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Supplement of

More is not always better: delta-downscaling climate model outputs from 30 to 5 min resolution has minimal impact on coherence with Late Quaternary proxies

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SOM. 1 Energetic cost of movement calculation.

First, we calculate the slope m of the terrain from the altitude z and the distance between cell centres d for each pair of cells i and j in the global relief map from ETOPO2022 (NOAA National Centres for Environmental Information, 2022):

$$m_{ij} = (z_j - z_i)/d_{ij}$$

We then transformed the slope (m) raster into values of energy expenditure (Joules per metre per second for an average 60kg person) following Minetti *et al.* [4]. This formula accounts for the fact that there are different energetic costs (cw) associated with moving on flat ground vs 10° slopes compared to 10° and 20° slopes, despite the difference in slope being the same.

$$cw = 60 \cdot \left((280.5m^5) - (58.7m^4) - (76.8m^3) + (51.9m^2) + (19.6m) + 2.5\right)$$

Supplementary figures

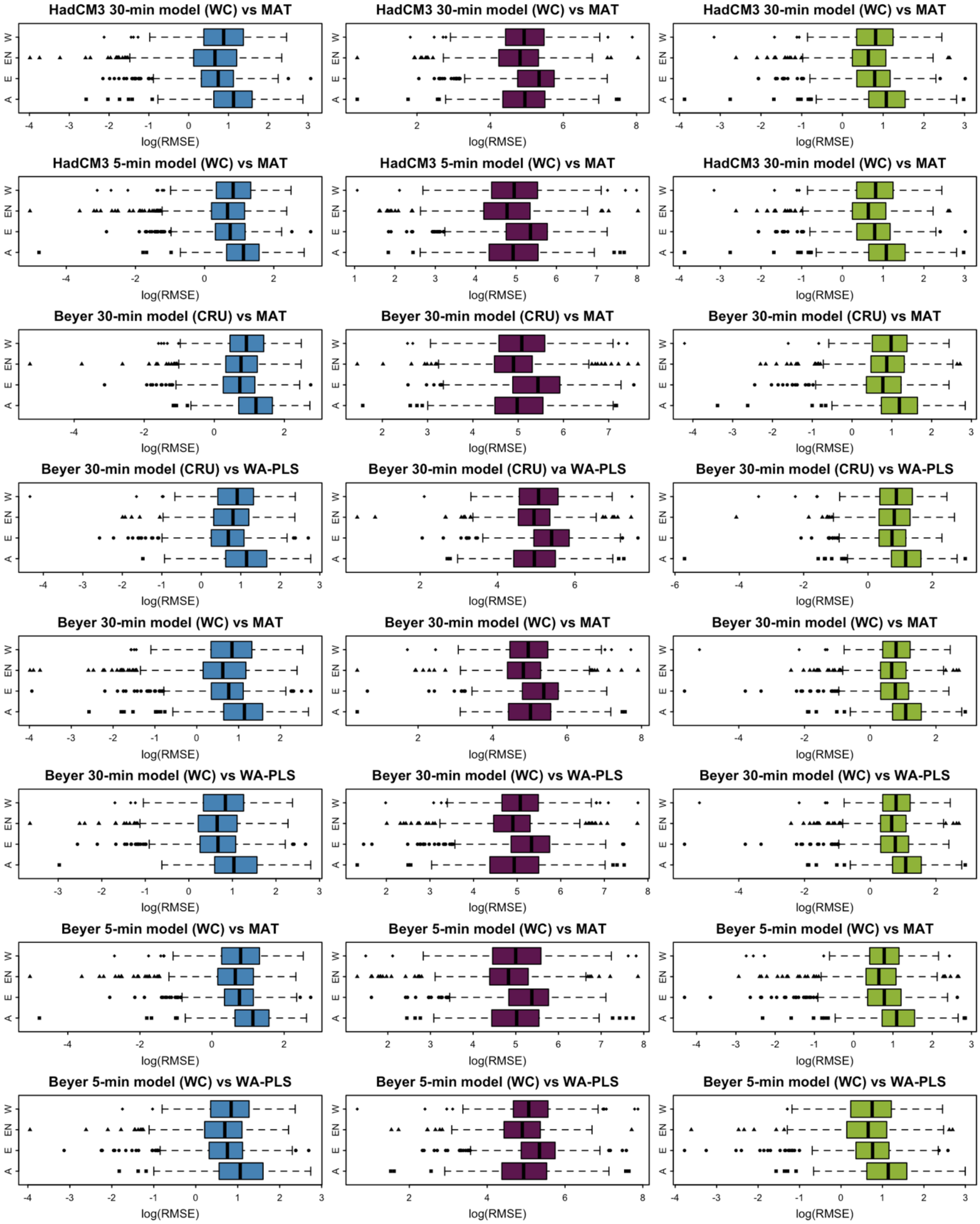

Figure S1. Boxplots of pair-wise log root mean square error (RMSE) results model-data comparisons of mean annual temperature (blue), mean annual precipitation (purple) and mean July temperature (green) from those in Asia (A), East North America (ENA), West North America (WNA) and Europe (Eu).

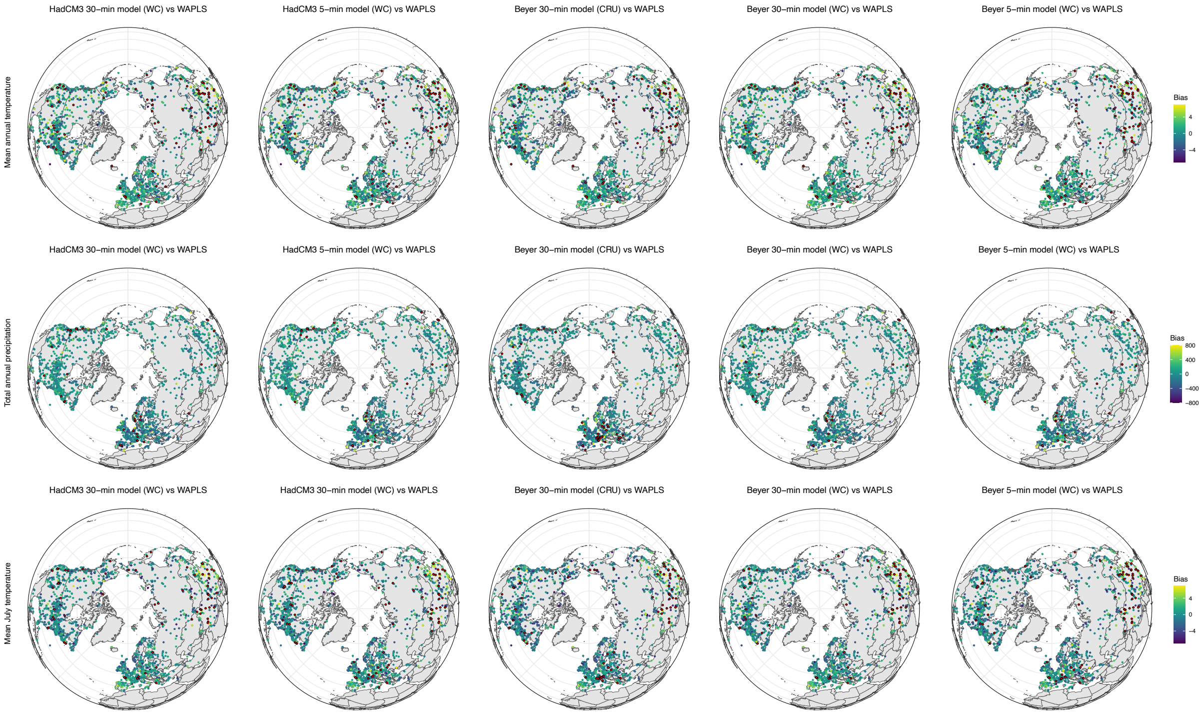

Figure S2. Absolute bias for mean annual temperature, mean annual precipitation, and mean July temperature for each proxy site, comparing the climatic values produced by the WA-PLS method of proxy reconstruction against different versions of the HadCM3 GCM and Beyer et al. (2020a) model. Extreme outliers have been highlighted in red, defined as < -7 and > 7 degrees Celsius for mean annual temperature and July temperature, and < -800 and > 800 millimetres for total annual precipitation.

