Supplement of Clim. Past, 21, 2115–2132, 2025
https://doi.org/10.5194/cp-21-2115-2025-supplement

Climate of the Past
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Supplement of

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

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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

Figure S1. High resolution IODP 1406 subset of measured $\delta^{13}C$ benthic foraminifera (red crosses), bulk carbonate (green circles), $C_{37.2}$ alkenone, calculated εp (where DIC $\delta^{13}C$ derived from bulk carbonate is solid line and circles, from benthic foraminifera transparent line and crosses), and SST.

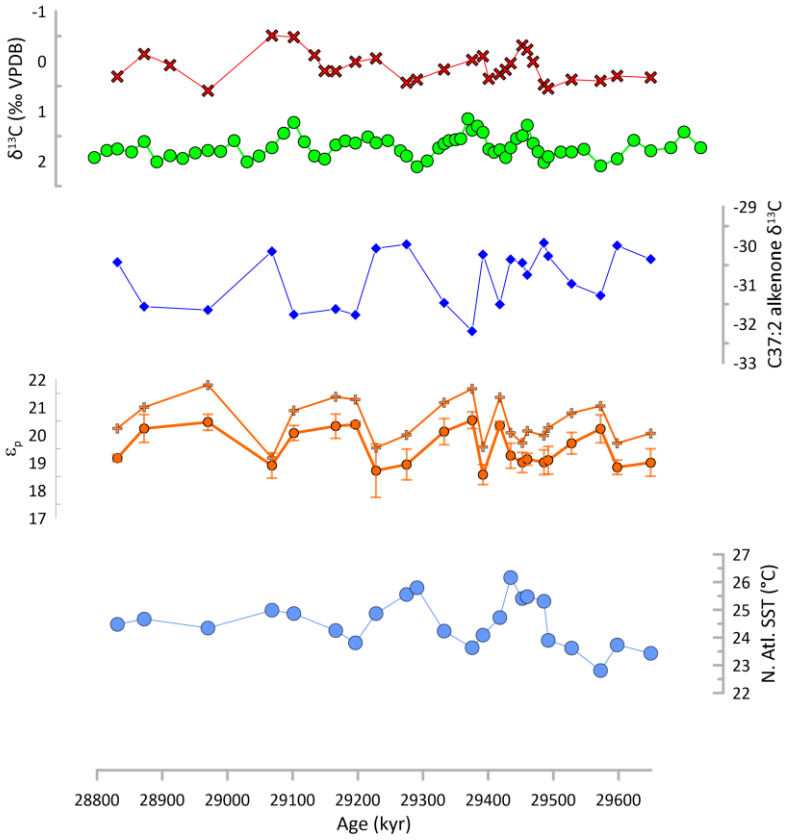

Table S2

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. -0.05 ‰
IODP 1406	Stoll *et al.*, (2024)	$U^{k'}_{37}$ This study	This study	Bulk sed. -0.05 ‰
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. -0.05 ‰

Figure S2. Measured biogenic silica vs SST from the same samples of IODP 1406 and ODP 1168. Dashed black line shows overall relation.

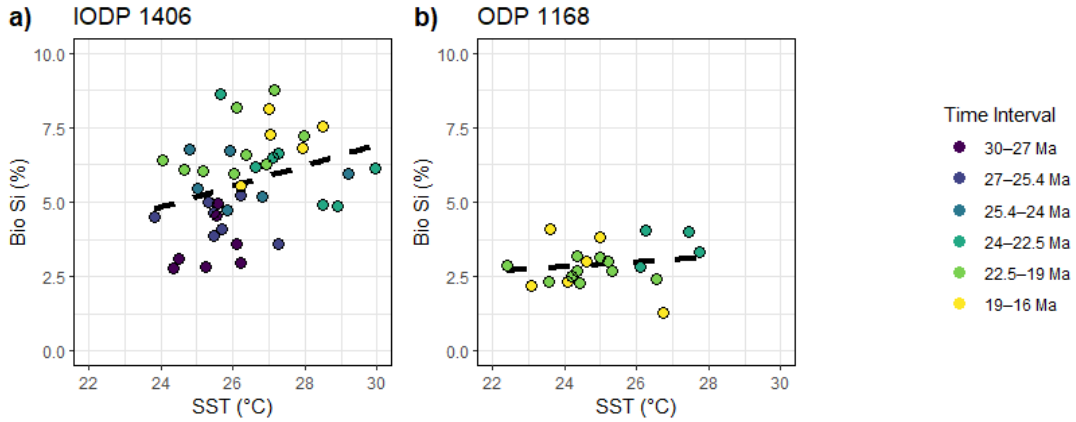

Table S3

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				

Figure S3. Entire studied period correlation regression lines, for the measured ε_p (solid), ε_p without the theoretical temperature effect (transparent), and ε_p without the temperature 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.***

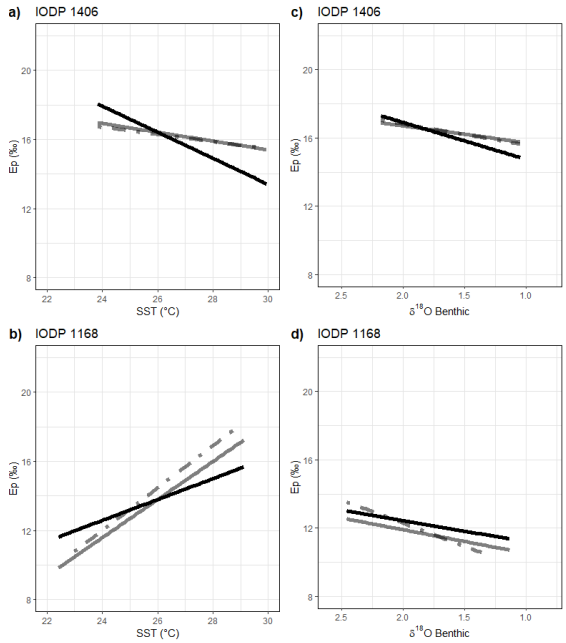

Figure S4. Relation between published ε_p estimates recalculated as described in text, and existing GDGTs-derived temperature reconstructions for same or nearby samples.