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Carbon isotope signatures of marine GDGTs across the last deglaciation: implications for archaeal paleobarometry

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The paleoclimate record provides key constraints on the behavior of the climate system under different boundary conditions. To better predict how the current increase in atmospheric carbon dioxide will affect global climate, it is essential to understand how atmospheric CO_2 and climate have varied in the past, particularly under elevated CO_2 conditions. A recently proposed method for reconstructing CO_2 concentrations utilizes the biosynthetic isotope effect (ε_{Ar}) associated with glycerol dialkyl glycerol tetraether lipid (GDGT) production by marine archaea. In this proxy framework, values of ε_{Ar} become smaller as ambient CO_2 increases, which makes GDGT carbon isotope ratios a potential CO_2 paleobarometer. However, whether this proxy records variations in CO_2 during time periods of known atmospheric CO_2 change has yet to be tested. Here we target the Late Pleistocene, during which atmospheric CO_2 levels varied between ~180 and ~280 ppm. Using spooling-wire micro-combustion isotope ratio mass spectrometry, we measured the carbon isotope ratios of GDGTs in sediment samples from the Portuguese Margin, the Gulf of Tehuantepec in the Eastern Tropical North Pacific (ETNP), and the Gulf of Mexico. We evaluate our data considering the known history of atmospheric CO_2 and proposed controls on GDGT carbon isotope fractionation, testing the potential of the archaeal paleobarometer. We also explore how the archaeal community may have responded to or participated in changes in nutrient cycling associated with glacial/interglacial oceanographic changes.