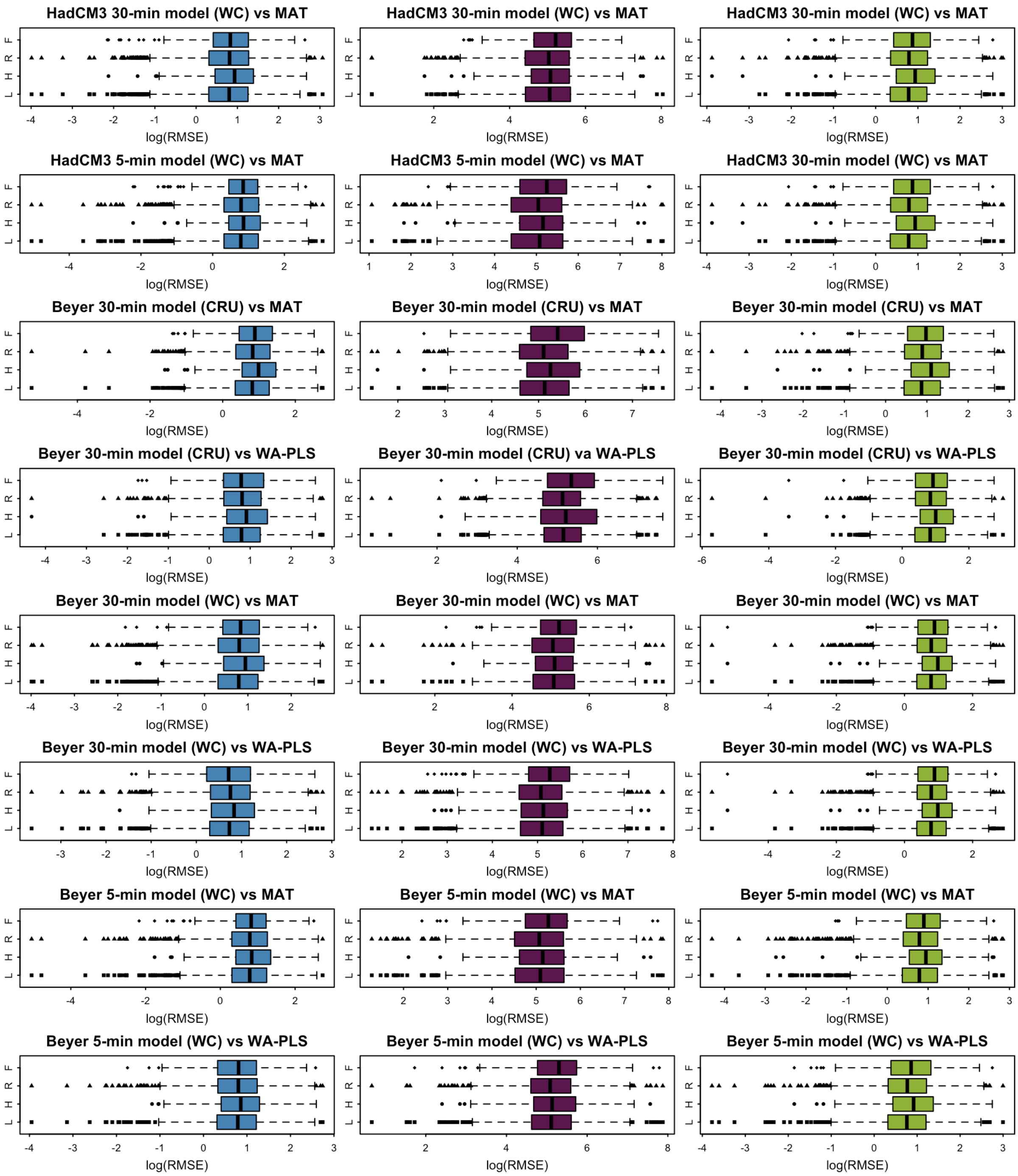

Figure S3. Boxplots of pair-wise log root mean square error (RMSE) results model-data comparisons of mean annual temperature (blue), mean annual precipitation (purple) and mean July temperature (green) from those in low altitude (L), high altitude (H), topographically flat (F) and topographically rough (R) landscapes.

