

Supplementary material for the manuscript “Simulating oceanic radiocarbon with the FAMOUS GCM: implications for its use as a proxy for ventilation and carbon uptake”

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1. Technical note

For future scientific application of the isotope-enabled model, readers may wish to implement an additional modification (“mod”) file to revise the ^{14}C half-life downwards from 5730 ± 40 years (Godwin, 1962) to 5700 ± 30 years (Audi et al., 2003), as per the Ocean Model Intercomparison Project’s (OMIP) biogeochemical protocol (Orr et al., 2017). All of the results in this study are based on the now-outdated half-life of 5730 years, following the earlier Ocean Carbon-Cycle Model Intercomparison Project (OCMIP) protocol (Orr et al., 2000) and the abiotic legacy code (Palmer, 1998).

2. Additional tables

Table S1: Number of pre-bomb $\Delta^{14}\text{C}$ data points in the compilation of Graven et al. (2012b) binned according to the vertical levels in FAMOUS.

Water depth (m)	Number of data points
0 to 10	67
10 to 20	2
20 to 30	0
30 to 40	0
40 to 55	2
50 to 80	2
80 to 120	0
120 to 170	1
170 to 250	4
250 to 375	8
375 to 550	3
550 to 830	9
830 to 1250	13
1250 to 1800	6
1800 to 2400	13
2400 to 3000	14
3000 to 3600	13
3600 to 4250	8
4250 to 4900	4
4900 to 5500	16
5500+*	7

* Not represented in the model, which has a maximum depth of approximately 5500 m.

Table S2: Coral and bivalve locations, record lengths, and original references.

Identifier	Location	Latitude (°N)	Longitude (°E)	Depth (m)	Archive	Length of record	Number of measurements	Reference
B	Bermuda	32	-64	0	Coral	1950 to 1983	35	Druffel et al. (1989)
B	Bermuda	32	-64	1410	Coral	≈1400 ¹ to 2001	26 ²	Lee et al. (2017)
BB	Bay of Biscay	46.9	-5.3	691	Coral	1950 to 1985	19	Montero-Serrano et al. (2013)
G	Grimsey	66	-18	82	Bivalve	1935 to 2005	16	Scourse et al. (2012)
GB	German Bight	54	7	37	Bivalve	1948 to 1990	20	Weidman (1995)
GeB	Georges Bank	41	-67	76	Bivalve	1939 to 1989	13	Weidman and Jones (1993)
GrB	Grand Banks	44.13	-52.93	0	Coral	1884 to 1991	12	Sherwood et al. (2008)
GrB	Grand Banks	44.13	-52.93	713	Coral	1879 to 2001	12	Sherwood et al. (2008)
HS	Hudson Strait	60.5	-61.4	0	Coral	1925 to 2000	18	Sherwood et al. (2008)
HS	Hudson Strait	60.5	-61.4	414	Coral	1941 to 1994	3	Sherwood et al. (2008)
NE	Northeast Channel	42	-65.5	0	Coral	1924 to 2002	26	Sherwood et al. (2008)
NE	Northeast Channel	42	-65.5	362.5 ³	Coral	1890 to 1983	14	Sherwood et al. (2008)
OG	Oyster Ground	54	4	40	Bivalve	1928 to 1986	30	Witbaard et al. (1994)
S	Siglufjörður	66	-19	22	Bivalve	1874 to 1991	17	Weidman (1995)
SB	Sable Bank	44	-61	35	Bivalve	1956 to 1981	15	Kilada et al. (2007)
T	Tromsø	70	19	3	Bivalve	1940 to 1993	14	Weidman (1995)

¹ 1441 based on the coral's higher vertical extension rate and 1373 based on the coral's lower vertical extension rate.

² 19 of which are between ≈1880 and 2001 and 7 of which are between ≈1400 and ≈1700.

³ Between 275 m and 450 m.

