

Das Klima der Städte – Konzepte, Methoden und Observierungen in Berlin

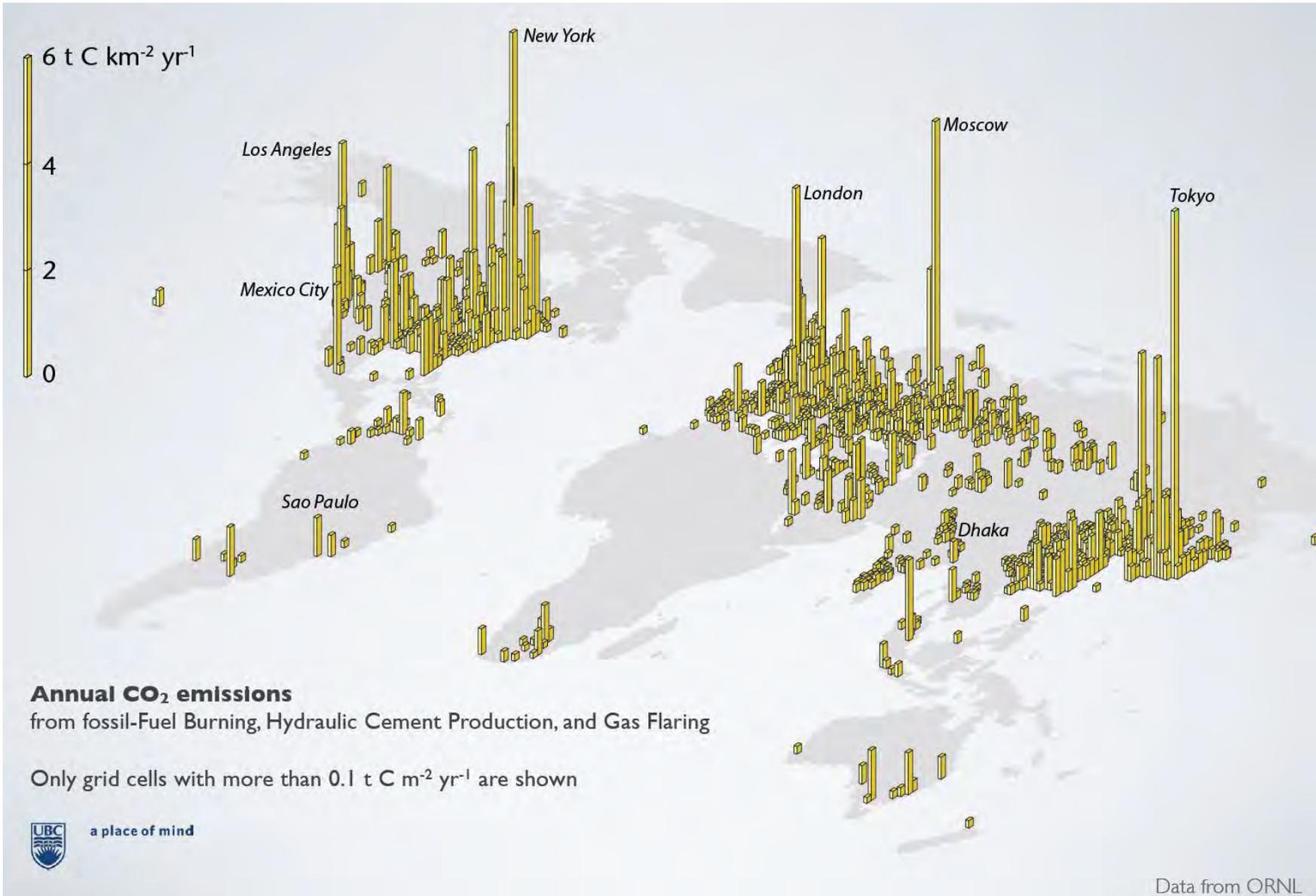


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www.uco.berlin



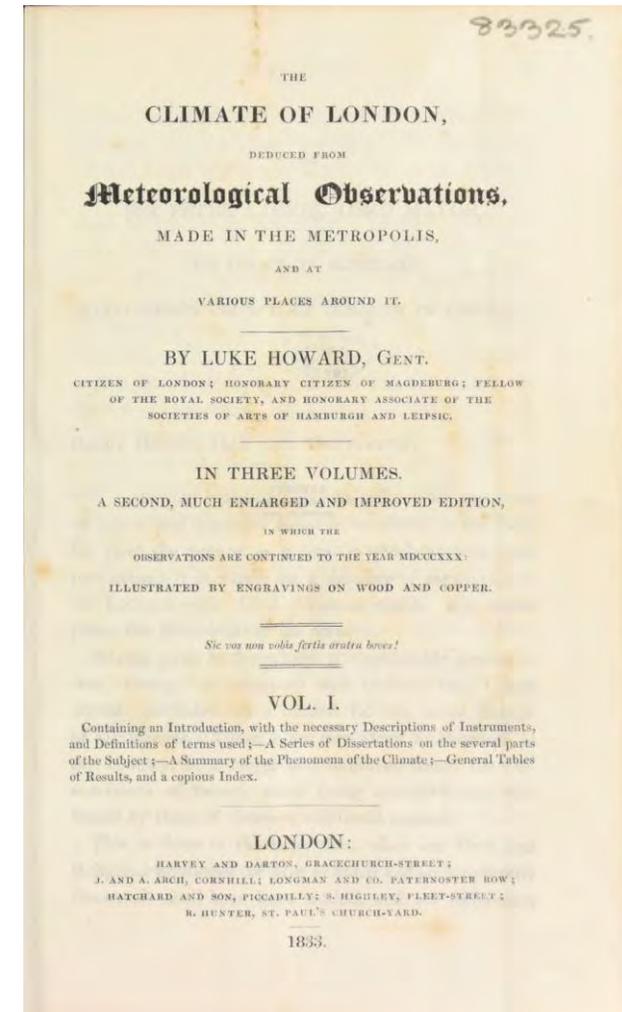
Das Zeitalter der Städte - CO₂ Emissionen



