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The role of North Atlantic Ocean circulation and biological sequestration on atmospheric CO_2 uptake during the last deglaciation (CL Division Outstanding ECS Award Lecture)

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Understanding the impact of ocean circulation on the global atmospheric CO_2 budget is of paramount importance for anticipating the consequences of projected future changes in Atlantic Meridional Overturning Circulation (AMOC). In particular, the efficiency of the oceanic biological pump can impact atmospheric CO_2 through changes in vertical carbon export mediated by variations in the nutrient inventory of the North Atlantic basin. However, the causal relationship between North Atlantic Ocean circulation, biological carbon sequestration, and atmospheric CO_2 is poorly understood. Here we present new high-resolution planktic-benthic ^{14}C data and biomarker records from an exceptionally well-dated marine core from the Nordic Seas spanning the last deglaciation (15,000-10,000 years BP). The records document for the first time large and rapid atmospheric CO_2 drawdowns and increase in plankton stocks during major North Atlantic cooling events. Using transient climate simulations from a fully coupled climate-biosphere model, we show that minor perturbations of the North Atlantic biological pump resulting from surface freshening and AMOC weakening can have a major impact on the global atmospheric CO_2 budget. Furthermore, our data help clarifying the timing and magnitude of the deglacial CO_2 signal recorded in Antarctic ice cores. We conclude that the global CO_2 budget is more sensitive to perturbations in North Atlantic circulation than previously thought, which has significance in the future debate of the AMOC response to anthropogenic warming.