How a Wayward Arctic Current Could Cool the Climate in Europe

The Beaufort Gyre, a key Arctic Ocean current, is acting strangely. Scientists say it may be on the verge of discharging a huge amount of ice and cold freshwater that could kick off a period of lower temperatures in northern Europe.

BY ED STRUZIK • DECEMBER 11, 2017, YaleEnvironment 360

For millennia, the Beaufort Gyre — a massive wind-driven current in the Arctic Ocean — has been regulating climate and sea ice formation at the top of the world. Like a giant spinning top, the gyre corrals vast amounts of sea ice. Trapped in this clockwise swirl, the ice has historically had more time to thicken than it generally does in other parts of the Arctic Ocean, where currents such as the Trans Polar Drift transport the ice into the warmer north Atlantic more rapidly. In this way, the Beaufort Gyre — located north of Alaska and Canada's Yukon Territory — has helped create the abundant layers of sea ice that, until recently, covered large parts of the Arctic Ocean year-round.

These days, however, something is amiss with this vital plumbing system in the Arctic, a region warming faster than any other on the planet. Thanks in part to rising air temperatures, steadily disappearing sea ice, and the annual melting of 270 billion tons of ice from Greenland's ice cap, the gyre is no longer functioning as it has predictably done for more than a half century. And now, scientists are anticipating that a sudden change in the Beaufort Gyre could set in motion events that — in a steadily warming world — would actually lead to a temporary but significant cooling of the North Atlantic region.

During the second half of the 20th century — and, most likely, earlier — the gyre adhered to a cyclical pattern in which it would shift gears every five to seven years and temporarily spin in a counter-clockwise direction, expelling ice and freshwater into the eastern Arctic Ocean and the North Atlantic. But for more than a dozen years, this carousel of ice and, increasingly, freshwater has been spinning faster in its usual clockwise direction, all the while collecting more and more freshwater from three sources: melting sea ice, huge volumes of runoff flowing into the Arctic Ocean from Russian and North American rivers, and the relatively fresh water streaming in from the Bering Sea.

Today, the Beaufort Gyre holds as much freshwater as all of the Great Lakes combined, and its continuing clockwise swirl is preventing this enormous volume of ice and cold, fresh water from flushing into the North Atlantic Ocean. But, scientists say, the gyre will inevitably weaken and reverse direction, and when it does it could expel a massive amount of icy fresh water into the North Atlantic. Polar oceanographer Andrey Proshutinsky of the Woods Hole Oceanographic Institution has labeled this anticipated surge of water a "ticking climate bomb," noting that even a partial flush of that growing reservoir —

a mere 5 percent — could temporarily cool the climate of Iceland and northern Europe and have a major impact on commercial fisheries in the North Atlantic.

A similar event, known as the Great Salinity Anomaly, occurred from the late 1960s into the 1970s, when a surge of water out of the Arctic Ocean freshened and cooled the top half-mile of parts of the North Atlantic. According to British oceanographer Robert R. Dickson, the Great Salinity Anomaly represented one of the most persistent and extreme variations in global ocean climate observed during the past century. The surge of ice and freshwater cooled Northern Europe dramatically and disrupted the North Atlantic food chain, which, in turn, caused a collapse of the lucrative herring fishery. Between 1951 and 2010, as many as eight of 18 exceptionally cold European winters occurred during the period of the Great Salinity Anomaly.

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Scientists studying the current state of the Beaufort Gyre say that when the wind-driven current finally becomes "unstuck" and propels freshwater into the North Atlantic, the event could possibly be more widespread and severe than the Great Salinity Anomaly.

"We're all waiting with bated breath to see what happens when this thing stops sucking in freshwater and finally exhales," says Alek Petty, a post-doctoral student at NASA's Goddard Space Flight Center and the University of Maryland, who is studying the gyre.

The Beaufort Sea, home of the gyre, is one of the most inaccessible and inhospitable places on the planet. Studying the behavior of the gyre is a major logistical challenge. But for the past 15 years, an international team of scientists from the United States, Canada, Japan, and several other countries has been conducting annual summer research expeditions into the region on icebreakers. The scientists from the Beaufort Gyre Exploration Project have watched with growing interest as the gyre has continued to expand.

