fellowships, she says, is increasing from 5 to up to 20. The program, she adds, focuses on early-career scientists and "can help bridge to the future."

The Research Corporation for Science Advancement tries to be "catalytic" with the $11 million it distributes annually, says Andrew Feig, a senior program director at the organization. In December, it gave a total of $800 000 to 11 current and past awardees who had lost funding or whose funding had been delayed. "We couldn't put a finger in the dike for all of the need," he says. "We triaged the applicants to see who had the most critical need and was experiencing meaningful disruption. We looked to see that they were making longer-term changes to meet the new funding norm."

In mid-January, Congress passed a budget that is nearly flat—a far brighter outlook than Trump's proposed budget, which would have cut funding for basic and applied research by 37%, according to estimates by the Science Philanthropy Alliance. Even so, research funding will change, says Feig. "If you are not in the pillars that the administration is interested in—critical materials, quantum information, AI—you had better be ready to pivot if you want to maintain funding," he says. "Federal funding may be more tied to translational work that can quickly move into applications."

"The goodwill of rich people"

"We are in a tight situation," says Mark Raizen, an experimental physicist at the University of Texas at Austin, "and it's clear that private foundations cannot pick up the slack." Applying for federal money has become very frustrating in recent years, says Raizen, whose work on production and applications of isotopes is mostly funded by philanthropies. "Researchers write proposals and get rejections. It's discouraging for young scientists." Still, he notes, federal agencies will renew funding for good work, whereas "foundations don't fund continuously: Once you have proven something, it's not high risk anymore."

"Researchers are looking more desperately for opportunities," says David Kaplan, a theoretical physicist at Johns Hopkins University. He notes that he and his colleagues are lucky to have funding from Michael Bloomberg. But philanthropies and individual donors can be "idiosyncratic," he says. Giorgio Gratta, an experimental physicist at Stanford University, says he appreciates the contributions of philanthropies and individual donors to science, but "going back to rely on the goodwill of rich people—like before World War II—seems like a step backwards for a nation that has been a trendsetter in funding fundamental science." PT

What the National Center for Atmospheric Research means to the atmospheric sciences

Born out of a time of great need for the federal government, NCAR plays a role with few analogues.

By Jenessa Duncombe

News that the National Center for Atmospheric Research (NCAR) may be dismantled broke in December. A senior White House official told *USA Today* that the administration wanted to eliminate the center's climate-related work and transfer some functions elsewhere. It was the first that NCAR's parent organization, the University Corporation for Atmospheric Research (UCAR), had heard of the plans.

NCAR's main sponsor, NSF, confirmed the news and announced that it would evaluate how to "redefine the scope" of NCAR's modeling and forecasting to concentrate on areas like weather prediction, severe storms, and space weather. The agency also said it would explore options to transfer the stewardship of NCAR's supercomputer, two research aircraft, and Mesa Laboratory.

The outcry was immediate. The American Meteorological Society, along with the American Astronomical Society, American Physical Society, and 11 other scientific societies, sent a letter to the White House and another to members of Congress expressing their concern. (AMS, AAS, and APS are member societies of the American Institute of Physics, publisher of *Physics*

The National Center for Atmospheric Research's Mesa Lab in Boulder, Colorado. (Photo by C. Calvin, © University Corporation for Atmospheric Research, CC BY-NC 4.0, via OpenSky.)

Today.) A congressional outreach campaign led by the American Geophysical Union has so far tallied 37 000 emails and phone calls. Supporters of NCAR gathered in protest in Boulder, Colorado, where NCAR is based.

Many of the news stories that followed highlighted NCAR's scientific contributions. Other coverage emphasized the center's climate research. At times, news articles implied that NCAR was a stand-alone climate lab, even though only about 100 of the center's 800-some employees work in the climate division. (For more on NCAR's programs, see the 2017 *PT* article "Atmospheric research in the Rocky Mountain foothills.")

