

Dead Trees and Shriveling Glaciers as Alaska Melts

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ABSTRACT (ABSTRACT)

Alaska is thawing, and much of northern Russia and Canada with it, and many scientists say that the warming of these cold regions is one of the most telling signals that the planet's climate is changing. Experts have long said that in an era of global warming, this bellwether region should warm more and faster than the Earth as a whole, and that is just how things are turning out.

Along the Fairbanks-to-Valdez stretch, entire mountainsides of spruce forest, prime timberland that used to be part of the magnificent taiga, the vast boreal forest of conifers that rings the world's northern latitudes, are dead and gray. The trees have been weakened by climate-related stress, then killed by spruce bark beetles whose population, scientists say, has exploded in the higher temperatures. "It has moved into high gear in the last six or seven years," said Dr. Glenn P. Juday, a forest ecologist at the University of Alaska. "It's just rolling through the forest."

Scientists are not certain how much of the regional warming relates to overall warming of the globe, if any. Some of it, they say, is clearly the result of a change in prevailing patterns of atmospheric circulation, beginning in the mid-1970's, which generally redirected the flow of warm air from the Pacific toward Alaska. But experts on climate change, like Dr. Gunter Weller of the University of Alaska in Fairbanks, point out that big areas of northern Russia not affected by the circulation change have warmed as much as Alaska. Moreover, say other experts, it is possible that global warming had something to do with the shift in circulation.

FULL TEXT

MIGHTY and majestic, the river of ice snakes down to Prince William Sound between classically craggy mountains wreathed in clouds. Through the mist-streaked windows of a light plane, Columbia Glacier's huge mass and aquamarine-flecked desolation have an almost visceral impact.

But like much of the rest of Alaska, the glacier is not what it used to be.

Not so long ago, cruise ships nosed right up to the glacier's 200-foot-high front wall to watch icebergs break off and crash into the Sound. That is impossible today. The front has retreated by more than eight miles in the last 16 years, and ships are separated from it by a vast expanse of melting icebergs, penned in by a rocky shoal that stretches from where the shrinking glacier's front wall used to be to where it is now.

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The signs are everywhere.

Scientists employing laser instruments have confirmed that many of Alaska's hundreds of glaciers are retreating. The warmer atmosphere, which holds more moisture, has produced more snow to feed the glaciers, but longer, warmer summers have in many cases melted them even faster than the heavier snows can build them up. At this time of year, countless streams run full and chalky with tiny rock particles pulverized to dust by the glaciers.

The region's permafrost, ground that is perpetually frozen, is thawing in Alaska's interior, and pockets of underground ice trapped in the frost are melting with it. Over thousands of miles, big patches of forest are drowning and turning gray as the ground sinks under them and swamp water floods them. Here and there, deep holes have opened in the earth. Here and there, roadside utility poles destabilized by the melting tilt at crazy angles. So do trees, creating a phenomenon known as drunken forest.

The intermittent character of the land's settling – the permafrost comes in patches in most of the state, and not every patch has ice pockets – wreaks havoc on paved roads. Between here and Fairbanks, 360 miles away, many stretches of highway are like ocean waves, and driving on them often requires vigilance. Maintenance crews in the summer are constantly busy not just repairing irregular breaks and cracks in roads, but constantly re-repairing them, at substantial cost.

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Rising Temperatures Region Is Warming Faster Than Globe

About the magnitude of the warming, there is little doubt. While the average surface temperature of the globe has risen over the last century by 1 degree Fahrenheit or a little more, it has increased over the last 30 years by up to about 5 degrees in Alaska, Siberia and northwestern Canada, say scientists at the University of Alaska and elsewhere. The warming has been most pronounced in winter.

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A number of experts believe the regional thaw has resulted from a combination of natural and human-induced climate change. Mainstream scientists predict that globally, the average surface temperature will rise by 2 to 6 degrees Fahrenheit over the next century, with a best estimate of about 3.5 degrees, if emissions of heat-trapping industrial waste gases like carbon dioxide are not reduced. The gases are produced by burning fossil fuels like coal, oil and natural gas.

The scientists say that Alaska and other far northern continental regions should warm about twice as much as the

average for the globe. Two main reasons lie behind this: As ice and snow melt, less heat is reflected off the land, amplifying the warming. And at these latitudes, the atmosphere is more stable in winter and spring. This confines more heat to its lower layers.

Whatever the combination of causes of Alaska's warming, the catalogue of effects is substantial.

Thirty years ago, the temperature at Fairbanks reached 80 degrees for only about a week in the summer. Now it hits or exceeds that mark for a total of about three weeks. On average, Dr. Juday says, a summer day is about 11 percent warmer than it was three decades ago.

When Dr. Weller moved to Fairbanks 30 years ago, winter temperatures frequently dipped well below minus-40. In the last two decades, the number of sub-40-degree days has dropped substantially compared with the three preceding decades.

In the Bering Sea, scientists have found, the extent of sea ice has decreased by about 5 percent over the last 30 years. In Nanana, inland near Fairbanks, people since 1917 have taken great pains to measure the exact moment when the Tanana River ice breaks up each spring. A lucrative lottery depends on the result. Four of the earliest breakups in that 81-year span have been in the 1990's.

