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Supplement of

A global dataset of daily maximum and minimum near-surface air temperature at 1 km resolution over land (2003–2020)

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S1 Estimating missing values at weather stations

We found that there were only a few weather stations with valid Ta measurements for some days of the study period in Africa, and South America (Fig. S1). When the number of weather stations with valid measurements was too small for a specific day, the performance of the SVCM-SP algorithm might be reduced. Therefore, we implemented a 5-day moving average algorithm (Kemp et al., 1983) to fill the missing Ta measurements at weather stations in Africa and South America. As shown in the example in Fig. S2, for a specific weather station, we checked each 5-day temporal window where the central day has a missing Ta measurement in the original time series data. When there are at least two days have valid measurements in the 5-day local window, the missing value in the central day was filled by using the average value of the local window. After filling the missing values, the number of weather stations with valid measurements was largely increased (Fig. S3). Taking the day 316 of 2016 in Africa as an example, after filling the missing values, the number of weather stations with valid measurements increased from 9 to 248 stations, and the spatial distribution of stations was improved significantly (Fig. S4). We also implemented leave-one-out cross-validation by randomly removing valid measurements from the original time series of Ta measurements at weather stations. Results of cross-validation indicated that the performance of the 5-day moving window algorithm performed well with RMSE values ranging from 1.6 to 2.7 °C in Africa and South America (Fig. S5).

