

Supplementary Information For DeepMIP: Model
intercomparison of early Eocene climatic optimum
(EECO) large-scale climate features and comparison with
proxy data

January 12, 2021

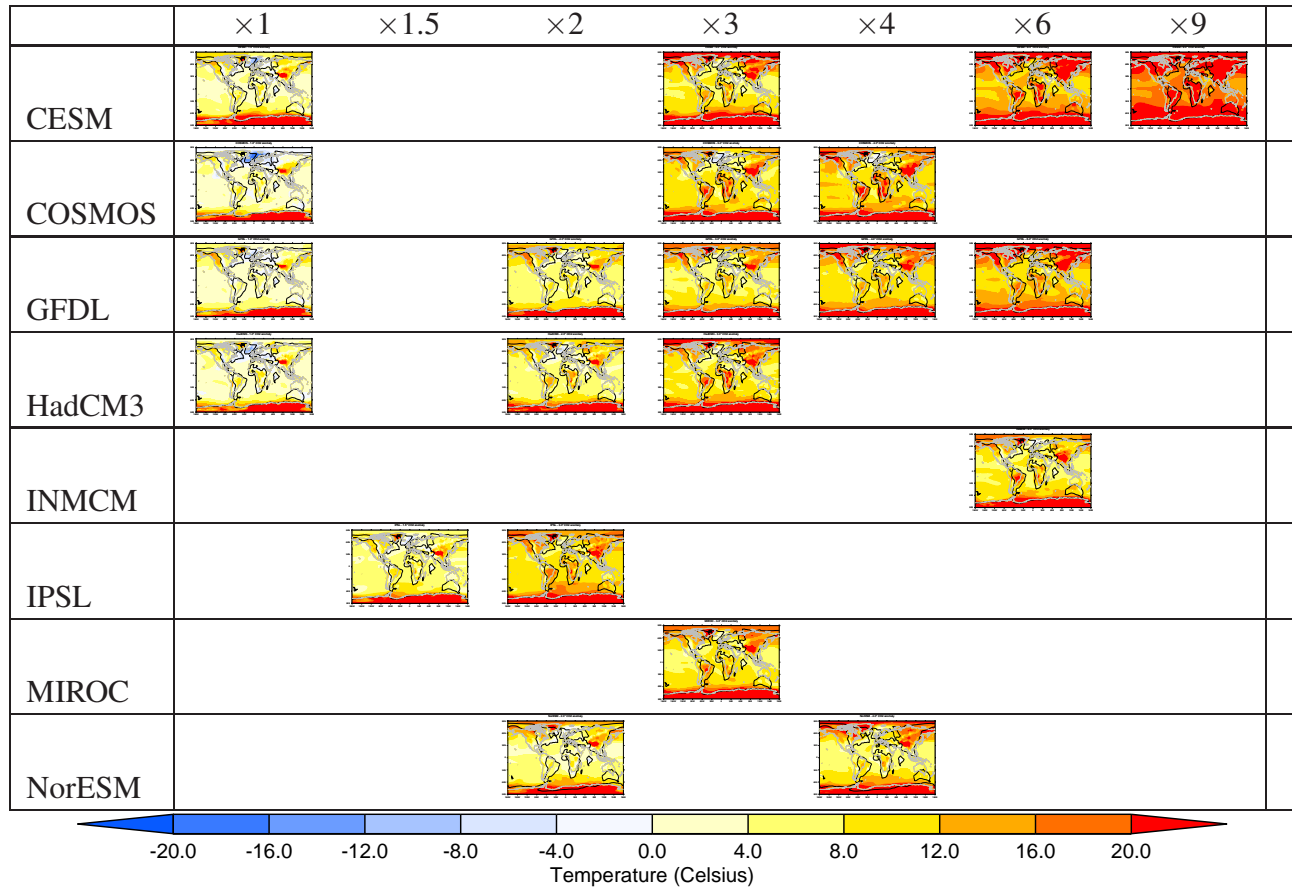


Figure S1: As Figure 3 in the main paper, but the variable plotted is $GAT_e^m - GAT_p^m$, and we include Eocene simulations with CO_2 below $\times 2$. The Eocene continental outline is shown in black and the modern is in grey.

