New Greenhouse Report Puts Down Dissenters

An international panel assessing greenhouse warming pointedly denies the validity of objections raised by a prominent minority

"THE GLOBAL WARMING PANIC: A Classic Case of Overreaction," screams the cover of *Forbes*. "U.S. Data Fail to Show Warming Trend," announces the *New York Times*. A greenhouse skeptic and a greenhouse advocate go head to head on "This Week with David Brinkley" in what looks like an even match. What's going on here? Is greenhouse warming for real or not? At the very least, recent media coverage has given the impression that scientists can't agree among themselves whether the buildup of greenhouse gases is going to scorch the globe or merely leave it imperceptibly warmed.

But a soon-to-be-published report, the most broadly based assessment of the greenhouse threat conducted to date, presents a very different impression: There's virtual unanimity, it says, among greenhouse experts that a warming is on the way and that the consequences will be serious (see box). The report, produced by a working group of the International Panel on Climate Change (IPCC), will be the basis for discussions at a major international meeting in October that is intended to provide governments with options for responding to greenhouse warming. *Science* has obtained a copy.

"The U.S. press has focused on the outlying views without pressing hard on justifying them," says climate modeler Michael MacCracken of Lawrence Livermore National Laboratory, a contributor to the IPCC study.

Some of the headlines were spurred when researchers such as Richard Lindzen of the Massachusetts Institute of Technology argued that there has been no clear sign of global warming in the past century, even though carbon dioxide and other greenhouse gases have been accumulating in the atmosphere at an accelerating rate. Their conclusion: computer climate models are probably greatly exaggerating the warming predicted for the next century.

Not so, says the IPCC working group, pointing to a small but, in its view, significant warming trend in global climate records. "I was amazed how simple it was to come to agreement," says climatologist Christopher Folland of the U.K. Meteorological Office in Bracknell, who is a lead author of the report's section on observed climate change. "In America, a few extreme viewpoints have taken center stage. There are none like that elsewhere." Not a single panel member or reviewer agreed with Lindzen that there is no sign of global warming in the climate records, says Folland. "That's about 200 people," he notes.

The consensus-forming process began with 170 scientists from 25 countries attending 12 workshops or making written contributions. Thirty-four authors wrote up the 11 report sections in groups of two to five, and another 200 scientists reviewed the full draft report. Then there were uncounted informal reviews, some of them by critics, as well as the inevitable unsolicited phone calls from other interested parties. As yet, dissenters contacted by *Science* had not seen the final working group report.

This extensive reviewing and a widely felt need for an authoritative product seems to have weeded out any and all views perceived in the community as scientifically suspect. For example, the authors of the report decided that one oft-cited piece of contrary evidence—the absence of a warming trend over the contiguous 48 states during nearly a century—was so trivial that they ignored it. "The U.S.A. is not an average place," notes Folland, "just as the U.K. isn't."

The authors did give space to a discussion of satellite temperature measurements that have failed to show a warming trend. But they gave the observations a decidedly different twist from that given by the headlines. Many news stories portrayed the failure to find a significant global warming at mid-tropospheric altitudes between 1979 and 1988 as a sign that greenhouse model predictions might be wrong. But the authors of the IPCC report claim that the satellite results in fact buttress their conclusion that temperature measurements at the earth's surface over the past century reveal a warming. "I was surprised how closely the [satellite data and surface measurements] matched" during the past decade, says Thomas Karl of the National Climatic Data Center in Asheville, one of Folland's coauthors. "It gave me more confidence" in the longer surface temperature record.

The Greenhouse Consensus

Things still look pretty grim in the greenhouse world of the not so distant future. In its soon-to-be released Scientific Assessment of Climate Change, a working group of the Intergovernmental Panel on Climate Change—a creation of two United Nations organizations—has come up with no major surprises, but the following conclusions are a reminder of the issue's seriousness.

■ The warming will likely be large enough to have socially significant effects. A doubling of preindustrial concentrations of carbon dioxide would increase the global average temperature 1.5° to 4.5°C by the middle of the next century, the same range quoted by climate modelers for more than a decade. The "best guess" is 2.5°C, a nod toward the low side of the range lately favored by some researchers (*Science*, 1 December 1989, p. 1119). Barring strict controls on greenhouse gas emissions, sea level will rise between 8 and 29 centimeters by 2030 and continental interiors, the bread baskets of North America and the Soviet Union, might dry during summer.

■ Considerable uncertainties remain. The quoted range of global warming runs from moderate but significant to just short of catastrophic. The authors of the report expressed their confidence in these numbers as being midway between "virtual certainty" and "low confidence." Uncertainties in predictions for areas as large as continents are far greater.

■ The driving force for any greenhouse warming is rapidly accelerating. Humankind's enhancement of the greenhouse since 1765 will be doubled during the next 35 years if a business-as-usual approach toward greenhouse gas emissions is taken.

■ The warming of the past century is real. The average global temperature has increased between 0.3° and 0.6°C since the late 19th century. What part of the warming might be attributable to an enhanced greenhouse is unknown.

■ Detection of the greenhouse warming with high confidence will likely require a decade or more of waiting. If the climate system has only a modest sensitivity to greenhouse gases, and the oceans act to greatly slow the warming, the wait for detection could stretch several decades. ■ R.A.K.

