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Hydrographic changes in the surface ocean of the sub-Antarctic Atlantic linked to atmospheric CO_2 variations over the last deglaciation and Marine Isotope Stage 3

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The deglacial rise in atmospheric CO_2 ($CO_{2,atm}$) is thought to be linked with the evasion of CO_2 from a carbon-enriched reservoir of the deep Southern Ocean. The transfer of carbon from the deep ocean to the atmosphere is associated with hydrographic changes in the surface ocean. For instance, exchange of carbon between the ocean and atmosphere is promoted by upwelling of CO_2-rich water masses to the surface, predominantly in winter. This process may be inhibited by a strong density stratification of the upper water column and the summer-time biological sequestration of carbon in the surface ocean which has been suggested to be driven by airborne dust supply. To what extent these hydrographic changes in the surface ocean and thus, biological and physical processes in the Southern Ocean are linked to millennial-scale variations in $CO_{2,atm}$ is insufficiently understood. Here, we present stable oxygen and carbon isotope records of the planktonic foraminifera *Globigerina bulloides* and *Neogloboquadrina pachyderma* (s.) and planktonic foraminiferal assemblages from the sub-Antarctic sediment core MD07-3076CQ (44°4'S, 14°12'W, 3770 m) in order to reconstruct surface ocean processes in the sub-Antarctic Atlantic and their linkage to millennial-scale variations of $CO_{2,atm}$ over the last 70 ka. Stable oxygen and carbon isotopes of *G. bulloides* and *N. pachyderma* (s.) are assumed to indicate spring and summer surface water conditions, respectively. Strong negative excursions of $\delta^{13}C$ of *G. bulloides* indicate nutrient-enriched surface water during intervals of rising $CO_{2,atm}$ which points at enhanced winter-time upwelling of CO_2- rich water masses in the Southern Ocean during these intervals. Simultaneously, increasing $\delta^{13}C$ of *N. pachyderma* (s.) paralleling the rate of CO_2 change in the atmosphere hints at enhanced carbon air-sea exchange during summer. A strong gradient in $\delta^{18}O$ between both foraminifera species suggests a strong vertical stratification of the water column during the LGM promoting an isolation of the deep carbon rich reservoir from the atmosphere. These results point at the link between oceanic evasion of CO_2 from the deep Southern Ocean and millennial-scale rises of $CO_{2,atm}$ during the last 70 ka and stress the role of vertical mixing in the Southern Ocean promoting air-sea equilibration of carbon in the surface ocean.