CAREERS

THUMBS UP Female administrators embrace strategies to retain women in STEM **p.567**

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Emissions from air travel constitute a large proportion of many scientists' individual carbon footprints.

SUSTAINABILITY

A greener culture

Creative minds are shrinking research's big carbon footprint.

BY JULIA ROSEN

In July 2015, Stephanie and Fraser Januchowski-Hartley left their home in Totnes, UK, and headed for the International Congress for Conservation Biology in Montpellier, France. Instead of catching a flight, they boarded a boat and then made their way across France by bicycle and train, pedalling more than 600 kilometres over 5 days. After the conference, they took a train home.

By eschewing air travel, the pair prevented carbon dioxide emissions of roughly one-half of a metric tonne, and received the Swarovski Optik Green Travel Award from the Society for Conservation Biology, which hosted the meeting. The European branch of the organization is encouraging scientists to shrink their carbon footprints, and Stephanie, now a postdoc studying freshwater conservation at Paul Sabatier University in Toulouse, France, took the challenge to heart. "I feel contradictory if I'm not making some effort in my own life," she says.

She is not alone. Although most researchers say that tackling climate change will require large-scale action from nations and corporations, many individuals are trying to do their own parts. "I think it's important for me as a global citizen," says Erich Osterberg, a climatologist at Dartmouth College in Hanover, New Hampshire. He and his family have taken personal steps such as reducing meat consumption and upgrading to high-efficiency appliances at home. He notes that such actions also help climate scientists such as him to ward off accusations of hypocrisy — that researchers talk the talk but don't walk the walk.

Shahzeen Attari, who studies cognitive science and sustainability at Indiana University Bloomington, has found that scientists' personal behaviour matters to the public. In a 2016 study[1], she and her colleagues found that audiences perceived carbon-conscious climate scientists as more credible than those with big carbon footprints and, consequently, reported a greater willingness to consider taking climate action in their own lives after hearing those scientists discuss ways to reduce energy use.

Although data are scarce, evidence also suggests that researchers may have larger-than-average carbon footprints. For example, 13 conservation scientists who evaluated their own greenhouse-gas emissions found that they were more than 10 times the global average, despite the researchers' efforts to lead low-carbon lives[2]. The greatest source of those emissions was work-related flying.

For many scientists, the high environmental costs of doing science can feel at odds with their values. So, some of them are trying to reduce the carbon footprint of their work by cutting back on air travel, finding creative ways to do fieldwork and 'greening up' their labs. The results often benefit not just the environment, but the science, the budget and even researchers' morale, says Kim Cobb, a climate scientist at the Georgia Institute of Technology (Georgia Tech) in Atlanta. "It's about that engagement — that daily reminder that I care."

AIR TIME

Flying is a routine part of doing science. The Tyndall Centre for Climate Change Research, a consortium in Norwich, UK, surveyed 79 of its researchers in 2012 and found that they flew an average of 2.3 times per year[3]. Often, these flights were to attend conferences and plan meetings — but each had a substantial climate impact. Another study found that presenting a single conference paper results, on average, in about 800 kilograms of CO_2 emissions[4]. The researchers also calculated average emissions for conference-paper presentations in popular but non-central locations such as Hawaii (1,290 kg per paper), as well as for scientists travelling from the Southern Hemisphere (between 1,400 and 1,900 kg per paper). One team notes that a trans-Atlantic flight produces emissions roughly equivalent to a year of commuting 25 kilometres round trip each day by car[5], an estimate that aligns well with US ▶

Environmental Protection Agency data.

Researchers make up a small proportion of air travellers, and aviation emissions account for only 2% of carbon dioxide from human sources. But those emissions have been steadily growing, and flying often constitutes the biggest chunk of an individual's carbon footprint — two-thirds, for the conservation scientists[2]. Flying less thus offers the biggest opportunity for reducing personal climate impacts (see 'Flight emissions').

