Supplementary Material

Article title: Homogenization of the long instrumental daily temperature series in Padua, Italy (1725-2023)

Claudio Stefanini [1], Francesca Becherini [2,*], Antonio della Valle [3], and Dario Camuffo [3]

[1] Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice, 30170 Venice Mestre, Italy; stefac88@gmail.com (C.S.)
[2] National Research Council-Institute of Polar Sciences, Via Torino 155, 30172 Venice Mestre, Italy (F.B.)
[3] National Research Council-Institute of Atmospheric Sciences and Climate, Corso Stati Uniti 4, 35127 Padua, Italy; a.dellavalle@isac.cnr.it (A.d.V.); d.camuffo@isac.cnr.it (D.C.)
* Correspondence: francesca.becherini@cnr.it

Table S1. Transfer functions from *PD_AM* of the period 1 Jan 1980 – 31 Dec 2022 to *PD_OB* for minimum temperature.

1980-2022	***PD_AM* (1 Jan 1980 – 31 Dec 2022) to *PD_OB***	
Month	**Tmin (°C)**	**r^2**
January	Y = 0.9177 · X + 1.20	0.957
February	Y = 0.9240 · X + 1.38	0.959
March	Y = 0.9242 · X + 1.52	0.956
April	Y = 0.9491 · X + 1.33	0.960
May	Y = 0.9696 · X + 1.00	0.962
June	Y = 0.9935 · X + 0.60	0.964
July	Y = 0.9848 · X + 0.87	0.953
August	Y = 0.9777 · X + 1.05	0.960
September	Y = 0.9333 · X + 1.70	0.960
October	Y = 0.9225 · X + 1.51	0.975
November	Y = 0.9172 · X + 1.35	0.975
December	Y = 0.9197 · X + 1.19	0.964

Table S2. Transfer functions from *PD_AM* of the period 1 Jan 1980 – 31 Dec 2022 to *PD_OB* for maximum temperature.

1980-2022	***PD_AM* (1 Jan 1980 – 31 Dec 2022) to *PD_OB***	
Month	**Tmax (°C)**	**r^2**
January	Y = 1.0112 · X – 0.05	0.980
February	Y = 1.0090 · X + 0.00	0.986
March	Y = 1.0272 · X – 0.13	0.987
April	Y = 1.0377 · X – 0.39	0.983
May	Y = 1.0265 · X – 0.28	0.986
June	Y = 1.0090 · X + 0.04	0.984
July	Y = 1.0055 · X + 0.12	0.980
August	Y = 1.0022 · X + 0.17	0.982
September	Y = 1.0163 · X – 0.41	0.986
October	Y = 1.0055 · X – 0.41	0.987
November	Y = 0.9946 · X – 0.15	0.983
December	Y = 0.9986 · X – 0.10	0.977

Table S3. Transfer functions from *PD_Idrografico* of the period 1 Jan 1951 – 31 Dec 1977 to *PD_AM* for minimum temperature.

1951-1977	*PD_Idrografico* (1 Jan 1951 – 31 Dec 1977) to *PD_AM*	
Month	**Tmin (°C)**	**r^2**
January	Y = 0.9943 · X – 0.38	0.983
February	Y = 1.0069 · X – 0.44	0.988
March	Y = 1.0109 · X – 0.59	0.984
April	Y = 1.0119 · X – 0.61	0.971
May	Y = 1.0109 · X – 0.62	0.966
June	Y = 0.9889 · X – 0.20	0.966
July	Y = 0.9969 · X – 0.32	0.957
August	Y = 1.0049 · X – 0.45	0.957
September	Y = 1.0090 · X – 0.61	0.973
October	Y = 1.0175 · X – 0.62	0.982
November	Y = 1.0174 · X – 0.42	0.978
December	Y = 1.0078 · X – 0.33	0.982

Table S4. Transfer functions from *PD_Idrografico* of the period 1 Jan 1951 – 31 Dec 1977 to *PD_AM* for maximum temperature.

