

Millennial-scale sea ice expansion in the glacial Southern Ocean driven by Antarctic warming

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The Southern Ocean has played an important role in the evolution of the global climate system. Area of sea ice shows a large seasonal variation in the Southern Ocean. Sea ice coverage on sea surface strongly affects the climate of the Southern Hemisphere through its impacts on the energy and gas budget, on the atmospheric circulation, on the hydrological cycle, and on the biological productivity. However, millennial-scale sea ice coverage and its impacts are not well understood. Here we show high-resolution records of sea ice-rafted debris (SIRD) and diatom assemblage to reveal a rapid change of sea ice distribution in the Indian sector of the Southern Ocean for last 43,500 years. The depositions of rock-fragment SIRD excluding volcanic glass and pumice were associated with increasing of sea-ice diatoms, suggesting that the millennial-scale events of sea-ice expansion and cooling were occurred in the glacial South Indian Ocean. The extent of sea ice in the Southern Ocean is occurred during the warming events, Antarctic isotope maximum (AIM). Sea ice expansion might be caused by enhanced production of sea ice in the Weddell Sea due to Antarctic ice sheet melting during the small Antarctic warming in the glacial climate.