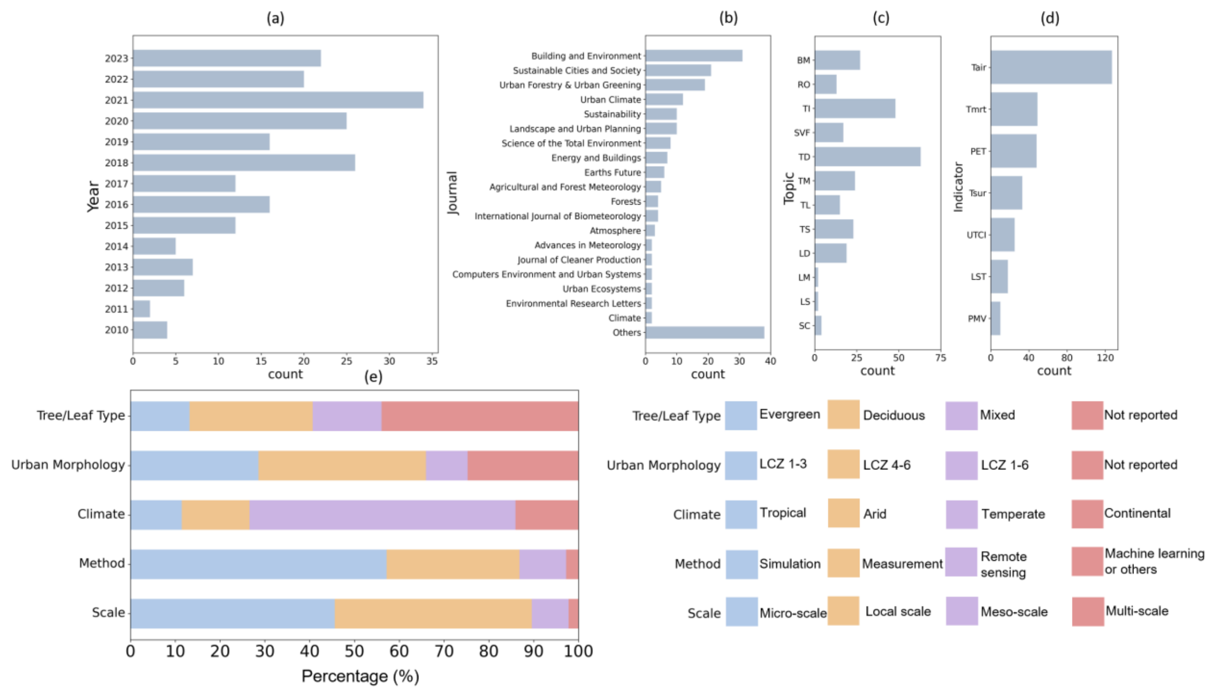
Supplementary Information

Supplementary Note 1. Characteristics of the reviewed literature

Our analysis is based on a thorough review of 182 scientific papers that investigate the effects of urban trees on urban heat mitigation and thermal comfort. **Supplementary Figure 1** illustrates the distribution of publication year, journal, topic, and climate indicators of the reviewed studies. It reveals a significant growth of awareness of the cooling benefits of urban trees with an increasing number of related publications in recent years. The number of articles has gradually increased since 2010, with 2021 reaching over six times the number of publications in 2010.



Supplementary Figure 1. Overview of the reviewed studies. The reviewed studies are classified by the (a) publication year, (b) publication journal, (c) topics describing the influencing factors of the trees' cooling effects and (d) quantitative climate indicator. (e) Percentage of studies classified by the tree/leaf retention type, urban morphology, methodology, spatial scale, and four main groups of Köppen climate classification of the study sites.

In **Supplementary Figure 1**(c), we summarized the topics investigated in the reviewed literature that influence the trees' cooling effects. A large majority of studies focus on tree traits, including tree morphology (TM), tree species (TS), LAI and LAD (LD), leaf morphology (LM), leaf stomatal characteristics (LS), soil characteristics (SC), while studies also highlighted the importance of urban morphology, including building morphology (BM) and road orientation (RO), tree location and arrangement (TL), sky view factor (SVF), tree density (TD). The most investigated topic, tree density (TD), influences the sky view factor (SVF), which determines the amount of blockage on shortwave solar radiation[1]. To harness trees' cooling effects, an optimization of the parametric combination of the above factors with the consideration of local background climate is necessary.

