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14C Ventilation ages suggest a brief reversal of ocean Meridional Overturning Circulation during deglacial 'Heinrich Stadial 1'

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Changes in the geometry of ocean Meridional Overturning Circulation (MOC) are crucial in controlling changes of climate and the carbon inventory of the atmosphere. However, the accurate timing and global correlation of short-term glacial-to-deglacial changes in the MOC of different ocean basins still present a major challenge. The suite of jumps and plateaus in the record of past atmospheric radiocarbon (^{14}C) concentrations offers a unique opportunity of age control and global correlation. The upper and lower boundaries of atmospheric ^{14}C plateaus in the ^{14}C records of both tree rings and Lake Suigetsu (age calibrated on the basis of Hulu U/Th model ages) provide a detailed stratigraphic 'rung ladder' of ~30 age tie points from 29 to 10 ka that can be used for dating of planktic ^{14}C records and an age correlation, by now employed to ~20 sediment cores obtained from key locations of MOC all over the global ocean. The age difference between paired planktic and benthic ^{14}C ages provides an estimate of the ventilation age of deep waters since their last contact with the atmosphere. ^{14}C ventilation ages of Last Glacial Maximum (LGM) deep waters reveal coeval opposed geometries of Atlantic and Pacific MOC. Similar to today, LGM Atlantic deep-water formation went along with an estuarine inflow of old abyssal waters from the Southern Ocean up to the northern North Pacific and an outflow of upper deep waters. Vice versa, low ^{14}C ventilation ages of N.E. Pacific deep waters suggest a reversed, anti-estuarine MOC during early Heinrich Stadial 1 with a ~1500 year-long flushing of the deep North Pacific up to the South China Sea, when the North Atlantic was marked by an estuarine circulation geometry, gradually starting near 19 ka. Elevated ^{14}C ventilation ages of LGM deep waters reflect a major drawdown of atmospheric carbon. Subsequent massive age drops accompanying changes in MOC reflect major events of carbon release to the atmosphere as recorded in Antarctic ice cores. These contemporaneous features of the MOC and the carbon cycle offer a great test case for comparison with model simulation.