

Looking for Mr. Greenhouse

Can scientists say whether humans have changed the climate through the greenhouse effect? If not, why not?

First in a two-part series

By RICHARD MONASTERSKY

While oat bran and fax machines were instant hits last year, 1988 may go down in history as the year the greenhouse effect became fashionable. Future scholars seeking the spark that ignited this public passion may well focus on a sweltering 98° F day in the nation's capital. On June 23, 1988, as heat waves and drought seared the United States, a climate expert made headlines by telling Congress he was 99 percent sure the long-expected greenhouse warming had begun.

NASA scientist James Hansen testified that the world had warmed significantly over the last century and that human activities had caused part of the temperature rise by releasing certain gases into the atmosphere (SN: 7/2/88, p.4). He also correctly predicted that 1988 would capture the highest mark on the century-long

record of global average temperatures.

Some climatologists have since joined Hansen in heralding the arrival of the greenhouse warming. Yet most have maintained a more cautious pose. Skeptical scientists acknowledge the world has warmed recently, and they agree that gases such as carbon dioxide, methane and chlorofluorocarbons are accumulating in the atmosphere, where they should eventually raise the average temperature of the Earth. But the vast majority of climate researchers are not willing to connect the rising levels of greenhouse gases with the climate warming.

Such hesitation has puzzled a public that has watched media reports of rising global temperatures. Last summer's drought, heat wave and forest fires exacerbated the confusion, especially when several press reports claimed that Hansen blamed the hot summer on the greenhouse effect — a connection he did not make.

In the gap between laboratory and city street, several questions are brewing. Nonscientists are wondering why experts are wavering on this issue. If specialists can't yet say whether the greenhouse warming has taken effect, when will they know?

While scientists are known as masters of equivocation, their hesitation on this issue does not stem simply from an aversion to definitive statements. Part of the problem lies in inaccuracies in the global temperature data, which may mean the Earth has not warmed as much as it seems. Resolving this issue will be one key to identifying Mr. Greenhouse.

Scientists say they don't know when they will be able to offer an unequivocal statement, but they expect it may be at least five to 10 years away. The wait depends on many factors, particularly how the climate behaves during the 1990s.

Most recent reports about rising global temperatures originate from a pair of scientific sources, one located in the United States and the other in England. Working independently, these two research teams have been

compiling huge sets of historical weather information from around the globe. Both data sets show that Earth's surface warmed significantly during the early part of the century, cooled slightly from 1940 to 1972, and then warmed sharply in the last 16 years.

Although the two records follow the same general pattern, they differ on the size of the temperature rise. According to work done by Hansen and Sergej Lebedeff at the NASA Goddard Institute for Space Studies in New York City, the globally averaged land temperature has risen about 0.7°C (1.3°F) during the last century. On the other side of the Atlantic, scientists at the United Kingdom Meteorological Office in Bracknell and the University of East Anglia in Norwich have surveyed both land and sea-surface temperatures. They find a smaller rise, about 0.5°C (0.9°F).

Measured in fractions of a degree Celsius, these warmings may seem small. Yet scientists say they represent quite large shifts. At the peak of the last ice age, 18,000 years ago, the average surface temperature was only about 5°C cooler. To put it another way, the climate difference between Boston and Washington, D.C., is only 3.3°C in mean annual temperature.

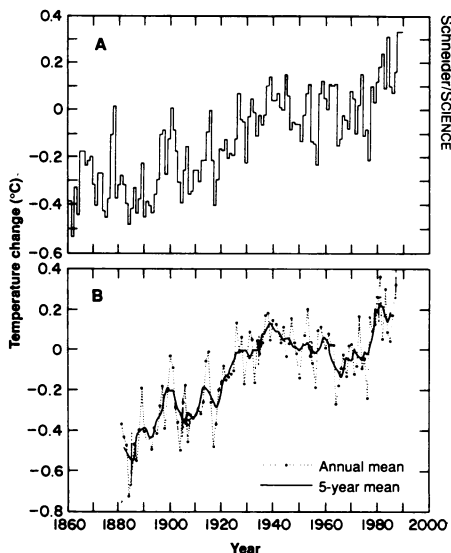
Yet even with such a significant change over the last century, several hurdles keep scientists from equating the observed warming with the greenhouse effect. First, for some unknown reason, the Northern Hemisphere cooled in the middle part of this century, even while greenhouse gases accumulated in the atmosphere. Climatologists would like to understand what produced this cooling.