Figures

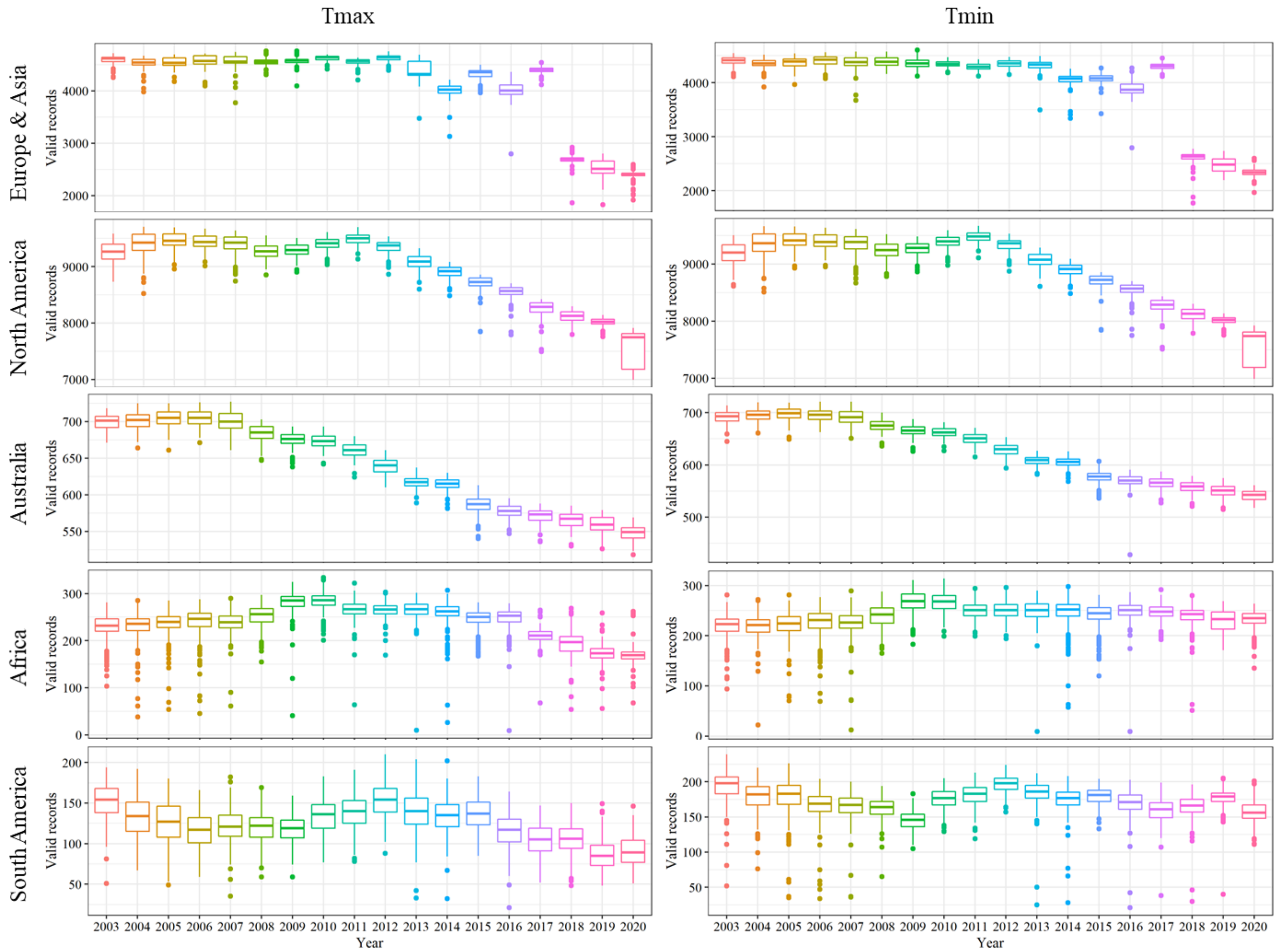

Figure S1: Number of valid records (Y-axis) in five regions. Each box is based on the daily number of valid records in a specific year. Each point represents the number of valid records in a specific day.

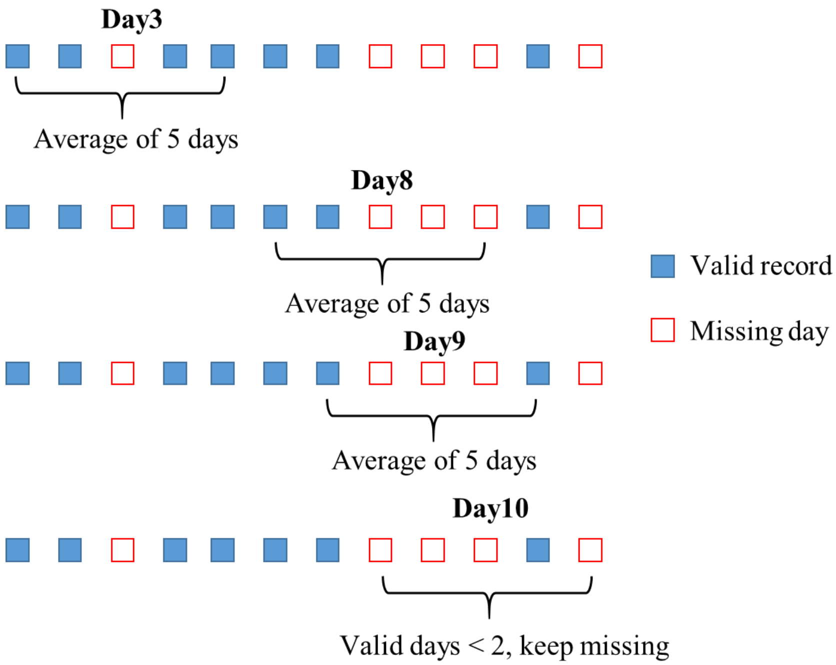

Figure S2: An example of filling missing Ta values at weather stations.

