such changes entirely plausible. The next ice age might start within their own lifetimes! When scientists in a 1972 workshop found themselves in agreement that such things could not be ruled out, several of them wrote a letter to President Nixon to recommend that the government support intensified studies. A high-level panel convened by the administration reported in 1974 that a sudden freeze was indeed possible within the next century, although the panelists did not find it likely.[1]

Other scientists, probably the majority, suspected that with the continuing rise of CO_2 in the atmosphere, the most likely future was not cooler but seriously warmer. Nixon&!s top advisers were aware of the possibility. For example, in 1969 one of them had sent a memo about the "apocalyptic" possibility that warming would raise sea level ten feet by the next century. "Goodbye New York. Goodbye Washington, for that matter.... This is a subject that the Administration ought to get involved with." The uncertainties could only be resolved by a large research program.[2]

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[1] Hecht and Tirpak (1995), p. 376; see Hecht (2014) for this and much else on climate and the U.S. government.

[2] Federal Council for Science and Technology (1974); included as appendix in United States Congress (95:1) (1977). Daniel P. Moynihan, Memorandum, For John Ehrlichman, Sept. 17, 1969. Richard M. Nixon Presidential Library and Museum, online at https://www.nixonlibrary.gov/sites/default/files/virtuallibrary/documents/jul10/56.pdf.

The drive to strengthen climate studies fitted with a broader movement, in which scientifically trained people were making contact with more traditional policy elites to address the planet&!s environmental future. As historian Paul Edwards described it, a "hybrid science/policy community" was taking shape. Policy makers as much as scientists were taking advantage of new tools, including the aggressive gathering of all sorts of global information.[1]

That was the traditional "insider" approach to policy. Other scientists thought government action would follow only if they could reshape public attitudes. A reshaping had in fact begun, in the mass environmental movement that burst into full flower in the early 1970s. Some climate scientists adopted the mood and rhetoric of the movement, describing climate change in dramatic terms as a threat to the well-being of the living planet.

One focus of environmentalists was atmospheric pollution, meaning the toxic smog that people felt in their eyes and lungs. Since factories and automobiles emitted not only smog but greenhouse gases, environmentalists sometimes mentioned global climate change as one more argument against polluting industries. Similarly around 1970 when groups fought to prevent the government from building a fleet of supersonic transport airplanes, their warnings included an occasional mention of the long-term harm that airplane exhaust might bring to the climate. However, the environmentalists focused on "backyard" problems, the smog from your nearby highway or factory, the shock-wave crack of a supersonic airplane passing over your head. When the Sierra Club surveyed its local groups about their concerns in 1976, the responses gave climate change a low priority if they mentioned it at all.[2]

There was still enough worry about the global effects of supersonic airplanes to push Congress to fund a "Climatic Impact Assessment Program" (CIAP). It was among the biggest scientific research projects undertaken to that time, involving numerous agencies of the U.S. and foreign governments and more than a thousand scientists. In three years of studies, ranging from data-collecting with balloons to mathematical modeling of stratospheric chemistry, scientists tried to define the threat from aircraft emissions.

The result was inconclusive, which meant the scientists could provide no reassurances that a fleet of supersonic airplanes would not change the weather. Meanwhile an even greater scientific concern had come up. Among the studies were some that pointed out a more definite and immediate risk: emissions from the airplanes could damage the high ozone layer that blocked solar rays. This might well bring a rise in skin cancers and other harm to people and biological systems. The main thing that offended the public, however, was a likelihood of noise pollution and the waste of their tax money. Congress closed the issue in 1971 by refusing to subsidize the airplanes.[3] For climate scientists, the CIAP program produced a trove of useful data. But it had

[1] Edwards (2000a), p. 245.

[2] Howe (2014), ch. 5.

[3] Dotto and Schiff (1978), esp. pp. 67-89; Conway (2008).

been only a short-lived effort on a narrow topic, far short of the sustained coordination and funding they desired.

Their opportunity came in the early 1970s, as news media reported an extraordinary series of weather disasters. Around the world droughts were bringing horrific famines and (what more deeply affected the U.S. government) distress to American farmers. For the first time ever, climate change mounted high in public awareness, catching the attention of some politicians and government officials. In 1974, Alvin Weinberg, a leading energy expert from the nuclear establishment, put the issue succinctly. The danger of climate change, he explained, placed some kind of limit on the world&!s energy systems. The nation needed proper organization for climate research "so that, say 20 years from now, we can base our energy policy on a much sounder understanding of this limit... The problem of global effects of energy production... is everyone&!s problem, and therefore no one&!s problem. I propose, therefore, that an institute (or even institutes) of climatology be set up with a long-term commitment..."[1]

Weinberg was only one of many scientists who were now urging the government to organize climate research. Another example was a group at the University of Wisconsin. In 1973 they presented a plan for a climate program to the National Security Council, and the plan was duly reviewed by the NOAA and NSF bureaucracies. Meanwhile the National Academy of Sciences established a Committee on Climatic Variation, which in 1974 presented its own recommendations for a national climate research plan. Alongside the recent weather troubles, policy-makers from Senators to Air Force generals continued to worry about deliberate climate modification. That meant everything from the recently revealed American rain-making in Vietnam to problematic Russian schemes for altering the Arctic. Such schemes now looked more likely to bring environmental damage and ignominy than useful results. Meanwhile, improved computer models were suggesting that greenhouse gas emissions really would cause a global warming within the foreseeable future. The entire human interaction with climate was looking increasingly problematic.

The President&!s Domestic Council worked to pull all the strands together in a 1974 proposal for a National Climate Program. Staff members drafted a National Climate Program Act, centered on an increase of funding for research and monitoring. The proposal would take four years to work its way through the political system. In May 1976, with the recent "world food crisis" of failed harvests and high prices much in mind, a Congressional committee began hearings, the first ever to take climate change as their main subject. Leading scientists explained at length why their work should get more attention and money. The most outspoken was Reid Bryson, who had been warning anyone who would listen that human activities could bring a climate catastrophe. Bryson&!s colleagues detested his zeal for barging into policy debates with claims far beyond what the scanty science of the time could justify. But something had changed—climate science

[1] Weinberg (1974).

had connected with politics. At the moment it was linked only with food policy, but the political engagement would grow and spread.[1]

The effort to organize climate research dragged on with little public attention and little result. Without the backing of some unified community or organization, the movement for reorganization was impeded by the very fragmentation it sought to remedy. The proposals were various, but all of them threatened to usurp the activities of existing research bureaucracies. And the effort had come in cramped economic times, as Congress sought ways to cut the budget. But the worst weakness was what one participant called "a failure to demonstrate to funders of such research the practical benefits that can result within a time frame of relevance to their mandate." Lawmakers cared far more about the few years until the next election than about the following century. (One scientist recalled briefing an official about a 1979 report on global warming; when the official was told that problems might develop in fifty years, he replied, "Get back to me in forty-nine.")[2]

Attempts at Coordination

The efforts continued. Ominous warnings in National Academy of Sciences reports and sensational journalism repeatedly brought climate change to the attention of the public and politicians. Scientists and officials tried again from time to time to create some kind of centrally organized national program or institution. For example, in 1978 a proposal was floated to establish a national CO_2 directorate at the MITRE Corporation, a Cold War think tank. The idea went nowhere. Meanwhile, prompted by scientists and bureaucrats, legislators in the U.S. Congress were proposing a small flurry of bills related to climate, starting in 1975 and reaching six introductions in 1977 and another six in 1978.[3] Scientists testified before Congress that the rise of CO_2 could bring world disaster. Agency officials wrote and rewrote plans and negotiated tenaciously over who should get control of what research budget.

Adding to this agitation was a fierce public controversy that erupted in the mid 1970s when scientists discovered that certain chemicals, widely used as propellants in spray cans, could damage the protective ozone layer in the stratosphere. Counter-arguments publicized by the chemical industry failed to quell the protests. Congress responded in 1977 by restricting the spray

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[1] The Domestic Council (1974); United States Congress (95:1) (1977), led by Rep. George Brown and also featuring i.a. Bolin and Schneider; United States Congress (94:2) (1976); Howe (2014), pp. 107-109; Naylor (2021).

[2] I have not done enough research to sort out all the details of this complicated movement. Sources include Impact Team (1977), pp. 190-91; Hammond (1976); Domestic Council (1974); Hecht and Tirpak (1995), pp. 375-76, 378; quote: Laurmann (1976). Briefing official: Oreskes & Conway (2010), pp.173-74 (citing Henry Abarbanel, personal communication), regarding the report JASON (1979); similarly, a UK cabinet member in 1990: "Fifteen years? Oh, it&!ll see me out then," Houghton with Tavner (2013), chapter 14.

[3] Balco (1999).

can chemicals. The issue had no visible connection with climate, but it showed that technical scientific findings about a future atmospheric risk could arouse the public enough to sway legislation and inconvenience major industries.

Scientists who hoped to stimulate action on climate, stymied in Washington, found better opportunities in working through the international science community. Efforts by a group of nations—not just their combined money but the consensus of their prestigious scientists—might help convince American politicians to act. Besides, internationalization might offer some of the organization that was lacking in the United States. Since 1963 the World Meteorological Organization (WMO), an association of national weather services under the auspices of the United Nations, had administered a World Weather Watch that usefully coordinated the gathering of data around the world. In 1968 the WMO combined forces with the International Council of Scientific Unions, a non-governmental congress of scientific organizations, to create a "Global Atmospheric Research Program" (GARP). This provided essential coordination for research projects everywhere.

To manage American participation in GARP, the National Academy of Sciences set up a "U.S. Committee for the Global Atmospheric Research Program" which included many top scientists. They kept up the pressure for organizational action. In 1975, the committee published an influential report, referring to the recent deadly droughts and declaring that "We simply cannot afford to be unprepared for either a natural or man-made climatic catastrophe." The scientists insisted that a rapid deterioration of climate was possible, although they could not agree on how likely that was to happen anytime soon. Emphasizing the lack of knowledge, the panel called on the government to build up a National Climate Research Program as the nation&!s share of an international effort. They said the Federal climate research budget should be doubled (from expenditures of less than $20 million in 1974), and doubled again by 1980.[1] This report was followed up in 1977 by a still more widely publicized Academy report on "Energy and Climate." The panel of experts, chaired by Revelle, announced that average temperatures might climb a dangerous 6°C by the middle of the next century, possibly with a catastrophic rise of sea level. They recommended "a lively sense of urgency" for studying the problem. There had never been so much reason to insist on the old principle, More Money Should Be Spent on Research.[2]

The Academy&!s experts were by no means prepared to stretch so far as to recommend actual changes in the nation&!s energy policies. They did suggest (not very prominently) that it might turn out that the world would need to reduce its use of fossil fuels. But they knew climate predictions were too unreliable to support such a move in the visible future. If the panel avoided concrete advice, they did drive home a general truth—the threat of climate change was intimately connected with energy production. As a page one headline in the *New York Times* (July 15, 1977) summed it up, "Scientists Fear Heavy Use of Coal May Bring Adverse Shift in Climate." Officials were starting to grasp the fact that CO_2 emissions had economic implications, and

[1] GARP (1975), quote p. 2, budget p. 99.

