HOW CONFERENCES WILL SURVIVE THE CORONAVIRUS SHOCK

Virtual meetings are becoming the norm under COVID-19 and winning over many researchers.

MAREKULIASZ/SHUTTERSTOCK

The American Geophysical Union's annual meeting is one of the largest science conferences.

Before the COVID-19 pandemic, Adam Fortais had never attended a virtual conference. Now he's sold on them — and doesn't want to go back to conventional, in-person gatherings.

That's because of his experience of helping to instigate some virtual sessions for the March meeting of the American Physical Society (APS), after the organization cancelled the regular conference at short notice. "If given the option, I think I would almost always choose to do the virtual one," says Fortais, a physicist at McMaster University in Hamilton, Ontario. "It just seems better to me in almost all ways."

Fortais could get his wish. Since the coronavirus spread worldwide in early March, many scientific conferences scheduled for the first half of the year have migrated online, and organizers of meetings due to take place in the second half of 2020 are deciding whether they will go fully or partially virtual. Some researchers hope that the pandemic will finally push scientific societies to embrace a shift towards online conferences — a move that many scientists have long desired for environmental reasons and to allow broader participation.

Scientists with disabilities and parents of young children are just two examples of the researchers who are benefiting from online meetings, says Kim Cobb, a climate scientist at the Georgia Institute of Technology in Atlanta. Cobb has been cutting back her own air travel since 2017, both to reduce her personal carbon footprint and to blaze a trail towards structural change in her discipline. She hopes the changes as a result of the pandemic will last long after it has ended. "In five years, we'll be in a remarkably different place."

But other researchers say that in-person conferences will once again dominate after the threat of COVID-19 has faded. For them, in-person meetings offer too many opportunities that virtual meetings can't replicate.

Greener gatherings

Estimates of the carbon cost of conferences vary, but range from 0.5 to 2 or more tonnes of carbon dioxide per participant in travel alone. If each of the estimated 7.8 million researchers in the world travelled to one conference every year, the lower bound of the annual carbon emissions would be roughly equivalent to those of some small nations.

Before the pandemic, many scientific societies had already begun exploring how to make virtual participation available for researchers who were unable or unwilling to travel. When the crisis hit, it forced them to speed up existing discussions and timelines. "We were going to start out with smaller meetings," says Hunter Clemens, director of meetings at the APS. Instead, the society scrambled to move its annual April meeting online in a matter of weeks. Despite the accelerated timeline, Clemens says, the virtual meeting was "something amazing".

That gathering, which took place on 18–21 April, drew more than 7,000 registrants — about four times more than its in-person attendance in a normal year, says Clemens. And almost all of them — around 96% — logged on to the conference at some point. The virtual sessions, on average, had higher attendance than in-person ones at standard APS April conferences.

Attendees say that virtual meetings are better in certain respects. Submitting questions online through moderated chats, for example, can help graduate students to feel less intimidated and allow scientists to formulate better queries. At the annual meeting of the American Association for Cancer Research in April, the ability of the audience to vote on questions in real time "resulted in a higher quality of question", says Emily Costa, a cancer researcher at Memorial Sloan Kettering Cancer Center in New York City.

Adam Tidball, a physicist at Rensselaer Polytechnic Institute in Troy, New York, saw another benefit when he presented at the APS virtual April meeting. "I found that the networking was a lot better than in-person," says

Tidball. The conference provided attendees with a sort of matchmaking app for networking, with which users could read other scientists' biographies and reach out to them to initiate a conversation or schedule a time to meet virtually.

The economics of online meetings are different from those of conventional ones. Clemens estimates that the virtual April meeting cost only about 45% of the equivalent in-person conference, although the society lost money on this year's meeting because it had to make the shift quickly and didn't charge for attendance. The American Astronomical Society has had more time to plan its online-only meeting in June, and the cost to attend is around 60% cheaper than it was for its January meeting.

But the shift to online meetings could shrink one of the major revenue streams for societies, some of which draw a large fraction of their operating budget from their annual meeting. And if societies move to hold a dual online and in-person meeting, that could drive up costs because the meeting would require more staff, and both a venue and an online platform.