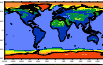
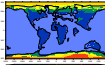
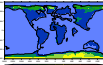
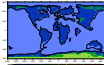
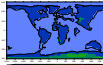
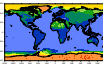
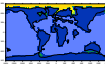
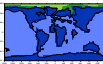
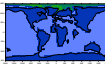
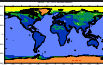
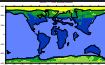
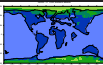
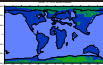
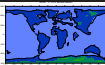
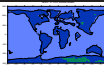
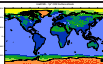
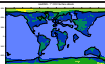
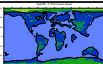
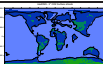
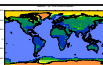
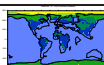
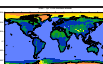
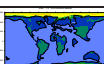

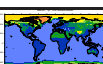
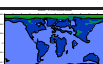
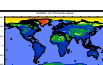
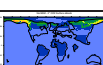

	PI	$\times 1$	$\times 1.5$	$\times 2$	$\times 3$	$\times 4$	$\times 6$	$\times 9$
CESM								
COSMOS								
GFDL								
HadCM3								
INMCM								
IPSL								
MIROC								
NorESM								

Figure S2: Surface albedo in each of the DeepMIP preindustrial and Eocene simulations.

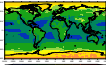
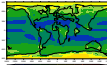
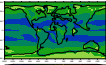
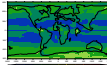
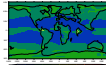
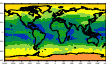
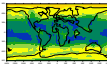
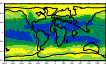
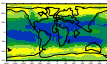
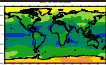
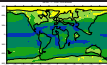
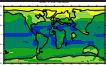
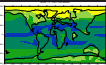
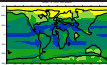
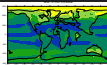
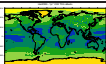
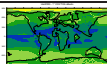
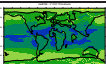
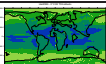
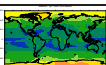
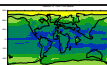
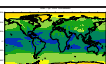
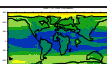
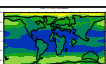
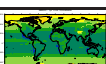
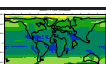
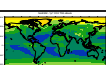
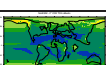
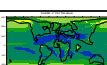
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CESM								
COSMOS								
GFDL								
HadCM3								
INMCM								
IPSL								
MIROC								
NorESM								

Figure S3: Planetary albedo in each of the DeepMIP preindustrial and Eocene simulations.

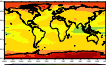
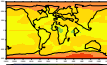
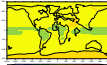
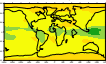
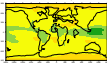
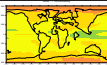
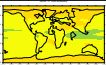
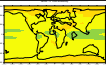
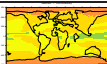
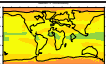
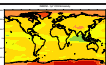
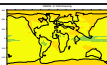
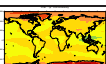
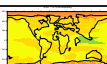
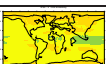
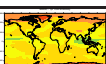
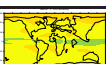
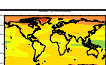
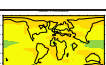
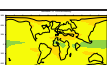
	PI	$\times 1$	$\times 1.5$	$\times 2$	$\times 3$	$\times 4$	$\times 6$	$\times 9$
CESM								
COSMOS								
GFDL								
HadCM3								
INMCM								
IPSL								
MIROC								
NorESM								

Figure S4: Emissivity in each of the DeepMIP preindustrial and Eocene simulations.

