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Changes in Polar Sea Ice and How They Illustrate the Complex Picture of Global Climate Change

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Sea ice spreads over vast areas of the polar oceans, typically covering 17-28 million km² globally. It is a critical element of the Arctic and Antarctic climate systems, with two of its most important roles being the reflection of solar radiation back to space and the hindering of exchanges of heat, mass, and momentum between the ocean and the atmosphere. Prior to the development of satellite technology, it was not feasible to obtain large-scale data records of the vast expanse of global sea ice. However, with satellites, and especially with multichannel passive-microwave satellite data available since late 1978, we can now monitor both Arctic and Antarctic sea ice coverages on a daily basis, irrespective of sunlight or darkness and under cloudy as well as cloud-free conditions. This has made sea ice one of the best observed climate variables since the late 1970s. The resulting satellite record has revealed many details of the seasonal cycle of the ice cover in both polar regions, considerable inter-annual variability, and long-term trends that show a decrease in the Arctic sea ice and an increase in the Antarctic sea ice since late 1978. The decreases in the Arctic sea ice extents, which have averaged approximately 51,000 km² per year on a yearly-average basis, were predicted and are tied closely to the warming of the Arctic over the same time period. The increases in the Antarctic sea ice extents, which have averaged approximately 17,000 km² per year, have come with stark spatial contrasts that suggest the likely impact of changes in atmospheric and/or oceanic circulations. Sea ice decreases in the vicinity of the Antarctic Peninsula, where warming has occurred, have been more than compensated for by increases in the ice cover elsewhere around the continent, especially in the Ross Sea. The patterns are suggestive of increased cyclonic flow centered over the Amundsen Sea, although more research is needed before the changes will be fully understood.