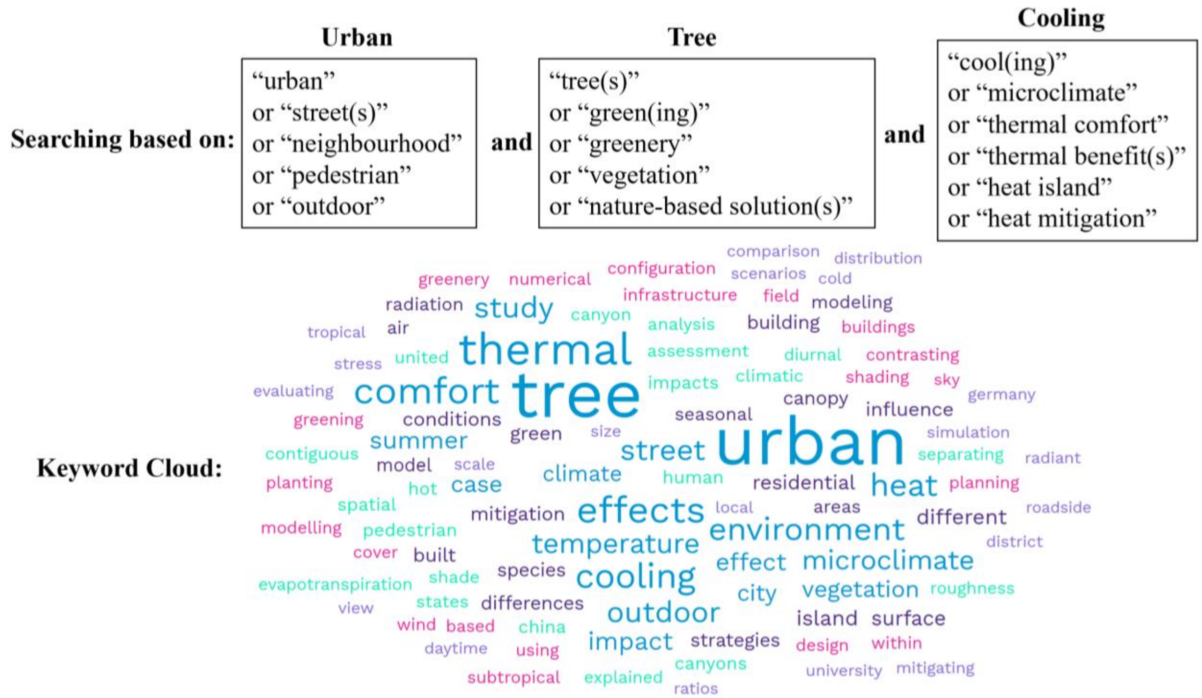
Supplementary Note 2. Research methodologies of the reviewed literature

Numerical simulation, full-scale and reduced-scale measurement, and remote sensing are the common, extensively applied methodologies for studying the thermal comfort of outdoor environments[2]. About 90% of the reviewed studies, focusing on street trees or trees adjacent to buildings, are carried out based on measurement and simulation methods. The choice of methodology depends on the research scales and available resources of the studies.

Studies on the local scale and micro-scale (up to 2 km) take up more than 80% of the studies. Micro-scale studies refer to a single street canyon or idealized standard street canyon investigations, while local scale studies investigate a neighborhood area with realistic urban morphology. At the micro- and local scale, the shading, evapotranspiration, and aerodynamic influences are investigated with high resolution, using field measurement, wind tunnel measurement, and urban microclimate simulations. On the micro-scale and local scale, Computational Fluid Dynamics (CFD) simulation is often used to predict complex outdoor wind and thermal environments under urban microclimate boundary conditions. More specifically, most of the simulation is coupled with heat-air-moisture (HAM) transfer model using software, including ENVI-met[3,4], OpenFoam[5,6], Anasys Fluent[7], RayMan[1,8], and SOLWEIG[9,10]. A few measurement studies are conducted on a reduced scale, in outdoor settings [11] and in the wind tunnel [12]. Urban trees are typically modeled as a porous medium with defined drag coefficients, thermal properties, and minimal stomatal resistance[5,13]. The CFD model can be solved in coupled subdomains, consisting of radiation, air, solid, and vegetation subdomains[5]. Radiation models, such as urban canopy models, are developed to simulate radiative heat exchange between trees and surrounding urban canopies[14–17].

The meso-scale studies account for around 10% of the total reviewed studies, mostly using Mesoscale Meteorological Models (MMMs)[18,19] and remote sensing technologies[20,21]. Weather Research and Forecasting (WRF) and Consortium for Small-scale Modeling (COSMO) are meso-scale systems widely used in weather forecasting and urban climate research. They can be coupled with small-scale models to increase the resolution of the simulation[2]. Remote sensing and GIS-based assessment can be used to understand different tree types, land surface temperature (*LST)*, humidity levels, etc. As satellite technology advances, the remote sensing technique is anticipated to become an increasingly helpful, non-invasive tool for collecting data.

Supplementary Note 3. Identification, screening, eligibility, and inclusion



Supplementary Figure 2. Illustration for keyword searching of systematic review. Word cloud is generated from the keywords from the eligible articles.

Following PRISMA guideline, in identification step, a total of 7859 articles are identified through the database. After that, 2517 records remain without duplications. In the second stage of the process, we screened the titles, abstracts, and keywords of the collected articles to exclude records that were not relevant to our research question. We excluded studies that focused on building energy consumption or green parks, for example. In total, 381 research articles are excluded during the screening process.

