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Climate
Research
Center**



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The reality of climate change

Increasing resilience is just common sense

Dr. Max Holmes President & CEO

Climate change is real. Last year, alone, warming-fueled disasters cost the U.S. at least \$185 billion and hundreds of Americans' lives.

Ignoring or denying the problem won't make it go away. In fact, it will make it decidedly worse. And yet, in recent weeks, we have seen a dangerous pullback of our federal government from activities that enable American communities to anticipate, prepare for, and respond to climate impacts.

For the first time in over a decade, climate change was omitted from the intelligence community's annual threat assessment. The U.S. Global Change Research Program and its flagship National Climate Assessment have been defunded. The National Oceanic and Atmospheric Administration's research programs are facing deep cuts. And most recently, the Federal Emergency Management Agency (FEMA) cancelled the Building Resilient Infrastructure and Communities (BRIC) program and rescinded nearly \$1 billion in previously awarded funding.

Ensuring every community has the information and resources it needs to reduce risks and increase resilience shouldn't be a partisan issue; it's just common sense. And we have seen in our own work that the benefits of climate science flow to all Americans, regardless of party affiliation.

The free risk assessments produced through our Just Access partnerships have benefited dozens of communities across the country—in South Carolina, Utah, Kentucky, and Nevada, as well as Massachusetts.

- Our soil carbon work helps rangeland managers in the American West and farmers in the midwest and mid-Atlantic make better decisions for the future health and productivity of their lands.
- Our Science on the Fly project engages fly fishers across the country—and across the political spectrum—in the work of monitoring and advocating for river health.
- Our federal government has a critical responsibility to advance climate awareness and preparedness. But non-profits like Woodwell Climate have always picked up where government leaves off.

In the face of a federal withdrawal—and with your help—we will step into the gap.

We're standing strong. Stand with us.

Onward,

Max

WOODWELL CLIMATE SPEAKING OUT: PUBLIC COMMENT

Why a strong National Environmental Policy Act is so important

New federal ruling undoes the efficient, science-backed decision-making process established in the NEPA

Sarah Ruiz Science Writer and Editor

Passed in 1970, the National Environmental Policy Act (NEPA) requires U.S. federal agencies to assess the environmental impacts of their proposed actions prior to implementing them. To facilitate this, and to ensure decisionmaking is uniform across government agencies, the law stipulates regulations around the process for conducting these impact assessments. A March ruling from the Council of Environmental Quality (CEQ) removes these regulations, opening up the possibility for regulatory confusion and inconsistency between agencies that ultimately lessens the effectiveness of environmental protections.

Woodwell Climate Research Center submitted a public comment on the ruling, criticizing the move for its potential to hinder coherent decisionmaking based on rigorous science. The comment states:

“NEPA reviews are not an impediment to “major federal actions” but provide an essential, science-based safeguard for ensuring that decisionmaking adequately balances a myriad of interests. This balance is especially critical in areas of the United States where increasingly frequent natural disturbances and extreme events threaten to derail the durability of a proposed federal action.”

The comment speaks to the effectiveness of the existing environmental review process, especially for decisionmaking in Alaska, where construction projects were guided to consider the impacts of permafrost thaw and erosion as part of hydrological and ground assessments, and in forest management plans, where the NEPA review process ensures management strategies are scrutinized with empirical data.

The ruling is considered “interim final” which means it can be put into effect before comments have been considered and is not dependent on public input. Despite this, engaging in the rulemaking process is one critical way Woodwell Climate contributes to environmental policy. It ensures that technical expertise is part of the public record, and provides evidence that can be used in court cases should the ruling or any action based on it be challenged in the future. nce is still largely what we see out there.”

**LEARN MORE**

Read the full public comments to the Council on Environmental Quality:
woodwellclimate.org/nepa-comments



To protect the climate, we need to protect mature and old growth forests

Stepping up protections for mature and old growth forests could help them reach their carbon storage potential

Katherine Sele Senior Associate, 90 West

A new study, published today in the peer-reviewed journal *Biological Conservation* and co-authored by scientists from Woodwell Climate Research Center and Wild Heritage, finds that greater protections of mature and old-growth forests in the United States are critical to meeting global commitments to forestall the climate and biodiversity crisis. The research underscores why safeguarding the nation's carbon stockpile in older forests needs to be a focus of U.S. policy to reduce emissions from commercial logging and burning of fossil fuels.