Another major cause for hesitation is the possibility that the historical records have painted a false picture of climate change during the last century.

Scientists know that cities can change the temperature of their nearby environment. In most cases, they tend to heat their surroundings — a process known as the urban heat-island effect. Even a casual observer can spot this effect by glancing at the daily temperature differences between cities and their cooler suburbs.

The cause of this warming is no mystery. As urban areas grow, concrete and asphalt replace trees and grass. Under the sun's rays, these building blocks of modern civilization heat up much more than an equal area of vegetation, which means they raise local daytime temperatures. At night, the urban surfaces release their stored thermal energy and prevent the city from cooling as much as outlying areas. Pollution hanging over cities also adds to urban warmth.

Many scientists have expressed concern that this heat-island effect has biased the temperature record for land areas. They argue that weather stations are often located in or near cities that



How much is real? Two sets of globally averaged temperatures show a climatic warming over the last century. But errors in the data have exaggerated the temperature rise. Scientists are now trying to determine the real size of the warming. The record from the U.K. Meteorological Office/University of East Anglia (A) includes both land and sea-surface temperatures, while the record from the Goddard Institute for Space Sciences (B) includes only land data.

The sources of future warmth

Although the greenhouse effect is attracting considerable attention these days, the phenomenon is far from new.

A variety of gases, most importantly water vapor, have warmed Earth's surface for billions of years. Without these infrared-absorbing molecules in the atmosphere, the planet would be some 30°C (about 55°F) colder than it is today.

Humans did not create the greenhouse effect. Rather, they are strengthening a preexisting situation by raising the concentrations of greenhouse gases in the atmosphere, primarily carbon dioxide, methane, chlorofluorocarbons and nitrous oxide.

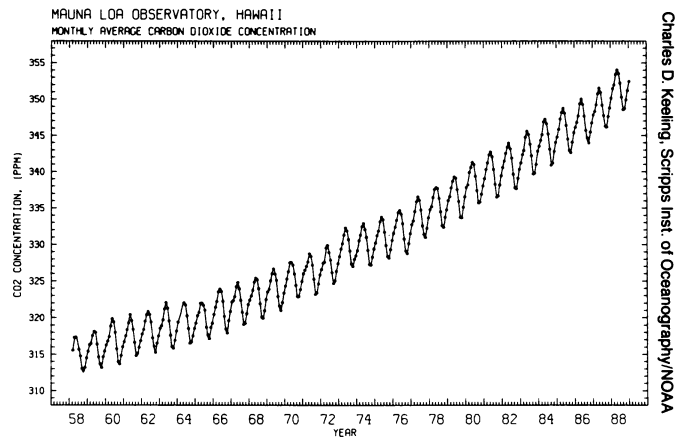
Carbon dioxide, the most concentrated of these gases, contributes about half of the increased greenhouse power in the atmosphere. Methane provides about 20 percent of the additional warming; chlorofluorocarbons and related halons add about 15 to 20 percent; nitrous oxide adds another 6 percent.

Measurements of carbon dioxide taken at the National Oceanic and Atmospheric Administration's Mauna Loa Observatory in Hawaii show that concentrations of this gas have increased by 10 percent since 1958, when observa-

tions first started. (Scientists think the sawtoothed seasonal cycle results from increased absorption of this gas by Northern Hemisphere plants during spring and summer.) Since preindustrial times, levels of carbon dioxide have risen some 25 percent, according to data

from ice cores in Antarctica and Greenland. Fossil-fuel burning and the elimination of forests are the two main culprits in the rise of carbon dioxide.

Methane levels are rising faster — currently by more than 1 percent per year — and have more than doubled over the last 300 years. Scientists say they do not know all the sources of this gas or how much each source contributes to the atmosphere. But human practices, particularly rice cultivation and domestication of cattle and sheep, are important causes of methane's rise.



Chlorofluorocarbons and halons are artificial compounds used in refrigeration, air conditioning, insulation production, circuit-board cleaning and fire extinguishing. They are accumulating at rates of more than 4 percent per year.

Nitrous oxide levels are rising at about 0.25 percent per year. While scientists say they cannot completely explain this rise, they believe it relates to the use of nitrogenous fertilizers, slash-and-burn agriculture, fossil-fuel combustion and other human practices.

