

SUPPLEMENTAL MATERIAL

Warming-induced positive age trends challenge MXD detrending

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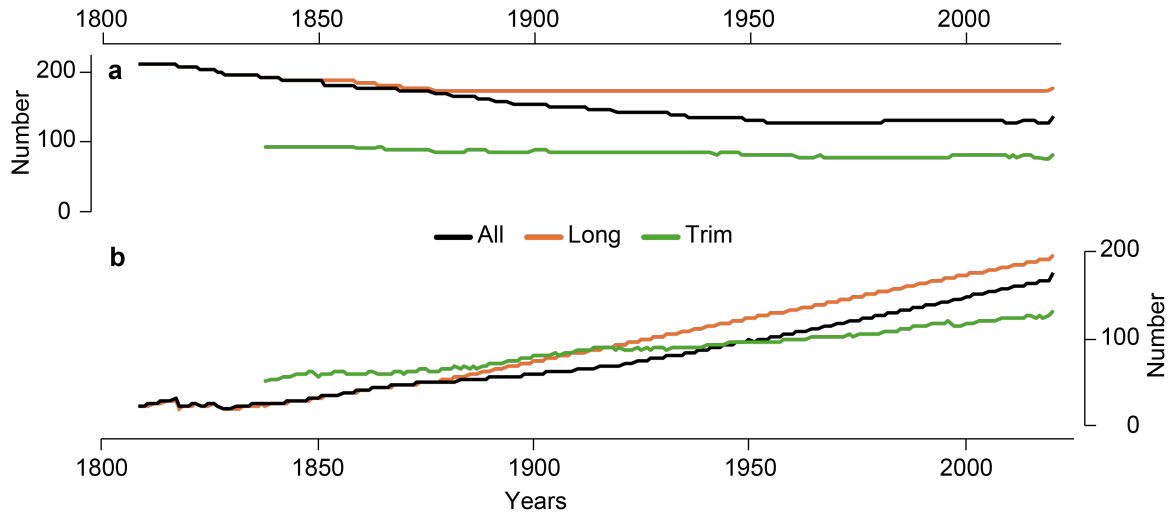


Fig. S1 Harz MXD data characteristics. Segment length curves (a) and mean age curves (b) of the All, Long, and Trim datasets.

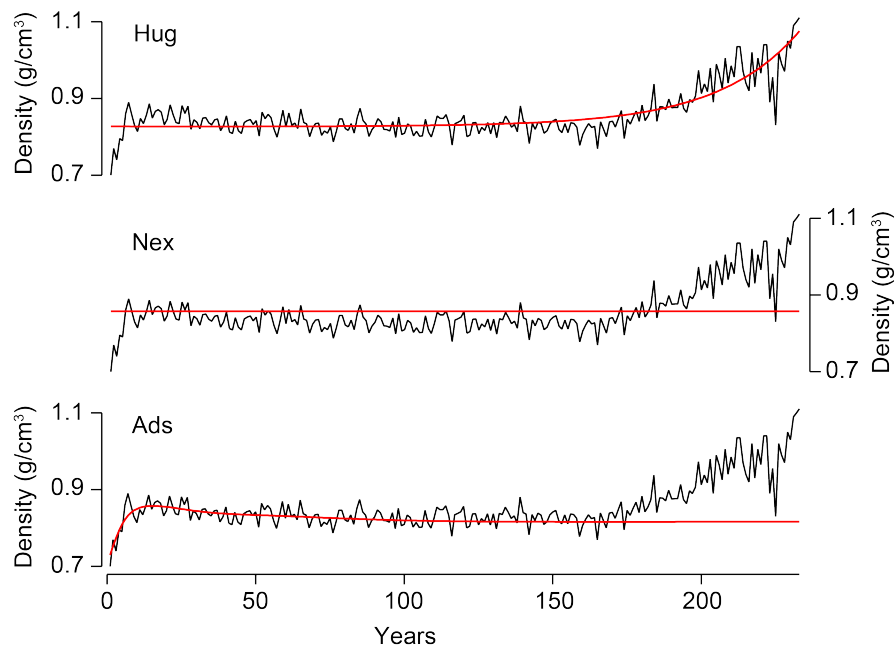


Fig. S2 Detrending examples. Arstan curve fits (red) when selecting Hegershoff (Hug), negative exponential (Nex), and age-dependent spline detrending (Ads), all fitted to a random MXD series (black). Hug allows positive curve fits. Nex is a replacement by a linear regression with zero slope. Ads starts as a 10-year spline and excludes positive slopes with aging.

