Southern Ocean High-nutrient, low-chlorophyll status during the last deglaciation: Insights from new N and Si isotope records

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Since the last glacial maximum (LGM), the Southern Ocean shifted from an efficient nutrient utilization state driven by stratification and high dust-borne iron input, into the high-nutrient, low-chlorophyll (HNLC) conditions of today. This change in the nutrient status of the ocean surface, arguably, reduced the efficiency of the biological pump in the Southern Ocean and may have contributed significantly to the observed glacial-interglacial atmospheric pCO_2 variability. In addition, the last deglaciation was marked by increased deep water overturning and CO_2 outgassing through the Southern Ocean, which has been linked to the observed deglacial rise in global atmospheric pCO_2. However, the sparse records from the Southern Ocean have yet to provide a coherent description of the biogeochemical changes that affected the Southern Ocean during the deglacial transition and, consequently, how the biological pump responded to the deglacial upwelling events.

Here we present new diatom-bound $\delta^{15}N$ and $\delta^{30}Si$ as nutrient utilisation proxies from three cores with highly-resolved deglacial intervals distributed across the modern polar front of the under-sampled Indian Sector of the Southern Ocean. These records show the decoupling between Si and N utilisation and dust-borne iron input across the deglacial transition. This decoupling is most apparent in our records that are close to the modern polar front and suggests that the HNLC status of the region was not realised until after the global atmospheric pCO_2 had plateaued at the end of the glacial termination, lagging documented declines in dust fluxes to Antarctica by thousands of years. We will explore possible causes of the dust – Si/N utilisation decoupling, including nutrient isotopic source signal changes and the potential contribution of non-dust iron inputs, as well as discuss the implications of these findings on the magnitude of the Southern Ocean CO_2 source during the deglaciation.