genetically modified (GM) organisms.

In 2014, the CBD convened an expert panel of scientists and environmentalists, with the goal of determining whether synthetic biology poses challenges to the treaty. Over the past few years, gene drives have risen to the top of the group's list of issues to tackle, notes Thomas, who sits on the panel.

It's not the first time the CBD has considered a ban on gene drives. At a meeting two years ago, multiple organizations, including the ETC Group, unsuccessfully pushed for a moratorium on the technology.

LANGUAGE DEBATE

At the meeting, negotiators will again consider controversial language that calls on signatories to "refrain from the release, including experimental release, of organisms containing engineered gene drives".

Although he supports a gene-drive moratorium, Thomas expects it to face steep opposition from some countries. Canada, Australia, New Zealand and Japan have all historically lobbied against limits on biotechnologies, he notes. Any addition to the treaty must be achieved by consensus.

Even if a gene drive moratorium is not approved, the language used is likely to frame how the CBD tackles gene drives in the future. A policy document prepared by the Outreach Network for Gene Drive Research, the group that organized the scientists' letter and which includes Target Malaria, says that countries will need to decide whether to take into account positive impacts of gene drives, and how to assess the environmental risk of any releases. Target Malaria hopes to start field trials as early as 2024.

One probable outcome of the meeting is an outline for future work on policy issues raised by organisms carrying gene drives, says Todd Kuiken, a biotechnology-policy specialist at North Carolina State University in Raleigh, who is also on the CBD's synthetic-biology panel. He says that key issues include determining whether existing guidelines for assessing risks from conventional GM organisms are suitable for those carrying gene drives, and working out how to ensure that local communities potentially affected by a gene drive are consulted first.

Because it is an existing treaty signed by most countries, the CBD is likely to remain the main forum for global discussion on the topic. But Natalie Kofler, founder of a coalition called Editing Nature formed to discuss the use of gene editing in the environment, questions whether the CBD is up to the challenge. "The conversation has become very polarized, and people are seeing it as this black-or-white issue. I think it demands so much more of us," says Kofler, a molecular biologist at Yale University in New Haven, Connecticut. "I'm not sure if the CBD is providing structure to ensure a middle-ground conversation." ■

MARIO TAMA/GETTY

Antarctic ice traps air bubbles from Earth's pre-industrial atmosphere.

ATMOSPHERIC SCIENCE

Hunt for the sky's 'detergent' begins

Ice-core team heads to Antarctica to measure past levels of chemical that scrubs atmosphere of greenhouse gases.

BY NICKY PHILLIPS

To understand how the sky cleanses itself, a team of Australian and US researchers is heading to Antarctica to track down the atmosphere's main detergent. By drilling deep into polar ice, the scientists hope to determine how the sky's capacity to scrub away some ozone-depleting chemicals and potent greenhouse gases has changed since the Industrial Revolution — information that could help to improve global-warming projections.

The first project-members travelled to Law Dome, their drilling site in East Antarctica, this week. There, they hope to capture the first historical data on concentrations of the dominant atmospheric detergent, the hydroxyl radical. This highly reactive molecule, made of an oxygen atom bonded to a hydrogen atom, breaks down about 40 gases in the air. They include methane and hydrofluorocarbons, but not the most prevalent greenhouse gas — carbon dioxide.

Researchers have used other atmospheric gases to infer the abundance of hydroxyl over the past four decades, but chemists still refer to the radical as 'the great unknown'.

"We have been more or less in the dark when it comes to how hydroxyl has evolved from pre-industrial times to present day," says Apostolos Voulgarakis, an environmental scientist at Imperial College London. "This new research endeavour can provide unprecedented information on hydroxyl variations in the deeper past, which is exciting."

Over two and a half months, the team will drill at least two ice cores — three if time allows — to depths of about 230 metres. They will then melt the cores to extract bubbles of air that were trapped as the ice froze. The samples will represent the atmosphere back to about 1880, before emissions of greenhouse gases from human activity started to increase.

Hydroxyl radicals form naturally in the atmosphere in a reaction involving ultraviolet rays, ozone and water vapour. But because the radicals last about a second before they react with other gases and break them down, as a proxy, the team will instead measure the tiny fraction of carbon monoxide that contains the carbon-14 isotope.

Carbon-14 in carbon monoxide is produced in the atmosphere by cosmic rays at a known rate, and is almost entirely removed ▶

by hydroxyl. Because of this, scientists can use the trend in its abundance to infer the trend of the radical, says David Etheridge, an atmospheric chemist at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Aspendale, Australia, and a co-leader of the drilling project.

RISKY BUSINESS

But measuring levels of carbon monoxide that contain carbon-14 is tricky, because there are only a few kilograms of it in the atmosphere, says Etheridge. "And we're trying to measure a bit of that over the last 150 years in the Antarctic ice."

