Supporting Online Material:

European seasonal and annual temperature variability, trends, and extremes since 1500

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Materials and Methods

Review of recent publications dealing with European surface temperature reconstructions

In their large-scale Northern Hemisphere (NH) temperature reconstructions (*S1, S2*) pointed out that there is a decrease of the number of eigenvectors resolved prior to 1760, which leads to a greater spatial smoothing and thus to less resolved high-frequency variance at continental spatial scales. Consequently, in order to accurately reproduce the spatial pattern within regions, an extensive and dense enough proxy network is required to capture several of the principal eigenvectors. (*S2*) published annual, boreal cold and warm seasonal spatial charts back to 1730. The authors pointed to the fact, that the reconstructed annual and seasonal mean (the latter have considerably greater uncertainties) have higher reliability at the European scale than at the grid-point scale, because of the spatial smoothing implicit in a truncated EOF basis set. (*S3*) used a multi-proxy data set to reconstruct an area summer temperature average for Europe back to 1761. (*S4*) presented decadal averaged European temperature back to 1400 based on five regional proxy series. (*S5*) used a combination of documentary proxy evidence, European and Moroccan tree-ring data and δ^{18}O data from Greenland to provide annual temperature estimates from 1068-1979 for the area 35°N-55°N and 10°W-20°E.

Prior to the late-17th/early-18th century, documentary evidence provides the most reliable source of independent reconstructions of seasonal temperature (e.g. *S6, S7, S8, S9, S10*). Documentary evidence (scientific writings, narratives, annals, monastery records, direction of cloud movement, wind direction, warm and cold spells, phenological information, freezing of water bodies, droughts and floods, e.g. *S7, S8, S10*) is a proxy for past climate and, just like natural archives (trees, ice cores, corals, etc.), must be calibrated against overlapping instrumental records so that it may be expressed on an equivalent scale (*S9, S10*).
'Calibration' of documentary data is achieved by the use of a 'scaling or grading' procedure. Documentary evidence has traditionally been grouped (generally for each season, but sometimes for individual months when possible) into a number of 'categories' ranging from the coldest to the warmest (*S9*). The number of categories is determined subjectively by the amount and quantity of the documentary evidence available (see extensive discussion in *S6, S7, S9, S10, S11*).
(*S12, S13*) provided summer temperature maps back to the mid 18th century using only tree-ring data. With a larger tree-ring data set and more sophisticated methods (*S14*) reconstructed averaged northern and southern European growing season (April-September) temperature series back to the 17th century. Additionally, (*S15*) published maps of estimated April-September mean temperature for each year between 1600 and 1887 for parts of the NH, including Europe. Except for (*S5, S14*) these European scale estimates were provided without corresponding uncertainties in the reconstructions.

Reconstruction method, calibration/verification experiments, data

Multivariate principal component regression was used for the monthly (back to 1659) and seasonal (four values per year; 1500-1658) European surface land-temperature fields (25°W-40°E; 35°N-70°N). This method places a greater weight on specific proxy series that exhibit greatest affinity with the 20th century large-scale instrumental record (*S1, S16, S17, S18*). In this study, we followed the method described in detail in (*S17*).
In order to reconstruct the gridded surface temperature for a given month (post 1659 period), we first identified all available predictors (instrumental temperature and pressure data and documentary proxy evidence; Fig. S1A, B) for which data were available for that particular month. Second, the same predictors from the first step, together with the two other months from the same climatological season (i.e. summer is June, July, August; winter is December, January, February) are selected and used for a multivariate calibration against the instrumental record (*S19*). Third, the leading Empirical Orthogonal Functions (EOFs) of the predictor data

