

Denying Global warming equals choosing to be blind

by

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It's sometimes said that modern science spends too much time on the documentation of a new trend and too little time on the replication of old ones. A new paper published Wednesday in the open-access journal *Science Advances* is important just because it does the latter. In fact, it sheds light on the scientific process in action—and also reveals how climate-change denialists can muddy that process.

Here's the big takeaway from the new study: *Across the planet, the ocean surface has been warming at a steady clip over the past 50 years.*



This warming trend shows up whether the ocean is measured by buoy, by satellite, or by autonomous floating drone. It also shows up in the global

temperature dataset created and maintained by the National Oceanic and Atmospheric Administration (NOAA).

In fact, the warming shows up in both datasets in essentially the same way. This is important because it confirms the integrity of the NOAA dataset—and adds further evidence to the argument that ocean temperatures have steadily warmed this century without a significant slowdown.



Zeke Hausfather is an energy systems analyst and environmental economist with a strong interest in conservation and efficiency. He was previously the chief scientist at C3, an energy management and efficiency company. He also cofounded Efficiency 2.0, a behavior-based energy efficiency company. He received a bachelor's degree from Grinnell College, a master's degree in environmental science from Vrije Universiteit in Amsterdam in the Netherlands, and another master's degree in environmental management from the Yale School of Forestry and Environmental Studies. He has published papers in the fields of environmental economics, energy modeling, and climate science.

“Our results essentially confirm that NOAA got it right,” says **Zeke Hausfather**, a researcher and economist at the University of California Berkeley. “They weren’t cooking the books. They weren’t bowing to any political pressure to find results that show extra warming. They were a bunch of scientists trying their hardest to work with messy data.”

Here’s why the finding matters: In June 2015, NOAA published an update to its long-running dataset of historical global temperatures. Thomas Karl, the director of the National Centers for Environmental Information, and his

colleagues at NOAA explained in a paper in Science that the old database had a critical flaw. In trying to merge temperature readings taken by ships and buoys, NOAA had been allowing “cooling bias” to seep into its numbers.

Sea surface temperature (SST) records are subject to potential biases due to changing instrumentation and measurement practices. Significant differences exist between commonly used composite SST reconstructions from the National Oceanic and Atmospheric Administration’s Extended Reconstruction Sea Surface Temperature (ERSST), the Hadley Centre SST data set (HadSST3), and the Japanese Meteorological Agency’s Centennial Observation-Based Estimates of SSTs (COBE-SST) from 2003 to the present. The update from ERSST version 3b to version 4 resulted in an increase in the operational SST trend estimate during the last 19 years from 0.07° to 0.12°C per decade, indicating a higher rate of warming in recent years. We show that ERSST version 4 trends generally agree with largely independent, near-global, and instrumentally homogeneous SST measurements from floating buoys, Argo floats, and radiometer-based satellite measurements that have been developed and deployed during the past two decades. We find a large cooling bias in ERSST version 3b and smaller but significant cooling biases in HadSST3 and COBE-SST from 2003 to the present, with respect to most series examined. These results suggest that reported rates of SST warming in recent years have been underestimated in these three data sets.

In other words, NOAA’s global temperature estimates had been too low, and its measurement of climate change was too conservative. With this newly updated data in hand, Karl and his colleagues found there had been no slowdown in global warming during the 2000s.

NOAA’s new findings disagreed with those of the U.K. Met Office, whose widely used global temperature dataset does show a slowdown in the 2000s.

So: Was there a slowdown? This is an interesting problem of some scientific interest. Researchers have pointed to El Niño, to multiyear oceanic cycles, and to the post-Soviet reforestation of Russia as possible explanations for the change.

But here’s the thing: The slowdown, or lack thereof, never threw the larger phenomenon of human-caused climate change into question. In fact, even

among the most conservative estimates, the globe kept warming right through the slowdown. The overwhelming consensus of Earth scientists is that the planet is harmfully warming due to human industrial activity. What's more, if a slowdown did occur in the 2000s, it seems to have abated now. The previous three years—2014, 2015, and 2016—have all broken the record as the hottest year ever in the modern temperature record.

But this hasn't seemed to matter in public debate, as climate-change denialists have found enormous success casting doubt on global warming by glomming onto this "slowdown" debate.

When the UN's 2013 assessment report on climate science said a slowdown seemed to have occurred, it dominated press accounts. That same report also found that global warming was real, quickly becoming irreversible, and that humans were more implicated in the phenomenon than ever—but it hardly seemed to matter. It was the slowdown that made headlines.

Perhaps this is why Representative Lamar Smith, a Republican of Texas who chairs the House Committee on Science, Space, and Technology, seized on the 2015 NOAA study. Smith rejects the existence of climate change, and he alleged that that NOAA scientists had "altered the data" in their study to get a chosen result. So in late 2015, he issued a subpoena to the agency, demanding all emails related to the study. Several months later, he expanded the demand again, requiring all documents and communications that included the words "temperature," "change," "climate," "Obama," "buoy," "Karl," "ship," and "Paris."

During this time, Smith falsely represented the research on the topic. He said climate data had "clearly showed no warming for the past two decades," which is not true. And when a new paper arguing for a slowdown during a different time period came out last year in *Science*, Smith said that it "confirms the halt in global warming."

But that paper showed no halt—it only argued for the slowdown. And its authors specifically wrote: "We do not believe that warming has ceased." There is no valid scientific debate about a "halt," but Smith seemed to be trying to manufacture one.