3. Additional figures

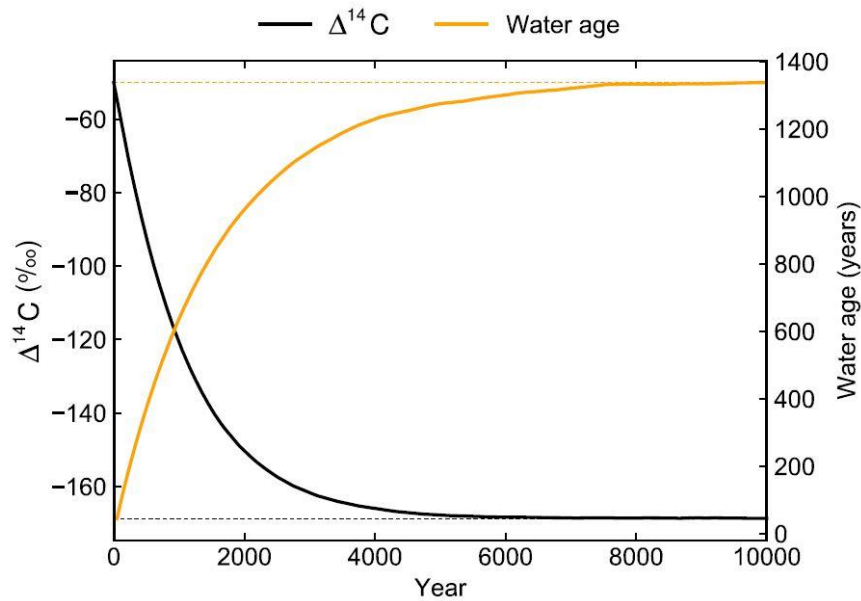


Figure S1: Global volume-weighted $\Delta^{14}\text{C}$ (black) and water age (orange) integrals for the spin-up simulation. The solid lines show the transient isotopic ratios and the dashed lines show the values at equilibrium.

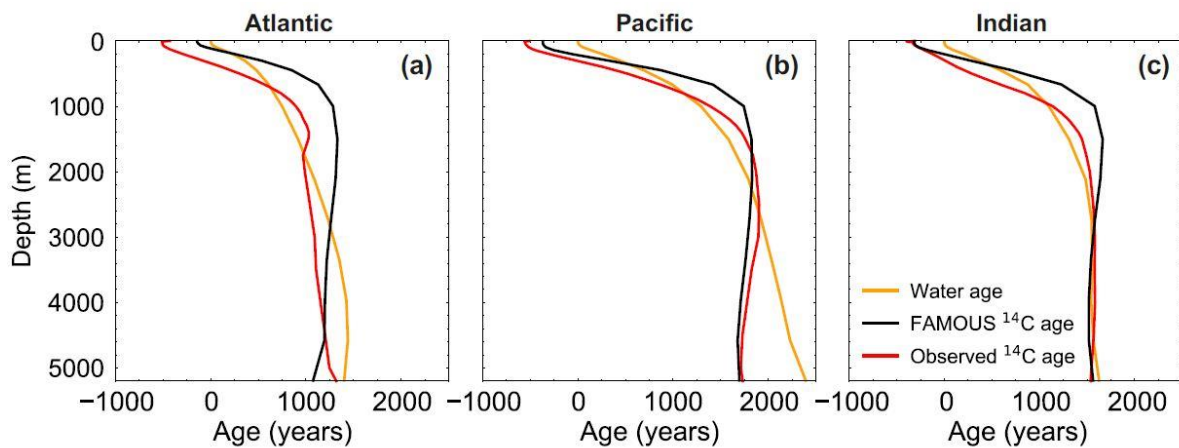


Figure S2: Basin-averaged depth profiles of ^{14}C age and water age during the 1990s: (a) Atlantic Ocean, (b) Pacific Ocean, and (c) Indian Ocean. The simulated ^{14}C age (black) is compared to the simulated water age (orange) and the ^{14}C age in the gridded GLODAP data (Key et al., 2004; red).

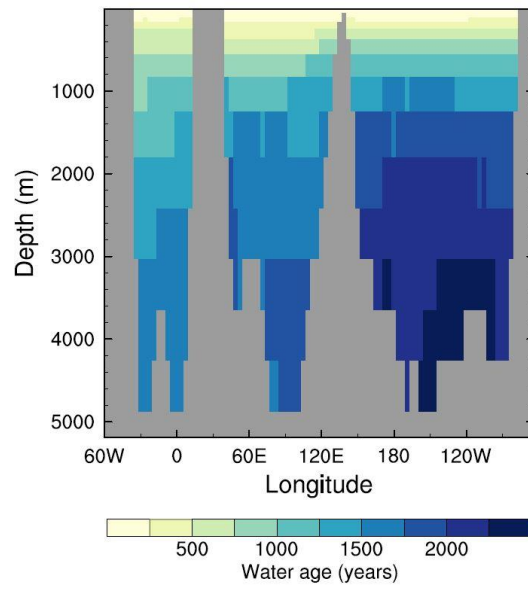


Figure S3: Idealised water age transect at 10° S at the end of the spin-up simulation (years 9900 to 10,000).

