

Signs From Earth: The Big Thaw

Written by Daniel Glick

5 "If we don't have it, we don't need it," pronounces Daniel Fagre as we throw on our backpacks. We're armed with crampons, ice axes, rope, GPS receivers, and bear spray to ward off grizzlies, and we're trudging toward Sperry Glacier in Glacier National Park, Montana. I fall in step with Fagre and two other research scientists from the U.S. Geological Survey Global Change Research Program. They're doing what they've been doing for more than a decade: measuring how the park's storied glaciers are melting.

10 So far, the results have been positively chilling. When President Taft created Glacier National Park in 1910, it was home to an estimated 150 glaciers. Since then the number has decreased to fewer than 30, and most of those remaining have shrunk in area by two-thirds. Fagre predicts that within 30 years most if not all of the park's namesake glaciers will disappear.

"Things that normally happen in geologic time are happening during the span of a human lifetime," says Fagre. "It's like watching the Statue of Liberty melt."

15 Scientists who assess the planet's health see indisputable evidence that Earth has been getting warmer, in some cases rapidly. Most believe that human activity, in particular the burning of fossil fuels and the resulting buildup of greenhouse gases in the atmosphere, have influenced this warming trend. In the past decade scientists have documented record-high average annual surface temperatures and have been observing other signs of change all over the planet: in the distribution of ice, and in the salinity, levels, and temperatures of the oceans.

20 "This glacier used to be closer," Fagre declares as we crest a steep section, his glasses fogged from exertion. He's only half joking. A trailside sign notes that since 1901, Sperry Glacier has shrunk from more than 800 acres (320 hectares) to 300 acres (120 hectares). "That's out of date," Fagre says, stopping to catch his breath. "It's now less than 250 acres (100 hectares)."

25 Everywhere on Earth ice is changing. The famed snows of Kilimanjaro have melted more than 80 percent since 1912. Glaciers in the Garhwal Himalaya in India are retreating so fast that researchers believe that most central and eastern Himalayan glaciers could virtually disappear by 2035. Arctic sea ice has thinned significantly over the past half century, and its extent has declined by about 10 percent in the past 30 years. NASA's repeated laser altimeter readings show the edges of Greenland's ice sheet shrinking. Spring freshwater ice breakup in the Northern Hemisphere now occurs nine days earlier than it did 150 years ago, and autumn freeze-up ten days later. Thawing permafrost has caused the ground to subside more than 15 feet (4.6 meters) in parts of Alaska. From the Arctic to Peru, from Switzerland to the equatorial glaciers of Man Jaya in Indonesia, massive ice fields, monstrous glaciers, and sea ice are disappearing, fast.

35 When temperatures rise and ice melts, more water flows to the seas from glaciers and ice caps, and ocean water warms and expands in volume. This combination of effects has played the major role in raising average global sea level between four and eight inches (10 and 20 centimeters) in the past hundred years, according to the Intergovernmental Panel on Climate Change (IPCC).

40 Scientists point out that sea levels have risen and fallen substantially over Earth's 4.6-billion-year history. But the recent rate of global sea level rise has departed from the average rate of the past two to three thousand years and is rising more rapidly—about one-tenth of an inch a year. A continuation or acceleration of that trend has the potential to cause striking changes in the world's coastlines.

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45 subsidence. A sinking coastline and a rising ocean combine to yield powerful effects. It's like taking the global sea-level-rise problem and moving it along at fast-forward.

The seventh-generation Cajun and manager of the South Lafourche Levee District navigates his truck down an unpaved mound of dirt that separates civilization from inundation, dry land from a swampy horizon. With his French-tinged lilt, Curole points to places where these bayous, swamps, and fishing villages portend a warmer world: his high school girlfriend's house partly submerged, a cemetery with water lapping against the white tombs, his grandfather's former hunting camp now afloat in a stand of skeleton oak snags. "We live in a place of almost land, almost water," says the 52-year-old Curole.

55 Rising sea level, sinking land, eroding coasts, and temperamental storms are a fact of life for Curole. Even relatively small storm surges in the past two decades have overwhelmed the system of dikes, levees, and pump stations that he manages, upgraded in the 1990s to forestall the Gulf of Mexico's relentless creep. "I've probably ordered more evacuations than any other person in the country," Curole says.

