# Ventilation and stratification of the Southwest Pacific Ocean across the last glacial termination

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Glacial atmospheric $CO_2$ was ~100 ppm lower than interglacial periods. Geochemical evidence suggests $CO_2$ was sequestered in a poorly-ventilated deep ocean during ice ages. At the end of the last ice age a rapid increase in atmospheric $CO_2$ coincided with changes in seawater $\delta^{13}C$ and deep-water radiocarbon, suggesting invigorated ventilation of the deep ocean and release of $CO_2$ to the atmosphere. Here we present high-resolution benthic foraminiferal $\delta^{13}C$ and $\delta^{18}O$ records on *Cibicidoides* (primarily *C*. or *P. wuellerstorfi*) from an eight-core depth transect (663-3836 m water depth) in the Australian-New Zealand region that documents rapid deglacial changes in intermediate and deep stratification in the Southwest Pacific Ocean. During the last glacial period, strongest gradients in $\delta^{18}O$ and $\delta^{13}C$ were between ~660 and ~1600 m ($\Delta\delta^{13}C$ was ~1.7‰, more than double the Holocene difference of ~0.7‰), This represents a geochemical divide between well- and poorly-ventilated waters. A rapid, transient shallowing of the $\delta^{18}O$ divide at ~18 ka was followed at 16 ka by a pulse of $\delta^{13}C$ enrichment, evidence for ventilation of intermediate water, followed at ~15 ka by permanent reduction of surface-deep $\delta^{13}C$ and $\delta^{18}O$ gradients. These suggest fundamental changes in $CO_2$ storage and vertical density structure, respectively. We suggest that Southern Hemisphere warming and the shift of the westerlies following the onset of Heinrich Stadial 1 produced a step-wise destabilization in ocean stratification that had both a short-term and enduring impact on deep ventilation in the Southern Ocean.