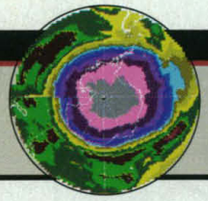

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Greenhouse shreds Antarctic ozone

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Far-out galaxies

LEAD STORY

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A credit-card–sized biolab

most incomprehensible," Schimel says.

Several modelers contend that the study is riddled with uncertainties. For one thing, the two models used to gauge carbon flux "could easily be off by just a little bit, and you get a very different conclusion," says Fung. The results could also be skewed by a dearth of data from the North Atlantic, as the authors note in their paper. For example, the group threw out readings off Sable Island, Nova Scotia, because the data were unreliable, says team member Pieter Tans of the National Oceanic and Atmospheric Administration. Factoring in Sable Island, the sink shrinks by 30%.

Even if the results do hold up, observers note, the CMC study's time period includes the 1991 Mount Pinatubo eruption, which led to cooler, wetter conditions and a much higher global carbon uptake than usual. "Some of this sink must clearly be … transient," says Martin Heimann, a modeler at the Max Planck Institute for Biogeochemistry in Jena, Germany. And the findings clash with those from a team led by Peter Rayner of Monash University in Australia, which calculates a North American sink of only 0.6 petagrams of carbon from 1988 to 1992—about one-third the CMC group's estimate. The Australian group's results will be published next year in *Tellus*.

The CMC team acknowledges that its results strain credibility. "I have trouble quite believing" the size of the sink, says Tans, adding that "We're pushing the data pretty far." But, says Sarmiento, "we've really carefully analyzed the data in a lot of different ways." U.S. Geological Survey geochemist Eric Sundquist agrees: "The paper is a credible and rigorous interpretation of the available data."

More and better data, including direct measurements of carbon storage and flux over land, will be needed to narrow the gap between the two studies. Already, this approach has turned up a big surprise: According to the U.K. group's results, undisturbed tropical forests in South America are getting thicker and may account for about 40% of the missing sink, a figure seemingly at odds with the CMC group's inversion results. The study is the first to pool data from measuring carbon storage, or biomass, over 2 decades at over 150 tropical forest plots worldwide. "This illustrates the types of studies that really need to be integrated," says Sundquist.

Before this research has time to mature, however, the possibly vast North American carbon sink could be the subject of heated debate in climate treaty implementation talks next month in Buenos Aires, Argentina. If the CMC team's findings are accurate, "the most obvious conclusion" would be that "there's no need for the U.S. and Canada to curb emissions," says Heimann. Indeed, Steven Crookshank of the American Petroleum Institute says the study "calls into question the scientific basis on which we're making these decisions, when we still don't know if the United States is even emitting any carbon in the net."

But some observers argue that a large North American sink should not be an excuse to go easy on emission controls. Maturing forests eventually stop storing carbon, so "this part of the missing sink [won't] be with us forever or even much longer," says atmospheric physicist Michael Oppenheimer of the Environmental Defense Fund in New York City. "The existence of the sink isn't important. What's important is the changes in the sink."

–JOCELYN KAISER

SOURCES: NATIONAL SCIENCE EDUCATION STANDARDS; CALIFORNIA ACADEMIC STANDARDS COMMISSION; PHOTO: VISUALS UNLIMITED

SCIENCE EDUCATION

California Adopts Controversial Standards

Third-graders in California will be taught about the periodic table, and sixth-graders will learn about Earth's "lithospheric plates" under a new set of standards* approved last week by the state Board of Education. The standards—which will be used to revise the state curriculum, set guidelines for textbooks, and develop statewide tests—have been sharply attacked by many science education reformers, who contend that they focus too much on detailed knowledge and too little on concepts. Although the board's action appears to put an end to the controversy, critics are hoping that the winner of next month's gubernatorial race will revive the debate.

The standards reflect California's first attempt to spell out what students in kindergarten through 12th grade should learn about science. They follow on the heels of mathematics standards that were even more hotly contested before their adoption last December (*Science*, 29 August 1997, p. 1194). New tests for the state's 5.5 million students are scheduled to be ready in 2000—the same year public school textbooks will have to meet new guidelines. Those are expected to influence science teaching across the country, as California represents more than 10% of the national textbook market.

