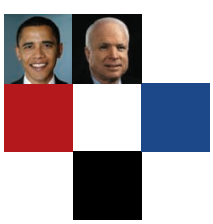
Into the woods. Research on climate change impacts includes studying how forests will respond to rising temperatures.

Impacts Research Seen As Next Climate Frontier

Scientists hope the next U.S. president will devote more of the billion-dollar climate change research program to impacts

Marine ecologist Jane Lubchenco was among the first scientists to study how ecosystems off the California coast are being affected by climate change. Although that work has put her ahead of the curve, it's hurt her chances of obtaining funding from the $1.8 billion U.S. Climate Change Science Program (CCSP), the major federal effort in the field. "[Its] focus has definitely not been on understanding impacts," says Lubchenco, a professor at Oregon State University, Corvallis, and a former president of AAAS (which publishes *Science*). Instead, she's relied on grants from private foundations to support her examination of oxygen-depleted oceanic "dead zones."



Science and the 2008 Campaign

Neither Republican John McCain nor Democrat Barack Obama has discussed climate change research on the campaign trail. But both presidential hopefuls have weighed in on the need to better understand the regional consequences of global warming—the kind of information Lubchenco is collecting. In May, at a town hall meeting in Portland, Oregon, McCain warned of "more forest fires" and "more heat waves afflicting our cities." In July, Obama told a Dayton, Ohio, audience that climate change could bring "devastating weather patterns, terrible storms, drought, and famine."

McCain is thinking about reorienting the climate research program toward what his aide, Floyd DesChamps, calls "urgent impacts." He says that the White House's "21 [CCSP] reports" are inferior to the "real National Assessment" that his boss would launch. Obama's campaign says he'll stress "short-term and long-term effects" on society and ecosystems. Both candidates have promised to strengthen Earth monitoring and efforts to link scientists and local officials.

To implement those changes, the next president will need to beef up and restructure the 18-year-old CCSP. A string of reports by experts say CCSP has been plagued by a stagnant budget, poor coordination between participating agencies, and a lack of White House leadership. The U.S. National Academies' National Research Council (NRC) concluded in 2007 that local and regional officials are receiving "inadequate" help in preparing for potentially catastrophic changes. Its report also pointed to the country's "relatively immature" understanding of how climate change may affect residents. "The health of the climate science [program] is not what it should be," says Representative Rush Holt (D–NJ), speaking on behalf of the Obama campaign.

Missed opportunities

Created by Congress in 1990, CCSP coordinates climate change research across 13 federal agencies. Initially called the U.S. Global Change Research Program, it helped U.S. scientists lead a global effort that by 1999 had, in the words of former GCRP Director Richard Moss, "nailed the question of detection, 'Is climate changing?' and attribution, 'There is a human cause.' " The next step, Moss says, would be getting a better handle on the impacts of climate change and developing adaptation strategies.

In 2002, the Bush Administration renamed the program and laid out five overarching strategic goals, three addressing basic climate science and two focused on impacts and adaptation. But roughly 75% of the funding gets spent on the first three goals. "They said, 'Wait a minute, we're not there on the question of detection and attribution,' " says Moss, who ran CCSP until 2006. "There was far less of a shift in the program than [we had proposed]."

William Brennan, the current CCSP

CREDIT: NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

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director, says the lopsided emphasis within CCSP on characterizing global climate change over identifying impacts reflects "our state of [scientific] understanding." But the NRC study said the U.S. program lacks the investment in data or modeling capabilities to forecast how warming might create feedbacks, such as carbon released from warming soils or methane from melting tundra.

As did the Clinton Administration, the Bush team gave CCSP little power to set agency budgets or shift priorities. Each participating agency controls its own budget and must approve decisions taken by CCSP staff. "The structure discourages the CCSP coordination office from taking initiatives on anything that even a single agency, or a single White House official, opposes," says former CCSP staffer Nick Sundt. "It's a deficiency," acknowledges Brennan.

A report released in August by eight national climate and weather organizations says CCSP needs more budgetary control and recommends that its director "report directly to the President." Policy experts believe a stronger CCSP could persuade agencies to invest more in areas such as impacts. They also argue that the effort needs more money.

