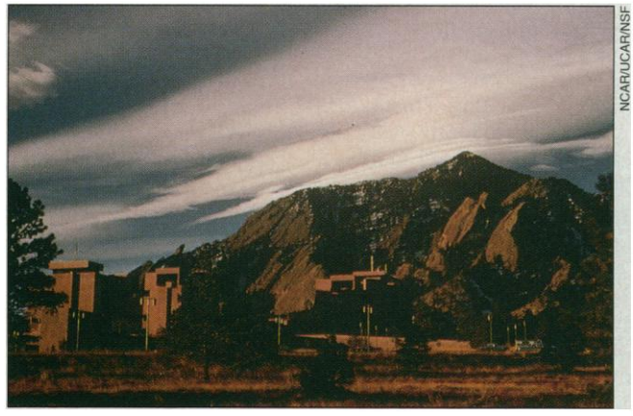
INSTITUTIONAL PROFILE

NCAR: Doing Quality Science In a 'Garage for Planes'

The National Center for Atmospheric Research, or NCAR, fits right into its environment. Its blocky pink walls soar upward like the great slabs of rock that rise behind the center's perch beneath Colorado's Flatirons, foothills to the Rockies. In winter snows, built and natural structures seem to merge completely. But as an institution for scientific research, NCAR stands out.

It's big: The $54 million it got last year from the National Science Foundation (NSF) was the largest single item in the NSF budget. And it has to balance two big jobs. On the one hand, the Boulder, Colorado, institution is supposed to provide planes, radars, computers, and other expensive hardware to let the rest of the atmospheric science community participate in big science, such as large-scale field studies of El Niño. At the same time, NCAR staff—using those same facilities—are expected to perform high-quality research of their own, such as climate modeling, on a scale unattainable by individual investigators or even a single university.



NCAR/UCAR/NSF

A place by the clouds. The National Center for Atmospheric Research sits beneath the Rockies' Front Range.

Recently a number of atmospheric researchers, both within and without the center, have argued that NCAR has lost its balance. NCAR, outside researchers say, has been neglecting the acquisition of facilities like planes and computers while emphasizing its own science, and funding that science with federal grants that might otherwise have gone to universities. Yet some of NCAR's own researchers feel that the center's mission to serve the outside community has distracted it from important scientific endeavors. They complain that an overemphasis on university meteorological research has kept NCAR from focusing on pressing scientific problems such as global change, and as a result some of the center's top scientists, including climate modeler Stephen Schneider, have left for positions at universities.

Last year, all the complaints got bad enough that NSF essentially put NCAR on academic probation. A consortium, the private, nonprofit University Consortium for Atmospheric Research (UCAR), usually gets 5-year agreements to manage NCAR for the foundation, but when they applied for a new one in 1992 NSF turned them down. Instead, NSF gave the consortium only a 1-year extension on the contract and some marching orders: straighten out NCAR's relations with the rest of the atmospheric science community.

Apparently they did, at least on paper, for a new 5-year agreement was just approved last month. Under it, most of any additional funding NCAR gets—above its present budget—will go to beefing up facilities, such as acquiring additional planes and a new computer, rather than supporting in-house science. It's a reasonable plan, says Richard Greenfield, director of NSF's Division of Atmospheric Science: "The response of UCAR and the community has been very positive. In the long run, this has been very healthy."

But no one expects the plan to make the tensions disappear, for the reasons behind them are also the reasons for NCAR's success. The conflict over facilities, for example, is exacerbated by the center's commitment to scientific excellence. The atmospheric technology division is NCAR's largest with 150 persons and a budget of $18 million per year. It operates three planes: a four-engine, long-range Lockheed Electra, a twin-jet North American Rockwell Sabreliner, and a twin-turboprop Beechcraft King Air. These and the 100-plus instruments they can carry operate in field studies of all sizes, from probing violent weather in the Midwest to taking the pulse of El Niño in the Pacific. But it takes money to get planes up in the air, and outside scientists had charged that NCAR wasn't spending enough of its budget on flights for university researchers, directing money instead toward enhancing computer models and other internal research. And some university scientists doubt that it's worth it. NCAR gets 40% of the NSF atmospheric science budget, notes Harvard atmospheric chemist Jennifer Logan, but "do they produce that fraction of the productivity of NSF-funded science?" She suspects not.