[2] National Academy of Sciences (1977).

therefore, political ones. The oil, coal, and electrical power industries began to pay close attention. The new president, Jimmy Carter, had appointed a geophysicist, Frank Press, as his science advisor, and Press called for a thorough policy analysis. After all, as a government energy official put it, "If CO_2 proves to be the problem people think it is, we&!ll have to restructure our entire fossil fuel program."[1]

The nation&!s fossil fuel policies were already under intense scrutiny. In the 1973 "energy crisis," inconvenience and anxiety attacked consumers when Persian Gulf states withheld their oil. As gasoline prices soared, cars lined up for hours at gas stations hoping to fill their tanks. When the Carter administration proposed to shift the nation from oil to coal, a new and crucial link was forged between politics and climate science. It became particularly noticeable that some of the people most concerned about CO_2, Alvin Weinberg in particular, were advocates of nuclear power—an industry vigorously promoted as an alternative to foreign oil, but coming under vehement attack as a danger to the environment. One environmental argument often made in *favor* of nuclear reactors was that they emitted scarcely any greenhouse gases. The greenhouse effect also came up when some proposed the government should subsidize synthetic fuels ("synfuels") as a substitute for oil: opponents pointed out that synthetics produced more CO_2 than comparable fossil fuels.[2]

The energy crisis was empowering advocates of renewable energy sources, ranging from Federal solar-energy bureaucrats to radical environmentalists, and they too found the greenhouse effect useful in arguing for their cause. The more of our power we generated from windmills, the lower our CO_2 emissions. Policy discussions grew increasingly sophisticated, exploring strategies to mitigate the effects of global warming, international legal mechanisms for restricting emissions, and ethical considerations in assigning costs and risks. In all these debates, however, climate change was only one more weight thrown into the balance, and far from the heaviest one in most people&!s minds. The argument for encouraging solar and wind power, along with nuclear reactors and synfuels, revolved around the imperative need for energy security. When Carter had solar water heater panels installed on the roof of the White House, he said it was to show how to "move away from our crippling dependence on foreign oil."[3]

Nobody of consequence proposed to regulate CO_2 emissions or make any other significant policy changes to deal directly with greenhouse gases. Academy reports and other scientific pronouncements advised that any such action would be premature. They pointed out that

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[1] Philip White, head of ERDA&!s fossil fuel division, quoted Business Week (1977).

[2] Pomerance (1989), pp. 260-61. Global warming is mentioned briefly in passing, for example, in the landmark essay on "soft" vs. "hard" energy paths, Lovins (1976).

[3] Kellogg and Schware (1981) is an example of policy discussions (1980 Aspen Institute workshops). Solar panels: Jimmy Carter, "Solar Energy Remarks Announcing Administration Proposals." June 20, 1979, online at https://www.presidency.ucsb.edu/documents/solar-energy-remarks-announcing-administration-proposals

predictions of future warming were based mainly on computer models, which were grossly oversimplified and relied on poorly measured numbers. Some scientists held that if the world was currently warming (which they doubted), that was just part of a natural cycle. Or the climate system might fluctuate in a purely random way, regardless of what humanity did.

Policy debate about the nation&!s energy systems revolved around more obvious economic, environmental, and national security problems. It was to address these issues that the Carter administration created a cabinet-level Department of Energy (DOE). With a mandate to lead in energy policy, a few DOE administrators proposed in 1977 to take responsibility for research on greenhouse gases. Their expansive plans ranged from monitoring the level of CO_2 in the atmosphere to predicting the economic and social consequences of future greenhouse warming. One administrator said that they needed data in less than a decade so the government could decide whether to promote coal and synfuels made from coal.[1] To pay for the research, they requested a big budget expansion, from the $1.5 million that DOE was spending in 1977 to as much as $30 million a year.

Other agencies disliked the DOE plan, however, and their complaints went beyond the normal bureaucratic defense of turf. NASA, NOAA, and the Department of Defense were each developing their own climate research agendas. They found an ally in a Climate Research Board, newly created by the Academy, which criticized the DOE plan as poorly designed and over ambitious. The Board benefitted from its outsider position and the prestige of its scientist members, not least its full-time chair, Robert M. White. A widely admired scientist-administrator, “Bob” White had already served as head of the Weather Bureau and then of NOAA, as official representative in international meetings—one on whaling, for example, another on desertification—and in countless other capacities. In particular, he had recently chaired the President&!s Committee on Climate Change and a committee on weather modification. Bob White deserves notice as an outstanding representative of many people whose names seldom appear in histories of scientific discovery. It was their long years of bureaucratic labor, quiet negotiating and hard thinking, mostly out of public view, that gave climate research its funding and organization.[2]

The meteorological community and its friends in the bureaucracy, resolved to consolidate climate research, pushed the Carter administration for legislation. The administration turned over the job to the Interdepartmental Committee on Atmospheric Sciences, an aggregation of department heads established as far back as 1959 to coordinate federal programs. They reported to the high-level Federal Coordinating Council for Science, Engineering, and Technology (FCCSET, nicknamed “Fix-it”). Every relevant government agency pushed its point of view, along with

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[1] Acting Asst. Secretary on the Environment James Liverman, cited by Science News (1977).

[2] Perry and O&!Neill (1979), p. 1757 gives references. See Fleagle (1994), p. 95. President&!s committee: the Domestic Council&!s Environmental Resources Committee, Subcommittee on Climate Change, 1975. On this and the following see Henderson (2016).

outside groups like the American Association for the Advancement of Science, which formed an Advisory Group on Climate that worked with the administration. Under Press&!s watchful eye a plan was eventually offered to Congress. Now the politicians had their say, putting forth bipartisan demands for a user-oriented program that would be designed primarily to provide climatology services of immediate economic value at the state and local level. The Carter administration resisted, but ultimately bowed to the pressure; late in 1978 the President signed a National Climate Program Act.

The Act established an interagency National Climate Program Office with NOAA, not DOE, named as the lead Federal agency. It looked like a step forward, but the new Office wound up with a feeble mandate, low bureaucratic status and a budget of only a few million dollars. State climatologists never got the federal support they had demanded, and the Office was unable to do much integration and coordination since each department and agency could and often did submit its own independent budget. In the end it was the hard-driving DOE officials who won large budget increases for CO_2 work—in their department. However, some of the expansion in the formal budget was not new money, but only a transfer of funds that had already been available through other programs. It was a pattern that administrations would often follow when they wanted to boast of their support for environmental causes.[1]

With the passage of the National Climate Act, the minor flurry of legislative attention ended. No climate-related bills were introduced in the U.S. Congress in 1979, and not more than one a year thereafter until the late 1980s.[2] The program to study climate change had been underfunded from the start, and the large increases of the 1970s came to a dead halt in 1980 as Congress tried to balance the budget. Such money as was available seemed to go as much into paperwork and meetings as into actual research.

Traditionally scientists worked to influence policy simply by presenting their results, expecting that intelligent and responsible policy-makers would act appropriately. The scientists&! tools ranged from secretive groups advising the armed forces up to the prestigious National Academy of Sciences. In the former category were the JASONs, recruited from the nation&!s most brilliant physicists to conduct wide-ranging studies on military topics. Their work had come under fire from fellow academics when they aided the Vietnam War effort, and for a 1979 study they decided to step away from national security affairs by studying climate change. They even constructed a simplified (one-dimensional) computer model all their own as a check on the meteorologists. The JASONs concluded, like earlier panels, that global warming might bring serious consequences. The world&!s food supply could shrink, the sea level might rise with harmful speed, and either of these might drive large-scale displacement of populations. The climate was not so remote from national security after all.

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[1] Fleagle (1994), p. 126; Henderson (2016); Speth (2021), p. 71.

[2] Balco (1999).

Rafe Pomerance, a lobbyist for the environmentalist group Friends of the Earth, saw an opportunity. He recruited one of the senior geophysicists responsible for the JASON report, Gordon MacDonald, to hold a series of briefings in Washington on the climate problem. The pair worked their way up to the President&!s Science Adviser, Frank Press, who asked the Academy to render judgment on what the JASONs had identified as the crucial issue: the validity of computer models. In 1979 a panel of experts chaired by veteran computer meteorologist Jule Charney endorsed the models, declaring they had grown good enough to rely on. The panel was quite confident that doubling of CO_2 would bring substantial warming (1.5-4.5°C) by the middle of the coming century. Heat was already building up in the atmosphere-ocean system, they concluded, so that "A wait-and-see policy may mean waiting until it is too late." Simultaneously the White House Council on Environmental Quality received a report from MacDonald and other top experts predicting that warming would threaten food supplies, bringing "an extremely serious international disruption within the lifetimes of those now living," and eventually "inundation of low-lying coastal zones." MacDonald went beyond the usual role of scientists at the time by openly advocating a specific policy, taxes on carbon emissions.

The Carter administration debated how to respond to the emerging scientific concerns. For the first time, the government had to confront a serious policy choice—protecting the climate versus promoting fossil fuels. Impose a tax on carbon, or increase subsidies for exploiting oil and coal? Carter&!s people knew that scientific opinion was tentative; the Secretary of Energy, James Schlesinger, was openly skeptical about global warming. In any case, nobody expected serious harm until the 21st century, almost unthinkably distant in politics. and the administration was already committed to expanding coal and synfuel production. That seemed all the more urgent because revolution in Iran had shut down its oil exports. Prices were rising and long lines had appeared at gas stations, a second "oil crisis." Noting that sensationalist claims about imminent ecological catastrophes of all sorts were proliferating in the media, the officials worried that "alarmist" official statements could "panic" the public. So they avoided public pronouncements or any other serious action on climate, trusting that studies by experts would eventually tell the government unequivocally what to do.[1]

A Democratic Senator, Paul Tsongas, denounced the failure to address global warming while embracing "insidious" fossil fuel, calling it a "disastrous example of short-term planning." Wallace Broecker, a prominent geophysicist who had spoken out repeatedly about the future

[1] JASON (1979); CEQ report: other authors were George Woodwell, Roger Revelle and C. David Keeling,Woodwell et al. (1979), pdf with new preface by J.G. (Gus) Speth (2008) online at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.174.936&rep=rep1&type=pdf. See Rich (2019); Speth (2021). Avoiding "panic": Henderson (2019); Finkbeiner (2006) and Oreskes (2008b), p. 116. National Academy of Sciences (1979), quote p. viii (in the Foreword by Climate Research Board chair V.E. Suomi); in 1982 another Academy panel, chaired by Joseph Smagorinsky, reviewed computer studies and confirmed the first group&!s findings. National Research Council (1982). For all this see Kutney (2023), ch. 6; my thanks to Kutney for sharing a draft of his work.

dangers of climate change, responded by venting his frustration in a letter to the Senator. Declaring that "the CO2 problem is the single single most complex environmental issue facing the world," and that "the clock is ticking away," Broecker insisted that in the absence of direct action, a better research program was needed. "Otherwise, another decade will slip by, and we will find that we can do little better than repeat the rather wishy washy image we now have as to what our planet will be like..."[1]

NASA and Other Funders

While research funding and organization remained well below the level climate scientists felt they needed to paint a correct picture of the future, the 1970s had not slipped by entirely without progress. Military agencies had continued to fund some research, such as secret computer-modeling studies of proposals to deliberately alter a region&!s climate. Meanwhile the NSF, DOE, and NOAA had supported a broad array of studies. Still more money had come from the National Aeronautics and Space Administration.

Founded in 1958, NASA was responsible for developing the satellites that were the primary source of accurate world-wide data on the atmosphere. There would have been no science satellites at all, of course, but for the billions of dollars lavished upon the exploration of space, thanks partly to popular enthusiasm and partly to the many military applications of rocketry. Military agencies had proposed the use of satellites for weather "reconnaissance" in a secret report as early as 1950. The first public "weather satellite," TIROS-1, launched into orbit in 1960, had originated in Department of Defense surveillance programs. It was transferred to NASA in 1959 as a civilian program, with the sensors degraded so they could see clouds but not small things like aircraft carriers. Through the following decades, military agencies secretly put up their own meteorological satellites that used the exquisite and highly classified technologies developed for spy satellites.

