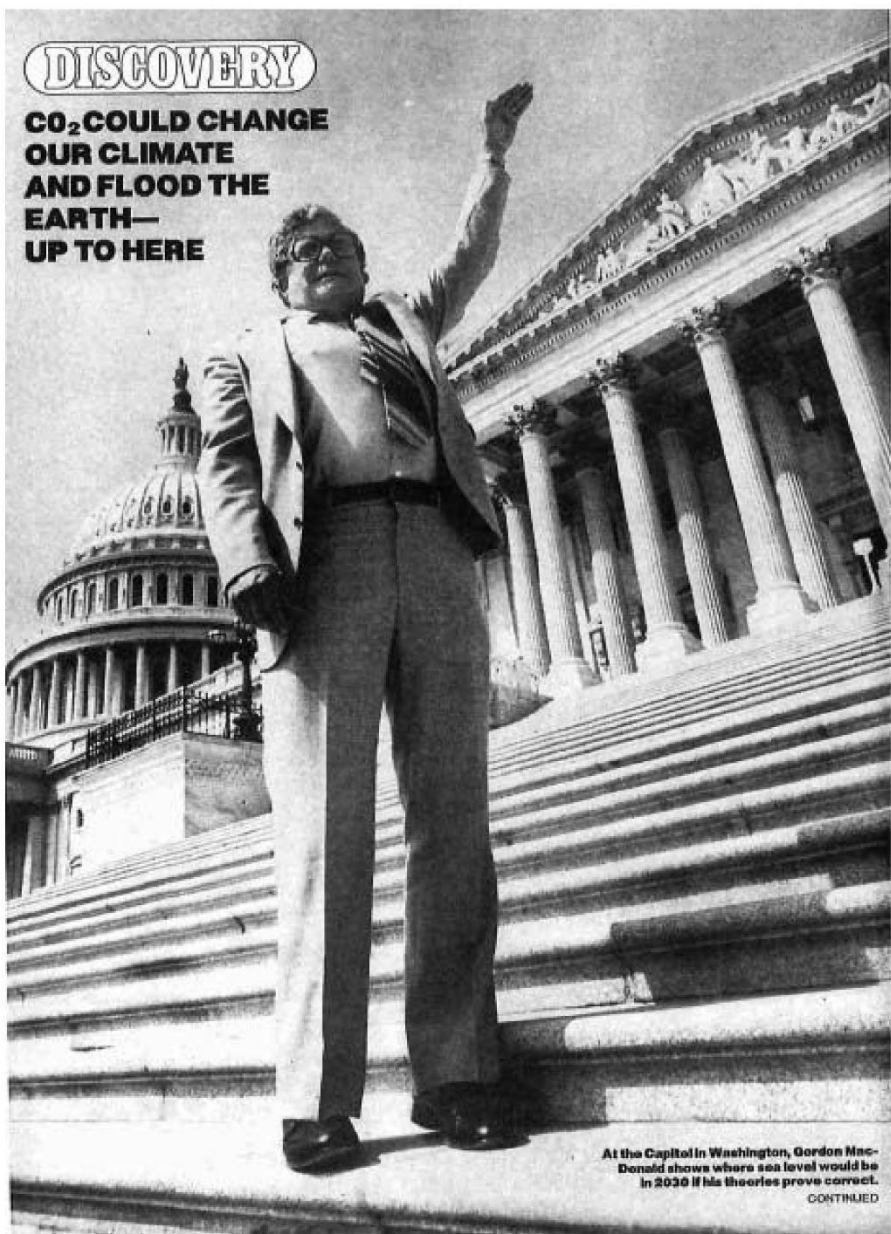


**DISCOVERY**

**CO<sub>2</sub> COULD CHANGE  
OUR CLIMATE  
AND FLOOD THE  
EARTH—  
UP TO HERE**



**At the Capitol in Washington, Gordon MacDonald shows where sea level would be in 2030 if his theories prove correct.**

**CONTINUED**

# Contents

## Introduction: The Reckoning

### PART I: SHOUTS IN THE STREET: 1979–1982

1. The Whole Banana: Spring 1979
2. Mirror Worlds: Spring 1979
3. Between Clambake and Chaos: July 1979
4. Enter Cassandra, Raving: 1979–1980
5. A Very Aggressive Defensive Program: 1979–1980
6. Tiger on the Road: October 1980
7. A Deluge Most Unnatural: November 1980–September 1981
8. Heroes and Villains: March 1982
9. The Direction of an Impending Catastrophe: 1982