Christen A. (2012): 'Progress in measuring and modeling greenhouse gas exchange in urban ecosystems'. Invited plenary talk at ICUC-8 - 8th International Conference on Urban Climate. Dublin, Ireland. Aug 6 - 10, 2012.

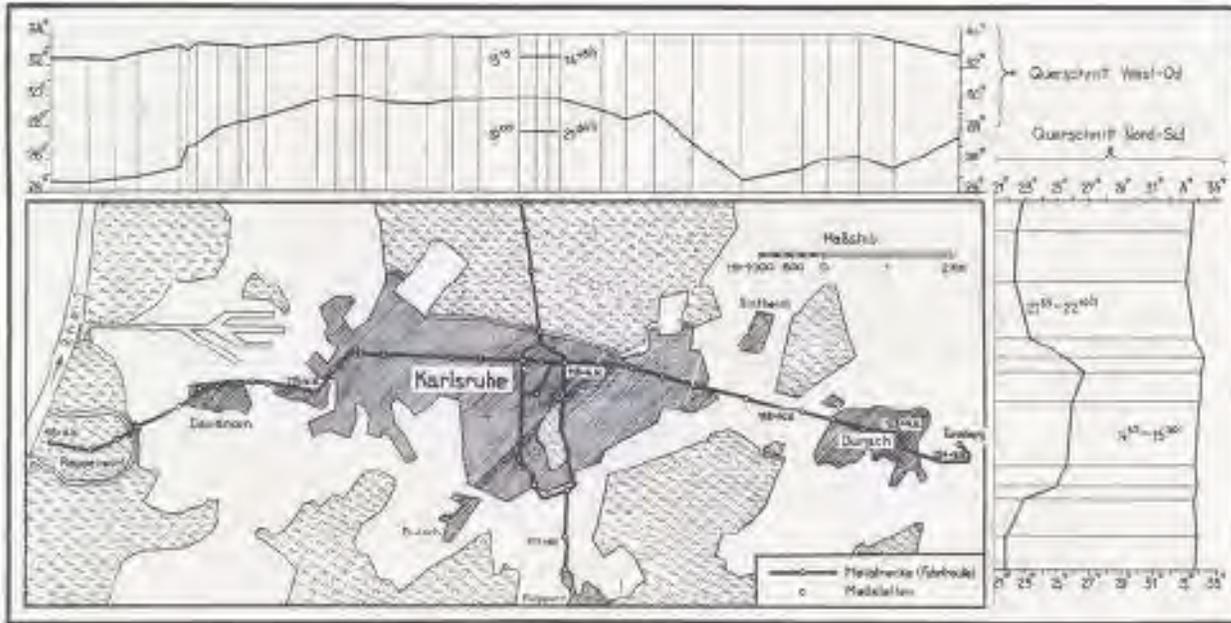
Geschichte der modernen Stadtklimatologie