Cutting back on conference travel or choosing low-carbon alternatives to flying are good places to start, says Parke Wilde, a food economist at Tufts University in Boston, Massachusetts. "It would not be possible to preserve what's important in our academic life without some flying," he says. "The question is about how much." Wilde runs a blog called 'Flying Less' and in 2015 he launched a petition aimed at persuading universities and professional societies to set reduction targets for air travel.

Wilde does not fly, but he doesn't expect everyone to follow his lead. Instead, he encourages researchers to strive to cut their flying in half. He advises them to prioritize the most important conferences, to make time to meet visiting colleagues and to reach out to local scientists while travelling. He recommends caution if buying carbon offsets — scientists should scrutinize programmes to verify them and ensure that they actually prevent emissions.

Scientific organizations that host major meetings could also take steps to reduce carbon footprints. In a 2011 study[6], Alexandra Ponette-González, a geographer at the University of North Texas in Denton, and her colleagues considered what would happen if organizations alternated large national or international meetings with regional ones every other year. They found that this could reduce conference-related carbon emissions by up to 73%, and that choosing central meeting locations could save further.

Ponette-González has cut back on her own conference travel. She recently attended a nearby meeting to establish more local connections and learn about science in her own backyard. However, she acknowledges that tenured professors such as herself have the luxury of choosing conferences and turning down speaking invitations. She does not recommend that early-career scientists skip opportunities to show off their work. Researchers in isolated locations also benefit from networking opportunities, she says, and may have a harder time accessing alternative forms of transportation.

One obvious solution to this trade-off is virtual meetings, but they have been slow to catch on. Many scientists say that although webinar technology has come a long way, it still can't provide opportunities for the casual one-on-one interactions that make conferences so valuable.

People such as Chris Welch are trying to change that. When Welch ran the technology-innovation group of health-care giant Merck, based in Kenilworth, New Jersey, he hired web designers to build a virtual conference, and hosted a meeting there. Using avatars and microphones, participants moved between posters, entering multiparticipant conversations inside a blue circle surrounding the presenter, or sitting in virtual chairs to chat in the 'conversation zone'.

"It's a personal level of being consistent with why they are a scientist in the first place."

The lack of virtual halls available to rent for web-based conferences may have prevented them from gaining popularity, Welch suspects. However, Linden Lab in San Francisco, California, which previously developed a virtual conferencing service called Second Life, is preparing to launch a beta version of a platform called Sansar. Users will be able to create custom virtual-reality experiences, including meetings.

As technology improves, Welch says, the benefits of virtual meetings will outweigh the downsides. A follow-up survey found that people enjoyed his virtual meeting and were more likely to approach senior executives at it than in real life[7]. Virtual meetings also take up less time and are cheaper to attend, which makes them more accessible to early-career scientists and those in far-flung locations or with tight budgets. "The more equitable participation is a really valid point for today's science," Welch says.

TREAD LIGHTLY

Many scientists also fly to do fieldwork, and Wilde says that he would never encourage people to give up important research that requires them to travel. However, a growing number of scientists are finding low-impact ways to do that work. For example, Osterberg wanted to cut his environmental impact when drilling ice cores. He was delighted when, in 2012, he got permission to drill inside Alaska's Denali National Park — but he wanted to avoid using a petrol-powered generator. So he asked engineers who design drills for US coring operations to develop a low-impact rig. They delivered. In 2013, Osterberg's team successfully drilled two 200-plus-metre cores by drawing power from only a few solar panels, a wind turbine and a bank of batteries.

PhD student Elly Knight, an ecologist at the University of Alberta in Edmonton, Canada, opted for leg power to do her work. Last summer, she travelled by bicycle to set up recording devices to monitor common nighthawks (*Chordeiles minor*) in Alberta's boreal forest. A raging wildfire had led to a ban on four-wheeled vehicles, so she arrived at the idea of using fat-wheeled bikes to negotiate the rough, sandy landscape. Her university's sustainability office helped her to draft a letter to local bike shops, which lent her the bicycles for free.

