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A negative feedback on pCO2 by shelf organic matters

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In the past 800 thousand years and before industrialization, the largest variations in atmospheric CO2 concentration (pCO2) occurred in connection with the glacial cycles that characterized Earth's climate over this period. The mechanisms responsible for the glacial-interglacial pCO2 changes have remained unresolved. One curious feature of at least the last four glacial-interglacial cycles is that atmospheric pCO2 reached about the same upper limit of 280 ppm during peak interglacial periods and about the same lower limit of 180 ppm during peak glacial periods. Here, we show using a numerical model of earth system that enhanced shelf sediment weathering during glacial sea-level low stand tends to raise pCO2 and thus stabilize it from further reduction. This is because not all nutrients from weathering will be utilized by biology but more importantly because the spatial distributions of carbon and phosphate from weathering become decoupled in such a way that carbon is preferentially stored in the upper ocean and phosphate in the deep ocean. This finding, combined with observations of preferential remineralization of phosphate in shelf sediment diagenesis, would predict enhancement of biological production during interglacial high stand and stabilization of pCO2 from further increase. The impact of sea level-driven continental shelf exposure and submersion on CO2 is therefore a negative feedback that may have contributed to limiting the variation of Pleistocene pCO2 to the observed 100 ppm range.