- 1818: Buch „Climate of London“ von *Luke Howard* (Mittelwert Wärmeinsel)
- 1848: Messnetz in Preußen
- 1896: Berlin: Niederschlag
- 1909: Berlin: Windbremsung
- 1927: Wien: Verteilung der Lufttemperaturen (Wilhelm Schmidt)
- 1937: erste Monographie (*Albert Kratzer*)
- 1966: München: Thermalluftbild
- 1968: WMO Symposium on Urban Climates and Building Climatology
- 1974: METROMEX (USA) Einfluss der Stadt auf Niederschlagsbildung
- 1976: Distinction between canopy and boundary-layer heat islands (*T. Oke*)
- 1976: Urban Development and Urban Climate–Stuttgart: An Example from the Federal Republic of Germany (<http://www.youtube.com/watch?v=-av6g4gdvw4>)
- 1981: Buch „The Urban Climate“ (*H. Landsberg*)
- 1984: Artikel „Methods in urban climatology“ (*T. Oke*)



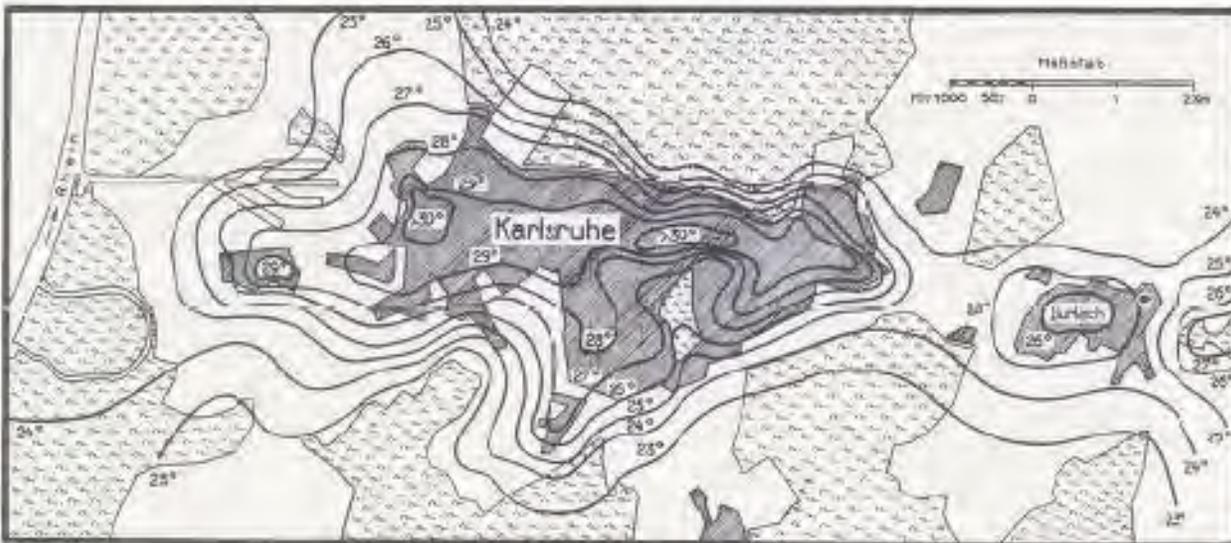
F. Fezer (1995): Das Klima der Städte. Perthes, Gotha.

Geschichte der modernen Stadtklimatologie



Messtrecke und das daraus abgeleitete
Temperaturfeld für Karlsruhe am 23.07.1929
Messungen von Albert Peppler

*„Um die meteorologischen Verhältnisse der
bodennahen Luftschichten rasch und bequem über
großen Flächen festzustellen, ist der Kraftwagen das
gegebene Forschungsmittel“*



*„Die Temperaturdifferenzen zwischen dem Stadtinnern
und der Umgebung betragen bis 7°.“*

Deutsches Meteorologisches Jahrbuch Baden 1929, S. 59f
<https://dwdbib.dwd.de/retrosammlung/periodical/pageview/138519>

Definitionen „Stadtklima“

“The study of the physical, chemical and biological processes operating to produce or change the state of the **urban atmosphere** is called **urban meteorology**. The study of the statistically preferred states of urban weather is **urban climatology**, which includes quantitative description of the climates themselves, the use of meteorological knowledge to explain climatic differences (**physical climatology**) and the use of climatic data to solve practical problems (**applied climatology**) in urban areas.”

