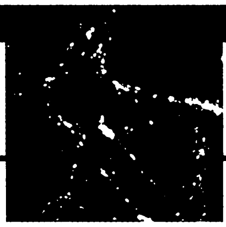
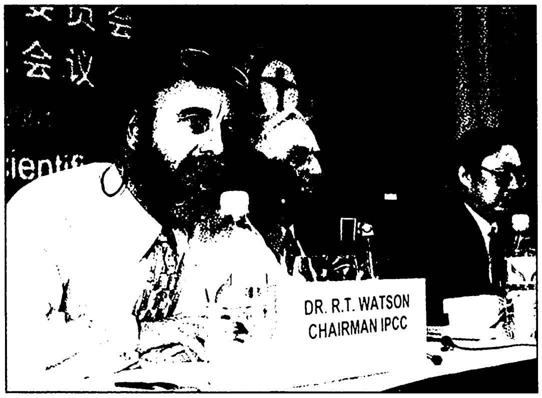


CLIMATE CHANGE

It's Official: Humans Are Behind Most of Global Warming

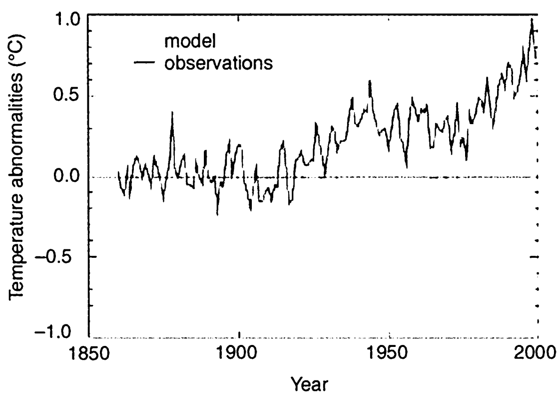
Expert opinion just got much more certain that humans are driving the planetary fever of recent decades. Eschewing its vagueness of 5 years earlier about glimpsing "a discernible human influence on global climate," the United Nations–sponsored Intergovernmental Panel on Climate Change (IPCC) officially declared early this week that "most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations." Not the sun, not natural climate fluctuations, not some bug in a computer model, but carbon dioxide and other heat-trapping gases that humans are pumping into the atmosphere. The panel—whose report represents the consensus of hundreds of participating scientists and was just approved by 100 participating governments in Shanghai—was vaguer than ever, though, about how bad things could get by the end of the century. At a minimum, the world will warm more than twice as much in the coming century as it did in the past one, the panel concluded, but it could warm 10 times as much.



Mixed progress. IPCC chair Robert Watson reports a human cause but uncertain outcome for global warming.

The warming outlook is founded on the improved scientific understanding since the last IPCC report in 1995. "There have been substantial increases in insight over the past decade," says atmospheric scientist and U.S. IPCC delegate Daniel Albritton of the National Oceanic and Atmospheric Administration in Boulder, Colorado. "I found it pretty impressive." Computer models now do a better job at calculating how much of past warming might be due to natural climate fluctuation and how much warming there might be in the future. Albritton and others are particularly impressed with the millennium-long temperature records extracted from tree rings and other climate proxies. With this long perspective, the Northern Hemisphere warming of the 20th century "is likely to have been the largest of any century during the past 1000 years," the report finds, and "is unlikely to be entirely natural in origin."

While uncertainties have narrowed about what's causing the warming, projecting it into the future seems more uncertain than ever. In the 1995 report, researchers combined projections of how much greenhouse gas humanity might produce with model estimates of climate sensitivity—that is, how much various increases in greenhouse gases should warm the climate. The range of possible warming by 2100 ran from 1.0°C to a hefty 3.5°C in 1995.



The greenhouse did it. A model with rising greenhouse gases and minor solar and volcanic effects simulates global warming.

In the new report, the projected range of warming starts from a still modest 1.4°C but rises to a staggering 5.8°C. While estimates of climate sensitivity haven't changed much, projections of possible global pollution levels in 2100 have. In this go-round, IPCC members considered scenarios in which countries drastically cut emissions of sulfurous pollution, which forms a cooling haze over large parts of the world. Without a protective umbrella, the greenhouse would sizzle.

Although only the upper end of a range of possibilities, the 5.8°C number is prompting headlines proclaiming seemingly inevitable climate disaster. Albritton views the broadened range of possibilities as a recognition of the obvious. "You can't forecast what technology or the human race is going to do 100 years from now," he notes. This socioeconomic uncertainty is currently as large as the uncertainty still inherent in climate models, the report notes.

Negotiators at last November's climate talks at The Hague (*Science*, 1 December 2000, p. 1663) were aware of the gist of the IPCC report—drafts of which were widely leaked last year—but negotiations on reining in greenhouse gases broke down anyway. Many problems remain to be taken up again when talks reconvene in May in Berlin, but a looming obstacle is the stance, which has yet to be spelled out, of President Bush and his Administration. Atmospheric physicist Michael Oppenheimer of Environmental Defense in New York City thinks the report could make a difference. It shows that "there's been a climate change, and there are going to be bigger changes in the future," he says. "It's hard to see how the new Administration could fail to take it seriously."