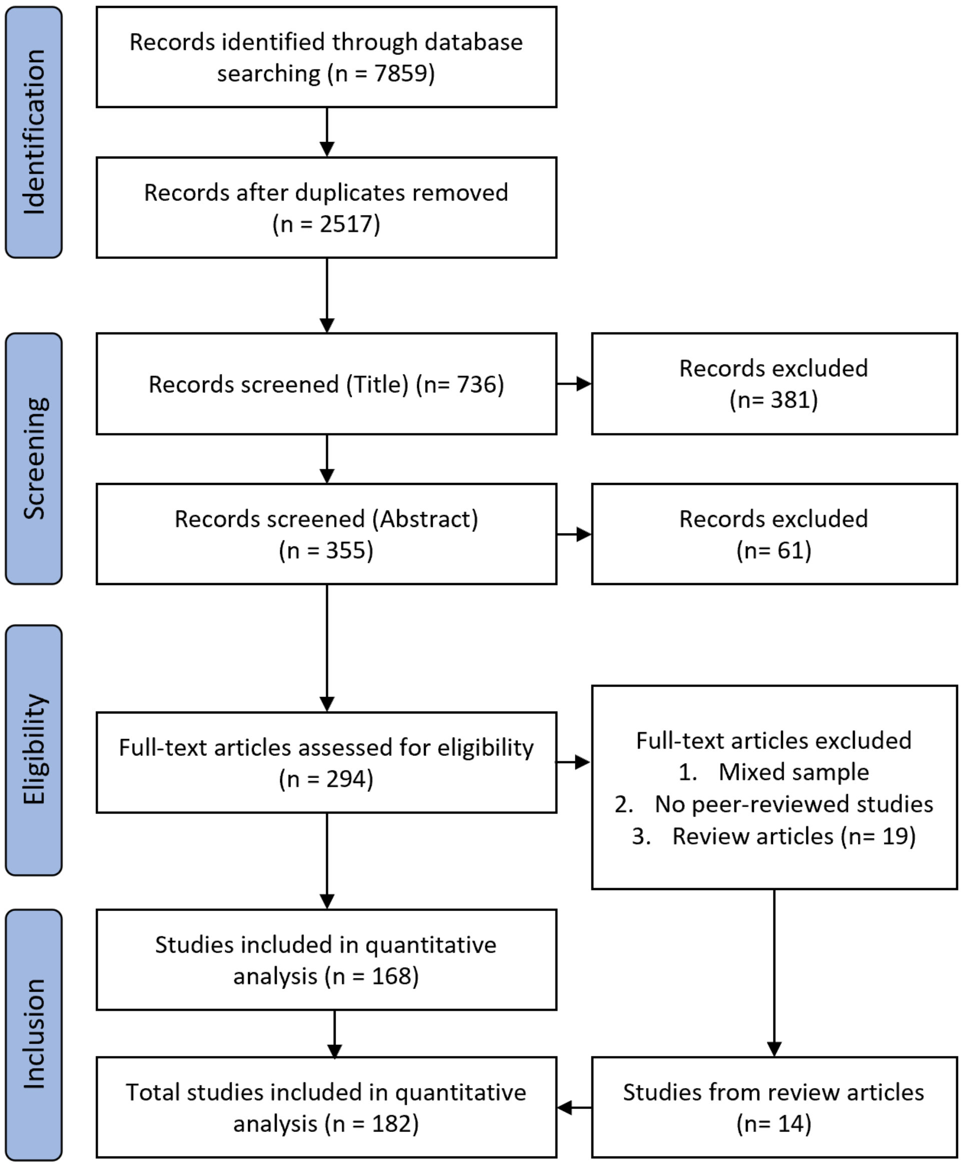
The third stage of the process involves assessing the full-text articles for eligibility based on the type of work and research scope. We excluded review papers and non-peer-reviewed studies from our analysis. 294 research articles are viewed and assessed in full text for eligibility.

In the final stage of the process, we carefully examined the research focus and methodology of the remaining articles and reviewed their cited references.

We selected a total of 182 articles that can be classified into eleven categories for further analysis.

(1) Year of publication;
(2) Journals;
(3) Site location;
(4) Study period;
(5) Background climate according to Köppen climate classification;
(6) Local climate zone according to sky view factor, aspect ratio and building surface fraction;
(7) Tree leaf retention type according to the plant species;
(8) Methodology, including simulations, measurements, remote sensing, machine learning, and others;
(9) Spatial scales, including micro-scale with a single street canyon, local scale, and meso-scale;
(10) Topic, describing the influencing factors or optimization factors of the trees’ cooling effects, including building morphology (BM), road orientation (RO), tree implementation (TI), sky view factor (SVF), tree

density (TD), tree morphology (TM), tree location and arrangement (TL), tree specie (TS), LAI and LAD (LD), leaf morphology (LM), leaf stomatal characteristics (LS), soil characteristics (SC);
(11) Quantitative climate indicators, including air temperature 2 m height (T_{air}), surface temperature (T_{sur}), mean radiant temperature (T_{mrt}), Universal Thermal Climate Index (*UTCI*), Physiological Equivalent Temperature (*PET*), and Predicted Mean Vote (*PMV*), land surface temperature (*LST*) and others.



Supplementary Figure 3. Identification, screening, eligibility and inclusion process of papers in review.

Supplementary Note 4. Classification of the reviewed literature

Supplementary Table 1. Köppen climate classification. The table shows the 17 climate types involved in the reviewed studies, explained by four main groups, names, and precipitation types. The table is presented for comprehending the definitions of climate zones[22].

Group	Name	Full name	Precipitation Type
Tropical	Af	Tropical rainforest climate	Fully humid
	Am	Tropical monsoon climate	Monsoon
	Aw	Tropical savanna, wet	Dry winter
Arid	BSk	Cold semi-arid (steppe) climate	Steppe
	BWh	Hot deserts climate	Desert
	BWk	Cold desert climate	Desert
Temperate	Cfa	Humid subtropical climate	Without dry season
	Cfb	Temperate oceanic climate	Without dry season
	Csa	Hot-summer Mediterranean climate	Dry summer
	Csb	Warm-summer Mediterranean climate	Dry summer
	Csc	Cool-summer Mediterranean climate	Dry summer
	Cwa	Monsoon-influenced humid subtropical climate	Dry winter
	Cwb	Subtropical highland climate or temperate oceanic climate with dry winters	Dry winter
Continental	Dfa	Hot-summer humid continental climate	Without dry season
	Dfb	Warm-summer humid continental climate	Without dry season
	Dsb	Mediterranean-influenced warm-summer humid continental climate	Dry summer
	Dwa	Monsoon-influenced hot-summer humid continental climate	Dry winter

Supplementary Table 2. Urban morphological characteristics. The case studies are classified into various LCZ types according to the reported sky view factor, aspect ratio, mean building height, and building surface fraction of the study cites.

