

Alaska's Glaciers Are Retreating

Although the mechanisms vary, together the glaciers are losing 75 billion tons of ice annually

In 1966, a team of U.S. Geological Survey scientists journeyed to two small glaciers in Alaska to dig snow pits needed for measuring snow depth and density at the remote mountainous locations.

Those early findings, repeated twice a year for the last 50 years, became the baseline for the government's Benchmark Glacier program, the longest continuous glacier research in North America. The program provides data on glacier health in a warming climate.

The USGS research has focused on two glaciers that represent two very different Alaska climates — the Gulkana Glacier in the eastern Alaska Range south of Fairbanks and the Wolverine Glacier in the Kenai Mountains on the southern coast of Alaska.

At both locations, the long-term records show that summer warming has resulted in sustained mass loss, noted Shad O'Neel, head of the glacier research program at the USGS Alaska Science Center.

"How the climate has been changing over the past few decades of anthropogenic influence really has manifest itself quite well" in these studies, O'Neel said. "It provides tangible evidence for how climate change is affecting the landscapes."

Since the 1990s, the retreat of glaciers in Alaska has made a disproportionately large contribution to global sea-level rise. The USGS reports that the state's glaciers are losing 75 billion tons of ice annually, equal to the amount of water needed to fill Yankee Stadium 150,000 times each year.

During that time, the Gulkana Glacier has steadily diminished due to significantly warmer summers in interior Alaska and a relatively unchanged level of snowfall. Gulkana drains west into the Yukon River.

Meanwhile, the Wolverine Glacier, which is also shrinking, has experienced slightly cooler summers and more variability in winter temperatures. That glacier is a coastal system that flows into the Gulf of Alaska.

USGS estimates that Alaska's glaciers and ice fields are responsible for nearly 50 percent of the water that flows into the Gulf of Alaska. The meltwater has a unique "glacial fingerprint" that is evident in the timing, volume and temperature of the water, as well as the nutrients it carries. It also influences the rich diversity of species in the marine ecosystem that are important to tourism and fishing industries.

To study those impacts, the glaciologists are teaming up with ecologists, oceanographers, biologists and botanists to assess how socio-economically important species like salmon are likely to fare in the warmer Alaska of the future.

"We're trying to quantify the water flow, the water chemistry and then the vegetation that's in the basin, the species that are there, all the way from the glacier terminus down to the ocean," O'Neel explained.

"We had a team of biological oceanographers that went into Kings Bay, which is where Wolverine drains into," he said. "They were able to see a pretty pronounced gradient of both physical and biological composition of what's living in the bay. So we're getting some core baseline biological data to go with the physical drivers that go back 50 years."

In the years since the USGS launched its landmark Alaska glacier research, the scientists have also begun combining their field studies data with new information gathered with modern geophysical and remote sensing methods. And they're now modeling how glaciers will respond to future climate scenarios, particularly how coastal glaciers like Wolverine impact the ecosystem along the Gulf of Alaska.

According to the USGS, climate change could cause summer temperatures to warm by 3.6 to 7.2 degrees Fahrenheit, and snow accumulation to markedly decrease. Those changes could contribute to the loss of thousands of glaciers in Alaska and northwest Canada by the end of the century.

Today, the federal benchmark glacier program extends beyond Alaska and includes research at the South Cascade Glacier in Washington state and the Sperry Glacier in Montana. Experts say those glaciers are influenced by

different climates, allowing scientists to compare how glaciers respond in different regions.

Daniel McGrath, a research geophysicist with the program, said much of the government's ongoing climate research draws from the USGS's 50 years of Alaska glacier studies.

