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Past and Future: Climate Experts Consider Where Our Planet Has Been and Where It Is Going

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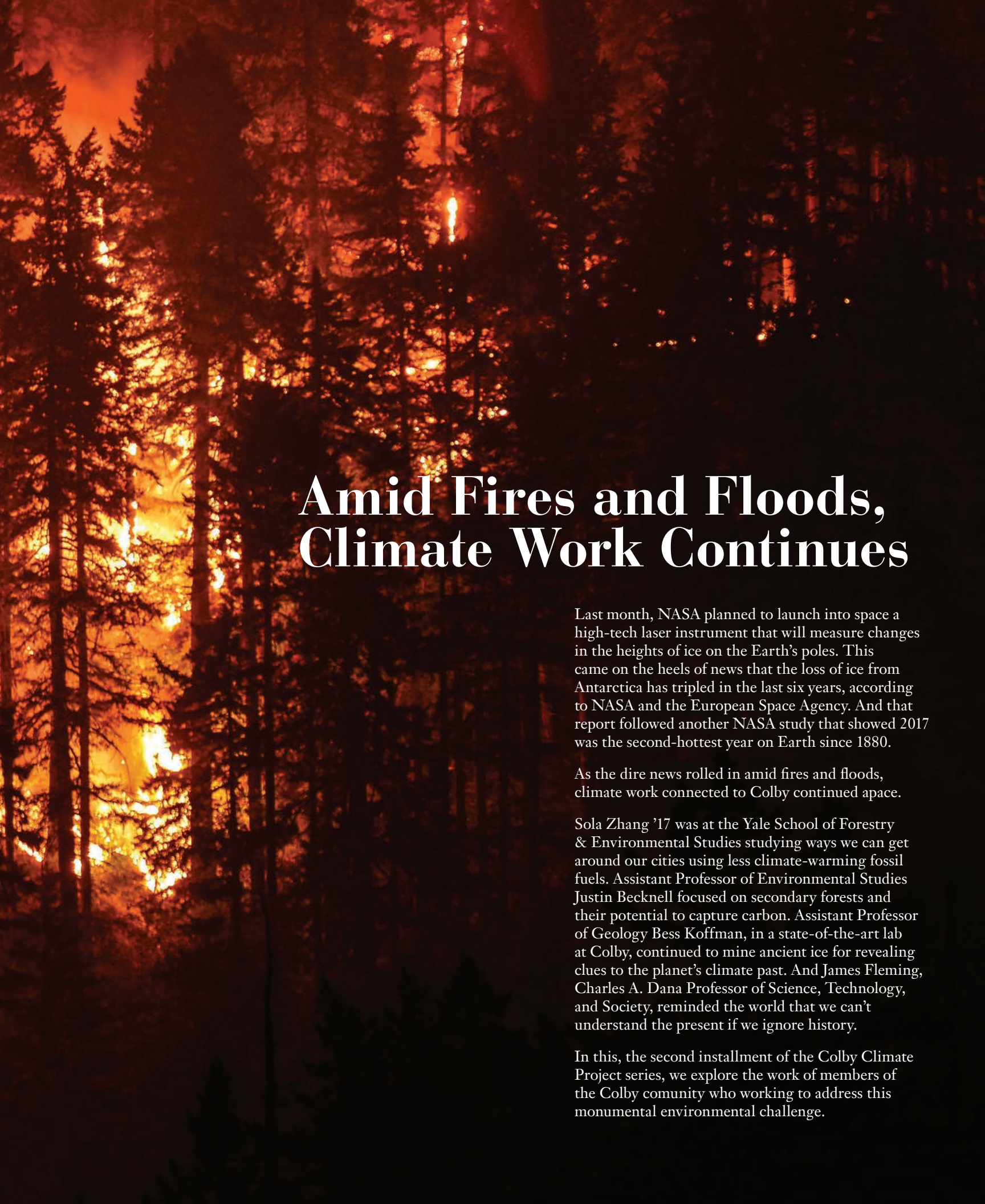


PAST and FUTURE

Climate experts consider where
our planet has been and where
it is going

Profiles by Christina Nunez
Portraits by Heather Perry '93





Amid Fires and Floods, Climate Work Continues

Last month, NASA planned to launch into space a high-tech laser instrument that will measure changes in the heights of ice on the Earth's poles. This came on the heels of news that the loss of ice from Antarctica has tripled in the last six years, according to NASA and the European Space Agency. And that report followed another NASA study that showed 2017 was the second-hottest year on Earth since 1880.