In the interior, higher temperatures have been accompanied by more snow in the winter (as is well known, extreme cold means a drier atmosphere and less precipitation), but also less rain in the summer. For Alaska agriculture, which is already limited by a scarcity of suitable land, the warming has been a double-edged sword. The good news is that the growing season is about 20 percent longer; the bad news is that sufficient water for crops is often lacking.

"It's changed dramatically since the 80's," said Scott Miller, who farms a big, flat spread of barley, oats and hay about a two-hours drive south of Fairbanks, within sight of the snow-capped Alaska Range. There, with a brilliant sun beating down and the temperature heading toward 80 on a recent summer day, Mr. Miller explained that in the 1980's, it rained practically all summer, and there was a danger of frost in July. "Now," he said, "we're way on the other end of the spectrum; we're usually hurting for water, and there's more heat."

On the other hand, according to the 1997 study, longer summers have allowed the state's vibrant tourist industry to expand. Other long-range benefits are expected. Shipping in the region should become easier, and an open-water sea route between Alaska and Europe could open up. The contraction of sea ice could allow more offshore oil drilling. Warmer water could help some fisheries.

But at the moment, the warming is perhaps most evident in its effects on forests, permafrost and glaciers.

Dying Trees Insects Imperil 'Cream of the Crop'

On a clear morning a few miles southwest of Fairbanks, from where the gleaming white pyramid of Mount McKinley rose hazily in the distance, Dr. Juday knelt on the floor of the Bonanza Creek Experimental Forest, a long-term ecological research reservation. A vintage old-growth forest of white spruce not far from the Arctic Circle, it is in the middle of the taiga. Moss-covered logs litter the ground. The spruces themselves, their short, needled branches draped with feathery lichens much like Spanish moss, tower overhead, straight and tall, rising to 100 feet.

"We're talking about the cream of the crop – the very best forests we have in interior Alaska," Dr. Juday said. As he spoke, he set up a hand-held global positioning instrument and contacted overhead satellites to fix the spot's coordinates. The purpose was to aid airborne scientists who later would survey the forest for climate-related damage – in this case, the extent to which the crowns of the big spruces have been snapped off by heavy snows.

Normally, the snows at that latitude are light and fluffy. But recently they have become heavier, apparently a result of the changing climate. The weight of two especially heavy snowfalls in the late 1980's and early 1990's broke off the tops of trees. "There was an incredible outbreak of insects following that," and they attacked the trees, Dr. Juday said as he pointed out two topless spruce giants.

On top of that, he said, the warming climate, coupled with less summer precipitation, has stunted trees' growth. The crowns of aspens, for instance, look puny, and that is where the recent growth would have taken place. Besides promoting a bigger buildup of tree-eating insects, the warming has prompted some species, like the spruce budworm, to move farther north.

"These trees are in real trouble," Dr. Juday said. "We've got a sick forest here."

Farther south, much of the forest is more than sick; it is dead or dying. In a broad swath stretching 300 or 400 miles along the state's southern tier, from the Kenai Peninsula south of Anchorage past the spectacular Chugach Mountains north and northeast of here, chunks of landscape have turned red (freshly killed) or gray (long dead). Spruce bark beetles are the killers, and they are "basically eliminating the forest canopy," said Jerry Boughton, who heads the United States Forest Service's regional forest health program, based in Anchorage. A third to half of Alaska's white spruce have died in the last 15 years.

Several factors have combined to produce this ecological holocaust, said Mr. Boughton, not least the fact that the forest is older, and therefore more vulnerable to insect attack. "But certainly, the warming has created a better environment for the bark beetle to expand," he said. In fact, mainstream scientists say, that is how the predicted global warming will often make itself felt: by exacerbating stresses of many kinds.

Many experts expect the taiga to migrate slowly north, replacing treeless tundra, if the warming continues or intensifies. In other regions of the world, other species from farther south would normally move in behind them. But in Alaska, which is bounded on the south by ocean, it is unclear what will happen.

"I don't know of any trees in the Gulf of Alaska," Dr. Juday said.

Thawing Permafrost Pit by Pit, the Chill Yields Its Ground

Dr. Vladimir E. Romanovsky, formerly of Moscow State University but now of the University of Alaska, has seen lots of permafrost; it is his area of expertise. But if he wants to see firsthand what can happen when permafrost melts, he need look no farther than the field next to his mother-in-law's home outside Fairbanks. There, a hole 15 feet long, 6 feet across and 8 feet deep has recently opened in the ground.

The hole, with doomed saplings and sod lying in the bottom, is a thermokarst: a sinking plot of ground caused by thawing permafrost. Growing numbers of thermokarsts now abound in Alaska.

Construction has long been known to thaw permafrost if not undertaken with care, but now something different is happening. A thicker layer of insulating snow in the winter, combined with warmer summer weather, is causing undisturbed permafrost to thaw, creating an uneven and sometimes crater-pocked landscape.

