Supplement of 'The role of atmospheric CO_2 in controlling patterns of sea surface temperature change during the Pliocene'

S1. Impact of calibration choice

The impact of calibration choice does not affect the FCO2 on SST results (Fig. S1). Using the Müller et al. (1998) calibration of the $U_{37}^{K'}$ data and the BAYMAG calibration (Tierney et al., 2019) of the Mg/Ca data (both in McClymont et al., 2020), many of the same sites are represented and the range in FCO_2 on SST at individual proxy sites is not changed.

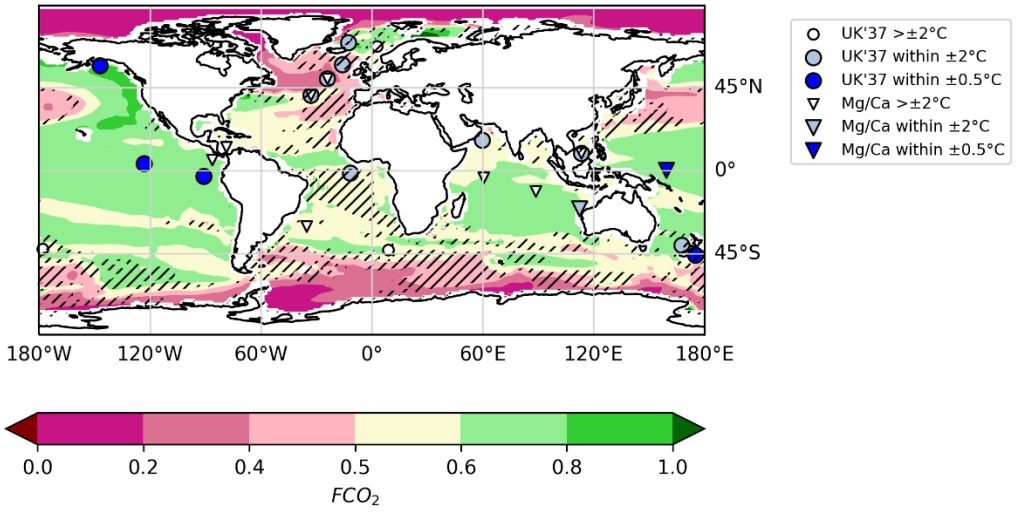

Figure S1: FCO_2 on SST MMM with proxy site locations. Proxy data is for KM5c presented in McClymont et al. (2020) and is either $U_{37}^{K'}$ data using the Müller et al. (1998) calibration (circles) or Mg/Ca data using the BAYMAG calibration (triangles). Seven sites with $U_{37}^{K'}$ data (Sicily Punta Piccola, U1387, ODP625, ODP1081, ODP1981, ODP1084 and ODP1087) and two sites with Mg/Ca data (DSDP603 and ODP959) are not shown as no FCO_2 on SST data is available due to the sites falling on land in the model Pliocene land-sea mask.

Four Mg/Ca sites are represented using the BAYMAG calibration that are not represented in the PlioVAR Mg/Ca calibration used in the main text: sites DSDP609, ODP709, ODP763 and ODP516. Only one additional $U_{37}^{K'}$ site is represented when using the Müller et al. (1998) calibration compared to the BAYSPLINE calibration (Tierney and Tingley, 2018) in the main text: site U1137.

CO_2 forcing remains dominant for almost all of the sites (21 of 23), with a maximum FCO2 on SST value of 0.82 at site U1417. The only sites predominantly driven by non-CO_2 forcing are consistent with the calibration choices for the main paper: site DSDP609 (0.27) and site ODP982 (0.44).

Commenting on the level of data-model agreement by calibration choice is beyond the scope of this paper, but there are approximately equal proportions of sites within ±0.5°C and ±2°C as in the main paper (Table S1).

