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Nutrient budgets in Southern Ocean mode waters controlled by nitrification

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Southern Ocean mode and intermediate waters supply nitrate-rich but silicate-poor waters to the lower latitudes, impeding diatom growth throughout the extra-polar ocean and weakening the ocean's ability to absorb carbon dioxide from the atmosphere. This silicate deficiency is widely attributed to high silicate to nitrate uptake by iron-limited diatoms. Here, we show that nitrification, by rapidly regenerating nitrate in shallow waters, drives the silicate deficiency. Measurements of nitrate dual isotopes and complementary modelling independently suggest that 15-35% of the nitrate within mode waters is generated by nitrification. Our results reveal that without nitrification, the silicate deficiency would disappear, which would allow the diatomaceous niche to expand. Nitrification therefore provides a key buffering service that mitigates against change in the silicate deficit and subsequently restricts diatom dominance to the polar ocean. This insight highlights the critical importance for understanding Southern Ocean processes, such that the large-scale effects of ongoing environmental change may be realised.

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