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Glacial-to-deglacial changes in ocean deepwater ventilation ages and the ocean's capacity to store atmospheric CO_2

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On a global scale, modern changes in the apparent 14C ventilation age of ocean waters below 2000 m water depth appear directly linked to variations in the concentration of locally dissolved natural CO_2 (with an aging by $\sim$400 yr corresponding to a CO_2 rise of 7μmol/kg water). This link is summarizing various independent effects of carbon supply, the solubility pump that includes the gradual aging of deep waters and the biological pump that integrates the local flux of organic carbon, carbonate dissolution, and plankton productivity. A very first global data set shows that ventilation ages of ocean deep and intermediate waters have strongly varied over three glacial-to-deglacial time slices, the Last Glacial Maximum (LGM), Heinrich stadial 1 (HS-1), and Bølling interstadial. On average, deep waters of the LGM and (parts of) the HS-1 ocean show an age difference with the atmosphere, that was $\sim$1000 to 2000 14C yr, in the extreme up to 4500 yr higher than today. These large and rapidly changing age differences suggest that the deep ocean was able to absorb and store a massive amount of additional atmospheric CO_2 during these times, when atmospheric CO_2 concentrations had dropped significantly. During HS-1, CO_2 was released from parts of the deep ocean in harmony with a successive rejuvenation of waters in the different ocean basins. An urgent challenge for oceanographers is to improve these estimates by developing a global 3-D network of additional paleoventilation age transects to achieve a crucial objective: linking changes in global climate and the ocean's capacity for storing atmospheric CO_2.