Response of oceanic carbon cycle during Heinrich events

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Paleoproxy indicate that a substantial weakening of the Atlantic Meridional Overturning Circulation (AMOC) during Heinrich events was often accompanied by a notable atmospheric CO_2 increase. However, previous modeling studies show conflicting atmospheric CO_2 responses to an AMOC shutdown. In this study, we investigate the response of ocean carbon cycle to weakening AMOC using freshwater experiment conducted with a coupled atmosphere-ocean general circulation model MIROC and offline ocean biogeochemical model. The weakening of AMOC under mid-Glacial condition leads to an oceanic carbon reservoir decrease and to a 4 ppmv atmospheric CO2 increase, which is smaller than the ice core date of 15 ppmv CO_2 rise. The weakening of the North Atlantic leads to a loss of DIC in the North Atlantic intermediate and deepwaters, resulting in CO2 outgassing into the atmosphere. In contrast, the greater mixing in the Southern Ocean enhances biological pump and thus increases CO_2 uptake from the atmosphere. Because thse two process cancel each other out, our simulation underestimates the observed atmosphric CO_2 increase. We also discuss the potential mechanisms which cause the additional CO_2 increase of 10ppmv in this presentation.

Keywords: Heinrch events, Carbon cycle

