

Expanding Antarctic sea ice linked to natural variability

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Credit: Ted Scambos, University of Colorado, NSIDC

The recent trend of increasing Antarctic sea ice extent—seemingly at odds with climate model projections—can largely be explained by a natural climate fluctuation, according to a new study led by the National Center for Atmospheric Research (NCAR).

The study offers evidence that the negative phase of the Interdecadal Pacific Oscillation (IPO), which is characterized by cooler-than-average [sea surface temperatures](#) in the tropical eastern Pacific, has created favorable conditions for additional Antarctic sea ice growth since 2000.

The findings, published in the journal *Nature Geoscience*, may resolve a longstanding mystery: Why is Antarctic sea ice expanding when climate

change is causing the world to warm?

The study's authors also suggest that sea ice may begin to shrink as the IPO switches to a positive phase.

"The climate we experience during any given decade is some combination of naturally occurring variability and the planet's response to increasing greenhouse gases," said NCAR scientist Gerald Meehl, lead author of the study. "It's never all one or the other, but the combination, that is important to understand."

Study co-authors include Julie Arblaster of NCAR and Monash University in Australia, Cecilia Bitz of the University of Washington, Christine Chung of the Australian Bureau of Meteorology, and NCAR scientist Haiyan Teng. The study was funded by the U.S. Department of Energy and by the National Science Foundation, which sponsors NCAR.

Expanding ice

The sea ice surrounding Antarctica has been slowly increasing in area since the satellite record began in 1979. But the rate of increase rose nearly five fold between 2000 and 2014, following the IPO transition to a negative phase in 1999.

The new study finds that when the IPO changes phase, from positive to negative or vice versa, it touches off a chain reaction of climate impacts that may ultimately affect [sea ice formation](#) at the bottom of the world.

When the IPO transitions to a negative phase, the sea surface temperatures in the tropical eastern Pacific become somewhat cooler than average when measured over a decade or two. These sea surface temperatures, in turn, change tropical precipitation, which drives large-scale changes to the winds that extend all the way down to Antarctica.

The ultimate impact is a deepening of a low-pressure system off the coast of Antarctica known as the Amundsen Sea Low. Winds generated on the western flank of this system blow sea ice northward, away from Antarctica, helping to enlarge the extent of sea ice coverage.

"Compared to the Arctic, global warming causes only weak Antarctic sea ice loss, which is why the IPO can have such a striking effect in the Antarctic," said Bitz. "There is no comparable natural variability in the Arctic that competes with global warming."

Sifting through simulations

To test if these IPO-related impacts were sufficient to cause the growth in [sea ice extent](#) observed between 2000 and 2014, the scientists first examined 262 climate simulations created by different modeling groups from around the world.

When all of those simulations are averaged, the natural variability cancels itself out. For example, simulations with a positive IPO offset those with a negative IPO. What remains is the expected impact of human-caused climate change: a decline in Antarctic sea ice extent.

But for this study, the scientists were not interested in the average. Instead, they wanted to find individual members that correctly characterized the natural variability between 2000-2014, including the negative phase of the IPO. The team discovered 10 simulations that met the criteria, and all of them showed an increase in Antarctic sea ice extent across all seasons.

"When all the models are taken together, the natural variability is averaged out, leaving only the shrinking sea ice caused by [global warming](#)," Arblaster said. "But the model simulations that happen to sync up with the observed natural variability capture the expansion of the

sea ice area. And we were able to trace these changes to the equatorial eastern Pacific in our model experiments."

Scientists suspect that in 2014, the IPO began to change from negative to positive. That would indicate an upcoming period of warmer eastern Pacific Ocean [surface temperatures](#) on average, though year-to-year temperatures may go up or down, depending on El Niño/La Niña conditions. Accordingly, the trend of increasing Antarctic sea ice extent may also change in response.

"As the IPO transitions to positive, the increase of Antarctic [sea ice](#) extent should slow and perhaps start to show signs of retreat when averaged over the next 10 years or so," Meehl said.

More information: Antarctic sea-ice expansion between 2000 and 2014 driven by tropical Pacific decadal climate variability, *Nature Geoscience*, [DOI: 10.1038/ngeo2751](https://doi.org/10.1038/ngeo2751)

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