Using a new approach combining remote sensing of forest structure with ground data from the federal Forest Inventory and Analysis (FIA) program, the research team analyzed younger, mature, and old-growth forests across the contiguous U.S., looking at their size and carbon stocks, as well as ownership (public or private) and protection status, to examine how much additional carbon could be protected if stricter regulations were in place to curb commercial timber harvesting.

According to the study, contiguous U.S. forests currently hold 54.3 billion tonnes of carbon. However, 83% of that carbon stock remains unprotected, revealing the critical role that policy action to prevent increased logging of federal forests can play in promoting ecosystem benefits and enabling U.S. forests to reach their full carbon storage potential. This is especially true for mature and old-growth forests, which provide the greatest climate and biodiversity benefits.

"Mature and old-growth forests are made up of our oldest and typically largest trees, that not only store massive amounts of carbon right now, but can continue to accumulate carbon for centuries if protected. These forests also play an irreplaceable role in maintaining biodiversity, fostering ecosystem resilience, promoting human health, and much more," said Dr. Rich Birdsey,



Senior Scientist at Woodwell Climate and lead author of the study. "As communities everywhere feel the real time consequences of the climate crisis, our policies must reflect the urgent and unparalleled importance of preserving these forests to reduce emissions and bring global temperatures back down."

With stepped-up protection measures that avoid logging of mature and old-growth forests and large trees, and allow mature forests to develop into old growth over time, researchers found that the total carbon stored in these forests could increase by 10.8 billion tonnes within decades, locking away the equivalent of eight full years of fossil fuel emissions in the United States.

"Our study points to the urgency of protecting the nation's best natural climate solution, especially as the current administration begins to ramp up logging on public lands under the President's executive orders," said Dr. Dominick A. DellaSala, Chief Scientist at Wild Heritage and study co-author. "This is the worst possible time for backpedaling on forest protections and our international commitments for a safe climate."

Two sides of the same coin: Conservation and science at Howland Forest

Conservation and science, when they work together, can build a richer world

Kathleen Savage Senior Research Scientist

I'm a field research scientist. What does this mean? I enjoy being outside, in forests and wetlands, studying the environment up close and personal. One of my favorite places to work and explore over the course of my career has been Howland Research Forest in central Maine.

Dominated by red spruce, eastern hemlock, and red maple, this mature northern forest feels old. There is a 400-year-old yellow birch that was already a mature tree during the American revolution. The ground is soft—spongy with a lot of “holes” where past trees have fallen and roots decomposed. My feet often plunge into these holes, which can sometimes be filled with water.

The Howland Forest Research station was established in 1986 by the University of Maine in partnership with a packaging and paper company, International Paper. My first trip to Howland Forest was in 1998 and at the time the research center was just a collection of trailers housing equipment. I had never seen so much mouse poop in a building.



Howland was one of the first sites ever dedicated to measuring the net exchange of carbon between a forest and the atmosphere. Its support comes from the Ameriflux Network, a grassroots, science-driven network of research stations spread across North and South America that monitors the flow of carbon and water across ecosystems. In these early years, Howland Forest also served as a training site for testing out NASA's remote sensing capabilities. At one time, Howland Research Forest was the most photographed site on earth from space. Soon the well-used trailers were replaced with multiple buildings to accommodate the ever-expanding research. The mice were evicted.

Howland Forest was selectively harvested over 100 years ago, evidenced by cut stumps, but the forest has remained intact, growing under natural conditions since then. Most trees range between 100-120 years old. In 2007, International Paper was scheduled to harvest these mature trees. Recognizing the value of maintaining a continuous long-term record of observations, scientists from Woodwell Climate Research Center, The University of Maine (UMaine Orono), and the U.S. Forest Service (USFS) partnered



with the Northeast Wilderness Trust (NEWT) to purchase the forest. The Howland Research Forest, now owned by NEWT, was protected in a forever wild state. This science and conservation partnership saved an invaluable mature natural forest and research site. As scientists continued to collect data over the next decades, we would learn just how important this partnership was to our understanding of mature forests.

Long-term measurements of carbon exchange between the forest and the atmosphere are being taken from the top of a tower, as part of the Department of Energy (DOE) supported Ameriflux Network, and paired with measurements on the ground. It's the measurements on the ground where I come in. Myself and collaborators at UMaine Orono, USFS and a host of other scientists and students over the decades have measured carbon exchange from soils, tracked changes in temperature and moisture, and taken tree inventories.