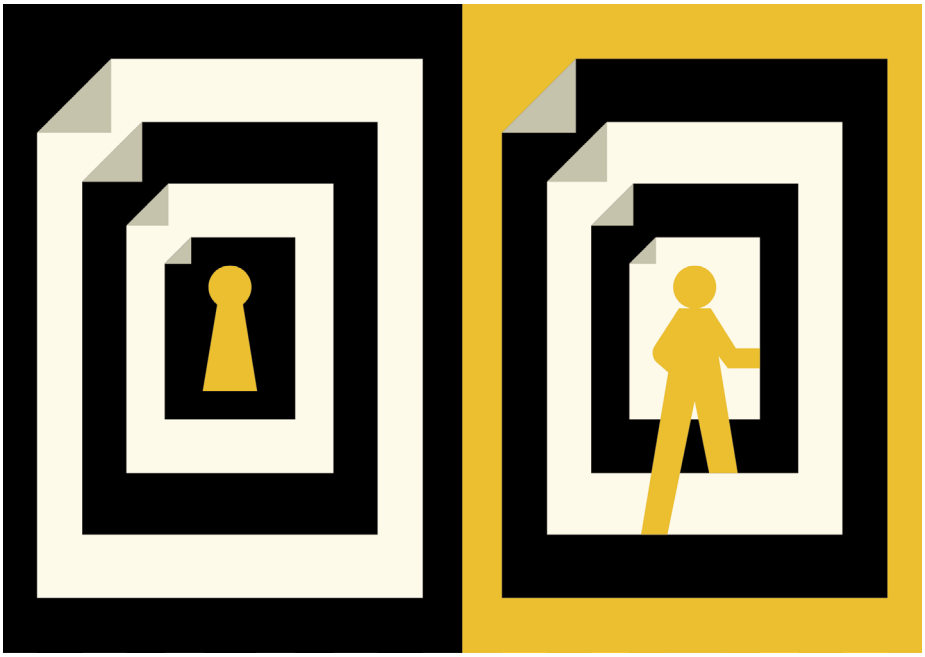
Researchers who have attended virtual meetings say that the meetings have several important downsides. Poster presentations can fall flat in an online space, and it's difficult to have serendipitous encounters between sessions, which is where a lot of collaboration normally happens. Social scientist Marzena Świgoń says that unofficial chats during conferences are the most important way that scientists share knowledge with each other. "I think that virtual conferences are only temporary," says Świgoń, who is at the University of Warmia and Mazury in Olsztyn, Poland. "As soon as the threat passes, conferences will return in their traditional form."

Anthony Watkinson, an information scientist at CIBER Research in Newbury, UK, who has co-authored papers with Świgoń, is similarly sceptical of the permanence of virtual conferences. He says that UK and US researchers overwhelmingly report that in-person interactions are necessary for forging relationships.

Among many scientists, however, there is a clear mandate for at least providing the option to participate virtually. In an informal survey conducted by *Nature*, roughly 80% of 486 respondents said they thought that some meetings should continue to be held virtually, at least in some capacity, after the pandemic has subsided.

Now that the idea of a virtual meeting is less abstract, Cobb says, people might be more willing to open up conferences, meetings and seminars to remote participation. "I do honestly believe there will be some remnants of this that resonate on for many years."

Giuliana Viglione is an intern with *Nature* in Washington DC.



THE COVID-19 CRISIS COULD PERMANENTLY CHANGE SCIENTIFIC PUBLISHING

The push for rapid and open publishing could take off – although financial pressures lie ahead.

Anna Obenauf had never posted her results to a preprint server, but she decided to make the jump in April. She was racing against another team to get findings on a rare skin cancer out quickly, so she uploaded her manuscript to bioRxiv – just like thousands of COVID-19 researchers have been doing during this pandemic. It was a turning point for Obenauf, a cancer biologist at the Research Institute of Molecular Pathology in Vienna, who particularly liked the quick feedback she received (L. Leiendecker *et al.* Preprint at bioRxiv http://doi.org/dw3f; 2020). She says she will probably continue to post some of her team's work on preprint servers in the future.