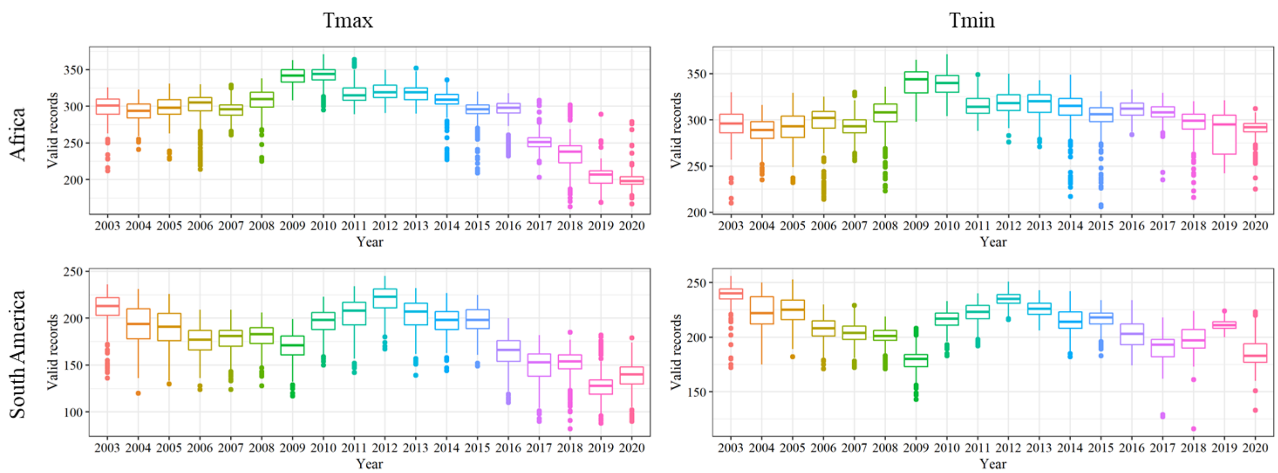

Figure S3: Number of valid records (Y-axis) after filling missing values in Africa and South America. Each box is based on the daily number of valid records in a specific year. Each point in the figure represents the number of valid records in a specific day. The number of filled records for Tmax and Tmin in Africa are 335,900 and 430,652, respectively, taking 17.7% and 21.4% of the total records. In South America, they are 371,193 and 249,186, taking 31.4% and 18.0%, respectively.

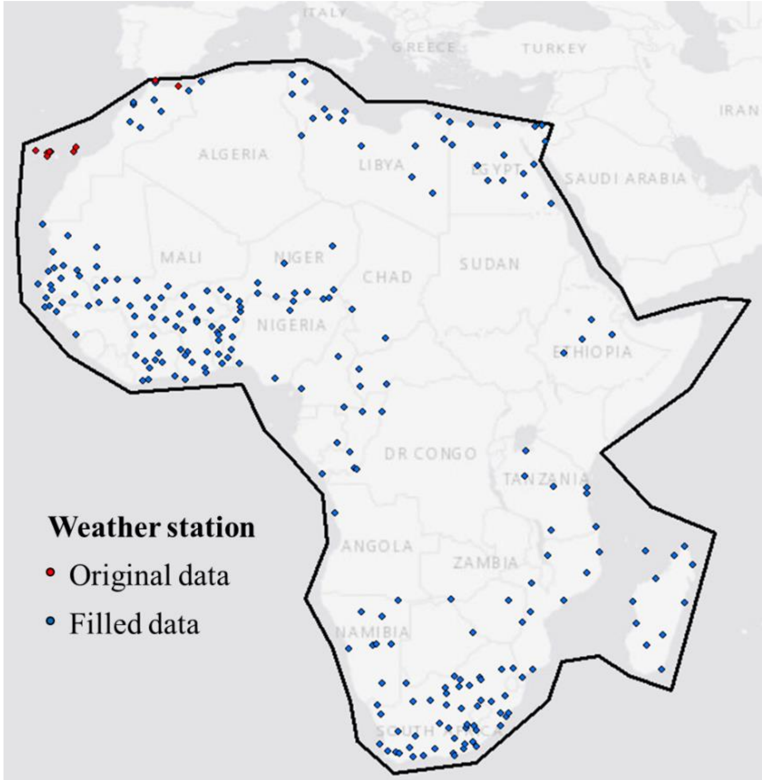

Figure S4: An example of valid observations in Africa (Tmax on day of 316 in 2016).