	Compact			
	LCZ 1: Highrise	LCZ 2: Midrise	LCZ 3: Lowrise	LCZ 1-3
Sky view factor	0.2-0.4	0.3-0.6	0.2-0.6	0.2-0.6
Canyon aspect ratio	>2	0.75-2	0.75-1.5	>0.75
Mean building height	>25 m	10-25 m	3-10 m	NA
Building surface fraction	40-60 %	40-70 %	40-70 %	40-70 %

	Open			
	LCZ 4: Highrise	LCZ 5: Midrise	LCZ 6: Lowrise	LCZ 4-6
Sky view factor	0.5-0.7	0.5-0.8	0.6-0.9	0.5-0.9
Canyon aspect ratio	0.75-1.25	0.3-0.75	0.3-0.75	0.3-1.25
Mean building height	>25 m	10-25 m	3-10 m	NA
Building surface fraction	20-40 %	20-40 %	20-40 %	20-40 %

Supplementary Table 3. Tree trait characteristics. Case studies are classified by the plant used.

	Deciduous	Evergreen
Leaf retention type	Leaf shedding	No shedding
Leaf shape	Broad and flat	Needle-like or scale-like
Leaf size	Large, up to 30 cm in length	Small and narrow
Leaf texture	Thin and flexible	Thick and waxy coating
Crown shape	Rounded and spreading	Conical (conifer), columnar or irregular
Seasonal density	Dramatic changes with the seasons	No visible seasonal change

	Example plants used in reviewed literature	
Broad and spreading crowns	Oak (Quercus), Maple (Acer), Elm (Ulmus)	
Rounded crowns	Apple (Malus), Cherry (Prunus), Linden (Tilia)	Holly (Ilex), Magnolia (Magnolia grandiflora)
Columnar crowns	Poplar (Populus), Lombardy Poplar (Populus nigra ‘Italica’)	Italian Cypress (Cupressus sempervirens), Skyrocket Juniper (Juniperus scopulorum ‘Skyrocket’)
Vase-shaped crowns	American Elm (Ulmus americana), Crepe Myrtle (Lagerstroemia)	
Conical or pyramidal crowns		Spruce (Picea), Fir (Abies), Pine (Pinus)
Irregular or open crowns		Live Oak (Quercus virginiana), Eucalyptus (Eucalyptus spp.)

Supplementary Note 5. Literature in the systematic review

Supplementary Table 4. Detailed information of 182 literature in tropical climates regarding the author (year), method, scale, climate type, city or region, country, topic and quantitative climate indicator.

Author[ref]	Year	Method	Scale	Climate	City or Region	Country or Region	Topic	ΔT_{air}? Or Other Climate Indicators
Zaki et al.[23]	2020	Measurement	Micro	Af	Kuala Lumpur	Malaysia	RO, TI	Yes
Meili et al.[24]	2021	Simulation	Local	Af	Singapore	Singapore	TI	Yes
Meili et al.[25]	2021	Simulation	Local	Af	Singapore	Singapore	TI	No, *UTCI*
Meili et al.[26]	2020	Simulation	Local	Af	Singapore	Singapore	TI	Yes
Wong and Jusuf[27]	2010	Measurement	Local	Af	Singapore	Singapore	SVF	Yes
Shahidan et al.[28]	2010	Measurement and Simulation	Micro	Af	Serdang	Malaysia	TS	No, thermal radiation filtration
Wong and Jusuf[29]	2010	Measurement	Micro	Af	Singapore	Singapore	TI	Yes
Shahidan et al.[30]	2012	Measurement and Simulation	Local	Af	Putrajaya	Malaysia	TI	Yes
Yang et al.[31]	2015	Measurement and Simulation	Micro	Af	Singapore	Singapore	RO, BM, TI	Yes
Liu et al.[32]	2022	Measurement and Simulation	Micro	Af	Singapore	Singapore	TL, TM, TD	No, *PET*
Herath et al.[33]	2018	Simulation	Local	Af	Colombo	SriLanka	TI	Yes
Saito et al.[34]	2017	Simulation	Local	Af	Malacca	Malaysia	TI	No, *PET*
Yang et al.[35]	2016	Measurement and Simulation	Local	Am	Tainan	Taiwan China	TI	Yes
Vailshery et al.[36]	2013	Measurement	Local	Aw	Bangalore	India	TI, TS, TM	Yes
Morakinyo et al.[37]	2013	Measurement	Micro	Aw	Akure	Nigeria	TI	Yes
Eente et al.[38]	2012	Measurement	Local	Aw	Enugu	Nigeria	TS	No, *UHI*
Obi[39]	2014	Measurement	Local	Aw	Enugu	Nigeria	TS	No, T_{mrt}
Alabi and Christian[40]	2013	Measurement	Local	Aw	Lokoja	Nigeria	TS	Yes
Morakinyo et al.[41]	2016	Measurement and Simulation	Micro	Aw	Akure	Nigeria	TI	No, *PET*
Jareemit and Srivanit[1]	2022	Measurement	Micro	Aw	Pathum Thani	Thailand	SVF, TD	Yes
Srivanit and Jareemit[42]	2020	Simulation	Micro	Aw	Bangkok	Thailand	BM, RO, TD	No, *PET*
Abdulkarim et al.[43]	2020	Measurement and Simulation	Local	Aw	Bauchi	Nigeria	TD	Yes

Supplementary Table 5. Detailed information of 182 literature in arid climates regarding the author (year), method, scale, climate type, city or region, country, topic and quantitative climate indicator.