The IPCC panel also tackled head on the good news message in a report last year by the George C. Marshall Institute that was well received at the Bush White House (*Science*, 24 November 1989, p. 992). The institute concluded that the enhanced greenhouse effect may well be a modest one and that it will possibly be counteracted in the next century by another Little Ice Age induced by a fading of the sun.

The IPCC's conclusion is that a varying sun cannot be a major player in the climate of the next century. Even another Little Ice Age cannot offset the greenhouse warming. The report says that "even if such a change occurred over the next few decades, it would be swamped by the enhanced greenhouse effect."

The Marshall report attracted attention in part because it was written by three prominent scientists: William Nierenberg, director emeritus of Scripps Institution of Oceanography; Robert Jastrow, founder and former director of NASA's Goddard Institute for Space Studies; and Frederick Seitz, president emeritus of Rockefeller University. "The problem is that these three well-known scientists are not experts in climate change," says Donald Wuebbles of the Lawrence Livermore National Laboratory and a lead author of the section on radiative forcing of climate. "The White House took [the report] overly seriously. A report done by famous scientists seems to have a lot of credence; whether it is inside or outside of their area of expertise doesn't seem to matter. We just couldn't let these misinterpretations go on any longer."

As for Lindzen's claim that a greenhouse-induced drying of the upper atmosphere would largely counteract the warming (*Science*, 1 December 1989, p. 1118), it garnered nary a mention. The process occurs in the models, IPCC researchers concede, but it has a small effect that is overwhelmed by other changes induced by greenhouse warming. But the report did consider at length the contention, based on studies of warm climates in the geologic past, that the future greenhouse world would largely be a mild, moist paradise. No such luck, say IPCC's climatologists. Weather patterns induced by greenhouse warming will be unlike those of previous periods of global warmth, so strict comparisons are meaningless.

Scientific outcasts have never fared well in consensus-building, but some have still triumphed. For now, the greenhouse skeptics are out in the cold. They will likely remain there for at least another decade while computer models are cranked up, the climate gives more clues of its ultimate direction, and the politicians draft international agreements. ■ RICHARD A. KERR

New Clue to Cancer Metastasis Found

A defect in one of the cell's major signaling pathways may contribute to the tendency of some cancer cells to spread

A REMARKABLE CONFLUENCE OF RESULTS from laboratories on three continents, working independently and on totally different organisms, set researchers hot on the trail of a major mystery in cancer biology: What causes tumor cells to metastasize to new sites in the body? Although numerous genes have been found that contribute to cancer development, the biological changes that allow some tumor cells, but not others, to spread are poorly understood. And since metastasis is what ultimately kills the great majority of cancer patients who succumb to their disease, the new findings have opened a window on a cellular process that researchers would dearly love to understand.

Unexpected result. *A gene found by Patricia Steeg encodes a key regulatory enzyme.*

The story began 3 years ago when a team of researchers at the National Cancer Institute discovered a novel gene with an intriguing activity; it apparently suppresses the ability of cancer cells to metastasize. But the group that found the gene, which was led by Patricia Steeg and Lance Liotta, had no clue about how it might work and they have been trying to puzzle it out ever since.

Now, thanks to an extraordinary piece of scientific serendipity, their puzzle may be solved. The metastasis suppressor gene, it turns out, closely resembles genes that control development in organisms as diverse as bacteria, slime molds, and fruit flies. Moreover, the new evidence indicates that the gene encodes a key enzyme in one of the cell's major pathways for responding to external stimuli. Since these stimuli include hormones and growth factors, alterations in the enzyme might derail a cell's growth control, pushing it into malignancy.

The connection between the metastasis suppressor gene and the signal transmission pathway took a lot of people by surprise, including the NCI workers who discovered the gene. Steeg says: "We never expected the relationship, but it makes for all sorts of exciting new prospects for understanding the mechanisms of metastasis."

Other genes are known to affect metastasis. Some make cancer cells more or less susceptible to killing by the immune system. Others affect the activity of the secreted protein-dissolving enzymes that cancer cells need to escape from a tumor and migrate to new sites. But this one is the first to work inside the cell in a regulatory pathway.

And that raises an intriguing possibility for therapy: It might be possible to find drugs that buttress the activity of the metastasis suppressor gene. "You can visualize inhibitors of metastasis that work inside the cell," Liotta remarks. Such inhibitors might be combined with agents that work externally, inhibitors of the protein-dissolving enzymes, for example. Moreover, by measuring the activity of the suppressor gene in cancer cells, physicians might be able to predict which tumors are likely to metastasize and require aggressive therapy.

Steeg, Liotta, and their colleagues originally detected the gene in mouse melanoma cells in 1987. These cells, like other cancer cells, differ widely in their metastatic potential. The NCI workers were comparing patterns of gene expression in melanoma cells that have little tendency to metastasize with the patterns in cells that metastasize readily. When they found one gene that was consistently expressed at higher levels in the poorly metastatic cells, they thought they might be on to a metastasis suppressor.

Steeg and her colleagues went to work and subsequently determined the nucleotide sequence of the gene, which they designated NM23 (because it was nonmetastatic and the 23rd gene clone they examined). Once they verified that the sequence didn't resemble that of any other gene recorded in the data banks at the time, they knew they had come up with a new gene. But because they had nothing to compare the new gene with, the NCI workers could make no predictions about how it might work. And that's where