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Climate, Mixing, and Carbon Budgets in a LGM set-up of CESM

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We use a free running Last Glacial Maximum (LGM) setup of CESM1 with its full ecosystem model to understand which processes are responsible for the large difference in atmospheric CO₂ concentration between the LGM and 1850 CE.

Just by accounting for the changed orbital forcing and replacing today's bathymetry and icesheet orography with their Peltier et al. (2015) LGM reconstructions, leads to a 55 ppm difference in atmospheric CO₂. Additional experiments with increased aeolian iron fluxes make it plausible that IPCC class ESMs can reproduce the processes that were hypothesized to be important for the observed low LGM CO₂ concentration.

A second focus of our study is the connection between sea level, ocean turbulence and the strengths of the various carbon pumps. Including the full amount of the suggested increase in ocean mixing during the LGM would lead to a 20 ppm larger CO₂ concentration. This suggests that either mixing during the LGM is not understood yet, or that ESMs may indeed misrepresent one or more aspects of the various carbon pumps.

We conclude with a discussion of uncertainties within the model setup, in particular with regards to the assumed structure of ocean mixing.