### PART II: BAD SCIENCE FICTION: 1983–1988

10. Caution Not Panic: 1983–1984
11. The World of Action: 1985
12. The Ozone in October: Fall 1985–Summer 1986
13. Atmospheric Scientist, New York, N.Y.: Fall 1987–Spring 1988

### PART III: YOU WILL SEE THINGS THAT YOU SHALL BELIEVE: 1988–1989

14. Nothing but Bonfires: Summer 1988
15. Signal Weather: June 1988
16. Woodstock for Climate Change: June 1988–April 1989
17. Fragmented World: Fall 1988
18. The Great Includer and the Old Engineer: Spring 1989
19. Natural Processes: May 1989
20. The White House Effect: Spring–Fall 1989
21. Skunks at the Garden Party: November 1989

## Afterword: Glass-Bottomed Boats

## **A Note on the Sources Acknowledgments**

# Introduction: The Reckoning

**N**early everything we understand about global warming was understood in 1979. It was, if anything, better understood. Today, almost nine out of ten Americans do not know that scientists agree, well beyond the threshold of consensus, that human beings have altered the global climate through the indiscriminate burning of fossil fuels. But by 1979 the main points were already settled beyond debate, and attention turned from basic principles to a refinement of the predicted consequences. Unlike string theory and genetic engineering, the “greenhouse effect”—a metaphor dating to the early twentieth century—was ancient history, described in any intro-to-biology textbook. The basic science was not especially complicated. It could be reduced to a simple axiom: the more carbon dioxide in the atmosphere, the warmer the planet. And every year, by burning coal, oil, and gas, human beings belched increasingly obscene quantities of carbon dioxide into the atmosphere.

The world has warmed more than 1 degree Celsius since the Industrial Revolution. The Paris climate agreement—the nonbinding, unenforceable, and already unheeded treaty signed on Earth Day 2016—hoped to restrict warming to 2 degrees Celsius. A recent study puts the odds of pulling this off at one in twenty. If by some miracle we succeed, we will only have to negotiate the extinction of the world’s tropical reefs, a sea level rise of several meters, and the abandonment of the Persian Gulf. The climate scientist James Hansen has called a 2-degree warming “a prescription for long-term disaster.” Long-term disaster is now the best-case scenario. A 3-degree warming, on the other hand, is a prescription for short-term disaster: forests sprouting in the Arctic, the abandonment of most coastal cities, mass starvation. Robert Watson, a former chairman of the United Nations

Intergovernmental Panel on Climate Change, has argued that a 3-degree warming is the realistic minimum. Four degrees: Europe in permanent drought; vast areas of China, India, and Bangladesh claimed by desert; Polynesia swallowed by the sea; the Colorado River thinned to a trickle. The prospect of a 5-degree warming prompts some of the world's preeminent climate scientists, not an especially excitable type, to warn of the fall of human civilization. The proximate cause will be not the warming itself—we won't burst in flame and crumble all to ashes—but its secondary effects. The Red Cross estimates that already more refugees flee environmental crises than violent conflict. Starvation, drought, the inundation of the coasts, and the smothering expansion of deserts will force hundreds of millions of people to run for their lives. The mass migrations will stagger delicate regional truces, hastening battles over natural resources, acts of terrorism, and declarations of war. Beyond a certain point, the two great existential threats to our civilization, global warming and nuclear weapons, will loose their chains and join to rebel against their creators.

If an eventual 5- or 6-degree warming scenario seems outlandish, it is only because we assume that we'll respond in time. We'll have decades to eliminate carbon emissions, after all, before we are locked into 6 degrees. But we've already had decades—decades increasingly punctuated by climate-related disaster—and we've done nearly everything possible to make the problem worse. It no longer seems rational to assume that humanity, encountering an existential threat, will behave rationally.

