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Knuckle walkers?

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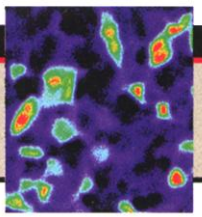


Leaving a bitter taste

CLIMATE CHANGE

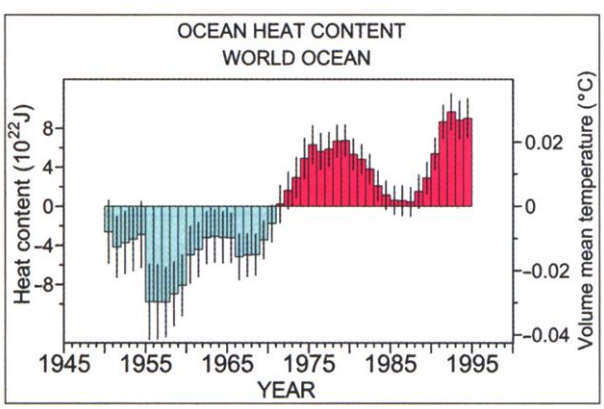
Globe's 'Missing Warming' Found in the Ocean

Greenhouse skeptics often point to the relatively modest atmospheric warming of the past few decades as evidence of the climatic impotence of greenhouse gases. Climate modelers respond that much of the heat trapped by greenhouse gases should be going into the ocean, delaying but not preventing some of the atmospheric warming. But oceanographers plumbing the ocean depths have been unable to say who was right, because records of deep-ocean temperature have been too spotty to pick out clear trends. Now, on page 2225 of this issue of *Science*, physical oceanographers rummaging through piles of neglected data report that they have turned up millions of old, deep-ocean temperature measurements, enough to draw up oceanic fever charts that confirm the climate models' predicted ocean warming. "We've shown that a large part of the 'missing warming' has occurred in the ocean," says oceanographer Sydney Levitus, the lead author of the paper. "The whole-Earth system has gone into a relatively warm state."

The international data search-and-rescue effort "adds credibility to the belief that most of the warming in the 20th century is anthropogenic," says climate modeler Jerry D. Mahlman of the National Oceanic and Atmospheric Administration's (NOAA's) Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey. It also suggests that past greenhouse gas emissions guarantee more global warming ahead and that the climate system may be more sensitive to greenhouse gases than some had thought.

How could millions of valuable oceanographic measurements go missing for decades? Oceanographers have never had the orchestrated, worldwide network of routine observations that meteorologists enjoy. Instead, 40 or 50 years ago, ocean temperature profiles made by dropping a temperature sensor down through the sea might end up handwritten on paper, captured in a photograph, or recorded in analog form on magnetic tape. Everything from mold to mice was devouring the data. That's why, under the auspices of the United Nations–sponsored Global Oceanographic Data Archeology and Rescue project, data archaeologists like Levitus have spent the past 7 years seeking out ocean temperature data around the world and digitizing them for archiving on modern media.

After adding 2 million profiles of ocean temperature to the previously archived 3 million profiles, Levitus and his NOAA colleagues in Silver Spring, Maryland, could see a clear change. Between 1955 and 1995, the world ocean—the Pacific, Atlantic, and Indian basins combined—warmed an average of 0.06°C between the surface and 3000 meters. That's about 20×10^{22} joules of heat added in 40 years, roughly the same amount the oceans of the Southern Hemisphere gain and lose each year with the change of seasons. Half the warming occurred in the upper 300 meters, half below. The warming wasn't steady, though; heat content rose from a low point in the 1950s, peaked in the late '70s, dropped in the '80s, and rose to a higher peak in the '90s. All three ocean basins followed much the same pattern.



A long, deep warming. Inclusion of neglected data shows that the ocean's top 3000 meters have been warming.

These rescued data have oceanographers excited. "I've never seen anything like this before," says physical oceanographer Peter Rhines of the University of Washington, Seattle. "What surprises me is how much [of the warming] is in the deepwater." The newly retrieved data "show how active the [deep-ocean] system is," says oceanographer James Carton of the University of Maryland, College Park, "and how it's a part of the climate system on short time scales."

The friskiness of the whole-ocean system came as a surprise as well. "There's striking variability from decade to decade," says Rhines. That the heat content tends to rise and fall in concert across all three ocean basins, in both the north and the south, is "quite amazing," he adds. Meteorologists and oceanographers are increasingly recognizing that the atmosphere connects ocean basins (*Science*, 10 July 1998, p. 157), but as to what could be coordinating global swings in heat content, "I really don't know," says Rhines.

The most immediate reward for retrieving so much data from the oceanographers' attic seems to be more confidence in climate models. The increased heat content of the world ocean is roughly what climate models have predicted. "That's another validation of the models," says climatologist Tom Wigley of the National Center for Atmospheric Research in Boulder, Colorado.

As the models implied, rising ocean temperatures have delayed part of the surface warming, says climate modeler James Hansen of NASA's Goddard Institute for Space Studies in New York City, but that can't continue indefinitely. Even if rising concentrations of greenhouse gases could be stabilized tomorrow, Hansen says, gases that have already accumulated will push surface temperatures up another half-degree or so.

