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# Last Glacial Maximum $CO_2$ and carbon-13 finally reconciled

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During the Last Glacial Maximum (LGM, ∼21,000 years ago) the cold climate was strongly tight to the low atmospheric $CO_2$ concentration (∼190 ppm) that has been inferred from ice core bubbles [Monnin et al., 2001]. Although it is generally believed that this low $CO_2$ was due to an expansion of the oceanic carbon reservoir, simulating this glacial level has remained a challenge especially with the additional carbon-13 constraint. Indeed the LGM carbon cycle was also characterized by a modern-like $\delta^{13}C$ in the atmosphere [Lourantou et al., 2009] and a higher surface to deep oceanic $\delta^{13}C$ gradient [Curry and Oppo, 2005] indicating probable changes in the thermohaline circulation.

To create a larger carbon reservoir in the deep ocean, one possible mechanism is to produce very dense glacial waters thereby stratifying the deep ocean and reducing the carbon exchange between the deep and surface ocean. This mechanism has been tested with the implementation of a brine mechanism [Bouttes et al., 2009] in the intermediate complexity CLIMBER-2 model. This brine mechanism corresponds to the rapid sink to the deep ocean of the brines, i.e. very salty water rejected by sea ice formation.

Here we show that this brine induced stratification associated to carbonate compensation [Brovkin et al., 2007], iron fertilization and stratification dependant diffusion both decreases dramatically $CO_2$ down to the glacial value of ∼190 ppm and provides the glacial carbon-13 inferred from proxy data. Thus LGM $CO_2$ and carbon-13 can at last be reconciled.

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