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Impact of ocean circulation on glacial Pacific abyssal carbon storage and deglacial release

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During the last glacial maximum (LGM) atmospheric carbon dioxide levels dropped to ∼180ppmv, significantly lower than interglacial concentrations. The mechanisms causing the glacial-interglacial range of ∼90ppmv are still not fully understood. Recent explanations have looked to the deep Pacific as a potential isolated storage reservoir of respired carbon related to reduced ocean ventilation at this time. During the initial deglaciation (18-14kyr BP), atmospheric carbon dioxide concentrations increased by ∼40ppmv. Corresponding records of atmospheric radiocarbon concentration display a massive decrease of 190‰, which also suggest the sudden release of a large store of carbon that has been isolated from the atmosphere for a significant period of time.

In this study we have used an Earth system model of intermediate complexity, GENIE (Grid ENabled Integrated Earth) to investigate the influence of plausible physical changes in ocean circulation on deep Pacific storage of carbon, and the impact on atmospheric carbon dioxide and distribution of carbon isotopes. We examine the sensitivity of Pacific carbon storage to prescribed ocean circulations. The model has then been applied to a Heinrich-1 scenario and subsequent simulation of the initial deglaciation period. We investigate the magnitude of carbon storage and length of time in isolation required to produce glacial-interglacial changes of the order seen in the data. In particular we present modelled changes in carbon dioxide and radiocarbon, which produce deglacial changes consistent with available palaeo-records in terms of time scale and similar magnitude.