

# THE CATASTROPHIST

*NASA's climate expert delivers the news no one wants to hear.*

BY ELIZABETH KOLBERT



*James Hansen on curbing coal emissions: "The science is clear. This is our one chance."*

A few months ago, James Hansen, the director of NASA's Goddard Institute for Space Studies, in Manhattan, took a day off from work to join a protest in Washington, D.C. The immediate target of the protest was the Capitol Power Plant, which supplies steam and chilled water to congressional offices, but more generally its object was coal, which is the world's leading source of greenhouse-gas emissions. As it happened, on the day of the protest it snowed. Hansen was wearing a trench coat and a wide-brimmed canvas boater. He had forgotten to bring gloves. His sister, who lives in D.C. and had come along to watch over him, told him that he looked like Indiana Jones.

The march to the power plant was to

begin on Capitol Hill, at the Spirit of Justice Park. By the time Hansen arrived, thousands of protesters were already milling around, wearing green hard hats and carrying posters with messages like "Power Past Coal" and "Clean Coal Is Like Dry Water." Hansen was immediately surrounded by TV cameras.

"You are one of the preëminent climatologists in the world," one television reporter said. "How does this square with your science?"

"I'm trying to make clear what the connection is between the science and the policy," Hansen responded. "Somebody has to do it."

The reporter wasn't satisfied. "Civil disobedience?" he asked, in a tone of mock incredulity. Hansen said that he

couldn't let young people put themselves on the line, "and then I stand back behind them."

The reporter still hadn't got what he wanted: "We've heard that you all are planning, even hoping, to get arrested today. Is that true?"

"I wouldn't hope," Hansen said. "But I do want to draw attention to the issue, whatever is necessary to do that."

Hansen, who is sixty-eight, has greenish eyes, sparse brown hair, and the distracted manner of a man who's just lost his wallet. (In fact, he frequently misplaces things, including, on occasion, his car.) Thirty years ago, he created one of the world's first climate models, nicknamed Model Zero, which he used to predict most of what has happened to the climate since. Sometimes he is referred to as the "father of global warming," and sometimes as the grandfather.

Hansen has now concluded, partly on the basis of his latest modelling efforts and partly on the basis of observations made by other scientists, that the threat of global warming is far greater than even he had suspected. Carbon dioxide isn't just approaching dangerous levels; it is already there. Unless immediate action is taken—including the shutdown of all the world's coal plants within the next two decades—the planet will be committed to change on a scale society won't be able to cope with. "This particular problem has become an emergency," Hansen said.

Hansen's revised calculations have prompted him to engage in activities—like marching on Washington—that aging government scientists don't usually go in for. Last September, he travelled to England to testify on behalf of anti-coal activists who were arrested while climbing the smokestack of a power station to spray-paint a message to the Prime Minister. (They were acquitted.) Speaking before a congressional special committee last year, Hansen asserted that fossil-fuel companies were knowingly spreading misinformation about global warming and that their chairmen "should be tried for high crimes against humanity and nature." He has compared freight trains carrying coal to "death trains," and wrote to the head of the National Mining Association, who sent him a letter of complaint, that if the comparison "makes you un-

comfortable, well, perhaps it should.”

Hansen insists that his intent is not to be provocative but conservative: his only aim is to preserve the world as we know it. “The science is clear,” he said, when it was his turn to address the protesters blocking the entrance to the Capitol Power Plant. “This is our one chance.”

The fifth of seven children, Hansen grew up in Denison, Iowa, a small, sleepy town close to the western edge of the state. His father was a tenant farmer who, after the Second World War, went to work as a bartender. All the kids slept in two rooms. As soon as he was old enough, Hansen went to work, too, delivering the Omaha *World-Herald*. When he was eighteen, he received a scholarship to attend the University of Iowa. It didn’t cover housing, so he rented a room for twenty-five dollars a month and ate mostly cereal. He stayed on at the university to get a Ph.D. in physics, writing his dissertation on the atmosphere of Venus. From there he went directly to the Goddard Institute for Space Studies—GISS, for short—where he took up the study of Venusian clouds.

By all accounts, including his own,

Hansen was preoccupied by his research and not much interested in anything else. GISS’s offices are a few blocks south of Columbia University; when riots shut down the campus, in 1968, he barely noticed. At that point, GISS’s computer was the fastest in the world, but it still had to be fed punch cards. “I was staying here late every night, reading in my decks of cards,” Hansen recalled. In 1969, he left GISS for six months to study in the Netherlands. There he met his wife, Annick, who is Dutch; the couple honeymooned in Florida, near Cape Canaveral, so they could watch an Apollo launch.

