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Glacial CO_2 drawdown due to particle ballasting by aeolian dust: an estimate using the ocean carbon cycle model MPIOM/HAMOCC

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Particle ballasting refers to the acceleration of sinking organic soft tissue in the ocean by aggregation with denser particles such as calcite shells, opal shells, or mineral dust. The acceleration of organic soft tissue due to, for example, higher aeolian dust deposition rates, may have led to a more effective biological carbon pump during glacial periods compared to interglacial periods. Particle ballasting changes may thus have contributed to the variability of atmospheric CO_2 concentrations during glacial-interglacial cycles.

Here we quantify the effect of dust ballasting changes on the ocean-atmosphere CO_2 fluxes during the last glacial cycle using the Hamburg Ocean Carbon Cycle model HAMOCC. We introduce a new parameterisation of particle ballasting that accounts for the acceleration of the sinking of detritus by denser particles, including the effect of mineral dust. Sensitivity experiments with respect to glacial-interglacial aeolian dust deposition changes indicate that the acceleration of detritus by enhanced dust deposition during glacials played a small role, contributing about 5 ppmv to the reconstructed 90 ppmv drawdown of atmospheric CO_2 concentrations. Our results further suggest that the additional iron input associated with the increased dust deposition played a more important role, leading to a reduction of atmospheric pCO_2 by at least 8 ppmv, comparable to previous estimates of 10 to 30 ppmv.