These technologies gradually made their way into the open civilian program of weather satellites. NASA built and launched the devices, but once they were in orbit they were operated by the Weather Bureau—which got its budget doubled for the purpose. The responsibility was taken over along with the Weather Bureau by ESSA, followed by NOAA. The arrangement worked well for a few years. But in the late 1970s, public interest in space exploration flagged, and NASA&!s budget was cut. NASA stopped developing and testing new spacecraft for NOAA, and the weather satellite program deteriorated.[2]

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[1] Tsongas in United States Senate (1980), *Effects of Carbon Dioxide Buildup in the Atmosphere.* Hearing before the Committee on Energy and Natural Resources, United States Senate, 96th Congress, Second Session, April 3, p.4, online at https://babel.hathitrust.org/cgi/pt?id=mdp.39015081188222&view=1up&seq=8; Broecker to Sen. Paul Tsongas, April 7, 1980, "CO_2 history" file, office files of Wallace Broecker, LDEO.

[2] Fleagle (1994), p. 120; Purdom and Menzel (1996), pp. 106-111; Johnson (1994). See Conway (2008).

TIROS and its successors were designed to help with daily weather forecasts, but some of the NASA satellites also did fine work for climate studies. Computer modelers had reached a point where their progress would come to a halt unless they got much better data on the actual atmosphere. The answer was Nimbus-3, launched from Vandenberg Air Force Base in 1969. The satellite&!s infrared spectrometers measured the temperature of the atmosphere comprehensively —at various levels, night and day, over oceans, deserts and tundra. It was a wealth of systematic data inconceivable a generation earlier, and invaluable for climate research. Combining this with data from TIROS and other weather satellites, analysts quickly found that earlier ground-based estimates of the planet&!s radiation budget had been seriously in error. In particular, the tropics were much "darker" than expected, absorbing heat from sunlight that must be transported somehow, by air or ocean currents, toward the poles. Nimbus-3&!s data eventually provided an important direct check for a key computer model of 1975.[1] The satellite was followed in the mid 1980s by a series of Earth Radiation Budget Experiment (ERBE) satellites which likewise provided data essential for accurate computer modeling.[2]

NASA&!s budget for atmospheric research had meanwhile been growing, stimulated by the fear that human emissions were destroying the ozone layer. Through the 1980s, NASA funded a variety of laboratory studies, field experiments, and theoretical studies and workshops related to atmospheric research, and vigorously advocated research on every kind of global change.[3]

NOAA, between operating the satellites and its other programs, was the world&!s most generous contributor to the international Global Atmospheric Research Program. Meanwhile, on the world&!s oceans NOAA almost fulfilled its ambition to be a "wet NASA." Its extensive oceanographic programs, mostly based in universities, produced many findings on ocean circulation and the like which were crucial for understanding climate change. No less important were NSF-funded projects. A survey of several oceans (GEOSECS, 1972-1978) took advantage of the one-time historical opportunity to track the fallout from the atomic bomb tests of the late 1950s, using the radioactive isotopes as markers of ocean circulation. Even more useful was NSF&!s Deep Sea Drilling Project, an ongoing series of cruises that extracted countless cores from the seabed (DSDP, 1968-1983, followed by an Ocean Drilling Program). Among much else, cores pulled from many locations helped map out the world&!s climate in the depths of the last ice age, posing an important test for computer climate models.[4]

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[1] Vonder Haar and Suomi (1971); Vonder Haar et al. (1981); Raschke et al. (1973); Manabe and Wetherald (1975). I have also used Jennifer Green (NASA History Office), "Nimbus Series," seen online at a site now gone.

[2] Satellite radiation budget measurement history is reviewed by House et al. (1986); for ERBE, see http://asd-www.larc.nasa.gov/erbe/ASDerbe.html.

[3] Fleagle (1994), p. 121. On all this see Conway (2008).

[4] For this and other NSF programs: National Research Council (2000).

Global Warming Rises as a political Issue (1980-1987)

By 1980, many climate scientists thought it likely that harmful global warming was on the way, but Federal budgets for their research were not rising. In 1981, Ronald Reagan took the presidency with an administration that openly scorned their concerns. He brought with him a backlash that had been building against the environmental movement. Many conservatives denied nearly every environmental worry, global warming included. They lumped all such concerns together as the rants of business-hating liberals, a Trojan Horse for government regulation. The National Climate Program Office found itself serving, as an observer put it, as "an outpost in enemy territory."[1] The new administration laid plans to cut funding for CO_2 studies in particular, deeming such research unnecessary. Everything connected with the subject became politically sensitive. Thus when NASA scientist James Hansen published a study showing that the world had been getting warmer, and the *New York Times* made it a front-page story, the DOE reneged on funding they had promised Hansen. He had to lay off five people from his institute.[2] Such cutbacks were not enough for the DOE program&!s enemies. "The question of concern," one staff scientist remarked, "will be whether we have jobs rather than how we spend money."[3] This was only one example of a politicization of science that extended into areas as diverse as smog pollution and embryonic research.

A total gutting of greenhouse effect research was narrowly averted when scientists rallied behind Representative Albert Gore, Jr. As a student at Harvard back in 1968, Gore had been impressed by lectures Revelle gave there. Revelle had displayed Keeling&!s curve of relentlessly rising CO_2. "We were looking at only eight years of information," Gore recalled, "but if this trend continued, human civilization would be forcing a profound and disruptive change in the global climate." It came as a shock to him, exploding his childhood assumption that "the Earth is so vast and nature so powerful that nothing we do can have any major or lasting effect on the normal functioning of its natural systems."[4] Over the years Gore had kept abreast of the technical issues as they developed, and he shared the concern about global warming as it grew among scientists. No doubt he also saw a political opening. As a champion of environmental issues he could display leadership in one of the few areas where the Reagan administration&!s policies disturbed a large majority of voters.

Gore joined a few others in Congress to embarrass the administration with hearings on the proposed cuts. The hearings won a smattering of attention in the press, including an editorial in the *Washington Post* saying that global warming had moved outside the "sandals and granola crowd" to mainstream science. The hearings themselves counted less than the echo in the press. As an aide close to the process put it, "the popular media is the most potent way of convincing a

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[1] Fleagle (1992b), p. 72.

[2] Stevens (1999), p. 150.

[3] Elliott (1977-89), 6 Oct. 1981.

[4] "Eight years" would make this ca. 1966. Gore was a freshman at Harvard in 1965, where Revelle delivered freshman lectures starting that year. Gore (1992), pp. 4-6.

member of Congress that he should pay attention to scientific issues." Politicians did not read scientific journals, nor much care what they said. Rather, they relied on the press as the "prime detector of the public&!s fears." Sporadic press attention to greenhouse warming through the rest of the year embarrassed the administration enough to avert the worst of the threatened budget cuts, although important research programs had been abruptly terminated and were sorely missed. The public controversy helped to establish CO_2 emissions as a major issue in energy policy. The battle also cemented a relationship among leading climate scientists, environmentalists, and Democratic Party politicians.[1]

The small band of climate scientists who were not only alarmed about global warming, but determined to do something about it, worked harder than ever to attract attention, even at risk of sounding alarmist. They had some success at getting stories into newspapers and magazines. The politicians who supported them were still more oriented toward getting press coverage. For example, for a 1984 hearing Gore called in Carl Sagan, a respectable atmospheric scientist but far more famous as an astronomy popularizer. Sagan would attract television cameras to the hearings better than the specialists who devoted all their time to research.

The biggest concern of Sagan and some other atmospheric scientists pointed in another direction. In 1983, they announced calculations that a nuclear war could bring on a "nuclear winter," a profound cooling that might last for years. While this warning had little connection with the greenhouse effect, it did thrust forward the troublesome idea that human technology could bring on a climate disaster. The "nuclear winter" discussion grew into a harsh political controversy, for it was a deliberate attack on the Reagan administration&!s refusal to reduce the nation&!s nuclear arsenal. This reinforced the tendency for debate about possible climate changes to polarize along traditional political lines.

As the public forum became a stage for strident combat, the only progress came from the scientists who worked quietly behind the scenes. One of the best tools they created was an Earth System Sciences Committee, set up by NASA in 1983. The space agency was planning a "Global Habitability" program, which would eventually launch satellites to observe global change, and needed to fit this in with the plans of other agencies. The new advisory committee organized the government&!s first truly large-scale, interdisciplinary initiative to study global change with full interagency and international cooperation. On the committee, members struck bargains among agency officials and leaders of science disciplines, forging a common front. Eventually they issued a report that represented a consensus of the leading players.

This method for consensual lobbying drew on practices that physicists and astronomers had devised in the 1960s in their search for increased funding. Rather than competing in the distorting hurly-burly of press releases, leading scientists fought out their differences first among themselves. Once they agreed on a short list of top-priority programs, they put the weight of their joint prestige behind it. The administration&!s budget officials and Congress, pleased to see a

[1] United States Congress (1977); Jensen (1990).

coordinated effort endorsed by scientific authorities, opened their pockets, and there was more money for everyone.[1]

Quiet negotiation among scientists of a consensus program also worked well on the international level. A landmark World Climate Conference, held in Geneva in 1979, gave rise to a "World Climate Research Programme" that organized a variety of large-scale cooperative projects through the 1980s. American scientists played a major role in designing the projects, then went back to government agencies with a strong case for funding their nation&!s share.

In 1980 Congress had passed an Energy Security Act which included a provision directing the administration to hire the Academy to carry out a comprehensive study on the impacts of rising CO_2. Using the JASON and Charney reports as a starting-point, in 1983 the Academy issued the fruit of a sustained effort to work out a consensus in a panel of leading experts. The scientists agreed that they were "deeply concerned" about the environmental changes that they expected a temperature rise would bring. Worse, they pointed out that "we may get into trouble in ways that we have barely imagined"—for example, if global warming released methane (a potent greenhouse gas) from seabed sediments. These cautions, however, were only passing remarks within a summary that was on balance reassuring. Hansen remarked that the report "seemed to be aimed at damping concern."

Indeed the report, following the Academy&!s traditions, avoided alarming claims. Its summary concluded that warming would probably come on the lower side of the range the Charney report had calculated, and certainly not soon. There would be time enough to take action if necessary. After all, if scientists did eventually demonstrate that global warming was a grave problem, governments would immediately take strong action... wouldn&!t they? The panelists failed to take note of the Charney report&!s concern that clear signs of warming would be delayed simply because the oceans were absorbing heat. Projecting temperature change in the lower half of the range the Charney group had predicted, the Academy&!s report noted that "climate change is far from novel; large numbers of people live in all climatic zones and move easily between them." At worst, people who found themselves in a region with a deteriorating climate could migrate to a better place. That reflected a benign view of an automatic self-regulating balance between natural forces and human society, a view still common among the conservative scientists who dominated the Academy. "Overall," the report concluded, "we find in the CO_2 issue reason for concern, but not panic." Heading off what some saw as a threat of intrusive government policy-making, the panel&!s chief recommendation was that the only thing to do at present was to fund vigilant monitoring and other studies. It was true, after all, that more money needed to be spent on research.[2]

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[1] NASA (1988).

[2] Hansen et al. (2000a), p. 139; Oreskes & Conway (2010), pp. 174-183. N.b. the conclusions of Oreskes et al. (2008b) have been challenged by Nierenberg et al. (2010) . Formally this Carbon Dioxide Assessment Committee, was under the Board of Atmospheric Sciences and Climate of the Commission on Physical Sciences, Mathematics, and Resources of

Americans might have received and ignored this as just another dull Academy document, but three days earlier the Environmental Protection Agency had released a report of its own about the greenhouse effect. The science was mostly the same, but the tone of the EPA&!s conclusions was more anxious. “Substantial increases in global warming may occur sooner than most of us would like to believe,” the EPA authors warned. However, delaying the warming would require nothing less than an outright ban on coal, which seemed out of the question for the foreseeable future on both economic and political grounds. There was no way to avoid a temperature rise, perhaps a big rise. That could mean “a change in habitability in many geographic regions” within a few decades, with potentially “catastrophic” consequences. The clear implication was that work on new energy policies should start immediately.[1]

The Reagan administration saw the EPA report as a political attack and attacked it in return, opening a caustic public debate between people who were alarmed by global warming and people who felt it could be ignored. The controversy, piled on top of Congressional hearings and the efforts of outspoken scientists, alerted a sizable fraction of citizens and politicians to the prediction that stood at the center of both reports. It was official—global warming might be coming. Climate scientists found themselves in demand to give tutorials to journalists, government agency officials, and even groups of senators, who would sit obediently for hours of lecturing on greenhouse gases and computer models.

