Late Pliocene (~2.7 Myr) onset of glacial carbon storage in the Atlantic Ocean

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During the last glacial pCO_2 was roughly 80-100 ppmv lower compared to interglacial levels (Petit et al., 1999). It is commonly accepted that changes in ocean circulation and strength/efficiency of the biological pump, ultimately triggered by small changes in astronomical forcing, altered ocean chemistry and increased the amount of respired nutrients and carbon stored in the ocean during glacials, lowering glacial pCO_2 (Broecker, 1982; Boyle, 1988; Sigman et al., 2010). However, evidence for this crucial ocean carbon feedback mechanism further back in time is limited and it is not known when it first evolved.

Because the regeneration of organic matter consumes oxygen, a direct result of enhanced storage of respired carbon in the ocean is a decrease in oxygenation of the ocean interior and sediments. We will present a novel organic geochemical proxy based on the abundance of biomarkers from anaerobic bacteria in marine sediments to traces changes in sedimentary oxygenation and hence carbon storage. We will then present orbitally-resolved records of the abundance of biomarkers from anaerobic bacteria in marine sediments from three sites in the North Atlantic to reconstruct changes in ocean oxygenation and hence carbon storage during the last 3.5 Myr.

We show that starting at 2.7 Myr, during each glacial sedimentary anaerobic bacterial lipids are abundant at all three sites, while they were largely absent prior to this, as well as during Pleistocene interglacials. Our results imply a change in sedimentary redox conditions during the late Pliocene, which we related to an increase in regenerated nutrients and storage of respired CO_2 in the glacial N. Atlantic and constrain the timing of first occurrence of the ocean carbon feedback mechanism. Its first appearance at 2.7 Myr coincides with the intensification of Northern Hemisphere Glaciation (iNHG), highlighting that the North Atlantic Ocean played a crucial role in modifying pCO_2 and hence global climate during the development of a bipolar glaciated world by storing carbon in its interior.