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Climate change between the Medieval Warm Period and the Little Ice Age: Model–data comparison between CMIP5/PMIP3 last millennium simulations and available temperature proxy records

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We present a model–data comparison between the CMIP5/PMIP3 last millennium simulations and available individual temperature proxy records from across the globe. Our focus is to investigate the agreement in amplitude of the simulated and the reconstructed temperature difference between the Medieval Warm Period (MWP, here defined as AD 950–1250) and the Little Ice Age (LIA, here defined as AD 1400–1700). An emphasis is placed on analysing to what extent the high latitude and continental amplification of the temperature signal is the same in the model simulations as in the proxies. We further discuss to what extent the models have captured the spatial signatures that is shown in the proxy data.

We have collected 125 calibrated proxy records – representing either annual mean, winter or summer temperature – extending back to at least AD 950. The proxies include data from a wide range of archives: ice-cores, marine and terrestrial sediments, tree-rings, speleothems and historical records. Only proxies with at least two observations per century were included. We calculated the amplitude of change between the MWP and the LIA in the individual proxy records using the temperature calibrations by the original authors. The last millennium simulations from 8 different models in CMIP5 database are used to compare with the proxy records.

This model–data comparison reveals that the ensemble mean and median of the models mostly underestimate the amplitude of temperature difference between the MWP and the LIA as estimated from the proxy records at those locations where proxy records exist. The relative lack of proxy data from the tropics and the Southern Hemisphere, however, precludes a fully comprehensive model–data comparison. We also note large differences between the model simulations both in amplitude of the temperature change and in their spatial patterns. The use of an ensemble mean or median of the model simulations emphasizes the averaged signature within the model ensemble. We observe an average tendency for the models to overestimate the magnitude of the Arctic amplification as compared to the proxies. On the other hand, the models underestimate the coastal–continental temperature gradient compared to the proxies.