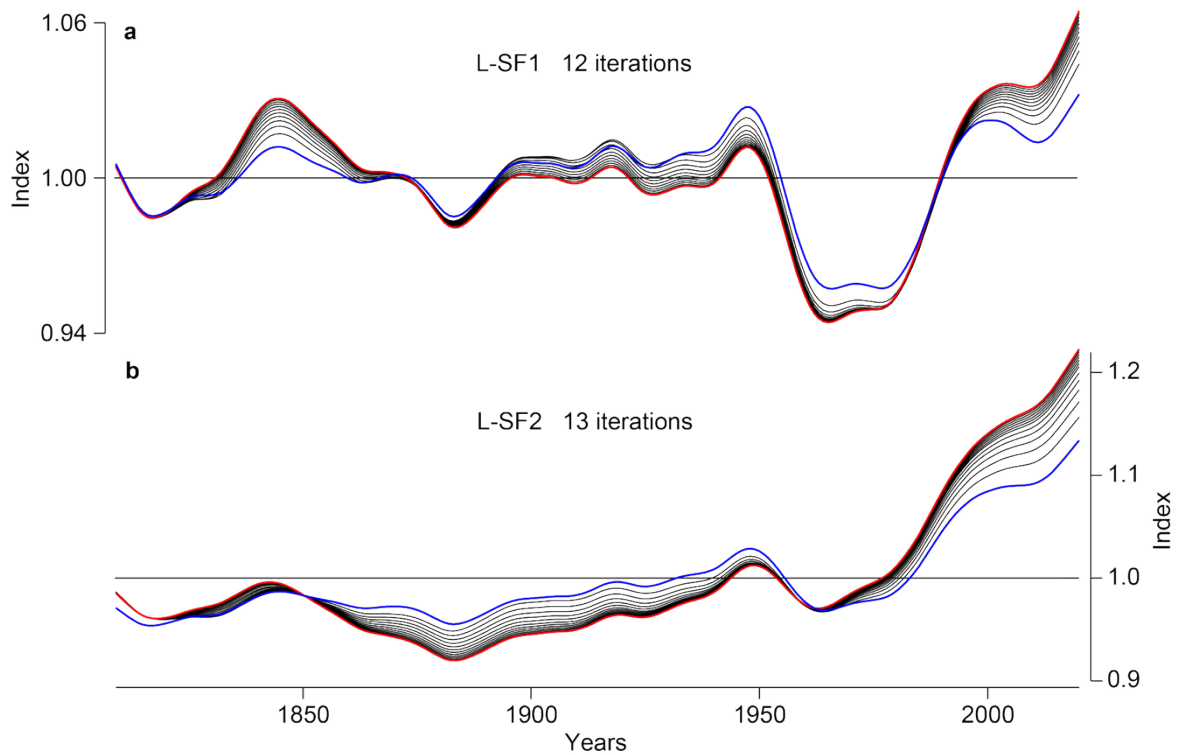


Fig. S3 Signal Free detrending iterations. **a**, L-SF1 detrending derived from using 50-year age-dependent splines including positive slopes with the Long dataset. The original chronology is shown in blue, the final L-SF1 chronology after 12 iterations in red. **b**, Same as in **a**, but using age-dependent splines without positive slopes (L-SF2).

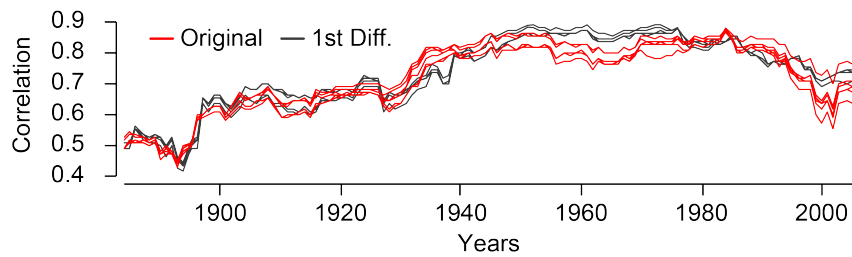


Fig. S4 Thirty-year running correlations of six differently detrended chronologies against April-September mean temperatures since 1870 CE (red). Black curves are running correlations using 1st differenced proxy and instrumental data.