There can be no understanding of our current and future predicament without an understanding of why we failed to solve this problem when we had the chance. For in the decade that ran between 1979 and 1989, we had an excellent chance. The world's major powers came within several signatures of endorsing a binding framework to reduce carbon emissions—far closer than we've come since. During that decade the obstacles we blame for our current inaction had yet to emerge. The conditions for success were so favorable that they have the quality of a fable, especially at a time when so many of the veteran members of the climate class—the scientists, policy negotiators, and activists who for decades

have been fighting ignorance, apathy, and corporate bribery—openly despair about the possibility of achieving even mitigatory success. As Ken Caldeira, a leading climate scientist at the Carnegie Institution for Science in Stanford, California, recently put it, “We’re increasingly shifting from a mode of predicting what’s going to happen to a mode of trying to explain what happened.”

So what happened? The common explanation today concerns the depredations of the fossil fuel industry, which in recent decades has committed to playing the role of villain with comic-book bravado. Between 2000 and 2016, the industry spent more than \$2 billion, or ten times as much as was spent by environmental groups, to defeat climate change legislation. A robust subfield of climate literature has chronicled the machinations of industry lobbyists, the corruption of pliant scientists, and the influence campaigns that even now continue to debase the political debate, long after the largest oil and gas companies have abandoned the dumb show of denialism. But the industry’s assault did not begin in force until the end of the eighties. During the preceding decade, some of the largest oil and gas companies, including Exxon and Shell, made serious efforts to understand the scope of the crisis and grapple with possible solutions.

We despair today at the politicization of the climate issue, which is a polite way of describing the Republican Party’s stubborn commitment to denialism. In 2018, only 42 percent of registered Republicans knew that “most scientists believe global warming is occurring,” and that percentage has fallen. Skepticism about the scientific consensus on global warming—and with it, skepticism about the integrity of the experimental method and the pursuit of objective truth—has become a fundamental party creed. But during the 1980s, many prominent Republican members of Congress, cabinet officials, and strategists shared with Democrats the conviction that the climate problem was the rare political winner: nonpartisan and of the highest possible stakes. Among those who called for urgent, immediate, and far-reaching climate policy: Senators John Chafee, Robert Stafford, and David Durenberger; Environmental Protection Agency administrator William K. Reilly; and, during his campaign for president,

George H. W. Bush. As Malcolm Forbes Baldwin, the acting chairman of Ronald Reagan's Council for Environmental Quality, told industry executives in 1981, "There can be no more important or conservative concern than the protection of the globe itself." The issue was unimpeachable, like support for the military and freedom of speech. Except the atmosphere had an even broader constituency, composed of every human being on Earth.

It was widely accepted that action would have to come immediately. At the beginning of the 1980s, scientists within the federal government predicted that conclusive evidence of warming would appear on the global temperature record by the end of the decade, at which point it would be too late to avoid disaster. The United States was, at the time, the world's dominant producer of greenhouse gases; more than 30 percent of the human population lacked access to electricity altogether. Billions of people would not need to attain the "American way of life" in order to increase global carbon emissions catastrophically; a light bulb in every other village would do it. A 1980 report prepared at the request of the White House by the National Academy of Sciences proposed that "the carbon dioxide issue should appear on the international agenda in a context that will maximize cooperation and consensus-building and minimize political manipulation, controversy and division." If the United States had endorsed the proposal broadly supported at the end of the eighties—a freezing of carbon emissions, with a reduction of 20 percent by 2005—warming could have been held to less than 1.5 degrees.

A broad international consensus had agreed on a mechanism to achieve this: a binding global treaty. The idea began to coalesce as early as February 1979, at the first World Climate Conference in Geneva, when scientists from fifty nations agreed unanimously that it was "urgently necessary" to act. Four months later, at the Group of Seven meeting in Tokyo, the leaders of the world's wealthiest nations signed a statement resolving to reduce carbon emissions. A decade later, the first major diplomatic meeting to approve a framework for a treaty was called in the Netherlands. Delegates from more than sixty nations attended. Among scientists and world leaders, the sentiment was unanimous: action had to be taken, and the United States would need to lead. It didn't.