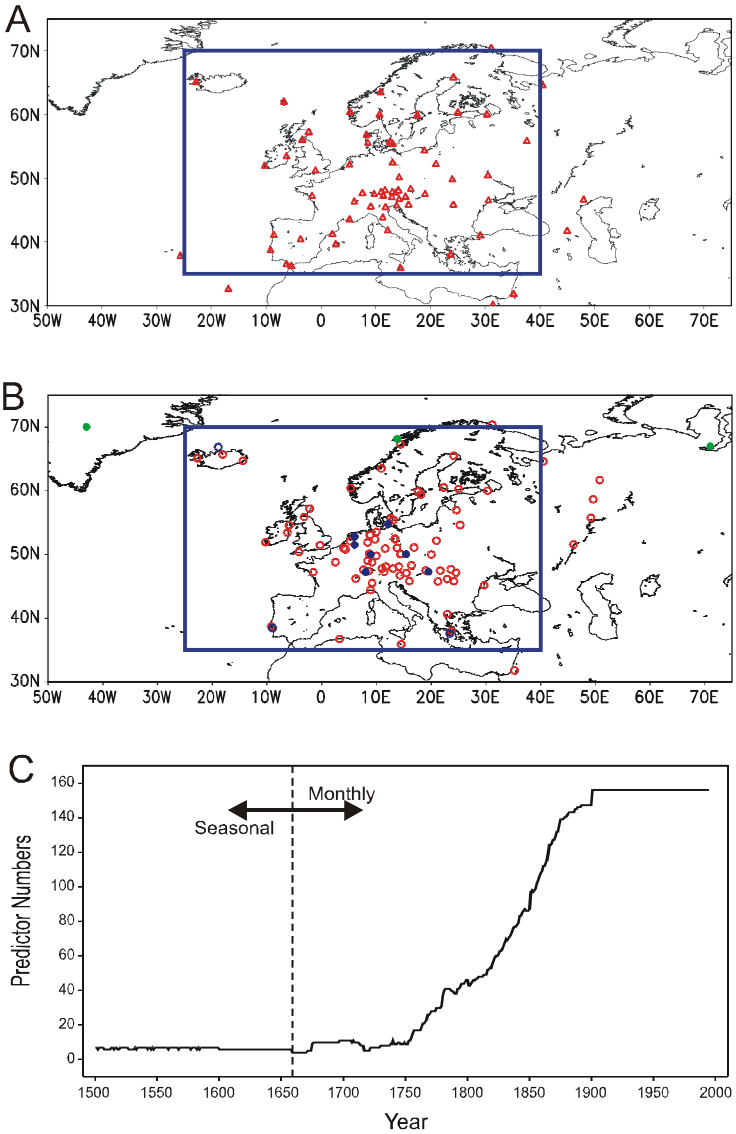
accounting for 95% of the variance and the leading EOFs of the gridded (0.5°x0.5°) instrumental data (*S19*) explaining 90% of the total European land-surface temperature variability were calculated for the 1901-1960 calibration period. The calculation of the EOFs was undertaken to separate the dominant spatial patterns of variability, accounting for a substantial fraction of the predictors and predictands variances, from noise and irrelevant details. Fourth, a multivariate regression was performed regressing each of the grid-point EOFs of the calibration period in turn against all the retained EOFs of the predictor data. We estimated the regression coefficients by using the least square method. The predictors of the verification period were transformed exactly the same way as the predictors of the calibration period and then put in the regression equation. The resulting predictions were transformed back on the original temperature scale (in °C).

The method only assumes that each predictor exhibits a linear relationship with one or more of the EOFs of the instrumental record, and not that the proxy itself necessarily be a temperature record (e.g. *S18*). Fifth, the quality of the reconstructions was tested by applying the multivariate regression model to independent data for the verification period 1961-1995. The number of predictors changes through time (Fig. S1 C), thus we applied a nested procedure with around 400 models to be calibrated/verified for the monthly reconstructions. The skill of each of the monthly models was assessed for the period 1961-1995 by the Reduction of Error (RE) (*S20*) statistic, which is the expected proportion of the variance of the predictand, given by the predictor. The range of RE is (-∞, +1) with a zero value representing the skill of climatology (i.e. mean) and increasingly positive RE representing increased regression skill. A RE of +1 is a perfect reconstruction, whereas RE<0 indicate no useful information in the reconstructions (*S20*).

For the seasonal (four values per year) reconstructions from 1500 to 1658, the same calibration/verification procedure was applied but regressing the seasonal means of the grid-point EOFs in turn against all the retained seasonal predictors EOFs. In this case 32 series of equations for the different predictor network were developed.

Finally, to guarantee as much recent variability within the reconstruction models, we established transfer functions over the full period 1901-1995 for each of the nested models in order to reconstruct the pre-1900 surface air temperature fields (monthly back to 1659 and seasonal 1500-1658). The temperature fields comprise 5050 grid-points at a spatial resolution of around 60 kilometres (0.5°x0.5°).