In 1973, the first Pioneer Venus mission was announced, and Hansen began designing an instrument—a polarimeter—to be carried on the orbiter. But soon his research interests began to shift earthward. A trio of chemists—they would later share a Nobel Prize—had discovered that chlorofluorocarbons and other man-made chemicals could break down the ozone layer. It had also become clear that greenhouse gases were rapidly building up in the atmosphere.

“We realized that we had a planet that was changing before our eyes, and that’s more interesting,” Hansen told me. The topic attracted him for much the

same reason Venus’s clouds had: there were new research questions to be answered. He decided to try to adapt a computer program that had been designed to forecast the weather to see if it could be used to look further into the future. What would happen to the earth if, for example, greenhouse-gas levels were to double?

“He never worked on any topic thinking it might be any use for the world,” Annick told me. “He just wanted to figure out the scientific meaning of it.”

When Hansen began his modelling work, there were good theoretical reasons for believing that increasing CO<sub>2</sub> levels would cause the world to warm, but little empirical evidence. Average global temperatures had risen in the nineteen-thirties and forties; then they had declined, in some regions, in the nineteen-fifties and sixties. A few years into his project, Hansen concluded that a new pattern was about to emerge. In 1981, he became the director of GISS. In a paper published that year in *Science*, he forecast that the following decade would be unusually warm. (That turned out to be the case.) In the same paper, he predicted that the nineteen-nineties would be warmer still. (That also turned out to be true.) Finally, he forecast that by the end of the twentieth century a global-warming signal would emerge from the “noise” of natural climate variability. (This, too, proved to be correct.)

Later, Hansen became even more specific. In 1990, he bet a roomful of scientists that that year, or one of the following two, would be the warmest on record. (Within nine months, he had won the bet.) In 1991, he predicted that, owing to the eruption of Mt. Pinatubo, in the Philippines, average global temperatures would drop and then, a few years later, recommence their upward climb, which was precisely what happened.

From early on, the significance of Hansen’s insights was recognized by the scientific community. “The work that he did in the seventies, eighties, and nineties was absolutely groundbreaking,” Spencer Weart, a physicist turned historian who has studied the efforts to understand climate change, told me. He added, “It does help to be right.”

“I have a whole folder in my drawer labelled ‘Canonical Papers,’ Michael



“All in favor?”

Oppenheimer, a climate scientist at Princeton, said. "About half of them are Jim's."

Because of its implications for humanity, Hansen's work also attracted considerable attention from the world at large. His 1981 paper prompted the first front-page article on climate change that ran in the *Times*—"STUDY FINDS WARMING TREND THAT COULD RAISE SEA LEVELS," the headline read—and within a few years he was regularly being invited to testify before Congress. Still, Hansen says, he didn't imagine himself playing any role besides that of a research scientist. He is, he has written, "a poor communicator" and "not tactful."

"He's very shy," Ralph Cicerone, the president of the National Academy of Sciences, who has known Hansen for nearly forty years, told me. "And, as far as I can tell, he does not enjoy a lot of his public work."

"Jim doesn't really like to look at anyone," Anniek Hansen told me. "I say, 'Just look at them!'"

Throughout the nineteen-eighties and nineties, the evidence of climate change—and its potential hazards—continued to grow. Hansen kept expecting the political system to respond. This, after all, was what had happened with the ozone problem. Proof that chlorofluorocarbons were destroying the ozone layer came in 1985, when British scientists discovered that an ozone "hole" had opened up over Antarctica. The crisis was resolved—or, at least, prevented from growing worse—by an international treaty phasing out chlorofluorocarbons which was ratified in 1987.

"At first, Jim's work didn't take an activist bent at all," the writer Bill McKibben, who has followed Hansen's career for more than twenty years and helped organize the anti-coal protest in D.C., told me. "I think he thought, as did I, if we get this set of facts out in front of everybody, they're so powerful—overwhelming—that people will do what needs to be done. Of course, that was naïve on both our parts."