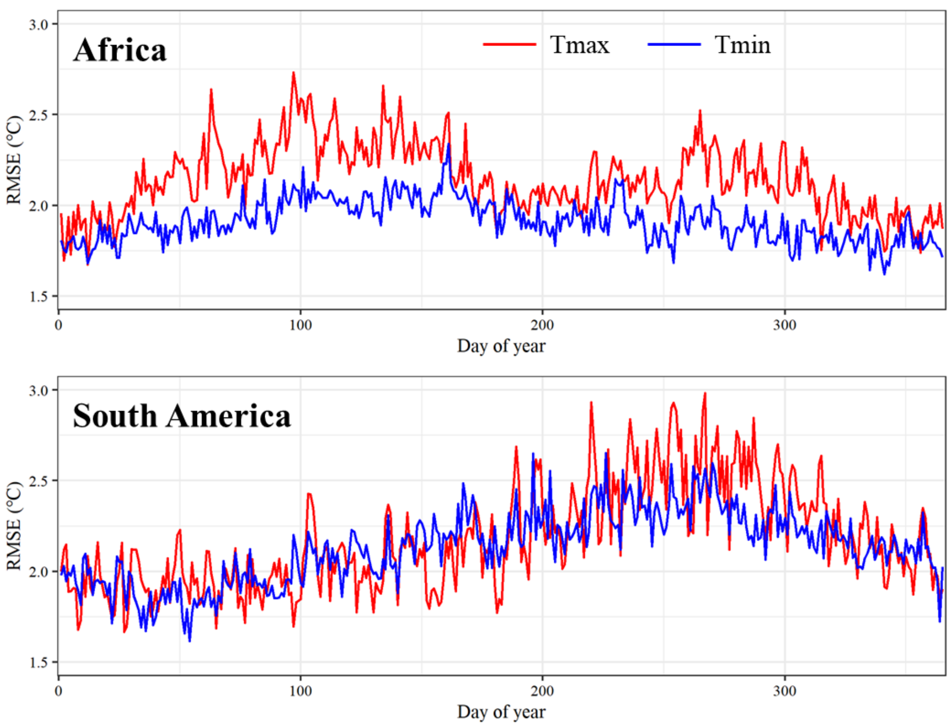

Figure S5: RMSE of filled missing values at stations in Africa and South America based on the cross-validation.

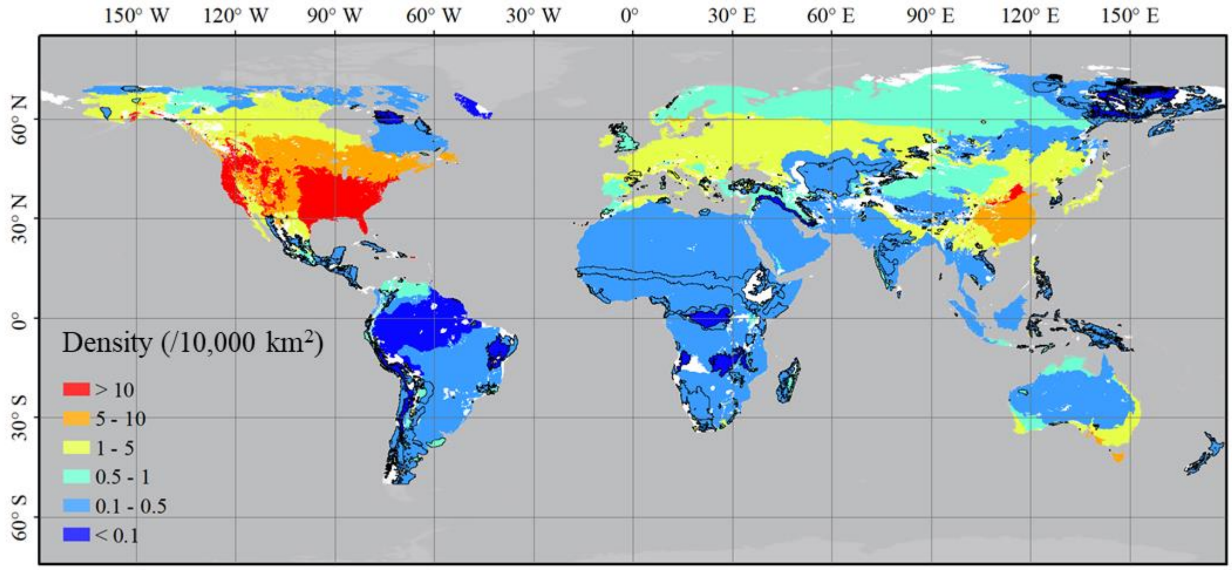

Figure S6: Station density in climate zones in 2003-2020. Climate zones with black boundaries are areas with low densities of weather stations (i.e., distances between training and validation sites are larger than 50 km). The white regions on land are areas without reliable evaluations due to the lack of weather stations.