In order to ensure that the model verification results are not statistical artefacts of small sample sizes of the calibration and verification periods within the 1901-1995 period, we performed analyses with the calibration period 1936-1995 and the verification period 1901-1935. The results did not change significantly and thus indicate a stable quality of our reconstructions. Considering decadal variability in surface temperature, experiments have also been conducted with 20, 25 and 30-year calibration periods that were then verified with the remaining years. Similar reconstruction skills have been achieved for these experiments (not shown).



***Supplemental Figure S1**: (A) station pressure locations (red triangles) and surface temperature sites (B, red circles) used to reconstruct the monthly European temperature fields (25°W-40°E; 35°N-70°N given by the rectangular blue box). Blue circles indicate documentary monthly-resolved data, blue dots represent documentary information with seasonal resolution back to 1500. Green dots stand for seasonally resolved temperature proxy reconstructions from tree-ring and ice core evidence. (C) Number of predictors through time.*

In addition, no notable changes in the regression results were found when applying different EOF truncations in the predictor and predictand fields. The same has been found by (*S17*) in the large-scale sea level pressure (SLP) reconstruction.

The reconstructions are based on the assumption of stationarity in the statistical relationships derived within the modern calibration periods, during which anthropogenic forcing played a prominent role. This assumption seems reasonable in view of the interannual variability that exceeds the differences in mean climatic states between different periods (e.g. *S17, S21*). Thus, the regression-type relationships derived are almost entirely based upon high-frequency relationships. Recent tests with forced and control model simulations *(S22)* revealed that the reconstruction methodology that uses roughly a century for calibration is not sensitive to the anthropogenic bias, i.e. patterns of past temperature variations do not differ much from those recorded in modern surface data.

Note that there is also a monthly, gridded and continuously updated surface temperature dataset available from the NASA (*S23, S24*). It is given on a 1°x1° resolution, (the data are available through http://www.giss.nasa.gov/data/update/gistemp/) though with unsystematically missing grid-point values throughout the 20th century. We decided to use the (*S19*) dataset for our 1901-1995 calibration since it is complete throughout the entire 1901-1995 period. The (*S19*) dataset is currently available to 1998. We used (*S23, S24*) data for the update until 2003. The (*S19*) and (*S23, S24*) temperature data are very similar and correlate at 0.98 for each season within the common 1901-1998 period for the chosen area and they do not indicate any bias.

Uncertainty calculations

Rough uncertainty estimates (Standard Error, SE; *S15, S25*) for reconstructed winter and summer average European surface temperature were determined from a multiple principal component regression model for the final calibration period (1901-1995) with the temperature average over Europe (average of 5050 grid-points) as dependent variable and EOFs of the predictors as exploratory variables. In order to obtain SE for annual temperature averages, we calculated the variances of the seasonal means and their correlations. The variances were obtained through the four regression models for each season whereas the correlations had to be estimated from the data. We compared several assumptions: independence, an AR(1) correlation structure, and a general approach for which we calculated seasonal correlations of the whole time period 1500-1995 as well as different sub-periods of 100 years each. It turned out that the differences in SEs between the various approaches are very small. We therefore used this general approach and obtained the annual SE by assuming the seasonal correlation over the entire 495-year period.

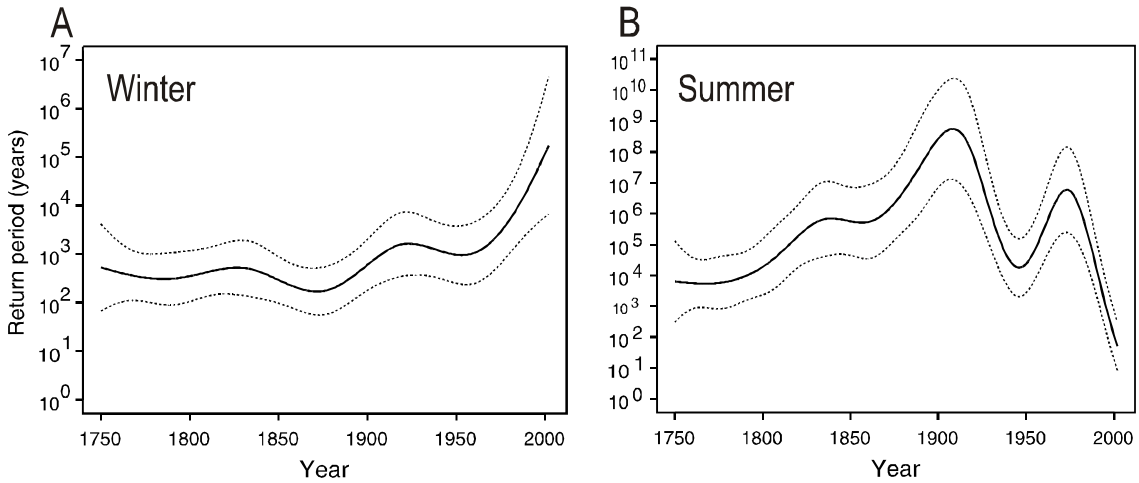
We believe that the calculated uncertainties for the time where instrumental data are missing (pre-1659 period) are optimistic estimates due to additional uncertainties in the documentary data (*S7, S8, S9, S10, S26*) and natural proxies (*S27, S28*).