One answer from NCAR researchers to questions of productivity is that they also produce "facilities" that neither fly nor compute—facilities that are open to anybody who wants to use them. Thomas Holzer, head of NCAR's High Altitude Observatory, which runs studies of the sun and its effects on the upper atmosphere, points to a computer model being developed by aeronomist Raymond Roble as an example of a community facility that exists only because of the science at NCAR. Much as cli-mate models simulate the behavior of the globe's lower atmosphere, Roble's model reproduces the "climate" of the rarefied upper atmosphere where solar radiation and cosmic rays combine to produce a strange brand of weather. Now extended down through the stratosphere, this model is available to anyone who wants to run it.

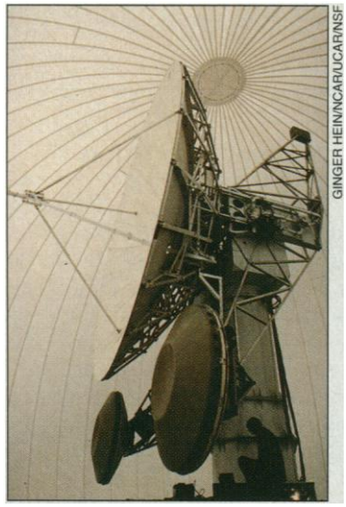
"To provide good products," says Guy Brasseur, head of the atmospheric chemistry division, "you need to have strong science related to the program." Furthermore, he says, the reason that NCAR scientists don't appear as productive as their university colleagues is precisely because they spend so much time serving the community, even to the point of shortchanging their own scientific efforts. "The number of discoveries per scientist is probably lower [at NCAR] than at a good university," says Brasseur, but "it's not that the scientists are not as good, it's because they have some different goals. People build tools used by others, organize field campaigns [for the community], and provide a framework" for the field, so that they are not as productive of science as they might otherwise be.

Part of the problem at NCAR is that bigness is emphasized but bigger isn't always better. It can also mean bureaucracy, which

NCAR/UCAR/NSF

High-flying facilities. The NCAR fleet studies everything from acid rain to tornadoes.

in turn can mean resistance to change, and some critics charge that NCAR's management has not picked up on new ideas very quickly. While global change centers boasting interdisciplinary staffs were popping up at universities like dandelions on a spring day, NCAR was slow to realize the possibilities, much less take the lead, according to some researchers. "We look to NCAR to show how the subfields relate to one another and make them work together," says atmospheric chemist Ralph Cicerone of the University of California, Irvine, who left NCAR several years ago. "It hasn't happened yet."



GINGER HEIN/NCAR/UCAR/NSF

Big eye. NCAR's Doppler radar spies foul weather.

Cicerone wasn't the only one who left. There was a brain drain of global change specialists who departed for greener pastures in academia. The list of departures includes Schneider, who is now at Stanford, radiation and climate specialist V. Ramanathan of Scripps Institution of Oceanography, and land-atmosphere interaction expert Robert Dickinson of the University of Arizona.

They "all felt that the scope of science was being limited not by budget, but by lack of vision of management," says Cicerone. Managers focused on traditional meteorology, he says, and missed the potential of global modeling. "There was a clinging to the science of the past," he adds. A former NCAR staffer, who wishes to remain anonymous, agrees: "The paradigm has passed them by." At their new university positions, these researchers feel less encumbered. Ramanathan says he can "decide what I want to do. If the ideas are good, I get the money and do it."

Modeler and UCAR board chairman Richard Somerville of Scripps concedes that "NCAR is a little more hierarchical" than universities, given that any NCAR researcher who wants to redirect their science fundamentally must argue their case all the way through a division, then to UCAR, and even to NSF. But that's a price that researchers must pay, he says, in return for access to superb facilities and a minimum of nonscience responsibilities, such as teaching. Still, "NCAR would be better," he says, "if it had a small number—but larger than it is today—of top, world-class scientific leaders."