Thawing permafrost has forced the relocation roads and runways. Agricultural fields have been damaged and houses have tilted off kilter. Roads and bridges have been abandoned, as has a hospital in the town of Kotzebue. Even the site for the University's building for international arctic research, under construction in Fairbanks, had to be moved.

Along interior roads, drivers can see the telltale sign of sinking ground: a stand of larch, its branches looking delicate and spidery, but gray rather than green, standing in the water of a stretch of muskeg, or subarctic swamp. When a thermokarst develops, the swampy water fills it, and the trees die.

Dr. Romanovsky said measurements from boreholes drilled into the ground show many areas are mere tenths of a degree from the melting point and will thaw if the warming continues. If the warming runs its course as predicted, thermokarsting will eventually be complete, the permafrost line will have moved farther north (it has already migrated 80 miles in the last century in some places), and a new stability will have set in, making construction and maintenance easier than before the thaw. The transition is the problem.

Receding Glacier Bereft of Anchor, Ice Beats a Retreat

When the Columbia Glacier was first studied a century ago, it was advancing rapidly from the land into Prince William Sound. The advance stopped about 1923 and was followed by a slight pullback. More recently the glacier was stable, its leading edge anchored to a broad underwater shoal of rocky debris, called a moraine, that the glacier had pushed ahead of it as it advanced. Each summer the glacier would fall back a bit, but would advance in the winter and reattach itself to the moraine.

Then, in 1983, it failed to reattach, and the retreat was on. It has been retreating toward the shore at an average rate of half a mile a year since. The moraine pens up the eight-mile field of icebergs that holds ships away from the glacier's front.

What touched off the pell-mell pullback? "My belief is that it is climate," said Dr. Will Harrison, a geophysicist at the University of Alaska, who is an expert on glaciers. One theory is that the warmer environment prevented the glacier from reattaching itself to the moraine after the seasonal summer fallback. "Once climate kicks it off, you can't stop it," Dr. Harrison said of the retreat. "Once the bullet's fired, that's it." Many climate experts believe that in general, abrupt changes like this, rather than gradual ones, will typify a warming climate.

Alaska has more than 1,000 glaciers, big and small, and together they make up the fourth-largest collection of ice in the world, after Antarctica, Greenland and the neighboring Queen Elizabeth Islands of the high Arctic. And as is true of mountain glaciers generally, many of Alaska's are retreating, ever faster in recent years.

Recent mapping of a sampling of nine glaciers, said Dr. Harrison, has revealed that all have thinned substantially at lower elevations, probably because of increased melting in the summer. But at higher elevations, most of the glaciers have thickened, probably because of increased winter precipitation. Still, in most instances, the melting at the base of the glaciers has outstripped the new ice provided by winter snows, and the trend has been especially pronounced in the last five years. "Something's happened here," Dr. Harrison said.

Indeed.

Given the uncertainty of climate predictions, the future is unclear. "But each year and each month that the temperature doesn't drop down," said Dr. Juday, "is confirmation that the whole system has been kicked up" to a new climatic state.

Photograph

Columbia Glacier is not what it used to be. The front of the glacier, in the foreground, has retreated eight miles in the last 16 years, and ships are separated from it by melting icebergs. (William K. Stevens/The New York Times)(pg. F5)

Chart/Photos: "The Big Thaw: Alaska as Harbinger"

While scientists debate the causes and effects of global warming, Alaska and much of the rest of the sub-Arctic have warmed by as much as 5 degrees Fahrenheit in the last three decades. Columbia Glacier, above, has retreated more than eight miles in the last 16 years, shedding melting icebergs (white expanse in the foreground) as it goes. The symbolic landscape below details some other effects.

Increased snowfall

In very cold climates, warmer temperatures mean more snow.

Agriculture

Warmer days have meant longer growing seasons, but less rain.

Rough roads

Roads originally built on permanently frozen ground (permafrost) have begun to crack and roll as the soil thaws and the ground softens.

Retreating glaciers

Although increased snowfall feeds mountain glaciers, this is often offset by summer melting, and many glaciers are shrinking.

Melting Ice

Columbia Glacier's rapid retreat began when it could no longer anchor to a moraine, or rocky shoal in Prince William Sound (left). Scientists say they believe a changing climate touched off the pullback.

Beetle attack

Warmer temperatures have encouraged populations of the voracious spruce bark beetle to expand, and it has killed much of the white spruce forest.

Runoff

In summer, thousands of waterfalls carry increased flows from melting snows and glaciers

Sinkholes

Holes as deep as 30 feet appear as subterranean ice melts. Dr. Vladimir Romanovsky checks out a recent example.

Roadside distractions

Leaning telephone poles are a common sight on the road to Fairbanks as increased temperatures thaw the once firm ground.

Besieged forests

Many trees are sinking into swamps and drowning as permafrost melts. Heavy snows have snapped the tops off others.

(Photographs by William K. Stevens/The New York Times and Juan Velasco/The New York Times)(pg. F1)

Map of Alaska highlights Columbia Glacier showing the distance it's receded from 1983 to 1998. (pg. F5)

DETAILS

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