THE

HIGH FLYER

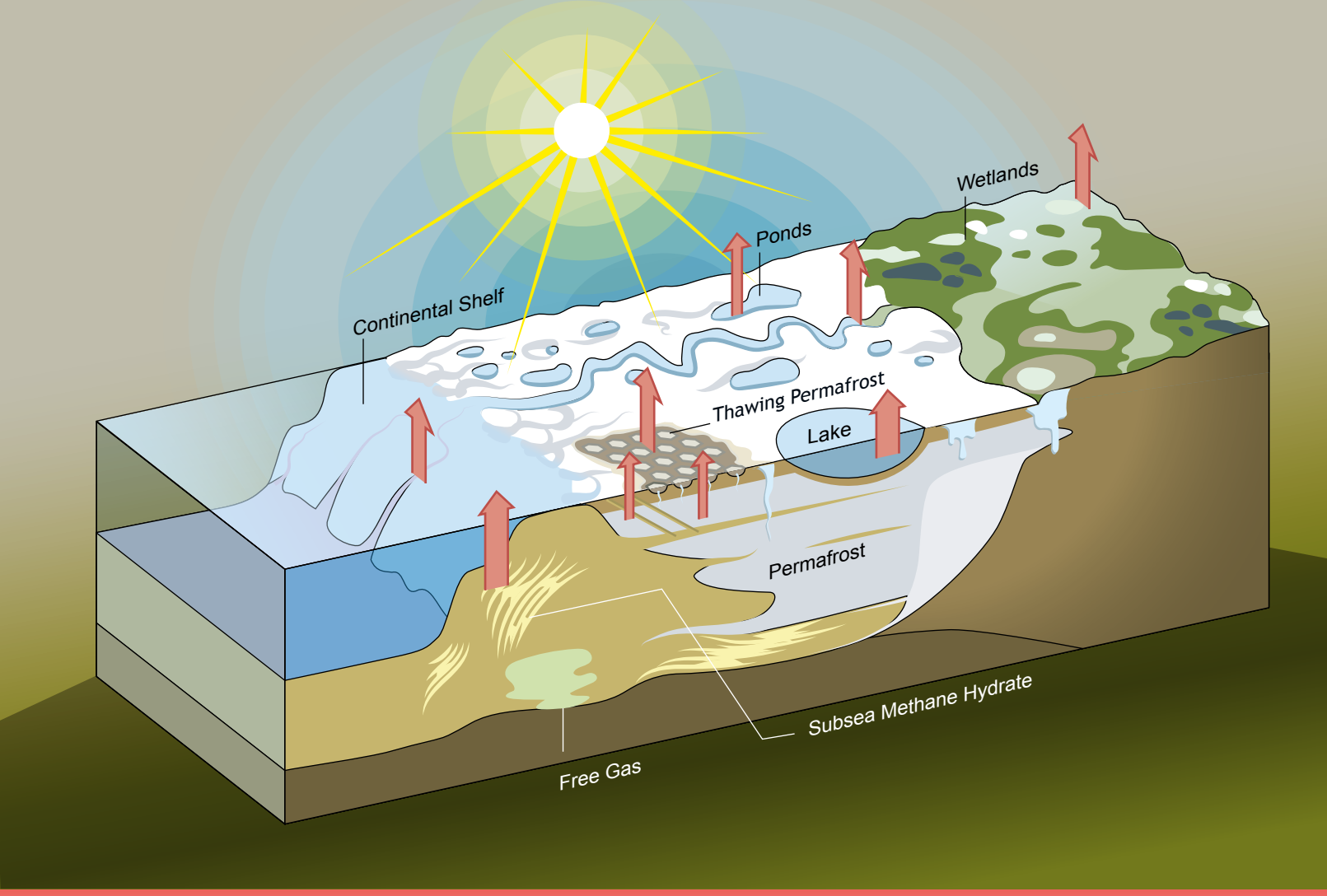
TEXT: KATJA TRIPPEL

How much methane is being emitted by Arctic permafrost and restored peatlands in northern Germany? Katrin Kohnert and her colleagues at the German Research Centre for Geosciences in Potsdam (GFZ) take to the skies to learn more about this essential climate-relevant gas.

On board the research aircraft Polar 5, environmental scientist Katrin Kohnert (small photo) has an unobstructed view of the Mackenzie Delta in northwest Canada. But she rarely has time to enjoy the view; her job is to monitor equipment that measures atmospheric methane concentrations.

Even on normal days, Dr Katrin Kohnert can't complain about her workplace: the postdoc's office at the GFZ is perched atop Potsdam's Telegrafenberg hill; surrounded by aromatic pine trees, the building is located right beside the legendary Einstein Tower observatory, where, from 1924, Germany's most famous scientist and his colleagues sought to experimentally test his gravitation theory.