For the time being the issue was resolved: yes, global warming could be a threat, and the practical response for the moment was to study it. Weary of the topic and distracted by more urgent matters, the media and public turned their main attention elsewhere. But while the issue was no longer at a boil it continued to simmer.

Through the 1980s, Gore (elected to the Senate in 1985) and others in Congress repeatedly called upon Revelle and like-minded colleagues to testify about global warming. The hearings won modest coverage on inside pages of leading newspapers and occasionally a minute or two on television. As one government scientist remarked, many in Congress had “for the most part accepted the potential Doomsday scenarios...”[2] An example of the tone was Broecker&!s 1987 testimony to the U.S. Senate&!s Subcommittee on Environmental Protection, reporting that his studies revealed the possibility of “very sharp jumps” of climate within the near future. “I come here as sort of the prophet,” he said. “There are going to be harsh changes.” Like a good prophet, Broecker remonstrated with the Senators. Money had been wasted in the bureaucracy, he

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the National Research Council. The study was commissioned by the President&!s Office of Science and Technology. The summary may be read online at http://www.nicolasnierenberg.com/uploads/1/1/6/6/1166378/executive_summary.pdf. National Academy of Sciences (1983), quotes pp. 3, 61.

[1] Seidel and Keyes (1983), quotes pp. ix, 7-7.

[2] E.g., *New York Times*, Dec. 11, 1985, p. 18. Quote: Elliott (1977-89), 13 June 1986 entry.

complained, rather than given to scientists for research. “We botched it—partly it is your fault —because you want answers to questions on a very short time scale.”[1]

Research Organization in the1980s

The Reagan administration meanwhile backed off from its dogmatic stand, as it did on many issues after its first couple of years in office. The most opinionated anti-environmentalist staff members had departed, and the DOE, EPA, and other agencies, responding to requests from Congress, began working to predict the likely social and economic impacts of global warming.[2] A broadly multi-disciplinary approach was taking shape, in which climate scientists began to interact with experts in many other fields. Most of their studies found that global warming could have severe consequences for agriculture, the economy, and so forth. They all became increasingly involved in discussing the issue with policy-makers.

The concern did not translate into increased funding for scientific research. Repeated Congressional attempts to restrain Federal spending kept NSF&!s total budget, among other research budgets, no higher in 1985 than in 1965. Leaders of the Reagan administration particularly distrusted any activity, even research, that they connected with a threat of government interference with business. Overall, the Federal government spent less money for the environmental sciences during the 1980s than during the 1970s. NASA and NOAA suffered cuts severe enough to force the entire meteorological program into stagnation, so that weather satellites launched in the 2000s would be flying with 1970s technology. As for global warming, by one discouraged estimate the Reagan administration spent less than $50 million per year for research directly focused on the topic—a trivial sum compared with many other research programs.[3]

Organization of the work remained scattered. Up through the mid 1980s, the Academy had taken the lead in providing some general guidance on priorities, but with the increased prominence of the issue, both Congress and various executive departments insisted on playing a role. The National Climate Program Office, with scant funds of its own to spend, held little sway. That left the job mainly in the hands of individual agencies, which, as an official complained, “pursued individual tracks, vying for primacy.” In 1989, Rep. George Brown of California—long a mainstay of Congressional support for science in general and climate research in particular—called the climate change research program “a bureaucratic nightmare,” a “failure” in addressing its vital goals.[4]

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[1] U.S. Senate, Subcommittee on Environmental Protection, Hearings, Jan. 26-28 1987, pp. 21-23.

[2] Schneider (1989a), pp. 130-32.

[3] Conway (2008). Budget: D. Slade to E. Bierly and 8 others, 1/28/86, in “Trivelpiece” file, office files of Wallace Broecker, LDEO..

[4] Brown, address to EOGC conference, 18 Sept. 1989. Fleagle (1992b), “vying” p. 69, see 70-74 for U.S. global change programs in general.

Yet the agencies had enough money and enough organization to push atmospheric research ahead, with results that aroused the public. The discovery of a "hole" in the atmosphere&!s protective ozone layer, although it was not directly connected with greenhouse warming, showed how industrial emissions could swiftly damage the planet&!s atmosphere. The 1977 law banning "spray can" chemicals was plainly insufficient. By 1987, scientific and public concern had grown so strong that the U.S. and many other nations signed an international treaty, the Montreal Protocol, decisively restricting production of the chemicals that were destroying ozone. The agreement had nothing to do with the main greenhouse gases, but it proved that the world could take effective action against an atmospheric threat—if the threat was sufficiently well publicized, convincing, immediate, and could be addressed without hurting anyone much (industries had found they could profitably switch to different chemicals). Some hoped that governments would follow the example in addressing greenhouse gases.[1] Sensitized to atmospheric risks, the public turned its attention back to global warming in the summer of 1988.

The Summer of 1988

It was a season of record heat waves, forest fires, and drought so severe that barges could barely navigate the Mississippi River. For the first time, the news media gave extensive coverage to predictions of global warming. After disquieting Congressional testimony Hansen told reporters, "the evidence is pretty strong that the greenhouse effect is here," and the public automatically connected that with the current weather anomalies. Shortly after, an international conference of scientists in Toronto not only concluded that greenhouse warming was a grave threat, but called on the world&!s governments to start taking action to avert it. The message to policy-makers and the public was summed up by a leader of the group: "If we choose to take on this challenge, it appears that we can slow the rate of change substantially, giving us time to develop mechanisms so that the cost to society and the damage to ecosystems can be minimized. We could alternatively close our eyes, hope for the best, and pay the cost when the bill comes due."[2] The media reported the Toronto conference&!s findings far more widely than earlier statements. The public began to feel that climate change was a serious issue, something their government should no longer ignore.

Under public pressure the U.S. Congress, where few bills on the subject had been introduced since 1978, returned to the issue. Several bills related to climate were introduced in 1987, four of which specifically mentioned "global warming." By early 1988, even before the hot summer, practical steps were under serious study, such as a "carbon tax" levied on emissions of CO_2. New climate bills reached an unprecedented peak later in 1988, and they continued to be introduced fairly frequently for the next few years. Along with the bills a large number of hearings and other congressional actions addressed climate change, peaking in 1989.[3]

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[1] Roan (1989), pp. 206, 208, 224; Parson (2003).

[2] Michael McElroy, quoted by Revkin (1988), p. 61.

[3] Bills: Balco (1999); hearings: Jensen (1990).

Most problems that a government addresses are thrust upon it by pressures of the day—foreign aggression, unemployment, and so forth. Global warming was harder to notice. It was only an issue because scientists predicted a future problem, and the scientists themselves shaded their predictions with qualifications and uncertainties. To get advice on what should be done, through the 1970s and 1980s the federal government had drawn on panels of experts, mostly convened by the National Academy of Sciences. These had recommended no big policy changes, but only the usual call to spend More Money on Research, and even that advice had not always been followed.

Around 1988, however, many people both in the scientific community and among the public began to feel that governments ought to do something to retard the emission of greenhouse gases. By the nature of the atmosphere, such steps needed international scope. The scientific advice likewise should be international. Foreign scientists would not only engage their own nations in the process, but would offer the most prestigious and convincing consensus.

In the negotiations that crafted the Montreal Protocol to restrict ozone-destroying gases, the U.S. Department of State, working in alliance with the EPA, had become committed to international environmental cooperation. Officials hoped to repeat the success with greenhouse gases. Here as with ozone, the key would be to get an international consensus on the science. For global warming, however, that could take a long time. The administration&!s greenhouse skeptics, loathing the idea of another Montreal-style agreement with mandatory targets, welcomed any delay which would stave off demands for concrete action. Greenhouse worriers, on their side, expected that thorough studies and discussions would eventually result in scientific recommendations that would exert irresistible political pressure. Thus both sides agreed on a lengthy process.

What kind of process? The administration&!s skeptics entirely distrusted the independent, international committees of scientists that had been driving the issue. If the process continued in the same fashion, the skeptics warned, future prestigious groups might make radical environmentalist pronouncements. Greenhouse worriers were ready to agree to government supervision of the process, recognizing that nothing practical could be done unless officials and bureaucrats were drawn into the work. The U.S. government therefore recommended to international agencies the creation of some kind of new “intergovernmental mechanism.” Other governments fell in line, and an Intergovernmental Panel on Climate Change was established in 1988.[1]

Resistance and Stasis (1989-2001)

The Intergovernmental Panel on Climate Change (IPCC) joined the National Academy as official climate adviser to the U.S. government. Representing virtually all the world&!s governments and

[1] Agrawala (1998a); Agrawala (1998b); Hecht and Tirpak (1995), pp. 380-81. I thank John Perry for comments.

their climate experts, the IPCC issued a series of reports that called with increasing conviction for action. Meanwhile other groups, ranging from government agencies to environmentalist organizations, devised lists of practical steps to retard global warming. In the first place, governments could set targets for reducing greenhouse gases. To meet the targets they could increase taxes on fossil fuels, impose efficiency standards, and so forth. There was no lack of advice on what should be done.

President George H.W. Bush was more receptive to environmental concerns than his predecessor. In a speech on the environment during the 1988 presidential campaign he had pledged to deploy the "White House effect" to take serious action on the greenhouse effect.[1] That summer a record heat wave and a scientist&!s outspoken declaration that "the greenhouse effect is here" had burst into the news, bringing the problem wide public attention for the first time. Concern mounted among citizens and officials, both Democratic and Republican. However many in the new administration, as in the earlier Reagan administration, only wished the issue would somehow disappear. In particular, the powerful White House Chief of Staff, John H. Sununu, despised every environmentalist policy. A sometime professor of mechanical engineering, Sununu convinced himself that he could prove that global warming was a chimera, and he suppressed discussion of climate throughout the administration. As one historian put it, Sununu "halted the political momentum in Washington, turned climate change into a partisan issue, and put denial of the science on its way toward Republican Orthodoxy."

In the end, the Bush administration did nothing that might have annoyed its industrial allies. The only actual climate measures it took were some mild improvements in the organization and funding of scientific research on climate (see below, USGCRP). By the end of Bush&!s first year in office, when the President spoke of global warming (or "global climate change" as he now called it), he concentrated on the scientific doubts and economic risks that argued against any action. A White House memorandum, inadvertently released, proposed that the best way to deal with concern about global warming would be "to raise the many uncertainties." As a cynical observer remarked, emphasizing uncertainties "had the dual effect of justifying increased research funding while delaying policy decisions—a win for both the scientists and the politicians!"[2]

Uncertainty was easy to raise, with an energetic minority of reputable scientists steadfastly denying all evidence and arguments for global warming. These scientists&! skepticism was widely circulated in publications sponsored by conservative groups and by industrial interests

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[1] Campaign speech Aug. 31, 1988. The phrase was pointed out in an editorial in the *New York Times*, April 21, 1990, p. 22, but little noted at the time, see *New York Times*, Sept. 1, 1988, p. B9 (archived as p. 24).

[2] Sununu "halted:" Anderson (2020), p. 228; see Kutney (2023), ch. 6; Rich (2019), chs. 18-20 and pp. 177-179. *New York Times*, Feb. 3, 1990, p. 12, Feb. 5, p. 15, Feb. 6, p. 1, memorandum: April 19, p. B4. Dual effect: Ryan M. Meyer, Letter, *Science* **314** (2006): 1681-82, referencing Meyer (2006).

that opposed regulation. In the forefront was the Global Climate Coalition, generously funded by dozens of major corporations. Advertising to the public and sending persuasive materials to journalists was the most visible part of the group&!s work, but perhaps not the most important part. With professionally crafted presentations, plus extensive face-to-face lobbying in Washington and at international meetings, the Coalition did much to persuade officials and members of Congress who were ignorant of science that there was no sound reason to worry about climate change.