Data-model agreement	Number of sites, by calibration			
	$U_{37}^{K'}$		Mg/Ca	
	BAYSPLINE	Müller et al. (1998)	PlioVAR	BAYMAG
< ±0.5°C	4 of 15	4 of 16	0 of 6	1 of 10
< ±2°C	7 of 15	9 of 16	1 of 6	1 of 10
> ±2°C	4 of 15	3 of 16	5 of 6	8 of 10

Table S1: Number of sites with levels of data-model agreement by calibration. Data-model agreement within ±2°C does not include the sites within ±0.5°C. The BAYSPLINE, Müller et al. (1998) and BAYMAG data for KM5c are presented in McClymont et al. (2020); the PlioVAR Mg/Ca data are in McClymont, Ho et al. (2023).

S2. FCO_2 on SST by model at the six proxy sites with uncertainty in FCO_2

Site	FCO_2 on SST by model					
	CCSM4-UoT	CESM2	COSMOS	HadCM3	MIROC4m	NorESM1-F
ODP662	0.47	0.44	0.90	0.32	0.71	0.70
DSDP607 / U1313	0.81	0.25	1.49	3.23	0.02	0.43
ODP982	0.59	0.28	0.75	0.25	0.66	0.34
ODP1143	0.48	0.45	0.91	0.57	1.54	0.46
DSDP594	0.49	0.37	-0.75	0.81	0.84	1.24

Table S2: FCO_2 on SST by model at sites with uncertainty in the dominant forcing (i.e., three or fewer of the models agree whether $FCO_2 < 0.5$ or $FCO_2 > 0.5$).

