Biogeochemical changes in the North Pacific in response to a shut down of the Atlantic Meridional Overturning Circulation

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As documented in paleoproxys, the last glacial period and the last glacial termination were punctuated by millennial-scale climate events that can be traced back to meltwater pulses in the northern North Atlantic realm (Heinrich events). Such events are known to have led to disruptions of the Atlantic Meridional Overturning Circulation (AMOC) and changes in poleward heat transport that affected climate worldwide. Still elusive is the response of North Pacific climate-carbon cycle system to reorganizations of the AMOC. Numerous paleo-proxy data indicate that Heinrich event I (18-16ka B.P.) and the subsequent Bolling-Allerod transition (14.6-13 ka B.P) were accompanied by fundamental changes in the North Pacific. Among them are changes in deep-ocean ventilation, anoxia, calcium carbonate preservation and isotope ratios.

Freshwater perturbation experiments under pre-industrial and glacial conditions are conducted with an earth system model of intermediate complexity (LOVECLIM) to study the response of the climate and the global carbon cycle to a weakening of the AMOC. During an AMOC shut down, hydrological changes in the North Pacific significantly enhance the formation of North Pacific Intermediate Waters (NPIW) altering the biogeochemical properties of North Pacific waters. In agreement with paleo proxy data, our modeling results show a reduction in the radiocarbon age of North Pacific Intermediate and Upper North Pacific Deep Water by about 600 years. Due to the enhanced ventilation, the oxygen content of these waters is also significantly increased. We discuss the implications of reorganizations of the North Pacific circulation on the marine carbon cycle.

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