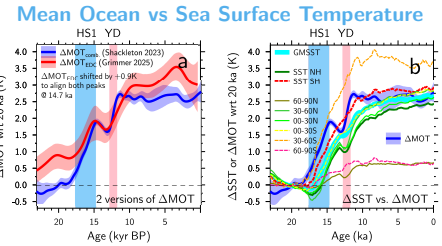


Net carbon transfer from ocean to land during the last deglaciation synchronous to sea level rise and lagging atmospheric CO₂ by several millennia

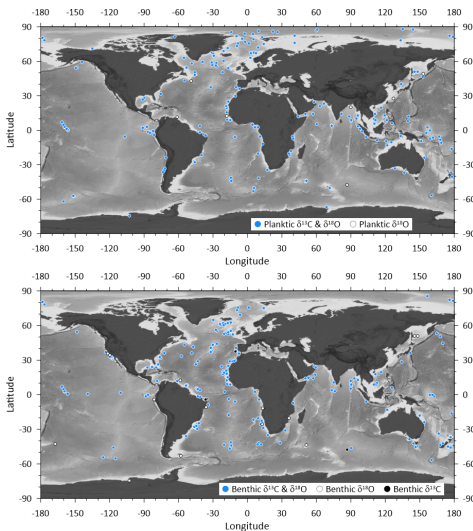


Peter Köhler¹, Stefan Mulitza² 1: Alfred-Wegener-Institut Bremerhaven, Germany; 2: MARUM, University of Bremen, Germany

The sequence of events in the global carbon cycle during deglaciations is not entirely understood. Here, we analyse mean ocean $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ in an updated compilation of foraminifera stable isotope data consisting of 902 time series from 381 sediment cores covering up to the past 23,000 years. We use changes in mean ocean temperature from ice cores to split $\delta^{18}\text{O}$ into its temperature and seawater components. We then show that a $0.47 \pm 0.05\text{‰}$ rise in mean ocean $\delta^{13}\text{C}$ occurred quasi-synchronously with changes in seawater $\delta^{18}\text{O}$ and is lagging the rise in atmospheric CO₂ during Termination I by $\sim 2,000$ years. Since mean ocean $\delta^{13}\text{C}$ is mainly recording net changes in land carbon storage and seawater $\delta^{18}\text{O}$ is mainly depicting the rise in global mean sea level this implies that land carbon varied in-phase with sea level and not with atmospheric CO₂.



Data Base



Methods

World Atlas of Foraminifera Carbon and Oxygen Isotopes (Mulitza et al., 2022) + 32 new data sets; 87% of the 381 cores have ¹⁴C ages for dating, else visual alignment of $\delta^{18}\text{O}$ to local stacks of Lisiecki & Stern (2016); Bacon age model (Blaauw & Christen, 2011) called out of PaleoData-View (Langner & Mulitza, 2019); intermediate averages in 21 boxes; 1000 Monte-Carlo with analytical SD of 0.05‰ ($\delta^{13}\text{C}$) and of 0.07‰ ($\delta^{18}\text{O}$); Final volume-weighted time series of mean ocean $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$: 23.0–0.5 ka.