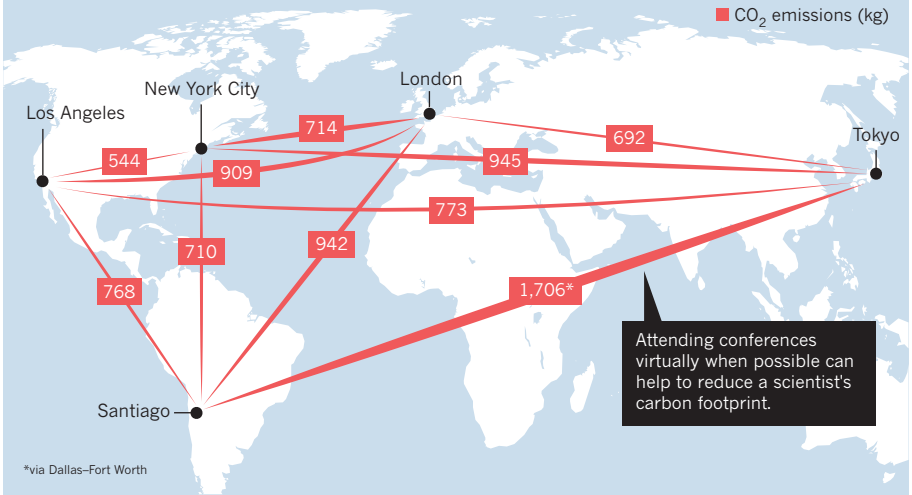
Jason Box, a climatologist at the Geological Survey of Denmark and Greenland in Copenhagen, has used skis instead of helicopters for his work studying the Greenland ice sheet. Box also directs a crowd-funded research initiative called Dark Snow, which is helping to support a six-week expedition on the ice, now under way, in which scientists traverse the ice sheet on a zero-emissions vehicle called the WindSled. The vehicle was modelled on Inuit dog sledges, and is pulled by a massive kite.

The WindSled has made several successful trips across Greenland and Antarctica and has supported one previous scientific expedition, says Box. The current trip will offer a prime opportunity to further demonstrate the vehicle's capacity to serve as a low-carbon scientific platform. Researchers will collect shallow cores as they travel 1,200 kilometres across the ice sheet. Box says that using the WindSled instead of a ski plane saves 100 barrels of fuel.

Teams are also looking for ways to shrink the carbon footprints of their labs. At Georgia Tech,

FLIGHT EMISSIONS

Researchers worldwide routinely fly to scientific conferences to present papers, learn of new findings and make connections. But there is an environmental cost to those flights. Here are the average carbon dioxide emissions for several common flights, in kilograms of CO_2 per round-trip economy ticket.



SOURCE: INTERNATIONAL CIVIL AVIATION ORGANIZATION

Raising freezer temperatures lowers energy use.

PETER MACDIARMID/GETTY

Cobb is part of an initiative to draw attention to fume cupboards, which account for much of lab energy use. Variable-air-volume models, however, automatically decrease airflow when the sash is fully closed, reducing the energy consumed by ventilation. In a pilot study[8] at Harvard University in Cambridge, Massachusetts, a team found that shutting fume cupboards in the chemistry department saved as much as US$250,000 a year and prevented emissions of 300 tonnes of greenhouse gases.

Cobb learnt about the Harvard study from a student project in a class that she teaches. She saw that helping people remember to close fume cupboards could offer major benefits for minimal effort, and so she tasked her lab manager with leading an initiative in her building this summer. She says that another effort, focused on undergraduate chemistry labs, will start in late August. She hopes that the idea will soon spread to the school's thousands of fume cupboards and beyond.

LOW-IMPACT LABS

Green-lab experts such as Kathy Ramirez-Aguilar, who runs the Green Lab programme at the University of Colorado Boulder, recommend that scientists buy or upgrade to energy-efficient equipment whenever possible. Sustainability offices such as hers, she says, can help scientists to research options and secure funding to subsidize the costs.