As the dire news rolled in amid fires and floods, climate work connected to Colby continued apace.

Sola Zhang '17 was at the Yale School of Forestry & Environmental Studies studying ways we can get around our cities using less climate-warming fossil fuels. Assistant Professor of Environmental Studies Justin Becknell focused on secondary forests and their potential to capture carbon. Assistant Professor of Geology Bess Koffman, in a state-of-the-art lab at Colby, continued to mine ancient ice for revealing clues to the planet's climate past. And James Fleming, Charles A. Dana Professor of Science, Technology, and Society, reminded the world that we can't understand the present if we ignore history.

In this, the second installment of the Colby Climate Project series, we explore the work of members of the Colby community who are working to address this monumental environmental challenge.

A black and white portrait of Bess Koffman, a woman with short dark hair and bangs, wearing large hoop earrings and a collared shirt. The portrait is overlaid with a complex geometric pattern of overlapping triangles in shades of blue, grey, and white. The text is positioned on the left side of the image, partially overlapping the geometric pattern.

Bess Koffman:
Time-Traveling
Through Antarctic Ice

From the outside, a plug of ice extracted from the depths of an Antarctic glacier might look like just that: ice. But that cylinder of frozen water contains an invisible layer cake of data about Earth's atmosphere over thousands of years.

Bess Koffman studies these ice cores, looking for clues about how wind patterns and dust levels have changed over time. Like tree rings or layers of mud at the bottom of a lake, ice can function as an "archive," storing past details that help us understand the current climate, says Koffman, an assistant professor of geology at Colby.

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Dust has an environmental significance that reaches far beyond the top of your television. Both in the past and today, airborne particles in the atmosphere reflect sunlight and contribute to cloud formation, producing a cooling effect. They also carry nutrients such as iron to the oceans, Koffman explained, feeding algae "that are working as the lungs of the world, eating carbon dioxide and pumping oxygen back out into the atmosphere."

Glaciers grind up a lot of dust. So do humans. The complex effects of farming around the world, from deforestation to fertilization runoff, also include dust that is "cooling the atmosphere just a tiny bit," Koffman said. The details about that grit—where it comes from, how much there is, and where it lands—have mind-boggling implications, touching everything from air temperature to marine life.

By melting an ice core one meter at a time and using advanced equipment to exhaustively analyze its contents, Koffman is able to see how dust composition in Antarctica has changed over time. Bigger dust particles, for example, point to stronger winds, which in turn affect ocean currents that influence how fast ice melts.

Koffman, who grew up in Maine, became interested in ice core research during her junior year at Minnesota's Carleton College, where she heard lectures from visiting glaciologist Richard Alley. Inspired, she read Alley's book about ice core research in Greenland, *The Two-Mile Time Machine*.

"I just found it really fascinating," she said. "He highlighted the fact that there are so many things we don't yet understand about the climate." She went on to conduct research in Antarctica, earning a Ph.D. in earth and climate sciences at the University of Maine.

One of the questions Koffman is exploring is how ongoing climate change will influence the natural sources of dust-derived nutrients in the ocean. Will we see an impact of these changes on marine algae and, in turn, the ecosystem as a whole? Understanding these dynamics will be important in managing marine fisheries, she says, as well as the sustainability of communities that depend on them.

Koffman is also interested in the best ways to engage students. She recently published a paper on how making scientific argumentation part of a college course can improve learning. "The idea is that you want to get students grappling with the evidence as much as possible," she says. She also plans to bring students into the lab and out in the field—going to local lakes, for example, to send a coring device into the mud.

It's a chance to inspire young students in the same way that glaciologist Alley inspired her as an undergrad. "I wanted to do something that I felt was relevant for society," she says of her research. "I felt like studying past climate would elucidate processes that are relevant for understanding our climate today and into the future." 🌍



Sola Zheng '17:
Seeking a
Smarter City

As a young student in Shanghai, Sola Zheng '17 wanted a college experience that would bring her closer to nature. She found it on Mayflower Hill, but one aspect of rural America jolted her.

“Lifestyle-wise it’s very different,” Zheng said. “I take subways, buses, or bikes everywhere in Shanghai. In Maine, it’s like you have to drive everywhere. That’s a really huge shift.”



You feel the magic of nature around you. [Colby] exposed me to the real damage that humans can do to these magical things.”