Estimation of return period

The return period is defined as the expected number of years until a given threshold is exceeded. The estimation of return period was based on the assumption that the averaged seasonal European surface temperature data follow a varying trend over the years and that also the return period of a particular event changes over time. To estimate the return period of an event given the state of the trend we assumed a Gaussian distribution with a time-dependent mean function and independent residuals with a constant variance.

We restrict our analysis over 1750-2002, the period for which most skilful winter and summer temperature reconstructions are available. The trend was modelled by a spline function. The selected model belongs to the class of parametric additive models (e.g. *S29*). The degrees of freedom were chosen such that the adjusted R-squared is maximized. Diagnostic checks indicate that the assumption of independent and identical Gaussian distributed residuals seems to be reasonable. We also calculated time-dependent 95% confidence intervals for the estimated return period.

Figs. S2 A, B show the change in the return period of an extremely cold european-wide winter (such as winter 1708/1709) exceeding -3.6°C (relative to the 1901-1995 average) estimated with the European winter surface temperature trend over the 1750-2002 period and the return period of a european-scale summer event exceeding +2°C (relative to the 1901-1995 average; such as the summer of 2003) calculated with the European summer surface temperature trend over the 1750-2002 period. Fig. S2 further shows the time-dependent 95% confidence intervals. Figure S2 intends to express the rareness of such an extreme winter and summer related to the most reliable data from 1750 onwards. However, the return periods should not be over interpreted due to the high uncertainties, also at right end of Fig. S2B, where the visual impression might be misled by the strong decreasing trend.



***Supplemental Figure S2**: (A) Change in the return period of an extremely cold european-wide winter (such as 1708/1709) exceeding -3.6°C, estimated with the European winter surface temperature trend over the 1750-2002 period. (B) as (A) but for a european-scale summer event exceeding+ 2°C (relative to the 1901-1995 average; such as the summer 2003), calculated with the European summer surface temperature trend over the 1750-2002 period (see text above). Dashed lines indicate the time-dependent 95% confidence intervals for the estimated return period.*

Compared to our findings (Fig. S2B) (*S30*) found a much higher return period (46,000 years) for the summer 2003 using the 1990-2002 climatology for a smaller region (greater Alpine area and central Europe). The differences between our results might be due to the different methods used (varying trend over time in our approach versus specified climatology by *S30*) and the choice of a different reference period in connection with a different standard deviation. Another reason might be the concentration on different geographical regions (regional in *S30* versus european-scale in this study, comprising stronger summer temperature variability in northern and eastern Europe compared to central Europe). Indeed, the respective return periods respond very sensitively to such differences.

Supporting text

Independent climate evidence for the coldest European winter 1708/1709

Apart from quantifying uncertainties and rigorous calibration/verification exercises, it is also important to identify and demonstrate, using independent data, the reliability of any reconstructions (e.g. *S1, S17, S21, S28, S31, S32*). The winter of 1708/1709 was the coldest European winter for at least the last 500 years. There is independent climate evidence for this feature (not used as predictors in the reconstructions) from different areas of Europe, including regions with low reconstruction quality: (*S33*) for Estonia, (*S34*) and (*S35*) for the Ukraine and Western Russia, (*S36*) for the Czech Republic, (*S37*) for Finland, (*S38*) for Italy, (*S39*) for the Western Baltic, (*S40*) for Germany and Poland, (*S41)* for Romania.
(*S42*) investigated in detail the well-known tendency for winter temperatures to be low over northern Europe when they are high in Greenland/Iceland. For the winter 1708/1709 we reconstructed a positive temperature anomaly over Iceland. According to the described seesaw by (*S42*), warmer conditions are also expected over Greenland. This is supported by findings of (*S43*, *S44, S45*).