Author[ref]	Year	Method	Scale	Climate	City or Region	Country or Region	Topic	ΔT_{air}? Or Other Climate Indicators
Darbani et al.[44]	2023	Simulation	Local	BSk	Mashhad	Iran	BM, RO, SVF, TD	Yes
Darbani et al.[45]	2021	Simulation	Local	BSk	Mashhad	Iran	BM, RO, TD	No, *PET*
Sodoudi et al.[46]	2014	Simulation	Local	BSk	Tehran	Iran	TI	Yes
Arghavani et al.[18]	2020	Simulation	Meso	BSk	Tehran	Iran	TD	Yes
Abdi et al.[47]	2020	Simulation	Micro	BSk	Tabriz	Iran	TL	No, *PMV*
Teshnehdel et al.[48]	2020	Simulation	Local	BSk	Tabriz	Iran	TS, TD	Yes
Yang et al.[49]	2019	Simulation	Micro	BSk/Cwa	Xian	China	TD	No, *PET*
Yang et al.[50]	2018	Simulation	Micro	BSk/Cwa	Xian	China	TM, TL	No, *PET*
Zhang et al.[51]	2022	Measurement	Local	BSk/Cwa	Xian	China	TS	No, *UTCI*
Middel et al.[52]	2015	Simulation	Local	BWh	Phoenix	USA	TD	Yes
Aboelata[53]	2020	Simulation	Micro	BWh	Cairo	Egypt	RO, TD	Yes
Aboelata and Sodoudi[54]	2020	Simulation	Local	BWh	Cairo	Egypt	BM, TD	Yes

Atwa et al.[55]	2020	Simulation	Local	BWh	New Borg El Arab	Egypt	TL	Yes
Fahmy and Abdelghany[56]	2020	Simulation	Local	BWh	New Cairo	Egypt	TI	Yes
Fahmy et al.[57]	2018	Simulation	Local	BWh	New Cairo	Egypt	TS, TI	Yes
Salmon and Saleem[58]	2021	Measurement and Simulation	Micro	BWh	Baghdad	Iraq	BM, TL	Yes
Zeeshan et al.[59]	2023	Measurement and Simulation	Local	BWh	Karachi	Pakistan	BM, TI	Yes
Zhao et al.[11]	2018	Measurement	Micro	BWh	Tempe	USA	TD, TL	No, T_{sur}
Shata et al.[8]	2021	Simulation	Micro	BWh	Giza	Egypt	SVF	Yes
Elbardisy et al.[60]	2021	Simulation	Micro	BWh	Cairo	Egypt	TD	Yes
Meili et al.[24]	2021	Simulation	Local	BWh	Phoenix	USA	TI	Yes
Fahmy et al.[61]	2010	Simulation	Micro	BWh	Cairo	Egypt	TS, LD	Yes
Zeeshan et al.[62]	2022	Simulation	Local	BWh	Keamari	Pakistan	TI	Yes
Zhao et al.[63]	2018	Simulation	Local	BWh	Tempe	USA	TL	Yes
Wang et al.[64]	2018	Simulation	Meso	BWh	CA-AZ	USA	TI	Yes
Ma et al.[65]	2019	Measurement	Micro	BWk	Lhasa	China	RO, LD	Yes
Ruiz et al.[66]	2015	Measurement	Micro	BWk	Mendoza	Argentina	BM, TD	Yes
Yahia and Johansson[67]	2014	Simulation	Micro	BWk	Damascus	Syria	BM, RO, TI	No, T_{sur}
Yahia and Johansson[68]	2013	Simulation	Micro	BWk	Damascus	Syria	BM, RO, TI	No, *PET*

Supplementary Table 6. Detailed information of 182 literature in Cfa temperate climates, regarding the author (year), method, scale, climate type, city or region, country, topic and quantitative climate indicator.

