The sun sets over San Francisco ahead of an early summer hot spell, May 2024.

Tayfun Coskun / Anadolu via Getty Images

What's Causing the Recent Spike in Global Temperatures?

Since early 2023, the world has seen a steep rise in temperatures that scientists are struggling to explain. Our contributor Elizabeth Kolbert talked with Gavin Schmidt, NASA's top climate scientist, about possible causes of the warming and why experts cannot account for the heat.

By Elizabeth Kolbert on October 10, 2024

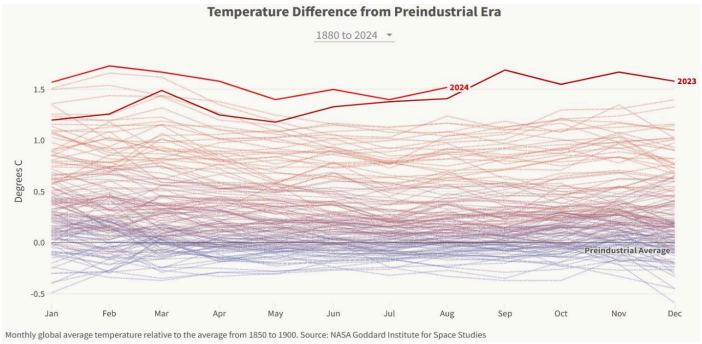
About 18 months ago, climate scientists began to notice something strange. In March of 2023, global sea surface temperatures started to rise. In a warming world, the seas would be expected to grow hotter, but the rise, which came at a time when the Pacific Ocean was in the neutral phase of the weather pattern known as the El Niño–Southern Oscillation, or ENSO, was unusually steep. In April, 2023, sea surface temperatures set a new record. They did so again in May.

As the months went on, the weirdness continued. In the summer of 2023, the world entered an El Niño, the warm phase of ENSO. El Niños typically bring higher temperatures, but in the second half of 2023, both sea surface and air temperatures increased so much that scientists were stunned. One called the figures "absolutely gobsmackingly bananas."

In an essay that appeared in *Nature* this past March, NASA's chief climate scientist, Gavin Schmidt said: "It's humbling, and a bit worrying, to admit that no year has confounded climate scientists' predictive capabilities more than 2023 has."

Officially, the El Niño ended in May 2024. But global temperatures have remained stubbornly high. This year they are expected to set yet another record.

Schmidt says that scientists still can't explain the unexpected spike in temperatures. When I talked with him recently, he called the continuing confusion "a little embarrassing" for researchers.



Scientists have identified several recent developments that could have contributed to the last year and a half of anomalous warmth. The first is a set of rules that reduced the sulfur content of the fuel used in super tankers. Since sulfur dioxide pollution reflects sunlight, this change, while good for public health, could have led to increased ocean heating.

A second potential contributor is an unusual eruption that occurred in January 2022. Normally, volcanoes emit sulfur dioxide and so produce temporary cooling. But the eruption of Hunga Tonga–Hunga Ha‘apai, an underwater volcano in the South Pacific, sent water vapor shooting into the stratosphere, which could have had a warming effect.

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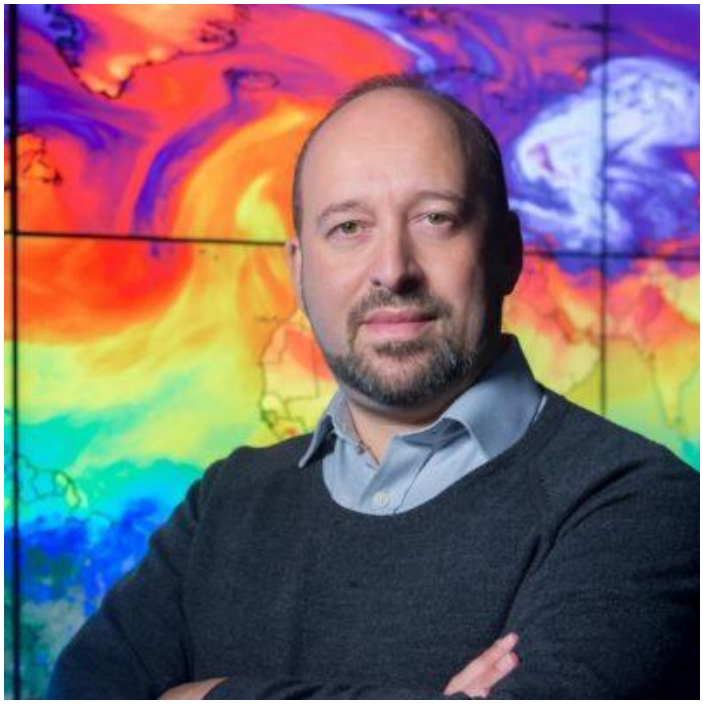
Yet another possible contributor is the solar cycle. The sun is currently at, or near, a peak of activity, and this, too, could be boosting temperatures.

