

► before the industrial revolution. But since the Hawaiian measurements began, the values have followed an upward slope that shows no sign of levelling off (see ‘On the rise’). Emissions of other greenhouse gases are also increasing, pushing the total equivalent concentration of CO₂ in the atmosphere to around 478 p.p.m. in April, according to Ronald Prinn, an atmospheric scientist at the Massachusetts Institute of Technology in Cambridge.

Data compiled by Le Quéré and other members of the Global Carbon Project suggest that humans contributed around 10.4 billion tonnes of carbon into the atmosphere in 2011. About half of that is taken up each year by carbon ‘sinks’ such as the ocean and vegetation on land; the rest remains in the atmosphere and raises the global concentration of CO₂.

“The real question now is: how will the sinks behave in the future?” says Gregg Marland, an environmental scientist at Appalachian State University in Boone, North Carolina, who helps to compile the emissions data.

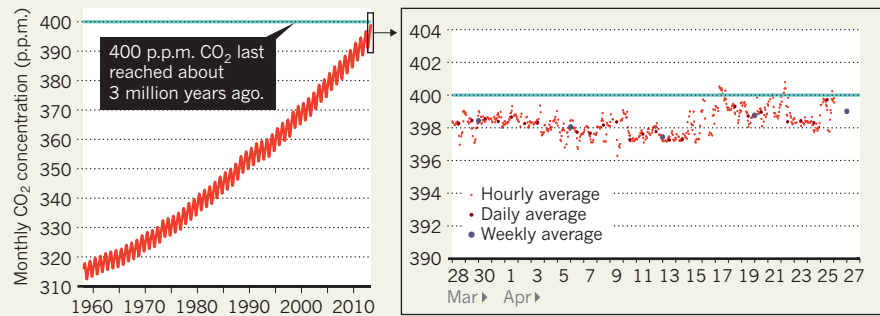
The sinks have grown substantially since Keeling began his measurements, when carbon emissions totalled about 2.5 billion tonnes a year. But climate models suggest that the land and ocean will not keep pace for long.

“At some point the planet can’t keep doing us a favour, particularly the terrestrial biosphere,” says Jim White, a biogeochemist at the University of Colorado Boulder. As the sinks slow down and more emitted CO₂ stays in the atmosphere, levels will rise even faster.

Some researchers have suggested that the sinks have already started to clog up, reducing their ability to take up more CO₂ (J. G. Canadell *et al. Proc. Natl Acad. Sci. USA* **104**,

ON THE RISE

Measurements of atmospheric CO₂ levels at Mauna Loa, Hawaii, show that the greenhouse gas has accumulated steadily, and spiked above 400 parts per million (p.p.m.) several times in April.



18866–18870; 2007). Others disagree.

Ashley Ballantyne, a biogeochemist at the University of Montana in Missoula, worked with White and others to examine records of emissions as well as CO₂ measurements made around the globe. They found no signs of sinks slowing down (A. P. Ballantyne *et al. Nature* **488**, 70–72; 2012). But it is difficult to be sure, says Inez Fung, a climate modeller at the University of California, Berkeley. “We don’t have adequate observing networks.” The largest global network, operated by the US National Oceanic and Atmospheric Administration, had to trim 12 stations in 2012 because of budget cuts.

Some of the most crucial areas, such as the tropics, are also the least monitored, although researchers are seeking to fill in the gaps. Scientists from Germany and Brazil are building a 300-metre tower to keep tabs on the Amazon (see *Nature* **467**, 386–387; 2010). And Europe’s Integrated Carbon Observation System is

setting up stations throughout the continent and at some marine sites to measure CO₂ and other greenhouse gases.

Satellites, too, could monitor carbon sources and sinks. Two orbiters are already providing some data, and NASA plans to launch the much anticipated Orbiting Carbon Observatory-2 next year (see page 5). An earlier version of that satellite failed during its 2009 launch.

Even as new resources come online, however, researchers are struggling to keep the Mauna Loa station going. “The amount of money that I’m able to obtain for the programme has diminished over time,” says Keeling, whose group monitors CO₂ concentration at 13 sites around the world.

“It’s kind of silly that we chose to go all ostrich-like,” says White of the funding difficulties. “We don’t want to know how much CO₂ is in the atmosphere, when we ought to be monitoring even more.” ■

GENETICS

Flu papers spark row over credit for data

Rush to publish on H7N9 avian flu upsets Chinese scientists.

BY DECLAN BUTLER AND DAVID CYRANOSKI

On 31 March, China reported the first human cases of infection with a new H7N9 avian flu virus. The same day, a team at the Chinese National Influenza Center (CNIC) in Beijing uploaded to a research database the genetic sequences of viruses isolated from the first three human cases. But *Nature* has learned that in the days that followed, Chinese scientists and officials grew increasingly concerned that China might lose credit for its work in isolating and sequencing the virus.

The sequences were placed in the Global Initiative on Sharing All Influenza Data (GISAID) database. According to the database’s rules, scientists who use sequences from it must credit those who deposited the data and, where possible, propose collaborations with them.

“Unfortunately some bad things happened when we released the sequences in GISAID, and they really hurt us,” says Yuelong Shu, head of the CNIC, which is also the World Health Organization (WHO) Collaborating Centre for Reference and Research on Influenza in China. “GISAID have tried their best to help us,” he

adds. “I really appreciate what they have done.”

