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The effects of marine carbonate dissolution, and enhanced carbonate and silicate weathering on the removal of fossil fuel CO_2.

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Silicate and carbonate weathering fluxes, and carbonate sediments on the ocean floor have been added to an existing global carbon cycle and surface temperature model. We use the model to examine the long-term response to fossil fuel CO_2 perturbation. Weathering fluxes of carbonate and silicate minerals are a function of temperature and CO_2 directly and via their effects on vegetation. The model is forced with a variety of emissions scenarios ranging from $<$4,000GtC to 15,000GtC in total.

Past studies have simulated the neutralisation of CO_2 by dissolution of $CaCO_3$ in seafloor sediments but maintained a constant weathering flux. However, global warming and the fertilisation of photosynthesis by increasing CO_2 should increase the weathering flux of carbonate and silicate minerals, increasing the flux of alkalinity to the oceans, and accelerating the removal of the remaining excess CO_2.

In contrast with earlier studies, our results suggest that the dissolution of carbonate sediments may significantly lower atmospheric CO_2 (by $\sim$50%) on the millennial timescale. Emissions of $>$4700GtC lead to the dissolution of essentially all carbonate sediments. For 15,000GtC emissions, increased weathering fluxes cause the drawdown of at least 70% more CO_2 from the atmosphere during the $\sim$12,000 years when the $CaCO_3$ sediment system is virtually inactive. Enhanced silicate weathering follows renewed carbonate deposition and eventually removes the last of the added CO_2 but it takes over a million years.