But if you truly want to see Kohnert's face light up, ask her about her research trips to the Arctic. During these treks, she sits on board the Polar 5 – an old DC3 that the Alfred Wegener Institute (AWI) refitted for service as a research aircraft – and spends hours cruising above the summer tundra. The terrain below could be Canada's Mackenzie Delta or the coastal landscape of Alaska's North Slope. Flying at just 50 m above ground provides a bird's eye view of winding rivers, herds of caribou, and glimmering lakes in a rich green mosaic dotted with pink flowers or white cotton grass, depending on the season – and if the screen in front of her indicates that all measurements are working properly. After all, they're the true purpose of her research flights: since 2013 she and her colleagues in Prof Torsten Sachs' Earth-Atmosphere Interactions Working Group at the GFZ have been investigating how much methane the soils of the Arctic tundra release into the atmosphere during summertime thawing. Methane, the climate gas with a single carbon atom and four hydrogen atoms (CH_4), can produce a greenhouse effect up to 28 times more powerful than carbon dioxide (CO_2). "Based on current knowledge, more than 55 percent of all methane emissions are produced by mining, livestock and crop farming, or landfills. In other words, they are directly caused by human activities," says Kohnert. "The rest stems from natural sources, especially in wetlands, where it is produced by natural decomposition processes in soils, ponds or lakes." Yet here, too, human actions are becoming increasingly relevant. While permanently frozen soils safely store organic



Using Polar 5's onboard camera, the experts captured this image of an emptied lake in the Mackenzie Delta (left). The formation and draining of lakes in permafrost regions are unmistakable signs that the once permanently frozen soils are gradually thawing. In the process, methane can be released in different ways, as the infographic shows.

carbon like a giant deep-freeze, in soils that thaw due to the warming climate just the opposite occurs: the deep-freeze opens, microbial decomposition sets in, and methane is released into the atmosphere.

Carbon reservoir peatlands

All told, roughly a quarter of the Northern Hemisphere, especially in the Arctic, belongs to the permafrost zones. Within the permafrost zone, only approximately 15 million square kilometres are permanently frozen. Yet the Arctic is warming faster and more dramatically than any other region on Earth. In contrast, peatlands cover only 3 percent of the Earth's surface, but sequester 25 percent of organic soil carbon; that's twice the amount stored in all of the world's forests. As such, both types of landscape are extremely important from a climatic standpoint.

To more precisely gauge permafrost soils' effects on the climate Katrin Kohnert gathers data on the natural gas exchange during her flights over research areas measuring up to 100,000 square kilometres. For the project "Airborne Measurements of Methane Fluxes" (AIRMETH) AWI engineers equipped the old DC3 with various types of equipment in the course of several-week-long preparations: sensors for measuring temperature, moisture, wind speed, and wind direction, are attached to the plane's nose. Further, a system of pipes pumps external air from an opening in the plane's roof and into a gas analyser, which can measure the concentrations of carbon dioxide, methane, and water vapour at high speeds.

"At roughly 50 metres up, the measuring systems can accurately record the exchange processes between the surface and atmosphere," Kohnert explains. In other words: only at this low altitude can they measure how much carbon dioxide is drawn from vegetation through photosynthesis on the one hand, and how much methane is released on the other. Katrin Kohnert's task was to prepare the aerial campaign down to the last detail. "I take care of planning the flight