Shu did not initially reveal specific concerns, but other researchers have told *Nature* some of the details. On 5 April, the Chinese scientists submitted their first major H7N9 paper, including analyses of the sequences, to *The New England Journal of Medicine* (NEJM).

Around the same time, the researchers learned that they might be scooped: several other research groups were preparing to publish papers on the virus, or already had done so, including analyses of the sequences in GISAID.

This news was followed by what seemed to be a snub. It emerged on 5 April that drug firm Novartis in Basel, Switzerland, and the J. Craig Venter Institute in Rockville, Maryland, planned to use the uploaded sequences to develop H7N9 vaccines. The initiative had US government funding and would be a collaboration with the US Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia — but not with the Chinese team. The Chinese researchers felt that this was not in the spirit of GISAID.

The sharing of flu-virus data and materials



CHINA/PHOTOPRESS/PHOTOSHOT

Chinese medical workers take part in a drill to simulate an outbreak of H7N9 flu in the population.

FLU TRACKING

A virus on the move

As the H7N9 avian influenza outbreak in China enters its fourth week, the virus has expanded its geographic range. Human cases have been reported in Fujian province, hundreds of kilometres south of the main outbreak area around Shanghai, and in the Jiangxi and Hunan provinces at similar distances to the southwest.

As of 29 April, the World Health Organization (WHO) had confirmed 126 cases, including 24 deaths, up from 104 confirmed cases on 22 April.

On 24 April, a China–WHO Joint Mission including a team of international flu experts ended a week-long investigation of the outbreak. They noted that some family

clusters of cases have occurred, which could signal either limited human-to-human spread or infection from a common source. But for the moment, there is no evidence of sustained human-to-human spread.

On the same day, the first human case outside mainland China was reported in Taiwan, but the 53-year-old man is thought to have caught the disease while on the mainland.

The outbreak is “complex and difficult and is evolving”, says Keiji Fukuda, the WHO’s assistant director-general for health security. The most probable source of the human infections is birds, particularly poultry, at live poultry markets, he says. **D.B.**

has long been a politically charged issue in global health. Timely information from potentially pandemic flu strains is crucial for efforts to monitor drug resistance and the evolution of viruses, and for the development of diagnostics and vaccines. But some countries have been reluctant to share such data because they have seen little in return in terms of collaboration, technology transfer or access to the drugs and vaccines developed as a result.

GISAID was created in 2008 to help overcome some of these concerns. “Without a mechanism like GISAID it would be very difficult for various authorities to make information available prior to publication,” says Alan Hay,

co-chair of GISAID’s scientific advisory council.

Novartis spokeswoman Liz Power says that after the company’s researchers downloaded the H7N9 sequences, it “explored research collaboration” with the Chinese CDC in Beijing, of which the CNIC is part. “We are committed to sharing any meaningful insights coming out of our work with China CDC,” she says.

Kristine Sheedy, a spokeswoman for the US CDC, acknowledges that “there were differences in understanding and expectations regarding use of the Chinese H7N9 sequence data by several outside groups”, but adds that the US CDC was not among them. The CDC has had a strong ongoing collaboration with

its counterpart in China since the start of the H7N9 outbreaks, she says.

Shu says that the Chinese researchers would have preferred for the vaccine developers to have told them in advance about how they intended to use the sequences, but adds that communication channels have now been opened and that the various parties have agreed to collaborate. “Thanks to the president of GISAID this situation was quickly mitigated,” says Shu.

Chinese worries over being scooped also seem to have been put to rest. The CNIC scientists were most concerned about a major analysis of the H7N9 virus scheduled for publication on 10 April in *Eurosurveillance* — which would have appeared before the Chinese *NEJM* paper.

A co-author on the *Eurosurveillance* paper, virologist Masato Tashiro of the Influenza Virus Research Center in Tokyo, the WHO’s influenza reference centre in Japan, says that he sent a draft of the paper to the Chinese researchers on 7 April, inviting them to be co-authors. They declined, but asked Tashiro to delay publication until after their *NEJM* paper had appeared. He agreed and the *NEJM* paper was published on 11 April (R. Gao *et al. N. Engl. J. Med.* <http://doi.org/k7r>; 2013), with the *Eurosurveillance* paper appearing later the same day (T. Kageyama *et al. Euro Surveill.* **18**, 20453; 2013). Tashiro notes that holding the paper did not have an impact on public health, because all its analyses were shared with the WHO’s global network of flu labs on 1 and 2 April, and were used to help the WHO to prepare its initial risk assessment of the virus (see ‘Flu tracking’).

“One has to recognize the sensitivities in relation to scientific priority,” says Hay, who thinks that many potential difficulties could be avoided if people spoke to each other more about their work and their publication plans.

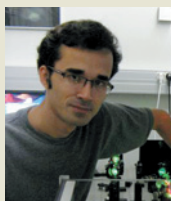
“Scientific etiquette is without doubt a key to keeping the rapid sharing of data a reality,” says Shu. In this case, he continues, “after some initial concerns we found that both researchers and publishers were understanding of our predicament”.

Hay hopes that the hiccups won’t discourage Chinese researchers from making their H7N9 data publicly accessible quickly. “It is very important to continue to share sequences from the more recent cases,” he says.

For his part, Shu says that he is keen to ensure that researchers continue to have “unfettered access to data.” ■

 **MORE ONLINE**

TOP STORY

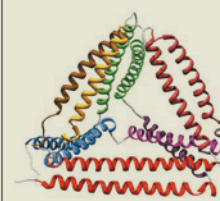


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