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Supporting tables

Supplemental Table S1: Climatological temperature time series (in chronological order) used for the seasonal (four values per year) reconstructions over the gridded European land temperature 1500-1658. Prior to 1659, there are only reconstructed climatic indices available, instrumental measurements are not available. Note, the indexed temperature indices (derived from documentary evidence) mostly represent the climatic conditions over a broader geographical area and do not refer to a single station. Thus, the latitude and longitude are discarded for these predictors and only the region or the representative station is given. 'None' in the column *Missing* indicates that temperature reconstructions are available for the entire period and for all four seasons.

Station/Region	Latitude	Longitude	Years	Missing	Sources
Germany	Southern		1500–1658	None	(1)
Switzerland	Swiss Plateau		1500–1658	None	(2,3)
Low Countries	NL, B, Lux		1500-1658	None, Winter and Summer predictor	(4,5)
Yamal, NW Siberia (tree-ring-width chronology based reconstruction from remains of subfossil Siberian larch trees)	Region between 67°N & 67.5°N	Region between 68.3°E & 71°E	1500-1658	None, Summer predictor*	(6)
1st PC of winter $\delta^{18}O$ from Greenland	4 cores stacked from southern (Dye), western (Milcent), eastern (Renland) and central Greenland	4 cores stacked from southern (Dye), western (Milcent), eastern (Renland) and central Greenland	1500-1658	None, Winter predictor	(7)
Tree-ring information of Scots pine, Pinus sylvestris L.	Coastal North Norway (Lofoten / Vesterålen / Tromsö; ~68°N	~12°E		None, Summer predictor	(8)
Western Baltic-Sea-Ice-Index	German and Denmark coasts		1501–1658	None, Winter predictor	(9)
Czech Republic**	50.05°N	14.42°E	1500–1599	Not continuous	(10-13)
'Ancient' Hungary	Budapest		1600–1658	Not continuous	(14)
De Bilt	52.10°N	5.20°E	1634–1658	1642-1644, Winter predictor	(15)

*According to the authors of the corresponding publications, the reconstructed June-July temperatures can also be used as June-August estimations.

**According to R. Brázdil (Masaryk University, Brno, Czech Republic) Prague-Klementinum (50.05°N, 14.42°E) has been taken as a reference station for the model calibration in the 20th century.

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Supplemental Table S2: Climatological time series (in chronological order) used for the monthly reconstructions of gridded land temperature over Europe 1659-1995. TT denotes station temperature and PP station pressure, (I) stands for indexed data (estimated from high resolution documentary evidence (see text for details): Note, the indexed temperature indices mostly represent the climatic conditions over a broader geographical area and do not refer to a single station. Thus, the latitude and longitude indications are discarded for these predictors and only the region or the representative station is given. 'None' in the column *Missing* indicates that temperature reconstructions are available for the entire period at a monthly resolution.