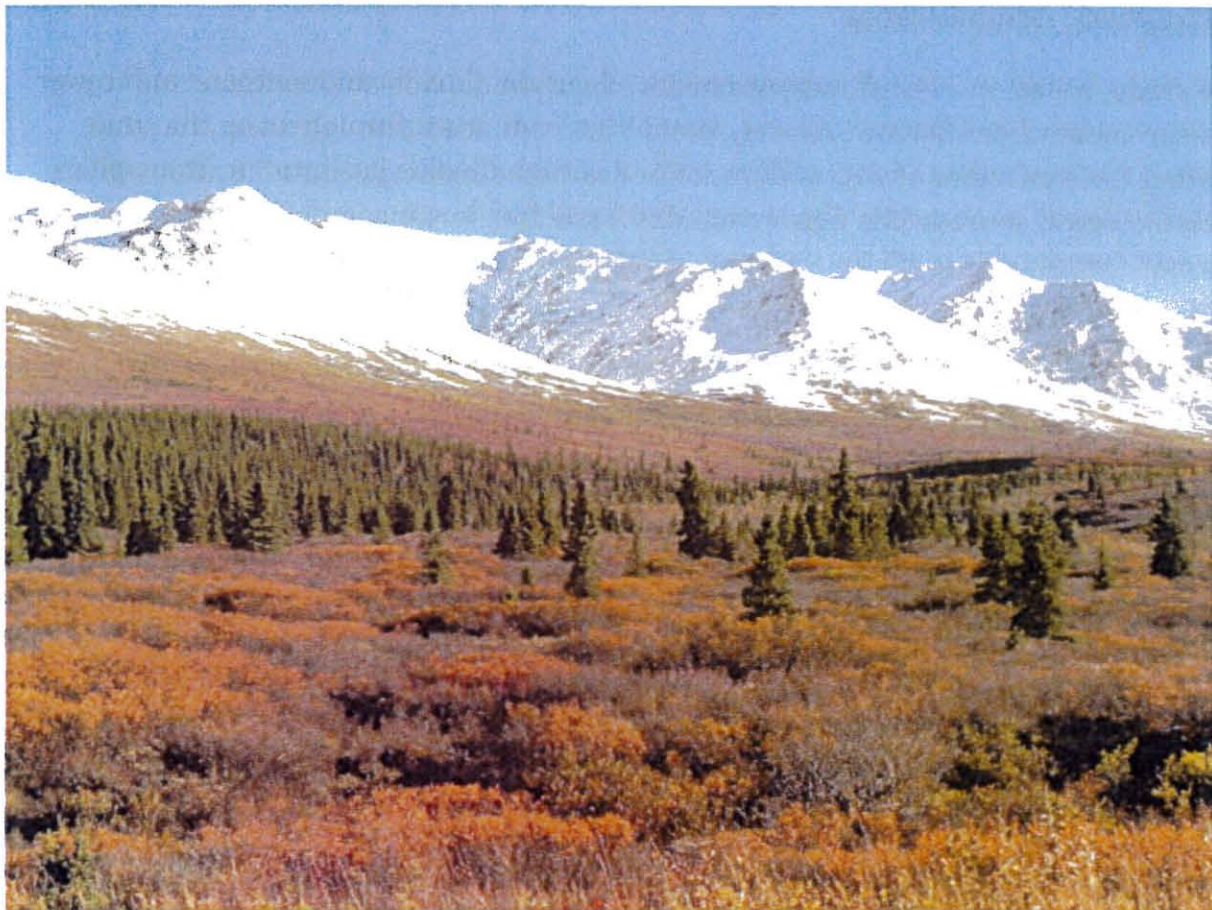
"Detailed and continuous records of this length are exceedingly rare in our field, and thus these are indispensable to our understanding of the changes we're observing across this region."



Nation

Monday, May 8, 2017 Last update: 8:53 p.m.

Alaska's tundra is filling the atmosphere with carbon dioxide, worsening climate change



Brent Frazee | TNS

Denali National Park in Alaska.

By Chris Mooney, Washington Post
Posted May 08, 2017, at 5:09 p.m.

Even as the Trump administration weighs withdrawing the United States from the Paris climate agreement, a new scientific paper has documented growing fluxes of greenhouse

gases streaming into the air from the Alaskan tundra, a long-feared occurrence that could worsen climate change.

The new study, published in the Proceedings of the National Academy of Sciences, suggests that frozen northern soils – often called permafrost – are unleashing an increasing amount of carbon dioxide into the air as they thaw in summer or subsequently fail to refreeze as they once did, particularly in late fall and early winter.

