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A spectral approach to estimating the timescale-dependent uncertainty of paleoclimate records – Part 2: Application and interpretation

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Radiocarbon dating was performed on 9 mono-specific samples of *Trilobatus sacculifer* consisting of approximately 50 specimens per sample from the 250-400 µm (Table S1). To determine the age-heterogeneity (τ_b) using the inter-individual standard deviation, 10 samples consisting of 10 specimens of *T. sacculifer* each from the same sediment depth (68-69 cm) were analysed (Dolman et al., 2020). All AMS-^{14}C dates were analysed using a Mini Carbon Dating System (MICADAS) at the Alfred Wegener Institute, Bremerhaven, Germany (Wacker et al., 2010). Samples consisting of 50 specimens were analysed using a graphite target, samples consisting of 10 specimens using a gas target.

Stable oxygen isotope measurements were performed on *Globigerinoides ruber* (s.s.) from the 250-355 µm (250-400 µm when not enough specimens were available) size fraction (Table S2). For Rep1 5 specimens were analysed; for Rep2 30 specimens were crushed and mixed before enough material was taken from this mixed sample for analysis. Analyses were performed Thermo-Fisher Scientific 253plus gas isotope ratio mass spectrometer with Kiel IV automated carbonate preparation device at MARUM, University of Bremen. Isotopic results were calibrated relative to the Vienna Pee Dee belemnite (VPDB) using the NBS19 standard. The standard deviation of the laboratory standard was lower than 0.05‰ for the measuring period.

References.

Dolman, A. M., Groeneveld, J., Mollenhauer, G., Ho, S. L. and Laepple, T.: Estimating bioturbation from replicated small-sample radiocarbon ages., Earth and Space Science Open Archive, 19, doi:10.1002/essoar.10504501.2, 2020.

Wacker, L., Bonani, G., Friedrich, M., Hajdas, I., Kromer, B., Nemec, N., Ruff, M., Suter, M., Synal, H.-A. and Vockenhuber, C.: MICADAS: Routine and High-Precision Radiocarbon Dating, Radiocarbon, 52(2), 252–262, 2010.

Table S1. Down-core AMS-^{14}C dates for GeoB 10054-4. Radiocarbon ages were calibrated with the Marine13 radiocarbon calibration curve.

Analysis ID	Depth top (cm)	14C age	σ 14C age	Calibrated age	No. foraminifera	Weight total (µg C)	Taxon
1660.1.1	3	944	59	551	100	84.0	*T. sacculifer /G. ruber*
2662.1.1	13	1662	64	1214	43	110.0	*T. sacculifer*
2663.1.1	28	1962	62	1514	50	136.0	*T. sacculifer*
2664.1.1	48	3113	64	2895	50	143.0	*T. sacculifer*
2665.1.1	88	4950	70	5282	50	169.0	*T. sacculifer*
2666.1.1	108	5520	72	5902	50	164.0	*T. sacculifer*

2667.1.1	128	6831	81	7346	50	165.0	*T. sacculifer*
2668.1.1	148	7675	81	8136	50	157.0	*T. sacculifer*
2669.1.1	173	8558	102	9194	50	154.0	*T. sacculifer*

Table S2. Foraminiferal oxygen isotope measurements for core GeoB 10054-4. Radiocarbon ages were calibrated with the Marine13 radiocarbon calibration curve. Delta ^{18}O is given relative to the Vienna Pee Dee belemnite (VPDB) using the NBS19 standard.

Core	Record	Depth (cm)	No. foraminifera	d180 (VPDB)	Calibrated age
GeoB 10054-4	Rep1	3.5	5	-2.017	550.8117
GeoB 10054-4	Rep1	4.5	5	-2.42	617.1036
GeoB 10054-4	Rep1	6	5	-2.23	716.5413
GeoB 10054-4	Rep1	8.5	5	-2.868	882.2708
GeoB 10054-4	Rep1	9	5	-2.78	915.4167
GeoB 10054-4	Rep1	10	5	-2.29	981.7085
GeoB 10054-4	Rep1	13.5	5	-2.068	1213.73
GeoB 10054-4	Rep1	14.5	5	-2.58	1233.763
GeoB 10054-4	Rep1	16	5	-2.44	1263.812
GeoB 10054-4	Rep1	18.5	5	-2.533	1313.894
GeoB 10054-4	Rep1	20	5	-2.48	1343.943
GeoB 10054-4	Rep1	21.5	5	-2.58	1373.993
GeoB 10054-4	Rep1	23.5	5	-2.404	1414.058
GeoB 10054-4	Rep1	25	5	-2.34	1444.108
GeoB 10054-4	Rep1	26.5	5	-2.27	1474.157
GeoB 10054-4	Rep1	28.5	5	-2.209	1514.223
GeoB 10054-4	Rep1	30	5	-2.95	1617.801
GeoB 10054-4	Rep1	31.5	5	-2.47	1721.38
GeoB 10054-4	Rep1	33.5	5	-2.421	1859.485
GeoB 10054-4	Rep1	34.5	5	-2.09	1928.538
GeoB 10054-4	Rep1	35.5	5	-2.42	1997.591
GeoB 10054-4	Rep1	38.5	5	-2.282	2204.748
GeoB 10054-4	Rep1	39	5	-2.77	2239.275
GeoB 10054-4	Rep1	40	5	-2.41	2308.327
GeoB 10054-4	Rep1	43	5	-2.217	2515.485
GeoB 10054-4	Rep1	44.5	5	-2.28	2619.064
GeoB 10054-4	Rep1	46.5	5	-2.36	2757.169
GeoB 10054-4	Rep1	48.5	5	-2.439	2895.274
GeoB 10054-4	Rep1	50	5	-2.3	3004.843
GeoB 10054-4	Rep1	51.5	5	-2.25	3114.413