Mature forests contain large stores of carbon in their tree stems, foliage, roots, and within the soils, accumulated over decades of growth and decomposition. Allowing mature forests to continue to grow, untouched, is beneficial to maintaining carbon stores along with the natural biodiversity and water cycling, often collectively called "ecosystem services."

Over the last 25 years, Howland Research Forest has seen the warmest, driest, and wettest years. Observations show an increasing trend in the net uptake of atmospheric carbon (as carbon dioxide) into this mature forest, meaning that Howland forest is continuing to take up and store more carbon each passing year.

If the forest had been harvested in 2007, observations spanning that shorter time frame would have indicated a decreasing trend in net carbon uptake, meaning Howland Forest was taking up less carbon each passing year.

Although Howland Forest continues to take up carbon, the overall number of live trees has been declining (17% decline since 2001 in live trees, particularly red spruce and northern white cedar) and the number of dead trees has nearly doubled since 2001. Theoretically, fewer live trees would indicate less carbon uptake, but that is not happening. The mature, large diameter trees continue to grow; although there may be fewer in number, they continue to take up significant amounts of carbon.

Tree species can differ in how they respond to environmental changes as well as how carbon is allocated within the tree and across a mature forest ecosystem. Teasing out these complex, multiscaled, multispecies responses requires long term studies. However, given the challenges to acquiring and sustaining funding for long-term studies, it's unusual to have this type of paired dataset like we have at the Howland Research forest. This would not have been possible without the forward-looking vision of scientists and NEWT, and the consistent support from the Ameriflux Network.

Thanks to its preserved, forever-wild status, a new generation of scientists has the opportunity to continue this work, building on our understanding of the mechanisms driving climate resilience in this mature northern forest.

The partnership between science and conservation is a victory for both. Results from the Howland Research Forest demonstrate the need to continue supporting long-term studies to fully understand how natural, mature forests respond to a changing climate. Conservation organizations and land trusts are preserving and restoring critical habitats across the U.S. and the globe. This is an opportunity to build alliances between science and conservation, to inform how natural ecosystems function and the impact of restoration efforts on the ecosystem services that we all benefit from, while preserving natural spaces for future generations.

How do we create equitable solutions to permafrost thaw? Together.

Permafrost Pathways connects science, people, and policy to advance Arctic justice

Jessica Howard Arctic Communications Specialist

A Permafrost Pathways study informed one of the biggest headlines in the National Oceanic and Atmospheric Administration's (NOAA) 2024 Arctic Report Card, sending a clear but alarming message to the world: more than one-third of Arctic-boreal region has shifted to a source of carbon. The sobering results, mentioned in over 700 news stories from 42 countries, shed light on the urgency of Arctic research.

Over the past three years, Permafrost Pathways has been advancing Arctic research through an inclusive and interdisciplinary approach—one that intertwines rigorous Western science with Indigenous Knowledge to co-produce critical insights into Arctic warming and generate equitable solutions to the rapidly growing issue of permafrost thaw.

When we invest in Arctic research, the once impossible becomes possible

The Arctic tundra was once a crucial carbon sink, but has now become a net emitter of carbon dioxide and a consistent source of methane. This shift, identified in a study led by Research Scientist Dr. Anna Virkkala, is likely due to rising emissions from thawing ground and increased wildfire activity.

“While we found many northern ecosystems are still acting as carbon dioxide sinks, source regions and fires are now canceling out much of that uptake and reversing long-standing trends,” said Virkkala in a January press release about the newly published research.



above: (left) Tribal Liaison Maamcuk Foss from the Native Village of Akiak and Tiffany Windholz map erosion. / photo by Darcy Peter
(right) Reggie Tuluk and Jackie Dean measure the erosion of a culvert in Ceva'q. / photo by Sue Natali

This finding was supported by Permafrost Pathways' expansion of the Arctic-boreal carbon monitoring network and the compilation of thousands of data points from active and historical monitoring sites. In 2024, four new carbon flux towers were installed across key Arctic ecosystems, including Nunavut, Canada, and Alaska, and researchers provided technical assistance to existing towers in Canada and Russia. The scarcity of data on carbon emissions and uptake from permafrost lands is a major barrier to fully accounting for permafrost thaw in global carbon budgets.