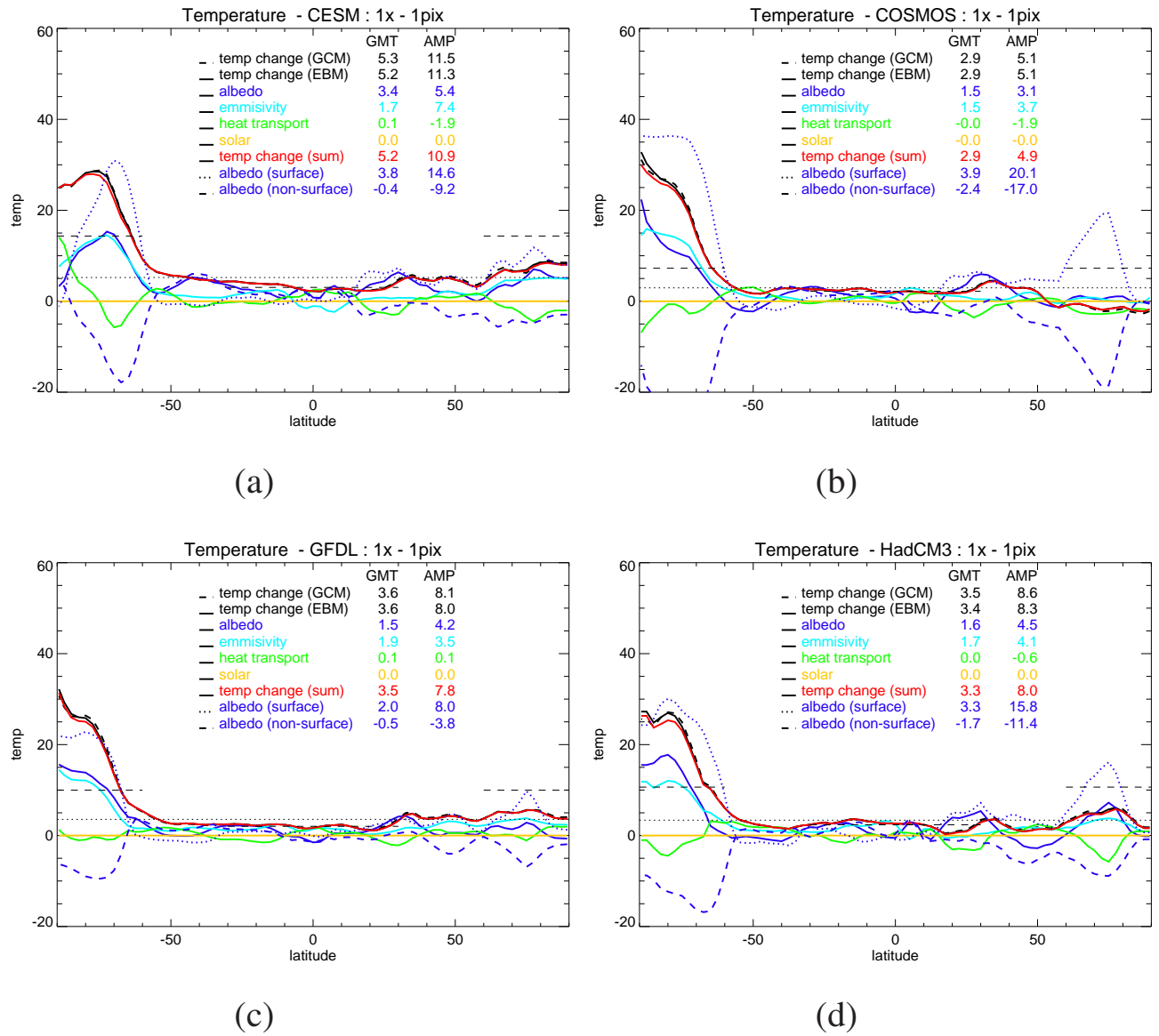


Figure S5: As Figure 4 in the main paper, but for $\times 1$ minus preindustrial rather than $\times 3$ minus preindustrial, and only for those models that carried out simulations at $\times 1$ and $\times 3$.

