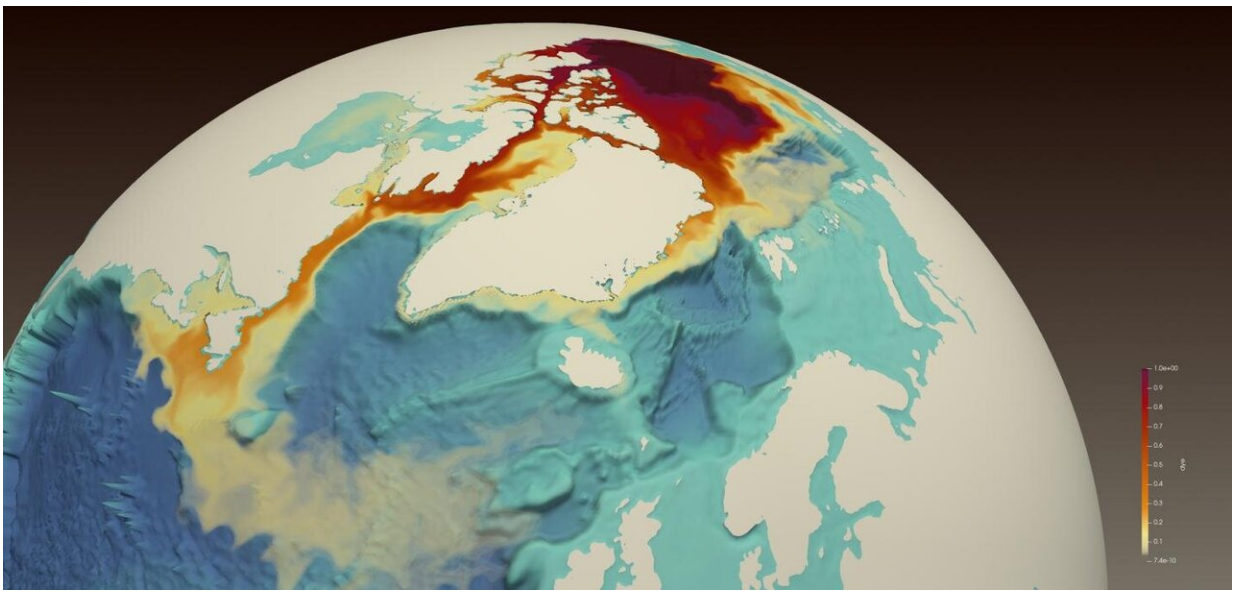
Record-high Arctic freshwater will flow to Labrador Sea, affecting local and global oceans

February 24 2021, by Hannah Hickey



A simulated red dye tracer released from the Beaufort Gyre in the Artic Ocean (center top) shows freshwater transport through the Canadian Arctic Archipelago, along Baffin Island to the western Labrador Sea, off the coast of Newfoundland and Labrador, where it reduces surface salinity. At the lower left is Newfoundland (triangular land mass) surrounded by orange for fresher water, with Canada's Gulf of St. Lawrence above colored yellow. Credit: Francesca Samsel and Greg Abram

Freshwater is accumulating in the Arctic Ocean. The Beaufort Sea,

which is the largest Arctic Ocean freshwater reservoir, has increased its freshwater content by 40% over the past two decades. How and where this water will flow into the Atlantic Ocean is important for local and global ocean conditions.

A study from the University of Washington, Los Alamos National Laboratory and the National Oceanic and Atmospheric Administration shows that this freshwater travels through the Canadian Archipelago to reach the Labrador Sea, rather than through the wider marine passageways that connect to seas in Northern Europe. The open-access study was published Feb. 23 in *Nature Communications*.

"The Canadian Archipelago is a major conduit between the Arctic and the North Atlantic," said lead author Jiaxu Zhang, a UW postdoctoral researcher at the Cooperative Institute for Climate, Ocean and Ecosystem Studies. "In the future, if the winds get weaker and the freshwater gets released, there is a potential for this high amount of water to have a big influence in the Labrador Sea region."

The finding has implications for the Labrador Sea marine environment, since Arctic water tends to be fresher but also rich in nutrients. This pathway also affects larger oceanic currents, namely a conveyor-belt circulation in the Atlantic Ocean in which colder, heavier water sinks in the North Atlantic and comes back along the surface as the Gulf Stream. Fresher, lighter water entering the Labrador Sea could slow that overturning circulation.