Around 1990 the character of Congressional hearings on climate changed. Instead of information sessions featuring experts who all agreed that warming was a growing threat, the hearings degenerated into cockpits where Republicans brought in "contrarian" witnesses. These scientists, mostly the same half-dozen or so people testifying year after year into the 2010s, denied that global warming would be a serious problem for many decades if ever. By casting doubt on the science and even the integrity of their peers, they gave politicians cover for doing nothing.

In 1990 the IPCC issued its first report. The Bush administration and some other governments pressured their representatives to water down the conclusions, emphasizing uncertainties. Nevertheless the international scientific consensus flatly contradicted the skeptical scientists&! arguments. The skeptical standpoint, however, continued to find favor with top administration officials. Their stubborn rejection of the IPCC report became an embarrassment in 1992. World leaders were preparing their grandest meeting ever, an "Earth Summit" in Rio de Janeiro (officially, the United Nations Conference on Environment and Development). "Unless the Bush Administration quickly adopts a more reasonable course," the *New York Times* editorialized (Feb. 18, 1992), "it will cast the U.S. as an environmental pariah more concerned with its own comfort than with the well-being of the Earth." Sununu&!s departure from the administration permitted a less rigid position. The Rio meeting adopted targets which included rolling back emissions in the United States to the 1990 level by the year 2000. The Bush administration responded by adopting several inexpensive, "no regrets" policies to promote energy efficiency. These were far too modest to meet the targets, and in fact emissions continued to climb. The U.S. government remained more resistant to serious action against greenhouse warming than almost any other major industrial power.

One thing that did move forward was studies, for the administration generously funded climate research (if only to sidetrack pressure for taking direct action). These studies were now expanding into complex economic and engineering issues. A 1991 Academy report listed no less than 58 policies proposed for mitigating greenhouse warming. Some were "no-regrets" policies, so practical that they would be beneficial to the economy whether or not there was a global warming problem. Governments might, for example, promote improvements in the efficiency of commercial lighting, home heating, and trucks. Or they could reduce the costly subsidies that encouraged wasteful use of fossil fuels. Some policies would carry a modest cost that would be compensated by valuable social benefits. Why not devise ways to reduce car commuting time, for example, and reforest overgrazed wastelands? Some ideas were too expensive at present, but might become practical if technology was driven forward by the regulation or taxation of

greenhouse gas emissions, or by plain desperation. It might someday make sense, for example, to extract CO_2 as a power plant burned fuel, and sequester the gas in the depths of the oceans or underground. And some proposals were visionary. Couldn&!t we replace fossil fuels by growing crops that stored energy from sunlight, or launch flotillas of mirrors into orbit to reflect sunlight away from the Earth?[1]

After Bill Clinton took office as President in 1993, his new Vice President, Gore, and others persuaded him to endorse a U.S. "Climate Change Action Plan." This formally committed the nation to the Rio target for reducing greenhouse gases. In Congress, however, powerful conservatives not only scoffed at research that pointed to any environmental problems, but held deep suspicions about the United Nations and all its cooperative international programs. Some turned away from science itself—preferring folk cures to research-based medicine, or denying the evidence for biological evolution. Faced with these ardent opponents, Clinton was unwilling to spend his limited political capital on an issue that would not become acute during his term in office.

Energy conservation was a more pressing matter, and here Gore&!s climate concerns could be subsumed within general environmental and energy independence issues. Leaning on Clinton&!s drive to balance the budget with increased revenues, the administration proposed to tax the heat content of fossil fuels (measured in British Thermal Units, BTUs). The outcome set the pattern for future attempts to tax carbon emissions. With the reluctant support of a slim majority of Democrats, a bill passed the House, but it met stiff opposition from industry and tax-averse Republicans in the Senate. Bending to demands for special treatment from every quarter, the bill was (as an environmental lobbyist reported) "poked full of holes by the many committees and worn thin to the bone by legislators who handled it." Disillusioned environmentalists now gave only lukewarm support, and the bill died.

The threat of a "BTU tax" was among the issues that helped Republicans to a historic victory in the 1994 midterm elections, and in later years Democratic politicians would remember only too well how it had hurt them. In the end, Clinton&!s greenhouse policy came down to only a few inexpensive steps such as improvements in energy efficiency, which would never meet the Rio target. Congress had never taken much interest in global warming, and during the mid-1990s almost no bills relating to climate were introduced.[2]

In international negotiations, which culminated in 1997 with a huge conference in Kyoto, the United States remained the most powerful holdout against mandatory greenhouse gas reductions. The American public was interested in the issue, but confused. Pressure on Congress came mainly from anti-government conservatives and industries that depended on fossil fuels. Right-leaning think tanks redoubled their efforts to deny that global warming posed a threat; they

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[1] National Academy of Sciences (1991).

[2] "Poked:" Erlandson (1994). On the Bush and Clinton policies, see Stevens (1999), pp. 290-95, 298. 1990s bills: Balco (1999).

published more documents on the topic in 1996 than in all previous years combined, and a far greater number still in 1997 as the Kyoto Conference approached. Corporate groups joined with their own well-funded publicity. A typical argument in the pamphlets, op-ed essays, and press conferences was to point with horror at the specter of a tax on emissions. They claimed it would impose a dreadful rise in gasoline prices, supposedly intolerable to Americans (that is, Americans in the United States; Canadians, like the citizens of almost every other advanced nation, accepted high gasoline taxes as beneficial). The opponents also appealed to nationalism by warning that other nations would seize an economic advantage over the United States unless all reduced their emissions together. Even before the Kyoto delegates assembled, the U.S. Senate declared by a vote of 95-0 that it would reject any treaty that did not set limits for developing countries.

The Kyoto conference nevertheless ended with an agreement that pledged to restrict greenhouse gases but allowed exemptions for developing countries—the Kyoto Protocol, a compromise brokered by Gore in an eleventh-hour intervention that saved the meeting from collapse. Back in the United States, the Global Climate Coalition mounted a multi-million-dollar advertising campaign, insisting yet again that greenhouse gas restrictions were needless and would bring economic disaster. The administration never submitted the treaty to the Senate for ratification. With little debate, Congress declined to make any policy changes that might help move toward meeting the Kyoto targets.[1]

With the American public mostly confused or indifferent, politicians gave little time to the matter among the many demands for their attention. Global warming did not look like a winning issue for either party. During the election campaign of 2000, the issue came up only briefly in passing, even though it had long been identified with the Democratic candidate, Gore. He later said that he and his advisers had not thought they would get favorable press attention, or much attention at all, by bringing up global warming. The media were full of doubts that there was actually a problem, and anyway his opponent, George W. Bush, had pledged to take action against greenhouse gases if elected.

Research Organization in the 1990s and After

During these decades, heightened concern about climate change brought only one solid result: a stronger Federal research effort. That came partly as a simple share of a general increase in funding for all scientific research (in particular, the NSF&!s budget doubled between 1985 and 2000). Equally important was the public anxiety and media outcry that had broken out in 1988, forcing politicians to take some kind of visible action. Although most policy-makers were loath to regulate fuels, they could promise more research. Plans to improve climate research organization and funding had been working their way up through the bureaucracy with support from the usual sources—the Department of State (under increasing pressure from European governments concerned about global warming), DOE, NOAA, and EPA.

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[1] Christianson (1999), pp. 254-58, 263-68; for politics in the 1990s, see also Leggett (1999). On conservative think tanks see McCright and Dunlap (2000), p. 509.

In 1989, the interagency Committee on Earth Sciences formulated a Global Change Research Plan for the United States, and the first Bush administration put the Presidential seal of approval on the initiative. The following year Congress codified and funded the program in a Global Change Research Act that created a "United States Global Change Research Program" (USGCRP), which would attempt with minor success to coordinate the work going on under various agencies. The program&!s annual budget exceeded $1 billion in 1991 and climbed to $1.8 billion by 1995.

As often in environmental budgeting, a good part of this was not new money, but a reshuffling of existing appropriations under new labels. More than half of the Global Change program&!s funds were committed to NASA&!s 1992 "Mission to Planet Earth." This was an ambitious program of observation satellites that had many purposes besides studying global change, and in the end it proved too ambitious. A conservative Congress cut NASA&!s overall budget sharply year by year through the 1990s, and the shortage of money, along with inconsistent administration, resulted in an observing program far inferior to what its planners in the 1980s had anticipated. But NASA did end up gathering data on everything from atmospheric ozone to tropical deforestation, much of it helpful to climate studies. Funding directly for climate research increased significantly in NSF and (at a somewhat lower level) in the DOE. Moreover, NOAA&!s support for research at universities took a big step up.[1]

Climate scientists were not satisfied, for the budgets were not rising as fast as their suspicion that global warming would wreak serious damage. Meanwhile, in a related and even more important area—basic research on alternatives to fossil fuels such as solar energy and conservation—U.S. government support had peaked in 1980 in the wake of the oil crisis and then fell back sharply. Private investment in energy research continued to decline into the 21st century, while government funding stagnated at a level too low to accomplish much.

Some climate researchers continued to lament that they were starved for funds. "Why is this so?" one scientist asked. "I suspect the answer lies mainly in the unwillingness of top officials to make firm commitments to a problem that requires sustained focus for many decades.... &!What? No immediate payoff?&!"[2] A panel reviewing U.S. climate studies reported in 1998 that the work suffered from concentrating on costly satellites at the expense of other approaches. There were also persistent problems with management, especially (no surprise) a failure to coordinate efforts across agency borders. "If you say everything is connected to everything else, then it&!s hard to make progress," the panel&!s leader observed.[3]

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[1] Conway (2008), ch. 8. Fleagle (1994), pp. 119, 122, 125, 127.

[2] Mahlman (1998), p. 96.

[3] Berrien Moore, quoted Lawler (1998). On supervision of the Global Change Research Program by the interagency Committee on Environment and Natural Resources see Lambright (1997).

That was exactly the difficulty in climate science that had long hindered everyone, from scientists doing research to politicians making laws. With research dispersed among a variety of independent-minded scientific disciplines and agencies, the data and ideas that some understood very well remained obscure to others. Important new topics of study fell between funding stools. And policy-makers stumbled amid a clamor of different voices. In 2001 yet another Academy panel declared yet again that the federal government needed much better coordination of research.[1] Nevertheless, the system of funding and administration established by the 1990 Global Change Research Act remained essentially the same for decades. Somehow a hundred threads, all the varieties of scientific and societal thinking, had to be woven into practical policies. If nobody did that, and so if nothing was done in the end—well, inaction would itself be a policy, if perhaps not the wisest.

The 1990 climate legislation had called for a "National Assessment" of the impacts of global warming. Vice President Gore saw this as an opportunity to build grassroots support for his plans to address the problem, and the Assessment became a large exercise. An innovative democratic process drew in over three hundred scientists and thousands of "stakeholders" —ranchers, farmers, local officials and other concerned citizens, in meetings where education mingled with debate. The resulting report was checked by a distinguished committee (including the ubiquitous Bob White), and finally appeared in 2000. The experts reported that global warming could produce some benefits, but most of the impacts would be harmful from the outset. (*This essay does not cover the many "impact studies" and debates that attended such conclusions. See the separate brief essay on Impacts.*) The report was meant to guide the work of the incoming administration.[2]

The George W. Bush Administration

When George W. Bush became President, some hoped that as a proven conservative he could get restrictions on CO_2 through Congress more easily than Gore could have done. A few members of Bush&!s cabinet, and many foreign leaders, pressed the new President to take steps against climate change. However, Bush&!s friends in the energy industries and other conservatives launched an intense lobbying campaign. Vigorously supported by the powerful Vice President (and former oil industry C.E.O.) Dick Cheney, they persuaded the administration to renounce all restrictions. The United States government repudiated the Kyoto Protocol. As for domestic initiatives that might reduce greenhouse gases, the administration considered them only so far as they might serve as public window-dressing for programs whose main aim was to strengthen corporations in the fossil fuel and other industries.[3]

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[1] National Academy of Sciences (2001).