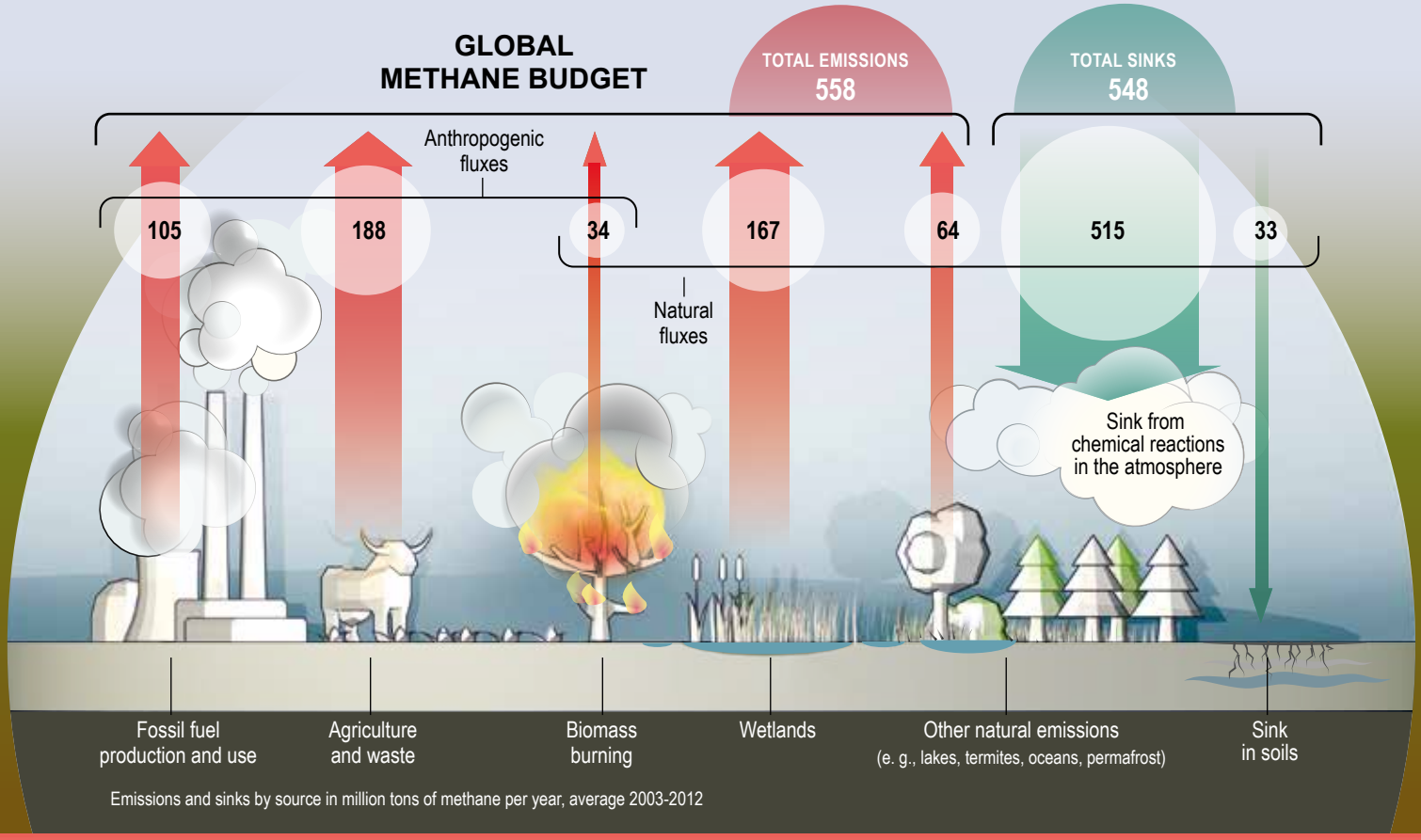
route. And once we're in the air, I have to make sure the pressure in the gas analyser remains stable; otherwise, the measurements are no good."

Good news

For every research campaign, her team usually has four weeks on site, during which they overnight in group housing units with what Kohnert affectionately refers to as 'the rustic charm of corrugated steel.' As team leader Torsten Sachs adds with a laugh, "You have to get along pretty well in order for it to work, especially if bad weather or technical problems force us to change the flight plan. After all, we're not there on holiday."

For her doctoral dissertation, which she defended in late 2018, Kohnert integrated not only her field data, but also information from satellite imagery into the analysis. "I wanted to determine whether or not there are spatial patterns in the emissions, say, if lakes emit more methane," she relates. She presented her findings as maps – pioneering work based on a painstaking calculation technique, and the results of which held their fair share of surprises for the members of the Working Group. "The initial outcomes show that, at least in Alaska, the soils aren't emitting as much methane as the readings from the ground stations would seem to indicate," says Kohnert. "And lakes and ponds, which were generally assumed to be 'hot spots', aren't particularly active on a regional scale, either." According to Torsten Sachs: "From a climate perspective, at least, that's good news."

Sachs' team is also measuring climate gas emissions in northern Germany – in the peatlands of Mecklenburg-Vorpommern, to be precise. Following German reunification, many hundred hectares of land that had previously been drained and intensively used for agriculture were restored, so that flora and fauna could once again grow and thrive there naturally – but also in order to reduce the high CO_2 emissions produced by the use of drained wetland soils. The long-term goal



For her fieldwork in the Siberian Lena Delta, Katrin Kohnert uses the Heliopod (left), which is towed below a helicopter as it flies over the tundra. The flights depart from and return to the Russian research station 'Samoylov Island' - clearly recognisable thanks to its brightly coloured buildings (bottom). The global methan budget shows: around the globe, industry and agriculture are currently releasing more methane than peatlands or thawing permafrost soils (top).

is for wetlands to form once again on a total area of roughly 37,000 hectares.

