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Lone pilot's Arctic mission to map dark side of carbon

By Lucas Laursen

Flying solo

Slovenian pilot and photographer Matevz Lenarcic is on a mission to fly over the North Pole in an ultralight plane and measure black carbon levels. (Copyright: Getty Images)

The role of soot in melting polar ice is believed to be greater than previously thought. One adventurer has taken to an ultralight plane to find out.

The sky north of Ellesmere Island had just cleared when Matevz Lenarcic, flying alone in a Pipistrel Virus airplane at around 3,600m (10,000ft), got a call on his satellite phone. His friend following the weather on a computer in Slovenia had spotted heavy clouds and snow closing in on Lenarcic's destination, an airfield near Resolute Bay, in the Canadian Arctic.

Lenarcic, a Slovenian pilot and adventurer, had departed Longyearbyen, Norway, early that morning. When he reached the North Pole, he tipped the ultralight plane's wings over and circled the Pole in a whimsical, if brief, round-the-world flight. Two hours later, shivering despite the immersion suit he wore, Lenarcic faced a more serious decision: race the storm to Resolute Bay or divert to Eureka, a nearby weather station with no facilities for protecting his plane after landing.

On the passenger seat beside him, he carried precious cargo – an experimental Aethalometer, a device that measures black carbon, or soot, in the air. Black carbon is a common contaminant, found in emissions from diesel engines and burning farm fields. Researchers say it is the second largest human contribution to climate change after carbon dioxide.

Flying above the Arctic Ocean may seem an unlikely way to look for humanity's footprints. But soot travels thousands of miles on winds, and the hundreds of cargo ships that ply the Arctic Ocean every year also inject it straight into the atmosphere. Soot has a stronger effect in the Arctic than in more temperate regions.

Clean Arctic sea ice can reflect as much as 90% of the sunlight that hits it. But a thin layer of soot makes the surface darker and less reflective. The Arctic has been losing sea ice since Nasa began tracking it in 1978, and it has been doing so much faster than climate models predict. Last year Arctic ice shrank by 18% compared to the previous record low of 2007, according to the official US monitoring organisation, the National Snow and Ice Data Center in Boulder, Colorado. Climate scientists have believed for some time that soot is accelerating Arctic sea ice melt.

Most soot monitoring is done from ground stations in populated areas and aerial data on polar soot are rare and scientifically valuable. "In the Arctic in particular the role of black carbon is potentially very, very important," says atmospheric scientist Drew Shindell of Nasa's Goddard Institute for Space Studies in New York, "What's really important is understanding how the black carbon interacts with clouds in the Arctic."

No-fuss approach

To address the data gap, Nasa launched a sensor-laden Gulfstream jet on a handful of soot-collecting missions. But these missions cost almost $500,000 a year. As a result, some researchers are now dabbling with aerosol-monitoring drones. Then there is Lenarcic's no-fuss, experimental approach in a **small private aircraft (http://www.worldgreenflight.com /index.php?id=28&x=2)**. "I would like to show how useful they are and that we could get huge benefits from them for just a fraction of the cost this kind of project normally requires," he says.

The black, brick-sized Aethalometer by his side feeds on air from a tube outside the airplane. Incoming particles pass through a filter under the steady gaze of an optical beam, which measures the colour of the filter, revealing the size, colour and density of the captured particles. The analysis can even distinguish between particles from forest fires, diesel engines, wood stoves and cargo ships. By repeating the process around the world, Lenarcic hopes to collect a global overview of the story of soot.

The work lends scientific meaning to Lenarcic's regular routine. He makes a living doing more mundane aerial surveys in Slovenia, punctuated with far-flung adventures in his plane. In 2011, he was planning a solo, round-the-world flight in pursuit of material for a photography book, when atmospheric scientist Grisa Mocnik asked him to test a prototype of the airborne Aethalometer. It was a good opportunity to show how small-time inventors and pilots can help to tackle a global problem.