Author[ref]	Year	Method	Scale	Climate	City or Region	Country or Region	Topic	ΔT_{air}? Or Other Climate Indicators
Gao et al.[69]	2020	Measurement	Micro	Cfa	Sydney	Australia	TI	Yes
Chen et al.[70]	2021	Measurement	Micro	Cfa	Guangzhou	China	BM, TD, TM, TS, LD	No, *PET*
Chen et al.[71]	2021	Measurement	Micro	Cfa	Guangzhou	China	BM, SVF, TD, TS	No, T_{air} 0.1m
Zheng et al. [72]	2018	Measurement	Micro	Cfa	Guangzhou	China	TS	Yes
Park et al.[73]	2012	Measurement	Micro	Cfa	Saitama Prefecture	Japan	TD, TL	No, T_{mrt}
Lin et al.[74]	2010	Measurement	Micro	Cfa	Taipei	Taiwan China	SVF, TD	No, *PET*
Wang et al.[75]	2023	Simulation	Micro	Cfa	Hangzhou	China	TD, TM	Yes
Feng et al.[76]	2021	Simulation	Micro	Cfa	Nanjing	China	TL, LD	No, T_{sur}
Lin et al.[77]	2021	Simulation	Micro	Cfa	Taipei	Taiwan China	RO, TD, LD	Yes
Zheng et al.[78]	2018	Simulation	Micro	Cfa	Shantou	China	BM, RO, TM, LD	Yes
Zheng et al.[79]	2016	Simulation	Micro	Cfa	Guangzhou	China	TS	Yes
Cai et al.[80]	2022	Measurement	Local	Cfa	Hangzhou	China	TD, TM, LD	Yes
Alonzo et al.[81]	2021	Measurement	Meso	Cfa	Washington DC	USA	TD	Yes
Razzaghmanesh et al.[82]	2021	Measurement	Local	Cfa	New Jersey	USA	RO, TD, TM	Yes
Sabrin et al.[83]	2021	Measurement	Local	Cfa	Philadelphia	USA	TI, TD	No, T_{mrt}
Yang et al.[84]	2015	Measurement	Local	Cfa	Shanghai	China	BM, TD	Yes
Chiang et al.[85]	2023	Others	Local	Cfa	Taichung City	Taiwan China	SVF	No, *PET*
Bartesaghi-Koc et al.[86]	2022	Remote Sensing	Local	Cfa	Sydney	Australia	SVF, TD	No, *LST*
Chen et al.[87]	2022	Remote Sensing	Local	Cfa	Nanjing	China	BM, TD	No, *LST*
Xi et al.[7]	2022	Simulation	Local	Cfa	Nanjing	China	TI	Yes
Tan et al.[88]	2022	Simulation	Local	Cfa	Chenzhou	China	TI	Yes
Liao et al.[89]	2021	Simulation	Local	Cfa	Changsha	China	TI	Yes
Zhang et al.[90]	2018	Simulation	Local	Cfa	Wuhan	China	TD, TM, TL, LD	Yes
Jiang et al.[91]	2018	Simulation	Local	Cfa	Shanghai	China	TL	Yes
Srivanit and Hokao[92]	2013	Simulation	Local	Cfa	Saga	Japan	TD	Yes
He et al.[21]	2021	Remote Sensing	Meso	Cfa	Washington DC	USA	TD	No, *LST*

Loughner et al.[19]	2012	Simulation	Meso	Cfa	Washington DC	USA	BM, TI	Yes
Johansson et al.[93]	2013	Simulation	Micro &Meso	Cfa	Sao Paulo	Brazil	BM, TI	Yes
Li et al.[94]	2020	Simulation	Local	Cfa	Guangzhou	China	TI	Yes
Rui et al.[95]	2018	Simulation	Local	Cfa	Nanjing	China	TD, TL	Yes
Rui et al.[96]	2019	Simulation	Local	Cfa	Nanjing	China	TD, TL	Yes
Shi et al.[97]	2020	Simulation	Local	Cfa	Chongqing	China	TI	Yes
Kusaka et al.[98]	2022	Measurement	Micro	Cfa	Tsukuba	Japan	TI	No, *UTCI*

Supplementary Table 7. Detailed information of 182 literature in Cfb temperate climate, regarding the author (year), method, scale, climate type, city or region, country, topic and quantitative climate indicator.

Author[ref]	Year	Method	Scale	Climate	City or Region	Country or Region	Topic	ΔT_{air}? Or Other Climate Indicators
Rahman et al.[99]	2020	Measurement	Micro	Cfb	Munich	Germany	BM, RO, TD, TS	Yes
Massetti et al.[100]	2019	Measurement	Micro	Cfb	Florence	Italy	LD	No, T_{sur}
Rahman et al.[101]	2019	Measurement	Micro	Cfb	Munich	Germany	TS	Yes
Rahman et al.[102]	2018	Measurement	Micro	Cfb	Munich	Germany	TS, SC	Yes
Rahman et al.[103]	2017	Measurement	Micro	Cfb	Munich	Germany	TS, SC	Yes
Sanusi et al.[104]	2017	Measurement	Micro	Cfb	Melbourne	Australia	TD, TS, LM	Yes
Rahman et al.[105]	2017	Measurement	Micro	Cfb	Munich	Germany	TM, SC	Yes
Coutts et al.[106]	2016	Measurement	Micro	Cfb	Melbourne	Australia	BM, TD	Yes
Konarska et al.[107]	2016	Measurement	Micro	Cfb	Gothenburg	Sweden	BM, SVF, TD	Yes
Wang et al.[108]	2015	Measurement and Simulation	Micro	Cfb	Assen	Netherlands	TI	Yes
Lachapelle et al.[109]	2023	Simulation	Micro	Cfb	Vancouver	Canada	RO, TD, TL	No, T_{mrt}
Bochenek and Klemm[110]	2021	Simulation	Micro	Cfb	Lodz	Poland	TD	Yes
Azcarate et al.[10]	2021	Simulation	Micro	Cfb	Bilbao	Spain	SVF	No, *PET*
Wang et al.[111]	2021	Simulation	Micro	Cfb	Basel	Switzerland	TI	Yes
Meili et al.[24]	2021	Simulation	Local	Cfb	Melbourne	Australia	TI	Yes
Bochenek and Klemm[112]	2020	Simulation	Micro	Cfb	Lodz	Poland	TD	Yes
Lee et al.[113]	2020	Simulation	Micro	Cfb	Freiburg	Germany	BM, TD, TM	Yes
Manickathan et al.[5]	2018	Simulation	Micro	Cfb	Validation in Varades	Validation in France	TD, TM, LD, LM, LS	Yes
Napoli et al.[114]	2016	Simulation	Micro	Cfb	Florence	Italy	TM, TS, LD, SC	No, T_{sur}
Mballo et al.[115]	2021	Measurement	Micro	Cfb	Angers	France	TI	Yes
Quanz et al.[116]	2018	Measurement	Local	Cfb	Berlin	Germany	RO, SVF, TD	Yes
Klein and Rozova[117]	2016	Measurement	Local	Cfb	Nitra	Slovakia	BM, TI	Yes
Sung[118]	2013	Remote Sensing	Local	Cfb	Woodlands Township	USA	TI	No, *LST*
Briegel et al.[119]	2023	Simulation	Local	Cfb	Freiburg	Germany	TI	No, T_{mrt}
Balany et al.[120]	2022	Simulation	Local	Cfb	Melbourne	Australia	TI	Yes
Aminipouri et al.[9]	2019	Simulation	Local	Cfb	Vancouver	Canada	TD	No, T_{mrt}
Aminipouri et al.[121]	2019	Simulation	Local	Cfb	Vancouver	Canada	TD	No, T_{mrt}
Morille and Musy[122]	2017	Simulation	Local	Cfb	Lyon	France	TI	No, *UTCI*
Lee et al.[123]	2016	Simulation	Local	Cfb	Freiburg	Germany	TI	Yes
Lindberg et al.[124]	2016	Simulation	Local	Cfb	Goteborg	Sweden	TD	No, T_{mrt}
Ketterer and Matzarakis[125]	2015	Simulation	Local	Cfb	Stuttgart	Germany	TI	No, *PET*
Morabito et al.[20]	2021	Remote Sensing	Meso	Cfb	Italy	Italy	TD	No, *LST*
Wang et al.[64]	2018	Simulation	Meso	Cfb	Florida	USA	TI	Yes
Wang et al.[64]	2018	Simulation	Meso	Cfb	Texas Triangle	USA	TI	Yes
Skelhorn et al.[126]	2014	Simulation	Local	Cfb	Manchester	UK	LD, TS	Yes
Duarte et al.[127]	2015	Simulation	Local	Cfb	Sao Paulo	Brazil	BM, TL	Yes
Lobaccaro and Acero[128]	2015	Simulation	Local	Cfb	Bilbao	Spain	BM, TI	No, *PET*
Zölch et al.[129]	2016	Simulation	Micro	Cfb	Munich	Germany	TI, TL, TM	No, *PET*
Milošević et al.[130]	2017	Simulation	Micro	Cfb	Novi Sad	Serbia	TL	No, *UTCI*

