Title: Overturning circulation, biogeochemistry, and climate in the glacial Atlantic and Pacific

Abstract

Ocean circulation at high latitudes exerts a strong control on heat transport, biological productivity, and ocean-atmosphere CO2 exchange. However the modes, mechanisms, and impacts of circulation in different climates remain debated. Although the Pacific contains 30 times more CO2 than the atmosphere, its circulation in past cold climates is poorly understood: some studies, based on productivity and nutrient tracers, argue for enhanced stratification, whereas others, based on ventilation tracers, suggest invigorated deep water formation. And while the North Atlantic's circulation during abrupt climatic events has been studied extensively, less is known about its biogeochemistry.

Here we present a new model for the link between the ocean's overturning circulation and biogeochemistry. We demonstrate a striking relationship between abrupt climate change events and productivity pulses in the North Atlantic, which may be explained by switches to a more Pacific-like circulation during cold climates. In contrast, cold climates in the North Pacific are characterized by a more Atlantic-like circulation, with warm, salty, and nutrient-poor waters transported to high latitudes. The associated flushing of nutrients and CO2 from the upper reaches of the glacial North Pacific likely helped lower atmospheric CO2. This enhanced overturning also supported a relatively equable regional climate, and may have aided early human settlement en route to North America.