Supplementary Tables

Table S1. Proportion of proxy records (reconstructed using the MAT and WA-PLS methods) that show higher error with lower resolution (30-min) models compared to the downscaled model (5-min). Those where the proportion is higher than 0.5 (and therefore highlights a net positive effect of downscaling) are in bold. Any comparisons deemed to be statistically significant ($p < 0.05$) are denoted with an asterisk (*)

	30-min model output	Proxy method	All	Europe	Asia	West North America	East North America	Present	MIS 1	MIS 2	High altitude	Low altitude	High roughness	Low roughness
Annual temperature	Beyer (CRU)	MAT	**0.51**	0.42	**0.53**	**0.59**	**0.58**	**0.59**	**0.50**	**0.57**	**0.60**	0.49	**0.53**	**0.50**
		WA-PLS	**0.50**	0.42	**0.52**	**0.53**	**0.60**	**0.52**	0.49	**0.56**	**0.53**	0.49	**0.50**	**0.50**
	Beyer (WC)	MAT	0.49	0.47	**0.51**	**0.52**	**0.50**	**0.55**	0.48	**0.55**	**0.54**	0.48	**0.51**	0.49
		WA-PLS	0.47	0.44	0.49	**0.50**	0.48	**0.51**	0.46	**0.51**	**0.51**	0.46	0.46	0.47
	HadCM3 (WC)	MAT	0.49	0.47	**0.51**	**0.54**	0.48	**0.55**	0.49	**0.52**	**0.54**	0.48	**0.51**	0.49
		WA-PLS	0.46	0.48	0.48	0.49	0.47	**0.51**	0.46	**0.51**	**0.52**	0.45	0.47	0.46
Annual precipitation	Beyer (CRU)	MAT	**0.55**	**0.58**	0.49	**0.52**	**0.57**	**0.62**	**0.56**	0.46	**0.56**	**0.55**	**0.57**	**0.55**
		WA-PLS	**0.55**	**0.57**	**0.51**	**0.51**	**0.57**	**0.55**	**0.55**	0.47	**0.56**	**0.55**	**0.55**	**0.55**
	Beyer (WC)	MAT	0.48	0.49	0.48	0.44	**0.51**	**0.53**	0.48	0.45	0.44	0.49	0.42	**0.50**
		WA-PLS	0.48	0.49	0.47	0.46	0.49	**0.51**	0.48	0.49	0.42	0.49	0.45	0.48
	HadCM3 (WC)	MAT	0.48	0.47	0.45	0.45	**0.52**	**0.53**	0.48	0.42	0.44	0.48	0.44	0.49
		WA-PLS	0.48	0.48	0.47	0.45	0.49	**0.51**	0.48	0.47	0.42	0.59	0.42	**0.50**
July Temperature	Beyer (CRU)	MAT	**0.58**	**0.53**	**0.50**	**0.65**	**0.67**	**0.65**	**0.57**	**0.54**	**0.60**	**0.57**	**0.57**	**0.58**
		WA-PLS	**0.56**	**0.51**	**0.52**	**0.62**	**0.63**	**0.58**	**0.55**	**0.56**	**0.57**	**0.56**	**0.54**	**0.56**

Beyer	MAT	0.47	0.45	0.44	**0.51**	**0.59**	0.49	0.46	**0.51**	0.49	0.47	0.46	0.47
(WC)	WA-PLS	0.47	0.46	0.44	0.49	0.48	0.46	0.46	**0.52**	0.47	0.47	0.45	0.47
HadCM3	MAT	0.49	0.49	0.48	**0.51**	0.47	**0.50**	0.48	**0.52**	0.49	0.48	0.48	0.48
(WC)	WA-PLS	0.47	0.47	0.46	**0.50**	0.48	0.47	0.46	**0.50**	0.46	0.48	0.48	0.47