As recently as the George W. Bush Administration, Hansen was still operating as if getting the right facts in front of the right people would be enough. In 2001, he was invited to speak to Vice-President Dick Cheney

and other high-level Administration officials. For the meeting, he prepared a detailed presentation titled "The Forcings Underlying Climate Change." In 2003, he was invited to Washington again, to meet with the head of the Council on Environmental Quality at the White House. This time, he offered a presentation on what ice-core records show about the sensitivity of the climate to changes in greenhouse-gas concentrations. But by 2004 the Administration had dropped any pretense that it was interested in the facts about climate change. That year, NASA, reportedly at the behest of the White House, insisted that all communications between GISS scientists and the outside world be routed through political appointees at the agency. The following year, the Administration prevented GISS from posting its monthly temperature data on its Web site, ostensibly on the ground that proper protocols had not been followed. (The data showed that 2005 was likely to be the warmest year on record.) Hansen was also told that he couldn't grant a routine interview to National Public Radio. When he spoke out about the restrictions, scientists at other federal agencies complained that they were being similarly treated and a new term was invented: government scientists, it was said, were being "Hansenized."

"He had been waiting all this time for global warming to become the issue that ozone was," Anniek Hansen told me. "And he's very patient. And he just kept on working and publishing, thinking that someone would do something." She went on, "He started speaking out, not because he thinks he's good at it, not because he enjoys it, but because of necessity."

"When Jim makes up his mind, he pursues whatever conclusion he has to the end point," Michael Oppenheimer said. "And he's made up his mind that you have to pull out all the stops at this point, and that all his scientific efforts would come to naught if he didn't also involve himself in political action." Starting in 2007, Hansen began writing to world leaders, including Prime Minister Gordon Brown, of Britain, and Yasuo Fukuda, then the Prime Minister of Japan. In December, 2008, he composed a personal appeal to Barack and Michelle Obama.

"A stark scientific conclusion, that we must reduce greenhouse gases below present amounts to preserve nature and humanity, has become clear," Hansen wrote. "It is still feasible to avert climate disasters, but only if policies are consistent with what science indicates to be required." Hansen gave the letter to Obama's chief science adviser, John Holdren, with whom he is friendly, and Holdren, he says, promised to deliver it. But Hansen never heard back, and by the spring he had begun to lose faith in the new Administration. (In an e-mail, Holdren said that he could not discuss "what I have or haven't given or said to the President.")

"I had had hopes that Obama understood the reality of the issue and would seize the opportunity to marry the energy and climate and national-security issues and make a very strong program," Hansen told me. "Maybe he still will, but I'm getting bad feelings about it."

There are lots of ways to lose an audience with a discussion of global warming, and new ones, it seems, are being discovered all the time. As well as anyone, Hansen ought to know this; still, he persists in trying to make contact. He frequently gives public lectures; just in the past few months, he has spoken to Native Americans in Washington, D.C.; college students at Dartmouth; high-school students in Copenhagen; concerned citizens, including King Harald, in Oslo; renewable-energy enthusiasts in Milwaukee; folk-music fans in Beacon, New York; and public-health professionals in Manhattan.

In April, I met up with Hansen at the state capitol in Concord, New Hampshire, where he had been invited to speak by local anti-coal activists. There had been only a couple of days to publicize the event; nevertheless, more than two hundred and fifty people showed up. I asked a woman from the town of Ossipee why she had come. "It's a once-in-a-lifetime opportunity to hear bad news straight from the horse's mouth," she said. For the event, Hansen had, as usual, prepared a PowerPoint presentation. It was projected onto a screen beside a faded portrait of George Washington. The first slide gave the title of the talk,

"The Climate Threat to the Planet," along with the disclaimer "Any statements relating to policy are personal opinion."

Hansen likes to begin his talk with a highly compressed but still perilously long discussion of climate history, beginning in the early Eocene, some fifty million years ago. At that point, CO<sub>2</sub> levels were high and, as Hansen noted, the world was very warm: there was practically no ice on the planet, and palm trees grew in the Arctic. Then CO<sub>2</sub> levels began to fall. No one is entirely sure why, but one possible cause has to do with weathering processes that, over many millennia, allow carbon dioxide from the air to get bound up in limestone. As CO<sub>2</sub> levels declined, the planet grew cooler; Hansen flashed some slides on the screen, which showed that, between fifty million and thirty-five million years ago, deep-ocean temperatures dropped by more than ten degrees. Eventually, around thirty-four million years ago, temperatures sank low enough that glaciers began to form on Antarctica. By around three million years ago—perhaps earlier—permanent ice sheets had begun to form in the Northern Hemisphere as well. Then, about two million years ago, the world entered a period of recurring glaciations. During the ice ages—the most recent one ended about twelve thousand years ago—CO<sub>2</sub> levels dropped even further.