***Andrew A. Rosenberg** is director of the Center for Science and Democracy at the Union of Concerned Scientists. He has more than 25 years of experience in government service, academic and non-profit leadership. He is the author of scores of peer-reviewed studies and reports on fisheries and ocean management and has published on the intersection between science and policy making.*

The Center for Science and Democracy, a nonpartisan advocacy group for scientists in the civil service, said that Smith was harassing NOAA for doing its job. “The use of a sledgehammer of a congressional subpoena to cast so wide a net is unprecedented and unjustified,” said **Andrew Rosenberg**, its director, in a letter to the House committee.

In June of this year, Smith responded by issuing a subpoena to the Center’s parent organization, the Union of Concerned Scientists. The non-profit said that Smith was well outside his legal authority, and it declined to respond.

Which brings us back to the new study. It finds that Smith was wrong: NOAA’s results are scientifically defensible, and its global temperature records match those prepared by different means. It does this by comparing NOAA’s record to all the smaller, highly reliable records that constitute it.

“The way that NOAA makes an ocean record is they take data from a lot of different sources, and they smash it all together into a single record. They do this so they can have a long, continuous record back to 1880 or so,” Hausfather told me.

Creating a record from 1880 is difficult, however—especially for the oceans, where there are no long-standing weather stations. Scientists have to piece

disparate historical records together over time. This is a typical problem in climate science, but it's typical that some of those constituent datasets impose slightly different biases on the data.

Before the 1990s, most of NOAA's ocean-temperature records came from ships logs. Ships are tricky because they have historically measured the sea surface in different ways. During the mid-20th century, most sailors measured the water temperature using "bucket measurements": They hauled a bucket over the side, dipped it in the water, brought it up, and put a thermometer in it.

More recently, most ships measure the ocean temperature mechanically through an "engine-intake valve." Ships pump water into their hull in order to cool the engine room, and a thermometer measures its temperature on the way. This can introduce bias to the numbers, though: Because engine rooms get hot, engine-intake-valve readings are skewed warmer than the actual ocean.

That's partly why, since the 1990s, the governments of the world have deployed a fleet of new sensors to measure the changing sea. Buoys, satellites, and autonomous sensors called Argo floats all patrol the ocean and measure its conditions. This has dramatically changed the makeup of NOAA's temperature record: Whereas 95 percent of NOAA's readings came from ship engine rooms in the early 1990s, 85 percent now come from buoys.

The fleet has provided a wealth of new data for climate science. But it also provokes the central scientific question of the NOAA study. Given the same patch of ocean, a thermometer on a buoy will produce a colder measurement than a thermometer on an engine-intake valve. This introduces some bias to the record—bias which, for years, NOAA never corrected.

Think of what was happening in historical context: At the same time the oceans were supposedly experiencing a slowdown in warming, NOAA transitioned from mostly ships to mostly using buoys. The underlying ocean may still have been warming, but NOAA's record was diluted by thermometers inclined to be cooler and cooler.

"The problem was, NOAA previously was just sticking the buoy data in with the ship data—and not accounting for the fact that the buoy data was about a tenth of a degree cooler than the ship," says Hausfather.

This was Karl's insight: He and the NOAA team found that, once this discrepancy was corrected for, the slowdown disappeared from their record. In fact, removing this discrepancy was the main focus of their infamous 2015 study.

The team behind Wednesday's Science Advances paper wanted to test this idea. There's all this disagreement over correcting for bias, they thought. What if you looked only at records that didn't need to be corrected? So Hausfather and his colleagues compared the new NOAA data to what they call "instrumentally homogenous records"—that is, records created by sensors that did not change throughout the period in question. In this case, those sensors are free-drifting buoys, Argo floaters, and infrared-sensing satellites.

What they found is that the single-instrument records matched the new NOAA global temperature records almost precisely. Almost all the single-instrument records showed that the pre-2015 NOAA records had a cooling bias. They also showed a slight cooling bias in the more popular U.K. database.

Specifically, data from the buoys and satellites agree with the NOAA record nearly perfectly. Those records are considered the most reliable, and they cover the entire period studied. The Argo data covers the shortest amount of time—only 11 years—so the authors used three different global realizations of the same raw data. Two of the three of those sets found that NOAA's data may have been too cool. The third "was more ambiguous," write the authors.

And that means they showed no global warming slowdown.

"There's no evidence from a statistical standpoint that temperatures over the last 15 years have been warming any slower than temperatures over the last 30 years or the last 50 years," Hausfather told me.

The paper has been greeted warmly by the larger climate science community, at least so far. "The laborious process in which scientists check and recheck their work and subject their ideas to peer review has led to another success," writes John Abraham, a thermal scientist who studies ocean temperatures, at The Guardian.

"This paper is another reminder why it is so important to invest in the temperature measurements that are needed to create long-term climate

records. We really need uninterrupted measurements that span many years/decades if we want to truly understand the Earth's changing climate," he adds.

It's not clear that this paper will end the scientific dispute over whether the early 2000s showed anomalous warming or not.

But it should end any spurious claims that NOAA's updates were politically motivated. And it should refocus readers on the main point: Human activity is already warming Earth and causing harmful changes to the seas, ice, weather, and land.

On that, climate science is in overwhelming agreement

blog.hotwhopper.com/2014/.../zeke-hausfather-understanding.html

www.yaleclimateconnections.org/author/zhausfather/