The COVID-19 crisis has underlined just how fast and open science publishing can be – when scientists want it that way. Researchers working on the pandemic are sharing preliminary results on preprint servers and institutional websites at unprecedented rates, embracing the kind of early, public sharing that physicists and mathematicians have practised for decades. Journals have whisked manuscripts through to formal publication in record time, aided by researchers who have rapidly peer-reviewed the studies. And dozens of publishers and journals, including Elsevier, Springer Nature and the *New England Journal of Medicine*, have made coronavirus research – new and old – free to read. They have pledged to continue doing so for the duration of the outbreak, and have encouraged or, in some instances, required researchers to post their manuscripts on preprint servers.

Even before COVID-19 spread around the globe, momentum was growing to share results early online and to make work open access. The coronavirus publishing frenzy has underlined the worth of these objectives, says Cameron Neylon, a researcher on scholarly communications at Curtin University in Perth, Australia. "If we think openness of communication is valuable in a crisis, it should surely be valuable in normal times as well," he says.

Although the experience might prod individual scientists into sharing work faster and more openly, this might not in itself lead

> **"The big changes that are going to come are going to be structural."**

to a publishing revolution, Neylon says. "I don't see this as a tipping point," he says. "The big changes that are going to come are going to be structural."

The current system would have to shift wholesale to rewarding open, early sharing of findings to give scientists incentives to communicate their work in this way. A few funders and research institutions were already advocating that approach, and the pandemic could nudge them further along this path. But the crisis could unleash other forces that might reshape science communication: not least an economic downturn that could disrupt research budgets, job markets and the scientific-publishing industry.

Preprint rush

Some changes in publishing are probably here to stay. Scientific communities that embrace preprints tend never to look back, says John Inglis, co-founder of the medRxiv and bioRxiv preprint sites and the executive director of Cold Spring Harbor Laboratory Press near New York City. And May was the busiest-ever month for both sites, says Inglis. (The arXiv preprint server, which hosts physics and mathematics manuscripts, still receives more papers per week, however.)

Submissions to bioRxiv were increasing even before the pandemic; an influx of coronavirus papers only partly contributed to its growth this year. But the growth in medRxiv, which is co-run with Yale University in New Haven, Connecticut, and BMJ Publishing Group in London, was due almost entirely to the more than 3,700 COVID-19 papers it hosts (see 'Torrent of preprints'). Inglis thinks the pandemic has raised the site's profile and that it could soon see growth in other areas of medical research. "We have a long, long way to go, but I think there is more awareness," he says.

With the outbreak emerging first in China, it's no surprise that preprint servers saw many more posts than before from Chinese authors, too. That change could stick — as might a growing tendency for scientists to publish in journals from Chinese publishers, as efforts to bolster the country's science-publishing industry gather pace, says Jie Xu, who studies scholarly communication at Wuhan University in China.

Rapid review

Some of the results that researchers have been posting online in the crisis are more like dispatches from the front line than carefully crafted papers intended to stand the test of time, Inglis suggests. That trend might not last after the pandemic is over.

Yet scientists still have a desire to produce polished peer-reviewed work quickly. Accordingly, journals are racing to publish peer-reviewed COVID-19 papers. A study posted on bioRxiv last month surveyed 14 medical journals (S. P. J. M. Horbach. Preprint at bioRxiv http://doi.org/dt3r; 2020), and found that they published papers on the coronavirus nearly twice as quickly as they did other papers at the time, largely due to quicker peer review. It's unlikely that journal-based peer review could regularly work at this pace, says Stefano Bertuzzi, chief executive of the American Society for Microbiology in Washington DC. "I don't see room for efficiency improvement in that respect on a regular basis. I think this is just the emergency situation that we're dealing with," he says.

But the crisis has inspired experiments in review that might persist. Some journals and publishers, including PLOS, *eLife,* the UK Royal Society and Hindawi, have launched an initiative to create a pool of scientists who are willing to rapidly review papers on COVID-19, as well as to share reviews between journals. An effort called Review Commons, launched in early December 2019, allows scientists to have their manuscripts reviewed even before being posted as a preprint. The manuscript and its reviews appear together on bioRxiv and are then submitted to a participating journal.