— R. Monastersky

have grown dramatically over the last century. Therefore, these stations would measure a temperature rise even if the natural climate remained absolutely the same. If urban development is artificially raising temperatures at many stations, then this influence could infect the entire worldwide data set.

Researchers are now starting to perform damage control on the records. Thomas R. Karl at the National Oceanic and Atmospheric Administration's Climatic Data Center in Asheville, N.C., and his colleagues have scrupulously examined several sets of U.S. observations in order to estimate the nation's urban bias. Karl's method pairs each urban station with a rural weather station that has not grown significantly. This allows him to derive a mathematical equation telling how population growth raises temperatures at urban stations.

Going the next step, Karl and East Anglia's Philip D. Jones have taken a first stab at estimating urbanization's effect on global temperature records. In the March BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY, they take the population-temperature equations from the U.S. study and apply the correction to the worldwide records. Using this admittedly rough technique, they estimate that the urban bias over the last 80 years has added about 0.3°C to the NASA record and about 0.15°C to the record of the U.K. Meteorological Office.

While these corrections temper the warming seen in both records, they do not entirely erase it, as some scientists predicted would happen. In other words, the urban heat-island effect fails to explain the entire temperature rise seen in the records. With this correction, the records still show a 0.3°C to 0.4°C warming over the last century, Karl says.

However, he cautions, these corrections are only crude estimates for the urbanization-related error in the global data sets. "The point is that right now we can make some educated guesses," Karl says. "But in actuality no one has the data right now to do these rather comprehensive urban-rural comparisons."

To clarify the global urban bias, researchers face the arduous task of collecting and compiling detailed information concerning stations and urban populations in nations where data are harder to obtain, such as the Soviet Union, China and India. Although the project will take several years at least, Karl calls it necessary to decipher how much the Earth has truly warmed.

While some scientists are addressing the urban bias in the land data, those working with sea temperatures face a more elusive problem.

The main error in ocean-temperature records stems from a change in technology. For well over a century, the inter-

national merchant marine has voluntarily recorded sea-surface temperatures and supplied them to scientists. In the past, all ships made their measurements by hauling a bucket of ocean water on deck and dunking a thermometer into it. Today, about two-thirds of the ships measure sea-surface temperature by monitoring the ocean water pumped onboard to cool the ship's engines.

The gradual shift from one method to the other has caused problems for climate researchers because each method has its built-in biases. Evaporation can cool water in a bucket, so water assessed by the older method was sometimes cooler than the actual sea. In contrast, water piped onto the ship can be warmed by the engine. Therefore, the switch from buckets is introducing an artificial warming in the ocean data, says Timothy P. Barnett of the Scripps Institution of Oceanography in La Jolla, Calif.

Barnett and others say it will be difficult, perhaps impossible, to correct for such a bias. "The real problem is that up until the mid-1970s no one knows how the data was taken, whether it was taken in buckets or by the injection method."

"I think the point of the story is that there is a lot of uncertainty. The uncertainty is on the order of a few tenths of a degree centigrade — probably less than half a degree. But that's about the size of

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the signal that people talk about. And I think we ought to be really cautious when there are known problems in the data that are about the size of the signal we're looking for."

A frustrated baseball fan sits with ear to radio, hoping to pick out from the static the faint voice of the game announcer — such is an example of a signal-vs.-noise problem. Climate researchers face a similar issue when they consider whether the greenhouse warming has started. Because of entirely natural processes, such as the El Niño-Southern Oscillation, Earth's average surface temperature can swing up and down from year to year by several tenths of a degree. Over a longer period — say, a few hundred years — the Earth has warmed and cooled by a degree or more. This natural "noise" makes it extremely difficult to spot a greenhouse warming.

At times the baseball fan mistakes static for a human voice. Likewise, scientists have to ensure that they don't mistake a natural temperature rise for a human-induced one.

Stephen H. Schneider, a climate modeler at the National Center for Atmospheric Research in Boulder, Colo., is one of many scientists who refuse to say

the rise in greenhouse gases has caused the observed warming. "Yes, I believe that the greenhouse signal is probably in the record," he says. "But can I prove it? No. I don't think it's 99 percent certain."

Schneider and others say the next decade holds the key to resolving the debate. If the warming seen in the 1980s continues into the 1990s, then it will become increasingly difficult to invoke natural climate shifts as an explanation.

"You can't say just because one decade warmed up that the cause is the greenhouse effect," Schneider says. "But for two decades to have a warming trend, that would be pretty unusual. And if it continues to crack records on an annual basis, then I think most of the skeptics will drop out and agree that there it is."