The ocean-induced delay in global warming also suggests to some climatologists that future temperature increases will be toward the top end of the models' range of predictions. Mainstream climatologists have long estimated that a doubling of greenhouse gases, expected by the end of the 21st century, would eventually warm the world between 1.5° and 4.5°C. Some greenhouse contrarians have put that number at 1°C or even less. Now, the ocean-warming data "imply that climate sensitivity is not at the low end of the spectrum," says Hansen. He, Wigley, and some others now lean toward a climate sensitivity of about 3°C or a bit higher. But as climatologist Christopher Folland of the Hadley Center for Climate Prediction in Bracknell, United Kingdom,

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notes, the considerable variability in ocean heat content from decade to decade means scientists will still be hard pressed to find a precise number for climate sensitivity.

Getting better numbers for ocean heat content remains a top priority for oceanographers. "There's still a vast amount of data out there that needs digitizing," says Folland. And for future numbers, an international effort called Argo, now under way, will create an ocean-spanning network of 3000 free-floating instrument packages. Linked by satellites, the Argo drifters will create a "weather map" of the ocean down to 1500 meters. At least future oceanographers won't have to rummage through the data detritus of their predecessors to see what the ocean is up to.

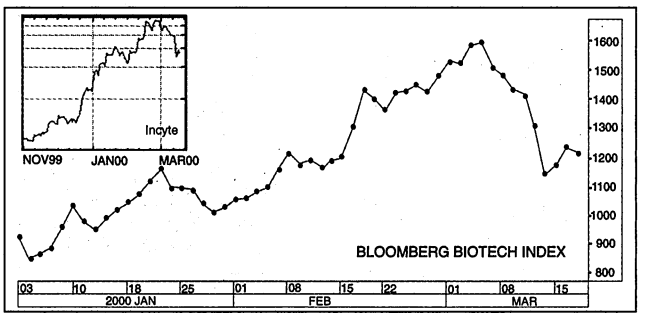
–RICHARD A. KERR

BIOTECHNOLOGY

How a Bland Statement Sent Stocks Sprawling

Muddled news reports and a volatile stock market turned a presidential statement on genome data last week into a disaster for many biotech companies. Stocks of genetic research companies, after shooting upward early this year, plummeted on 14 March when President Bill Clinton and British Prime Minister Tony Blair issued a bland statement urging all labs to provide "unencumbered access" to raw DNA sequence information (*Science*, 17 March, p. 1903). Almost immediately, biotech stocks, which were already headed downward, went into a nose dive; some companies lost as much as 20% of their value on paper in a few hours. Within 48 hours many began to stabilize, but remained well below their peak a week later. Industry analysts had trouble interpreting these market gyrations. One biotech expert suggested a simple explanation: Stock buyers "don't understand what they're investing in," he said, and they can be easily spooked.

The spark that ignited the panic may have come during an informal briefing given by Clinton's press secretary Joe Lockhart on the morning of 14 March. As *The Wall Street Journal* reported the next day, Lockhart told a "gaggle" of regulars who cover the president that Clinton and Blair intended to issue a statement in the afternoon about a plan to restrict the patenting of human genes. If this is what Lockhart said—his remarks were off the record—it was not correct. Francis Collins, director of the U.S. National Human Genome Research Institute, says the statement was never meant to describe a new policy. The wording—which had been debated and revised "in many iterations ... over many months," Collins says—simply affirmed support for a 1996 research policy that calls for the immediate release of raw sequence data. Indeed, the Clinton-Blair statement specifically endorsed the patenting of "new gene-based health care products." But this clear message became tangled in stories of the rivalry between publicly and privately funded genome scientists over who should control human genome data (*Science*, 10 March, p. 1723). The upshot: Early news reports were confused.



Biotech bubble. A 14 March Clinton-Blair statement accelerated a drop in biotech stocks, especially those of genomics companies like Incyte *(inset)*.

At 9 a.m., CBS Radio News broadcast that the United States and Britain were aiming to "ban patents on individual genes." The Associated Press reported that there was a plan to restrict gene patents, but later said that Britain and the United States would begin to "openly share data" on the human genome. (They already do.) The stories became clearer later in the day. Even so, Chuck Ludlam, vice president of the Biotechnology Industry Organization in Washington, D.C., who saw the Clinton-Blair statement as "positive news" for industry, says he found it "unbelievable how wrong the reports were all day."

White House spokesperson Jake Siewert later told *Science* that "we completely dispute" the *Journal*'s account of what caused the muddle. Lockhart, he says, told reporters that the Clinton-Blair announcement "had to do with public access to raw genomic data." But there was "confusion" during the "back and forth" between Lockhart and the reporters, Siewert concedes. "I don't think Joe got it perfectly right. ... And some reporters didn't get it perfectly right."

During the confused morning, stocks of companies that are creating private genetic databases—such as Celera Genomics of Rockville, Maryland, and Incyte Pharmaceuticals of Palo Alto, California—began to tumble. Other genome-related stocks began to slide, too. Soon the entire biotech sector slumped, as did the Nasdaq stock exchange index, which tracks high-tech firms. The Nasdaq index bounced back within 48 hours, but dropped again later, as investors remained wary of genomics and biotech companies. A week later, Celera and Incyte stocks, for example, were still 60% below their peak immediately before the statement. Predicts industry analyst Sergio Traversa of Mehta Partners in New York City, "Investors will remain a little bit more careful now," having been stung so badly.

–ELIOT MARSHALL

TAIWAN

Academy Head Touted For Top Political Post

TOKYO—Last week's presidential election in Taiwan, hailed as a boost for the country's young democracy, may also have a major impact on Academia Sinica, the island's premier collection of research institutes. Its leader, Nobel laureate Lee Yuan-tseh—who publicly backed the winning candidate, Chen Shui-bian, just days before the 18

Center of attention. Nobelist Lee Yuan-tseh, left, teams up with Chen Shui-bian before last week's vote.

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