Supplementary Figures and Tables to:

Oligocene-early Miocene paradox of pCO_2 inferred from alkenone carbon isotopic fractionation and sea surface temperature trends

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Figure S1. High resolution IODP 1406 subset of measured δ^{13}C benthic foraminifera, bulk carbonate, $C_{37.2}$ alkenone, calculated εp, and SST.

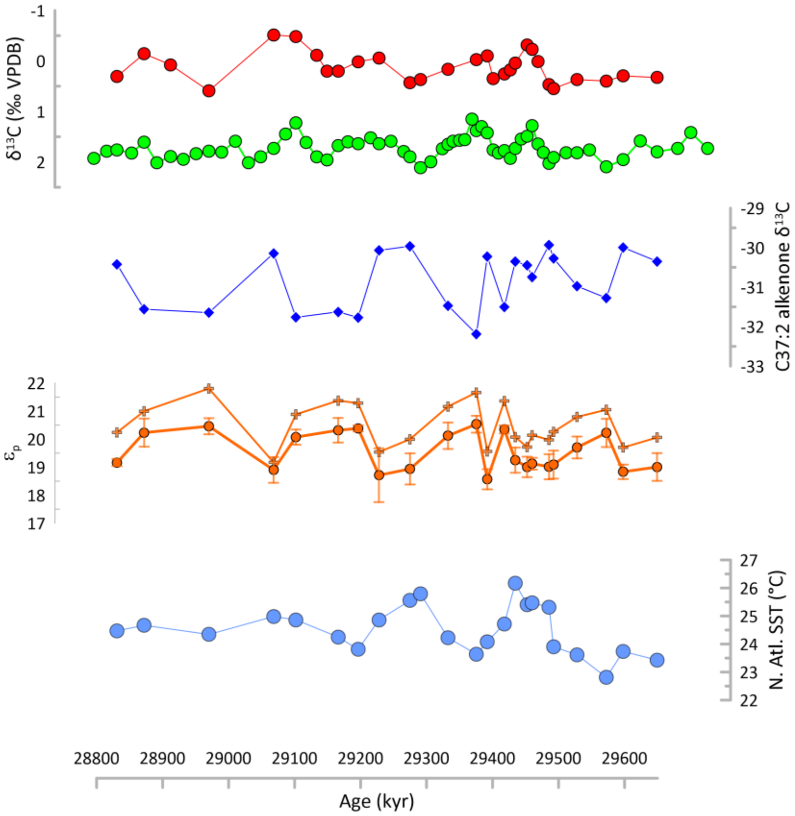

Figure S2. Measured biogenic silica vs SST from the same samples of IODP 1406 and ODP 1168. Colour code shows time intervals as main Figure 6. Dashed black line overall relation.

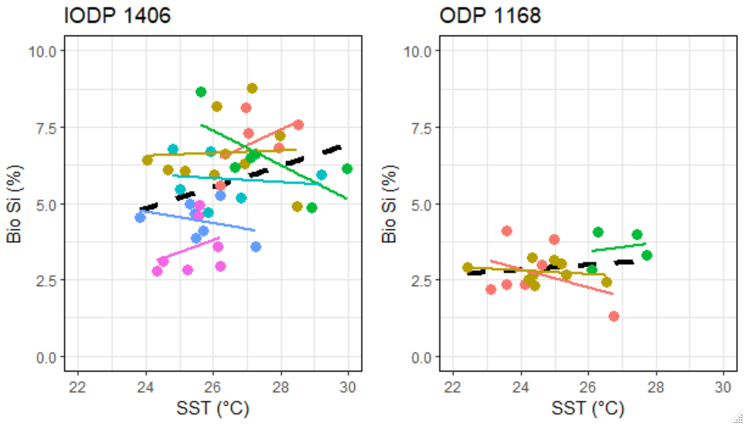

Figure S3. Entire studied period correlation regression lines, for the measured ep (solid), ep without the theoretical temp effect (transparent), and ep without the temp and size effect (dashed). R2-values: a (-0.43, -0.16, -0.09); b (0.58**, 0.78**, 0.73**); c (0.25, 0.13, 0.15); d (0.29, 0.25, 0.48).** *** p value <0.05.*

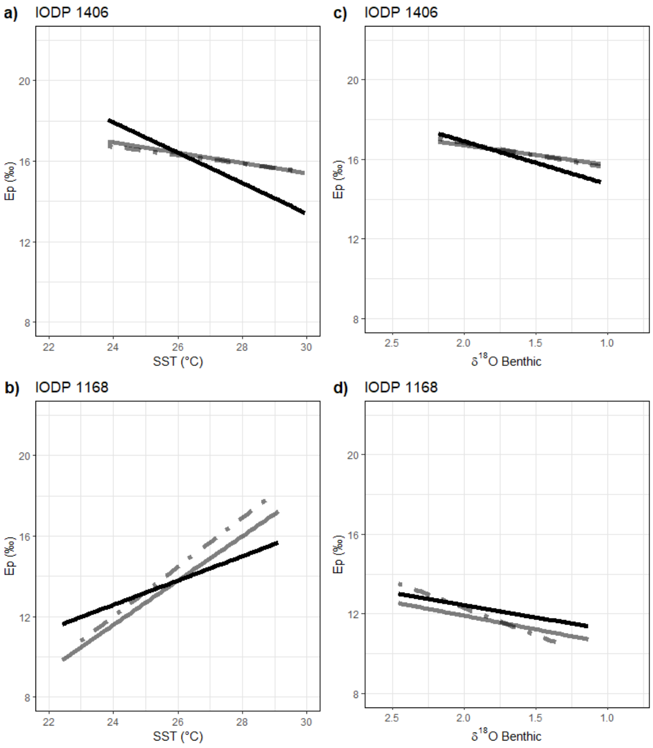

Figure S4. Relation between published εp estimates recalculated as described in text, and existing GDGTs-derived temperature reconstructions for same or nearby samples.