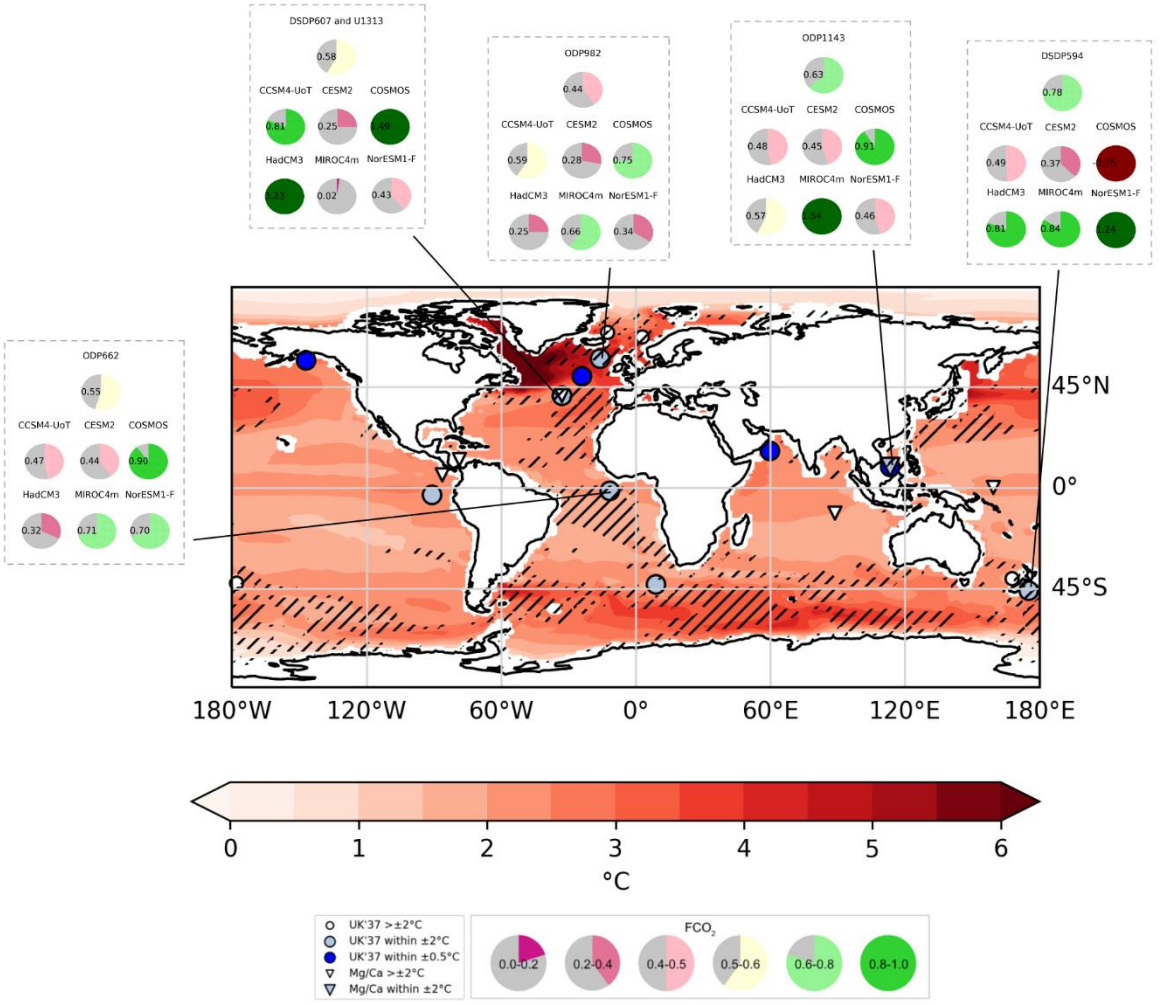

Figure S2: MMM Eoi^{400}-E^{280} SST anomaly, represented by the background red shading. The MMM is comprised from CCSM4-UoT, CESM2, COSMOS, HadCM3, MIROC4m and NorESM1-F. Hatching represents uncertainty in FCO_2, where three or fewer of the six models agree on the dominant forcing (i.e., whether $FCO_2 < 0.5$ or $FCO_2 > 0.5$). The shape of the overlying symbols denotes the type of proxy data at each site (circle = $U^{K'}_{37}$, triangle = Mg/Ca); and the colour represents the level of data-model agreement (darker = stronger agreement). All proxy data is for KM5c.

The FCO_2 on SST is represented by pie charts at each proxy site where there is good data-model agreement (i.e., the MMM Eoi^{400}-E^{280} SST anomaly is within ±2°C of the proxy data SST anomaly) and uncertainty in FCO_2 (i.e., three or fewer of the models agree whether $FCO_2 < 0.5$ or $FCO_2 > 0.5$). The pie chart at the top of each box is the MMM, with the FCO_2 on SST in each of the six models shown individually below. The proportion of the pie chart that is coloured denotes the proportion of total change attributable to CO_2 forcing (the FCO_2), also represented by the colour.

S3. Sampling densities at proxy sites with site names

	$U_{37}^{K'}$ sites		Mg/Ca sites	
n	**KM5c**	**PRISM3**	**KM5c**	**PRISM3**
n ≤ 5	ODP907, DSDP593, DSDP607, ODP1143, U1417, ODP1090, ODP982, DSDP594	DSDP610*	DSDP214, ODP806, ODP1241, ODP999, U1313	DSDP214
5 < n ≤ 25	ODP846, DSDP609, ODP722, ODP642, ODP1125, U1313, ODP662	DSDP593, U1417, ODP999	ODP1143	ODP806
25 < n ≤ 50	-	ODP907, ODP1090	-	ODP1241, ODP999, U1313
50 < n ≤ 100	-	ODP642, ODP662, DSDP607, U1307*, ODP982, DSDP609, U1313, ODP1143, ODP846, DSDP594	-	ODP1143
n > 100	-	ODP1125, ODP722	-	-

Table S3: Sampling densities at proxy sites. Note that two sites (U1313 and ODP1143) have $U_{37}^{K'}$ and Mg/Ca data available for both KM5c and the PRISM3 interval, and a further site (ODP999) has only Mg/Ca data available for KM5c but both Mg/Ca and $U_{37}^{K'}$ data available for the PRISM3 interval. Sites marked with an asterisk (*) only have PRISM3 interval data available (no data is available for KM5c).

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