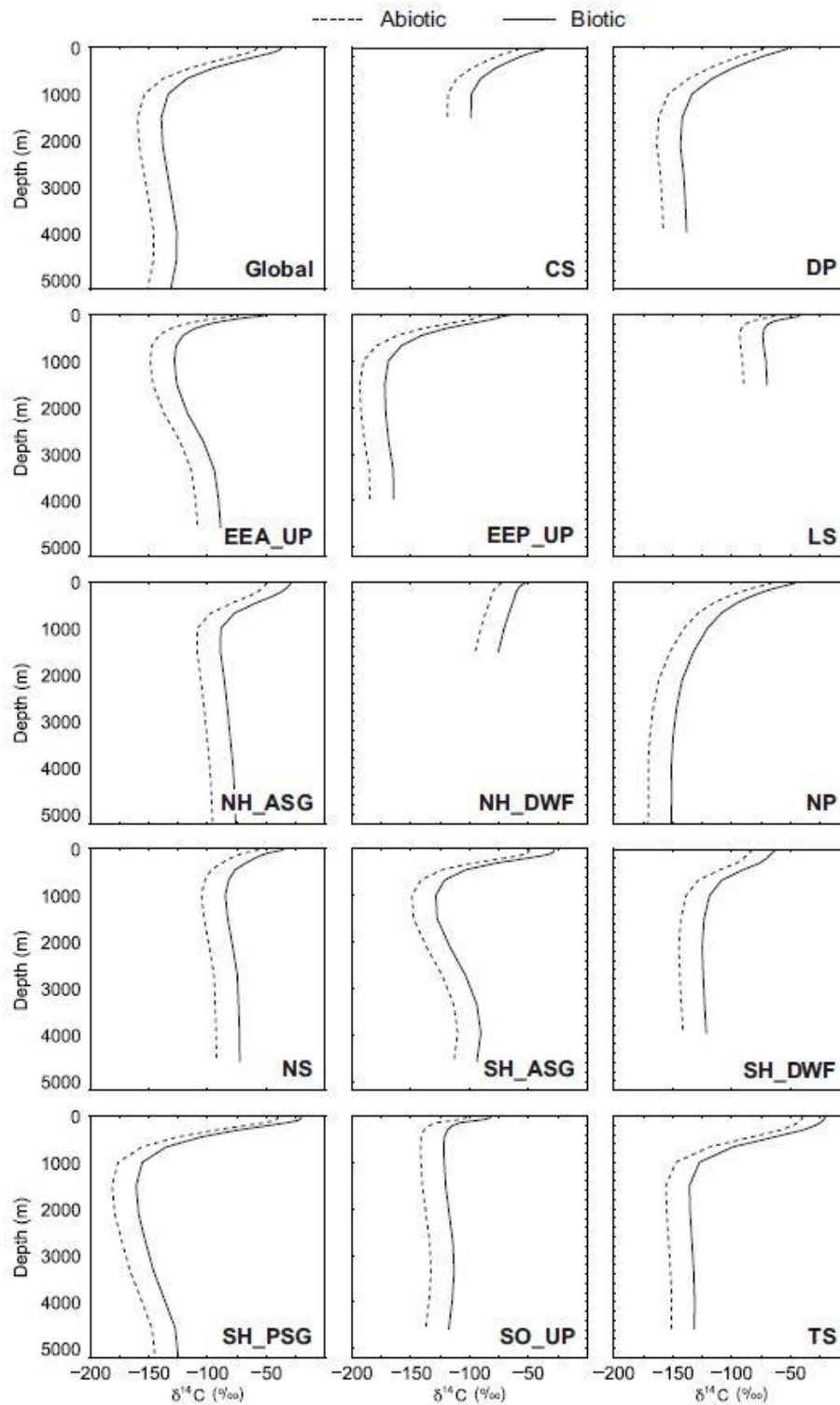


Figure S4: Global and regional depth profiles of abiotic (dashed) and biotic (solid) $\delta^{14}\text{C}$ at the end of the spin-up simulation (years 9900 to 10,000). The regions are outlined in Figure 7 in the main manuscript: Caribbean Sea (CS), Drake Passage (DP), eastern equatorial Atlantic upwelling zone (EEA_UP), eastern equatorial Pacific upwelling zone (EEP_UP), Labrador Sea (LS), Northern Hemisphere Atlantic sub-tropical gyre (NH_ASG), Northern Hemisphere deep water formation region (NH_DWF), North Pacific (NP), Nova Scotia (NS), Southern Hemisphere Atlantic sub-tropical gyre (SH_ASG), Southern Hemisphere deep water formation region (SH_DWF), Southern Hemisphere Pacific sub-tropical gyre (SH_PSG), Southern Ocean upwelling zone (SO_UP), and Tasman Sea (TS).