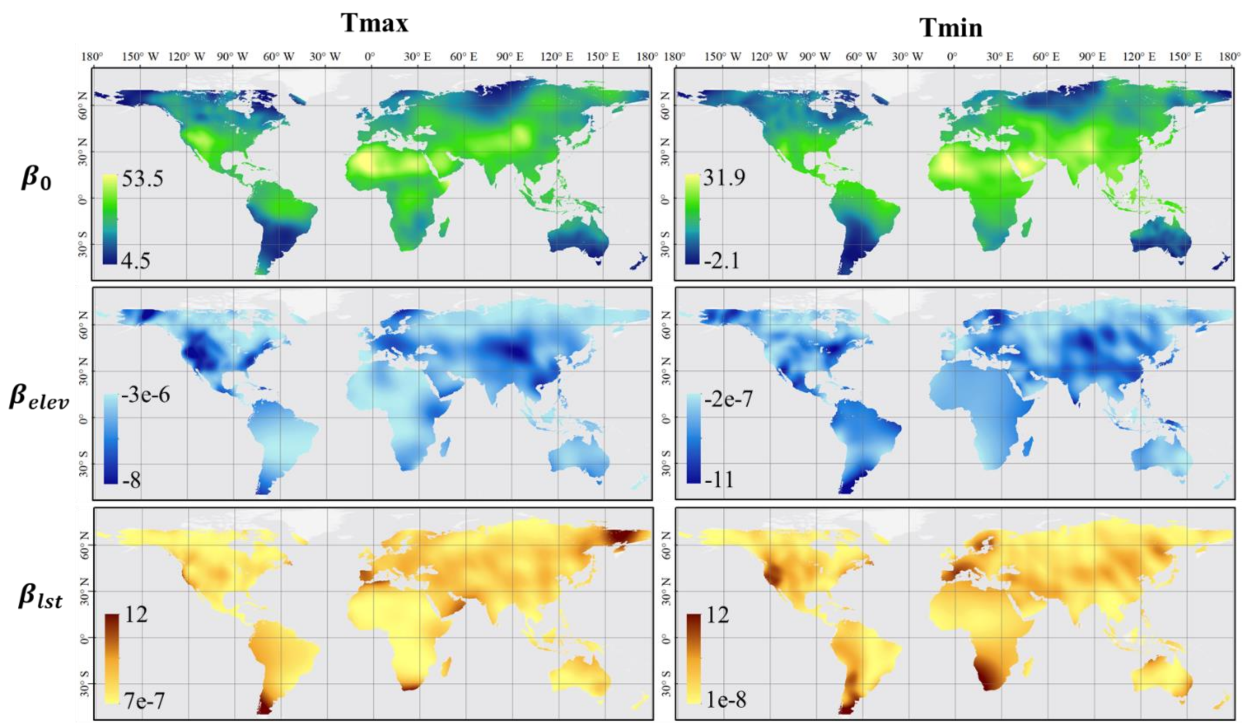

Figure S7: Spatial patterns of intercept (β_0), standardized regression coefficients of elevation (β_{elev}) and LST (β_{lst}) in day 200 of the year 2010.