Speak et al.[131]	2022	Measurement	Local	Cfb	Florence	Italy	TL, TS, TM, TD	No, *UTCI*
Jamei and Rajagopalan [132]	2017	Simulation	Local	Cfb	Melbourne	Australia	TI	No, *PET*
Stratópoulos et al.[133]	2018	Measurement	Micro	Cfb	Munich	Germany	TS, LS	No, transpiration rate
Speak et al.[134]	2020	Measurement	Micro	Cfb	Bolzano	Italy	TM, TS, LD	No, T_{sur}
Geletič et al.[135]	2022	Simulation	Local	Cfb	Prague	Czech Republic	TS	No, *UTCI*
Meili et al.[24]	2021	Simulation	Local	Dfb/Cfb	Zurich	Switzerland	TI	Yes
Zhao et al.[12]	2023	Measurement	Local	Dfb/Cfb	Zurich	Switzerland	BM, TD, TM	Yes

Supplementary Table 8. Detailed information of 182 literature in Csa, Csb, Csc, Cwa and Cwb temperate climate, regarding the author (year), method, scale, climate type, city or region, country, topic and quantitative climate indicator.

Author[ref]	Year	Method	Scale	Climate	City or Region	Country or Region	Topic	ΔT_{air}? Or Other Climate Indicators
Shashua-Bar et al.[136]	2012	Measurement	Micro	Csa	Athens	Greece	BM, TD	Yes
Shashua-Bar et al.[137]	2010	Measurement	Micro	Csa	Athens	Greece	BM, TD, TS	Yes
Gulten et al.[138]	2016	Simulation	Micro	Csa	Elazığ	Turkey	TI	No, T_{sur}
Thom et al.[139]	2016	Simulation	Micro	Csa	Adelaide	Australia	TD	No, T_{mrt}
Salata et al.[3]	2015	Simulation	Micro	Csa	Rome	Italy	TI	Yes
Gatto et al.[140]	2020	Measurement and Simulation	Local	Csa	Lecce	Italy	TD, TS	Yes
Segura et al.[141]	2022	Simulation	Local	Csa	Barcelona	Spain	SVF, TD	Yes
Bachir et al.[142]	2021	Simulation	Local	Csa	Mostaganem	Algeria	SVF, TD	Yes
Duncan et al.[143]	2019	Remote Sensing	Meso	Csa	Perth	Australia	TI	No, *LST*
Altunkasa and Uslu[144]	2020	Simulation	Local	Csa	Adana	Turkey	TI	No, *PMV*
Antoniadis et al.[145]	2018	Simulation	Micro	Csa	Volos	Greece	TI	Yes
Salata et al.[146]	2017	Simulation	Local	Csa	Rome	Italy	TI, TD	No, *MOCI*
Detommaso et al.[147]	2021	Simulation	Micro	Csa	Catania	Italy	TI	Yes
Makido et al.[148]	2019	Simulation	Local	Csb	Portland	USA	BM, TI	Yes
Eckmann et al.[149]	2018	Simulation	Micro	Csb	Portland Oregon	USA	TI	Yes
Wang et al.[64]	2018	Simulation	Meso	Csc	Cascadia	USA	TI	Yes
Zhang et al.[150]	2022	Measurement	Micro	Cwa	Zhumadian	China	TD, TM	Yes
Ouyang et al.[151]	2021	Measurement	Micro	Cwa	Hong Kong	China	TI	Yes
Cheung and Jim[152]	2018	Measurement	Micro	Cwa	Hong Kong	China	TI	Yes
Wang et al.[153]	2022	Simulation	Micro	Cwa	Hong Kong	China	TM, TL, TS, LD	Yes
Jia and Wang[154]	2021	Simulation	Micro	Cwa	Hong Kong	China	TI	Yes
Raman et al.[155]	2021	Simulation	Local	Cwa	Patna	India	BM, TD	No, T_{mrt}
Ouyang et al.[156]	2020	Simulation	Local	Cwa	Hong Kong	China	BM, TD	Yes
Tan et al.[157]	2017	Simulation	Local	Cwa	Hong Kong	China	SVF	Yes
Tan et al.[158]	2016	Simulation	Local	Cwa	Hong Kong	China	SVF	Yes
Morakinyo et al.[159]	2020	Simulation	Micro &Local	Cwa	Hong Kong	China	SVF, TD, TM, LD	Yes
Morakinyo et al.[160]	2017	Simulation	Micro &Local	Cwa	Hong Kong	China	BM, TM, TS, LD	No, *PET*
Ma et al.[161]	2019	Measurement and Simulation	Local	Cwa	Fo Shan	China	TI	No, *PET*
Ng et al.[162]	2012	Simulation	Local	Cwa	Hong Kong	China	BM, TD	Yes
Yang et al.[49]	2019	Simulation	Micro	BSk/Cwa	Xian	China	TD	No, *PET*
Yang et al.[50]	2018	Simulation	Micro	BSk/Cwa	Xian	China	TM, TL	No, *PET*
Zhang et al.[51]	2022	Measurement	Local	BSk/Cwa	Xian	China	TS	No, *UTCI*
Ballinas and Barradas[163]	2016	Simulation	Local	Cwb	Mexico city	Mexico	TD	Yes
Wang et al.[64]	2018	Simulation	Meso	Cwb	Northeast	USA	TI	Yes