"Many of us expected that the high atmospheric pressure that drives those clockwise winds over the region would have temporarily weakened or reversed by now, as they seem to have done with some regularity in the past," says Richard Krishfield, a Woods Hole oceanographer who is part of the project. "We had expected to see that happen in 2003 when we first went up. But for reasons that are not clearly understood, that hasn't happened. The gyre has been stuck in this anticyclonic [clockwise] pattern ever since."

An international team of scientists has been studying the Beaufort Gyre for 15 years. In 2016, the researchers (left) measured ice thickness from points around the gyre, traveling aboard the icebreaker CCGS Louis S. St. Laurent (right). NASA

The gyre's strange behavior is likely linked, at least in part, to the profound warming of the Arctic, and it demonstrates how disruptions in one rapidly changing region of the world can affect ecosystems hundreds, even thousands, of miles away. In a recent paper, Krishfield, Proshutinsky, and other scientists suggest that frigid freshwater pouring into the north Atlantic Ocean from the rapidly melting Greenland ice sheet is forming a cap on the North Atlantic that results in stratification that prevents storm-triggering heat from the northern end of the Gulf Stream from rising to the surface. The scientists say this may be inhibiting the formation of cyclones that would cause the motion of the gyre to weaken or temporarily reverse.

If that is the case, it may mean the gyre will continue to grow and spin clockwise for years to come. That may be good news for northern Europeans and North Atlantic fishermen who would likely suffer from the freshening of the upper layer of their ocean and the ensuing dip in temperatures. But it may simply be delaying a potentially larger flush and more profound cooling event in the future.

Some scientists suggest that the Beaufort Gyre's expansion and continuing clockwise movement may be having one beneficial consequence for marine life in the Arctic. As Arctic sea ice has disappeared — losing 40 percent of its summer extent and about two-thirds of its total volume in the last 40 years — various nations have been eyeing a potential fishing boom. That anticipated fishing bonanza would occur as retreating ice allows sunlight to strike the water, touching off phytoplankton blooms that would then nourish populations of zooplankton, fish, seals, and whales.

But Eddy Carmack — an oceanographer who recently retired from Canada's Institute of Ocean Sciences and who has been studying the gyre longer than any other scientist — says that as long as that thick cap of freshwater over the Beaufort Gyre prevents the saltier and nutrient-rich water located below from rising and mixing with the colder and fresher surface layer, no amount of sunshine is going to support the rich underwater life. And Carmack says that even if the gyre reverses direction and expels some freshwater and sea ice, enough cold water will remain on the surface of the Beaufort Sea to inhibit plankton growth and fisheries.

No one knows what will happen in the future when a seasonally ice-free Arctic Ocean becomes increasingly exposed to the warmth of sunshine. A gradual warming of water could someday release some of that heat that is now trapped far below the surface. But for much of this century, scientists expect that melting sea ice and frigid water flowing from Arctic rivers will leave a cold, freshwater cap on the surface of the Beaufort Gyre. And, influenced by the generally westerly winds associated with the polar high-pressure system, the gyre is expected to continue to spin in the Arctic Ocean, albeit with much less ice.

The first confirmation of the Beaufort Gyre's existence came in the 1950s when Soviet scientists conducted research in the region. Carmack first visited the gyre in 1971. At that point, the gyre had weakened and had set in motion the Great Salinity Anomaly.

Carmack suspects that another smaller pulse of fresh Arctic water that leaked into the North Atlantic in the early 1990s — the result of the Beaufort Gyre spinning in a counter-clockwise direction — may have suppressed the recovery of the severely overharvested cod populations in Newfoundland and Labrador. That fishery has yet to rebound in any significant way.

Carmack, Woods Hole's Krishfield, and others are not ruling out the possibility that the gyre will weaken or reverse direction sooner rather than later. In fact, research conducted by the expedition this summer suggests that a change may be coming. The volume of freshwater in the gyre had not increased since the previous summer's expedition, and changes in atmospheric circulation suggested a possible shift to the cyclonic activity that might weaken the clockwise rotation of the gyre.

But it remains to be seen when and whether the next big flush will occur and whether it will set off the "ticking climate bomb" that Proshutinsky has forecast.

Speaking about the possibility of a gyre-driven surge of cold water temporarily altering the climate of the North Atlantic, NASA's Petty says, "It's not going to be a scene from `The Day After Tomorrow,' [the film in which the earth's climate radically cools]. But the fact is we just don't know. There just isn't enough Arctic data out there to make firm predictions in a world where climate change, ocean currents, and atmospheric forces interact in complex ways."