[2] National Assessment Synthesis Team (2000).

[3] Kyoto: *New York Times*, March 15, 2001, p. A23. An outstanding case of window-dressing was an administration initiative (Feb. 2003) to study hydrogen as a fuel. This could only reduce greenhouse gases in a distant future, provided that nuclear or renewable sources were developed to generate the hydrogen. For Cheney and the early decision in favor of

The new White House staff deliberately buried Gore&!s climate assessment, and persistently ignored the Congressional mandate to publicly assess impacts. Government scientists and officials were forbidden from using the Assessment or referring to it in any way.[1] It was only the beginning of efforts by Bush administration appointees to suppress scientific reports, if they threatened opinions popular among conservatives.

Andrew Revkin of the *New York Times*, in these years almost the only science reporter giving global warming the sustained attention it merited, heard about the censorship in 2005. Scientists were appalled by Revkin&!s report that a NASA administrator had threatened Hansen with severe consequences if he made public his belief that global warming required immediate action. Hansen knew such administrative threats were not idle, as mentioned above. Other NASA scientists and some at NOAA and EPA told similar stories—mostly in private. The political imbroglio left Hansen more exposed than ever to the political limelight. Relying on the respect he had earned for his outstanding scientific work, Hansen increasingly addressed every audience that would listen to his soft-spoken warnings of approaching disaster. He testified before Congress, sought interviews with political leaders from state governors to foreign presidents, responded to journalists and spoke to audiences of ordinary citizens. As one reporter noted, "Here&!s a guy who really just wanted to get back to the hobbit hole of his research, but who was forced by the political situation in which he found himself... to march off and confront the dragon."[2]

The Bush administration, under pressure to do something about global warming, in 2002-2004 developed a "Climate Change Research Initiative" managed under a "Climate Change Science Program." Scientists initially criticized the plans, but after a series of revisions, they agreed that the program would modestly improve coordination among the 13 semi-autonomous federal agencies involved in climate change research. The budgets for this research remained flat at best, in keeping with the administration&!s overall weakening of programs relating to the environment. Meanwhile political appointees cast doubt on the emerging scientific consensus

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oil companies see Coll (2012), pp. 89-91, Kutney (2023), ch. 6, Hecht (2014), pp. 788-89, q.v. for more on the U.S. government and climate.

[1] Piltz, (2005); Mooney (2007b); Morgan et al. (2005).

[2] Revkin, "Climate Expert says NASA Tried to Silence Him," *New York Times,* January 29, 2006, p. 1. The NASA Inspector General later reported that political appointees had "reduced, marginalized or mischaracterized climate change science made available to the general public," Revkin, "NASA Office Is Criticized on Climate Reports," *New York Times,* June 3, 2008 . Also Kennedy (2006); Antonio Regalado and Jim Carlton, "Agency [NOAA] Retreats from Discounting Global Warming," *Wall Street Journal,* Feb. 16, 2006, p. A4, and personal communications. See Mooney (2005) pp. 232-35 and ch. 7 *passim*; Bowen (2007). "Here&!s a guy:" my personal observations agree with Chris Mooney, "A Reluctant Hero of Climate Politics," *New Scientist,* Jan. 5, 2008, p. 44.

about global warming (or "climate change," a phrase that a Republican Party strategist suggested sounded less frightening).[1]

Yet ultimately the science was undeniable. In August 2004, the administration sent Congress an analysis (developed at NCAR) explaining that greenhouse gases were the only likely explanation for the warming seen in recent decades. Unlike earlier reports, this came with endorsement letters signed by the Secretary of Energy, the Secretary of Commerce, and the President&!s science adviser. The administration thus at last officially agreed that humans were bringing on global warming. But it proposed no new practical actions to address the problem. In 2005, Bush appointees struck from NASA&!s budget important satellite missions that would have improved observations of climate change and its causes. They even reduced funding for analyzing data already in hand.

The Global Climate Coalition had collapsed in 2000 as key corporations withdrew under pressure from public advocacy groups. Such a lobbying organization hardly seemed to be needed, since the energy business felt its interests were well represented by the Bush Administration. Nevertheless a "Cooler Heads Coalition" (created in 1997) and many right-wing organizations not only carried on but expanded their efforts in the early 2000s. The work was amply funded by oil and coal corporations such as ExxonMobil as well as utilities that relied on fossil fuels, railroads (which derived important income from transporting coal), automobile makers, and a variety of other businesses, plus wealthy individuals like the billionaire brothers Charles and David Koch. Even the powerful U.S. Chamber of Commerce argued that climate science was in doubt and that the proposed solutions would be harmful. The various groups found many ways to lobby legislators, the press and the public. For example, in February 2005 the Cooler Heads Coalition held a "Congressional and media briefing on the Kyoto Protocol" with "light refreshments" in the Senate Dirksen Office Building. The aim was to decry the Protocol, which was about to go into effect after ratification by nearly every significant nation in the world except the United States.[2]

Climate change was scarcely mentioned by the presidential candidates during the 2004 election. During this period it stood in a political spotlight for only a few days in October 2003, when the Senate debated a bill sponsored by two sometime presidential hopefuls, maverick Republican

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[1] These developments can be followed, for example, in the *New York Times* and news articles in *Science* magazine. Strategist: memo by Frank Luntz, 2002, leaked in 2004, online at http://www.luntzspeak.com/graphics/LuntzResearch.Memo.pdf.

[2] For the Bush administration and global warming see Gelbspan (2004), esp. ch. 33, Mooney (2005) *passim*, and Goodell (2006), ch. 9; on opposition funding see Brulle (2019). The Coalition holds the valuable URL globalwarming.org. Cole Triedman, et al., "Chamber of Obstruction: The U.S. Chamber of Commerce&!s Shifting Discourses on Climate Change, 1989-2009," Climate and Development Lab, Brown University, June 29, 2021, 12 pp., pdf online at http://www.climatedevlab.brown.edu/uploads/2/8/4/0/28401609/chamber_of_obstruction_report.pdf. See Anderson (2020), pp. 271-273. Briefing: I received an invitation, probably by mistake.

John McCain and Democrat Joseph Lieberman. They hoped to create a weak carbon emissions trading system. The bid met opposition from the Bush administration, and was denounced by Senators who exclaimed that restrictions would devastate the American economy. When the bill was defeated by a not overwhelming margin of 55-43, environmentalists were encouraged that opinion was moving in their favor, although slowly.

The Obama Administration

After the Democratic Party regained control of Congress in the 2006 elections, most political observers predicted that some sort of meaningful legislation on climate change would be enacted within the next few years. In the 2008 elections the Republican Party platform had expressed serious concern for climate change and called for reductions in greenhouse gas emissions; their Presidential candidate, Senator John McCain, proposed legislation to impose costs on the emissions. Hopes redoubled when the Barack Obama administration took office in 2009, declaring that it fully accepted the necessity of curbing greenhouse gas emissions.

An immediate opportunity came in a "stimulus" bill, a response to the 2008 economic collapse that was rushed through Congress in February 2009. Buried among the bill&!s many provisions were subsidies for programs related to climate change, such as loans to fragile start-up companies. (A bad investment in a solar-cell manufacturer, Solyndra, would attract criticism for many years; less noted was a profitable loan that rescued a struggling electric-car company, Tesla.) Altogether the bill allocated some $26 billion for climate work, far more than anything previous—although a barely noticed fraction of the $800 billion total. Over the following decade, with little fanfare, the money would jump-start a transition to a low-carbon economy. But it was a one-time bump. The administration turned its efforts to what it hoped would be more lasting changes. *(This essay does not address the complex debates over the economics of climate policies in general, and in particular subsidies and tax credits for research, development, and deployment of technologies.)*

Congress remained sharply divided along partisan lines on climate, as on matters more obviously political. Polarization had been growing with Americans taking sides on almost every problem. The Republican grassroots were increasingly scornful of warnings about global warming, associating climate concern with the despised liberal intellectual elites. Republican Senator James Inhofe repeatedly held hearings that he imagined would expose global warming as "the greatest hoax ever perpetrated on the American people." No Republican rose to oppose his arguments.

The Democrats themselves were divided, with powerful Senators representing the viewpoints of corporations and regions that depended on fossil fuels. In 2007 when former Senator Al Gore had visited his old colleagues to urge them to impose a tax on carbon emissions, few politicians of either party had been willing to move in that direction. Every attempt to initiate legislation was

immediately warped by demands, from a variety of powerful constituencies, for exemptions or outright subsidies.[1]

In preparing to take office, Obama&!s advisers had debated whether to spend their political capital on health care or climate or both. They decided to give priority to health care. In the end the White House did little to support climate legislation. Lobbying was left largely to the U.S. Climate Action Partnership, a coalition created to coordinate the efforts of ten major environmental groups and 60 associates. The partners included not only such groups as the National Resources Defense Council and the Environmental Defense Fund but also corporations including Shell, General Electric, and DuPont—corporations willing to join the effort if they could win concessions for their industries. In 2009 the House of Representatives managed to pass, by a slim majority, a bill that would institute a European-style "cap-and-trade" scheme to restrict emissions (the Waxman-Markey bill, named after its sponsors, both Democrats).

The bill and indeed the entire problem of global warming had never inspired much public pressure for government action. Urgent issues like health care and jobs (during the worst economic times since the 1930s) were far more salient. The bill had made many concessions to industrial interests, which was hardly surprising considering that corporations reliant on fossil fuels spent roughly a billion dollars lobbying Congress about climate change during this five-year period—ten times the amount spent by environmental organizations and their allies in the renewable-energy industry. Senators and representatives from states with a strong fossil-fuel industry had reservations in any case. Deeply compromised, the bill got only lukewarm support even among citizens alarmed by climate change, while the majority of Americans had scarcely heard of it. It was the well-funded right-wing organizations who were mobilizing a ferocious "Tea Party" public opposition to almost any government action. That included carbon regulation, and from this point on, opposition to such actions was obligatory for anyone seeking position in the increasingly radicalized Republican party. The Waxman-Markey bill died in the Senate when the Republican minority exercised a veto through threats of filibuster.[2]

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[1] A Wikipedia article lists the provisions of The American Recovery and Reinvestment Act of 2009. The $26 billion figure is from United States Government Accountability Office (2018), p. 58. The often-cited "hoax" statement first appeared at the end of Inhofe, "The Science of Climate Change," Senate Floor Statement, July 28, 2003, press release, online thanks to the Wayback Machine (https://web.archive.org/), search for www.inhofe.senate.gov, July 2003 - July - Press Releases. See news reports, for example, Monastersky (2006) and Eugene Bierly, *Eos* **87**:35 (2006), p. 354, and Inhofe (2012). For the Obama administration in general see Speth (2021), ch. 7.