Last Friday's unanimous vote by the board came after a final flurry of lobbying and letter-writing by more than a dozen scientific societies (including the American Association for the Advancement of Science, which publishes *Science*). Some of these groups offered to help rewrite the final draft to bring it into line with National Science Education Standards issued in 1996 by the National Academy of Sciences (NAS). "It doesn't match the [national] standards in any way," says NAS President Bruce Alberts. He and others believe that the state standards contain so much factual material that teachers will be forced to skip more in-depth learning activities that would give students a better understanding of the scientific process.

But others praise the California standards as a challenging but realistic set of ex-

* See http://www.ca.gov/goldstandards; revisions are at http://www.cde.ca.gov/board/board.html

WHAT THE BATTLE'S ABOUT

NAS STANDARDS (Physical Science, grades K-4)

"Materials can exist in different states—solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling."

[Elements are introduced in grades 5-8; atoms are covered in grades 9-12.]

CALIFORNIA STANDARDS (Physical Science, grade 3)

"Matter has three forms: solid, liquid, and gas. … Evaporation and melting are changes that occur when the objects are heated. … All matter is made of small particles called atoms, too small to see with our eyes. … There are over 100 different types of atoms which are displayed on the periodic table of elements."

Standard deviation. California's new science standards introduce the periodic table in grade 3, while those developed by the National Academy of Sciences discourage use of the terms "atom" and "molecule" with students younger than high school.

pectations for students. "I think they're perfect," says Michael Morgan, a chemistry teacher and chair of the science department at Francisco Bravo Medical Magnet School in Los Angeles, who helped to draft the document. "The average student with a caring teacher can get through this."

At the heart of the debate is the role of the state standards. Should they represent a realistic goal for all students, or should they be a challenge for even the brightest ones? Supporters say the new standards set high expectations and will prepare students for tomorrow's technology-driven economy. The California standards "are not designed to be a description of basic literacy," says biologist Stan Metzenberg of California State University in Northridge, one of the lead consultants on the writing committee. "It's obviously much more than what you might expect every student to leave high school with." But the standards will provide a basis for tests that will allow school districts and parents to gauge how well students are doing, he adds.

In contrast, detractors fear that the quantity of material required by the standards will drive students away from science by making it unappealing. "These standards are so chock-full of factoids," says American Physical Society President Andrew Sessler, "the only way you can get them across is by rote learning." Critics also complain that abstract concepts are introduced too early (see figure). "When you start teaching first- and third-graders about abstract things like atoms and molecules," says Alberts, "what we actually do is not have kids understand anything."

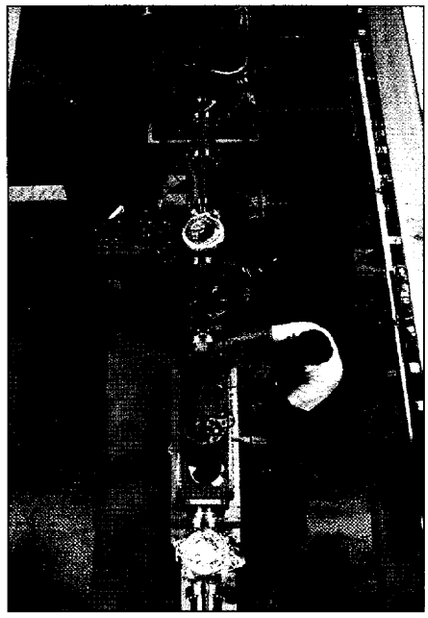
The state board is expected in the next few weeks to form a committee that will draft a set of curriculum frameworks based on the standards. But opponents are clinging to one last hope. "My hope is that the next governor takes care of this" by commissioning a major overhaul of the standards, says Alberts. Such a decision, say political observers, might well set a new standard for controversy. —GRETCHEN VOGEL