Supplementary Table 9. Detailed information of 182 literature in continental climates, regarding the author (year), method, scale, climate type, city or region, country, topic and quantitative climate indicator.

Author[ref]	Year	Method	Scale	Climate	City or Region	Country or Region	Topic	ΔT_{air}? Or Other Climate Indicators
Ziter et al.[164]	2019	Measurement	Local	Dfa	Madison	USA	TD	Yes
Park et al.[165]	2021	Remote Sensing	Local	Dfa	Columbus	USA	TD	No, *LST*
Berardi et al.[166]	2020	Simulation	Micro &Meso	Dfa	Greater Toronto Area	Canada	TD	Yes
Wang et al.[64]	2018	Simulation	Meso	Dfa/Dfb	Great Lakes	USA	TI	Yes
Gillner et al.[167]	2015	Measurement	Micro	Dfb	Dresden	Germany	TS, LD, LS	Yes
Millward et al.[168]	2014	Measurement	Micro	Dfb	Toronto	Canada	TM, TL, TS, LD	No, T_{sur}
De Luca[6]	2022	Simulation	Micro	Dfb	Tallinn	Estonia	TD	No, *UTCI*
Wang and Akbari[169]	2016	Simulation	Local	Dfb	Montreal	Canada	TD, TM, TS, LD	Yes
Meili et al.[24]	2021	Simulation	Local	Dfb/Cfb	Zurich	Switzerland	TI	Yes
Zhao et al.[12]	2023	Measurement	Local	Dfb/Cfb	Zurich	Switzerland	BM, TD, TM	Yes
Wang et al.[170]	2016	Simulation	Local	Dfb	Toronto	Canada	BM, TI	Yes
Yilmaz et al.[171]	2020	Simulation	Micro	Dsb	Erzurum	Turkey	BM, TI	Yes
Du et al.[172]	2020	Measurement	Micro	Dwa	Harbin	China	TI	Yes
Jiao et al.[173]	2017	Measurement	Micro	Dwa	Beijing	China	TL, TS	Yes
Li et al.[4]	2020	Simulation	Micro	Dwa	Harbin	China	SVF	Yes
Park et al.[174]	2019	Simulation	Micro	Dwa	Seoul	South Korea	TI	No, T_{mrt}
Park et al.[175]	2019	Simulation	Micro	Dwa	Seoul	South Korea	TM, TL	No, T_{mrt}
Hong and Lin[176]	2015	Simulation	Micro	Dwa	Beijing	China	BM, TL	No, *SET*
Zhang et al.[177]	2023	Simulation	Local	Dwa	Qingdao	China	TM, TS, LD	No, *PET*
Choi et al.[178]	2021	Simulation	Local	Dwa	Seoul	South Korea	TD	Yes
Wu et al.[179]	2019	Simulation	Local	Dwa	Beijing	China	BM, TD	Yes
Wang and Zacharias[180]	2015	Simulation	Local	Dwa	Beijing	China	TD, TM	Yes
Wu and Chen[181]	2017	Measurement and Simulation	Local	Dwa	Beijing	China	TL	Yes
Ren et al.[182]	2021	Measurement	Local	Dwa	Changchun	China	TD	Yes
Park et al.[183]	2018	Simulation	Micro	Dwa	Seoul	South Korea	BM, TI	No, T_{mrt}
Miao et al.[184]	2023	Measurement	Local	Dwa	Shenyang	China	TI	Yes
Yang et al.[185]	2022	Remote Sensing	Meso	None	None	None	TI	Yes
Marando et al.[186]	2022	Remote Sensing	Meso	None	Europe	Europe	TI	Yes
Wang et al.[187]	2019	Remote Sensing	Meso	None	USA	USA	TI	No, *LST*

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