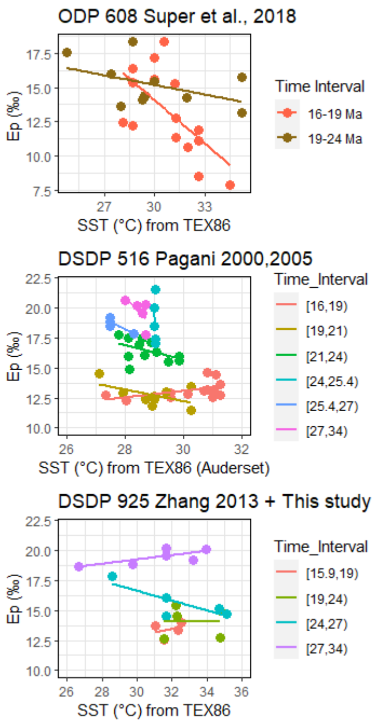

Table S1.
Differences between SST proxy between ZB-1 column and RTX-200 column measurement

	Proxy	av. diff. (°C)	Stdv.
IODP 1406 (subset)	$U^{k'}_{37}$	-0.6	0.4
	$U^{k'}_{38ME}$	-0.8	1.9
ODP 1168 <22.4 Ma	$U^{k'}_{37}$	-0.5	1.2
	$U^{k'}_{38ME}$	-1	0.7
ODP 1168 >22.4 Ma	$U^{k'}_{37}$	-1.8	1.7
	$U^{k'}_{38ME}$	-2.8	1.8

Differences between $\delta^{13}C$ alkenone between ZB-1 column and RTX-200 column measurement

		av. diff. (‰)	Stdv.
IODP 1406 (subset)	$\delta^{13}C$ alk	-0.2	0.9
ODP 1168 <22.4 Ma	$\delta^{13}C$ alk	-1.1	1
ODP 1168 >22.4 Ma	$\delta^{13}C$ alk	-3.7	1.6

Table S2

Site	***Source age model***	***Source SST***	***Source $\delta^{13}C$_alk***	***Source $\delta^{13}C$_DIC***
ODP 1168	Stoll *et al*., (2024)	Miocene = $U^{k'}_{37}$ This study Oligocene = $U^{k'}_{38ME}$ This study	This study	Bulk sed. -0.5 ‰
IODP 1406	Stoll *et al*., (2024)	$U^{k'}_{37}$ This study	This study	Bulk sed. -0.5 ‰
DSDP 516	Guitian *et al*., (2020)	TEX_{86} Auderset *et al*., (2022)	Pagani *et al*., (2005)	Miocene = Planktic foram. Oligocene = Benthic foram. + 2 ‰
ODP 608	CenCO2PIP Consortium, (2023)	TEX_{86} Super *et al*., (2018)	Super *et al*., (2018)	Planktic foram.
ODP 925	Guitian *et al*., (2020)	TEX_{86} Zhang *et al*., (2013) and this study	Zhang *et al*., (2013) and this study	Bulk sed. -0.5 ‰

Table S3

Slopes	IODP 1406							
	SST				Benthic			
Interval (Ma)	ε_p measured	ε_p temp	ε_p size	ε_p sum	ε_p measured	ε_p temp	ε_p size	ε_p sum
30 to 27	0.5	1	0.2	0.7	-0.5	-1	2	1.49
27 to 25.4	0.7	1.1	1	1.5	-2.8	-3.1	-3.7	-4.03
25.4 to 24	-0.2	0.3	-0.1	0.4	0.1	-0.9	1.8	0.70
24 to 22.5	-0.3	0.2	-0.7	-0.2	0.5	-1.2	1.9	0.14
22.5 to 19	0	0.5	-0.2	0.3	0.4	0.1	2.7	1.82
19 to 16	0.2	0.7	0.9	1.4	0.8	1.6	6.3	7.21
All	-0.75	-0.25	-0.71	-0.21	2.16	0.98	2.53	1.24

Slopes	ODP 1168							
	SST				Benthic			
Interval (Ma)	ε_p measured	ε_p temp	ε_p size	ε_p sum	ε_p measured	ε_p temp	ε_p size	ε_p sum
30 to 27	0.5	1	0.5	1				
27 to 25.4								
25.4 to 24	0.6	1.1	1.5	2				
24 to 22.5	-0.3	0.3	-1	-0.5				
22.5 to 19	-0.4	0.1	-0.9	-0.4				
19 to 16	-0.3	0.2	-0.3	0.2	-0.7	-0.2	-0.9	-0.4
All	0.6	1.1	0.7	1.2				