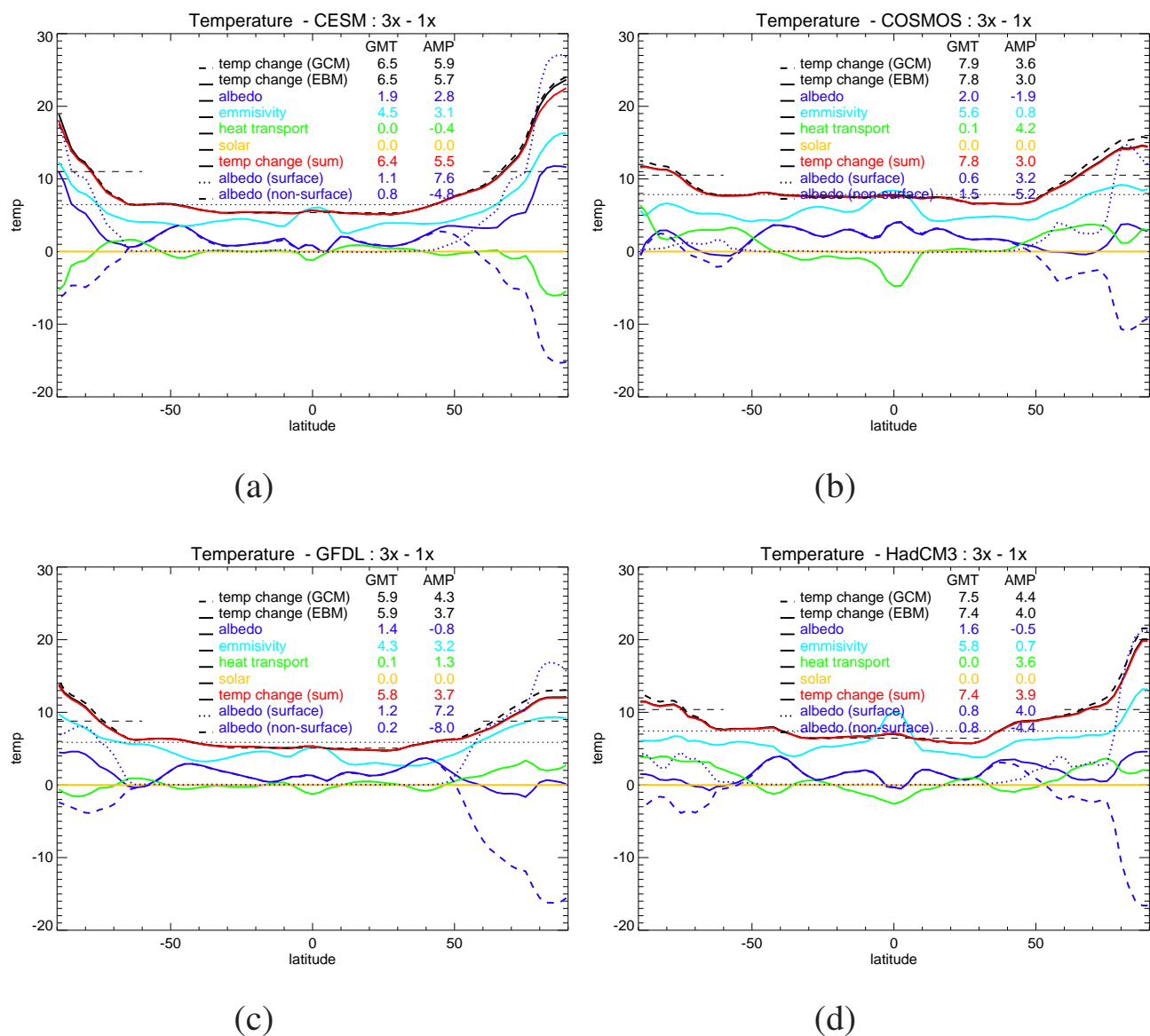


Figure S6: As Figure 4 in the main paper, but for $\times 3$ minus $\times 1$ rather than $\times 3$ minus preindustrial, and only for those models that carried out simulations at $\times 1$ and $\times 3$.