1951-1977	*PD_Idrografico* (1 Jan 1951 – 31 Dec 1977) to *PD_AM*	
Month	**Tmax (°C)**	**r^2**
January	Y = 1.0044 · X – 0.17	0.984
February	Y = 0.9978 · X – 0.15	0.989
March	Y = 0.9926 · X – 0.18	0.989
April	Y = 0.9861 · X – 0.10	0.984
May	Y = 0.9892 · X – 0.25	0.979
June	Y = 0.9882 · X – 0.07	0.981
July	Y = 0.9993 · X – 0.59	0.975
August	Y = 0.9980 · X – 0.29	0.973
September	Y = 0.9971 · X – 0.18	0.980
October	Y = 1.0017 · X – 0.02	0.985
November	Y = 0.9920 · X + 0.00	0.983
December	Y = 0.9911 · X – 0.09	0.985

Table S5. Transfer functions from *PD_Specola* of the period 1 Jan 1920 – 31 Dec 1955 to *PD_Idrografico* for minimum temperature.

1920-1955	*PD_Specola* (1 Jan 1920 – 31 Dec 1955) to *PD_Idrografico*	
Month	**Tmin (°C)**	**r^2**
January	Y = 1.0149 · X – 0.81	0.940
February	Y = 1.0289 · X – 0.88	0.946
March	Y = 1.0537 · X – 1.09	0.938
April	Y = 1.0265 · X – 1.14	0.940
May	Y = 0.9766 · X – 0.59	0.950
June	Y = 0.9712 · X – 0.59	0.937
July	Y = 0.9576 · X – 0.43	0.931
August	Y = 0.9671 · X – 0.59	0.931
September	Y = 0.9793 · X – 0.78	0.945
October	Y = 1.0187 · X – 1.27	0.940
November	Y = 1.0275 · X – 1.04	0.949
December	Y = 1.0232 · X – 0.73	0.954

Table S6. Transfer functions from *PD_Specola* of the period 1 Jan 1920 – 31 Dec 1955 to *PD_Idrografico* for maximum temperature.

1920-1955	***PD_Specola* (1 Jan 1920 – 31 Dec 1955) to *PD_Idrografico***	
Month	**Tmax (°C)**	**r^2**
January	Y = 1.0398 · X + 0.41	0.945
February	Y = 1.0375 · X + 0.78	0.948
March	Y = 1.0474 · X + 0.69	0.964
April	Y = 1.0219 · X + 0.88	0.969
May	Y = 0.9974 · X + 1.11	0.975
June	Y = 0.9635 · X + 1.76	0.959
July	Y = 0.9900 · X + 1.19	0.960
August	Y = 0.9993 · X + 1.25	0.961
September	Y = 1.0125 · X + 1.05	0.971
October	Y = 1.0361 · X + 0.57	0.955
November	Y = 1.0094 · X + 0.67	0.939
December	Y = 0.9976 · X + 0.46	0.963

Uncertainties estimation

Over 1725-1773, three types of errors have been considered:

1) Observation errors (σ_1). These errors were evaluated in Camuffo and Bertolin 2012 [4]. Sources of error related to time transformation, sampling made at different times, conversion from original temperature units to °C, calibration and drift of the thermometer, building and solar beams influence, were corrected and discussed in previous works [1,5,6,7].

2) Propagation errors (σ_2). These errors are related to the transfer functions which homogenize the time series. Winter has the largest errors while summer has the lowest values.

3) Reanalysis errors (σ_3). These errors are linked to the uncertainties associated to the ModE-RA reconstructions for the pixel nearest to Padua. Errors in summer are slightly higher than in winter.

The total standard errors (σ) are given by:

$$\sigma = \sqrt{\sum_{i=1}^{3} \sigma_i^2}$$

All the uncertainties are reported in Table S7.

Table S7. Daily mean temperature uncertainties.

Period	Observation errors	Propagation errors	Reanalysis errors	Total error
	σ_1	σ_2	σ_3	σ
1725-1739	0.6°C	1.0-1.3°C	0.1°C	1.2-1.5°C
1740-1768	0.3°C	1.0-1.3°C	0.1°C	1.1-1.4°C
1769-1773	0.3°C	1.0-1.3°C	0.1-0.2°C	1.1-1.4°C