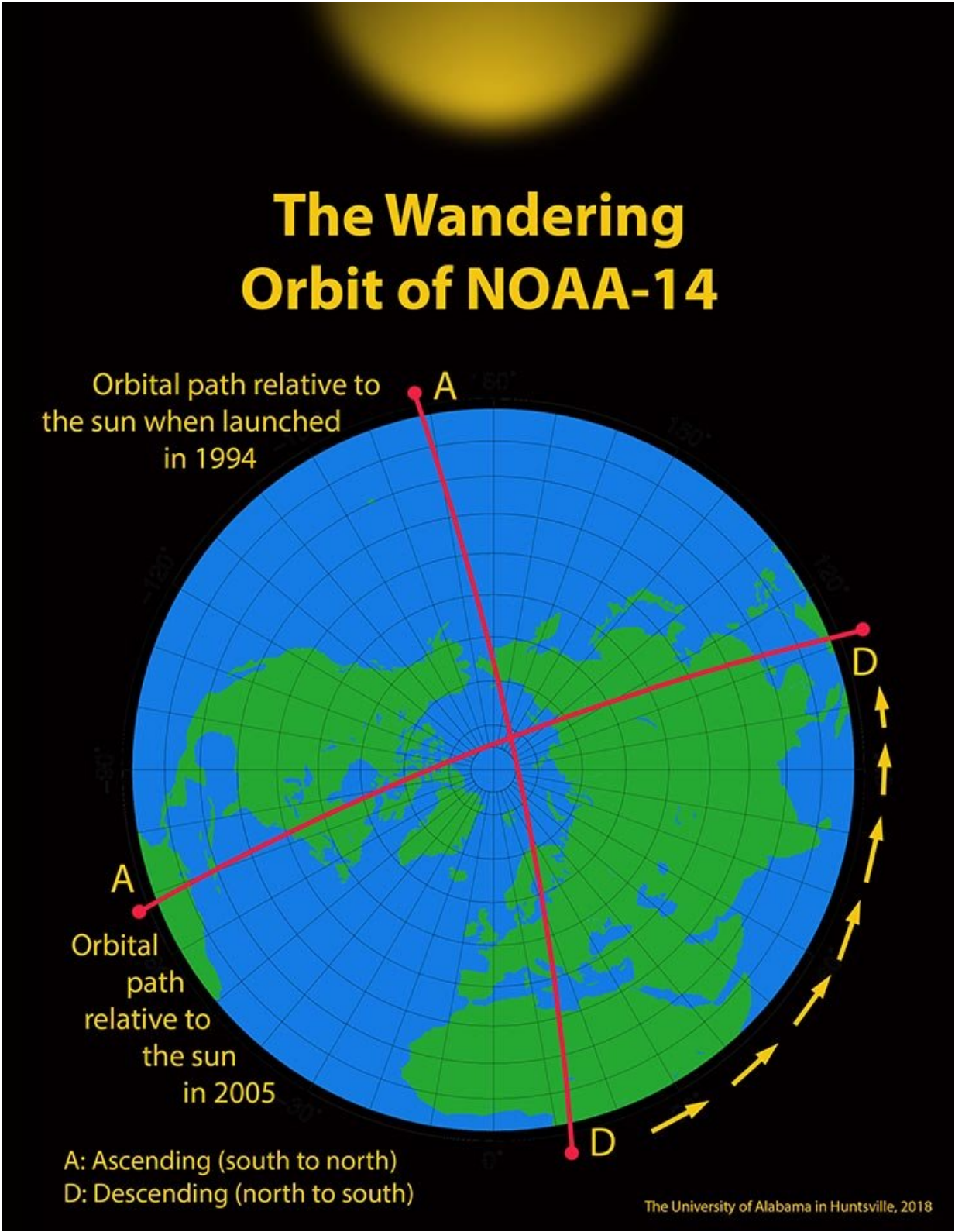


Weather satellite wanders through time, space, causing stray warming to contaminate data

April 5 2018

The Wandering Orbit of NOAA-14



Credit: University of Alabama Huntsville

In the late 1990s, the NOAA-14 weather satellite went wandering through time and space, apparently changing the record of Earth's climate as it went.

Designed for an orbit synchronized with the sun, NOAA-14's orbit from pole to pole was supposed to cross the equator at 1:30 p.m. on the sunlit side of the globe and at 1:30 a.m. on the dark side, 14 times each day. One of the instruments it carried was a microwave sounding unit (MSU), which looked down at the world and collected data on temperatures in Earth's atmosphere and how those temperatures changed through time.

By the time NOAA-14 was finishing its useful life in 2005, however, it had strayed eastward from its intended orbit until it was crossing the equator not at 1:30 but at about 8:00. That pushed its early afternoon passage until after dark and its middle of the night measurements until well after dawn.

Because local temperatures typically change between 1:30 and 8:00, this introduced spurious temperature changes that had to be calculated and removed from long-term temperature datasets that use data from [satellite](#) instruments.

The drift also changed the satellite's orientation relative to the sun, so that instead of instruments being shielded from sunlight in a consistent way, the sun's rays peaked into unshielded and open crevices and other places where intense sunlight could influence the sensors. It warmed the MSU, which caused it to look at the atmosphere's mid-troposphere (from the surface up to about 40,000 feet) as very slightly warmer than it actually was relative to its initial 1:30 crossing time.