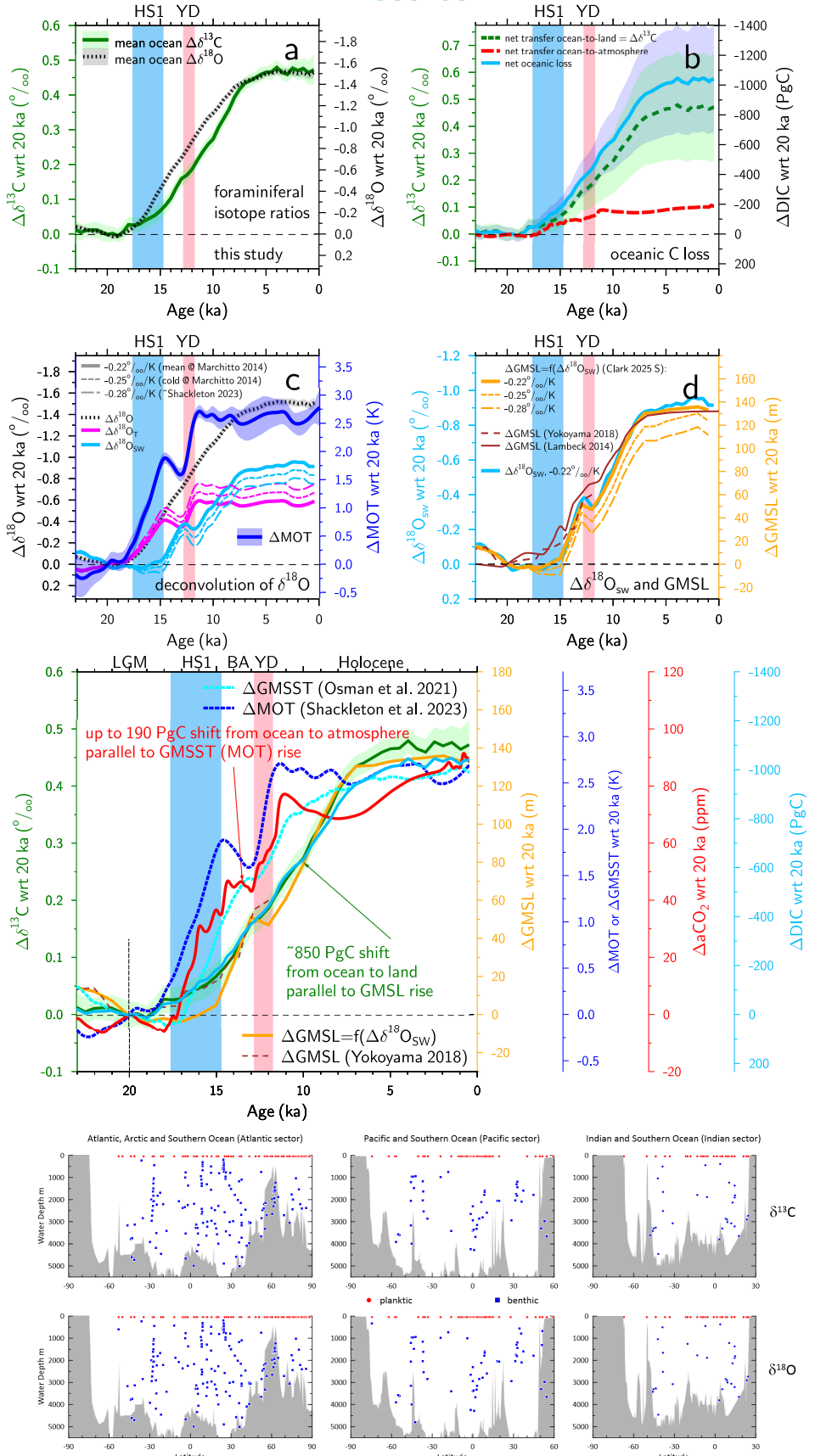
902 time series — 381 cores

Species	# Data Points		Share (%)	
	$\delta^{13}\text{C}$	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$	$\delta^{18}\text{O}$
Planktic species				
<i>Globigerinoides ruber</i>	18076	18993	29.1	29.9
<i>Neoglobobulimina pachyderma</i>	9534	9934	15.4	15.7
Benthic species				
<i>Cibicides/Cibicidesoides</i>	31878	31811	51.4	50.1
<i>Uvigerina</i> ¹	1100	1282	1.8	2.0
Other benthics	1442	1444	2.3	2.3
Total	62030	63464	100	100

21 Regional Boxes

Name	Volume 10 ¹⁵ m ³	Depth km	Lat.	# Records $\delta^{13}\text{C}$ $\delta^{18}\text{O}$
Surface Arctic	1.26	0–0.1	60–90°N	42 42
Surface North. N. Atlantic	0.899	0–0.1	40–60°N	15 16
Surface N. Atlantic	2.92	0–0.1	0–40°N	21 23
Surface S. Atlantic	2.60	0–0.1	0–40°S	13 13
Surface Southern Ocean	7.53	0–0.1	40–70°S	16 17
Surface North. N. Pacific	1.38	0–0.1	40–60°N	8 9
Surface N. Pacific	6.43	0–0.1	0–40°N	20 21
Surface S. Pacific	6.35	0–0.1	0–40°S	23 23
Surface Indian	4.74	0–0.1	40°S–25°N	30 31
Intern. North Atlantic	66.8	0.1–2	0–60°N	45 46
Intern. South Atlantic	48.2	0.1–2	0–40°S	17 19
Intern. North Pacific	141	0.1–2	0–60°N	10 14
Intern. South Pacific	117	0.1–2	0–40°S	5 6
Intern. Indian	86.7	0.1–2	40°S–25°N	10 11
Deep North Atlantic	81.7	>2	0–60°N	58 56
Deep South Atlantic	17.6	>200	0–40°S	21 20
Deep North Pacific	199	>2	0–60°N	18 18
Deep South Pacific	130	>2	0–40°S	8 8
Deep Indian	103	>2	40°S–25°N	13 13
Non-surf. Arctic	20.6	>0.1	60–90°N	23 23
Non-surf. South. Ocean	276	>0.1	40–70°S	27 30
Total	1321.7			443 459

Results



GERMAN CLIMATE MODELING INITIATIVE



Federal Ministry of Education and Research

sponsored by