Tracking deep ocean carbon release over the last deglaciation

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Complete understanding of the mechanisms that drive glacial-interglacial atmospheric CO_2 variations remains elusive. This presents a challenge for the reliable predictions of our future climate in the face of anthropogenic CO_2 emissions. The current leading hypothesis states that changes in the deep ocean carbon reservoir, regulated by the Southern Ocean, control atmospheric CO_2 on glacial-interglacial timescales [1]. There is a growing body of evidence that during the last deglaciation when this deep ocean carbon reservoir reconnected with the atmosphere it left a tell-tale low pH and low $\delta^{13}C$ fingerprint in the surface water [2, 3]. The extent of this ocean-atmosphere reconnection is however currently poorly constrained having only been documented in a few locations. Here we present the first complete deglacial Atlantic and Pacific Sub-Antarctic surface water pCO_2 records, from planktic foraminifera $\delta^{11}B$ measurements. By comparing this new data to a compilation of surface water CO_2 elsewhere during the deglaciation we investigate the role of Southern Ocean deep water upwelling and degassing in driving deglacial atmospheric CO_2 rise. We conclude that significant upwelling occurred throughout the Sub-Antarctic Zone which led to enhanced CO_2 degassing from the region between 18 – 15 ka relative to modern mean disequilibria. This process is proposed to have triggered deglacial atmospheric CO_2 rise as the intermediate waters transmitted the excess CO_2 around the global ocean, thus confirming the important role of the Southern Ocean in driving natural CO_2 change.

[1] Sigman et al., (2010), *Nature* **466**, 47-55. [2] Spero & Lea (2002), *Science*, **296**, 522-525. [3] Martinez-Boti & Marino et al., (2015), *Nature*, **518**, 219-222.