At this point, though, Schmidt says, none of these developments — or even a combination of all of them — seems sufficient to explain the heat. This, in turn, raises several other possibilities. The recent temperature run-up could be the result of some development that’s yet to be identified. Or it could mean the climate system is more unpredictable than was thought. Alternatively, it could indicate that something is missing from climate models, or that amplifying feedbacks are kicking in sooner than the models had predicted.

I spoke with Schmidt, who is the director of NASA’s Goddard Institute for Space Studies, over Zoom.



Gavin Schmidt. NASA

Elizabeth Kolbert: When did people like you start to say, “Okay, there’s something going on here that is not what I expected?”

Gavin Schmidt: We started to see something eyebrow-raising in the spring in 2023. We expected that 2023 would be another warm year because all of the years are warm now, but it probably wasn’t going to be a record-warm year. So when the records started to be broken, first in the North Atlantic in March and April, June, and then the global mean in June, and then throughout the rest of the year, and then absolutely ridiculously large record-breaking events in the fall — August, September, October, November — people started using adjectives that scientists don’t generally tend to use.

At the end of 2023, we summed it up: It was a record warm year and it was a record-breaking size of the record. Our eyebrows at this point were rolling over the top of our heads. It was clear that the predictions that people had made at the beginning of year were all wrong. It doesn’t matter what the method was, they were all wrong, and they were all wrong by about 0.2 degrees Celsius. Now that doesn’t sound like a lot, but it’s a big deal.

You can accommodate a missed prediction in two ways. You can either say, your actual prediction was wrong. Or you can say, no, we underestimated the uncertainty.

So at the beginning of 2024, we thought: Hopefully we’ll get some more information from people doing science for all the different things that were happening. And maybe we’ll get some more analyses of the internal variability. Some of that has happened, but not in a coordinated way. And it’s still pretty much, I would say, amateur hour in terms of assessing what actually happened in 2023.

Kolbert: There was a whole list of things people thought might have contributed.

Schmidt: Right. One was a change in regulations by the International Maritime Organization, which took effect in January 2020 to clean up the fuel that was being used for shipping**.**

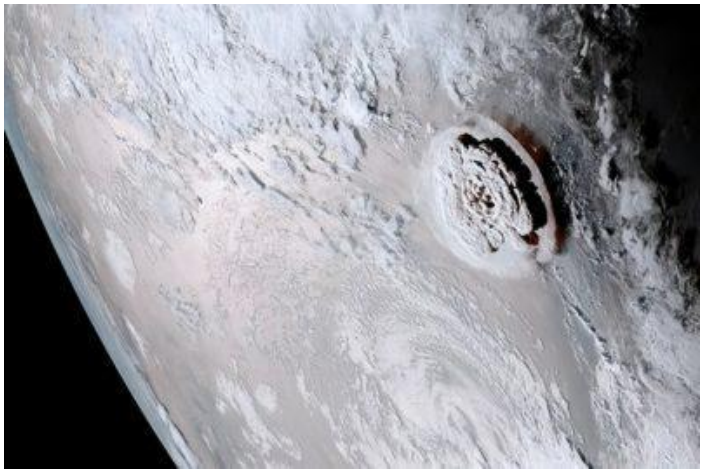
"Things are behaving in a more erratic way than we expected, and that means the future predictions may also be more off."

One other event was the eruption of the Hunga Tonga-Hunga Ha'apai volcano in the South Pacific, which was a very unusual eruption. It put a lot of water vapor into the stratosphere, which is normally super dry. That was a very new thing, and people were saying, well, maybe that's contributing.

People were also talking about unusual behavior of the Saharan dust or the wind pattern in the North Atlantic. People were talking about long-term, ongoing changes in how much pollution is coming from China and India. Maybe those things are changing faster than we anticipated. The pollution in the air is a cooling factor, and so if you take it away, then that's a warming factor.

The science that's been done has not been equally spread amongst all of those things. A lot of people have looked at the impact of the marine shipping regulation change. If you take that and you put it into some climate model and you estimate the temperature change, right now you'd expect about 0.05 of a degree, 0.08 of a degree [of warming per year**],** and then building over a decade to about 0.1 degree. So that seems like it helps, but it doesn't seem like it's sufficient. And the first paper that came out about the volcano, they said, no, no, the normal cooling volcanic pollution is still bigger than the warming water vapor component. So now I have more warming to explain and less things to explain it.

We are still waiting on the assessments of emissions from China. We don't have what's happening to pollution.



The January 2022 eruption of the underwater Hunga Tonga-Hunga Ha'apai volcano produced water vapor that could have had a warming effect. NOAA

Kolbert: We don't have it because we don't have a data collection method?

Schmidt: All of the forecast systems are now using input files that are out of date. And for some of them a lot.

Kolbert: [In March you wrote in *Nature*] that "a warming planet is already fundamentally altering how the climate system operates, much sooner than scientists had anticipated." What did you mean by that? And what are your thoughts on that now, six months later?

