Record low sea ice cover in the Antarctic

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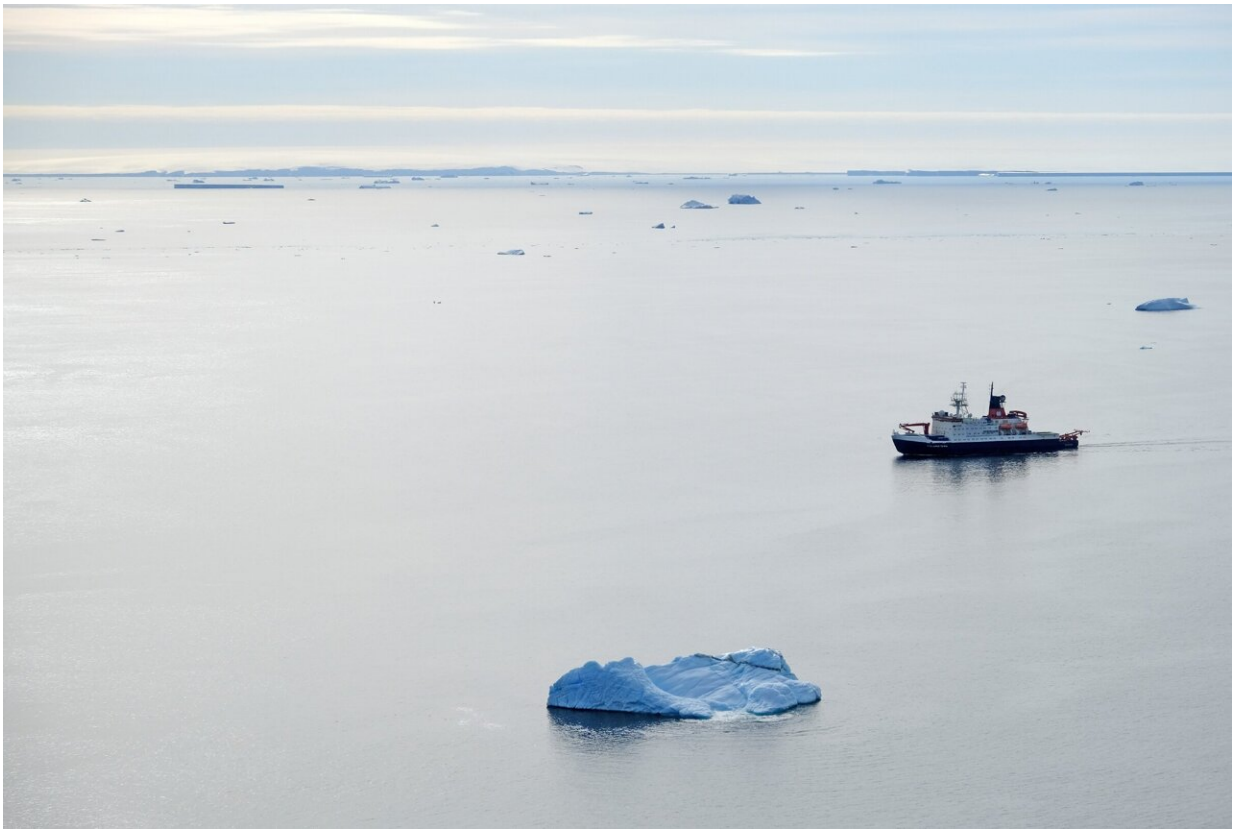

Polarstern in ice-free Bellingshausen Sea, West Antarctica, in January 2023. Credit: Daniela Röhnert (University of Bremen)

There is currently less sea ice in the Antarctic than at any time in the forty years since the beginning of satellite observation: in early February 2023, only 2.20 million square kilometers of the Southern Ocean were covered with sea ice. Researchers from the Alfred Wegener Institute and

the University of Bremen analyze the situation for the Sea Ice Portal.

January 2023 had already set a new record for its monthly mean extent (3.22 million square kilometers), even though the melting phase in the Southern Hemisphere continues until the end of February. The current expedition team on board RV Polarstern has just reported virtually ice-free conditions in its current research area, the Bellingshausen Sea.

"On 8 February 2023, at 2.20 million square kilometers, the Antarctic sea ice extent had already dropped below the previous record minimum from 2022 (2.27 million square kilometers on 24 February 2022). Since the sea ice melting in the Antarctic will most likely continue in the second half of the month, we can't say yet when the record low will be reached or how much more sea ice will melt between now and then," says Prof Christian Haas, Head of the Sea Ice Physics Section at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), with regard to the current developments in the Antarctic.