With all the unanswered questions about the validity of past temperature records, the future of the climate looks even hazier. Most experts believe accumulating greenhouse gases will warm the world. But climate researchers can only offer broad predictions. The planet may heat up at a pace that leads to global catastrophes, or it may warm at an extremely slow rate that allows more time for people, plants and animals to adjust. According to computer models of the climate, the real future most likely lies somewhere between these extremes.

Some groups cite the scientific uncertainty as a reason to stall any response to

greenhouse warming. Yet in testimony before Congress earlier this year, several scientists argued that questions about future warming are not strong enough to warrant hesitation. Addressing the House subcommittee on energy and power, National Academy of Engineering President Robert M. White said, "Our view is that when the risks of the consequences are put in the balance against the certainties and uncertainties of our knowledge, a prudent course of public action is now called for."

At the same hearing, Schneider warned that if policymakers awaited scientific certainty, the world would have to adapt to a much larger dose of global change. Last month, the Environmental Protection Agency echoed this point in its report on policy options for slowing global warming (SN: 3/25/89, p.183).

While the scientists at the subcommittee hearing advocated political response to the threat of global warming, they stressed the importance of taking scientific action as well. Only an understanding of global change will enable researchers to make predictions that can guide future policy. According to White, "The most immediate need is action to reduce uncertainties in our knowledge through an intensified program of research on climate." □

Next: Scientific challenges in the 1990s

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DSM is a distraction. Psychiatrists need to become grounded in basics such as understanding the cultural context of an individual's character and recognizing substance abuse and its effects in the family. There are fundamental skills that become virtually reflexive in genuine psychiatric practice. They are not subject to the deliberations of a committee, nor are they found by reference to an ever-expanding index of classification. When they are mastered, however, there's no mistaking them. And a committee of a thousand learned psychiatrists saying otherwise will not alter that.

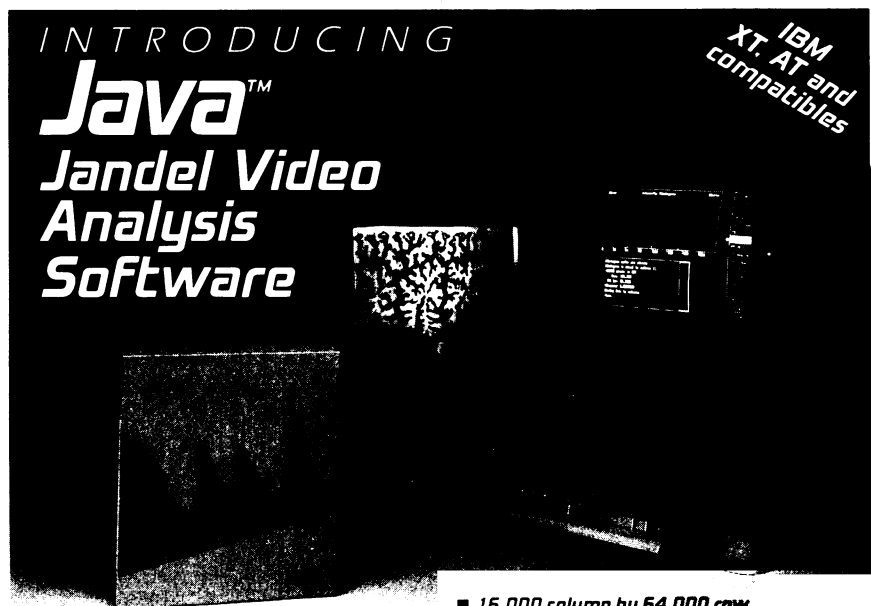
William S. Greenfield
Chairman, Penn Recovery Systems, Inc.
Philadelphia, Pa.

I find it curious that a group of feminist psychotherapists is lobbying against the inclusion of a diagnosis for PMS.

You describe the Coalition Against Misdiagnosis as "aghast" because a gynecological problem was labeled as mental illness. Certainly for many women PMS involves anxiety, depression, hostility and other manifestations of mental illness.

Diagnoses are available for organic mental disorders; research is exploring physiological origins for many disorders described as mental illness. Could it be that despite the efforts of mental health professionals to promote the validity of mental illness, this group of therapists still attaches a stigma to a psychiatric diagnosis?

Nicole D. Booze
Roanoke, Va.



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