

Satellites Misread Global Temperatures

Scientists have detected an error in satellite records of Earth's temperature—a discovery that could help resolve one of the thorniest controversies in climate studies.

"It strengthens the case for global warming," says Frank J. Wentz, a physicist who discovered the error.

The flaw artificially depressed atmospheric temperature readings, thereby masking signs of increasing air temperatures, according to Wentz and Matthias Schabel, both at Remote Sensing Systems in Santa Rosa, Calif. The error arises from changes in the satellites' orbits, they report in the August 13 *NATURE*.

The new study offers a potential solution to a long-standing enigma: Why have satellite data been at odds with surface measurements of global temperature? From 1979 through 1995, the satellite

record suggested that the lower atmosphere was cooling at a rate of 0.05°C per decade, whereas data from the ground showed Earth's surface warming by 0.13°C per decade. Skeptics have long pointed to the satellite data as evidence that the globe is not warming.

With the discovery of the new complication in the satellite record, "the bottom line is that it's hard to deny there is warming," says James E. Hansen of NASA's Goddard Institute for Space Studies in New York.

The researchers who published the original satellite data agree that they need to correct for orbital changes but contend that their record still fails to show any significant global warming.

The instrument at the center of this controversy, an atmospheric thermometer known as the Microwave Sounding

Unit (MSU), works by measuring radiation emitted by oxygen molecules; warmer air gives off more radiation than cooler air. MSUs have flown on a series of weather satellites since 1979.

Wentz and Schabel made their discovery while analyzing other satellite data that stood at odds with the MSU data. They determined that changes in the satellites' altitude can skew the MSU analysis, a factor previously overlooked. The satellites start orbiting 850 kilometers above Earth but drop about 1 km per year.

"We were able to show that the decline in altitude would produce a spurious cooling" in the MSU data, says Wentz. When he and Schabel corrected for the orbital error, the MSU record showed the lowermost troposphere—from ground level to 7 kilometers above ground—warming at a rate of 0.07°C per decade.

John R. Christy of the University of Alabama at Huntsville, who analyzes the MSU data, acknowledges the orbit problem. "The orbit decay effect is real. It has now been removed. But because of compensating factors, it does not change the data set by much," he says.

In the newest version of the data set, which extends beyond the period analyzed by Wentz and Schabel, Christy has corrected several problems. Some had contributed artificial increases to the record, he says. When he removed all these problems, the temperature record shifted upward only slightly. Through the end of 1997, he says, the improved version of the MSU data shows no temperature trend.

Christy says that he has confidence in the new MSU record because it agrees extremely well with his analysis of atmospheric measurements made by balloons, which have shown the troposphere cooling. Other studies of balloon data, however, suggest that the troposphere is warming slightly, argues Hansen in a commentary in the August 14 *SCIENCE*.

Hansen's own reading of the available atmospheric data suggests that the troposphere is warming but not as much as the surface. "The issue is what is the magnitude of that and what is the practical significance," he says.

Dian J. Gaffen of the National Oceanic and Atmospheric Administration in Silver Spring, Md., points out that current satellite instruments and balloon networks were fashioned for gauging weather day to day. To track temperature trends more accurately over decades, researchers need much more sophisticated arrangements, she says.

—R. Monastersky

Not all pirate wasps have a tragic past

The home wreckers, kidnappers, and hijackers of the paper wasp world may not all be driven to mayhem by broken homes. Instead, some of these wasps are playing out a novel sit-and-wait reproductive strategy, says Philip T. Starks of Cornell University.

The European wasp species *Polistes dominulus* landed in Massachusetts some 20 years ago. Its kingdom of papery combs now extends into the Midwest.

Lone females of the species sometimes buzz out of the sky onto another female's nest and take over, chasing away the original queen and eating her youngest offspring. The older offspring are allowed to live but must tend the eggs laid by the new ruler. Lone females also appropriate undefended nests whose founding females have died.

Researchers once assumed that these takeover artists had lost their own nests or been stuck as subordinate females in other queens' colonies. In the early 1990s, however, two behavioral ecologists proposed that some nest-grabbers had never bothered to build or tend a nest. These wasps just waited for the right moment to pirate somebody else's, suggested Peter Nonacs, now of the University of California, Los Angeles, and H. Kern Reeve of Cornell.

To test this idea, Starks established colonies of labeled wasps in a greenhouse and noted which captive wasps were tending nests and which were unaffiliated. He then collected more nests from the wild, removed the queens, and left the undefended combs and young-



A paper wasp queen can either start her own nest or hang around and hijack someone else's.

sters up for grabs in the greenhouse.

All the females who took over the introduced nests came from the population of floaters, Starks says. His analysis appears in the Aug. 7 *PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON B*.

"It's a very risky behavior," Starks observes. A pirate female whose takeover bids fail hits a genetic dead end.

What prompts some females to lurk for takeover opportunities while others build nests? "I'm having a heck of a time figuring out the conditions," Starks says.

Nonacs notes that "nest-building is very dangerous too." Dashing around for nest fibers and food for her offspring exposes a wasp queen to spiders, praying mantises, and other killers. How many females in the wild dodge these risks early in the season and go into piracy is not clear from Starks' greenhouse test, Nonacs cautions.

He would not be surprised if other *Polistes* wasps include lurking takeover queens. "I don't think it's been looked for a lot," Nonacs says.

—S. Milius