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Implication of a strong deep ocean stratification on the carbon cycle

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The link between the carbon cycle and the climate is at the core of the understanding of the climate system, and drives many researches. Different mechanisms have been proposed to explain the variations of $\delta^{13}C$ and atmospheric CO_2 measured during the glacial/interglacial cycles. Still, though the addition of several mechanisms does help, even the most recent scenarios are neither sufficient to fully explain the low atmospheric CO_2 concentration observed during the Last Glacial Maximum, about 21 kyrs ago (e.g. Brovkin et al., 2007) nor producing an oceanic $\delta^{13}C$ distribution compatible with what is inferred from sediment cores proxy data (Curry & Oppo, 2005). Indeed, according to sediment core proxy data, the deep glacial ocean should have been colder and much saltier, thus acquiring a higher density. This, in turn, should provide a huge, less-ventilated, carbon reservoir. The deep ocean stratification therefore appears as a possible mechanism to store carbon in the ocean and ultimately decrease the atmospheric CO_2 concentration (Paillard & Parrenin, 2004).
Here we investigate this mechanism and the impact on the carbon cycle through sensitivity experiments testing various ways of stratifying the deep ocean. For this purpose we use the CLIMBER-2 fully coupled intermediate complexity climate model, well suited for the long simulations we run. As the model version used explicitly computes the evolution of the carbon cycle and carbon isotopes (such as $\delta^{13}C$) in every reservoir, it allows us to directly compare the model output with data from sediment cores. We show that the existence of a largely isolated deep ocean is an important physical mechanism in the view of explaining the glacial oceanic $\delta^{13}C$ distribution, and discuss its impact on the glacial atmospheric CO_2 lowering.

References

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