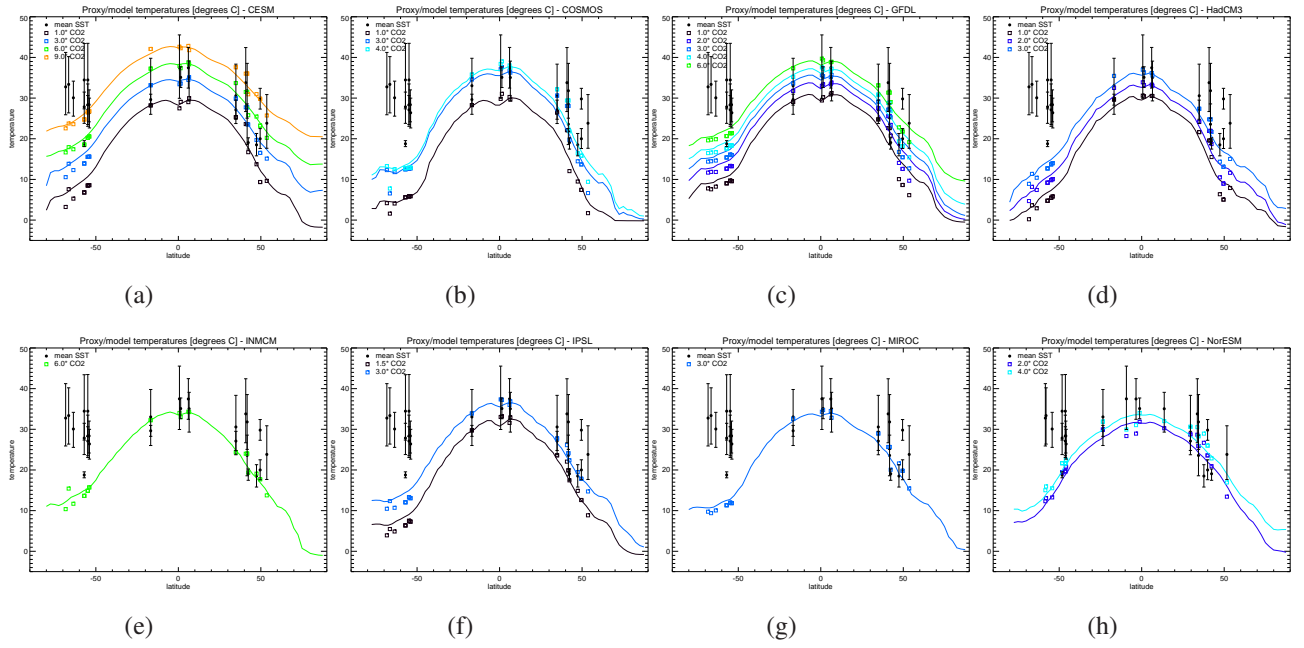


Figure S7: Zonal mean Eocene sea-surface temperatures (SST) in each DeepMIP model, for each CO₂ simulation carried out. EECO SST proxies from [Hollis *et al.*(2019)] are shown as black circles with error bars, and the modelled SST at these locations are shown as coloured squares.

