Geophysical Research Abstracts
Vol. 21, EGU2019-17670-1, 2019
EGU General Assembly 2019

Accurate Timing and Implications of the Atlantic-Pacific Seesaw in Overturning Circulation During LGM and Deglacial

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Today, North Atlantic Deep Water formation forms the major 'lung' of the deep ocean and drives the global thermohaline circulation system (Meridional Overturning Circulation – MOC) reaching up to its turning point in the North Pacific, where deep waters upwell to near the sea surface. As proposed by various authors over the last 40 yr, however, this system is by no means stable but has been subject to major changes from glacial to present interglacial times. To meet the challenge of an accurate and precise timing and correlation of glacial and deglacial changes in global ocean circulation and to uncover the links amongst changes in different ocean basins, its chemical inventories, and global climate change we now apply the absolute chronology presented in the varve-counted atmospheric 14C record of Lake Suigetsu (Bronk Ramsey et al. 2012, Schlolaut et al. 2018) to sediment records near to the turning points of ocean MOC, where sedimentation rates of 25-60 cm/ky make possible detailed age control.

During LGM, deep-water 14C ventilation ages reveal precisely a seesaw in the geometries of Atlantic and Pacific MOC, the main traits of which were similar to those found today: Deep-water formation in the Norwegian Sea and North Atlantic paralleled an estuary-style inflow of abyssal waters from the Southern Ocean into the northern North Pacific and outflow of upper deep waters. In contrast, 14C ventilation ages during parts of Heinrich Stadial 1 suggest a largely reversed circulation pattern marked by a thousand-year long event of deep-water formation and flushing of the northern North Pacific. These deep waters reached far south, even entering the South China Sea. This event was paralleled by a coeval thousand-year-long interval of estuary-style circulation geometry in the northern North Atlantic, starting with a very gradual change as early as 19 ka. Increased 14C ventilation ages and carbon (DIC) inventories of deep waters in the global ocean suggest a major drawdown of carbon into the deep ocean during LGM. Conversely, the subsequent massive changes in MOC have induced two major events of carbon release to the atmosphere as recorded in WAIS ice cores (Marcott et al. 2014) that highlight the significance of ocean MOC for atmospheric CO_2 and its radiocarbon inventories.

References

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