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Migration of the Subtropical Front as a modulator of glacial climate

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Ice cores extracted from the Antarctic Ice sheet suggest that glacial conditions, and the relationship between isotopically-derived temperatures and atmospheric pCO2 have been constant over the last 800,000 years of the Late Pleistocene. But independent lines of evidence, such as the extent of northern hemisphere ice sheets, sea level, and other temperature records point towards a fluctuating severity of glacial periods, particularly during the severe glacial stadials centred around 340,000 and 420,000 years ago (marine isotope stages (MIS) 10 and 12). Previously unidentified mechanisms therefore appear to have mediated the relationship between insolation, CO2 and climate. Here we test whether northward migration of the subtropical front (STF) off the southeastern coast of South Africa acts as a gatekeeper for the Agulhas Current which controls the transport of heat and salt from the Indo-Pacific to the Atlantic Ocean. Using a new 800,000 year record of sea surface temperature (SST) and ocean productivity from ocean sediment core MD962077, we demonstrate that during cold stadials (particularly MIS 10 and 12), productivity peaked and SST was up to 6 oC cooler than modern temperatures. This suggests that during these cooler stadials, the STF moved northward by up to 7o latitude, nearly shutting off the Agulhas Current. Our results, combined with faunal assemblages from the south Atlantic show that variable northwards migration of the southern hemisphere STF can modulate the severity of each glacial period by altering the strength of the Agulhas Current carrying heat and salt to the Atlantic meridional overturning circulation (AMOC). Either the degree of northwards migration of the STF can act to partially decouple global climate from atmospheric pCO2. Alternatively, there is a longer term trend in pCO2, parallel to these frontal migrations, as suggested by major change in ocean carbonate chemistry of the Mid-Brunhes dissolution event in the ocean, which is somehow not captured by the atmospheric record from Antarctic ice.