60 The current trend is consequential not only in coastal Louisiana but around the world. Never before have so many humans lived so close to the coasts: More than a hundred million people worldwide live within three feet (a meter) of mean sea level. Vulnerable to sea-level rise, Tuvalu, a small country in the South Pacific, has already begun formulating evacuation plans. Megacities where human populations have concentrated near coastal plains or river deltas—Shanghai, Bangkok, Jakarta, Tokyo, and New York—are at risk. The projected economic and humanitarian impacts on low-lying, densely populated, and desperately poor countries like Bangladesh are potentially catastrophic. The scenarios are disturbing even in wealthy countries like the Netherlands, with nearly half its landmass already at or below sea level.

65 Rising sea level produces a cascade of effects. Bruce Douglas, a coastal researcher at Florida International University, calculates that every inch (2.5 centimeters) of sea-level rise could result in eight feet (2.4 meters) of horizontal retreat of sandy beach shorelines due to erosion. Furthermore, when salt water intrudes into freshwater aquifers, it threatens sources of drinking water and makes raising crops problematic. In the Nile Delta, where many of Egypt's crops are cultivated, widespread erosion and saltwater intrusion would be disastrous since the country contains little other arable land.

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80 Local projects like that might not do much good in the very long run, though, depending on the course of change elsewhere on the planet. Part of Antarctica's Larsen Ice Shelf broke apart in early 2002. Although floating ice does not change sea level when it melts (any more than a glass of water will overflow when the ice cubes in it melt), scientists became concerned that the collapse could foreshadow the breakup of other ice shelves in Antarctica and allow increased glacial discharge into the sea from ice sheets on the continent. If the West Antarctic ice sheet were to break up, which scientists consider very unlikely this century, it alone contains enough ice to raise sea level by nearly 20 feet (6 meters).

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Rising sea level is not the only change Earth's oceans are undergoing. The ten-year-long World Ocean Circulation Experiment, launched in 1990, has helped researchers to better understand what is now called the ocean conveyor belt.

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The engine running the conveyor belt is the density-driven thermohaline circulation ("thermo" for heat and
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While scientists like Bates monitor changes in the oceans, others evaluate CO₂ levels in the atmosphere. In
Vestmannaeyjar, Iceland, a lighthouse attendant opens a large silver suitcase that looks like something out of
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Around the world, collectors like these are monitoring the cocoon of gases that compose our atmosphere and
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160 gases are a climate-change driver," says Tans, poking his graph definitively with his index finger. The three lines on the graph follow almost identical patterns: basically flat until the mid-1800s, then all three move upward in a trend that turns even more sharply upward after 1950. "This is what we did," says Tans, pointing to the parallel spikes. "We have very significantly changed the atmospheric concentration of these gases. We know their radiative properties," he says. "It is inconceivable to me that the increase would not have a significant effect on climate."

165 Exactly how large that effect might be on the planet's health and respiratory system will continue to be a subject of great scientific and political debate—especially if the lines on the graph continue their upward trajectory.

Eugene Brower, an Inupiat Eskimo and president of the Barrow Whaling Captains' Association, doesn't need
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"It's happening as we speak," the 56-year-old Brower says as we drive around his home in Barrow, Alaska—
the United States' northernmost city—on a late August day. In his fire chief's truck, Brower takes me to his family's traditional ice cellars, painstakingly dug into the permafrost, and points out how his stores of muktuk—whale skin and blubber recently began spoiling in the fall because melting water drips down to his
175 food stores. Our next stop is the old Bureau of Indian Affairs school building. The once impenetrable permafrost that kept the foundation solid has bucked and heaved so much that walking through the school is almost like walking down the halls of an amusement park fun house. We head to the eroding beach and gaze out over open water. "Normally by now the ice would be coming in," Brower says, scrunching up his eyes and scanning the blue horizon.

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There are no words, though, to describe how much, and how fast, the ice is changing. Researchers long ago predicted that the most visible impacts from a globally warmer world would occur first at high latitudes: rising air and sea temperatures, earlier snowmelt, later ice freeze-up, reductions in sea ice, thawing permafrost, more erosion, increases in storm intensity. Now all those impacts have been documented in Alaska. "The changes observed here provide an early warning system for the rest of the planet," says Amanda Lynch, an Australian researcher who is the principal investigator on a project that works with Barrow's residents to help them incorporate scientific data into management decisions for the city's threatened infrastructure.

Before leaving the Arctic, I drive to Point Barrow alone. There, at the tip of Alaska, roughshod hunting shacks dot the spit of land that marks the dividing line between the Chukchi and Beaufort Seas. Next to one shack someone has planted three eight-foot (2.4-meter) sticks of white driftwood in the sand, then crisscrossed their tops with whale baleen, a horny substance that whales of the same name use to filter life-sustaining plankton out of seawater. The baleen, curiously, looks like palm fronds.

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