SCIENCE
CLIMATOLOGY

Satellite vs. Surface: Two Points of View on Global Warming

By Boyce Rensberger
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If there has been a planetwide warming trend over the last decade and a half—a claim repeated so often in recent years that many assume it is an established fact—it ought to have shown up by now in the 15 years of temperature readings taken by a network of Earth-orbiting satellites.

So said James Hansen, the Goddard Institute for Space Studies scientist who alarmed the world in the late 1980s with his assertion that Earth's atmosphere had been warming since the mid-1970s—caused by growing concentrations of carbon dioxide in the air, which trap heat that otherwise would radiate into space. Hansen bolstered his case with a chart showing that after 35 years of fairly steady temperatures, surface thermometer readings around the world were suddenly showing a warming trend.

Yet no sign of such warming has shown up in the satellite data.

"We've had total satellite coverage of the Earth since 1979, and we sure don't see it," said John Christy, of the University of Alabama at Huntsville.

For the last few years Christy and Roy Spencer of NASA's Marshall Space Flight Center, also in Huntsville, have been processing data collected by satellites operated by the National Oceanic and Atmospheric Administration (NOAA).

Causes for Discrepancies in Data

Each month Christy and Spencer update their analysis, issuing the planetary equivalent of a fever chart. Their latest report (upper chart) shows that in June, as in the 19 previous months, the average global temperature was cooler than the average for the previous decade. July, despite a local heat wave in the eastern United States, is shaping up to be cooler as well.

More significantly, instead of a global warming trend, the satellite data show no clear pattern. According to the space-based sensors, the temperature of the lower atmosphere has fluctuated irregularly—cooler than average for two or three years, then warmer for about the same time, then back, then forth.

Christy said the warmer intervals coincide with El Niño—the mysterious, periodic phenomenon in which the surface waters of the South Pacific become warmer than usual. Because heat from ocean surfaces supplies the energy that drives many weather phenomena, this warming sets off major weather shifts around the planet. El Niño appeared in 1983, recurred in 1987 through early 1988 and came back again for a prolonged stay in 1990 and 1991.

At the same time, however, Mount Pinatubo erupted in the Philippines in June 1991 and soon reversed El Niño's effect. It spewed tiny droplets of sulfuric acid into the upper atmosphere, where they eventually spread to cover much of the globe. Because the droplets reflected some sunlight back into space, they caused a global cooling. Most of the droplets have since rained out of the atmosphere.

Overall, Christy said, there has been no apparent warming trend.

Hansen's more widely reported data (lower chart) show similar fluctuations from year to year. But, he said, they indicate a clear warming trend that reached record high temperatures in the late 1980s before Pinatubo chilled the air.

Hansen said the readings show the lower atmosphere's average temperature rose by about a quarter of a degree Fahrenheit in that time. (Most of that warming in the Northern Hemisphere, the detailed records show, has happened at night and during the winter. Summertime high temperatures have not risen.)

Why the difference?

"Our data," Christy said, "come from satellite readings taken over the entire globe. Their data come from thermometers, mostly in industrial areas."

In other words, the temperature records were gathered in two very different ways.

The older method relies on conventional thermometers at weather stations around the world, most at airports and in cities in the industrialized world, plus scattered readings in Third World regions and aboard ships at sea. At some stations, readings have been taken regularly for more than a century. Because the readings are taken just a few feet off the ground, they are relevant to what most living things feel.

A major drawback is that many of the thermometers are in "heat islands"—places that have been artificially warmed by the growth of pavement and cities. Christy argues that this effect—as well as the fact that the limited number of stations provides uneven coverage of the globe—create the appearance of a warming trend. Hansen said the heat island effect is understood and that thermometer readings are routinely lowered a certain amount to correct for it.

The newer method uses a series of weather satellites that scan the entire surface of Earth several times a day and record the intensity of microwave radiation that comes naturally from oxygen molecules in the bottom-most four miles of the atmosphere. The warmer the oxygen, the more intense the radiation. A major advantage of this method is that it monitors the whole planet evenly.