The inaugural chapter of the climate change saga is over. In that chapter—call it Apprehension—we identified the threat and its consequences. We debated the measures required to keep the planet within the realm of human habitability: a transition from fossil fuel combustion to renewable and nuclear energy, wiser agricultural practices, reforestation, carbon taxes. We spoke, with increasing urgency and self-delusion, of the prospect of triumphing against long odds.

We did not, however, seriously consider the prospect of failure. We understood what failure would mean for coastlines, agricultural yield, mean temperatures, immigration patterns, and the world economy. But we did not allow ourselves to comprehend what failure might mean for us. How will it change the way we see ourselves, how we remember the past, how we imagine the future? How have our failures to this point changed us already? Why did we do this to ourselves? These questions will be the subject of climate change's second chapter. Call it the Reckoning.

That we came so close, as a civilization, to breaking our suicide pact with fossil fuels can be credited to the efforts of a handful of people—scientists from more than a dozen disciplines, political appointees, members of Congress, economists, philosophers, and anonymous bureaucrats. They were led by a hyperkinetic lobbyist and a guileless atmospheric physicist who, at severe personal cost, tried to warn humanity of what was coming. They risked their careers in a painful, escalating campaign to solve the problem, first in scientific reports, later through conventional avenues of political persuasion, and finally with a strategy of public shaming. Their efforts were shrewd, passionate, robust. And they failed. What follows is their story, and ours.

It is flattering to assume that, given the opportunity to begin again, we would act differently—or act at all. You would think that reasonable minds negotiating in good faith, after a thorough consideration of the science, and a candid appraisal of the social, economic, ecological, and moral ramifications of planetary asphyxiation, might agree on a course of action. You would think, in other words, that if we had a blank slate—if we could magically subtract the political toxicity and corporate agitprop—you'd think we'd be able to solve this.



Yet we did have something close to a blank slate in the spring of 1979. President Jimmy Carter, who had installed solar panels on the roof of the White House and had an approval rating of 46 percent, hosted the signing of the Israel-Egypt peace treaty. “We have won, at last, the first step of peace,” he said. “A first step on a long and difficult road.” The number one film in America was *The China Syndrome*; the number one song was the Bee Gees’ “Tragedy.” Barbara Tuchman’s *A Distant Mirror*, a history of the calamities that befell medieval Europe after a major climatic change, had been near the top of the bestseller list all year. An oil well off Mexico’s Gulf Coast exploded and would gush for nine months, staining beaches as far away as Galveston, Texas. In Londonderry Township, Pennsylvania, at the Three Mile Island nuclear plant, a water filter was beginning to fail. And in the Washington, D.C., headquarters of Friends of the Earth, a thirty-year-old activist, a self-styled “lobbyist for the environment,” was struggling through a dense government report, when his life changed.

# Part I

## Shouts in the Street

### 1979–1982

The mad girl with the staring eyes and long white fingers  
Hooked in the stones of the wall,  
The storm-wrack hair and the screeching mouth: does it matter, Cassandra,  
Whether the people believe  
Your bitter fountain? Truly men hate the truth; they'd liefer  
Meet a tiger on the road.

—ROBINSON JEFFERS, "CASSANDRA," 1948



Rafe Pomerance in 1983

# 1.

## The Whole Banana

Spring 1979

**T**he first suggestion to Rafe Pomerance that humankind was destroying the conditions necessary for its own survival came here of the government publication EPA-600/7-78-019. It was a technical report, bound in a coal-black cover with beige lettering, about coal—one of many such reports that lay in uneven piles around Pomerance’s windowless office on the first floor of the Capitol Hill town house that served as the Washington headquarters of Friends of the Earth. In the final paragraph of a chapter on environmental regulation, the coal report’s authors noted that the continued use of fossil fuels might, within two or three decades, bring about “significant and damaging” changes to the global atmosphere.