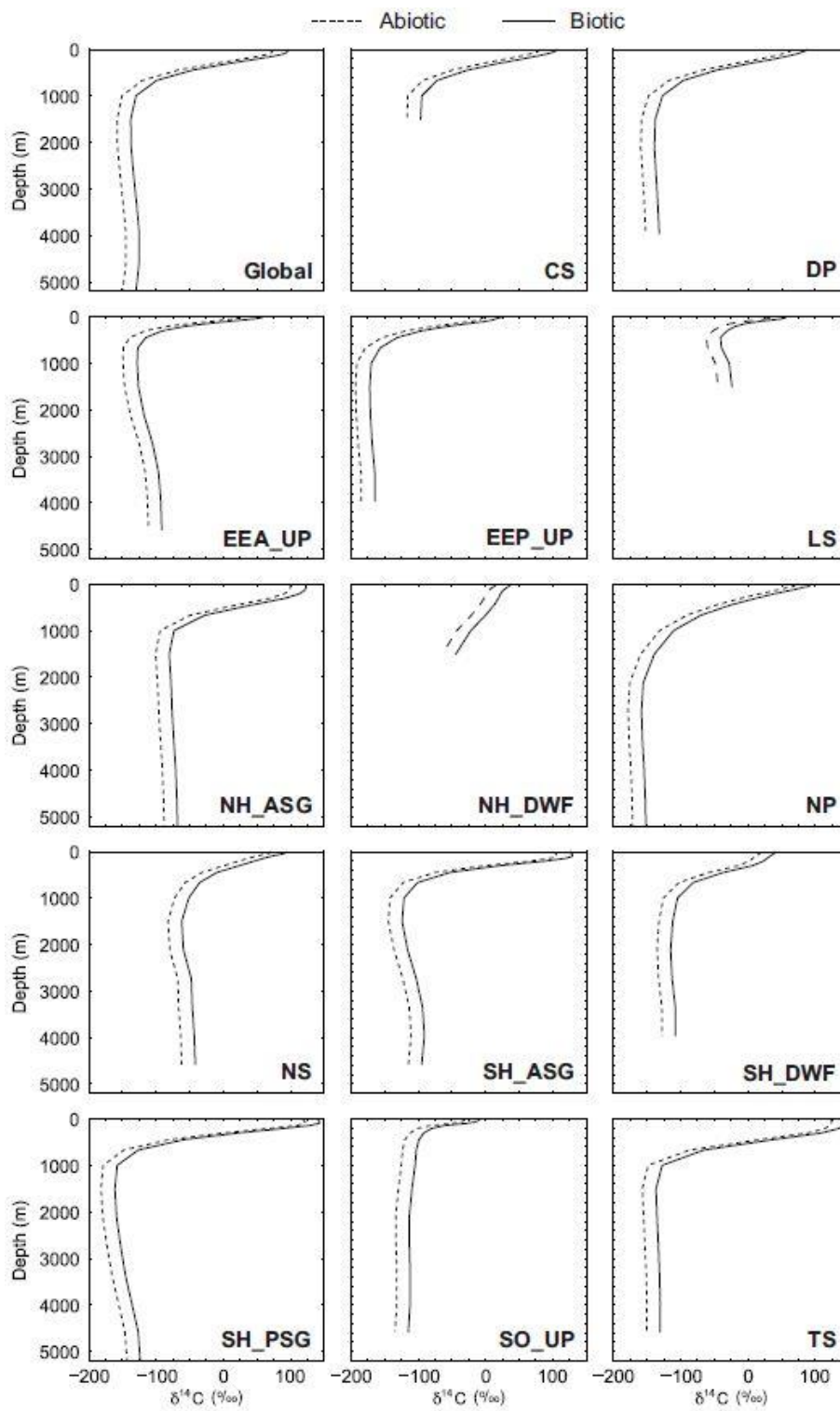


Figure S5: As for Figure S4, but for the 1990s.