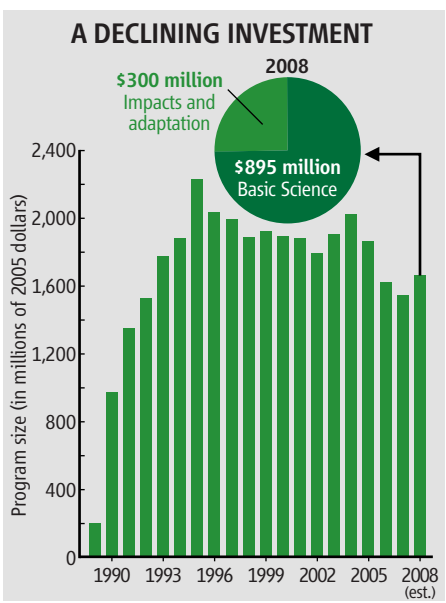
The bread-and-butter climate research budget has hovered at about $1.9 billion in constant dollars since 1994, although a recent downward trend has squeezed academic researchers and federal climate scientists alike (see graph). The totals include funds for satellite programs—more than $1 billion in some years. Infrastructure needs for labs run by the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service, and NASA take up much of the rest, although the exact distribution is hard to follow. (A 2005 report by the Government Accountability Office, for example, is labeled *Federal Reports on Climate Change Funding Should Be Clearer and More Complete*.)

The declining amount of funds actually available for scientific research has meant fewer scientists tackling increasingly complex issues, including modeling ice sheets and measuring the effect of aerosols on local climates (*Science*, 22 August, p. 1032). A flat budget has also put a squeeze on hiring the next generation of scientists. As an example, the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, receives 300 or so mostly "outstanding" applications each year for postdoctoral fellowship spots but can support only 40, says Jack Fellows of the University Corporation for Atmospheric Research, which manages the center. "The system is so starved right now," adds Harvard University atmospheric chemist James Anderson.

Feeding it would require a budget of $4.5 billion by 2014, say climate research advocates, citing recommendations in reports by the U.S. Commission on Ocean Policy and NRC. But achieving that level won't be easy, admits Fellows, who helped write the August report and who briefed White House budget officials on its contents. "They kind of laughed at me," he recalls.

Having a voice

Researchers who run the nation's Earth-sensing network are feeling the pinch as much as anyone. Continuous measurements from space are crucial for monitoring climate impacts such as ice melting, sea-level rise, and changing pollution patterns, and such data underpin the whole climate research program. In addition, as support grows for implementing emissions cuts, "you have to monitor the planet closer than we're doing to see that [the cuts] are working," says NCAR Director Eric Barron.



A basic difference. The CCSP's research budget is dominated by efforts to characterize and model global climate rather than understand its impacts.

SOURCE: U.S. CLIMATE CHANGE SCIENCE PROGRAM

The U.S. environmental sensor fleet includes roughly 30 orbiting satellites studded with more than 120 instruments, as well as land stations and ocean buoys. Most climate sensors fly on experimental NASA crafts designed to last roughly 5 years. To establish a more permanent system, the government is building the $14 billion National Polar-orbiting Operational Environmental Satellite System (NPOESS). Managed jointly by NASA, the Pentagon, and NOAA, NPOESS includes 12 weather, climate, and space weather sensors on five bus-sized satellites, launched sequentially from 2010 to 2026.

It's an audacious vision, but the next Administration will inherit a 14-year-old program in trouble. In addition to soaring costs, repeated delays have increased the chances there won't be NPOESS satellites in orbit to continue crucial climate data records when NASA satellites fail. Scientists say an influential White House climate office might have made a difference. "We didn't play a role in that," says Brennan, who is also acting NOAA administrator. "I wasn't pleased."

Both presidential candidates have promised to revitalize Earth monitoring, but they'll also face the problem of processing NPOESS climate data on the ground. "The NPOESS program lacks essential features of any well-designed climate observing system," noted last year's NRC report.

Some critics of the U.S. climate research program say it needs more than an increase in funds and new hands on the helm. One radical government restructuring would merge NOAA and the U.S. Geological Survey to create an Earth Systems Science Agency. "No one agency has Earth observation as their number-one priority," says Mark Schaefer, a former official at the Interior Department, who proposed the idea in an article in *Science* earlier this year (*Science*, 4 July, p. 44) with former top brass from NOAA, NASA, and other agencies. A unified monitoring agency could manage huge programs like NPOESS more effectively, he claims.

The Bush Administration opposes such a massive reshuffling. "We need to focus on what needs to get done. I don't want to spend 2 years moving boxes around in the federal government," says Mary Glackin, NOAA's chief operating officer.

Scientists who have briefed the campaigns on how to reform the nation's current climate research say the candidates have gotten the message. The current CCSP staff is also preparing transition documents that recommend a shift toward impacts science. "The campaigns are talking about this," says Lubchenco, approvingly. "What I would like to see is that [talk] transformed into viable research programs."

–ELI KINTISCH

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