On that flight too, in transit between the Cook Islands and New Zealand, a friend called to warn him of clouds on his route. There were no nearby airports. "Sometimes you have to go through because you cannot go back," Lenarcic later recalled. The moist, tropical clouds tossed the Virus and frightened Lenarcic, but he collected the data, which Mocnik and colleagues at the Slovenian company Aerosol, which makes the instrument, are preparing for publication. However the itinerary lacked Arctic soot, so Lenarcic set his course north in April. This time, facing the prospect of icy clouds choking the engine's air intake, Lenarcic pulled back the throttle on the cockpit floor and descended towards Eureka.

Two months before Lenarcic's polar flight, an international team of scientists announced that most climate models underestimate black carbon's impact on atmospheric warming by up to a factor of three. "We think [black carbon] is a really powerful warming agent on its own," says Shindell, "But without really understanding what it does to clouds, it's hard to draw a more definitive conclusion." In

warm temperatures, for example, black carbon particles can seed clouds, which reflect sunlight and may cool the atmosphere. But to understand how freezing clouds behave, researchers need fresh aerial data on soot and clouds.

Researchers studying Arctic climate change say that there is little manoeuvring room for mitigating human-provoked ice melting. But they say reducing black carbon emissions may be the best short-term bet. The Arctic is responding faster to climate change than are other regions on Earth. Black carbon acts over short timescales. It sinks quickly out of the atmosphere compared to greenhouse gases such as carbon dioxide, making it a good target for reducing atmospheric warming in the short term, according to a 2012 study by Shindell and colleagues.

Data gap

International organisations are already taking note. In February, Arctic environment ministers agreed to cooperate on estimating and eventually reducing emissions of short-lived pollutants including soot. The UN Economic Commission for Europe issued its first reporting guidelines for black carbon emissions at a mid-May meeting in Istanbul. Arctic residents say regulation cannot happen fast enough. Last month the international treaty organisation Arctic Athabaskan Council petitioned the Inter-American Commission on Human Rights for help regulating Canadian black carbon emissions.

But reporting, says Mocnik, is not as good as measurement. Reporting tends to be a calculation based on official estimates of what an economy is burning. Since people do not report home woodstove burning to tax authorities or economists, for example, those estimates are often too low to be useful. Researchers will need real-world data such as those Nasa and Lenarcic are collecting. And the most cost-effective way to do that is still up in the air.

Having slowed his descent to Eureka, Lenarcic still had to land with his data intact. The plane's shadow slowed over the snow as Lenarcic circled the airfield and aligned the plane's nose with the runway. He drew back the throttle just enough to establish a gentle descent and waited until crossing the runway threshold before he reached up to the cockpit roof, pulled the air brake lever and committed to the landing. The Virus' wheels met the snow-drifted runway and rolled to a stop.

"This is not a very pleasant place to stay for a long time," he told me from the shelter of the eight-man weather station the next day. Before landing the temperature had been -18C (-0.4F). He fretted about starting the Virus' engine again. Such deep cold can sap the starter battery and the howling winds can press sharp ice crystals deep into the engine's tubes and wires.

But he was able to upload the data to Mocnik, who hopes to persuade his peers in the atmospheric science community that such data are useful. They are accustomed to rare injections of higher-precision data from the occasional Nasa or German jet mission, he says. "We hope to prove ... that one can do really sophisticated aerosol science on a scale which does not require this huge infrastructural investment," says Mocnik. If he can make the Aethalometer simple and robust enough, even recreational paraglider pilots might one day provide scientists with aerosol profiles, he says.

Such a widespread, consistent dataset would allow researchers to compare how black carbon travels the globe, says Shindell. It would let climate modellers test their theories against real-world data to improve their accuracy. Then it will be up to policymakers to make the changes which could improve the actual forecast, says Mocnik.

"We believe we collected quite interesting information," Lenarcic said after his polar flight. "I could see something in the air which might have been soot." If low cost efforts such as his can help plug the black carbon data gap, perhaps the warnings of scientists and fine words of politicians will finally be translated into action.

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