[2] For polls throughout this period a main source is Anthony Leiserowitz&!s Yale Project on Climate Communication, http://environment.yale.edu/climate/. Lizza (2010) is one example of a growing literature on the failure. Lobbying: for the years 2007-2011, out of two billion spent 2006-2016, Brulle (2018). An influential but controversial analysis: Theda Skocpol, "Naming the Problem: What It Will Take to Counter Extremism and Engage Americans in the Fight against Global Warming," Symposium on The Politics of America&!s Fight Against Global Warming,

Any hopes for action were squashed by the 2010 elections, which replaced many representatives concerned about global warming with more conservative Republicans. A network of organizations, amply funded by the oil billionaires Charles and David Koch among others, had attacked Republicans friendly to fossil fuel regulation and driven them from Congress. Denying that climate change was a problem had become an important token of right-wing tribal loyalty. Most of the new representatives openly repudiated any concern about global warming. Under pressure from corporate donors and a populist movement with anti-intellectual undertones, the Republican politicians who did worry about climate change refused to address the issue. Funding for organizations that lobbied to protect fossil fuels fell off sharply: their work was done. By 2012 the Republican Party&!s platform would flatly oppose any action on climate, and even question climate scientists&! integrity.[1]

Stymied by lack of Congressional support, the Obama administration determined to do what it could on its own using presidential prerogatives. Foreign affairs was one such area, and the administration pushed for an international agreement to restrict emissions. When the multilateral approach faltered, Obama turned to bilateral agreements. An important step was a 2014 joint pledge with China, each setting its own limits on future CO_2 emissions. The scheme of independent national commitments became central to the 2015 Paris Agreement. However, the Agreement was deliberately made weaker than a treaty so that Obama could sign it without the impossible task of securing ratification by the U.S. Senate.

Meanwhile, another route to attack global warming had been working its way through the law courts. The Clean Air Act of 1970 required the Environmental Protection Agency to regulate "pollution". A long legal battle initiated by environmental groups resulted in a 2007 U.S. Supreme Court ruling that the EPA was required to regulate greenhouse gas emissions if it found them dangerous. The Bush administration had resisted such a finding, but in 2009 the EPA issued a ruling that the gases were indeed dangerous. The President&!s executive authority could bypass Congress here. Already in 2009 the EPA issued regulations requiring better fuel economy in cars and light trucks, and in 2013 it imposed strict standards on CO_2 emissions from any coal- or gas-fired power plant to be built in the future.

Most significantly, in 2014 the EPA issued a draft of new regulations that would severely restrict emissions from the nation&!s 600 existing coal-fired power plants. The goal was to cut CO_2 emissions from the plants to 30% below the 2005 level by 2030. This was less ambitious than environmentalists wanted, but it could make the United States a credible leader in international negotiations. However, legal challenges left it uncertain whether the regulations would ever be

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Harvard University, Feb. 2013, online at https://scholars.org/sites/scholars/files/skocpol_captrade_report_january_2013_0.pdf; Pooley (2010); on lobbying throughout this period see Leonard (2019), chapters 19, 20 & passim.

[1] Coral Davenport, "Heads in the Sand," *National Journal,* Dec. 1-2, 2011, online at http://nationaljournal.com/magazine/heads-in-the-sand-20111201. Funding decline: Brulle (2019).

implemented. (In 2021 a conservative majority on the Supreme Court struck down the plan by ruling that Congress had not explicitly given the EPA such sweeping powers. A few months later Congress replied by inserting explicit language into the Inflation Reduction Act of 2022, setting off a new round of lawsuits.)

The US Government Accounting Office reported that budget allocations for climate science grew from $1.3 billion for the 1993 fiscal year to $2.8 billion for 2017. In constant dollars that was a modest rise of 28%, and a significant *decline* as a fraction of the total federal budget. On the other hand, funds for research and development of technology, for example to reduce emissions from automobiles, rose from $845 million to $9.0 billion. Also important was a rise in "expenditures" in the form of tax breaks for things that might reduce greenhouse gases, from a bare $580 million starting in 2003 to $5.17 billion in 2017.[1]

The Trump Administration and After

In the 2016 elections, the major television networks offered less coverage of climate change than in previous years and aired no reports whatsoever about what the voters&! choice might mean for climate policy.[2] When Donald Trump became President he quickly appointed Scott Pruitt, a lawyer and politician who denied that human activity was a main cause of global warming, to lead the Environmental Protection Agency. Pruitt set to work to demolish the measures that the Obama administration had put in place to reduce emissions. He even removed climate change information from the EPA website. When Pruitt resigned under a cloud of inquiries into ethics violations, he was replaced by a former coal lobbyist who likewise dismissed scientific advice and despised regulation. Other top appointees followed the same line.

Climate science denial gradually worked its way through the bureaucracy as mid-level managers, fearing for their budgets or their jobs, put a lid on statements or research proposals that might offend their masters. Government scientists were demoralized, some fine experts were pushed out, those who stayed kept their heads down and waited for better times. Meanwhile in June 2017 Trump announced that the United States would withdraw from the Paris Agreement.

Four years was not enough time for the administration to destroy federal climate science altogether. Trump&!s appointees did halt enforcement of regulations, but removing regulations permanently was another matter. The officials, inexperienced and often incompetent, were repeatedly stymied by the law courts and the normal inertia of bureaucracy. When the administration submitted budgets eliminating funds for climate research, Congress restored the funds. Although thousands of experts had left, in the wounded agencies scientific work continued in the shadows. For example, in 2018 when the fourth National Climate Assessment was due,

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[1] Hecht (2014), pp. 790-91, q. v. for much else on climate and the U.S. government. The decline was from roughly 0.09% to 0.07% (my estimate). United States Government Accountability Office (2018), pp. 58, 60, 87.

[2] Kalhoefer (2017).

scientists wrangled a brutally honest warning of future damage past inept appointees to be published as an official administration report.[1]

Meanwhile in Congress a growing number of representatives were worried about climate (or at least about the people in their districts who were worried about it). Some joined a bipartisan Climate Solution Caucus in the House and, he b later, in the Senate. For two years they worked to negotiate a bipartisan energy and climate bill. It was the first major reform in a decade and, a supporter boasted, "the most significant greenhouse gas reduction bill to ever pass Congress." If so, that showed how little Congress had done hitherto. The bill extended a variety of clean-energy tax credits, banned potent new greenhouse gases that industry was putting into refrigerators (HFCs), and maintained research and development funding with an allocation of $35 billion over the next decade. Amid the crisis of the Covid-19 pandemic the group attached their bill, scarcely noticed by the press and public, to the trillion-dollar stimulus bill enacted in December 2020.[2]

Climate was now the most divisive issue of any in American politics, separating liberals from conservatives by a wider gap than even long-standing issues like abortion and gun control. American polarization on the issue along ideological lines was much greater than in other nations.[3] Some Republican politicians equivocated, worried that the rising cohorts of young voters

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[1] For the Trump administration in general see Speth (2021), ch. 8. On government scientists, see. e.g., Lisa Friedman, "A War Against Climate Science, Waged by Washington&!s Rank and File," *New York Times*, on p. 1 June 15, 2020, online updated July 14 at https://www.nytimes.com/2020/06/15/climate/climate-science-trump.html. On Paris Agreement withdrawal see Cooper (2018), pp 441-42. For disinformation and lobbying see Drilled at https://www.drilledpodcast.com/, for example, a deep look into the fossil fuel operation: Amy Westervelt, "Drilled Down: Old School Climate Denial Is Back," Drilled News, Nov. 28, 2022, online at https://www.drilledpodcast.com/drilled-down-when-it-comes-to-climate-obstruction-coal-is-still-very-much-alive/. U.S. Global Change Research Program, *Fourth National Climate Assessment* (2020), online at https://www.globalchange.gov/nca4, see Christopher Flavelle, "How Trump Tried, but Largely Failed, to Derail America&!s Top Climate Report," *New York Times,* Jan. 1, 2021, online at https://www.nytimes.com/2021/01/01/climate/trump-national-climate-assessment.html.

[2] Energy Act of 2020: Jeremy Dillon and Nick Sobczyk, "4 Takeaways on Clean Energy, Climate Deal," *E&E Daily,* Dec, 15, 2020, online at https://www.eenews.net/eedaily/stories/1063720703; Geof Koss, Jeremy Dillon and Emma Dumain, "Year-end Deal Includes Major Energy, Environment Wins," *E&E Daily*, Dec. 21, 2020, online at https://www.eenews.net/stories/1063721189; "most significant:" Sen. John Barrasso quoted in U.S. Senate Committee on Environment and Public Works, "Congress Passes Historic, Bipartisan Environmental Innovation Legislation," Dec. 22, 2020, online at https://www.epw.senate.gov/public/index.cfm/2020/12/congress-passes-historic-bipartisan

[3] James Bell et al., "In Response to Climate Change, Citizens in Advanced Economies Are Willing To Alter How They Live and Work," Pew Research Center (Sept. 14, 2021), online

seemed to be much more concerned about climate than their elders. But they also noted that the right-wing populism that had been gaining power around the world typically rejected any restraint on fossil fuels. No matter what they personally thought about climate science, to support restraints would alienate many constituents and, perhaps more important, campaign fund donors. With the right wing ascendant, the Republicans (and a few allied Democrats from coal-mining and oil-drilling regions) stood ready to block more serious Congressional action.

Action proceeded more effectively at other levels of society. In 2009 when the Climate Action Partnership had failed to get legislation through the Senate, its Washington-insider strategy of lobbying and negotiating compromises was discredited and the movement made a tough reappraisal of its methods. Activists turned to a grassroots strategy that aimed to mobilize large masses of people to donate, demonstrate, and get active in local Congressional elections.[1]

One example was an impressive outpouring of citizens (reportedly more than 300,000) who marched in New York City in 2014. The People&!s Climate March and thousands of associated demonstrations around the world were organized by a coalition of some 1500 groups ranging from unions to indigenous peoples. In the lead was the international organization 350.org, founded in 2008 by the writer and activist Bill McKibben and others. (According to James Hansen and some other scientists, to be safe the atmospheric concentration of CO_2 had to be reduced to 350 parts per million from the current 400-and-climbing.)[2] The demonstrations signaled the emergence of a political mass movement that promised to have some influence on politicians. Activists found ways to merge fear of global climate change with local environmental issues. Demonstrations and civil disobedience blocked fossil-fuel projects ranging from coal-fired power plants to oil pipelines (the most symbolically important was the Keystone XL pipeline extension, which the Obama administration rejected under intense pressure in 2015 and the Trump administration revived). By the end of the decade millions of people were involved in marches around the world and tens of thousands in civil disobedience actions.

Responding in part to public concern, in the early 2000s some centrist Republicans like the Governors of California and Florida had joined with more traditionally “green” politicians to address the issue. For example, in 2007 separate coalitions of Northeastern, Midwestern, Southwestern and West Coast states laid plans for mandatory regional systems to track and cut back their emissions. California in particular acted less like a typical U.S. state than like an entire country. With an economy larger than India&!s and a history of taming smog pollution, California had the heft to impose regulations on automobile emissions and other industries when the federal government held back. Hundreds of U.S. cities and thousands of smaller governmental entities

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at https://www.pewresearch.org/global/2021/09/14/in-response-to-climate-change-citizens-in-advanced-economies-are-willing-to-alter-how-they-live-and-work/

[1] Michael Wines, “Environmental Groups Focus on Change by Strengthening Their Political Operations,” *New York Times,* June 1, 2014, p. 21.

[2] Hansen et al. (2008).

also looked into a variety of practical steps. Overall ,the United States was doing as much as most industrialized nations. Meanwhile numerous corporations large and small, worried about adverse public opinion and legal liability, and noticing that the governments of nearly every other industrial nation were beginning to regulate greenhouse gases, prepared themselves by launching programs to reduce their own emissions.[1]

The job of conserving energy and reducing pollution had also been taken up by agencies of the federal government from the Department of Energy to the National Park Service. The military services, which had noticed global warming ever since suggestions in the 1950s that the Arctic Ocean might some day become navigable, realized that they might be called upon to handle everything from hordes of environmental refugees to outright conflict over dwindling resources, to say nothing of naval bases flooded by the rising oceans. Recognizing global warming as a "national security" problem on a level with war or terrorism, military units began working to reduce their greenhouse emissions.

Churches, universities, and countless other nonprofit organizations joined in, along with a rapidly increasing number of individual citizens. They understood that even the smallest step was a step to delay the impending dangers. Many insisted the United States could and should meet its Paris Agreement target even without the Trump administration&!s support, thanks to redoubled efforts by states, cities, corporations, and other organizations.