Researchers can also share equipment, she says. Ultra-low-temperature freezers, for instance, consume huge amounts of energy, but many teams don't need a full unit. Her university launched a programme in which scientists can rent space for their samples, starting at $0.25 per month for a 5-centimetre-tall freezer box. (Scientists with their own freezers can reduce their impact by setting them at −70 °C instead of −80 °C, which may be just as safe for many samples, and keeping the filter and coils clean and removing built-up frost, defrosting if necessary.)

Energy reductions also come from sharing lab space — a green perk of efforts aimed at encouraging collaboration and innovation. Ramirez-Aguilar points to the cell-culture lab at her university as a flourishing example. It has 70 active users from 16 lab groups and is staffed by full-time technicians, which, Ramirez-Aguilar says, is key. "It places upkeep, repairs, training responsibility on an equipment manager, rather than on the researchers," she says. But the biggest benefit is that it makes efficient use of space in lab buildings, which are three to five times more energy intensive than office buildings, according to the US Department of Energy.

Labs at the University of California, Davis, take up one-third of the university's floor space, but account for two-thirds of its energy use, says Allen Doyle, the university's sustainability manager. He advises researchers to work with the limitations of their buildings or campaign to have them upgraded. Depending on the building, that might mean situating high-heat-output instruments away from thermostats or putting energy-intensive machines in a room with extra cooling capacity.

Doyle's office helps teams with questions such as these, and conducts sustainability audits to certify their labs as a Green Lab. Those audits include questions such as whether teams turn off equipment when not in use, and whether they measure their energy consumption. Such certification programmes exist at many universities. Scientists can also contact My Green Lab, a non-profit organization in Los Gatos, California; join the online Green Labs Planning Group; or attend workshops on lab sustainability, through groups such as S-Lab in the United Kingdom.

Doyle says that however they accomplish it, researchers must get serious about sustainable science. "It's a personal level of being consistent with why they are a scientist in the first place," says Doyle, who began as an Earth scientist. "It doesn't make sense to be wasteful if you're interested in the arithmetic of nature." ■

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WOMEN IN SCIENCE

Finding consensus

US female deans, provosts and other academic administrators gave higher ratings than did their male counterparts to policies and strategies aimed at improving the professional lives of women in science, a study finds (W. Williams *et al. Front. Pyschol.* http://doi.org/b8m7; 2017). And they disagreed with male administrators about the value of some strategies for retaining female faculty members in science, technology, engineering and mathematics (STEM).

US universities have considered dozens of ways to bolster the number of women in senior academic posts, yet women hold less than 20% of combined tenured and tenure-track posts in such fields as physics, chemistry and computer science, notes the study, published in *Frontiers in Psychology*.

Researchers analysed responses from 344 provosts, deans, associate deans and department chairs in STEM fields at 96 public and private US research universities. They asked about the quality and feasibility of 44 strategies for recruiting, retaining and promoting women in STEM.

Women and men strongly endorsed two ways to increase the number of female administrators in academia — providing on-campus day care and offering equal opportunities for women to lead committees and research groups. "There is common ground here," says study co-author Wendy Williams, director of the Cornell Institute for Women in Science at Cornell University in Ithaca, New York. Women and men also both rejected gender quotas for promotion.

But more men than women eschewed expanding the role of service and teaching — obligations historically shouldered more by female than by male academics — in tenure decisions. "Women see it as more important to broaden criteria for tenure, so that tasks traditionally excelled at by women receive more weight," says Williams.

Men were also less keen on policies that would enable mothers to use grant funds to take children and carers with them to conferences, or that would provide grant funding so that women could hire postdocs for cover during leaves of absence for family reasons.

"Women endorse policies that reflect the world of being a woman in STEM. It's different from the world men inhabit," says Williams. "When men and women department chairs, deans and provosts disagree, we should carefully consider women administrators' wisdom about policies for retaining women in STEM."