There is also a risk that the ice cores will become contaminated with external sources of carbon-14 from cosmic rays. This high-energy radiation cannot penetrate the ice, but the moment the cores are removed, they are at risk of exposure. This would interfere with the signal the team is trying to measure, says co-leader Vasilii Petrenko, an ice-core scientist at the University of Rochester in New York. To avoid that risk, the researchers will melt the ice and extract the air on site.

Organizing the equipment to do this and transporting it to a remote ice sheet has been a huge logistical challenge, says team member Peter Neff, an ice-core scientist at the University of Washington in Seattle.

Tractors pulled giant sleds loaded with equipment to the Law Dome drilling site, more than 130 kilometres from the nearest research station. And it will take the team 36 days to melt the ice they need to get enough air samples. "It's a marathon, not a sprint," says Neff.

The project is co-funded by the Australian Antarctic Division and the US National Science Foundation.

Once the researchers return from Antarctica, to assess the levels of carbon-14 in carbon monoxide, the team will convert the gas into carbon dioxide and then into graphite, from which the isotope can be measured. The scientists can then use the information to infer how hydroxyl levels in the Southern Hemisphere have changed over time.

Up to now, information on historical trends in hydroxyl levels has come solely from atmospheric models; these simulations suggest that concentrations remained fairly stable from 1850 until the 1970s, when they started to rise (A. Voulgarakis *et al. Atmos. Chem. Phys.* **13**, 2563–2587; 2013). The increase was mainly because of a boost in atmospheric warming at the time, says Voulgarakis.

The data collected from Law Dome will help to determine whether the atmospheric models have captured this trend correctly, says Matt Woodhouse, a climate modeller at CSIRO, who will use the information to improve Australia's global chemistry-climate model, called ACCESS. "Our ability to resolve hydroxyl won't revolutionize climate models, but it'll increase our confidence in them."

And accurate pictures of hydroxyl's historical and current atmospheric concentrations are essential for developing better projections of its future levels, says Voulgarakis. This will then enable more-accurate projections of the future abundance of gases that affect climate — such as methane, ozone in the lowest layer of the atmosphere, and aerosols — that hydroxyl scrubs from the sky, he says. This would make it easier to determine the gases' potential contribution to global warming. ■

GEOLOGY

Volcano algorithm predicts Etna's eruptions

System tracks low-frequency waves to determine when volcano is about to erupt.

BY SHANNON HALL

Smoke filled the cabin as the Boeing 747 plunged towards snow-covered mountains in southern Alaska. All four engines had shut down, and it took the pilots eight long minutes to regain control of the aircraft. No one on board was hurt — but they had had a very close call with an erupting volcano. The jet had flown through an ash cloud.

Incidents such as this near miss from 1989 show why geologists have long sought to forecast volcanic eruptions: to protect people, whether in the air or on the ground. Now scientists are one step closer to this goal.

Maurizio Ripepe, a geophysicist at the University of Florence in Italy and his colleagues have created the world's first automated volcano early-warning system, which alerts authorities near Mount Etna in Sicily about one hour before an eruption. The team described the system in a study published last month (M. Ripepe *et al. J. Geophys. Res. Solid Earth* http://doi.org/cw6w; 2018).

The approach relies on the fact that volcanoes are noisy. Their rumblings and explosions can sound like a jet engine or even a high-pitched whistle, but they also produce low-frequency infrasound waves that people cannot hear. Unlike seismic waves, infrasound waves can travel for thousands of kilometres, allowing scientists to spot volcanic eruptions from afar. When Krakatoa, in Indonesia, erupted in 1883, its infrasound signal travelled around the globe twice.

> ***"If there is an ash cloud that has suddenly popped up, then the pilots need to know that information."***

With that in mind, Ripepe and his colleagues turned to Mount Etna, Europe's largest active volcano. At first, they wanted to create a simple system that could detect an eruption using data from an existing array of infrasound sensors, and automatically alert authorities. But their ambitions grew when they discovered that the volcano often produces infrasound waves before it erupts, making prediction possible.

Although the finding was a surprise, the scientists say that it makes sense, given that Mount Etna is an 'open-vent' volcano with exposed magma. As gas rises out of the magma before an eruption, it causes air in the volcano's crater to slosh back and forth — creating sound waves like those in a woodwind instrument. And just as the sound of a musical instrument depends on its shape, the geometry of a crater also affects the sounds it can produce.

The team created its early-warning system in early 2010 and tracked its performance during 59 eruptions over the next 8 years. The system — an algorithm that analyses infrasound signals from the sensor array — predicted 57 of those events and sent messages to the scientists about 1 hour before an eruption took place. In 2015, the scientists programmed the system to send automatic alerts to the Italian Civil Protection Department.

An automated alert system can broadcast warnings faster than can predictions that require experts to vet information beforehand, says John Lyons, a geophysicist at the Alaska Volcano Observatory in Anchorage. And time is of the essence for communities near