Sea-ice variability along the Antarctic continental margin since the Last Penultimate Glacial

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Antarctic sea ice plays a crucial role in buttressing ice shelves, enhancing their stability, and protecting them from potential catastrophic collapse – a significance underscored by recent calving events along the Antarctic Peninsula. Presence or absence of sea ice in the Southern Ocean, and details of its distribution patterns, therefore have relevance far beyond the realm of high latitudes of the Southern Hemisphere. Investigating past sea-ice conditions in proximity to ice shelves, and changes in sea ice distribution over time, particularly across glacial-interglacial cycles, is therefore essential. We may gain insights into the sea-ice's response to a changing climate, and address gaps in our understanding of ocean-sea ice-ice shelf interactions and dynamics. In our study, we adopt a multiproxy approach to explore glacial-interglacial environmental variability since the Last Penultimate Glacial close to the Antarctic continental margin in the Weddell Sea. We analyze the novel sea-ice biomarker IPSO\textsubscript{25} (a di-unsaturated highly branched isoprenoid (HBI)), open-water biomarkers z-/e-trienes (tri-unsaturated HBI), diatom assemblages and primary productivity proxies in a marine sediment core (PS118_63-1) retrieved from Powell Basin in the northwestern Weddell Sea. These biomarkers are reliable proxies for reconstructing near-coastal sea-ice conditions in the Southern Ocean, where the use of sea ice-related diatoms may be subject to bias due to silica dissolution. We present the first continuous record of ice-proximal Antarctic sea ice since the Last Penultimate Glacial. Our results unveil a highly dynamic environment, characterized by significant shifts from a climate with perennial (sea) ice cover to more seasonal sea-ice cover and open ocean conditions, over the last approximately 145 krys. Furthermore, to gain a better understanding of the spatial heterogeneity of sea-ice distribution and sea ice-ice shelf system dynamics in the Southern Ocean, we use numerical climate modeling to expand our view across the Southern Ocean, while comparing data from marine cores PS67/219-1 (southern Scotia Sea) and PS128_14 (eastern Weddell Sea) helps track latitudinal sea-ice changes and identify common forces driving sea ice-ice shelf system dynamics along continental margin, respectively.