Using data from weather satellites that stayed closer to home than

NOAA-14, scientists in the Earth System Science Center (ESSC) at The University of Alabama in Huntsville (UAH) have calculated how much false warming NOAA-14 reported so the false warming could be removed from a long-term global atmospheric temperature record collected by MSU's on satellites since mid-November 1978.

Details of that research have been published in the *International Journal of Remote Sensing*.

The wandering satellite became an issue when Dr. John Christy, director of UAH's ESSC and lead author of the study, and Dr. Roy Spencer, an ESSC principal research scientist, were updating and revising UAH's satellite-based global temperature [dataset](#). (Version 6.0 was completed in 2016.) While they knew NOAA-14 had strayed from its path, a closer look showed the warming reported by the MSU on NOAA-14 was out of kilter with temperature data collected by instruments on other NOAA satellites. This seemed to be especially true in the tropical mid-troposphere.

NOAA-14 was "drifting more than any other spacecraft used in this dataset," said Christy.

"We were looking at 39 years of a temperature trend, and this stray satellite affected the trend by about 0.05 degrees Celsius (about 0.09° F) per decade," said Christy said. "Over 39 years, that would be a total warming of about 0.2 C, or more than one-third of a degree Fahrenheit. And this problem occurred, almost all of it, in the 1990s and the early 2000s.

"An important piece of evidence pointing to a problem with the NOAA-14 satellite was its warming relative to the new NOAA-15 satellite that came in at the end of the 1990s," Christy said.

To measure the scale of the problem after the UAH satellite dataset was finalized, the ESSC team started with a subset of U.S. weather balloons that hadn't changed either instruments or software during at least a major part of the period NOAA-14 was in orbit. Weather balloons are a useful tool for benchmarking against the satellite data because both collect temperatures from the surface up through deep layers of the atmosphere.

When the U.S. balloons showed less warming than the MSU on NOAA-14, Christy expanded the study to include a group of Australian [weather balloons](#) that also hadn't changed instruments during a major part of the time NOAA-14 was in orbit.

"This gave us two reputable datasets that are widely separated across the Earth's surface," Christy said. "Then we also looked at homogenized data from independent groups that correct balloon datasets."

That data from NOAA, the University of Vienna and the University of New South Wales was added to data from three other groups—the European Center for Medium Range Forecasts, the Japan Climate Research Group and NASA—that "reanalyze" global weather data, correcting for flaws and problems.

UAH even created its own homogenized balloon dataset from raw balloon data archived by NOAA, which came from 564 stations around the world.

"We tried to understand the situation by inter-comparing against as many individual, independent datasets as possible," Christy said. "We know no dataset is perfect, so comparing against various sources is a key part of dataset analysis. This allows us to zero in on places with the greatest discrepancy. We found the largest difference between the UAH dataset versus other satellite datasets—and even some with balloons—was found in the 1990s and early 2000s, the period of NOAA-14."

And NOAA-14 was showing more warming than any of the balloon datasets, as well as more warming than NOAA-12 or NOAA-15, each of which overlapped NOAA-14 at some point during its time in service. They also compared temperature data from NOAA-15 to data from NASA's orbit-stabilized AQUA satellite.

When the UAH team, led by Spencer, Christy and W. Daniel Braswell, built the Version 6.0 UAH dataset in 2016, they serendipitously did two things that limited the drift's influence.

"First, we stopped using NOAA-14 in 2001, when it had drifted to 5 p.m.," Christy said. "In our view, that was just too much drift to have confidence an accurate correction could be found."

They also applied an algorithm that minimized the differences between the satellites, largely removing the NOAA-14 drift relative to the other satellites.

This resulted in a long-term mid-troposphere warming trend in the tropics of about 0.082 C (about 0.15° F) from late 1978 to 2016. This compares well with the +0.10 C (± 0.03 C) per decade trend found by other sources that weren't exclusively satellite based.

The way UAH built its dataset and accounted for these issues is unique among the four major satellite temperature datasets. The other three datasets still include all of the NOAA-14 data and show warming trends greater than the trend shown in the UAH dataset.

Other satellite-only [temperature](#) datasets report tropical mid-troposphere warming trends ranging from +0.13 to +0.17 C per decade.

"Not realizing it at the time, the methods we used to build the newest dataset appear to have dealt with a discrepancy that came to light

through this inter-comparison study," Christy said.

Note: This is not the lower tropospheric data or long-term [warming](#) trend reported each month for more than 27 years in UAH's Global Temperature Report. The lower troposphere extends from the Earth's surface to an altitude of about eight kilometers (more than 26,000 feet).

Because most low Earth orbiting satellites tend to stray somewhat from their intended orbits, new NOAA polar-orbiting weather satellites scheduled for launch in coming years will carry the extra fuel needed to keep them closer to home throughout their time in space.

More information: John R. Christy et al. Examination of space-based bulk atmospheric temperatures used in climate research, *International Journal of Remote Sensing* (2018). [DOI: 10.1080/01431161.2018.1444293](#)

Provided by University of Alabama in Huntsville

Citation: Weather satellite wanders through time, space, causing stray warming to contaminate data (2018, April 5) retrieved 18 April 2024 from <https://phys.org/news/2018-04-weather-satellite-space-stray-contaminate.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.