"The rapid decline in sea ice over the past six years is quite remarkable, since the ice cover hardly changed at all in the thirty-five years before. It is still unclear whether what we are seeing is the beginning of a rapid end to summer sea ice in the Antarctic, or if it is merely the beginning of a new phase characterized by low but still stable sea ice cover in the summer."

The melting has progressed since December 2022, especially in the Bellingshausen and Amundsen Seas in the West Antarctic; the former is virtually ice-free. That is also where the research vessel Polarstern currently is, exploring the evidence left behind of past glacials and interglacials.

According to expedition leader and AWI geophysicist Prof Karsten

Gohl, who is now in the region for the seventh time, having first come in 1994: "I have never seen such an extreme, ice-free situation here before. The continental shelf, an area the size of Germany, is now completely ice-free. Though these conditions are advantageous for our vessel-based fieldwork, it is still troubling to consider how quickly this change has taken place."

In the course of the year, the Antarctic sea ice generally reaches its maximum extent in September or October and its minimum extent in February. In some regions, the sea ice melts completely in summer. In winter, the cold climate throughout the Antarctic promotes the rapid formation of new sea ice. At its maximum, the sea ice cover in the Antarctic is generally between 18 and 20 million square kilometers. In summer, it dwindles to roughly 3 million square kilometers, displaying far more natural annual variability than ice in the Arctic.

Further, Antarctic sea ice is much thinner than its Arctic counterpart and appears only seasonally—which explains why, for a very long time, its development was considered impossible to predict beyond a matter of days. In recent years, however, science has uncovered several mechanisms for predicting the development of sea ice on seasonal time scales. Knowing the sea ice presence weeks to months in advance is of great interest to Antarctic shipping.

Analyses of the current sea ice extent, conducted by the Sea Ice Portal team, show that, for the entire month of January 2023, the ice was at its lowest-ever extent recorded for the time of year since the beginning of record-keeping in 1979. The monthly mean value was 3.22 million square kilometers, ca. 478,000 square kilometers (an area roughly the size of Sweden) below the previous minimum from 2017.

With regard to its long-term development, the Antarctic sea ice shows a declining trend of 2.6 percent per decade. This is the eighth consecutive

year in which the mean sea-ice extent in January has been below the long-term trend.

This intense melting could be due to unusually high air temperatures to the west and east of the Antarctic Peninsula, which were ca. 1.5 °C above the long-term average. In addition, the Southern Annular Mode (SAM) is in a strongly positive phase, which influences the prevailing wind circulation in the Antarctic. In a positive SAM phase (like today), a low-pressure anomaly forms over the Antarctic, while a high-pressure anomaly develops over the middle latitudes.

This intensifies the westerly winds and causes them to contract toward the Antarctic. As a result, upwelling of circumpolar deep water on the continental shelf intensifies in the Antarctic, promoting sea-ice retreat. More importantly, it also intensifies the melting of ice shelves, an essential aspect for future global sea-level rise.

Unraveling the geological evolution of the West Antarctic Ice Sheet, i.e., the massive glaciers that cover the Antarctic continent and fuel the ice shelves, is the proclaimed goal of the current Polarstern expedition. Doing so, it is hoped, will allow us to make more accurate statements on the ice sheet's future development, and therefore on sea-level rise in the face of constant climate change.

For example, the last interglacial, 120,000 years ago, and a prolonged warm period in the Pliocene roughly 3.5 million years ago, are considered analogous to today. In both past periods, the warming was exclusively due to gradual changes in Earth's orbit—today, these are supplemented by carbon dioxide emissions, which are produced by the use of fossil fuels and accumulate in the atmosphere.

The insights gleaned from the ice sheets' history are intended to help estimate how rapidly and extensively they will melt when certain tipping

points of today's rapid anthropogenic climate change are exceeded. In this regard, researchers use geophysical and geological methods to investigate marine sediments at the sea floor, which, as archives of past ice-sheet movements, hold valuable information.

Historical records also reflect the tremendous changes. For example, in the Antarctic summer 125 years ago, the Belgian research vessel Belgica was trapped in the massive pack ice for more than a year—in exactly the same region where the Polarstern can now operate in completely ice-free waters.

The photographs and diaries of the Belgica's crew offer a unique chronicle of the ice conditions in the Bellingshausen Sea at the dawn of the industrial age, which climate researchers often use as a benchmark for comparison with today's climate change.

Provided by Alfred Wegener Institute