—Sola Zheng '17

Both aspects of Colby—the beautiful setting and Maine’s dependence on cars—informed the path she is on today as a graduate student focused on climate change adaptation and mitigation at the Yale School of Forestry & Environmental Studies. She is especially interested in how we can reduce our dependence on planet-warming fossil fuels by changing the ways we get around.

Zheng chose Colby for its renowned environmental studies program, but her education took on an unexpected dimension in the spring of her first year. “To be honest, I had no idea I would do computer science,” she said. An introductory class with Professor of Computer Science Dale Skrien caught her interest; in subsequent work with Associate Professor of Environmental Studies and Program Director Philip Nyhus using GIS (Geographical Information Systems), she realized she enjoyed applying spatial analysis to real-world environmental problems—mapping deforestation in Indonesia, for example.

She began pursuing classes in both environmental studies and computer science, “trying to think about ways the two can go together.” The result: Zheng was the first student at Colby to graduate with the interdisciplinary ES-computation major.

For her senior thesis, she worked with Loren McClenachan, Colby’s Elizabeth and Lee Ainslie Assistant Professor of Environmental Studies, to track the impact of climate change

on lobster distribution in the Gulf of Maine. Using remote-sensing data and GIS, they found lobsters were likely to move northward and also farther offshore to seek colder waters as the ocean warms.

“Lobsters move easily, but fishermen don’t,” Zheng said. So lobster fishermen on the southern coastline may eventually need to decide “whether they’re going to move with the

lobsters, or whether they are going to find a new livelihood.”

Aside from her mother’s love of plants, Zheng said, her megacity upbringing (Shanghai is home to more than 23 million people) was fairly detached from nature. The Colby campus was an introduction to the natural world, and a Jan Plan field trip to Belize—her first experience of the tropics—was “transformative,” she said. “You feel the magic of nature around you,” she recalled. “[Colby] exposed me to the real damage that humans can do to these magical things.”

Now back in a more urban setting in New Haven, Conn., Zhang is focusing her academic work on climate change topics such as energy and transportation, with a goal of working on climate-related analytics. One independent study has looked at improving sustainable transportation metrics for a statewide certification program. For an extracurricular project she worked with an NGO, Center on Climate and Energy Solutions, to look at challenges to implementing 100 percent renewable energy policies in small- and medium-sized cities.

Though she is likely to remain a city person, Zheng says she gained an appreciation of the natural world through Colby that she wouldn’t have gotten somewhere else. It’s a connection that will be important to establish in a world where two-thirds of the population will be living in cities by 2050.

“I’m a fan of the urban lifestyle,” she said, “but I really want to know how we can make it more environmentally friendly.” 🌍

Once a patch of tropical forest is razed, it isn't necessarily gone forever. Trees and wildlife often return, if given a chance. As trees grow, the forest resumes its role as an air filter, drawing planet-warming carbon dioxide out of the atmosphere and storing it.

That recovery process carries with it both hope and unanswered questions. "Can we help mitigate climate change by restoring tropical forests?" asks Justin Becknell, assistant professor of environmental studies. "If so, by how much, and how fast?"

Becknell's research aims to answer those questions.

Humans are destroying tropical forests at a breakneck pace for logging, agriculture, and real estate. But when loggers move on, or markets fall out, new plant growth filters back in, creating

behavior at the University of Minnesota, he worked as a research assistant in Costa Rica on evaluations of forest land recovering from conversion to beef pasture. He was energized both by the scientific questions surrounding secondary forests and their potential role as a solution in the quest to manage climate change.

His fieldwork typically has two modes. On the ground, he measures trees from plot to plot of forest, using that inventory to estimate carbon storage across a region. In the air, he uses LIDAR—which stands for Light Detection and Ranging, a form of remote sensing using laser light—to conduct landscape-scale surveys.

Becknell, who joined Colby's environmental studies faculty in the summer of 2017, plans to study Maine's



Can we help mitigate climate change by restoring tropical forests? If so, by how much, and how fast?"

—Justin Becknell,
assistant professor of environmental studies

what are known as secondary forests. Becknell has surveyed such forests in Costa Rica and Brazil, measuring how much carbon they are on track to sequester.

His findings were included in a broad analysis, published in the journal *Nature* in 2016, concluding that secondary forests in Latin America can accumulate 90 percent of the carbon that a mature forest would have, and do so within 66 years.

Sixty-six years "is a great number, because it says that these forests grow back really, really quickly," Becknell said. "That's a cool finding that kind of surprised us all as we put all of that data together."

Becknell grew up in Minnesota, where regular father-son getaways to the state's northern wilderness fostered an early love of the woods. Later, as a science-interested undergrad at the University of Minnesota, he said, "my ears would always perk up when we started talking about forest ecosystems."