Station Name	Latitude	Longitude	Years	Missing	Sources
TT-Germany (I)	Southern		1659–1995	None	(1)
TT-Switzerland (I)	Swiss Plateau		1659–1780	None	(2,3)
TT-Central England	51.47°N	0.32°W	1659–1995	None	(4,5,6)
TT-Hungary (I)	Budapest		1659–1779	None	(7)
TT-De Bilt	52.10°N	5.20°E	1659–1995	Till 1705, Winter predictor	(8,9)
PP-Paris	49.00°N	2.50°E	1670–1995	7. 1713-12. 1763	(10,11,12)
Icelandic-Sea-Ice	North, east and south off the Icelandic coast		1675-1995	1716-1900, Winter, Spring and Summer predictor	(13,14,15)
TT-Greece (I)	Athens		1675-1715	None	(16)
TT-Portugal (I)	Lisbon		1675-1715	None	(17)
PP-London	51.20°N	1.00°W	1697-1708 1774-1995	1707	(11,18)
TT-Paris	48.80°N	2.50°E	1676-1995	1.1713-12.1756	(10,19,20)
TT-Berlin	52.50°N	13.40°E	1701–1995	1701-1729; 1752-1755	(19,21)
TT-Uppsala	59.88°N	17.60°E	1722–1995	None	(21)
PP-Uppsala	59.90°N	17.60°E	1722-1995	None	(21)
TT-Tornio*	65.50°N	24.08°E	6.1737–6.1749	None	(22,23)
TT-Czech Republic**	50.05°N	14.42°E	Winter 1739/1740	None	(24,25)
TT-St. Petersburg	60.00°N	30.30°E	1743-1995	None	(26)
TT-Turku	60.52°N	22.27°E	11.1748–1800	None	(27)
TT-Geneva	46.20°N	6.20°E	1753–1995	None	(19,20)
TT-Lund	55.40°N	13.10°E	1753-1995	None	(28,29)
PP-Basel	47.60°N	7.60°E	1755–1995	None	(11,12)
TT-Basel	47.60°N	7.60°E	1755–1995	None	(19,20)
TT-Stockholm	59.40°N	18.10°E	1756–1995	None	(30)
TT-Frankfurt	50.10°N	8.70°E	1757–1995	None	(19,20)
PP-Milan	45.50°N	9.10°E	1763–1995	None	(31,32)
TT-Milan	45.50°N	9.20°E	1763–1995	None	(31,32)
TT-Edinburgh	55.90°N	3.20°W	1764–1995	None	(19,20)
PP-Padova	45.40°N	11.80°E	1766-1995	None	(33-36)
TT-Kremsmünster	48.10°N	14.10°E	1767-1995	None	(37,38)
PP-Geneva	46.30°N	6.10°E	1768-1995	None	(11,12)
PP-Trondheim	63.50°N	10.90°E	1768-1995	None	(11,12)

TT-Copenhagen	55.70°N	12.60°E	1768-1995	1777-1781; 1789-1797	(19,20)
PP-Edinburgh	56.00°N	3.40°W	1770-1995	None	(11,12)
TT-Prague	50.05°N	14.42°E	1771-1995	None	(24,26)
PP-Vienna	48.30°N	16.40°E	1775-1995	None	(11,12)
TT-Vienna	48.30°N	16.40°E	1775-1995	None	(19,20,37,38)
TT-Vilnius	54.63°N	25.28°E	1777-1995	some gaps	(39,40***)
TT-Warsaw	52.17°N	20.97°E	1779-1995	None	(41)
TT-Budapest	47.50°N	19.00°E	1780-1995	None	(19,20)
PP-Barcelona	41.20°N	2.10°E	1780-1995	None	(11,12)
PP-Lund	55.40°N	13.10°E	1780-1995	None	(11,12,42)
TT-Karlsruhe	49.01°N	8.39°E	1780-1995	None	(43)
TT-Berlin-Tempelhof	52.40°N	13.40°E	1780-1995	None	(43)
PP-Hohenpeissenberg	47.80°N	11.00°E	1781-1995	None	(37,38)
TT-Hohenpeissenberg	47.80°N	11.00°E	1781-1995	None	(19,20)
TT-Munich	48.10°N	11.70°E	1781-1995	None	(19,20)
TT-Würzburg	49.80°N	9.95°E	1781-1995	None	(43)
PP-Madrid	40.40°N	3.70°W	1786-1995	None	(11,12)
PP-Prague	50.10°N	14.30°E	1789-1995	None	(11,12)
TT-Stuttgart	48.77°N	9.18°E	1792-1995	None	(43)
TT-Wroclaw	51.10°N	16.88°E	1792-1995	some gaps	(39,40***)
TT-Cracow	50.00°N	20.00°E	1792-1995	None	(44)
TT-Central Belgium	~51°N	~4°E	Feb. 1794-1995	None	(45)
TT-Innsbruck	47.27°N	11.40°E	1795-1995	None	(37,38)
TT-Riga-University	56.95°N	24.60°E	1795-1995	None	(46)
TT-Bremen	53.08°N	8.80°E	1803-1995	None	(43)
PP-Gdansk	54.30°N	18.90°E	1807-1995	None	(11,12)
PP-Budapest	47.50°N	19.00°E	1809-1995	None	(11,12)
TT-Klagenfurt	46.70°N	14.30°E	1813-1995	None	(37,38)
PP-Florence	43.80°N	11.30°E	1814-1995	None	(11,12)
PP-Bergen	60.40°N	5.30°E	1816-1995	None	(11,12)
PP-Oslo	60.00°N	10.70°E	1816-1995	None	(11,12)
TT-Bergen	60.40°N	5.30°E	1816-1995	None	(39,40***)
TT-Trondheim	63.50°N	10.90°E	1818-1995	None	(47)
PP-Cadiz – San Fernando	36.50°N	6.30°W	1820-1995	None	(48)
TT-Jena	50.93°N	11.58°E	1820-1995	None	(43)
PP-Gibraltar	36.20°N	5.40°W	1821-1995	None	(11,12)
PP-Reykjavik	65.10°N	22.80°W	1821-1995	None	(11,12)
PP-St. Petersburg	60.00°N	30.30°E	1822-1995	None	(11,12)
PP-Kremsmünster	48.05°N	14.13°E	1822-1995	None	(37,38)
TT-Stykkisholmur	65.08°N	22.73°W	1823-1995	None	(39,40***)
PP-Munich	48.10°N	11.70°E	1825-1995	None	(37,38)
TT-Frankfurt	50.10°N	8.70°E	1826-1995	None	(43)
TT-Dresden	51.05°N	13.75°E	1828-1995	None	(43)
TT-Helsinki	60.30°N	25.00°E	1829-1995	None	(39,40***)
PP-Innsbruck	47.27°N	11.40°E	1830-1995	None	(37,38)
PP-Dublin	53.40°N	6.30°W	1831-1995	None	(11,12)
TT-Dublin	53.43°N	6.25°W	1831-1995	None	(39,40***)
TT-Uccle	50.80°N	4.32°E	1833-1995	None	(39,40***)
TT-Gütersloh	51.90°N	8.38°E	1835-1995	None	(43)
PP-Warsaw	52.20°N	21.00°E	1836-1995	None	(11,12)
TT-Zurich	47.37°N	8.55°E	1836-1995	None	(11,12)
TT-Graz	47.07°N	15.45°E	1837-1995	None	(37,38)
PP-Graz	47.07°N	15.45°E	1837-1995	None	(37,38)
PP-Moscow	55.80°N	37.60°E	1838-1995	None	(11,12)
TT-Vardo	70.37°N	31.10°E	1840-1995	None	(39,40***)