Despite all the attention that has been given to what NCAR does, there has been little discussion of what NCAR is. NCAR is an oddity in the scientific ecosystem: It's not a government lab, nor is it a university. It's a federally funded R&D center (FFRDC). NCAR is managed by a nonprofit consortium of universities, which sets it apart from many of the nation's FFRDCs. NCAR has been continuously funded by NSF since its beginnings, and it represents a Big Science mode of support that is envied by researchers in other fields.

NSF is in the process of deciding how to transform NCAR, and the community can weigh in by responding to NSF's Dear Colleague letter through 13 March. During this time of transition, it is worth exploring why NCAR is the way it is and what makes its role in its field unique. This picture came together via historical records, interviews with past NCAR and UCAR employees, and conversations with past and present collaborators with the center.

The backwaters of science

Atmospheric science in the US was not in a good place after World War II. About 90% of meteorologists were employed by the federal government, and few worked at universities. Meteorology was thought of as more of a trade than a science, and many people interested in science looked elsewhere. Between 1953 and 1957, an average of 10 meteorologists were awarded PhDs per year nationwide, according to a paper in the *Bulletin of the American Meteorological Society* by George Mazuzan, a former NSF historian.

Officials at the National Weather Service's predecessor, the US Weather Bureau, worried about an impending workforce shortage. A special committee of

A meteorologist adjusts an anemometer on a weather station, on a 1945 cover of the Army Air Forces *Weather Service Bulletin*. (Image from Headquarters Weather Wing Army Air Forces; courtesy of the family of Nels Johnson, US Weather Bureau [dec.].)

meteorologists convened in 1956 by the National Academy of Sciences considered solutions. The committee concluded that the lack of both academic departments and money to support them was preventing the realization of the discipline's potential. Simply awarding more small grants to university scientists or setting up localized research centers would not be adequate.

The committee argued instead for what NSF calls Big Science—large-scale research programs or centers funded by the agency. It recommended in 1958 that NSF sponsor a new, independent institute where internal interdisciplinary scientists would join those from academia and government to tackle global problems. It was a lofty goal, and NSF signed a contract with UCAR to start NCAR in 1960. NSF has been its main sponsor ever since.

Over time, meteorology was broadened into the atmospheric sciences, which synthesizes meteorology with many other disciplines, including engineering, physics, chemistry, math, and astronomy. Smaller-scale funding grew too. The number of universities receiving grants for meteorology or atmospheric sciences increased sixfold from 1958 to 1962, according to Mazuzan. From 1959 to 1963, the total money awarded shot up more than 150%.

Science is the customer

The center's first director, Walter Orr Roberts, insisted that NCAR "must be, first and foremost, an intellectual center." It would have its

own staff and a central lab. There was, however, an inherent tension in NCAR's formation. Principal investigators at universities and at NCAR would be competing for the same talent and pots of federal money. The solution was to make the university community NCAR's primary customer. Anything that individual institutions would be hard pressed to pursue by themselves, NCAR could take on.

Of the country's current 41 FFRDCs, many are run by a corporation or a university. For example, the not-for-profit Mitre Corp runs six FFRDCs, including the Center for Advanced Aviation System Development in McLean, Virginia; Caltech manages the Jet Propulsion Laboratory. A subset of FFRDCs are run by university consortia, like UCAR. The nonprofit is made up of 129 North American colleges and universities in the Earth system sciences. UCAR's close collaboration with the geosciences community sets NCAR apart from other FFRDCs.

Multiple researchers expressed concern about breaking apart NCAR and therefore potentially fragmenting the university-led, Big Science vehicle. "NCAR truly has been and remains a singular institution," says Daniel Swain, a research partner at NCAR and a climate scientist at the University of California Agriculture and Natural Resources. "To break it up would be to greatly diminish it. It's more than the sum of its parts."

Modeling the fundamentals

One important example of Big Science at NCAR is in its research in atmospheric modeling. In the dawn of weather modeling in the 1960s, NCAR was one of the US innovators of general circulation models to mathematically represent Earth's atmosphere and related components. Powerful computers run simulations by solving fundamental physics equations to account for constraints like mass and energy conservation.

NCAR focused on reducing the errors in its models' numerical schemes. Led by NCAR scientists Akira Kasahara and Warren Washington, NCAR's modeling group was one of the first to build a global model and to build a model that used a height-based z-coordinate system, which improved the simulation of mountain ranges.

