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At the Edge [1]

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Increased storm activity driving decreases in Arctic ice extent.

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Sea ice reflects up to about 80 percent of spring time solar radiation, and from 40 to 50 percent during summer. In winter, it slows heat loss from the relatively warm ocean water to the cold atmosphere. Primarily fresh water, sea ice has a strong effect on deep water production in the Arctic peripheral seas, and influences critical interactions within horizontal and vertical ocean structures. The extent of Arctic sea ice is seen as a sensitive indicator of climate change. Scientists agree that long-term changes in Arctic sea ice extent could have important consequences for Northern Hemisphere climate.

But sea ice extent is like the stock market -- it fluctuates. With large differences from season to season and year to year it can be as hard to assess a trend as predicting the direction your investments are taking. Only long-term tracking can lend coherence to the characteristically dramatic variations inherent to the extent of polar sea ice.

1995 marked the accumulation of 17 years of remotely sensed passive microwave sea ice data from polar orbiting satellites. Now, analyses of the Arctic record show a quantifiable downtick in sea ice extent and ice area. Researchers say the decreases seem to be accelerating, and what's more, that the trend appears to be linked to significant shifts in Northern Hemisphere atmospheric circulation patterns.

Scientists at the Nansen Environmental and Remote Sensing Center (NERSC) in Bergen, Norway, using the passive microwave record processed by the National Snow and Ice Data Center (NSIDC) DAAC are finding that Arctic sea ice extent -- the region with at least 15 percent ice cover -- is shrinking 2.7 percent per decade. Total ice-covered ocean area is falling 3.4 percent per decade. These decreases represent the overall trend from the beginning of the passive microwave record in 1978 through mid-1995.

Is the trend a harbinger of global warming, or merely the result of interannual variabilty?

The record is not a simple one. Passive microwave sensors measure surface brightness temperatures, from which sea ice concentrations are mathematically determined. Derived ice concentrations are generally accurate to about five percent, except in summer, when melting conditions can affect the signal, leading to underestimations of ice.

To complicate matters, the passive microwave record is actually a combination of data collected by different sensors on two satellite systems. Comparing these essentially different data sets requires compensating for differences in instrument sensitivity, operations, and resolutions.

"Merging data raises important issues," says NERSC research scientist Martin Miles. "There's an overlap between the two data sets of one month. You can use that overlap to try to adjust algorithms so that the values you get from one sensor will match the other.

"Initially, we decided to treat the two time series as separate. It's a very safe, conservative way of assessing events, because you bypass intercalibration errors and instrument factors. You look for a consistent trend in each data set.

"We work with monthly averages. We're not interested in the very high frequency -- such as day-to-day or week-to-week -- variability. In the context of looking for long-term trends you remove the 'noise.' For instance, we take the seasonal component out, because that's always going to be going up and down, winter and summer. So we end up with a sequence of one value per month from 1978 through the present and look for the trend.

"We found decreases in both data sets. The decreases in the more recent data were greater. Subsequently, we performed an intercalibration" Miles says, in which the team subjected the data to time-consuming tests for errors. "We found a very good match in results, which adds to our confidence that the intercalibration is reliable.

"We also used two algorithms simultaneously to compute ice concentrations, the NORSEX algorithm and the NASA Team algorithm. In spite of the fact that derived ice concentrations may not match up between the two algorithms very well, the trends over time give the same result."

"We think these reductions are real," concurs Mark Serreze, a research scientist at the NSIDC DAAC, who specializes in arctic atmospheric circulation patterns. "Besides the passive microwave record there's a lot of corroborating evidence. There is a trend

"What's particularly interesting is the later part of the record, when anomalies in sea ice area appear to be unprecedented. We saw record lows in 1990 and '93; 1995 may be the lowest yet."

Serreze and NSIDC colleagues Jim Maslanik and Roger Barry examined ice observations independent of the passive microwave record, and combined them with sea level pressure, surface temperature and snow cover data sets from the same period to analyze these recent anomalies. They found that the ice reductions were late summertime anomalies occurring predominantly in the East Siberian Sea. The low ice extent could be directly attributed to unusual atmospheric conditions.

"Regional changes are manifestations of significant large scale changes in circulation," Serreze says. "In May 1990, there was a deep mean low pressure system over the central Arctic Ocean. Strong, warm, offshore winds advected the ice poleward, initiating an early melt that dropped down the albedo with a corresponding increase in net radiation. Temperatures in parts of the Arctic were, on average, 2.5 degrees above normal. Albedo was 30 percent below normal in certain areas."

Serreze and others also identify increased storm activity over the Arctic as the cause of the decreases in ice extent in more recent years. The increase in high latitude storm activity appears to be part of a much larger change in Northern Hemisphere circulation and temperature patterns, he says. But, Serreze points out, we don't know yet what's behind the circulation change.

Whether the summer time sea ice reductions in the East Siberian Sea hold clues to global warming is still speculative, and climate investigators are not ready to sell short on the basis of the data to date.

"The record is brief," Miles says. "Once we have years and years of data we can be more confident -- another five, 10 years of these trends -- then we can suspect global warming."

Reference(s)

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