Pomerance, startled, paused over the orphaned paragraph. It seemed to have come out of nowhere. He reread it. It made no sense. Pomerance was not a scientist; eleven years earlier he had graduated from Cornell with a degree in history. He had the tweedy appearance of an undernourished doctoral student emerging at dawn from the stacks, with horn-rimmed glasses and a thickish mustache that wilted disapprovingly over the corners of his mouth. His defining characteristic was his gratuitous height, six feet four inches, which seemed to embarrass him; he stooped over to accommodate his interlocutors. His active face was prone to breaking out in wide, even maniacal grins, but in composure, as when he read the coal report, it projected concern. He struggled with technical reports. He proceeded as a historian would: cautiously, scrutinizing the source material, reading between the lines. When that failed, he made phone calls, often to the authors

of the reports, who tended to be surprised to hear from him. Scientists were not used to fielding questions from political lobbyists. They were not used to thinking about politics.

Pomerance had one big question about the coal report: If the burning of coal, oil, and natural gas could invite global catastrophe, why had nobody told him about it? If there was anyone in Washington—anyone in the United States of America—who should have been aware of such a danger, it was Pomerance. As deputy legislative director of Friends of the Earth, the wily, pugnacious nonprofit that David Brower helped found after resigning from the Sierra Club a decade earlier, Pomerance was one of the nation's most connected environmental activists, on intimate terms with staffers at all levels of the legislative and executive branches. That he was as easily accepted in the halls of the Dirksen Senate Office Building as at Earth Day rallies might have had something to do with the fact that he was a Morgenthau—great-grandson of Henry Sr., Woodrow Wilson's ambassador to the Ottoman Empire; great-nephew of Henry Jr., Franklin D. Roosevelt's Treasury secretary; and second cousin to Robert, district attorney for Manhattan. Or perhaps it was simply his charisma—self-effacing and rambunctious, voluble and obsessive, with a visceral talent for rousing soliloquy, he seemed to be everywhere, speaking with everyone, *in a very loud voice*, at once. His chief obsession was air. After working as an organizer for welfare rights, he spent the second half of his twenties laboring to protect and expand the Clean Air Act, the comprehensive law regulating air pollution, drafting the language of several amendments himself. That led him to the problem of acid rain, and the coal report.

He showed the unsettling paragraph to his office-mate Betsy Agle. Had she ever heard of the “greenhouse effect”? Was it really possible that human beings were overheating the planet?

Agle shrugged. She hadn't heard about it either.

That might have been the end of it had Agle not greeted Pomerance in the office a few mornings later holding a copy of a newspaper forwarded by Friends of the Earth's Denver office.

“Isn't this what you were talking about the other day?” she asked, gesturing.

There was an article about a geophysicist named Gordon MacDonald. Pomerance hadn't heard of MacDonald, but he knew all about the Jasons, the mysterious coterie of elite scientists to which MacDonald belonged. The Jasons were like one of those teams of superheroes with complementary powers who join forces in times of galactic crisis. They were convened by the U.S. intelligence apparatus to devise novel scientific solutions to the most vexing national security problems: how to detect an incoming missile; how to predict fallout from a nuclear bomb; how to develop unconventional weapons, like high-power laser beams, sonic booms, and plague-infected rats. Some of the Jasons had federal contracts or long-standing ties to U.S. intelligence; others held prominent titles at major research universities; all were united by the conviction, shared by their federal clients, that American power should be guided by the wisdom of its superior scientific minds. The Jasons met each summer in secret, and their very existence had been a loosely guarded secret until the publication of the Pentagon Papers, which exposed their plan to festoon the Ho Chi Minh Trail with motion sensors that signaled to bombers. After Vietnam War protesters set MacDonald's garage on fire, he pleaded with the Jasons to use their powers for peace instead of war.

He hoped that the Jasons could join forces to save the world. For human civilization, as he saw it, was facing an existential crisis. In "How to Wreck the Environment," an essay published in 1968, while he was a science adviser to Lyndon Johnson, MacDonald predicted a near future in which "nuclear weapons were effectively banned and the weapons of mass destruction were those of environmental catastrophe." The world's most advanced militaries, he warned, would soon be able to weaponize weather. By accelerating industrial emissions of carbon dioxide, they could alter weather patterns, forcing mass migration, starvation, drought, and economic collapse.