GeoB 10054-4	Rep1	53.5	5	-2.263	3260.505
GeoB 10054-4	Rep1	54.5	5	-2.63	3333.551
GeoB 10054-4	Rep1	56	5	-2.34	3443.121
GeoB 10054-4	Rep1	58.5	5	-2.159	3625.736
GeoB 10054-4	Rep1	59.5	5	-2.44	3698.783
GeoB 10054-4	Rep1	61	5	-2.65	3808.352
GeoB 10054-4	Rep1	63.5	5	-2.354	3990.968
GeoB 10054-4	Rep1	64.5	5	-2.12	4064.014
GeoB 10054-4	Rep1	66	5	-2.47	4173.583
GeoB 10054-4	Rep1	68.5	5	-1.742	4356.199
GeoB 10054-4	Rep1	69.5	5	-2.16	4402.47
GeoB 10054-4	Rep1	71	5	-2.04	4471.876
GeoB 10054-4	Rep1	73.5	5	-2.342	4587.552
GeoB 10054-4	Rep1	74.5	5	-2.25	4633.823
GeoB 10054-4	Rep1	76	5	-2.45	4703.229
GeoB 10054-4	Rep1	78.5	5	-2.361	4818.906
GeoB 10054-4	Rep1	79.5	5	-2.28	4865.177
GeoB 10054-4	Rep1	81	5	-2.01	4934.583
GeoB 10054-4	Rep1	83.5	5	-2.31	5050.26
GeoB 10054-4	Rep1	84.5	5	-2.52	5096.53
GeoB 10054-4	Rep1	86.5	5	-2.31	5189.072
GeoB 10054-4	Rep1	88.5	5	-2.157	5281.613
GeoB 10054-4	Rep1	89.5	5	-2.34	5312.622
GeoB 10054-4	Rep1	91	5	-2.4	5359.136
GeoB 10054-4	Rep1	93.5	5	-2.053	5436.659
GeoB 10054-4	Rep1	94.5	5	-2.26	5467.668
GeoB 10054-4	Rep1	96	5	-2.45	5514.181
GeoB 10054-4	Rep1	98	5	-2.36	5576.2
GeoB 10054-4	Rep1	98.5	5	-2.142	5591.704
GeoB 10054-4	Rep1	99.5	5	-2.02	5622.713
GeoB 10054-4	Rep1	103.5	5	-1.908	5746.75
GeoB 10054-4	Rep1	104	5	-2.26	5762.254
GeoB 10054-4	Rep1	106	5	-1.78	5824.272
GeoB 10054-4	Rep1	108.5	5	-2.325	5901.795
GeoB 10054-4	Rep1	109	5	-2.27	5937.908
GeoB 10054-4	Rep1	111	5	-2.13	6082.359
GeoB 10054-4	Rep1	113.5	5	-2.429	6262.923
GeoB 10054-4	Rep1	114.5	5	-2.61	6335.149
GeoB 10054-4	Rep1	116	5	-1.83	6443.487
GeoB 10054-4	Rep1	118.5	5	-2.102	6624.052
GeoB 10054-4	Rep1	119	5	-2.33	6660.164
GeoB 10054-4	Rep1	120.5	5	-2.4	6768.503
GeoB 10054-4	Rep1	123.5	5	-2.403	6985.18
GeoB 10054-4	Rep1	124	5	-2.19	7021.293
GeoB 10054-4	Rep1	125.5	5	-2.41	7129.631
GeoB 10054-4	Rep1	128.5	5	-2.442	7346.308