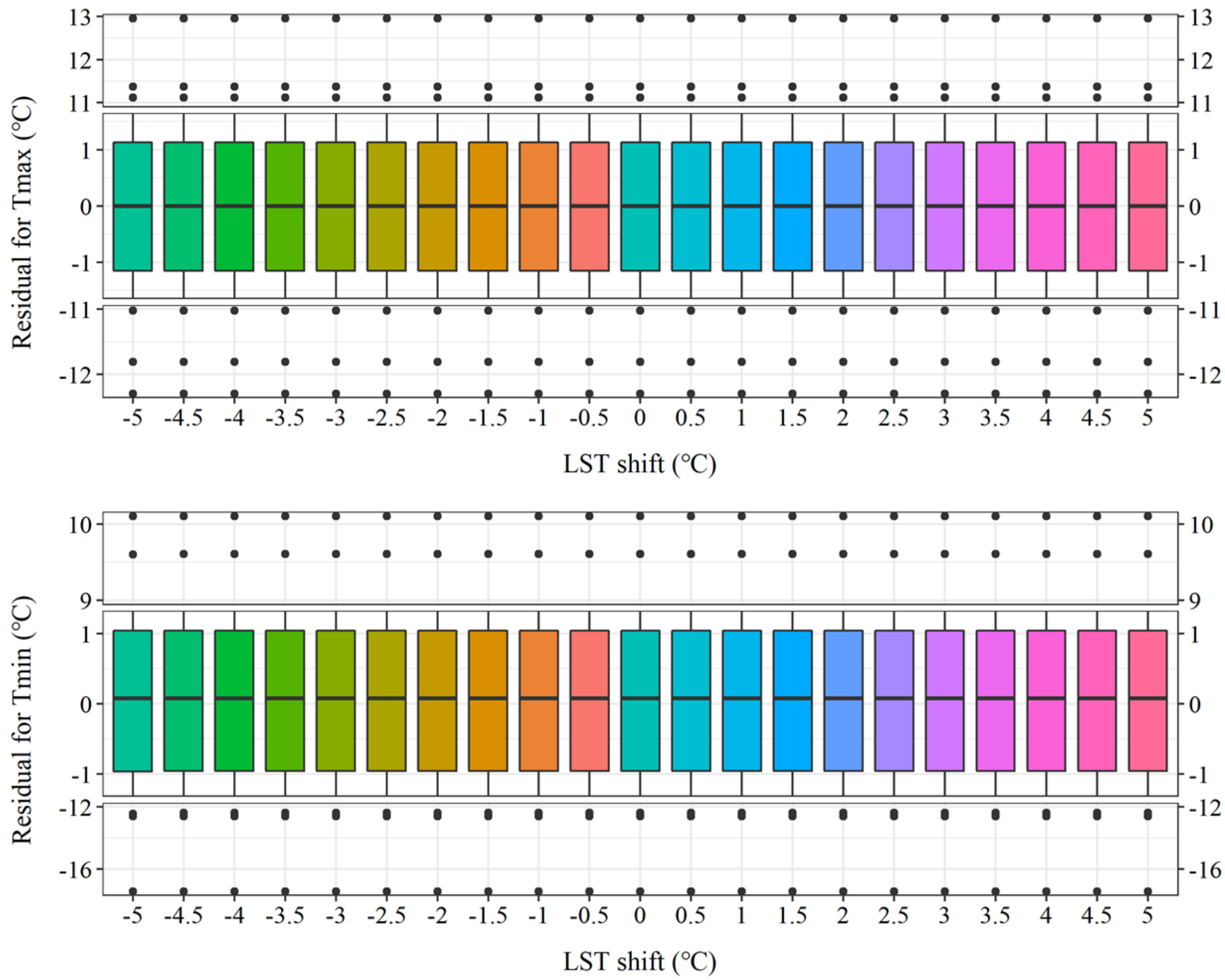

Figure S8: Residuals of estimated Ta based on the 10-fold cross-validation by shifting LSTs from -5 to 5 °C at a step of 0.5 °C in North America in the day 200 of 2010. Each box is based on the residual between observed and estimated Ta in the stations. Each point represents the residual in a specific station.

Tables

Table S1. Average RMSEs (±standard deviation) for Tmax and Tmin in five regions from 2003 to 2020 (Unit: °C)

Year	North America		South America		European & Asia		Africa		Australia	
	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin
2003	2.49±0.39	2.42±0.36	2.10±0.32	1.82±0.18	1.79±0.19	1.74±0.27	2.09±0.56	2.10±0.37	1.20±0.27	1.63±0.23
2004	2.46±0.39	2.38±0.39	2.02±0.29	1.87±0.19	1.74±0.17	1.74±0.27	2.19±0.69	2.20±0.39	1.17±0.25	1.65±0.24
2005	2.44±0.39	2.36±0.38	2.03±0.34	1.80±0.19	1.79±0.20	1.73±0.26	2.20±0.63	2.28±0.43	1.15±0.22	1.63±0.23
2006	2.41±0.36	2.40±0.35	2.00±0.25	1.85±0.19	1.79±0.18	1.73±0.25	2.35±0.70	2.44±0.51	1.20±0.27	1.74±0.27
2007	2.45±0.36	2.42±0.36	2.08±0.30	1.94±0.23	1.74±0.18	1.72±0.23	2.26±0.58	2.60±0.53	1.18±0.25	1.64±0.25
2008	2.50±0.45	2.48±0.44	1.94±0.25	1.87±0.18	1.74±0.17	1.71±0.23	2.22±0.54	2.33±0.48	1.16±0.22	1.66±0.26
2009	2.48±0.41	2.40±0.43	2.11±0.32	1.92±0.20	1.81±0.18	1.75±0.25	2.07±0.51	2.19±0.37	1.19±0.27	1.67±0.22
2010	2.36±0.32	2.32±0.36	2.06±0.25	1.93±0.20	1.84±0.22	1.76±0.34	2.00±0.48	2.23±0.39	1.14±0.23	1.57±0.25
2011	2.45±0.37	2.39±0.43	2.02±0.31	1.95±0.24	1.81±0.18	1.71±0.26	1.98±0.49	2.12±0.34	1.14±0.21	1.62±0.29
2012	2.41±0.36	2.39±0.35	1.94±0.26	2.00±0.19	1.81±0.19	1.71±0.27	2.03±0.53	2.21±0.40	1.16±0.23	1.71±0.28