T.R. Oke, G. Mills, A. Christen, J.A. Voogt (2017): Urban Climates. – Cambridge University Press, Cambridge

„Das **Stadtklima** ist das durch die Wechselwirkung mit der Bebauung und deren Auswirkungen (einschließlich Abwärme und Emission von luftverunreinigten Stoffen) modifizierte Klima.“

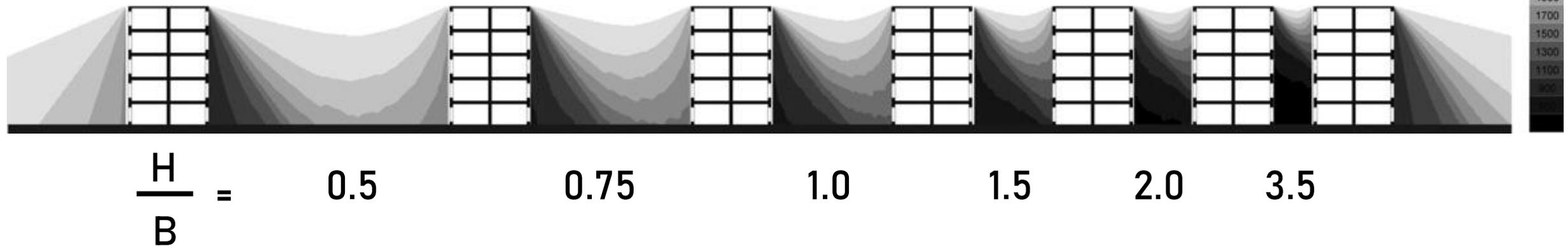
W. Kuttler (2004): Stadtklima, Teil 1: Grundzüge und Ursachen. In: Umweltwissenschaften und Schadstoffforschung – Zeitschrift für Umweltchemie und Ökotoxikologie 16(3), S. 187–199.

„**Ideales Stadtklima** ist ein räumlich und zeitlich variabler Zustand der Atmosphäre in urbanen Bereichen, bei dem sich möglichst **keine** anthropogen erzeugten **Schadstoffe** in der Luft befinden und dem **Stadtbewohner in Gelänge** (charakteristische Länge 150 m) eine möglichst **große Vielfalt** an Atmosphärenzuständen (Vielfalt der urbanen **Mikrokimate**) unter **Vermeidung von Extremen** geboten wird“



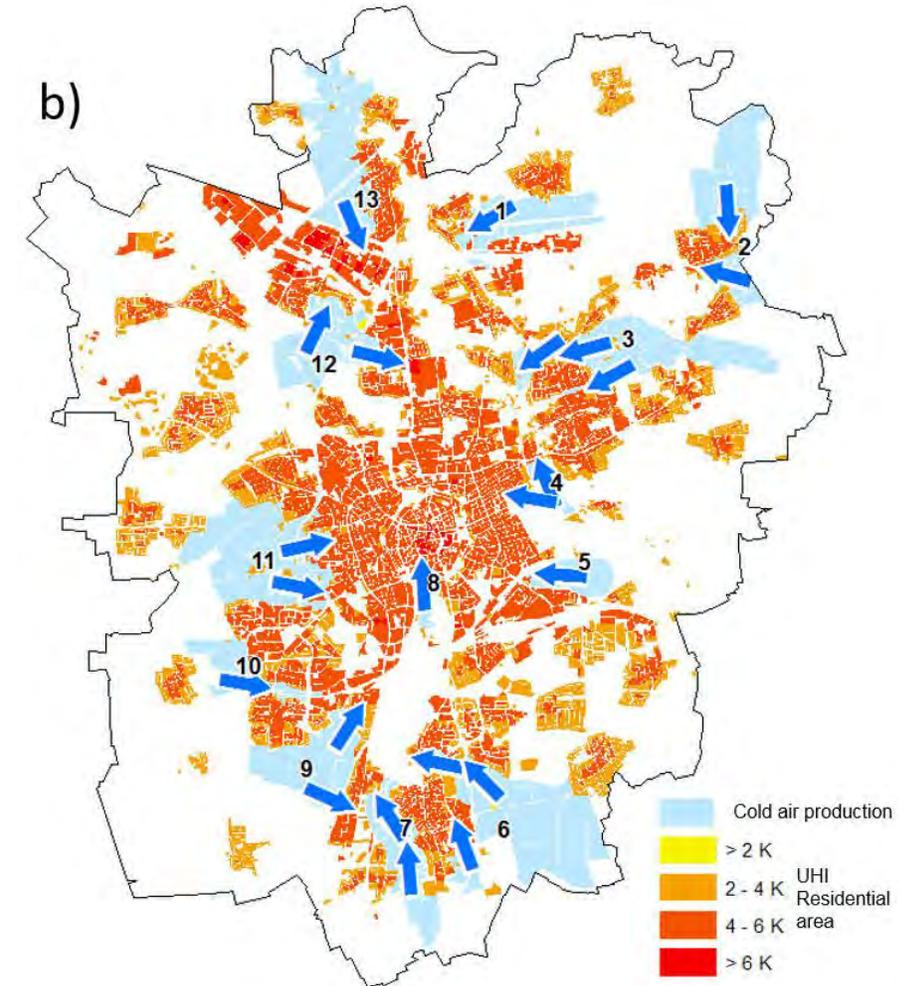
- Gute natürliche Beleuchtung
- Schaffung günstiger Innenraumklimata
- Vermeidung klimatisch bedingter Bauschäden
- Reduktion des Energie- und Ressourcenverbrauchs