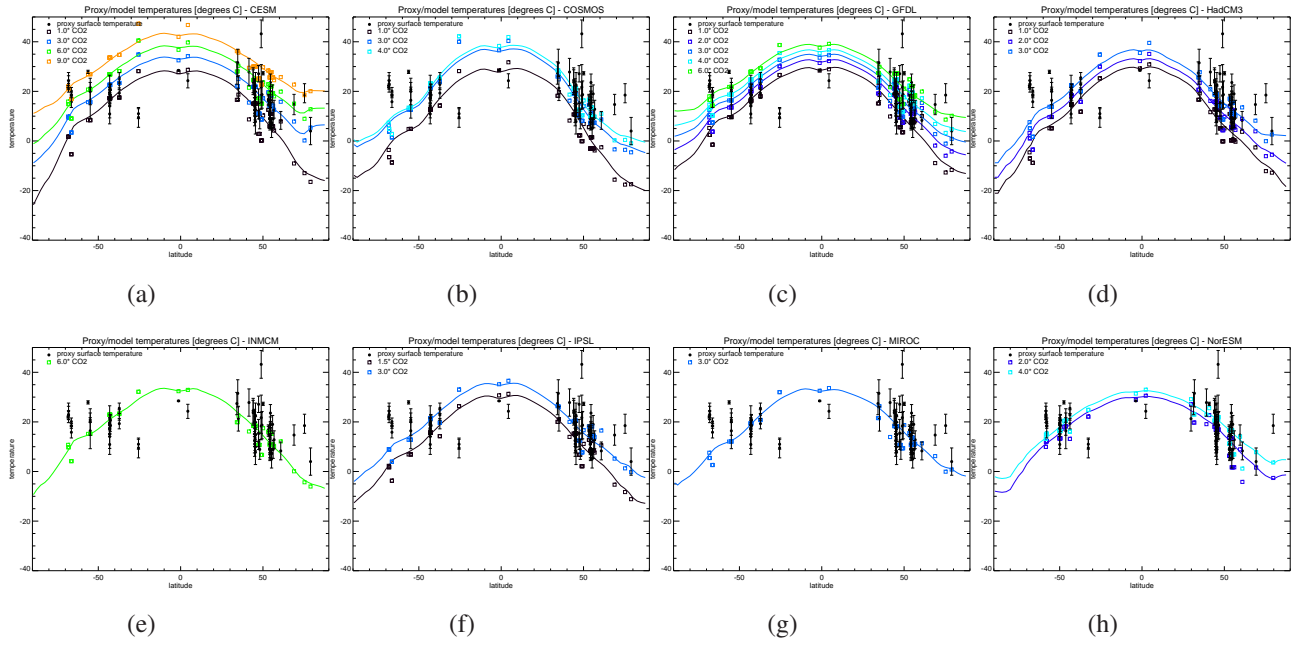


Figure S8: Zonal mean Eocene near-surface air temperatures (SAT) in each DeepMIP model, for each CO₂ simulation carried out. EECO SAT proxies from [Hollis *et al.*(2019)] are shown as black circles with error bars, and the modelled SAT at these locations are shown as coloured squares.