NUCLEAR PHYSICS

Tight Budget Could Shut Down MIT Accelerator

Unless the U.S. government finds more money for medium-energy physics research, the Siberian Snake may never slither into the Massachusetts Institute of Technology's (MIT's) Bates Linear Accelerator. Last week, a government advisory panel recommended that the MIT accelerator be shut down in 2 years and that other nuclear physics experiments elsewhere be abandoned if the Department of Energy (DOE) and the National Science Foundation do not boost funding for the field. DOE officials plan to use the report* to convince the Administration to do exactly that in its upcoming 2000 budget. If they succeed, physicists at the suburban Boston laboratory will be able to complete studies that require installation of the snake, a ring of magnets that organizes the accelerator's beam of electrons.

The Bates facility, which has operated since 1968, has been a training ground for many medium-energy physicists, who explore the properties of the atomic nucleus, including the forces that bind it together. However, 2 years ago DOE opened the $600 million Continuous Electron Beam Accelerator Facility at the Thomas Jefferson National Accelerator Facility in Newport News, Virginia, a larger facility that provides researchers with higher energy electron beams.



Scattered to the wind? Researchers won't be able to finish electron scattering experiments unless Bates lab gets funding boost.

Despite the increased capacity, DOE funding for the $116 million program has failed to keep pace with inflation over the last few years and has fallen at least 10% below levels suggested in a 1996 plan. "The budget pressure has been building—not everything can continue under a flat [funding] scenario," says James Symon, a physicist at the Lawrence Berkeley National Laboratory in California. In June, Symon was appointed head of an 11-member Nuclear Science Advisory Committee (NSAC) charged with recommending how scarce DOE funds should be spent.

Symon and others hope their report will help the department win a 10% to 15% in-

* "Scientific Opportunities and Funding Priorities for the DOE Medium Energy Nuclear Physics Program" (http://www.er.doe.gov/production/henp/nucphys.html)

CREDIT: (TOP) MIT/BATES LINEAR ACCELERATOR; (BOTTOM) NASA

ScienceScope

DOE Mulls Restarting Spacecraft Fuel Production

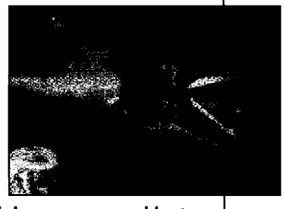
In a proposal that promises to spark further furor over the use of nuclear power aboard spacecraft, the U.S. Department of Energy (DOE) wants to begin making radioactive spacecraft fuel at home again. Department officials announced on 5 October that they are considering restarting production of plutonium-238—used to produce heat and electricity aboard some of NASA's planetary probes—at government reactors.

The move comes amid worries that future political instability in Russia could threaten NASA's supply of plutonium, which has come mainly from Russia since domestic production ceased in the early 1990s. It also follows protests against launches of several NASA craft carrying plutonium-powered generators, such as last year's Cassini mission to Saturn, which activists say could shower Earth with radioactive debris in the event of an accident (*Science*, 12 September 1997, p. 1598).

DOE officials estimate that the United States needs to make 2 to 5 kilograms of Pu-238 a year over the next 25 years to fuel NASA spacecraft. Before production can begin, however, DOE must complete an environmental study, which is due next spring.

X-ray Telescope Delayed Again

In a move that could scramble space shuttle schedules, NASA has again delayed the launch of its $2 billion x-ray observatory. Last week, space agency officials announced that flight software troubles will prevent manufacturer TRW Inc. from shipping the Advanced X-ray Astrophysics Facility from its California plant to the Kennedy Space Center in Florida in time for a planned launch aboard the shuttle next January. That launch date was set following a 5-month delay announced last January (*Science*, 16 January, p. 318).



NASA officials say that this time, they don't know when the troubled satellite will finally fly. While TRW tries to exterminate software bugs, NASA Chief Engineer Dan Mulville will lead a top-to-bottom review of the program aimed at producing a realistic schedule. But the report isn't due until January, and some scientists worry that reshuffling launch plans will delay missions critical to assembling the international space station and maintaining the Hubble Space Telescope.