Disadvantages are that the readings go back only to 1979 and that instead of measuring the temperature near the ground, it reads an average for the bottom-most four miles of atmosphere. So it's less relevant to life on the ground, though perhaps more relevant to cloud formation, which cools the surface in the daytime and warms it at night. The cooler the air at cloud altitudes, the more likely it is that water vapor will condense, forming clouds.

Moreover, Hansen points out, the satellite microwave readings can be thrown off by water droplets and other particles in the air that interfere with the microwaves' path to the satellite detectors.

Nonetheless, "if there's a greenhouse warming," Hansen said, "it should be visible in their data. The fact that it isn't tells me there's something wrong with their data. There should be similar trends."

It is also possible that the discrepancies are revealing genuine differences in the atmosphere, Hansen said. There could be a warming near the ground and little or no change a few miles up.

Greenhouse Effect Still a Concern

"The fact that we see no warming doesn't mean there's nothing to worry about," Christy said. "From simple physics we know that increasing the amount of carbon dioxide in the atmosphere raises the possibility of a greenhouse effect. A concern is certainly warranted. But, I have to add, our data show little or no warming—indicating that this problem is a lot less than what the [computer-generated] climate models would make you think."

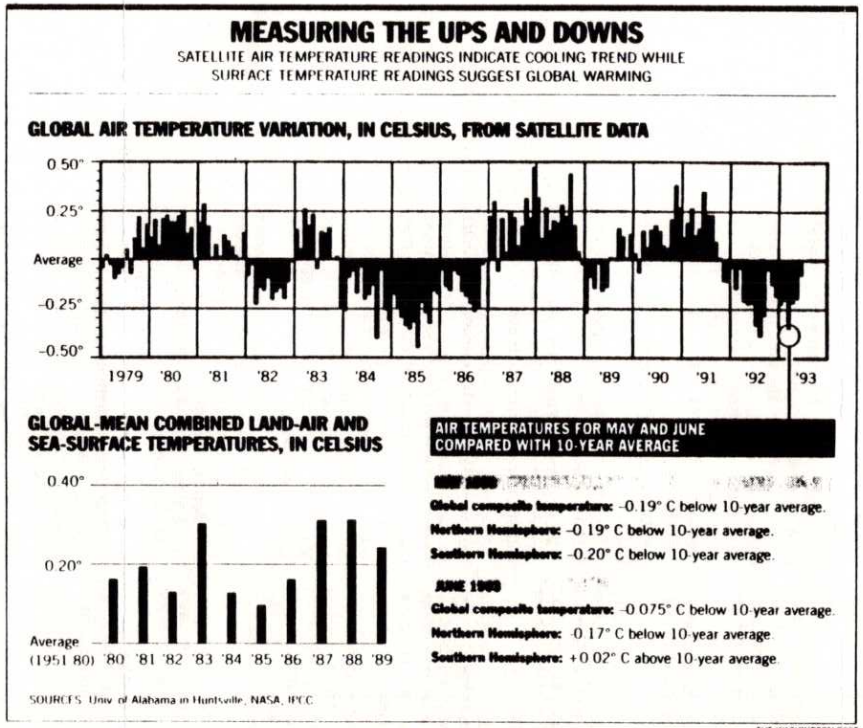
To one climate researcher the differences are not so troubling.

"If you look at them closely, they agree remarkably well," said Jerry Mahlman, head of NOAA's Geophysical Fluid Dynamics Laboratory in Princeton, N.J., a major climate research center. "There's no data set that's perfect. They've all got problems."

For one thing, Mahlman said, the satellite data cover a fairly brief interval: "It's extraordinarily hard just to look at one decade and get any sense of a trend."

Perhaps more perplexing than the air temperature discrepancy is one involving ocean temperatures. Two of the most complete sets of global water temperatures give opposite results. NOAA's Comprehensive Ocean Atmosphere Data Set says the oceans cooled during the 1980s. The United Kingdom Meteorological Office's Global Ocean Surface Temperature Atlas says the oceans warmed during the same decade.

Because scientific efforts to monitor real-world changes yield such ambiguous results, the clamor to "do something" about global warming remains largely an emotionally guided phenomenon.