Avg. Daily solar radiation, (North-South)



Stromann-Andersen, J. & Sattrup, P. A. (2011): The urban canyon and building energy use: Urban density versus daylight and passive solar gains. Energy and Buildings 43, 2011-2020.

- Reduktion negativer klimatischer Effekte (Hitzestress, Kältestress, Turbulenzen, Wasserstress bei Pflanzen)
- Verbesserung des Lokal- und Mikroklimas (Kaltluftbildung)
- Reduktion der Luftschadstoffemissionen
- Reduktion von Luftbelastungen (Transmission)
- Reduktion des Energie- und Ressourcenverbrauchs



Grunwald L, Kossmann M, Weber S (2019) Mapping urban cold-air paths in a Central European city using numerical modelling and geospatial analysis. Urban Climate 29

- Inwiefern unterscheiden sich Städte klimatisch vom Umland?
- Wie unterscheidet sich das Klima innerhalb von Städten?
- Wie genau können stadtklimatische Phänomene quantifiziert werden?
- Wie gut können stadtklimatische Phänomene modelliert werden?
- Welche Auswirkungen haben Stadtwetter, Stadtklima und Luftqualität auf Mensch, Umwelt und Gesellschaft?
- Wie wirken sich Stadtentwicklung und der Klimawandel auf Stadtklimate aus?

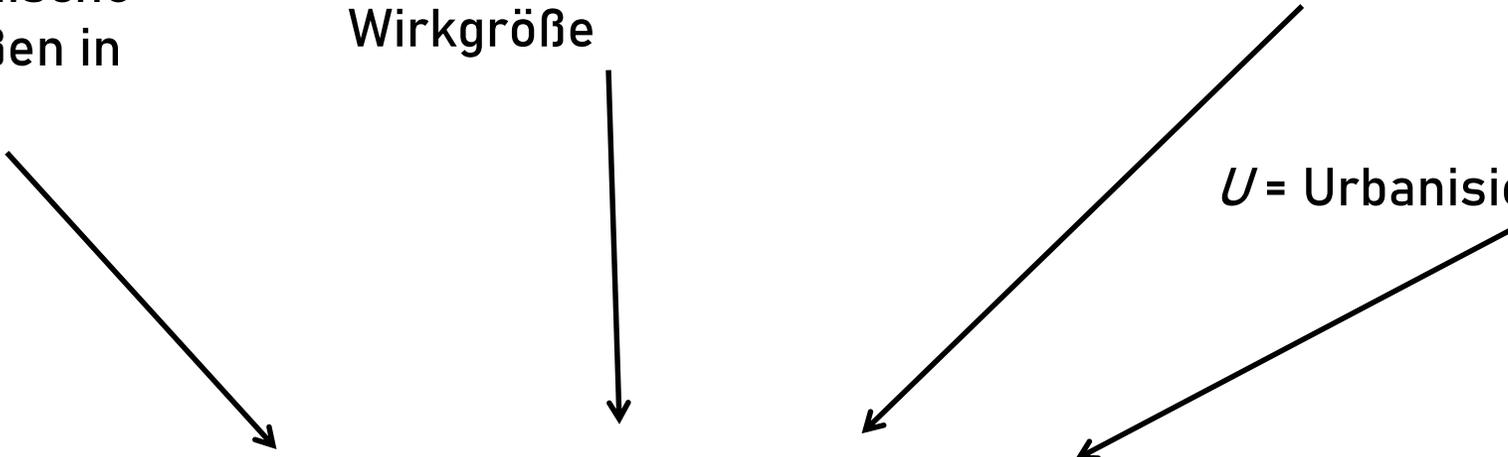
Methodischer Rahmen – Empirische Ermittlung stadtklimatischer Phänomene

