(NOAA), funding for climate science would drop by 19%, according to Serrano, who provided no further details. Overall, the House bill would impose a 14%, $710 million cut to NOAA's current $5.7 billion budget. Representative Nita Lowey (D–NY), the top Democrat on the full appropriations committee, said the cuts are "further proof that the Republican majority doesn't take the science of climate change seriously."

DOE's $300-million-a-year Advanced Research Projects Agency-Energy (ARPA-E) would disappear, in line with Trump's request. NSF would retain current funding levels for its six research directorates, but Culberson's panel rejected its $105 million request to start building the first two of three new research ships. (However, Senate appropriators are almost certain to restore the money for the ships in their version of the bill, continuing a battle between the two houses over the project. Senators have also signaled support for ARPA-E.)

At the National Institute of Standards and Technology, scientific programs would face a 4% cut rather than Trump's proposed 13% reduction, although House appropriators balked at Trump's plan to eliminate its Manufacturing Extension Partnership, which helps domestic companies. The Census Bureau would receive a 4% boost for its array of censuses and surveys, the same amount Trump has requested. But demographers say that amount is woefully short of what the agency needs to finish preparations for the decennial head count of the U.S. population in 2020.

All of those numbers, however, come with major caveats. The Senate needs to come up with its own spending bills. Also, Congress as a whole has yet to adopt an overall 2018 spending blueprint, called a budget resolution, which lawmakers use to set how much money is allocated to each of the 12 appropriations bills. Republicans are eager to finalize a resolution because, under the Senate's arcane rules, it would ease the way to passing tax reform legislation later this year.

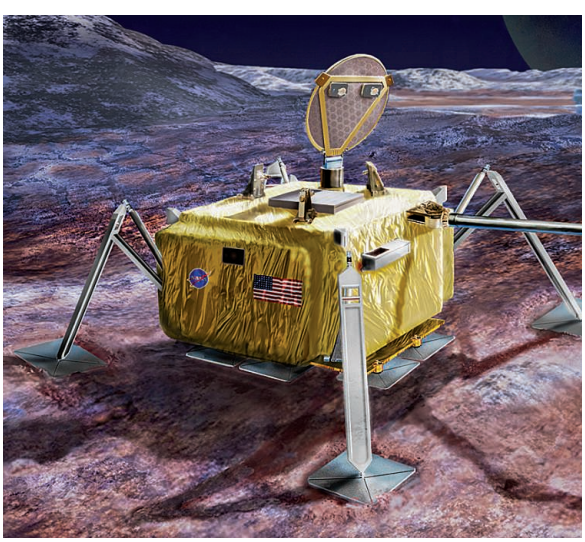
Absent that resolution, legislators are supposed to adhere to a 2011 budget deal that sets annual spending caps for both civilian and military programs. The two sectors are supposed to move in lockstep. But Republicans have proposed an increase in military spending that could top $60 billion, while shrinking civilian spending by $4 billion. Many Democrats would be happy to boost military spending, too, but only if Congress scraps the caps and approves a big hike for civilian programs as well.

Culberson says that such a deal would let him increase funding for some programs now being squeezed in his bill. "We're counting on a bigger overall budget deal that hopefully will give us a little more room to take care of some of these important things," he told his colleagues on both sides of the aisle. "But until we get that, it's going to be tough."

Given that jockeying, and the White House's apparent hostility to research spending, many research lobbyists have embraced a "flat is the new up" mentality for science budgets. That approach runs counter to the community's traditional push for steadily growing budgets, but it may be more realistic in the current political climate.

Many important numbers are pending. Lawmakers have yet to release spending bills covering the National Institutes of Health (NIH)—which accounts for about half of all civilian basic research dollars—the Centers for Disease Control and Prevention (CDC), and the Environmental Protection Agency (EPA). Trump has targeted all of those agencies for large cuts. But lawmakers have strongly condemned the NIH and CDC cuts at recent budget hearings, raising hopes that both agencies will escape the ax. The outlook for EPA, which has fewer fans on the Republican side, might be grimmer.

Republican leaders want to finish these and other House bills before the August recess. But the Senate is unlikely to move as quickly. Most observers expect current spending levels to be extended well into the 2018 year, which begins 1 October, before Congress reaches a final agreement. That means researchers may have a long wait before they learn the fate of their favorite federal funding source. ■



A House of Representatives spending panel gives a boost to a proposed NASA mission to land a probe on the jovian moon Europa.

CLIMATE CHANGE

NASA armada targets thaw in Arctic soil

Air fleet to study effects of melting permafrost on ecosystems and the climate

By **Paul Voosen**

On a 10-meter-square plot of frozen soil in central Alaska, Ted Schuur is creating a window to the future. Schuur, an ecologist at Northern Arizona University (NAU) in Flagstaff, is intentionally warming this patch of permafrost to see how much of its carbon—now locked in frozen plant matter buried for centuries or more—will thaw, decompose, and escape to the atmosphere, where it will make an infinitesimal contribution to global warming. How fast the same processes will play out across the Northern Hemisphere's expanses of permafrost is one of the wild cards of climate change. But it's difficult for Schuur to extrapolate his measurements because they reflect local influences like topography and the water content in the soil. Last month, however, he gained a new ally. High above his field site appeared the silvery glint of an airplane: NASA had arrived.