The Beaufort Gyre is a clockwise wind pattern in the western Arctic Ocean that causes freshwater to accumulate at the ocean's surface. When those winds relax, the freshwater drains not through Fram Strait, but through the narrow channels of the Canadian Archipelago to reach the Labrador Sea, off the coast of Canada's Newfoundland and Labrador. Credit: University of Washington

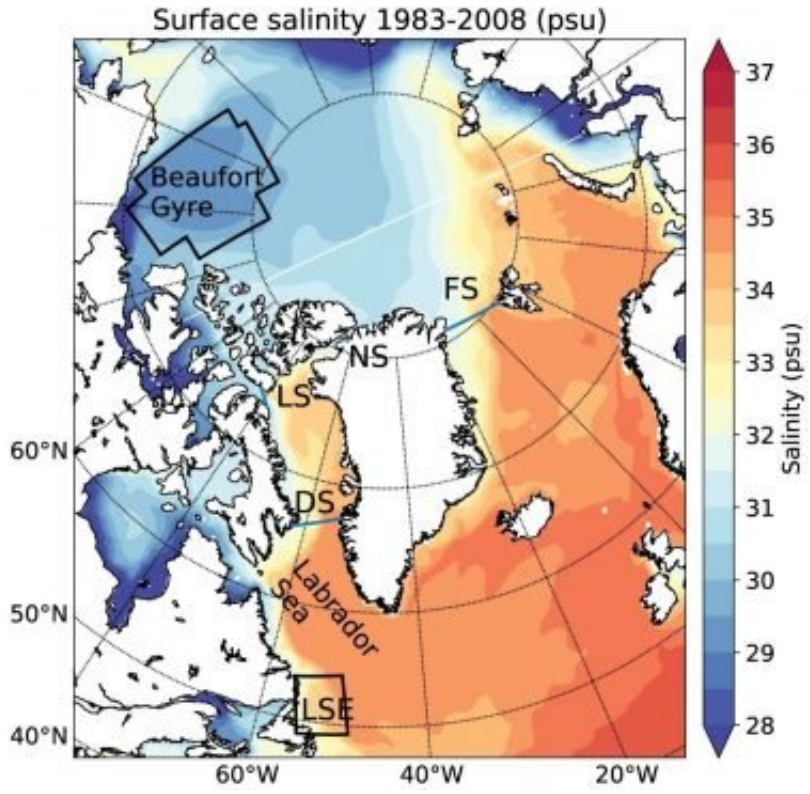
"We know that the Arctic Ocean has one of the biggest climate change signals," said co-author Wei Cheng at the UW-based Cooperative Institute for Climate, Ocean and Atmosphere Studies. "Right now this freshwater is still trapped in the Arctic. But once it gets out, it can have a very large impact."

Fresher water reaches the Arctic Ocean through rain, snow, rivers, inflows from the relatively fresher Pacific Ocean, as well as the recent

melting of Arctic Ocean sea ice. Fresher, lighter water floats at the top, and clockwise winds in the Beaufort Sea push that lighter water together to create a dome.

When those winds relax, the dome will flatten and the freshwater gets released into the North Atlantic.

"People have already spent a lot of time studying why the Beaufort Sea freshwater has gotten so high in the past few decades," said Zhang, who began the work at Los Alamos National Laboratory. "But they rarely care where the freshwater goes, and we think that's a much more important problem."



This map shows the study region of the Beaufort Gyre and nearby waters, with colors showing the average surface salinity for 1983-2008. Labels show the Labrador Sea's exit region, Nares Strait, Lancaster Sound, Davis Strait and Fram

Strait. Credit: Zhang et al./Nature Communications

Using a technique Zhang developed to track ocean salinity, the researchers simulated the ocean circulation and followed the Beaufort Sea freshwater's spread in a past event that occurred from 1983 to 1995.

Their experiment showed that most of the freshwater reached the Labrador Sea through the Canadian Archipelago, a complex set of narrow passages between Canada and Greenland. This region is poorly studied and was thought to be less important for freshwater flow than the much wider Fram Strait, which connects to the Northern European seas.

In the model, the 1983-1995 freshwater release traveled mostly along the North American route and significantly reduced the salinities in the Labrador Sea—a freshening of 0.2 parts per thousand on its shallower western edge, off the coast of Newfoundland and Labrador, and of 0.4 parts per thousand inside the Labrador Current.

The volume of freshwater now in the Beaufort Sea is about twice the size of the case studied, at more than 23,300 cubic kilometers, or more than 5,500 cubic miles. This volume of freshwater released into the North Atlantic could have significant effects. The exact impact is unknown. The study focused on past events, and current research is looking at where today's freshwater buildup might end up and what changes it could trigger.

"A freshwater release of this size into the subpolar North Atlantic could impact a critical circulation pattern, called the Atlantic Meridional Overturning Circulation, which has a significant influence on Northern Hemisphere climate," said co-author Wilbert Weijer at Los Alamos National Lab.

More information: Jiaxu Zhang et al. Labrador Sea freshening linked to Beaufort Gyre freshwater release, *Nature Communications* (2021). DOI: 10.1038/s41467-021-21470-3

Provided by University of Washington