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Southern Ocean carbon sink enhanced by Last Glacial Termination seasonal sea-ice feedbacks

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The Southern Ocean plays a fundamental role in regulating global atmospheric CO_2 levels, yet the underlying processes and feedbacks that control carbon cycle during climate transitions remain unclear. Following the last glacial, the rapid and punctuated rise in atmospheric CO_2 was interrupted by an enigmatic 1,900-year plateau during a period of pronounced mid- to high-latitude Southern Hemisphere cooling called the Antarctic Cold Reversal (ACR, 14,600-12,700 years ago or 14.6-12.7 kyr BP). Here we report the first biomarker and DNA analysis of a highly-resolved Antarctic ice core, which combined with marine sediment records reveals a coherent signal of high-latitude Southern Ocean marine productivity and microbial diversity across the ACR. Transient climate modelling finds this period coincided with maximum seasonal variability in sea-ice extent, suggesting sea-ice feedbacks enhanced CO_2 sequestration, making the high-latitude Southern Ocean a significant carbon sink. We propose that this feedback mechanism contributed to the sustained plateau in CO_2 during the ACR, enhancing the high-latitude Southern Ocean biological carbon pump at a time of reduced wind-driven upwelling across the mid-latitude Southern Ocean.