W = Werte,
klimatische und
luftthygienische
Messgrößen in
Städten

H = Hintergrundwert,
durch großräumige
geographische Lage
vorgegebene
Wirkgröße

T = Topographiewert, durch
Oberflächengestalt und
Flächennutzung bestimmte
regionale Beeinflussung

U = Urbanisierungsgrad

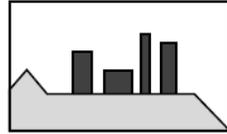
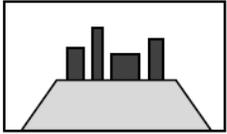

$$W_{itx} = H_{itx} + T_{itx} + U_{itx}$$

i = Witterungstyp, t = Messzeitpunkt, x = Lage des Messpunktes in der Stadt

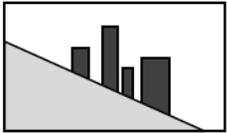
Methodischer Rahmen – Empirische Ermittlung stadtklimatischer Phänomene

1. Orographic element > urban area

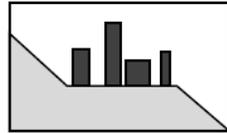
1.1 Mountain top or ridge 1.2 Plateau



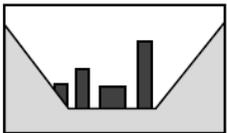
1.3 Slope



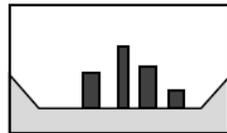
1.4 Slope terrace



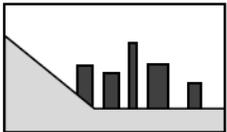
1.5 Valley



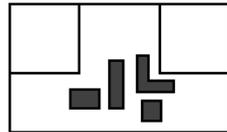
1.6 Basin



1.7 Slope base



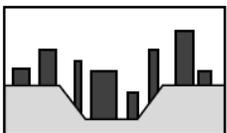
1.8 Mountain pass entrance



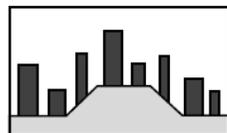