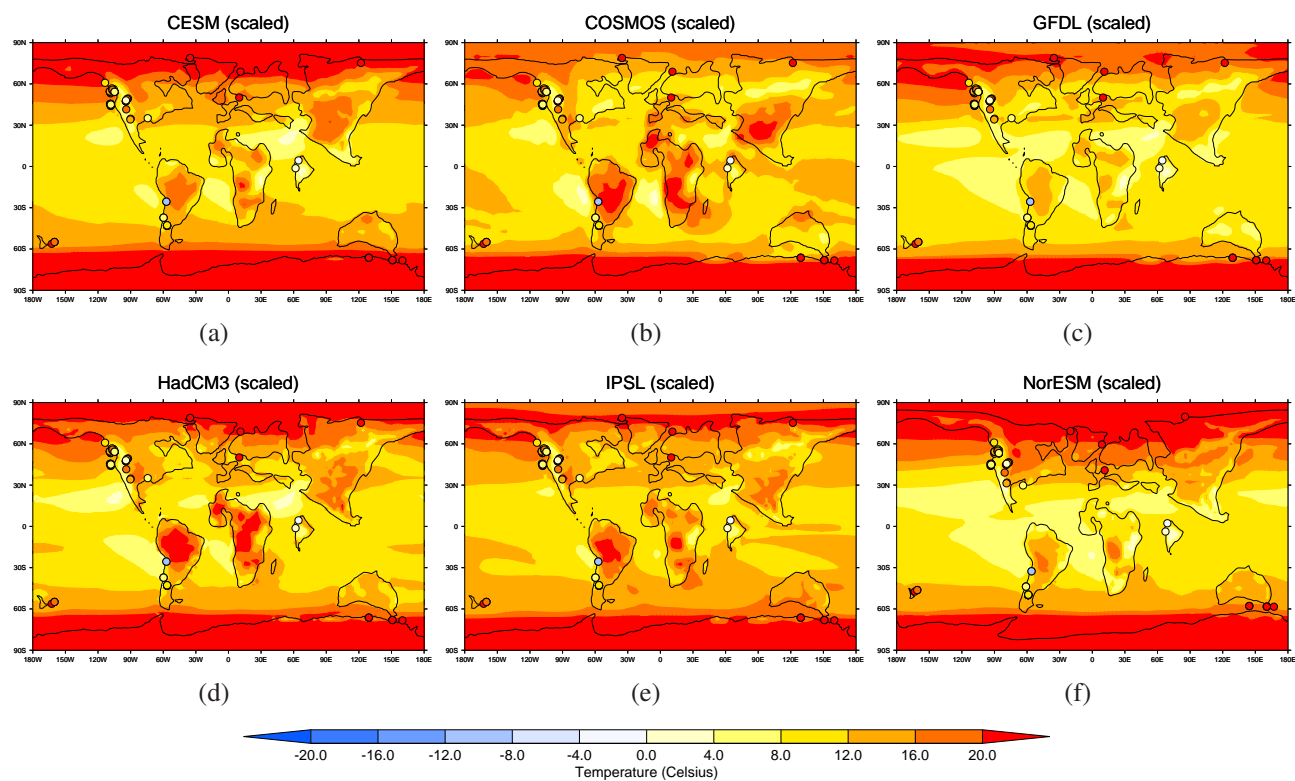


Figure S9: As Figure 5 in the main paper, but for near-surface air temperatures from models and proxies instead of SSTs.

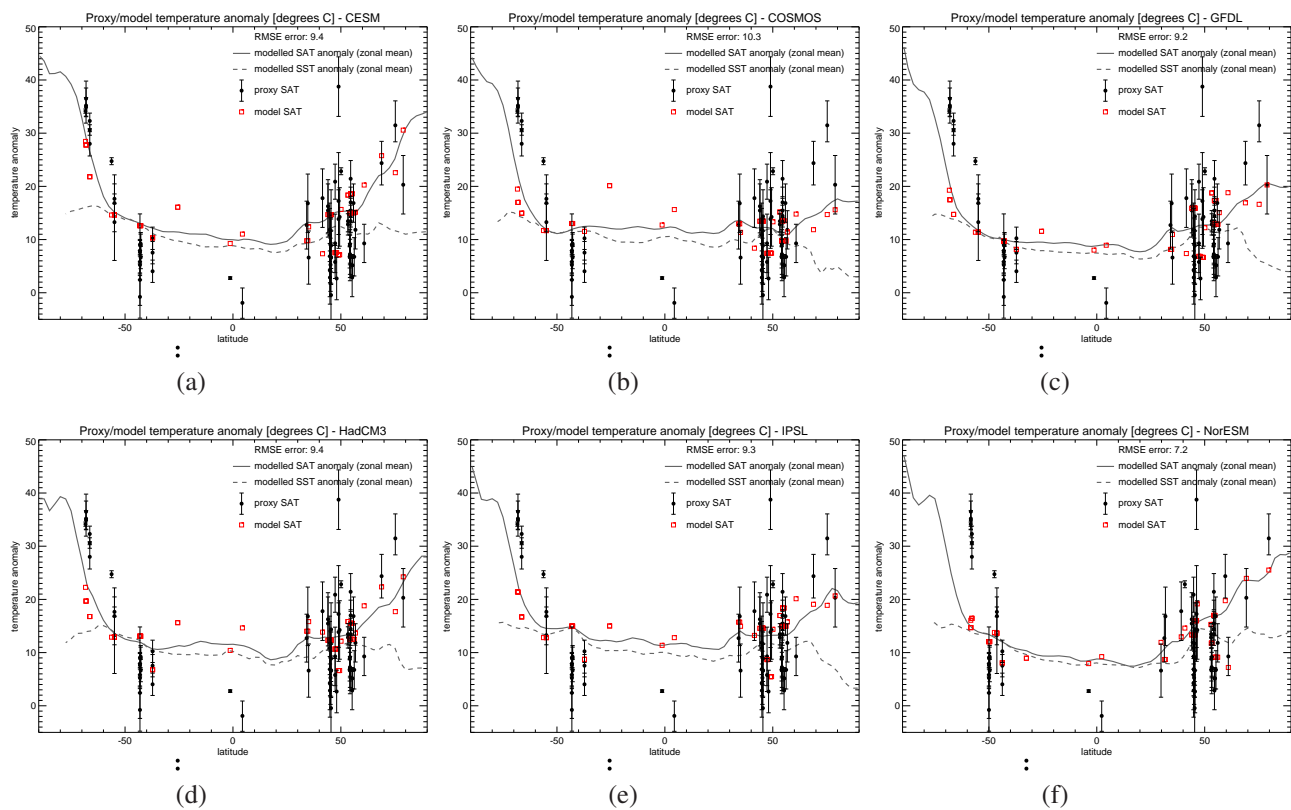


Figure S10: As Figure 6 in the main paper, but for near-surface air temperatures from models and proxies instead of SSTs.