Along with NCAR, UCLA and the US Weather Bureau's Geophysical Fluid Dynamics Laboratory were the hotbeds for computational modeling at the time. That was an ideal situation for NSF: Rather than funding half a dozen or more university labs across the country to build fundamental models, the agency could concentrate its money in a few places. The consolidation was all the more important because computer technology was progressing so quickly that institutions were purchasing new equipment and recoding their models every three to five years.

The work paid off: NCAR had released three major general circulation models by 1980. Crucially, it made its user manuals and code for its Community Climate Model freely available. As computing facilities at university departments became more widespread, academics used NCAR's model to test their ideas. There was no need for a university lab to have a software engineer—NCAR had them. Among NCAR's popular models is one of its prediction systems, the Weather Research and Forecasting Model. UCAR says it has 39 000 registered users worldwide. All software is public. (See Ryder Fox's 2016 *PT* article, "Dissecting the rapid intensification of Hurricane Patricia," which discusses the model.)

NCAR's fundamental research informs not only users but also public models. Today, the Department of Energy hosts the world's fastest supercomputers, and the agency decided a decade ago that it wanted to build a climate model on one of them. It used the architecture from NCAR's Community Earth System Model to build it. The Energy Exascale Earth System Model won the Gordon Bell Prize in 2023 when it succeeded at modeling cloud formations over decades. (For some history about DOE building its exascale model, see *PT*'s 2014 article.)

Private-sector scientists use NCAR's tools too. Mary Glackin was the senior vice president for science and forecast operations at the Weather Company until 2019. NCAR had recently rolled out the Model for Prediction Across Scales (MPAS), and the Weather Company became an early adopter of it. NCAR's work was first class, Glackin says, and it packaged the model in

Learn more about NCAR history

- P. N. Edwards, "History of climate modeling," *WIREs Clim. Change* **2**, 128 (2011).
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From left: Sara Paull, Mary Hayden, and Savannah Ciardelli-Mullis collect mosquito samples in Colorado. As part of NCAR's interdisciplinary work, researchers study vector-borne diseases like Zika. (Photo by C. Calvin, © University Corporation for Atmospheric Research, CC BY-NC 4.0, via OpenSky.)

a way that was easy for the company's researchers to use. In January, the National Weather Service announced plans to adopt MPAS for the mathematical core of its next-generation flagship US weather forecasting model.

Although serving the private sector and other government agencies was not in the original design for NCAR, the center has grown to have "many, many collaborations," says UCAR spokesperson David Hosansky. Navigating those collaborations has posed a challenge for some scientists, including climate scientist and NCAR distinguished scholar Kevin Trenberth. As his work grew in scope beyond the funding that NCAR could provide, he had to write proposals to NOAA, NASA, and DOE. "Then, we were subject to their missions as well as NCAR's missions," says Trenberth.

"The glue and the oil"

Multiple people who spoke with *PT* emphasized that NCAR serves as a central hub in the atmospheric sciences. More than 600 visitors traveled to NCAR in fiscal year 2025 from 165 institutions across 37 states and 23 countries, according to Hosansky. Others come for graduate and postdoc fellowships or internships.

When the news broke that NCAR might be dismantled, the words that scientists used to describe NCAR were telling. They called it the "beating heart," "global mother ship," and "the glue and the oil of atmospheric science." The broad reach is illustrated in the diversity of scientific societies—including ones in oceanography, entomology, microbiology, astronomy, and geology—that signed the letter protesting the rescoping of NCAR.

NCAR is a community social activity, says former NSF program director Clifford Jacobs. Even the layout of the Mesa Lab, one of NCAR's many buildings in Boulder, was designed to encourage small groups of people to stop and chat. (See the 2010 *PT* feature by Stuart Leslie, who takes a deep dive into laboratory architecture, including Mesa Lab's.) "We so often forget that science has a strong social component to it. We always just talk about the formulas and this and that. But I'm a very big believer in the social aspects of science," says Jacobs. "NCAR has that community sense of them. Everybody feels that they have ownership in NCAR." PT