"Having data in these under-sampled areas will greatly help our understanding of Arctic-boreal carbon cycling. Models depend on their data to represent the full spread of conditions across the model, which is lacking," says Dr. Kyle Arndt, who leads the Arctic Carbon Monitoring Network team for Permafrost Pathways. "This project is unique in that it enabled us to measure less-studied areas with the goal of filling data gaps and really capturing the big picture. So, to install these towers in crucial ecosystems in a relatively short time and collect that necessary data year-round is pretty remarkable."

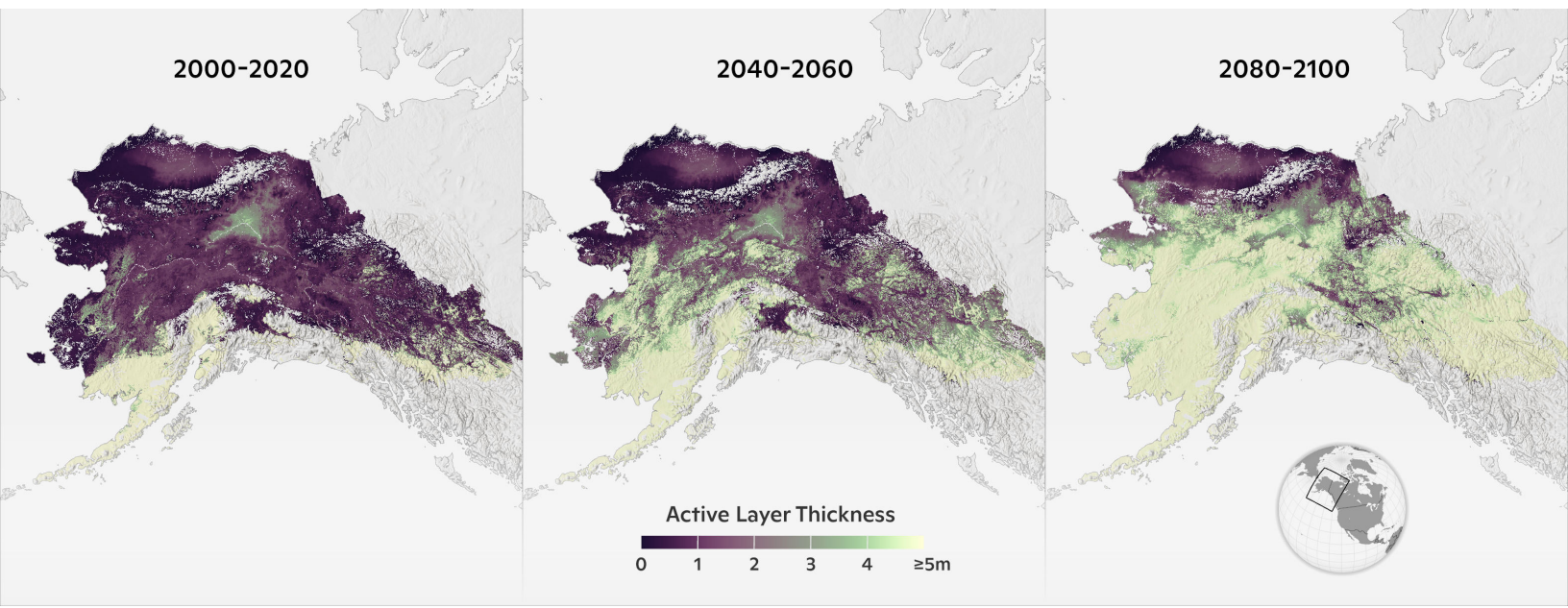
These efforts, supported by an international network of collaborators, have contributed to the development of the most comprehensive database of carbon dioxide and methane fluxes ever assembled across the permafrost region. The Arctic-boreal carbon flux database contains roughly 23,000 monthly observations compiled from both active monitoring sites and historical data.

Additionally, the Permafrost Pathways team is using novel methods to map disturbances—such as wildfire and sudden ground collapse—at high spatial resolution by leveraging commercial satellite imagery and artificial intelligence. These events have the potential to double the warming effect of permafrost thaw, but they have not been accounted for in international assessments used to guide climate policy.

"We're working with partners at Esri, the global leaders in mapping software, to create the first-ever circumpolar map of abrupt thaw events, a dramatic and important type of disturbance that can generate high levels of carbon emissions. The tools and data we develop will not only allow us to better monitor major disturbances, but also provide crucial information needed to project these into the future," said Associate Scientist Dr. Brendan Rogers, who co-leads the project.

