EGU21-11047
https://doi.org/10.5194/egusphere-egu21-11047
EGU General Assembly 2021

Reconstructing the surface temperature fields of the Last Glacial Maximum and mid-Pliocene Warm Period using climate models and data.

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We present new reconstructions of global climatological temperature fields for the Last Glacial Maximum and the mid-Pliocene Warm Period.

The method is based on an Ensemble Kalman Smoother which combines globally complete modelled temperature fields, with sparse proxy-based estimates of local temperature anomalies. This ensures spatially coherent fields which respect physical principles and which are also tied closely to observational estimates.

For the Last Glacial Maximum, we use the full set of PMIP2/3/4 model simulations, and we combine this with a wide range of proxy-based SST and SAT estimates of local temperature to ensure the best possible global coverage. Our reconstruction has a global mean surface air temperature anomaly of -5.3 +- 0.9C relative to the pre-industrial climate, and thus lies roughly half-way between the estimates of Annan and Hargreaves (2013) and Tierney et al (2020). We examine the reasons for these differences and discuss their implications.

For the mid-Pliocene Warm Period, we use the PlioMIP 1 and 2 model simulations and the PRISM proxy estimates for the 3.2 Ma time slice. These data are considerably more sparse and uncertain than for the LGM and our reconstruction is correspondingly more uncertain. We obtain an estimate of 5.6 +- 1.6C which is considerably warmer than most previous estimates, suggesting a significant discrepancy between the models and the data. We investigate the reasons for this and discuss the implications.