Schuur's site is one of hundreds that will be surveyed this year in a $100 million, 10-year, NASA-led campaign to study the

CREDITS: (ILLUSTRATION) NASA/JPL-CALTECH; (PHOTO) NASA/KATE RAMSAYER

A "drunken tree" tips over a lake near Fairbanks, Alaska, a sign of loose soil and thawing permafrost.

permafrost. The program, called the Arctic-Boreal Vulnerability Experiment (ABoVE), began in 2015, but this summer marks the first time its nine aircraft have fanned out across Alaska and Canada's Yukon and Northwest Territories in an effort to link precision measurements of permafrost at field sites to remote sensing data.

The permafrost is home to a vast store of carbon, some 1400 billion tons, by rough estimates—about twice the carbon already in the atmosphere. As the Arctic warms, an "active layer" of soil that thaws above the permafrost during the summer grows deeper. Microbes busy themselves on organic matter and release methane and carbon dioxide (CO_2), adding to the greenhouse effect. But vegetation is also migrating north and enjoying a longer growing season, taking more carbon out of the atmosphere. The two trends appear to balance each other out, for the moment. But at some point in the future, the thawing permafrost will come to dominate, and the carbon ledger will drop into the red, with worrisome consequences for the climate. Some scientists believe that line could be crossed any year now; others say late this century; still more say not until next century. "That's a really tough question," says Scott Goetz, ABoVE's lead scientist and a remote-sensing expert at NAU. "Getting these measurements will help us."

To forecast how the permafrost will shape future climate, it is not enough to know how fast the soil is thawing. It's also critical to understand how ice-rich the permafrost is, and how local topography holds or sheds the meltwater. An ice-rich lowland could turn into a lush wetland that burps methane, a greenhouse gas far more powerful than CO_2. A different topography could drain the water away, carrying with it much of the carbon, which could end up being sequestered in the ocean, or released elsewhere to warm the climate. Or there could be no water at all—which would help slow decay and keep the carbon sequestered. Current satellites cannot capture the depth and moisture content of the active layer in detail, although future orbiters may prove up for the job.

In the meantime, the instruments carried on ABoVE's planes are designed to stitch the field measurements into a broader picture. One instrument, a laser altimeter, will penetrate forest canopy and measure topography. Go Iwahana, a geocryologist at the University of Alaska in Fairbanks, wants to monitor how the topography at his field sites changes year by year. He studies thermokarst, undulating terrain dotted with ponds that can form in low-lying permafrost areas as they thaw. By correlating the aircraft readings with ground measurements, Iwahana hopes to develop a remote-sensing technique that can estimate soil carbon loss from the amount of subsidence.

The planes also carry two radars that operate at wavelengths long enough to probe into the permafrost. A new "P-band" radar, in particular, will travel deep enough to measure the depth at which the ground freezes and help determine how ice-rich the soil is, says Mahta Moghaddam, an electrical engineer at the University of Southern California in Los Angeles, who developed the radar with NASA colleagues. (Prized by the U.S. military, the P-band is in a restricted part of the spectrum; ABoVE has to get clearance for each day it wants to transmit on it.) Already, test flights in 2014–15 hinted that the permafrost's active layer could be deepening by an average of some 7 millimeters per year in central and northern Alaska. If validated, this rate of permafrost loss could provide a new vital sign for the Arctic, like sea-ice extent.

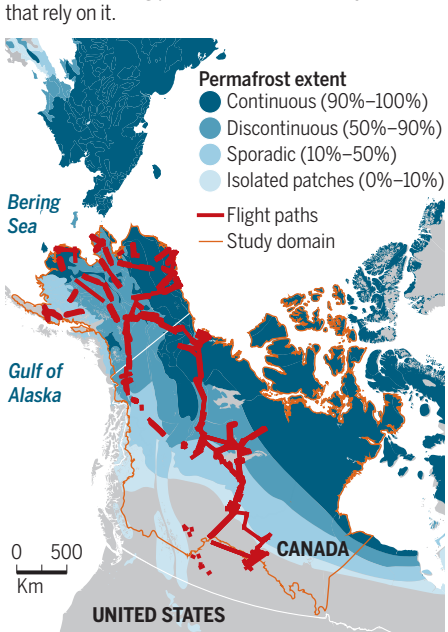
ABoVE flights also sniff out the greenhouse gases that may be emanating from the soil. Past NASA flights in Alaska discovered what seemed to be CO_2 emissions from thawing permafrost persisting into the late fall, after the first snowfall, when Arctic microbes were once thought to be dormant. But ABoVE researchers can't say whether these emissions are from microbes feasting on ancient carbon, or on the remains of newer surface vegetation that has spread north.

This fall, one of the ABoVE planes will try to settle the question by continuing to measure trace gases until early November—well after most researchers pack up their bags for the season. By overlapping their path with those of earlier imaging flights, the team hopes to see whether elevated CO_2 is coming from regions where the active layer is thickening, perhaps bolstering the case that the ancient carbon in permafrost is the source.

Many of the ABoVE researchers are based in Alaska, and for them permafrost thaw is far more than an academic problem. It's an everyday one. Schuur, for one, owns a cabin in Fairbanks. "My yard is subsiding as the permafrost is thawing," he says. Fixing the foundation takes perpetual work. But for now, he's keeping up. ■

An icy world defrosted

A $100 million NASA-led campaign, involving 520 scientists and nine aircraft, will study North America's thawing permafrost and the ecosystems that rely on it.



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