Permafrost Pathways and collaborators are also working on improving Arctic ecosystem models to better predict future changes in permafrost and Arctic emissions. Preliminary findings show significant thawing of permafrost across Alaska and western Canada, and future research will expand the model's scope to the entire Arctic.





Arctic science must include Indigenous Knowledge

While Western scientists continue to refine their understanding of the climate impacts of permafrost thaw, communities on the ground have been actively witnessing and experiencing those impacts for decades.

“You really gotta go out and watch this stuff. It’s really changing, things are really wrong,” Elder Wilson Justin, Athabascan Dine, recalls his uncle telling him about the cascading effects of permafrost thaw in the late 1970s. “So I went out to look at the permafrost and was flabbergasted that it had disappeared.”

Understanding the larger picture of Arctic warming is not possible without the knowledge and expertise of Arctic Indigenous communities who have called the region home since time immemorial.

Permafrost Pathways has prioritized the integration of Indigenous and Western knowledge systems to support climate adaptation in Alaska and beyond. Working closely with Alaska Native community partners, the project is co-creating Indigenous-led strategies to address the impacts of permafrost thaw, flooding, and erosion.

One of the standout developments has been the co-creation of a flood model that factors in sinking ground from thawing permafrost. The model was developed using information from sensors installed in communities and on-the-ground knowledge from Tribal collaborators, ensuring that results are deeply rooted in local observations and Indigenous expertise.

In addition, Permafrost Pathways prioritizes skills training to build community capacity and inform adaptation decision-making. At a spring mapping workshop Tribal liaisons and representatives gained introductory Geographic Information

System (GIS) skills, learning how to map Indigenous place names, and develop digital storytelling tools.

“We really prioritize relationship-building and working in partnership. A large part of that is skill-sharing because projects come and go, so we recognize the importance of community capacity-building in our adaptation work,” said Research Assistant Tiffany Windholz, a member of the Permafrost Pathways adaptation team who works closely with Alaska Native community partners on environmental monitoring and GIS capacity-building.

Permafrost Pathways provides ongoing one-on-one GIS training with Alaska Native community partners, who are now leading efforts to map climate impacts in their communities. Several partners are applying these GIS skills to map shoreline erosion, flooding, and proposed relocation sites for threatened infrastructure.

Tribal Liaison Maamcuk Foss from the Native Village of Akiak (Akiak) is working on mapping Indigenous place names in Akiak to help younger generations connect with their traditional language. “I’m learning [mapping and GIS] stuff every day,” said Foss. However, the learning in this work is mutual. Foss is also working with Research Assistant Jackie Dean to map Akiak’s rapidly eroding river shoreline, providing local knowledge and expertise critical to developing accurate representations of climate impacts that Akiak is up against.

Centering Arctic voices in conversations with policymakers

Permafrost Pathways’ work with communities has begun to establish adaptation strategies that could be scaled up to serve as a national framework. As climate change accelerates, getting



the best available science on the desks of policymakers and centering the voices of those on the frontlines is a top priority.

Influencing policy in Alaska has historically been difficult due to challenges in federal interagency coordination on climate adaptation and hazard responses. In the village of Cev’aq (Chevak), the severe erosion of a culvert is threatening a steam house and inching closer to a village home. Despite multiple agencies being aware of the ongoing crisis, coordinated action has been slow because of jurisdictional limitations, leaving Cev’aq in a dangerous state of uncertainty.

Here, Permafrost Pathways was able to provide support, working with Tribal Liaison Reggie Tuluk to conduct environmental surveys and map the rate of erosion. Together, the project and Cev’aq were able to leverage these outputs to draw attention from necessary state and federal entities.

“Putting this expertise on a map makes people pay more attention to the environmental hazards that the community is leading efforts to address,” said Dean, who is working with Tuluk to co-produce erosion maps.

Permafrost Pathways has also been cultivating relationships with Congressional leaders, including staff from the Senate Committee on Indian Affairs, the House Sustainable Energy and Environment Coalition, and Senator Lisa Murkowski. In September 2024, the team met with Senator Murkowski to advocate for legislative solutions to climate risk mitigation and funding for permafrost research.

“I’ve met twice with Murkowski’s office over the past couple of years,” said Morris Alexie, Tribal Liaison for the Native Village

of Nunapicuaq (Nunapitchuk). “She was hearing our cry of not understanding the complete FEMA processes for disaster declarations, especially when it comes to the required paperwork and language translations. So far, I see that she has been working towards alleviating those barriers for Tribes in Alaska.”