Model	CO ₂	length [years]	TOA [Wm ⁻²]	Trend [°C/century]	PI TOA [Wm ⁻²]	PI trend [°C/century]
CESM	×1,×3,×6,×9	2000+	−0.25,−0.32,0.34,0.64	0.06,−0.11,−0.01,0.04	−0.05	−0.01
COSMOS	×1,×3,×4	8500,9500,8500	1.91,1.78,1.95	0.07,0.04,−0.26	1.75	−0.05
GFDL	×1,×2,×3,×4,×6	6000	0.10,−0.08,−0.14,−0.19,−0.28	0.018,0.049,−0.016,0.05,0.011	0.31	0.012
HadCM3	×1,×2,×3	>4000 + 2950	−0.02,−0.08,−0.08	−0.06,−0.18,0.21	−0.08	−0.04
INMCM	×6	1150	2.87	−0.1	4.37	0.01
IPSL	×1.5,×3	4000	0.59,0.76	0.05,0.04	0.08	−0.01
MIROC	×3	5000	0.93	0.08	0.96	0.00
NorESM	×2,×4	2100,2000	0.03,0.24	0.00,0.02	−0.02	−0.01

Table S1: Information on spinup of the DeepMIP Eocene simulations, including the length of simulation, the climatological TOA energy imbalance at the end of the simulation, and global mean near-surface air temperature trend. The temperature trend is calculated as the average of the final 100 years of the simulation minus the 100 years before that, to give a trend per century. The exception is HadCM3 for which the trend is calculated as the average of the final 50 years of the simulation minus the 50 years before that, and multiplied by two to give a trend per century. Also shown are the TOA imbalance [Wm⁻²] and trend [°C/century] for the associated preindustrial (PI) simulation. The PI trends are calculated in the same way as for the Eocene trends, apart from for NorESM, which is a reported value calculated over the last 1000 years, and divided by 10 to give a trend per century.

surface type	region [° latitude]	mean temperature difference [°C]
global	-90 to 90	14.0989
global	-30 to 30	10.9590
global	+90 to +-60	12.9766
global	-90 to -60	30.4559
global	-60 to -30	13.5576
global	-30 to 0	11.4765
global	0 to 30	10.5202
global	30 to 60	14.6240
global	60 to 90	21.5664
land	-90 to 90	16.4419
land	-30 to 30	14.6890
land	+90 to +-60	14.2471
land	-90 to -60	41.0243
land	-60 to -30	9.48574
land	-30 to 0	15.8816
land	0 to 30	13.7946
land	30 to 60	15.7113
land	60 to 90	20.8675
ocean	-90 to 90	13.0000
ocean	-30 to 30	9.97039
ocean	+90 to +-60	12.3579
ocean	-90 to -60	22.8349
ocean	-60 to -30	13.7086
ocean	-30 to 0	10.3929
ocean	0 to 30	9.60428
ocean	30 to 60	12.9857
ocean	60 to 90	22.4782
ocean (seaice=-1.8 °C)	-90 to 90	13.0078
ocean (seaice=-1.8 °C)	-30 to 30	9.97039
ocean (seaice=-1.8 °C)	+90 to +-60	12.3661
ocean (seaice=-1.8 °C)	-90 to -60	22.8370
ocean (seaice=-1.8 °C)	-60 to -30	13.7086
ocean (seaice=-1.8 °C)	-30 to 0	10.3929
ocean (seaice=-1.8 °C)	0 to 30	9.60428
ocean (seaice=-1.8 °C)	30 to 60	12.9857
ocean (seaice=-1.8 °C)	60 to 90	22.6652

Table S2: Table of metrics for the ensemble of post-EoMIP simulations that were carried out at CO₂ concentrations that fall within the observations; i.e. CCSM.K, GFDL (at ×4 and ×6), CESM (at ×6 and ×9), NorESM, COSMOS, and INMCM. Mean near-surface air temperature difference is expressed as Eocene minus preindustrial.

References

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