Asynchronous changes in the vertical structure of the Southern Ocean and the deglacial rise in atmospheric CO_2: Inferences from isotopic differences

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Changes in Southern Ocean meridional overturning circulation and water column stratification likely played a role in CO_2 drawdown during the Last Glacial Maximum (LGM; 23-19 ka). We use $\delta^{18}O$ and $\delta^{13}C$ based on *Cibicidoides spp.* from two sediment core depth transects—Southwest Pacific (660-3800 m) and Southwest Atlantic (440-3900 m) oceans—to calculate vertical isotope differences ($\Delta\delta^{18}O$ and $\Delta\delta^{13}C$) and compare vertical structure changes in the basins since the LGM. During the LGM, diminished $\Delta\delta^{18}O$ below 1100 m (relative to 660 m) in the Pacific compares with reduced $\Delta\delta^{18}O$ below 1800 m (relative to 440 m) in the Atlantic. Similarly, $\Delta\delta^{13}C$ was enhanced below 1100 m in the Pacific, but only below 2500 m in the Atlantic. Together, this suggests that stratification and the location of CO_2 storage shoaled in the Pacific and deepened in the Atlantic at the LGM. During Heinrich Stadial 1 (HS1; 17.5-14.5 ka), $\Delta\delta^{18}O$ increased in both basins with the steady increase in the Atlantic occurring below 2500 m, attributable to meltwater influences at shallower depths. This contrasts with a rapid increase in Pacific $\Delta\delta^{18}O$ below 1100 m at 16.5 ka that coincided with a rapid reduction in $\Delta\delta^{13}C$ above 1600 m, owing to the ventilation of Pacific-sector intermediate waters. Between the Younger Dryas (YD; 12.8-10.5 ka) and Early Holocene (10.5-8 ka), $\Delta\delta^{18}O$ in the Atlantic reduces as does $\Delta\delta^{13}C$ in both basins, which can be attributed to a deepening of North Atlantic-sourced water entering the Southern Ocean ventilating the abyssal ocean. Taken together, the findings imply a tight coupling between asynchronous, sector-specific changes in the vertical structure of the Southern Ocean and the two-step increase in atmospheric CO_2 following the last ice age.