PP-Trieste	45.70°N	13.80°E	1841-1995	None	(11,12)
PP-Copenhagen	55.70°N	12.60°E	1842-1995	None	(11,12)
PP-Odessa	46.50°N	30.60°E	1842-1995	None	(11,12)
PP-Salzburg	47.80°N	13.03°E	1842-1995	None	(37,38)
TT-Salzburg	47.80°N	13.03°E	1842-1995	None	(37,38)
PP-Tbilisi	41.70°N	45.00°E	1844-1995	None	(11,12)
PP-Klagenfurt	46.70°N	14.30°E	1844-1995	None	(37,38)
TT-Kirov	58.65°N	49.62°E	1845-1995	None	(39,40***)
TT-Kazan	55.78°N	49.18°E	1846-1995	None	(39,40***)
PP-Debilt	52.10°N	5.20°E	1849-1995	None	(11,12)
TT-Genova	44.40°N	8.90°E	1850-1995	None	(39,40***)
PP-Archangelsk	64.60°N	40.50°E	1851-1995	None	(11,12)
PP-Berlin	52.40°N	13.10°E	1851-1995	None	(11,12)
PP-Lvov	49.80°N	24.00°E	1851-1995	None	(11,12)
PP-Marseilles	43.50°N	5.20°E	1851-1995	None	(11,12)
PP-Nantes	47.20°N	1.60°W	1851-1995	None	(11,12)
PP-Rome	41.80°N	12.20°E	1851-1995	None	(11,12)
PP-Sibiu	45.80°N	24.20°E	1851-1995	None	(11,12)
TT-Sibiu	45.80°N	24.15°E	1851-1995	None	(49)
TT-Hamburg	53.55°N	10.00°E	1851-1995	None	(47)
TT-Nantes	47.22°N	1.55°W	1851-1995	None	(39,40***)
PP-Luqa (Malta)	35.90°N	14.50°E	1852-1995	None	(11,12)
TT-Luqa (Malta)	35.90°N	14.50°E	1853-1995	None	(19,20)
PP-Lisbon	38.70°N	9.20°W	1855-1995	None	(11,12)
PP-Bad Ischl	47.72°N	13.63°E	1855-1995	None	(37,38)
PP-Istanbul	41.00°N	29.10°E	1856-1995	None	(11,12)
TT-Hannover	52.37°N	9.72°E	1856-1995	None	(43)
TT-Bucharest	46.13°N	22.90°E	1857-1995	None	(49)
TT-Lisbon	38.70°N	9.20°W	1857-1995	None	(19,20)
PP-Athens	38.00°N	23.70°E	1858-1995	None	(11,12)
TT-Debrecen	47.48°N	21.63°E	1859-1995	None	(39,40***)
TT-Syktyvkar	61.67°N	50.81°E	1859-1995	None	(39,40***)
PP-Haparanda	65.80°N	24.20°E	1860-1995	None	(11,12)
PP-Jerusalem	31.80°N	35.20°E	1861-1995	None	(11,12)
PP-Vardo	70.40°N	31.10°E	1861-1995	None	(11,12)
TT-Jerusalem	31.80°N	35.20°E	1861-1995	None	(39,40***)
TT-Zagreb	45.80°N	16.00°E	1861-1995	None	several sources
PP-Zagreb	45.80°N	16.00°E	1862-1995	None	(11,12)
PP-Oporto	41.10°N	8.60°W	1863-1995	None	(11,12)
TT-Athens	38.00°N	23.70°E	1863-1995	None	several sources
PP-Funchal	32.60°N	16.90°W	1865-1995	None	(11,12)
PP-Ponta Delgada	37.80°N	25.70°W	1865-1995	None	(11,12)
TT-Belfast	54.58°N	5.93°W	1865-1995	None	(39,40***)
TT-Plymouth	50.39°N	4.15°W	1865-1995	None	(39,40***)
PP-Palma	39.60°N	2.70°E	1866-1995	None	(11,12)
PP-Valencia (Ire)	51.93°N	10.25°W	1866-1995	None	(50)
PP-Aberdeen/Dyce	57.20°N	2.22°W	1866-1995	None	(50)
TT-Godthab	64.17°N	51.75°W	1866-1995	None	(39,40***)
PP-Astrakhan	46.60°N	48.00°E	1868-1995	None	(11,12)
TT-Bodo	67.27°N	14.37°E	1868-1995	None	(39,40***)
PP-Cairo	30.10°N	31.40°E	1869-1995	None	(11,12)
TT-Valentia	51.93°N	10.25°W	1869-1995	None	(39,40***)
PP-Kiev	50.40°N	30.50°E	1871-1995	None	(11,12)
TT-Bistrita	47.15°N	24.52°E	1871-1995	None	(49)
TT-Aberdeen	57.20°N	2.22°W	1871-1995	None	(39,40***)