Meanwhile solar and wind power were rapidly becoming economically competitive with fossil fuels—thanks to subsidies for research, development, and deployment bestowed by the governments of the United States and other nations from Germany to China. Even so, to stave off dangerous climate change would require comprehensive new laws and regulations with powerful effects on established interests. Neither lawmakers, Federal officials, nor the public had yet mobilized the will to enact these.

As the world continued to get warmer and media reports of climate-related disasters accumulated, calls for effective action kept rising—almost entirely from the left. Climate change was a significant campaign theme among the wave of new representatives who helped Democrats take control of the House in the 2018 midterm elections. Citizens were taking sides over an expanding list of issues, and they placed climate concern among the social causes on the liberal side of the "culture wars." Wide press coverage drew attention to calls for a multi-trillion-dollar "Green New Deal" that would address global warming and social inequality as a single problem.

The combination followed from demands for "climate justice," a term popularized in the 2010s. Advocates pointed to the contrast between the world&!s wealthiest people, who caused and

[1] For the start of this movement see Rabe (2004); these developments were covered mainly in the business press.

benefitted from a large fraction of the greenhouse gas emissions, and those who contributed little to emissions but would suffer most from impacts: the poor, people of color, the young. Liberal thinkers concluded that the struggle to preserve a hospitable planet was inseparable from the struggle for justice (and therefore, the struggle for greater democracy). Climate activists stopped talking about saving future polar bears and proposed measures with near-term benefits for farmers and workers. By 2019 reporters were noting that among Democrats, "Climate change has for the first time emerged as a front-and-center issue in national political campaigns."[1]

The 2020 presidential debates were the first to take climate as a main topic. Public awareness had grown with catastrophic wildfires in California and elsewhere around the world plus the worst Atlantic hurricane season ever. A majority of Americans now felt that "dealing with climate change should be a top priority" of government. There were other things that people wanted even more to be a top priority, from jobs to crime, but concern about climate was presumably among the factors that contributed to Joe Biden&!s razor-thin margin of victory in swing states.

During the campaign Biden had told a journalist that he saw climate change as "the number one issue facing humanity. And it&!s the number one issue for me.... an existential threat to humanity." That put Biden in tune with a large section of the educated elite, but well ahead of the American public as a whole. (A 2020 poll of "political elites and public servants" found them overall more supportive of restricting emissions than typical voters.) Most citizens saw climate change as only one item in their list of concerns and far from the top. Even environmentalist groups often gave higher priority to local issues like closing a nuclear power plant or blocking an unsightly wind farm. The new president was not bowing to public pressure so much as to scientific reality.

From his first day in office Biden hastened to restore the climate-oriented programs and regulations that had operated four years earlier, such as rejoining the Paris Agreement and killing the Keystone XL pipeline. In every department he appointed officials with a mandate to push

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[1] Anthony Leiserowitz et al., "Politics & Global Warming, April 2019," Yale Program on Climate Change Communication (May 16, 2019), online at https://climatecommunication.yale.edu/wp-content/uploads/2019/05/Politics-Global-Warming-April-2019b.pdf . On climate discourse in the culture wars see King et al. (2022). "The richest 10% of the world&!s population... were responsible for 52% of the cumulative carbon emissions" 1990–2015; the poorest half were responsible for 7%, according to Tim Gore, "Confronting Carbon Inequality," Sept. 21, 2020, online at https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621052/mb-confronting-carbon-inequality-210920-en.pdf. Rise in 2010s: https://books.google.com/ngrams. CarbonBrief.org, "In-depth Q&A: What is &!climate justice&!." (Oct. 4, 2021), online at https://www.carbonbrief.org/in-depth-qa-what-is-climate-justice. "Emerged:" Coral Davenport and Sheryl Gay Stolberg, "Pressed by Climate Activists, Senate Democrats Plan to &!Go on Offense&!," New York Times March 4, 2019, online at https://www.nytimes.com/2019/03/04/us/politics/senate-democrats-climate-change.html.

much farther, as well as a new cabinet-level Special Presidential Envoy for Climate, the former Secretary of State and presidential candidate John Kerry. The new administration was the first in American history to act from an understanding that climate change posed, as the incoming Treasury Secretary bluntly repeated, an "existential threat."[1]

Politicians had learned that carbon taxes were off the table. Attempts to pass such measures in individual American states had been beaten at the polls. Abroad, when liberals in drought-stricken Australia made action on climate change a central issue in the 2019 national election, they were soundly defeated, while in France a simple plan to raise gasoline taxes was blocked by massive and sometimes violent "yellow vest" demonstrations. The only way forward would be through regulations—insofar as interminable legal delays and conservative judges allowed them to be implemented—and direct government programs and subsidies.

The Biden administration staked its political future on plans for massive spending with a joint focus on the economy and the climate. Accepting that serious climate impacts were inevitable, political and budgetary attention began to pay attention not only to "mitigation" (that is, reduction) of future global warming, but also to "adaptation" or "resilience," for example by erecting sea walls or discouraging construction at the seashore. Climate activists tended to downplay adaptation, fearing with good reason that promoting it would provide an excuse for avoiding efforts at mitigation. *(These essays do not cover adaptation.)*

The President and the left wing in Congress crafted a bill that would spend trillions of dollars on climate and other social goods. Lacking any Republican allies, however, with an evenly split Senate, the Democrats could do nothing if even one of their Senators dissented. Attention focused on the Democratic Senator Joe Manchin of West Virginia, who seemed emblematic of structural

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[1] Lisa Friedman, "In a Switch, Some Republicans Start Citing Climate Change as Driving Their Policies," *New York Times* (April 30, 2019), online at https://www.nytimes.com/2019/04/30/climate/republicans-climate-change-policies.html. Priority: Funk and Brian Kennedy, "How Americans See Climate Change and the Environment," Pew Research Center, April 21, 2020, online at https://www.pewresearch.org/fact-tank/2020/04/21/how-americans-see-climate-change-and-the-environment-in-7-charts/ . Emma Newburger, "Joe Biden Calls Climate Change the &!Number One Issue Facing Humanity&!," cnbc.com, Oct. 20, 2020, online at https://www.cnbc.com/2020/10/24/joe-biden-climate-change-is-number-one-issue-facing-humanity.html. Poll: Alexander C. Furnas and Timothy M. LaPira, "Political Elites Are More Supportive of Progressive Policies Than the Average Voter," Dec. 9, 2021, Data for Progress, online at https://www.dataforprogress.org/blog/2021/12/9/political-elites-are-more-supportive-of-progressive-policies-than-the-average-voter. Kate Davidson, "Yellen Is Creating a New Senior Treasury Post for Climate Czar," *Wall Street Journal,* Feb. 12, 2021, online at https://www.wsj.com/articles/yellen-is-creating-a-new-senior-treasury-post-for-climate-czar-11613138479.

problems in American politics. His state was a major exporter of coal. The increasingly automated industry now employed fewer than 3% of West Virginia&!s workers, but profits from coal were a major force in the state&!s politics. Manchin himself took nearly half a million dollars a year from his coal brokerage business, not to mention millions in campaign donations from the wealthy people he consorted with. He rejected all proposals to restrain fossil fuels.

New spending on climate in the administration&!s first year boiled down to parts of two bills whose main thrust was elsewhere. In March 2021 Congress passed a $1.9 trillion bipartisan "stimulus" bill responding to the Covid-19 pandemic. Among the many provisions was $30 billion for mass transit (buses, rail), an indirect but important way to reduce carbon emissions. But overall, analysis showed the bill would have negligible net effect on climate.

In November 2021 the President signed an "infrastructure" bill of $1.2 trillion, about half of which was money Congress would normally have spent in any case. Again the biggest impact on climate would come in money for surface transportation, some $600 billion of the total. The initial implementation of the bill was disappointing: mass transit got far less money than repairing and expanding roadways, which would encourage more auto travel and more emissions. Unambiguously helpful was an award to the Department of Energy of some $42 billion over five years for clean-energy research and development, roughly doubling the previous budget. Support for creating a cheap and safe new generation of nuclear reactors might turn out to be the most significant part of the entire bill.

The legislative session was about to end when Manchin, responding to promises and urgent pleas, agreed to a major bill (the "Inflation Reduction Act") that directly addressed climate change along with taxes and other provisions. The compromise abandoned the old "carrot and stick" approach, which would have included carbon taxes and penalties; it was a banquet of carrots. Buying solar panels and insulating houses would be rewarded, while building oil and gas pipelines would not be restrained, indeed would be assisted. One of the few actual sticks, a fee on excessive methane leaks, was balanced by subsidies for fixing leaks so generous that few would ever need to pay the fee... and so forth. Fossil-fuel corporations found little reason to object (indeed the law mandated offshore oil and gas lease sales that would allow them to *expand* production). In August 2022, amid appalling heat waves and droughts around the world, the bill passed the Senate by the smallest possible margin, all Republicans opposed.

The bill offered copious tax credits and direct subsidies to stimulate work on climate over the next decade; an enthusiastic response from industry indicated the total cost would approach a trillion dollars if not more. Even so, the annual expense would be a minuscule fraction of the government&!s budget. But the bill went far above anything the nation had previously done for climate, and the funds could have powerful leverage in this early stage of an economic transformation. Analysts projected the bill would bring a 40% reduction in the nation&!s emissions by 2030, a substantial improvement over the trend under previous policies. More important, the investment could set in motion changes whose main impact would be felt in later decades. Nascent industries could achieve economies of scale. Research (bolstered by tens of

billions more from a bipartisan bill to advance microchips and other relevant technologies) might open altogether new possibilities.[1]

Encouraging the development and deployment of technologies was always the most cost-effective of all policies. Solar and wind power and electric vehicles were now competitive industries only because the United States and other nations had given them large subsidies for decades. In basic research, American scientists no longer dominated the world&!s climate studies as thoroughly as they had in the postwar decades. Many of them now worked in formal or informal collaborations with colleagues in other nations, all part of a sprawling international complex of studies and workshops coordinated under the auspices of the World Climate Research Programme. Yet scientists and scientific institutions in the United States, funded mostly by the Federal government, remained by far the world&!s biggest contributors to climate science.

"Innocently pursuing their research," an observer remarked, "climate scientists were unwittingly destabilizing the political and social order." The scientific findings threatened industries at the foundation of the world&!s economy, undercut optimistic assumptions about the future, aroused hostility between people with differing fundamental beliefs about the role of government in society, and forced politicians to choose between scientific advice and the comfort of their constituents. The scientists&! research "has brought us to one of those rare historical fracture points when knowledge diverges from power, portending a long period of struggle before the two are once more aligned."[2]

> *What can governments do about global warming, and what should they do? See my Personal Note and Links.*

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[1] It must be left to future historians to unravel the history of the bill. For one insider viewpoint of interactions behind the Inflation Reduction Act of 2022, see Akshat Rathi and Jennifer A. Dlouhy, "Bill Gates and the Secret Push to Save Biden&!s Climate Bill," Bloomberg.com (Aug. 16, 2022), online at https://www.bloomberg.com/news/features/2022-08-16/how-bill-gates-lobbied-to-save-the-climate-tax-bill-biden-just-signed. The "CHIPS and Science Act" passed soon after.

[2] Biggest contributors: Robert McSweeney, "Analysis: The Most 'Cited' Climate Change Papers," CarbonBrief.org July 8, 2015, pdf online at https://www.carbonbrief.org/analysis-the-most-cited-climate-change-papers. For "climate change as cultural trauma" see Brulle and Norgaard (2019). "Innocently:" Clive Hamilton, "Why We Resist the Truth About Climate Change" (2010), online at https://clivehamilton.com/wp-content/uploads/2012/11/why_we_resist_the_truth_about_climate_change.pdf. See Monbiot (2017).

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