In the decade since, MacDonald had grown alarmed to see humankind accelerate its pursuit of this particular weapon of mass destruction, not maliciously, but unwittingly. President Carter's initiative to develop high-carbon synthetic fuels—gas and liquid fuel extracted from shale and tar sands—was a frightening

blunder, the equivalent of building a new generation of thermonuclear bombs. During spring 1977 and summer 1978, the Jasons met in Boulder at the National Center for Atmospheric Research to determine what would happen once the concentration of carbon dioxide in the atmosphere doubled from pre-Industrial Revolution levels. It was an arbitrary milestone, the doubling, but a dramatic one, marking the point at which human civilization would contribute as much carbon to the atmosphere as the planet had done in the preceding 4.6 billion years. The inevitability of the doubling was not in question; a high school student could do the arithmetic. Depending on the future rate of fossil fuel consumption, the threshold would likely be breached by 2035 and no later than 2060.

The Jasons' report to the Department of Energy, *The Long-Term Impact of Atmospheric Carbon Dioxide on Climate*, was composed in an understated tone that only enhanced its nightmarish findings: global temperatures would increase by an average of 2 to 3 degrees Celsius; Dust Bowl conditions would "threaten large areas of North America, Asia and Africa"; and agricultural production and access to drinking water would plummet, triggering unprecedented levels of migration. "Perhaps the most ominous feature," however, would be the effect on the poles. Even minimal warming could "lead to rapid melting" of the West Antarctic ice sheet, which contained enough water to raise the oceans sixteen feet.

The Jasons sent the report to dozens of scientists in the United States and abroad; to industry groups like the National Coal Association and the Electric Power Research Institute; and, within the government, to the National Academy of Sciences, the Commerce Department, the Environmental Protection Agency, the National Aeronautics and Space Administration, the National Security Agency, the Pentagon, every branch of the military, the National Security Council, and the White House.

Pomerance read about this in a state of shock that, as was the pattern with him, swelled briskly into outrage. "This," he told Agle, "is the whole banana."

He had to meet Gordon MacDonald. The scientist, the article had mentioned, worked at the MITRE Corporation, a federally funded think tank that developed national defense and nuclear warfare

technology. His title was senior research analyst, which was a delicate way of saying science adviser to the national intelligence community. After a single phone call, Pomerance, a Vietnam War protester and conscientious objector, drove several miles on the Beltway to a group of anonymous white office buildings that more closely resembled the headquarters of a regional banking firm than the solar plexus of the American military-industrial complex. He was shown into the office of a brawny, soft-spoken man with a wave of glossy, silverish hair over horn-rimmed frames, who possessed more than a passing resemblance to Alex Karras—a geophysicist trapped in the body of an offensive lineman. He extended a hand like a bear's paw.

"I'm glad you're interested in this," said MacDonald, taking in the young activist.

"How could I not be?" said Pomerance. "How could anyone not be?"

MacDonald seemed miscast as a preacher of existential doom; he was too imposing of physical bearing and too decorous of manner. A bout of polio at the age of nine had left him with a chronic limp and a passion for scientific inquiry, awoken by the months of convalescence he had spent at a Dallas clinic reading medical journals about his illness. Despite his bad leg, he started at guard for the San Marcos Academy Bears and was offered a football scholarship to Rice. Harvard offered him a scholarship with no strings attached. Upon reaching campus, he swiftly earned a reputation as a prodigy. In his twenties, he advised Dwight D. Eisenhower on space exploration; at thirty-two, he became a member of the National Academy of Sciences; at forty, he was appointed to the inaugural Council on Environmental Quality, where he advised Richard Nixon on the environmental dangers of burning coal. Now approaching his fiftieth birthday, MacDonald explained that he first studied the carbon dioxide issue when he was about Pomerance's age—in 1961, when he served as an adviser to John F. Kennedy. MacDonald had followed the problem closely ever since, with increasing alarm.

