

involving collective action, such as volatile demonstrations over government land grabs in Fujian province. Others responded to events involving no collective action, like a corruption investigation of a provincial vice governor. For each event, the assistants authored both pro- and antigovernment posts.

Within the same period, the researchers found, posts advocating collective action were between 20% and 40% more likely to be censored than were posts not advocating it. Posts critical of the government, on the other hand, were not significantly more likely to be censored than supportive posts—even when they called out leaders by name. “Criticisms of the state are quite useful for the government in identifying public sentiment, whereas the spread of collective action is potentially very damaging,” Roberts explains. China’s so-called Jasmine Revolution, in which protesters inspired by the Arab Spring in early 2011 called for democracy, is a case in point. Many sites promptly blocked words like “jasmine” and “Egypt.”

To trawl for insights into how the censorship machine works, the researchers set up a bulletin board system—a popular type of community forum in China—and asked for advice about “how to stay out of trouble with the Chinese government,” King says. Staff at the software platform they used cheerfully answered questions posed online and by phone. (The trio “didn’t advertise that we were Harvard researchers,” King says, and no one asked their identities.) One piece of advice was to muscle up on staff who can watch for troublesome posts: Even when a site uses automated review, King says, most posts are still vetted by a pair of eyeballs.

The Harvard team didn’t demystify the process entirely. Yu Xie, a sociologist at the University of Michigan, Ann Arbor, says that although the study is methodologically sound, it overemphasizes the importance of coherent central government motives. Political outcomes in China, he notes, often rest on local officials, who are evaluated on how well they maintain stability. Such officials have a “personal interest in suppressing content that could lead to social movements,” Xie says.

One factor that complicates any study of censorship in China is a rapidly shifting social media landscape. Local governments now frequently insert themselves into conversations as well as control them. And the study omitted WeChat, a burgeoning social network set up by Chinese Internet giant Tencent that combines features from Facebook and the mobile application WhatsApp. Earlier this year, the app started censoring keywords and in some cases deleting entire accounts. That, King says, may be fodder for future studies. ■

CLIMATE CHANGE

Is Atlantic holding Earth’s missing heat?

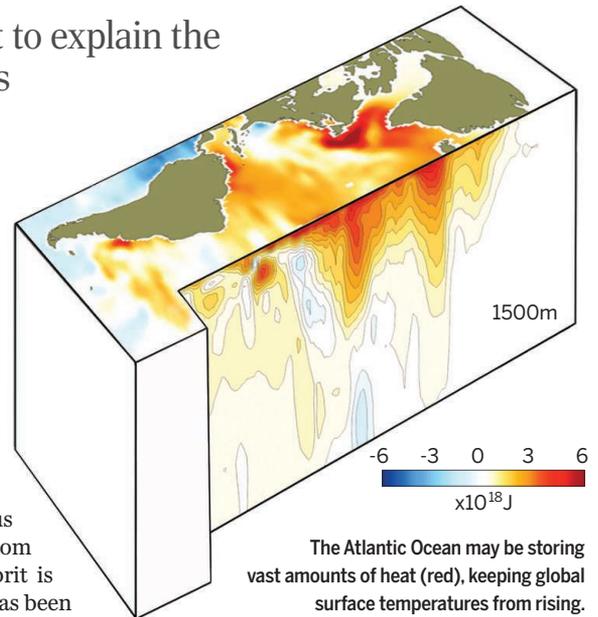
New leads in the hunt to explain the global warming hiatus

By Eli Kintisch

Armchair detectives might call it the case of Earth’s missing heat: Why have average global surface air temperatures remained essentially steady since 2000, even as greenhouse gases have continued to accumulate in the atmosphere? The suspects include changes in atmospheric water vapor, a strong greenhouse gas, or the noxious sunshade of haze emanating from factories. Others believe the culprit is the mighty Pacific Ocean, which has been sending vast slugs of cold bottom water to the surface.

But two fresh investigations finger a new suspect: the Atlantic Ocean. One study, on page 897 of this issue of *Science*, presents sea temperature data implying that most of the missing heat has been stored deep in the Atlantic. The other, published online on 3 August in *Nature Climate Change*, suggests a warming Atlantic is abetting the Pacific by driving wind patterns that help that ocean cool the atmosphere. Together, the papers “raise the tantalizing possibility” that the Atlantic is playing a major role in the warming hiatus, says climate dynamicist Shang-Ping Xie of the University of California, San Diego, who was not involved in the studies.

Some climate specialists remain skeptical. In a third recent paper, published



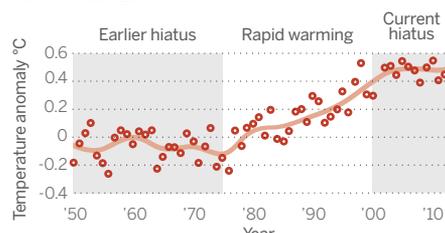
online in *Nature Climate Change* on 17 August, other researchers argue that the Pacific remains the kingpin. “It’s the Pacific driving the Atlantic, not the other way around,” says one of the authors, climate dynamicist Kevin Trenberth of the National Center for Atmospheric Research in Boulder, Colorado.