While pursuing his Ph.D. in ecology, evolution, and

forests as well, to see how forest management practices relate to carbon absorption. He also wants to experiment with different uses of LIDAR. One involves mounting a sensor on a drone, which can fly lower than a plane would and collect data at a higher density, while the other involves using LIDAR from a tripod under the canopy. Both are complicated, relatively new approaches in forest ecology, he said.

"My early work was mostly measuring tapes and shovels," Becknell said, "but now I do a lot more laser beams and writing computer programs." The stakes are higher than you might think. Between 50 and 60 percent of the world's tropical forests are recovering from some kind of human disturbance, Becknell estimates. And as the human population grows, the pressure on forests will continue.

"We're continuing to log the whole world," he said. Because of that, "the forests of the future are really going to be the secondary forests." 🌍



Justin Becknell:
Studying the
Forests' Return

A black and white portrait of an older man, Jim Fleming, smiling. He is wearing a dark jacket over a light-colored shirt. The background is a light blue and white geometric pattern of triangles and polygons. On the left side, there is a vertical band with a darker blue and white geometric pattern. The text is overlaid on the left side of the image.

Jim Fleming:
Putting Science
into Historical
Perspective

Climate change in today's terms can often feel like a precipice: a 2°C limit for warming; 410 parts per million carbon dioxide in the atmosphere; 100-year weather events.

Carbon budgets. Thresholds. Milestones. Tipping points.

James Fleming looks beyond the immediate moment. People “often think of climate change as a static thing,” he said. “Things are more complex than we might imagine.”

The Charles A. Dana Professor of Science, Technology, and Society, Fleming holds the line for history in a relentlessly future-oriented culture. Currently, he’s “totally inspired,” he said, working on a book about Joanne Simpson, the first woman to earn a Ph.D. in meteorology. Among other accomplishments, Simpson made the first computer cloud model and became an expert in field projects in the tropics, furthering our understanding of how the tropical atmosphere affects global weather patterns.



History absolutely matters. You can't really understand science unless you take a serious look at its history.”

—James Fleming,
the Charles A. Dana Professor of Science, Technology, and Society

“History absolutely matters,” Fleming said. “You can’t really understand science unless you take a serious look at its history.”

Fleming began his career as a meteorological aircraft observer, measuring and modeling clouds. “It was a short-term employment because of the danger,” he said. “We only flew in bad weather, and we did have a near-accident.”

He switched fields and earned an M.S. in atmospheric science and a Ph.D. in the history of science. Fleming had found a niche. “Doors just opened up for me to publish,” he said. In addition to teaching, he has written and reviewed for the Intergovernmental Panel on Climate Change, and he’s authored five books, including *Fixing the Sky: The Checkered History of Weather and Climate Control and Inventing Atmospheric Science*.

As Fleming’s book title suggests, climate change has prompted lots of ideas about how to “fix the sky,” or alter the atmosphere to avoid the worst. In 2015 he served on a National Academies of Science panel to evaluate two concepts: reflecting sunlight to cool the earth and

removing planet-warming carbon dioxide from the atmosphere.

While these efforts are often called geoengineering, a label the panel planned to use on its reports, Fleming argued “engineering” was the wrong word.

“It’s tinkering,” he said. “The people who want to control the Earth tend not to be the most sophisticated in their understanding of atmospheric science.”

The panel concluded that reducing human-caused greenhouse gas emissions and adapting to our new reality were far more sensible measures than trying to exert control over the planet. Fleming prevailed on the word choice, convincing the panel to title its two 2015 reports Climate Intervention instead.

Rather than trying to bend the atmosphere to our will, he says, we should focus more on “changing ourselves and changing our hubris about that stuff.”

Recently, Fleming was elected to the council of the American Association for the Advancement of Science, the world’s largest multidisciplinary scientific society. It’s a fitting position, given his response when the conversation turns to how we can fine-tune our understanding of the changes taking place.

“We need a whole bunch of disciplines, not just the technical,” he said. “Atmospheric science is an umbrella term that covers a lot of different disciplines, and I think we need them all.”

Bringing themes together is one of Fleming’s roles. He thrives on getting students into the archives, showing them actual records of the past, and working with them to put history into context. From momentous data landmarks to outlandish schemes for controlling the environment, he finds many parallels between science conversations today and those decades ago.

“Everything’s unprecedented,” he says, “if you don’t study history.” 🌍