What is now happening, Hansen explained to the group in New Hampshire, is that climate history is being run in reverse and at high speed, like a cassette tape on rewind. Carbon dioxide is being pumped into the air some ten thousand times faster than natural weathering processes can remove it.

"So humans now are in charge of atmospheric composition," Hansen said. Then he corrected himself: "Well, we're determining it, whether we're in charge or not."

Among the many risks of running the system backward is that the ice sheets formed on the way forward will start to disintegrate. Once it begins, this process is likely to be self-reinforcing. "If we burn all the fossil fuels and put all that CO<sub>2</sub> into the atmosphere, we will be sending the planet back to the ice-free state,"

Hansen said. "It will take a while to get there—ice sheets don't melt instantaneously—but that's what we will be doing. And if you melt all the ice, sea levels will go up two hundred and fifty feet. So you can't do that without producing a different planet."

There's no precise term for the level of CO<sub>2</sub> that will assure a climate disaster; the best that scientists and policymakers have been able to come up with is the phrase "dangerous anthropogenic interference," or D.A.I. Most official discussions have been premised on the notion that D.A.I. will not be reached until CO<sub>2</sub> levels hit four hundred and fifty parts per million. Hansen, however, has concluded that the threshold for D.A.I. is much lower.

"The bad news is that it's become clear that the dangerous amount of carbon dioxide is no more than three hundred and fifty parts per million," he told the crowd in Concord. The *really* bad news is that CO<sub>2</sub> levels have already reached three hundred and eighty-five parts per million. (For the ten thousand years prior to the industrial revolution, carbon-dioxide levels were about two hundred and eighty parts per million, and if current emissions trends continue they will reach four hundred and fifty parts by around 2035.)

Once you accept that CO<sub>2</sub> levels are already too high, it's obvious, Hansen argues, what needs to be done. He displayed a chart of known fossil-fuel reserves represented in terms of their carbon content. There was a short bar for oil, a shorter bar for natural gas, and a tall bar for coal.

"We've already used about half of the oil," he observed. "And we're going to use all of the oil and natural gas that's easily available. It's owned by Russia and Saudi Arabia, and we can't tell them not to sell it."

So, if you look at the size of these fossil-fuel reservoirs, it becomes very clear. The only way we can constrain the amount of carbon dioxide in the atmosphere is to cut off the coal source, by saying either we will leave the coal in the ground or we will burn it only at power plants that actually capture the CO<sub>2</sub>. Such power plants are often referred to as "clean coal plants." Although there has been a great deal of talk

about them lately, at this point there are no clean-coal plants in commercial operation, and, for a combination of technological and economic reasons, it's not clear that there ever will be.

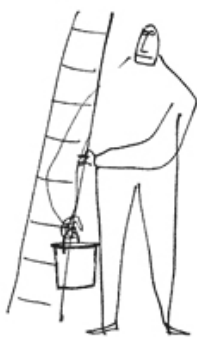
Hansen continued, "If we had a moratorium on any new coal plants and phased out existing ones over the next twenty years, we could get back to three hundred and fifty parts per million within several decades." Reforestation, for example, if practiced on a massive scale, could begin to draw global CO<sub>2</sub> levels down, Hansen says, "so it's technically feasible." But "it requires us to take action promptly."

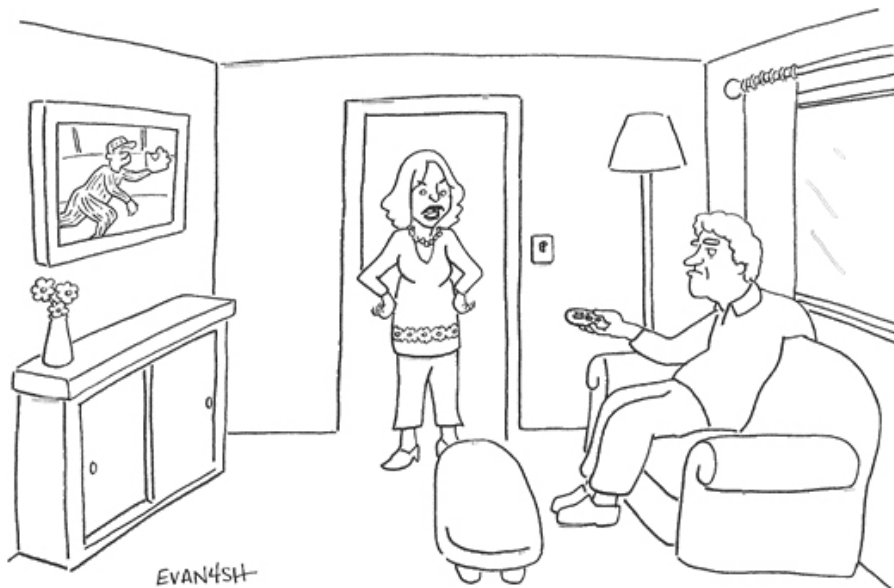
Coincidentally, that afternoon a vote was scheduled in the New Hampshire state legislature on a proposal involving the state's largest coal-fired power plant, the Merrimack Station, in the town of Bow. The station's owner was planning to spend several hundred million dollars to reduce mercury emissions from the plant—a cost that it planned to pass on to ratepayers. Hansen, who said he thought the plant should simply be shut, called the plan a "terrible waste of money." A lawmaker sympathetic to this view had introduced a bill calling for more study of the project, but, as several people who came up to speak to Hansen after his talk explained, it was opposed by the state's construction unions and seemed headed for defeat. (Less than an hour later, the bill was rejected in committee by a unanimous vote.)

