January 08, 2020

Earth & Space

Recent Rapid Changes in Antarctic Sea Ice Coverage

by **Claire Parkinson**[1] | Climate Change Senior Scientist

[1]: NASA Goddard Space Flight Center, Cryospheric Sciences Laboratory, USA

This Break was edited by Max Caine, *Editor-in-chief* - TheScienceBreaker

ABSTRACT

A newly completed 40-year satellite record of Antarctic sea ice coverage reveals that after slowly increasing, overall, from the late 1970s to 2014, Antarctic sea ice expanse rapidly decreased from 2014 to 2017, followed by a slight rebound in 2018 that hasn't continued so far in 2019.

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Sea ice spreads over vast areas of both the north and south polar regions, especially in the respective winters, and is a significant component of the polar climate system. Sea ice reflects far more of the sun's radiation that reaches it than liquid water does. Therefore, when the sea ice coverage decreases, more of the sun's radiation is retained within the Earth system rather than being reflected away - hence contributing to further warming. This adjustment is one of the many significant impacts of changes in the sea ice cover. Sea ice is also an important environmental component for the polar ecosystem, serving as a platform for some species and a hindrance for others. Hence as the sea ice cover changes, the ecosystem is forced to adjust.

Before satellites, it was not feasible to get a reliable record of changes throughout the vast expanse of the polar sea ice covers; and in the early years of Earth-observing satellites, starting in the 1960s, the data collected were not sufficient for a consistent long-term record. However, since the launch of the Nimbus 7 satellite in late October 1978, there has been an uninterrupted series of satellites carrying instruments that have allowed the monitoring of the sea ice covers on a daily or near-daily basis. By now, the data sets include 40 full years, 1979-2018, with detailed information about the distribution and expanse of polar sea ice and how these have changed. My recently published study analyzes the 40-year satellite record of Antarctic sea ice.

The 40-year record derives from instruments measuring microwave radiation. The microwave data are particularly valuable for several reasons. First, the microwave radiation is emitted from within

the Earth system rather than being reflected sunlight, and hence the data can be collected during darkness as well as sunlit conditions. Second, the microwave radiation can go through most clouds, and hence the data can be collected even where clouds occur between the surface and the satellite. Third, there is a clear distinction between the microwave emissions of sea ice and seawater. Wonderfully, throughout the 40 years 1979-2018, there have been microwave instruments on satellites with orbits that allow monitoring of the entire Antarctic sea ice region every one or two days.

The Antarctic results are far different from the more widely publicized situation in the Arctic, where sea ice coverage has, overall, been decreasing for the past several decades. This decrease in Arctic sea ice had been expected, in light of global warming, and so was not particularly surprising to scientists, although at times the decreases were faster than expected. However, Antarctic sea ice coverage was also expected to decrease, but for over three decades, from the late 1970s to 2014, that was not happening. Antarctic sea ice coverage, overall, increased over this period. Scientists have speculated on why the increases occurred, tying them to various changes in the atmosphere and oceans, but there is no consensus on what the causes were.

With uncertainty remaining as to why the Antarctic sea ice cover was expanding, a sharp turnaround occurred. The 40-year satellite record, covering 1979-2018, shows that, on a yearly average basis, the Antarctic sea ice reached its record high for the 40-year period in 2014, then decreased precipitously to its record low in 2017. The total decrease in yearly average Antarctic sea ice extent from 2014 to 2017 was over 2 million square kilometers, which is greater than the area of Mexico. In comparison, it took the Arctic yearly average ice extents over three decades to register a decrease exceeding 2 million square kilometers.

The Antarctic yearly average ice extent rebounded a small amount in 2018. Halfway through 2019, the rebound is not continuing. There is no way of knowing now whether in the next decade or so, the ice extent will recover back to higher levels or whether it will decrease even below its 2017 level. Still, the rapidity of the decrease in yearly average Antarctic sea ice extents from 2014 to 2017 stands out in the 40-year record of consistent satellite-based observations, far exceeding the rates of change observed in the Arctic or at other time periods in the 40-year record in the Antarctic. There is much remaining to understand. At present, there is no consensus amongst scientists on either why the Antarctic sea ice extent was, overall, increasing from 1979 to 2014 or why it decreased so rapidly from 2014 to 2017.