The Unseen Way in Which Climate Change Is Altering the Arctic Ocean

Scientists have found that melting sea ice is increasing the flow of nutrients into the central Arctic from the continental shelf. That could disrupt the marine food chain in unpredictable ways.

www.newsdeeply.com / January 2018

A walrus rests on an ice floe in pack ice in the Arctic Ocean north of Svalbard, Norway. Wolfgang Kaehler/LightRocket via Getty Images

AS CLIMATE CHANGE accelerates, the Arctic Ocean has experienced tremendous upheaval over the past decade: Warm water streaming into the region north of Scandinavia and Russia has led to an “atlantification” of the ocean; sea ice cover has experienced the greatest sustained rate of decline on record; and in some areas, surface waters are more than 7.2F (4C) warmer than the 1980–2010 average. Now scientists say the volume of carbon and nutrients flowing into the Arctic Ocean is also growing, potentially altering the biological makeup of the region.

In a new study published in the journal Science Advances, researchers found that there’s been an increase in the amount of sediment-derived materials flowing into the Arctic Ocean from the continental shelf, the underwater landmass that extends from the
continent and forms an area of relatively shallow water known as a shelf sea. The impacts of increased sediment, which include nutrients, trace metals and carbon, could trigger a plankton bloom in the central Arctic, disrupting the Arctic food web.

Low light and limited nutrients keep the biological productivity of the central Arctic in check. However, the retreat of sea ice has already brought more light to the Arctic Ocean, allowing for a longer growing season. That and nutrients from sediment flow could boost plankton and algae growth in the region – the bedrock of maritime food chains – which would alter the life cycles of other species that depend on those food sources, namely small fish and marine organisms. Ultimately, these changes work their way up to higher trophic levels, affecting marine mammals such as polar bears.

“As the ocean chemistry changes, different species may do better under increased nutrient conditions,” said Lauren Kipp, a researcher at the Woods Hole Oceanographic Institution and lead author of the new study.

“Scientists have been studying the continental shelf sources of carbon and of major nutrients, such as nitrogen and phosphorous, in the Arctic Ocean for many years, but we are just beginning to investigate the shelf sources of metals,” said Robert F. Anderson, a research professor of geochemistry at Columbia University’s Lamont-Doherty Earth Observatory. “If climate change is causing the sources of these metals to increase, as has been inferred for radium by Kipp and [her] coworkers, then we want to monitor these changes to assess their potential impact on Arctic ecosystems.”

A polar bear running on pack ice floating in the Arctic Ocean. (Arterra/UIG via Getty Images)
In the Arctic Ocean, the continental shelf makes up more than half of the total area. In turn, the waters here are heavily influenced by any changes in sediment flows. Melting sea ice has exposed these shallow shelf seas along the coast to more wave and wind action, stirring up sediment from the continental shelf and drawing it into the water column.

Until now, little work has been done to monitor the discharge of shelf-derived materials into the central Arctic Ocean. The region is hard to access, and carbon, nutrients and trace materials can be hard to measure. So Kipp and her colleagues measured the presence of radium-228 – a naturally occurring element found in soils – in surface waters at 69 stations in the Arctic, ranging from the Chukchi Shelf to the North Pole.

“Radium-228 makes a great tracer for other sediment flows,” said Kipp, noting that it is relatively water-soluble and therefore can be used to track the amount, direction, source and destination of sediment flows. In turn, researchers were able to compare their samples against previous data collected in a 2007 study. Their results provide one of the first estimates of Arctic shelf flux and reveal that sediment discharge into the ocean had roughly doubled during the past decade.

But pinning down the exact mechanism by which radium has arrived in surface waters is much harder. “It’s hard to detangle exactly where change is happening on the shelf,” Kipp said. Increased mixing with the continental shelf is the most likely source, but there are others, too.

Thawing permafrost on land and on the shelf also releases radium from previously frozen soils, and can create more submarine groundwater channels that transport sediment-heavy waters to the coast. Rivers, too, carry these terrestrial materials into the sea, where the Transpolar Drift Stream pushes them out into the central Arctic Ocean. This process is critical to the ways in which varying nutrients and trace metal concentrations in Arctic waters could alter biodiversity in the central Arctic Ocean. The Transpolar Drift directly transports nutrients to the surface layer, requiring less need for mixing and upwelling of nutrients from deeper waters.
As sea ice continues to decline, more monitoring is needed.

“It will be important to find out whether the observed increase in [radium-228] flux is permanent and whether there is any evidence that this increased flux is indeed accompanied by a change in the supply rate of other [land-eroded] components in the Transpolar Drift,” said Michiel Rutgers van der Loeff, a geochemist with the Alfred Wegener Institute for Polar and Marine Research in Germany and lead author of the 2007 study that the researchers used for comparison.

Open water will bolster the influence of wind stress on river plumes and coastal waters, which could lead to more turbulence over the shelves and greater offshore transport of sediments. “We want to increase our data coverage over the parts of the shelf where we think these changes are occurring,” said Kipp, “particularly the East Siberian shelf seas, where we don’t have a lot of data, so that we can pinpoint the distribution of radium over the shelves in the future.”

Anderson noted that as the sea ice continues to retreat, the Arctic Ocean will be increasingly open to shipping. “These activities could also introduce potentially toxic metals into the Arctic marine environment,” he said. “Studying these metal distributions now, together with radium and other chemicals that provide clues to the source of the metals, may one day help discriminate between global warming versus industrialization versus some as-yet-unidentified source of potentially toxic substances should there be evidence for an impact on Arctic ecosystems and questions about legal liability for the consequences.”