Some researchers have taken the initiative to curate preprints themselves. Scientists at the Precision Immunology Institute at Icahn School of Medicine at Mount Sinai in New York City, for instance, have reviewed dozens of bioRxiv and medRxiv preprints, posting their assessments alongside the manuscripts. Efforts such as these show that it is possible to do thorough peer review outside journal-organized mechanisms, says Inglis — which might be a theme of science publishing's future.

Financial pressures

Many experts say some of the biggest impacts on the scientific-publishing industry are likely to be financial, and will play out over years. If economies continue to nosedive, the budgets that support the scholarly publishing enterprise will come under pressure.

"It's really hard to see the big publishers not facing a very substantial revenue hole," says Neylon. Institutions might try to cancel or renegotiate contracts with publishers, he says. (In March, the non-profit organization Jisc in Bristol, UK, which negotiates contracts on behalf of British university libraries, asked publishers to delay or minimize subscription increases, and to take other measures to cushion the blow to university budgets.)

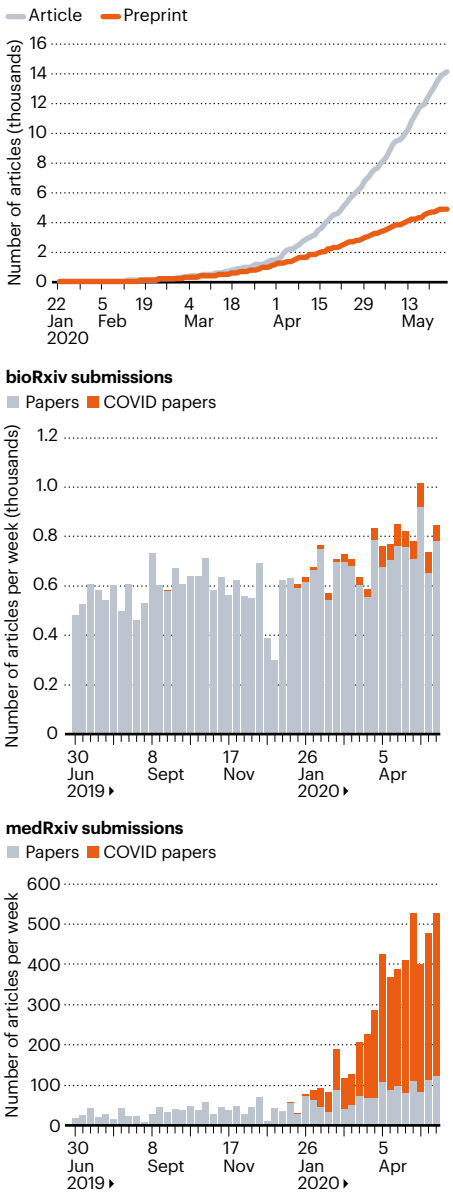
Neylon thinks that university presses, learned societies and other small publishers will be under the most pressure. And Joseph Esposito, a senior partner at publishing consultancy Clarke & Esposito in Washington DC, wonders whether an economic downturn could even slow growth in open-access publishing. "We might find that some of the heat is going to go out of the open-access movement, and that you're going to find fewer journals, fewer articles being written, and greater attempts in a tight job market to publish in highly regarded publications," he says.

But Robert-Jan Smits, president of Eindhoven University of Technology in the Netherlands and architect of the European-led 'Plan S' for open-access publishing, thinks that the coronavirus crisis will be looked back on as the event that tipped science in general towards fast, open publishing. "It's the final push that is necessary," he says.

Ewen Callaway writes for *Nature* from London.

TORRENT OF PREPRINTS

Around one-quarter of the scientific articles that relate to COVID-19 are preprints, by one estimate. Many appeared at medRxiv, a site for medical preprints, which has grown hugely as a result of the pandemic. Some were posted on bioRxiv and other preprint servers.



SOURCES: NUMBER OF ARTICLES (TOP PANEL): PRIMER. SUBMISSIONS (MIDDLE AND LOWER PANELS): J. INGLIS/N. FRASER *ET AL.* PREPRINT AT BIORXIV HTTP://DOI.ORG/DXDB (2020).

Clarification

The COVID-19 crisis could permanently change scientific publishing

This story has been amended online to name Hindawi as a prominent publisher in the rapid-review system initiative.