Schmidt: Like I said, there's two reasons why you could have messed up the prediction. One is you are missing some driving element. Another is you are underestimating the spread. Things are behaving in a more erratic way than we expected, and that means the future predictions may also be more off. And you could think of things being more off in multiple ways because the system is changing in a way where what happened in the past is no longer a good guide to what's going to happen in the future. And that's concerning. For example, we have huge industries and huge expectations based on temperature anomalies that are associated with [El Niño].

So if we predict an [El Niño] coming, then people in Africa start planting different crops. People in Indonesia start preparing for a dry season. If the connections between the rest of the world and what's happening in the tropical Pacific are changing, then all of those previous practices or recommendations based on the past relationships, maybe they're no longer any good. And if that is now the new normal, there's no new normal.

"The big uncertainty that determines whether 2100 is a happy place or a less happy place is our decisions on emissions."

But if it's the forcing from the volcano was a little bit larger than we thought, then all previous stuff is still fine, and the history is fine, and we can just make a correction for that one volcano, right? But we haven't been able to pin that down yet, and that's a little embarrassing for the community.

Kolbert: How do we resolve this?

Schmidt: We need to get updates to these input data sets.

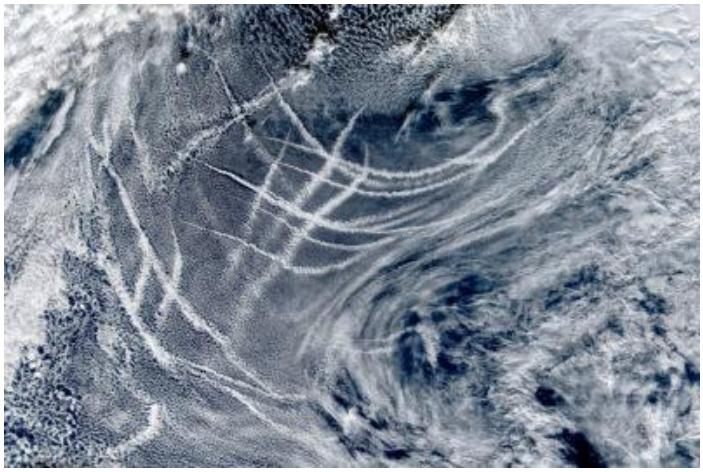
We have got 15 or 20 modeling groups ready to look at exactly at the questions that everybody seems to be interested in. And we're just twiddling our thumbs going, where's the data?

Kolbert: If things are happening faster than anticipated, that would seem to be extremely concerning.

Schmidt: It is. There are real decisions that need to be made, and we are giving people information that effectively dates from the last IPCC report in 2020. And for most things it's probably fine, but I'd feel a lot more confident if we had a process in place that updated these things, not every day, but maybe once a year.

Kolbert: What should lay people know?

Schmidt: We are going to get to 1.5 degrees a little faster than we anticipated even four years ago. I think this year it's about 50-50 whether we will reach 1.5 degrees in the [NASA Goddard Institute for Space Studies] temperature record.



A satellite view of ship trails in the North Pacific. New limits on pollution have resulted in fewer trails, which have a cooling effect. NASA

Kolbert: I know that people like you don't like to answer questions like this, but I'm going to ask you anyway, since I believe you're sitting at home, and maybe that's even a picture by your daughter behind you. What concerns you most as a dad about the data that you've seen over the last year and a half?

Schmidt: My daughter was born in 2015, which means that she may well live to 2100. So the projections that we make, she'll see how that all works out.

We are looking at very, very small amounts of tea leaves to try and predict the future. What happened this month? What happened last month? What was going on in Sahara? What was going on in the Antarctica?

But the big uncertainty that determines whether 2100 is a happy place or a less happy place is our decisions on what we do with emissions. And they dwarf the uncertainties that we're talking about here. We're talking 0.1, 0.2 degrees. Well, the difference emissions make is 1 degree, 2 degrees, 3 degrees. So it's an order of magnitude larger. And given the non-linearity of impacts, that's a much, much larger amount of impact that we would see.

Having things happen faster [than anticipated] might encourage people to act more aggressively, or reaching 1.5 degrees might cause people to stop bothering. That's very difficult to predict. I have this feeling that what we're doing will influence these decisions, but I don't know how it will influence these decisions. And so my best plan is just to do the best that we can in terms of the science and hope that by knowing more about the system, people will make better choices. But obviously that's hopelessly naive.

Kolbert: One has to cling to what one's got.

Schmidt: I mean, if we really felt that people would make better decisions without information, you would not be a journalist. I would not be a scientist. We would not believe in democracy.

Elizabeth Kolbert is a regular contributor to *Yale Environment 360* and has been a staff writer for the *New Yorker* since 1999. She won the 2015 Pulitzer Prize for general nonfiction for *The Sixth Extinction: An Unnatural History*, which was based in part on reporting she did for *Yale Environment 360*. Her latest book is *Under a White Sky: The Nature of the Future*.