The new *Science* study, from oceanographer Xianyao Chen of the Ocean University of China in Qingdao and atmospheric scientist Ka-Kit Tung of the University of Washington, Seattle, draws on tens of millions of ocean temperature and salinity measurements taken globally by buoys, floats, and ships since 1970. The data, which cover 24 depths from the sea surface down to 1500 meters, enabled the researchers to calculate how the heat content of ocean water (a measure of stored energy) has changed over time. They found that, during the hiatus, the Atlantic has been absorbing heat that would have otherwise warmed the surface. Over the last 14 years, they write, water below 300 meters in the North and South Atlantic oceans has stored more energy than the rest of the global oceans combined. “We found the missing heat,” Chen concludes.

A key heat storage mechanism, they say, is the “conveyor belt” current that moves salty tropical water to the North Atlantic, where it sinks, carrying heat with it. Chen and Tung think that, because of a

Warming takes a pause

After a rapid rise, global mean temperatures have stabilized.



Source: Xianyao Chen/Ka-Kit Tung

natural cycle, the conveyor sped up during the 1990s and slowed around 2006. Atlantic heat storage has meanwhile “gone straight up” by 30 zettajoules (sextillion joules) since 1999, while global air temperatures remained relatively flat, Tung says. In contrast, their data show little heat being stored in the deep Pacific. “We were surprised—especially by the difference between the two oceans,” Chen says.

One reason some scientists remain convinced the Pacific is behind the hiatus is a measured speedup in trade winds that drive a massive upwelling of cold water in the eastern Pacific. But there, too, the Atlantic may be responsible, modeling experiments suggest. In the 3 August *Nature Climate Change* study, scientists fed measurements of the Atlantic’s warming surface temperatures into a global climate simulation. The result was a “seesaw” in which air rose over the Atlantic and fell toward the Pacific, fueling the Pacific trade winds, says climate dynamicist Axel Timmermann of University of Hawaii, Manoa, a co-author. The resulting increase in Pacific upwelling could be responsible for a global cooling effect of between 0.1° and 0.2°C, researchers have estimated, enough to explain a healthy chunk of the hiatus.

The evidence for the central role of the seesaw mechanism isn’t conclusive, some climate researchers say. And in the 17 August *Nature Climate Change* study, a team led by Trenberth suggests that natural variability in the Pacific explains more than half of the hiatus. Based on data and climate simulations, they argue that a pattern known as the Pacific Decadal Oscillation, which shifts every 20 to 30 years, is driving the increased upwelling as well as other climate trends, including the rapid warming of the Arctic and recent cold winters in Europe.

A consensus about what has put global warming on pause may be years away, but climate scientist Judith Curry of the Georgia Institute of Technology in Atlanta applauds how the debate is forcing scientists to grapple with a long-standing challenge: reconciling human-caused warming with the random wiggles in the global climate system. The hunt for the missing heat also helps scientists respond to global warming misinformation, says climate scientist Michael McPhaden of the National Oceanic and Atmospheric Administration in Seattle. “Climate change denialists have made hay with [the hiatus] in an attempt to discredit the science and confuse the public,” he writes in an e-mail.

The recent papers confirm that Earth’s warming has continued during the hiatus, McPhaden notes, at least in the ocean depths, if not in the air. ■



A child in Ivory Coast gets the Salk vaccine.

PUBLIC HEALTH

A one-two punch against polio

The once-sidelined injected vaccine could boost eradication

By Leslie Roberts

In 1988, the world set out to eradicate polio with two drops of a sugary vaccine. Compared with the injected vaccine used in wealthy countries, the live oral polio vaccine (OPV) developed by physician Albert Sabin in the 1950s was cheap—pennies as opposed to dollars a dose—and easy to use, which made it well-suited for massive immunization campaigns in poor countries where polio persisted. OPV has another benefit as well: It not only prevents paralytic disease, as does the injectable vaccine, but also blocks infection and transmission of the virus—key to wiping it out. But in the dirty, crowded corners of the world where the poliovirus hangs on, as many as 10 separate doses of OPV might be needed to confer immunity. Those areas are often tumultuous and conflict-ridden—think of northern Nigeria and the tribal areas of Pakistan—making it difficult to stage repeated vaccination campaigns.

Now, two new studies suggest that the injectable polio vaccine, sidelined long ago in the eradication effort, may offer a way out of the impasse. Published today on page 922 and online in *The Lancet* on 11 July, they show that in kids who have already received multiple doses of OPV, adding a shot of Jonas Salk’s inactivated polio vaccine (IPV) can be more effective at stopping polio transmission than another dose of OPV.

Together with an early test of this combination vaccine strategy last year in a refugee camp in Kenya, the new findings could give IPV an expanded role in the Global Polio Eradication Initiative (GPEI). “This is the evidence the program has been waiting for,” says Nicholas Grassly, an epidemiologist at Imperial College London and a co-author on both studies. John Modlin, deputy director of the polio program at the Bill & Melinda Gates Foundation, which funded the *Lancet* study, adds that the results suggest IPV “can play a major role in completing the goal of eradication.”

Since 1988, billions of doses of OPV have been delivered in door-to-door campaigns, to remarkable effect: Global polio cases have dropped more than 99%. Wealthy countries, meanwhile, turned away from OPV because it contains live but weakened virus, which has the potential to revert to its disease-causing form. In those countries IPV, which contains only killed virus, became the vaccine of choice.

Because of the risk of outbreaks sparked by the vaccine, the use of OPV must be stopped as eradication nears. In anticipation, the World Health Organization (WHO) has called on all countries to introduce at least one dose of IPV into routine immunization by the end of 2015. But the new studies may persuade many public health experts that IPV should be brought into the polio-fighting armamentarium even before the war is won.