“Over a large area, we’re seeing a substantial increase in the amount of CO₂ that’s coming out in the fall,” said Roisin Commane, a Harvard atmospheric scientist who is the lead author of the study. The research was published by 19 authors from a variety of institutions, including NASA’s Jet Propulsion Laboratory and the National Oceanic and Atmospheric Administration.

The study, based on aircraft measurements of carbon dioxide and methane and tower measurements from Barrow, Alaska, found that from 2012 through 2014, the state emitted the equivalent of 220 million tons of carbon dioxide gas into the atmosphere from biological sources (the figure excludes fossil fuel burning and wildfires). That’s an amount comparable to all the emissions from the U.S. commercial sector in a single year.

The chief reason for the greater CO₂ release was that as Alaska has warmed up, emissions from once frozen tundra in winter are increasing – presumably because the ground is not refreezing as quickly.

“The soils are warmer deeper, and as they freeze in the fall, the temperature of every soil depth has to come to zero before they hard freeze,” Commane said. “The temperature has to come to zero and equilibrate, for the soils to freeze hard through. And through that whole period you have emissions because the microbes are active.”

In particular, the research found that since 1975, there has been a 73.4 percent increase in the amount of carbon lost from the Alaskan tundra in the months of October through December as the climate warmed steadily.

The new study is “the first to show that a large region of the Arctic is a carbon source and that this change is driven by increased carbon emissions during the winter,” said Sue Natali, a permafrost researcher with the Woods Hole Research Center, who was not involved in the study. “Because the models aren’t capturing these cold-season processes, we’re very likely underestimating carbon losses from the Arctic under current and future climate scenarios.”

The fears about permafrost carbon losses are based on some simple chemistry. Unlike at warmer latitudes, where microorganisms in the soil constantly break down plant matter

and return the carbon it contains to the atmosphere, Arctic soils have been cold enough to preserve the frozen remains of ancient plant life. But as the planet warms, soil microbes become able to break down more and more of this carbon, sending it back into the atmosphere and worsening global warming in a troubling feedback loop.

Some scientists, however, held out hope that there would be a key offsetting process: As the Arctic warms, it might also stow away more carbon as it becomes greener and supports the additional plant life, particularly in tundra regions. This “Arctic greening” is indeed occurring, but the new research suggests that the permafrost losses in early winter are more than enough to offset that.

“There is greening going on, but it seems like you run out of the sunlight so far north, so it doesn’t matter how much greening there is, eventually, the plants just run out of light,” Commane said. “It appears now that the microbes are winning.”

The new study contrasts with a 2016 study by the U.S. Geological Survey, which had found that Alaska was acting as a net carbon “sink” at the moment – removing more carbon from the air than it is emitting – and that this should continue and expand over the course of the century as plant growth increases.

One of the lead authors of that research, Dave McGuire of the University of Alaska at Fairbanks and USGS, said the new study is “not the final word, but it is a significant step forward.” McGuire pointed out that the new study looks at the years 2012 to 2014, whereas the 2016 USGS study looked at earlier years and ended in 2009, making an “apples to apples” comparison difficult.

Alaska is only one area of the Arctic where permafrost soils could be emitting carbon dioxide into the atmosphere. Permafrost regions in Canada and Siberia are even vaster. But the new study’s lessons could also apply to those areas, researchers say.

The study “shows that the Alaska region, which may be representative of large swaths of boreal forest and Arctic tundra biomes elsewhere, appear to be releasing net carbon to the atmosphere, in particular with stimulated emissions in the fall/early winter period,” said Ted Schuur, an ecologist at Northern Arizona University, who was not involved in the research.

“We all knew this was coming, but I’m surprised that we can even see it now,” Commane said.

Thawing Alaska Permafrost Sends Autumn CO2 Emissions Surging

Emissions from thawing permafrost are now outpacing the uptake of carbon dioxide during the growing season, a new study suggests

BY BOB BERWYN, INSIDECLIMATE NEWS

MAY 8, 2017



Coastal erosion reveals the extent of ice-rich permafrost underlying an active upper layer in Alaska. A new study finds that as temperatures rise, the ground is freezing later in the season and greenhouse gas emissions that normally slow in the fall are continuing into early winter. Credit: Brandt Meixell/USGS

Soaring temperatures in the Arctic have triggered a huge seasonal surge in carbon dioxide emissions from thawing permafrost and may be tipping the region toward becoming a net source of heat-trapping greenhouse gases, a new study shows.