TT-Teigar	64.70°N	14.40°W	1871-1995	None	(39,40***)
TT-Saratov	51.57°N	46.03°E	1872-1995	None	(39,40***)
PP-Vestervig	56.77°N	8.33°E	1874-1995	None	(51)
PP-Nordby	55.52°N	8.57°E	1874-1995	None	(51)
TT-Archangelsk	64.60°N	40.50°E	1874-1995	None	(39,40***)
PP-Torshavn	62.02°N	6.77°W	1874-1995	None	(51)
TT-BaiaMare	47.67°N	23.58°E	1875-1995	None	(49)
PP-Bregenz	47.50°N	9.73°E	1875-1995	None	(37,38)
TT-Sulina	45.15°N	29.67°E	1876-1995	None	several sources
TT-DarElBeida	36.72°N	3.25°E	1878-1995	None	(39,40***)
TT-Timisoara	45.76°N	21.23°E	1880-1995	None	(49)
PP-Helsinki	60.30°N	25.00°E	1881-1995	None	(51)
TT-Akureyri	65.68°N	18.08°W	1882-1995	None	(39,40***)
PP-Sonnblick	47.01°N	12.95°E	1887-1995	None	(37,38)
TT-Thessaloniki	40.63°N	22.93°E	1892-1995	None	several sources

* Haparanda (Sweden; 65.8°N, 24.20°E) has been taken as a reference station for the model calibration in the 20th century.

** According to R. Brázdil (Masaryk University, Brno, Czech Republic) Prague-Klementinum (50.05°N, 14.42°E) has been taken as a reference station for the model calibration in the 20th century.

*** The GISS analysis uses the Global Historical Climatology Network (GHCN) of (*20*) without homogeneity adjustments, as adjustments are carried out independently in the GISS analysis. The GISS adjustments consist of data quality control and a homogeneity adjustment applied to urban stations. GISS updates electronically available monthly mean station temperatures from the National Climatic Data Center (NCDC).

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