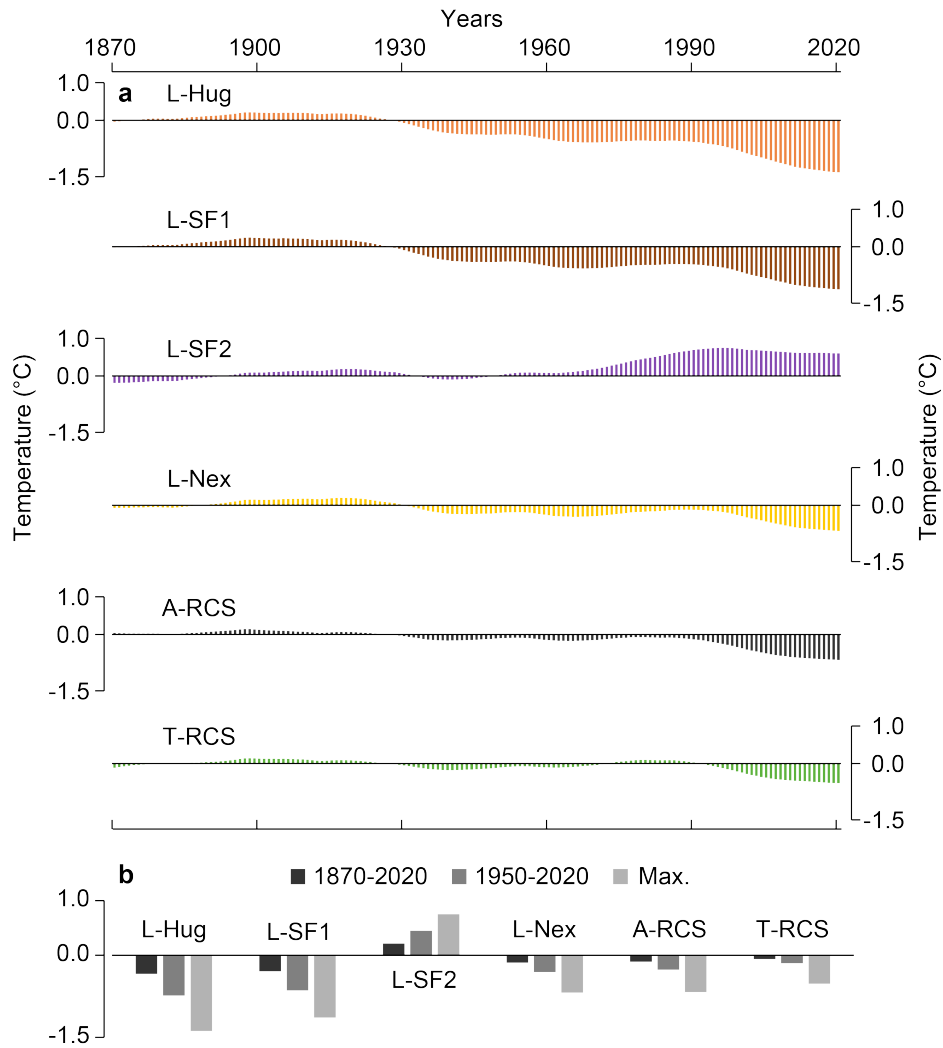


Fig. S5 Temperature-proxy residuals. **a**, Residuals between smoothed April-September temperatures and L-Hug, L-SF1, L-SF2, L-Nex, A-RCS, and T-RCS chronologies as shown in **Fig. 4b**. Average residuals over the 1870-2020 CE (dark grey) and 1950-2020 CE (grey) periods, as well as maximum residual recorded towards the recent ends of the timeseries (1996 CE in L-SF2).

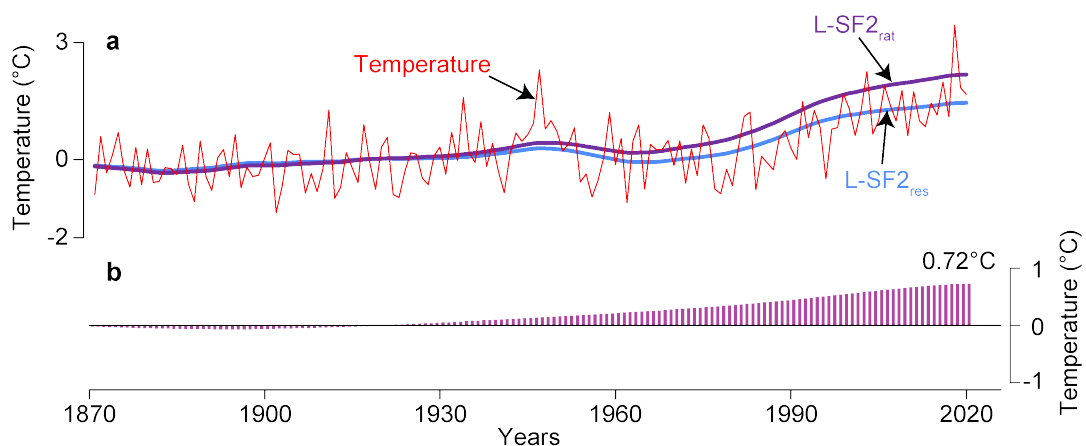


Fig. S6 Signal free residuals. **a**, April-September temperatures (red) shown together with the 30-year smoothed L-SF2 chronologies computed using ratios ($L-SF2_{rat}$, purple) and residuals ($L-SF2_{res}$, blue). **b**, Residuals between the smoothed chronologies reaching a maximum of 0.72°C in 2020.