Even into early winter, when typically the ground was frozen 40 years ago, microbes in the permafrost are now continuing to release heat-trapping greenhouse gases. Carbon dioxide emissions are now outpacing the uptake of CO₂ during the spring and summer growing season, the study suggests.

The researchers from Harvard, the National Oceanic and Atmospheric Administration and other institutions measured atmospheric CO₂ in Alaska and found that emissions from October through December have increased by 73 percent since 1975 and that the increase correlates with rising summer temperatures.

The findings suggest that global climate models are underestimating how much heat-trapping greenhouse gas pollution will be unleashed as the Arctic continues to warm at twice the global average rate, said lead author Roisin Commane of the Harvard School of Engineering and Applied Sciences.

The Arctic climate feedback loop is stronger than scientists estimated, Commane said. Global warming thaws permafrost, releasing more greenhouse gases, which causes yet more warming.

"It's consistent with the effects of a warming Arctic," she said. "We're seeing very large emissions in the early winter. When I looked at the models used by the IPCC [Intergovernmental Panel on Climate Change], none of them looked at the fall respiration. They didn't realize how important that is."

The study, published May 8 in the *Proceedings of the National Academy of Sciences*, adds critical emissions data for the autumn season, from October through December, after Arctic vegetation stops growing but before the ground freezes solid and locks up the carbon again.

Year-round measurements of CO₂ emissions from permafrost have been sparse up to now, and some widely cited studies suggested that rising emissions from thawing permafrost were offset by increased uptake from Arctic forests. But according to the new research, those calculations need to be revised.

Plants inhale massive amounts of CO₂ in the spring and summer growing season. Then, in the fall and winter, the plants die and decompose, releasing CO₂ and methane. That cycle gives the global CO₂ level its signature zigzag pattern. In the Arctic, emissions during the decomposition phase are outpacing CO₂ uptake during the growing season, the study shows.

The scientists analyzed data from a three-year (2012-2014) NASA aerial mission aimed at quantifying carbon in Arctic ecosystems. The planes flew over Alaska to measure seasonal and regional distributions of CO₂ emissions. A 41-year record of CO₂ from

NOAA tower sensors at Barrow, as well as satellite measurements, gave the study long-term historical context.

The combined data enabled the scientists to separate Alaska CO₂ emissions from three sources: local fossil fuel burning, wildfires and thawing permafrost. In some years, wildfires were a significant source, but emissions from local fossil fuel burning are negligible in Alaska, Commane said. Identifying the various sources enabled them to conclude that permafrost emissions account for the big autumn increase they measured.

Commane said emissions are surging from October through November because the ground isn't freezing up as fast as it was before the 1970s.

"In some places in Alaska, it's taking nearly 100 days until the entire layer, about 1 meter down, gets frozen hard through," she said.

A recent report from the Arctic Council found that near-surface permafrost has warmed by more than 0.5 degrees Celsius in the last 10 years, and that summer thawing has deepened at most monitoring locations.

Permafrost currently covers about 5.8 million square miles. A study published in April that looked at the impact rising temperatures would have on the permafrost and found that as much as 2.5 million square miles of it could thaw if global temperatures reached 2 degree Celsius above pre-industrial temperatures. Another study, published in February, found that 52,000 square miles of Canadian permafrost was already in rapid decline.

The new Alaska study is another step toward understanding how sensitive the Arctic is to increasing temperatures. The Arctic permafrost seals in a massive store of carbon, roughly double the amount of CO₂ currently in Earth's atmosphere. If the trends being seen in Alaska are similar in Siberia and Canada, it would have a big effect on the global carbon budget, said co-author Pieter Tans, with NOAA's Earth Systems Research laboratory.

"The important thing in this paper is, it shows where the models fail. They don't capture these cold-season emissions very well," said Donatella Zona of San Diego State University in California, who was not involved in the new research.

"We need to make the case that this is important and get the resources to expand the studies in other areas, especially Siberia," she said.