"I assume you're used to telling policymakers the truth and then having them ignore you," one man said to Hansen.

Hansen smiled ruefully. "You're right."

In scientific circles, worries about D.A.I. are widespread. During the past few years, researchers around the world have noticed a disturbing trend: the planet is changing faster than had been anticipated. Antarctica, for example, had not been expected to show a net loss of ice for another century, but recent studies indicate that the continent's massive ice sheets are already shrinking. At the other end of the globe, the Arctic ice cap has been melting at a shocking rate; the extent of the summer ice is now only a little more than half of what it was just forty years ago. Meanwhile, scientists have found that the arid zones that circle the globe





*"I said I don't want to fight. That's your cue to apologize."*

north and south of the tropics have been expanding more rapidly than computer models had predicted. This expansion of the subtropics means that highly populated areas, including the American Southwest and the Mediterranean basin, are likely to suffer more and more frequent droughts.

"Certainly, I think the shrinking of the Arctic ice cap made a very strong impression on a lot of scientists," Spencer Weart, the physicist, told me. "And these things keep popping up. You think, What, another one? Another one? They're almost all in the wrong direction, in the direction of making the change worse and faster."

"In nearly all areas, the developments are occurring more quickly than had been assumed," Hans Joachim Schellnhuber, the head of Germany's Potsdam Institute for Climate Impact Research, recently observed. "We are on our way to a destabilization of the world climate that has advanced much further than most people or their governments realize."

Obama's science adviser, John Holdren, a physicist on leave from Harvard, has said that he believes "any reasonably comprehensive and up-to-date look at the evidence makes clear that civilization has already generated dangerous anthropogenic interference in the climate system."

There is also broad agreement among scientists that coal represents the most serious threat to the climate. Coal now provides half the electricity in the United States. In China, that figure is closer to eighty per cent, and a new coal-fired power plant comes online every week or two. As oil supplies dwindle, there will still be plenty of coal, which could be—and in some places already is being—converted into a very dirty liquid fuel. Before Steven Chu, a Nobel Prize-winning physicist, was appointed to his current post as Energy Secretary, he said in a speech, "There's enough carbon in the ground to really cook us. Coal is my worst nightmare." (These are lines that Hansen is fond of invoking.) A couple of months ago, seven prominent climate scientists from Australia wrote an open letter to the owners of that country's major utility companies urging that "no new coal-fired power stations, except ones that have ZERO emissions," be built. They also recommended an "urgent program" to phase out old plants.

"The unfortunate reality is that genuine action on climate change will require that existing coal-fired power stations cease to operate in the near future," the group wrote.

But if Hansen's anxieties about D.A.I. and coal are broadly shared, he is still, among climate scientists, an outlier. "Almost everyone in the scientific commu-

nity is prepared to say that if we don't do something now to reverse the direction we're going in we either already are or will very, very soon be in the danger zone," Naomi Oreskes, a historian of science and a provost at the University of California at San Diego, told me. "But Hansen talks in stronger terms. He's using adjectives. He has started to speak in moral terms, and that always makes scientists uncomfortable."

Hansen is also increasingly isolated among climate activists. "I view Jim Hansen as heroic as a scientist," Eileen Claussen, the president of the Pew Center on Global Climate Change, said. "He was there at the beginning, he's faced all kinds of pressures politically, and he's done a terrific job, I think, of keeping focussed. But I wish he would stick to what he really knows. Because I don't think he has a realistic view of what is politically possible, or what the best policies would be to deal with this problem."

