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Reconstruction of the extra-tropical NH mean temperature over the last millennium with a method that preserves low-frequency variability

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A new multi-proxy reconstruction of the Northern Hemisphere extra-tropical mean temperature over the last millennium is presented. The reconstruction is based on a set of 40 proxies of both annual and decadal resolution that have been shown to relate to the local temperature.

The reconstruction is performed with a novel method, LOC, that has been designed to avoid the underestimation of low-frequency variability that has been a general problem for regression based reconstruction methods. The new method reconstructs the local temperatures at the locations of the proxies. The reconstruction is based on one-dimensional linear regression with the local temperature as the independent variable and the proxy as the dependent variable. The local reconstructed temperatures are then averaged to get the NH mean temperature. While this method preserves low-frequency variability, the drawback is an exaggerated high-frequency variability. This adverse effect can be dampened by temporal averaging and decreases with the number of proxies.

The new reconstruction shows a very cold Little Ice Age centered around the 17th century with a cold extremum (for 50-year smoothing) of about 1.1 K below the temperature of the calibration period, AD 1880-1960. This cooling is about twice as large as corresponding numbers reported by most other reconstructions. In the beginning of the millennium the new reconstruction shows small anomalies in agreement with previous studies. However, the new temperature reconstruction decreases faster than previous reconstructions in the first 600 years of the millennium and has a stronger variability. The salient features of the new reconstruction are shown to be robust to changes in the calibration period, the source of the local temperatures, the spatial averaging procedure, and the screening process applied to the proxies.

An ensemble pseudo-proxy approach is applied to estimate the confidence intervals of the 50-year smoothed reconstruction showing that the period AD 1500-1850 is significantly colder than the calibration period.