GeoB 10054-4	Rep1	129	5	-1.76	7366.039
GeoB 10054-4	Rep1	130.5	5	-2.52	7425.233
GeoB 10054-4	Rep1	133.5	5	-2.082	7543.621
GeoB 10054-4	Rep1	134	5	-1.79	7563.352
GeoB 10054-4	Rep1	135.5	5	-2.73	7622.546
GeoB 10054-4	Rep1	138.5	5	-1.925	7740.934
GeoB 10054-4	Rep1	138.5	5	-1.96	7740.934
GeoB 10054-4	Rep1	139.5	5	-2.49	7780.396
GeoB 10054-4	Rep1	143	5	-2.06	7918.515
GeoB 10054-4	Rep1	144.5	5	-2.07	7977.709
GeoB 10054-4	Rep1	146.5	5	-2.4	8056.634
GeoB 10054-4	Rep1	148.5	5	-2.125	8135.56
GeoB 10054-4	Rep1	150	5	-1.83	8199.086
GeoB 10054-4	Rep1	151.5	5	-2.34	8262.612
GeoB 10054-4	Rep1	153.5	5	-2.351	8347.314
GeoB 10054-4	Rep1	155	5	-2.04	8410.84
GeoB 10054-4	Rep1	156.5	5	-2.68	8474.366
GeoB 10054-4	Rep1	158.5	5	-2.297	8559.068
GeoB 10054-4	Rep1	160	5	-1.98	8622.594
GeoB 10054-4	Rep1	161.5	5	-2.24	8686.12
GeoB 10054-4	Rep1	163.5	5	-1.977	8770.822
GeoB 10054-4	Rep1	165	5	-2.66	8834.348
GeoB 10054-4	Rep1	166.5	5	-2.04	8897.874
GeoB 10054-4	Rep1	168.5	5	-1.99	8982.576
GeoB 10054-4	Rep1	169.5	5	-2.16	9024.926
GeoB 10054-4	Rep1	170.5	5	-1.77	9067.277
GeoB 10054-4	Rep1	173.5	5	-2.05	9194.33
GeoB 10054-4	Rep1	174.5	5	-1.95	9240.985
GeoB 10054-4	Rep1	176.5	5	-2.28	9334.295
GeoB 10054-4	Rep1	178.5	5	-1.898	9427.605
GeoB 10054-4	Rep1	180.5	5	-1.73	9520.915
GeoB 10054-4	Rep1	182	5	-2.44	9590.897
GeoB 10054-4	Rep1	183.5	5	-2.279	9660.879
GeoB 10054-4	Rep1	185	5	-2.43	9730.862
GeoB 10054-4	Rep1	186.5	5	-1.75	9800.844
GeoB 10054-4	Rep1	188.5	5	-2.172	9894.154
GeoB 10054-4	Rep1	190	5	-1.9	9964.137
GeoB 10054-4	Rep2	3.5	30	-2.333	550.8117
GeoB 10054-4	Rep2	8.5	30	-2.277	882.2708
GeoB 10054-4	Rep2	13.5	30	-2.496	1213.73
GeoB 10054-4	Rep2	18.5	30	-2.37	1313.894
GeoB 10054-4	Rep2	23.5	30	-2.386	1414.058
GeoB 10054-4	Rep2	28.5	30	-2.363	1514.223
GeoB 10054-4	Rep2	33.5	30	-2.419	1859.485
GeoB 10054-4	Rep2	38.5	30	-2.511	2204.748
GeoB 10054-4	Rep2	43	30	-2.392	2515.485

GeoB 10054-4	Rep2	48.5	30	-2.244	2895.274
GeoB 10054-4	Rep2	53.5	30	-2.331	3260.505
GeoB 10054-4	Rep2	58.5	30	-2.477	3625.736
GeoB 10054-4	Rep2	63.5	30	-2.475	3990.968
GeoB 10054-4	Rep2	68.5	30	-2.238	4356.199
GeoB 10054-4	Rep2	73.5	30	-2.275	4587.552
GeoB 10054-4	Rep2	78.5	30	-2.343	4818.906
GeoB 10054-4	Rep2	83.5	30	-2.337	5050.26
GeoB 10054-4	Rep2	88.5	30	-2.241	5281.613
GeoB 10054-4	Rep2	93.5	30	-2.258	5436.659
GeoB 10054-4	Rep2	98.5	30	-2.471	5591.704
GeoB 10054-4	Rep2	103.5	30	-2.252	5746.75
GeoB 10054-4	Rep2	108.5	30	-2.2	5901.795
GeoB 10054-4	Rep2	113.5	30	-2.154	6262.923
GeoB 10054-4	Rep2	118.5	30	-2.244	6624.052
GeoB 10054-4	Rep2	123.5	30	-2.509	6985.18
GeoB 10054-4	Rep2	128.5	30	-2.36	7346.308
GeoB 10054-4	Rep2	133.5	30	-2.167	7543.621
GeoB 10054-4	Rep2	138.5	30	-2.21	7740.934
GeoB 10054-4	Rep2	143	30	-2.29	7918.515
GeoB 10054-4	Rep2	148.5	30	-1.938	8135.56
GeoB 10054-4	Rep2	153.5	30	-2.208	8347.314
GeoB 10054-4	Rep2	158.5	30	-2.2	8559.068
GeoB 10054-4	Rep2	163.5	30	-1.889	8770.822
GeoB 10054-4	Rep2	168.5	30	-2.098	8982.576
GeoB 10054-4	Rep2	173.5	30	-2.172	9194.33
GeoB 10054-4	Rep2	178.5	30	-1.969	9427.605
GeoB 10054-4	Rep2	183.5	30	-2.195	9660.879
GeoB 10054-4	Rep2	188.5	30	-1.931	9894.154