To attract more heavy hitters, keep the entire scientific staff energized, and supplement NSF funds, researchers have been allowed to compete for more outside grant money. Non-NSF funding has doubled since 1982 and now amounts to more than one-third of NCAR's total funding. Climate and global dynamics, which was 80% funded by NSF 5 years ago, now gets 50% of its money elsewhere, from agencies such as the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, and the Department of Energy. It even has a Cray Y-MP2 computer that is funded by a consortium of industry, government, and academic interests. "We're a different NCAR," says climate division director Warren Washington. "We're not just an NSF center."

These new sources of funding, although well-intentioned, have brought troubles of their own, and again they involve NCAR's relationship with the rest of the world. University researchers are perennially worried that NCAR scientists set loose in the federal grant system will drain away money that would otherwise go to them. And beyond that, if the upward trend in outside funding were to continue, NSF—the agency ultimately in charge of NCAR—would soon find itself a minor stockholder in the enterprise, notes Eugene Bierly of the American Geophysical Union, a former NSF Atmospheric Science Division director. The new contract with NSF contains some clauses about limiting NCAR's reliance on outside funding, and while that may ensure that NSF remains in the driver's seat, it's not clear whether it will solve the larger problem of competition with university researchers.

It seems that no matter what NCAR does, it's so big it annoys someone, somewhere. The late Jules Charney, the preeminent dynamical meteorologist of his day, once observed that "NCAR wouldn't succeed if it were nothing more than a garage for airplanes." Yet it must not be too successful. It must serve others while looking after its own considerable interests. Shaping a good neighbor policy that works when you're also a landlord will continue to challenge the entire atmospheric research neighborhood.

–Richard A. Kerr

SUPERCOMPUTERS

Favoritism Found in ARPA Funding

More than a half-dozen U.S. companies make the new breed of supercomputer known as massively parallel machines, which harness anywhere from dozens to thousands of low-powered central processing units working in tandem to solve big problems. Yet just two firms, Thinking Machines Corp. and Intel Corp., have locked up more than half of the total U.S. market for these innovative machines, which are now finding many niches in science, from analyzing protein structure to forecasting the weather. An investigation of the parallel computing program at the Advanced Research Projects Agency (ARPA), whose funding helped create the revolution in parallel processing, has now provided at least one reason why a couple of giants dominate the field.

In a report released last week, the congressional General Accounting Office (GAO) confirms industry allegations (*Science*, 2 April, p. 20) that in the past ARPA's research support and purchasing policies have consistently favored the two companies, to the extent of essentially excluding their competitors. GAO found that, of the 68 massively parallel machines that researchers have purchased with ARPA support (excluding a few from companies that have since left the business), nearly two-thirds were made by Intel—and all the rest by Thinking Machines.

This imbalance stemmed from ARPA's initial support for Intel's and Thinking Machines' development of massively parallel computers. Starting in the late 1980s, ARPA backed Intel and Thinking Machines hardware development as a way to spur research in the area and also funded researchers to test prototypes and buy finished machines from those companies so they could conduct research on software to exploit the parallel computer designs. GAO concluded that, while it was appropriate for ARPA to support the testing of ARPA-funded prototypes, "ARPA does not appear to be justified in restricting the [subsequent software research] program to only those machines it helped develop." For research on the general application of massively parallel machines, as opposed to the design of a particular machine, GAO recommends that ARPA place a wider range of machines in the laboratories of its grantees.

ARPA responded in a statement that it is "having discussions" with previously excluded companies on ways to include them in future selections. Industry observers agree that the agency appears to be mending its ways. Since the GAO investigation was launched last year at the request of the House of Representatives Armed Services Committee, "my sense is that there has been considerable movement to level the playing field," says Jeffrey Kalb, chief executive officer of MasPar Computer Corp., a Sunnyvale, California, company that had previously been one of those shut out of ARPA's contracts.

–Christopher Anderson