Moving forward together in a time of uncertainty

Drastic shifts in both the U.S. and international political landscapes have thrown up obstacles for Arctic research. Continued complications from Russia’s invasion of Ukraine and recent actions by the new U.S. federal administration that target science funding, research infrastructure, and climate adaptation programs will necessitate more creative and thoughtful approaches to the project’s objectives going forward.

“We have experienced slow progress on expanding carbon monitoring in Russia, and we anticipate challenges to advancing climate policy in the United States,” said Dr. Sue Natali, Project Lead and Senior Scientist.

But the team continues to move forward, investing in the strength of the network they have helped build between policymakers, Arctic communities, and scientists.

“Despite the uncertainty ahead, we’ve been highly adaptable in identifying and pursuing new paths to advancing equitable solutions to permafrost thaw,” says Natali. “We remain committed to our scientific collaborators and Indigenous partners in continuing to work toward Arctic justice and resilience with our communities of practice, without which progress in this work would not be possible.”



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Learn more: woodwellclimate.org/biodiversity



Woodwell Climate @ Mountainfilm

Woodwell Climate Research Center is once again partnering with Mountainfilm in Telluride, CO this Memorial Day weekend to elevate stories and generate conversations that inspire climate action and environmental stewardship.

Woodwell Climate has been a Mountainfilm sponsor and participant for several years. Each year is memorable and brings fresh ideas, connections, and collaborations and this year promises to be thought-provoking and action inspiring, with climate change featured front and center in films and events.

To learn more, visit: www.mountainfilm.org

In the news: highlights

TV Globo's *Rede Amazônica* interviewed Dr. Foster Brown about the recently published report of the National Drought Monitoring Program, which found that for the first time since 2022, Acre recorded drought across 100% of its territory.

Alaska Native News published a press release quoting Dr. Anna Liljedahl about how her newly published collaborative research shows the massive scale of risks to infrastructure from permafrost thaw.

A *Boston Globe* column focused on the Trump administration's efforts to eliminate the National Climate Assessment quoted Dr. Max Holmes on the report's importance for helping prepare for climate risks.

Dr. Jen Francis was interviewed on *Living on Earth* to discuss a new study, which suggests that shrinking cloud cover is playing a big role in Earth's energy imbalance and global warming.

Senators Edward J. Markey (D-Mass.) and Roger Wicker (R-Miss.) introduced the FORECAST Act of 2025, which would authorize federal funding to improve the reliability of weather forecasting. Woodwell Climate has endorsed this legislation.

The University of Connecticut published a press release quoting Dr. Anna Liljedahl on recent collaborative research that doubles the mapped infrastructure of Alaska and more accurately projects economic risks associated with permafrost thaw. The research was also covered in an article from *Scienmag*.

Dr. Foster Brown participated in a live broadcast hosted by the Acre State Secretariat of Education, answering questions from high school students about climate change.

Globo Rural and *The AgriBiz* covered how Folio, an initiative to promote regenerative agriculture, has now become an institute—Dr. Ludmila Rattis is a member of its advisory council.

The Arctic Institute published an article by Lynn Heller about the importance of including permafrost emissions in climate policy.

Dr. Max Holmes joined Nipham H. Patel (Director, MBL) and Peter B. de Menocal (President & Director, WHOI) in writing a Letter to the Editor in the *Falmouth Enterprise* that underscored the importance of science, both locally and to the nation.

AP News quoted Dr. Jen Francis on how disappearing sea ice is an "early warning system" for harder-to-see changes, which was syndicated in a number of outlets, including *The Seattle Times*, *Earth.com*, and *Anchorage Daily News*.

In an article about the recent International Energy Agency report, *Grist* quoted Dr. Max Holmes on the inevitability of the energy transition.

The *Boston Globe* also featured Holmes in an article about threats to science in Woods Hole, in which he spoke about Woodwell Climate's decision during the first Trump Administration to reduce our reliance on federal funding.

cover: Tiffany Windholz, Reggie Tuluk, Permafrost Pathways Tribal Liaison for the Native Village of Cev'aq, and Darcy Peter download data from a temperature sensor. / photo by Aurora Taylor

Donations play an important role in securing the future of Woodwell Climate Research Center's work—and help safeguard the health of our planet for generations to come.

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