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Glacial carbonate compensation in the Pacific Ocean constrained from paired oxygen and carbonate system reconstructions

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The tendency of $CaCO_3$ dissolution/burial to minimise changes in the carbonate ion concentration of the deep ocean following perturbations to the carbon cycle (‘*carbonate compensation*’) is thought to act as a first order control on atmospheric CO_2 on timescales of ~10^3 to 10^5 years. Although carbonate compensation could account for up to ~*half* of the glacial drawdown of CO_2, quantitative estimates of changes in ocean alkalinity are lacking. As such, the role of carbonate compensation in driving glacial-interglacial CO_2 variations remains poorly understood.

Here, we combine paired reconstructions of dissolved oxygen from the infaunal-epifaunal benthic foraminiferal $\delta^{13}C$ proxy ($\Delta\delta^{13}C$) and the carbonate system from boron proxies (B/Ca, $\delta^{11}B$) in benthic foraminifera; this approach allows us to quantify both changes in deep ocean respired CO_2 storage, and the response of the carbonate system to this addition/removal of respired CO_2, providing the first quantitative estimates on the amount and timing of alkalinity changes in the deep Pacific during the Last Glacial Maximum (LGM) and over deglaciation. Our results indicate an increase in deep ocean alkalinity during the LGM, and suggest the buffering of the deep ocean may occur substantially faster than the canonical timescale of ~5 kyr (Broecker and Peng, 1987). We present results from a series of sensitivity experiments and long-term simulations using the recently coupled iLOVECLIM-MEDUSA climate/carbon-cycle/sediment model, with implications for our understanding of carbonate compensation in both glacial times, and the long-term future.