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Let's cool the rhetoric about global warming

By John R. Christy

COMMUNITY VOICES

The Philippine volcano Mount Pinatubo threw a curve to climate watchers around the world: Just when reports of global warming and its terrible consequences were becoming standard fare, the global temperature dropped by an amount equal to a quarter-century of the predicted warming.

Forecasts of a Midwestern desert or of melted polar ice caps flooding coastal cities in the 21st century are more difficult to accept these days when we've just experienced the Blizzard of '93.

But how reliable are the data used to support claims of warming due to the enhanced greenhouse effect?

Earth's atmosphere includes some gases which have a distinctive trait: They let sunlight pass through to heat Earth's surface, but they capture energy that leaves this sun-warmed surface. These are called greenhouse gases.

If more of these gases were added to the air — and nothing else changed — the atmosphere would retain more heat. It would get warmer. If that were the case, global warming due to an "enhanced greenhouse effect" should occur.

The concentration of some greenhouse gases, like carbon dioxide and methane, is increasing. There is really no debate on that issue. The debate arises from results expected for the real atmosphere, the behavior of which, scientists agree, contains great uncertainties.

What about the data? Most of the data used to support global warming forecasts come from temperature records collected by a wide variety of thermometers and stations around the world. Most are in easily accessible land areas. Other reports come from "ships of opportunity," which record the temperature of the water (not the air) drawn in to cool the engines.

In any case, most of the world is not covered with regular thermometer readings. The "global temperature" from these surface stations is, in reality, *not* global. It neglects vast regions, including most of the world's oceans, Antarctica and interiors of South America, Africa and Greenland.

There is another problem, too. Of great concern to scientists is the lack of consistency in the way readings are taken and in the thermometer surroundings. Since most thermometers for which long-term records exist are in towns and cities, the effects of population growth and the construction of nearby roads, parking lots, runways and buildings will cause the temperature to rise a little due to urbanization.

Many of these sites are easily detected by their strong warming trends, though they are still averaged into the "global temperature" and give a false climate signal.

Are we really witnessing an "asphalt effect" instead of the "greenhouse effect" in these data? The best that can be said for the surface temperature is that over the last 100 years one can see about a 1 degree Fahrenheit warming for those places that have thermometers. This is a valuable record, but it is far from perfect.

A new method for measuring global temperatures was developed by Dr. Roy Spencer of NASA's Marshall Space Flight Center and myself. We use satellites to record the "brightness temperature" of microwaves emitted by oxygen in the atmosphere. The key advantages of this method are:

- The satellite observes the entire Earth.
- Its thermometer is calibrated more than 3,000 times a day.
- Only one thermometer per satellite does the measuring, so there is no conflict with incompatible instruments.

The instruments which collect these data provide global temperature readings to an accuracy of about 0.04 degrees Fahrenheit per month. They have shown that the temperature of the entire globe, for the atmosphere from the surface up to about 16,000 feet, has experienced warm and cool periods, but there is no significant trend up or down since 1979. As of March 31, 1993, the 14-year trend was slightly downward.

In contrast, the surface record shows an upward trend of about 0.2 degrees Fahrenheit per decade in that same period. Before Pinatubo, the surface data trend since 1979 was up almost 0.4 degrees Fahrenheit.

Even then, the satellites showed no significant trend at all.

When Mount Pinatubo exploded in June 1991, it sent more dust, ash and sulfur into the stratosphere than any volcano this century. Those "aerosols" had a slight shading effect on the Earth; the global temperature has since fallen more than 1 degree Fahrenheit. The Northern Hemisphere's summer of 1992 and the Southern Hemisphere's just completed summer of 1992-93 were both the coolest in 14 years.

There are many environmental problems — toxic waste disposal, water and air pollution (remember, carbon dioxide is *not* a pollutant), deforestation, ecological degradation and overpopulation — that are immediate threats to our well-being.

Evidence that global warming is an immediate threat has not been substantiated.

Some day, after a lot of research, we may finally know if the climate is changing. Let us hope we make the proper decisions along the way to mitigate real problems and not perceived ones.

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