Winds, ice motion root cause of decline in sea ice, not warmer temperatures

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Extreme changes in the Arctic Oscillation in the early 1990s -- and not warmer temperatures of recent years -- are largely responsible for declines in how much sea ice covers the Arctic Ocean, with near record lows having been observed during the last three years, University of Washington researchers say.
It may have happened more than a decade ago, but the sea ice appears to still "remember" those Arctic Oscillation conditions, according to Ignatius Rigor, a mathematician with the UW's Applied Physics Laboratory and a presenter at the American Geophysical Union's annual fall meeting this week in San Francisco.

The Arctic Oscillation is a seesaw pattern in which atmospheric pressure at the polar and middle latitudes fluctuates between positive and negative phases. The wind patterns associated with the Arctic Oscillation affect the surface winds and temperature over North America and Eurasia, as well as the Arctic.

The Arctic Oscillation was in an extreme "high," or positive, phase in the early '90s and is generally in a moderate phase today. Rigor and John M. Wallace, UW professor of atmospheric sciences, say the extreme high caused winds at the surface to circulate in ways that blew most of the thicker, older ice out of the Arctic Ocean into the Atlantic.

"It was as if winds generated in response to the Arctic Oscillation in those years became a far bigger 'broom' sweeping ice out of the arctic," Rigor says.

At the same time, changes in surface winds started causing the already thin ice to re-circulate back to the Alaska coast more quickly, decreasing the time it had to thicken before another melt season started. Today the ice in places remains just too thin to last through the summer melt, he says.

The result is that 70 percent of the ice is 3 years old or younger, Rigor says. In the 1980s, some 80 percent of the ice was 20 to 30 years old or more. As for ice extent -- the area of the ocean covered by ice -- last summer was again among the record low years, nearly 15 percent lower than average. With a wintertime ice pack roughly the size of the United States, that's like having areas equivalent to the states of Texas and Colorado melt away. In the 1980s, it was more an area the size of Rhode Island.

The melting in places was extensive even where local temperatures were colder than normal. This was the case in the summers of 2002 and 2003 for Alaskan coastal waters.

"The temperature itself doesn't explain it all," Rigor says, "but the age of sea ice explains more than half the variance in summer sea-ice extent in those coastal waters."

Just because warming temperatures may not be the key reason for declines in ice extent that doesn't mean greenhouse gases and warming are not contributing factors, Rigor says.

"The Arctic Oscillation has been in a primarily moderate to high phase during the last decade or more, and the only way to reproduce this tendency in the oscillation using a numerical climate model is if you include the observed increase in greenhouse gases in the model."

To estimate the age of sea ice, the researchers used a simple model that

tracks a grid of ice parcels as they move about the Arctic Ocean. Data about the ice parcels comes from the International Arctic Buoy Program. Under way since 1979, the 40 buoys currently deployed in the ice are from 19 institutions in 10 countries.

The fluctuations in the Arctic Oscillation to its positive phase set the stage for the recent reductions in ice extent, and Rigor and Wallace think low summer sea-ice extents are likely to persist for at least a few years. It is conceivable that, given an extended interval of low-index Arctic Oscillation conditions, ice thickness and summertime sea-ice extent could gradually return to levels characteristic of the 1980s, they say.

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