Arctic Sea Ice Decline May Trigger Climate Change Cascade

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Arctic sea ice that has been dwindling for several decades may have reached a tipping point that could trigger a cascade of climate change reaching into Earth's temperate regions, says a new University of Colorado at Boulder study.

Mark Serreze, a senior research scientist at CU-Boulder's National Snow and Ice Data Center who led the study synthesizing results from recent research, said the Arctic sea-ice extent trend has been negative in every month since 1979, when concerted satellite record keeping efforts began. The team attributed the loss of ice, about 38,000 square miles annually as measured each September, to rising concentrations of greenhouse gases and strong natural variability in Arctic sea ice.

"When the ice thins to a vulnerable state, the bottom will drop out and we may quickly move into a new, seasonally ice-free state of the Arctic," Serreze said. "I think there is some evidence that we may have reached that tipping point, and the impacts will not be confined to the Arctic region."

A review paper by Serreze and Julienne Stroeve of CU-Boulder's NSIDC and Marika Holland of the National Center for Atmospheric Research titled "Perspectives on the Arctic's Shrinking Sea Ice Cover" appears in the March 16 issue of *Science*.

The loss of Arctic sea ice is most often tied to negative effects on wildlife like polar bears and increasing erosion of coastlines in Alaska and Siberia, he said. But other studies have linked Arctic sea ice loss to changes in atmospheric patterns that cause reduced rainfall in the American West or increased precipitation over western and southern Europe, he said.

The decline in Arctic sea ice could impact western states like Colorado, for example, by reducing the severity of Arctic cold fronts dropping into the West and reducing snowfall, impacting the ski industry and agriculture, he said. "Just how things will pan out is unclear, but the bottom line is that Arctic sea ice matters globally," Serreze said.

Because temperatures across the Arctic have risen from 2 degrees to 7 degrees F. in recent decades due to a build-up of atmospheric greenhouse gases, there is no end in sight to the decline in Arctic sea ice extent, said Serreze of CU-Boulder's Cooperative Institute for Research in Environmental Sciences. Arctic sea ice extent is defined as the total area of all regions where ice covers at least 15 percent of the ocean surface.

"While the Arctic is losing a great deal of ice in the summer months, it now seems that it also is regenerating less ice in the winter," said Serreze. "With this increasing vulnerability, a kick to the system just from natural climate fluctuations could send it into a tailspin."

In the late 1980s and early 1990s, shifting wind patterns from the North Atlantic Oscillation flushed much of the thick sea ice out of the Arctic Ocean and into the North Atlantic where it drifted south and eventually melted, he said. The thinner layer of "young" ice that formed it its place melts out more readily in the succeeding summers, leading to more open water and more solar radiation being absorbed by the open ocean and fostering a cycle of higher temperatures and earlier ice melt, he said.

"This ice-flushing event could be a small-scale analog of the sort of kick that could invoke rapid collapse, or it could have been the kick itself," he said. "At this point, I don't think we really know."

Researchers also have seen pulses of warmer water from the North Atlantic entering the Arctic Ocean beginning in the mid-1990s, which promote ice melt and discourage ice growth along the Atlantic ice margin, he said. "This is another one of those potential kicks to the system that could evoke

rapid ice decline and send the Arctic into a new state."

The potential for such rapid ice loss was highlighted in a December 2006 study by Holland and her colleagues published in Geophysical Research Letters. In one of their climate model simulations, the Arctic Ocean in September became nearly ice-free between 2040 and 2050.

"Given the growing agreement between models and observations, a transition to a seasonally ice-free Arctic Ocean as the system warms seems increasingly certain," the researchers wrote in Science. "The unresolved questions regard when this new Arctic state will be realized, how rapid the transition will be, and what will be the impacts of this new state on the Arctic and the rest of the globe."

Source: University of Colorado at Boulder