2013	2.44±0.42	2.40±0.42	2.02±0.38	2.03±0.22	1.81±0.21	1.76±0.27	2.10±0.43	2.29±0.39	1.20±0.26	1.75±0.23
2014	2.50±0.49	2.41±0.44	1.95±0.26	2.10±0.19	1.84±0.20	1.64±0.23	2.19±0.38	2.17±0.41	1.23±0.27	1.73±0.26
2015	2.39±0.40	2.35±0.40	1.86±0.25	2.04±0.22	1.83±0.20	1.66±0.22	2.23±0.42	2.15±0.37	1.22±0.26	1.71±0.27
2016	2.37±0.38	2.34±0.38	1.89±0.27	1.96±0.24	1.84±0.18	1.63±0.25	2.18±0.46	2.13±0.37	1.21±0.27	1.64±0.25
2017	2.45±0.41	2.39±0.40	1.80±0.24	1.92±0.22	1.81±0.19	1.69±0.25	2.44±0.58	2.15±0.35	1.24±0.27	1.74±0.28
2018	2.43±0.41	2.38±0.39	2.04±0.28	1.87±0.22	1.83±0.18	1.98±0.34	2.40±0.60	2.04±0.37	1.27±0.28	1.76±0.29
2019	2.43±0.42	2.38±0.42	2.00±0.29	1.83±0.19	1.79±0.19	1.94±0.32	2.48±0.66	2.08±0.40	1.30±0.32	1.81±0.27
2020	2.41±0.42	2.42±0.36	2.03±0.29	1.85±0.25	1.72±0.16	1.84±0.23	2.52±0.67	2.04±0.38	1.25±0.28	1.69±0.28

Note: The selected testing stations were within 50 km surrounding the training stations.

Table S2. Average MAEs (±standard deviation) for Tmax and Tmin in five regions from 2003 to 2020 (Unit: °C)

Year	North America		South America		Europe & Asia		Africa		Australia	
	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin
2003	1.86±0.30	1.79±0.27	1.56±0.23	1.34±0.14	1.29±0.15	1.27±0.20	1.55±0.40	1.62±0.28	0.89±0.18	1.24±0.19
2004	1.83±0.29	1.77±0.29	1.48±0.20	1.39±0.14	1.25±0.14	1.27±0.20	1.60±0.49	1.71±0.29	0.87±0.18	1.26±0.20
2005	1.82±0.30	1.75±0.28	1.50±0.21	1.33±0.15	1.29±0.16	1.26±0.19	1.59±0.40	1.76±0.32	0.86±0.15	1.25±0.19
2006	1.81±0.27	1.79±0.27	1.47±0.18	1.35±0.15	1.30±0.15	1.27±0.18	1.70±0.49	1.84±0.34	0.89±0.19	1.33±0.23
2007	1.82±0.27	1.80±0.27	1.53±0.21	1.41±0.16	1.26±0.15	1.25±0.18	1.59±0.38	1.94±0.35	0.88±0.17	1.25±0.21
2008	1.87±0.34	1.84±0.33	1.44±0.18	1.39±0.13	1.25±0.14	1.25±0.18	1.56±0.36	1.76±0.34	0.86±0.16	1.26±0.22
2009	1.85±0.31	1.78±0.32	1.56±0.21	1.45±0.15	1.31±0.15	1.28±0.19	1.49±0.35	1.68±0.27	0.89±0.19	1.27±0.18
2010	1.76±0.24	1.71±0.27	1.54±0.18	1.45±0.14	1.34±0.18	1.29±0.25	1.45±0.31	1.70±0.28	0.86±0.16	1.19±0.21
2011	1.83±0.28	1.77±0.32	1.49±0.22	1.45±0.17	1.30±0.15	1.25±0.19	1.44±0.32	1.62±0.24	0.85±0.16	1.22±0.24
2012	1.79±0.27	1.78±0.27	1.44±0.18	1.48±0.15	1.3±0.15	1.25±0.20	1.51±0.38	1.68±0.29	0.86±0.17	1.30±0.23
2013	1.82±0.31	1.78±0.32	1.48±0.24	1.52±0.16	1.31±0.18	1.29±0.20	1.57±0.31	1.72±0.29	0.89±0.18	1.32±0.19
2014	1.87±0.36	1.79±0.33	1.45±0.19	1.58±0.15	1.32±0.16	1.21±0.18	1.62±0.28	1.63±0.27	0.92±0.20	1.32±0.21
2015	1.79±0.31	1.75±0.30	1.37±0.18	1.52±0.16	1.32±0.17	1.22±0.17	1.63±0.28	1.64±0.27	0.91±0.18	1.30±0.22
2016	1.78±0.29	1.74±0.28	1.40±0.19	1.46±0.16	1.33±0.16	1.19±0.18	1.61±0.30	1.64±0.27	0.90±0.20	1.25±0.21
2017	1.83±0.31	1.77±0.29	1.35±0.17	1.44±0.16	1.30±0.16	1.24±0.19	1.77±0.36	1.66±0.26	0.92±0.20	1.33±0.24
2018	1.82±0.30	1.77±0.30	1.49±0.19	1.39±0.17	1.28±0.14	1.46±0.24	1.76±0.38	1.56±0.26	0.94±0.21	1.34±0.24
2019	1.82±0.31	1.77±0.31	1.47±0.20	1.37±0.14	1.26±0.15	1.43±0.23	1.84±0.43	1.58±0.27	0.96±0.23	1.38±0.22
2020	1.80±0.31	1.80±0.27	1.47±0.20	1.38±0.17	1.20±0.13	1.35±0.17	1.85±0.42	1.54±0.26	0.93±0.20	1.28±0.23