–RICHARD A. KERR

QUANTUM OPTICS

Atomic Squeeze Play Stops Light Cold

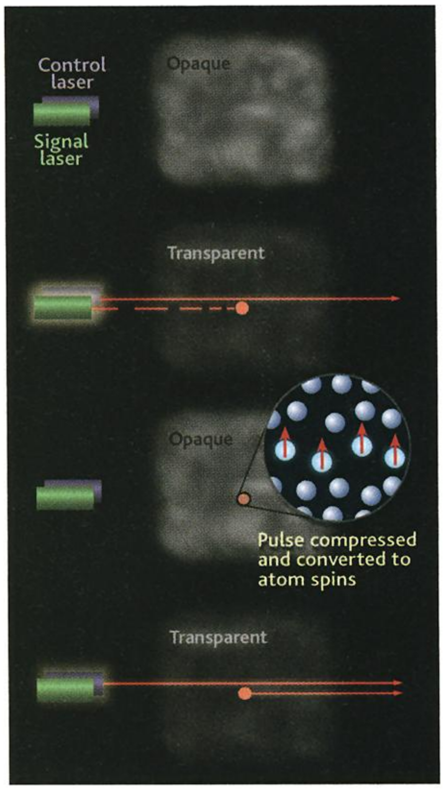
Last year, physicists made headlines by slowing light down to the speed of a leisurely bicycle ride. Now, pushing the experiment to its logical conclusion, they have slammed on the brakes. In papers in *Physical Review Letters* and *Nature*, scientists report that they have used atomic gases to grab light pulses, squeeze them into a smaller space, imprint them on atoms, and read them out again after a delay. The researchers speculate that such sleight-of-light tricks might

CREDITS: (TOP TO BOTTOM) EUGENE HOSHIKO/AP; SOURCE: IPCC one day be useful in the still theoretical field of quantum information processing.

"This is very brilliant stuff," says Steve Harris of Stanford University, a physicist who first measured the optical slowing effect 5 years ago. "You can compress this kilometers-long pulse down and store it completely, and all of the information is preserved."

Light travels at about 300 million meters per second, a fact hammered into the heads of beginning science students. But that's in a vacuum, and it is only half the story. In fact, light has two different velocities—the phase velocity and the group velocity—and they can be very different. Phase velocity is the speed of a theoretical, pure light wave of a single frequency. Group velocity, by contrast, measures how fast a real signal moves through real matter.

Last year, researchers led by Lene Hau of Harvard University slowed light to a crawl by exploiting the way special kinds of atomic matter can play around with the group velocity of a laser pulse. They started with a gas of sodium atoms, chilled down to nanokelvin temperatures, of the sort used to study Bose-Einstein condensates (*Science*, 22 December 1995, p. 1902). Normally the sodium vapor is opaque to laser pulses, but the researchers canceled out the absorption by tweaking the atomic energy levels with another laser. Such "electromagnetically induced transparency" (EIT), which Harris and colleagues discovered nearly a decade ago, suddenly makes the gas transparent to the laser light. It also causes the light pulses to slow down by factors of millions and shrinks them by seven orders of magnitude, like a stretched-out Slinky toy dropped into a tank of molasses. Last year, Mikhail Lukin, Susan Yelin, and Michael Fleischhauer of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts, worked out a theory for how this EIT effect could be used to trap, store, and release light.



Light trap. Beam from a "control laser" first clears the way for a second pulse to enter atomic vapor, then releases it from confinement. Real beams are collinear.

In their new experiments, Hau's group prepped the sodium for EIT by hitting the atoms with a "coupling laser." Then they fired in another laser pulse, which slowed and scrunched down inside the vapor. When the pulse had fully entered the atomic soup, they turned off the coupling beam. "The light pulse comes to a grinding halt," Hau says. "All the information in the pulse gets stored in the atoms, and we can park it there for a while." When they switched the coupling laser on again, the vapor became transparent again, and the atomic spins regenerated a perfect copy of the original laser pulse. With this atomic Silly Putty, Hau's team could store light pulses for up to 1 millisecond and spit them out again.

Meanwhile, another group at CfA has stored and reemitted light by very different methods. Rather than supercold sodium atoms, Ron Walsworth, Mikhail Lukin, and their colleagues used a warm rubidium vapor to catch a laser pulse and then read it out again. In contrast to Hau's tailor-made equipment, the CfA group cobbled theirs together from components they were using in other experiments. "We basically did this with atomic-clock technology," Lukin says. Their simpler apparatus stored light for up to half a millisecond before releasing it.

Both sets of researchers stress that they haven't actually trapped photons like butterflies in a jar. The information contained in the laser pulse, they point out, is converted into atomic states that sit around until the control beam tells the light to emerge. Then energy from the control beam is converted into an outgoing pulse identical to the input pulse.

Many researchers are excited by the prospect of using the technique as a kind of coherent optical storage device—a sort of quantum hologram. Or it might lead to a quantum Internet, with light beams coherently ferrying information from atom cloud to atom cloud. But there is a long way to go before anyone will be saving e-mail in frozen light.

–DAVID VOSS

NOBEL PRIZE

Researcher Overlooked For 2000 Nobel

When the Nobel Foundation announces its list of prize winners, there are often grumbles that somebody's seminal work was overlooked. Last year's award of the medicine prize has provoked something more: an open letter to the award committee signed by more than 250 neuroscientists.

The award went to three researchers for their work on how nerve cells exchange signals, and the Nobel Foundation's announcement pointed out the relevance of such work for treating Parkinson's disease and other neurological disorders. The problem, say those who signed the letter, is that the person who discovered the underlying neurotransmitter deficit in Parkinson's disease—and designed the treatment still in use today—wasn't included in the award or even mentioned in the accompanying announcement.

"Everyone was surprised" that neurologist Oleh Hornykiewicz didn't receive the Nobel Prize last year when the committee recognized contributions to the study of neurotransmitters, says neuroscientist John Hardy of the Mayo Clinic in Jacksonville, Florida. Hornykiewicz's work "fundamentally changed how neuropharmacology is practiced," he asserts. His colleagues who

Nobel slight? Neuroscientists say Oleh Hornykiewicz deserved a Nobel.

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