Here, too, the Potsdam-based efforts are measuring the climate effects of these land restoration efforts from the air – but, given the power lines and wind turbines in the region, they're flying at 150 metres above ground using a motor glider from the Free University Berlin. In addition, together with colleagues in Rostock, they operate stationary measuring towers and are gathering additional soil data. What they've learned so far: though these efforts are beneficial in terms of plant and animal diversity, they don't necessarily immediately produce positive climate effects: "When the

LOOKING AHEAD

It's still very unclear how much methane is actually being released in the Arctic and in peatlands because we lack a complete understanding of, and data on, the complex systems involved. With my measurements, I hope to help shed new light on the subject.

KATRIN KOHNERT
Environmental scientist, German Research Centre for Geosciences in Potsdam (GFZ) and Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)

Using a small measuring station, geoscientist Torsten Sachs (small photo) records methane emissions at the Zarnekow polder, a peatlands ecosystem on the Peene River in Mecklenburg-Vorpommern.

Hütelmoor peatland on the Baltic coast near Rostock was flooded in 2009, the methane emissions increased 100-fold," Sachs reports. "By 2011, they had dropped by roughly a third, but the level has remained fairly constant ever since."

Emissions remain

In contrast, the researchers are still waiting for the methane emissions to drop substantially at the Zarnekow polder on the Peene River, whose dikes were dismantled in 2005; it didn't become a CO_2 sink until 2018, and the carbon dioxide emissions still remain far higher than predicted. "Apparently, the massive agriculture-based changes have very long-term impacts," says Sachs. One potential explanation: methane-producing microorganisms (archaea), which break down the available biomaterial, are already thriving in the rewetted, once intensively fertilised soils, while their counterparts, the oxidisers, still need more time to establish themselves.

Consequently, the climate experts suggest that, in future land restoration projects, the uppermost soil layers be removed before the land is flooded. "In the best-case scenario, this could significantly reduce the negative effects," hopes Sachs. Even if many questions regarding the climate effects of wetlands and permafrost regions remain open, for the Potsdam-based team one thing is certain: when left alone, peatlands guarantee that little carbon dioxide or methane is released, but human activities can permanently destroy the biotope's fragile equilibrium – which makes it all the more important that the potential risks and benefits of such activities be carefully considered in advance.

IN BRIEF

- **When permafrost regions thaw, they emit the greenhouse gas methane. Just how much they emit is currently being investigated.**
- **With the aid of readings from stationary towers and data gathered by low-flying, specially equipped aircraft, gas exchange can be documented on a broad scale.**
- **Land restoration projects in the peatlands of northern Germany are having a positive effect on biodiversity. However, in the Hütelmoor peatland and the Zarnekow polder, primarily negative climate effects have been observed to date. Accordingly, optimising land restoration methods would be a sensible next step.**

WE BRING TOGETHER DISPARATE WORLDS

Highlighting climate-related topics at the Berlinale film festival: can that work? Absolutely, says Anna Kalbhenn, project manager and co-curator of the Berlinale special series 'NATIVe – a Journey into Indigenous Cinema'. For the past three years Kalbhenn, the DEKRA University of Applied Sciences in Berlin, and REKLIM have successfully brought together researchers and filmmakers, attracting viewers in droves.

Ms Kalbhenn, since 2017 you and the Climate Office for Polar Regions and Sea Level Rise at the Alfred Wegener Institute have been coordinating Berlinale events where researchers and filmmakers can compare notes. How did this all begin?

It was a bit of a coincidence: that year, the DEKRA University of Applied Sciences in Berlin and REKLIM had focused their long-standing media cooperation on the topic of permafrost – partly because those responsible had visited the federal Russian republic Sakha (Yakutia) the year before, where they established several contacts with indigenous communities. This work gave them the idea of initiating a joint round of discussions on climate change and indigenous life at the Berlinale – a topic that was of interest to researchers and movie buffs alike – and to get REKLIM on board.

And how does it work?

In keeping with NATIVe's regional focus topics – which in previous years have been on the Arctic, and on islands in the Pacific – we, together with REKLIM and the DEKRA University of Applied Sciences, organised panel discussions involving a range of experts: researchers, directors, and producers. In 2017 we had a movie producer from Sakha, in 2018 it was an author from Tahiti, whose poetry was integrated into a documentary piece, and this year we've invited a filmmaker from the Salomon Islands – and the public, of course. This combination is the perfect recipe for exciting discussions, and can even lead to new collaborative projects.

Has the response been positive?

It's been excellent, precisely because we bring together worlds that otherwise have little to do with one another: art, film, science, and enthusiastic spectators. They can learn how indigenous experts and European researchers respectively view the indicators and impacts of our warming climate. And all of the participants learn a bit about how to present their topic to the public. In turn, as a film festival, we are delighted when we can use formats like this one to spark a change of attitude. ■

ANNA KALBHENN *is a project manager and co-curator of the special series 'NATIVe – a Journey into Indigenous Cinema' at the Berlinale. NATIVe offers indigenous filmmakers from around the globe a forum for their short or feature-length documentary / non-documentary films.*