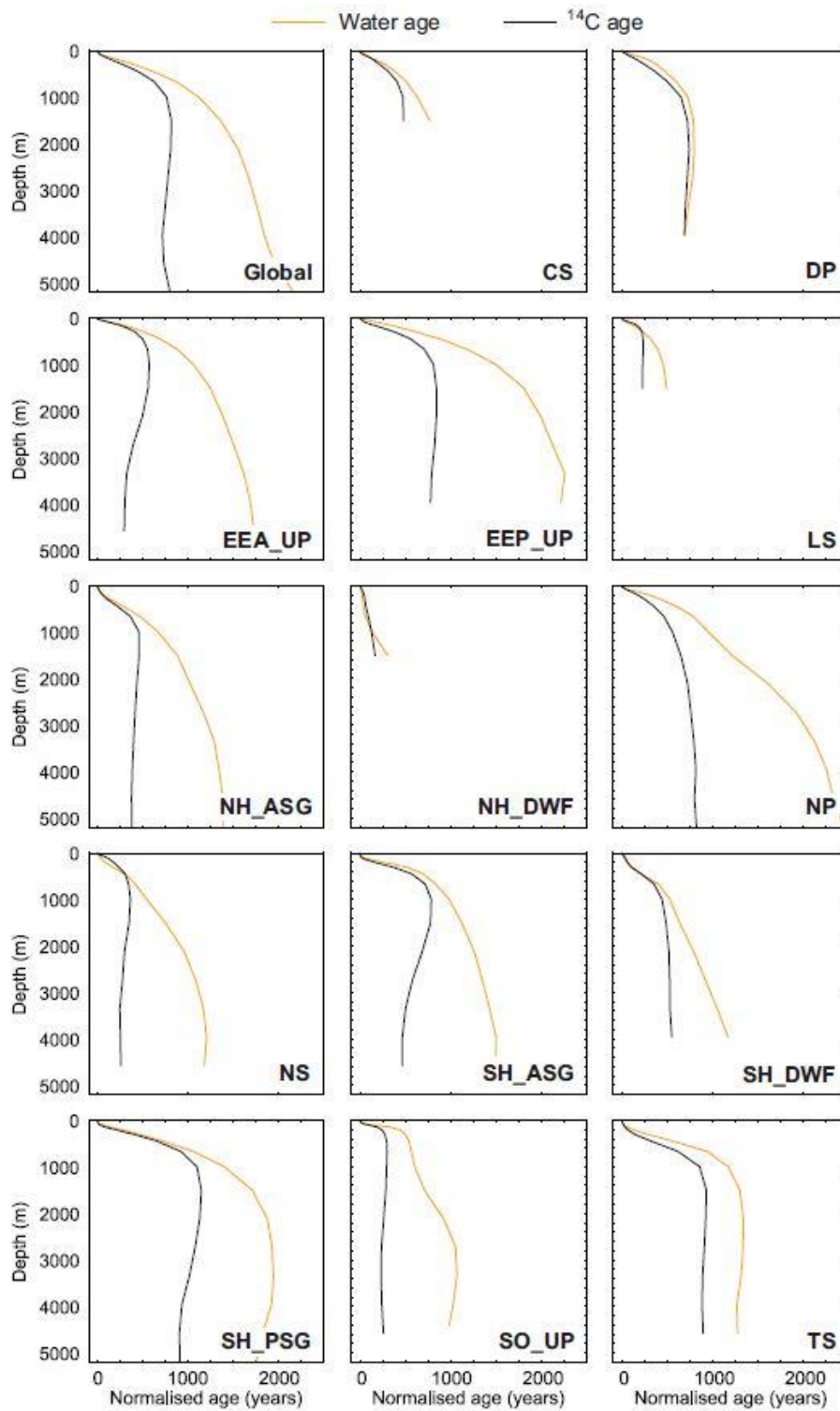


Figure S6: Global and regional depth profiles of water age (orange) and normalised ^{14}C age (black) at the end of the spin-up simulation (years 9900 to 10,000). The ^{14}C ages have been normalised relative to the surface ocean in each region, so that both the ^{14}C age and the water age in the uppermost layer are 0 years. The regions are outlined in Figure 7 in the main manuscript: Caribbean Sea (CS), Drake Passage (DP), eastern equatorial Atlantic upwelling zone (EEA_UP), eastern equatorial Pacific upwelling zone (EEP_UP), Labrador Sea (LS), Northern Hemisphere Atlantic sub-tropical gyre (NH_ASG), Northern Hemisphere deep water formation region (NH_DWF), North Pacific (NP), Nova Scotia (NS), Southern Hemisphere Atlantic sub-tropical gyre (SH_ASG), Southern Hemisphere deep water formation region (SH_DWF), Southern Hemisphere Pacific sub-tropical gyre (SH_PSG), Southern Ocean upwelling zone (SO_UP), and Tasman Sea (TS).

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