In Washington, the only approach to limiting emissions that is seen as having any chance of being enacted is a so-called "cap and trade" system. Under such a system, the government would set an over-all cap for CO<sub>2</sub> emissions, then allocate allowances to major emitters, like power plants and oil refineries, which could be traded on a carbon market. In theory, at least, the system would discourage fossil-fuel use by making emitters pay for what they are putting out. But to the extent that such a system has been tried, by the members of the European Union, its results so far are inconclusive, and Hansen argues that it is essentially a sham. (He recently referred to it as "the Temple of Doom.") What is required, he insists, is a direct tax on carbon emissions. The tax should be significant at the start—equivalent to roughly a dollar per gallon for gasoline—and then grow steeper over time. The revenues from the tax, he believes, ought to be distributed back to Americans on a per-capita basis, so that households that use less energy would actually make money, even as those that use more would find it increasingly expensive to do so.

"The only defense of this monstrous absurdity that I have heard," Hansen wrote a few weeks ago, referring to a cap-and-trade system, "is 'Well, you are right,

it's no good, but the train has left the station.' If the train has left, it had better be derailed soon or the planet, and all of us, will be in deep do-do."

GISS's headquarters, at 112th Street and Broadway, sits above Tom's Restaurant, the diner made famous by "Seinfeld" and Suzanne Vega. Hansen has occupied the same office, on the seventh floor, since he became the director of the institute, almost three decades ago. One day last month, I went to visit him there. Hansen told me that he had been trying to computerize his old files; still, the most striking thing about the spacious office, which is largely taken up by three wooden tables, is that every available surface is covered with stacks of paper.

During the week, Hansen lives in an apartment just a few blocks from his office, but on weekends he and Anniek frequently go to an eighteenth-century house that they own in Bucks County, Pennsylvania, and their son and daughter, who have children of their own, come to visit. Hansen dotes on his grandchildren—in many hours of conversation with me, just about the only time that he spoke with unalloyed enthusiasm was when he discussed planting trees with them this spring—and he claims they are the major reason for his activism. "I decided that I didn't want my grandchildren to say, 'Opa understood what was happening, but he didn't make it clear,'" he explained.

The day that I visited Hansen's office, the House Energy and Commerce Committee was beginning its markup of a cap-and-trade bill co-sponsored by the committee's chairman, Henry Waxman, of California. The bill—the American Clean Energy and Security Act—has the stated goal of cutting the country's carbon emissions by seventeen per cent by 2020. It is the most significant piece of climate legislation to make it this far in the House. Hansen pointed out that the bill explicitly allows for the construction of new coal plants and predicted that it would, if passed, prove close to meaningless. He said that he thought it would probably be best if the bill failed, so that Congress could "come back and do it more sensibly."

I said that if the bill failed I thought

it was more likely Congress would let the issue drop, and that was one reason most of the country's major environmental groups were backing it.

"This is just stupidity on the part of environmental organizations in Washington," Hansen said. "The fact that some of these organizations have become part of the Washington 'go along, get along' establishment is very unfortunate."

Hansen argues that politicians willfully misunderstand climate science; it could be argued that Hansen just as willfully misunderstands politics. In order to stabilize carbon-dioxide levels in the atmosphere, annual global emissions would have to be cut by something on the order of three-quarters. In order to draw them down, agricultural and forestry practices would have to change dramatically as well. So far, at least, there is no evidence that any nation is willing to take anything approaching the necessary steps. On the contrary, almost all the trend lines point in the opposite direction. Just because the world desperately needs a solution that satisfies both the scientific and the political constraints doesn't mean one necessarily exists.

For his part, Hansen argues that while the laws of geophysics are immutable, those of society are ours to determine. When I said that it didn't seem feasible to expect the United States to give up its coal plants, he responded, "We can point to other countries being fifty per cent more energy-efficient than we are. We're getting fifty per cent of our electricity from coal. That alone should provide a pretty strong argument."

Then what about China and India?

Both countries are likely to suffer very severely from dramatic climate change, he said. "They're going to recognize that. In fact, they already are beginning to recognize that.

"It's not unrealistic," he went on. "But the policies have to push us in that direction. And, as long as we let the politicians and the people who are supporting them continue to set the rules, such that 'business as usual' continues, or small tweaks to 'business as usual,' then it is unrealistic. So we have to change the rules." He said that he was thinking of attending another demonstration soon, in West Virginia coal country. ♦