Note: The selected testing stations were within 50 km surrounding the training stations.

Table S3. Summary of publicly available gridded near-surface air temperature datasets

Literature	Spatial extent	Spatial resolution	Temporal frequency	Coverage time	Accuracy (default: RMSE)
Kalnay et al., 1996	Global	2.5 º	4-times daily	1948 – present	--
Hersbach et al., 2018	Global	0.25 º	Hourly	1979 – present	--
Thornton et al., 2021	North America, Hawaii, and Puerto Rico	1 km	Daily (Tmax and Tmin)	1950 – present calendar year	MAE of 1.52 ºC (Tmax) and 1.78 ºC (Tmin)
Oyler et al., 2015	CONUS	30-arcsec (~800m)	Daily (Tmax and Tmin)	1948 – 2016	MAE of 1.03 ºC (Tmax) and 1.06 ºC (Tmin)
Hooker et al., 2018	Global	0.05 º	Monthly	2003 – 2016	1.14–1.55 ºC
Meyer et al., 2019	South Africa	3.5 km	Hourly	2010 – 2014	2.61 ºC
Werner et al., 2019	Northwestern North American	1/16 º	Daily	1971 – 2000	~2.2–3.5 ºC
Nashwan et al., 2019	Central North region of Egypt	0.05 º	Daily (Tmax and Tmin)	1981 – 2017	1.41 ºC (Tmax) 1.31 ºC (Tmin)
MacDonald et al., 2020	North American	60-arcsec (~2 km)	Monthly (Tmax and Tmin)	1901 – 2016	MAE of 0.7 ºC (Tmax) and 1.02 ºC (Tmin)
Crespi et al., 2021	North-eastern Italy	250 m	Daily (Tmean)	1980 – 2018	MAE is 1.5 ºC
Chen et al., 2021	Mainland China	1 km	Daily (Tmean)	2003 – 2019	1.615–1.957 K (leave-location-out cross-validation)
Fang et al., 2021	China	0.1 º	Daily (Tmax, Tmin, and Tmean)	1979 – 2018	0.86–1.78 ºC (Tmax), 0.78–2.09 ºC (Tmin), 0.35–1.00 ºC (Tmean)
This study (Zhang and Zhou, 2022)	Global	1 km	Daily (Tmax and Tmin)	2003 – 2020	1.20–2.44 ºC (Tmax), 1.69–2.39 ºC (Tmin)

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