He spoke for two hours. As he traced the history of humanity's understanding of the problem, explaining the fundamental science, Pomerance grew increasingly appalled.



scientists who, since the Manhattan Project, had advised every president on major policy; Revelle had been a close colleague of MacDonald's and Press's since they had all served together under Kennedy. Whereas Arrhenius and Callendar, in their icy Northern European hamlets, welcomed the prospect of warmer weather, Revelle recognized that human society had been organized around specific climatic conditions that, if altered, would lead to violent disruptions. MacDonald quoted from a major paper Revelle and Hans Seuss had published in 1957: "Human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor be repeated in the future." The following year, Revelle helped the Weather Bureau establish a continuous measurement of atmospheric carbon dioxide at a site perched near the summit of Mauna Loa on the Big Island of Hawaii, 11,500 feet above the sea—a rare pristine natural laboratory on a planet blanketed by fossil fuel emissions. A young geochemist named Charles David Keeling charted the data. Keeling's graph came to be known as the Keeling curve, though it more closely resembled a jagged lightning bolt hurled toward the firmament. As MacDonald's imperturbable audience looked on, he traced the Keeling curve in the air, his thick forefinger jabbing toward the ceiling.

With each passing year, MacDonald explained, humanity's large-scale geophysical experiment grew more audacious. After Keeling had charted it for nearly a decade, Revelle shared his concerns with Lyndon Johnson, who included them in a special message to Congress two weeks after his inauguration. Johnson explained that his generation had "altered the composition of the atmosphere on a global scale" through the burning of fossil fuels. His administration commissioned a study by the president's Science Advisory Committee, led by Revelle, which warned in its 1965 report of the rapid melting of Antarctica, rising seas, increased acidity of fresh waters—changes that could be "not controllable through local or even national efforts." Nothing less than a coordinated global effort would be required. Yet no such effort materialized, and emissions continued to rise. At this rate, said MacDonald, they could see a snowless New England, the swamping of major coastal cities, a 40 percent decline in national wheat

production, and the forced migration of one-quarter of the world's population. Not within centuries—within their own lifetimes.

“And what,” asked Press, “would you have us do about it?”

President Carter's efforts, in the wake of the Saudi oil crisis, to promote solar energy—he had proposed that Congress enact a “national solar strategy” and installed thirty-two solar panels on the roof of the White House to heat the First Family's water—was a strong start, said MacDonald, though Carter's plan to stimulate production of synthetic fuels was a dangerous lurch in the direction of auto-annihilation. Nuclear power, despite the recent horrors at Three Mile Island, should be expanded. But even natural gas and ethanol were preferable to coal. There was no way around it: coal production would ultimately have to end.

Carter's advisers asked respectful questions but Pomerance couldn't tell whether they were persuaded. The men stood and shook hands and Press led MacDonald and Pomerance out of his office. As they emerged onto Pennsylvania Avenue, Pomerance turned to MacDonald.

Knowing Press as you do, asked Pomerance, what do you think he's going to do?

Knowing Frank as I do, said MacDonald, I really couldn't tell you.

Pomerance grew uneasy. Since meeting MacDonald, he had fixated on the science of the carbon dioxide problem and the prospect of a political solution. But with their tour of Capitol Hill concluded, Pomerance began to question how the warming of the atmosphere might touch his own life. Lenore, his wife, was eight months pregnant. They had spent a lot of time talking about their hopes for the future. Was it ethical, he wondered, to bring a child onto a planet that before much longer could become inhospitable to humanity? Was there still time to avoid the worst? And why had it fallen to him, a thirty-two-year-old lobbyist without scientific training, to bring attention to an urgent, global crisis?

After several weeks, MacDonald called to tell him that Press had taken action. On May 22, Press wrote to the president of the National Academy of Sciences, Philip Handler, requesting a full assessment of the carbon dioxide problem. Handler tapped Jule Charney, the father of modern meteorology, to gather the nation's top oceanographers, atmospheric scientists, and climate modelers.



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