Plan view

2. Orographic element < urban area

2.1 Valley within urban area

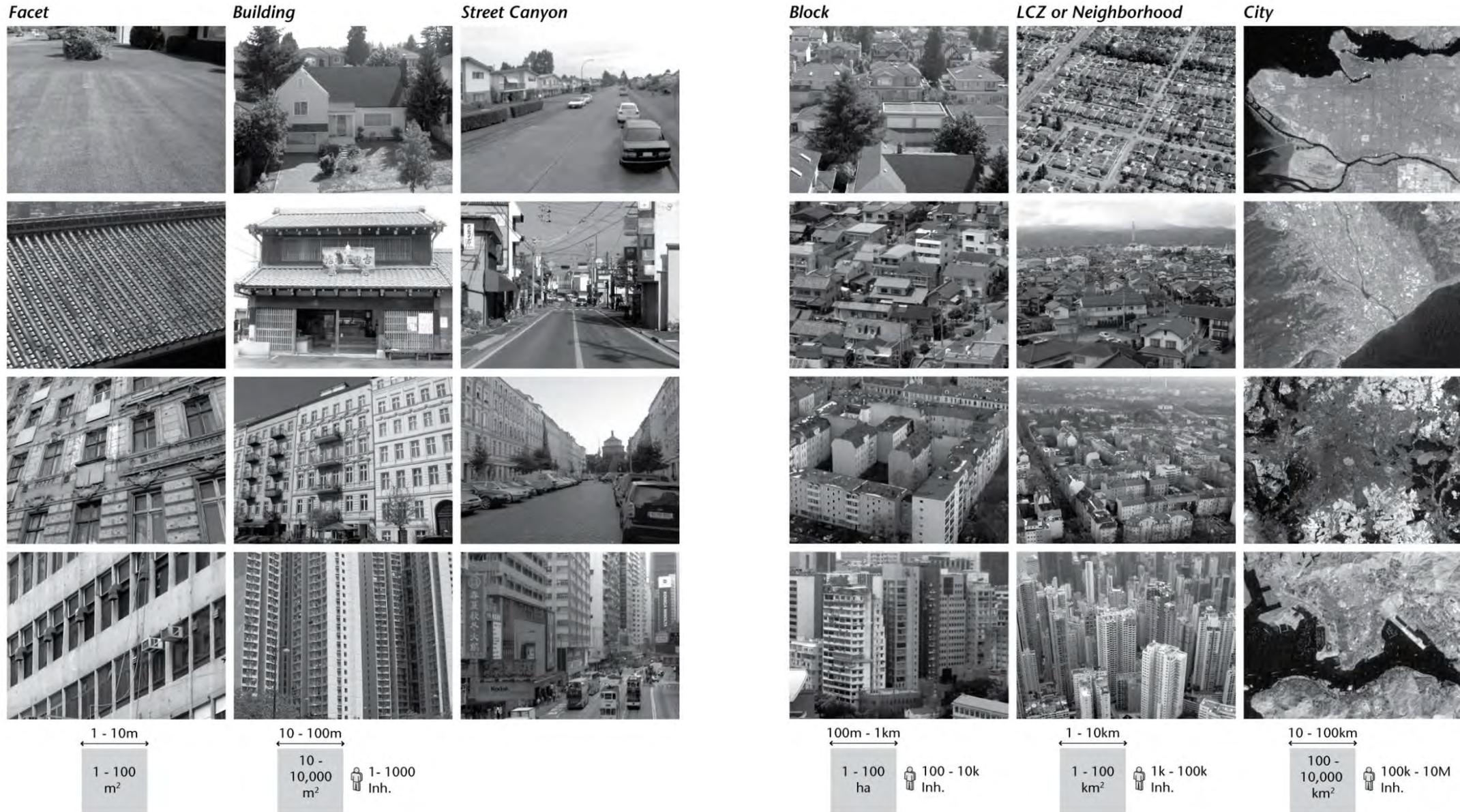


2.2 Small mountain or hill within urban area

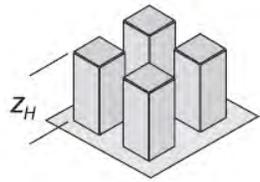


Wanner H, Filliger P (1989): Orographical influence on urban climate. Weather and Climate 9, 22–28.

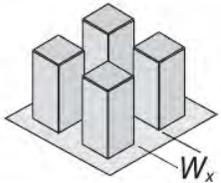
Methodischer Rahmen – Horizontale Skalen



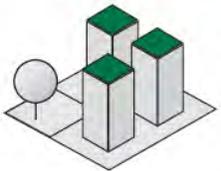
Methodischer Rahmen – Charakteristika der städtischen Morphologie



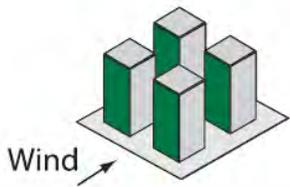
Mittlere Gebäudehöhe (z_H)
Flächengewichtete mittlere Gebäudehöhe
Suburban: 4–8 m
Urban: 8–20 m (City: > 20 m)



Charakteristische Strassenschluchtbreite (W_x)
Mittlere Entfernung zwischen Gebäuden. Beinhaltet Strassen, Hinterhöfe und andere unbebaute Flächen.



Grundflächenindex
Grundfläche pro Einheitsfläche
Suburban: 0.15–0.4
Urban: 0.35–0.65



Stirnflächenindex
Verhältnis der projizierten Stirnfläche zur Einheitsfläche (richtungabhängig). Mit Vegetation erhöht sich der Index deutlich.
Suburban: 0.1–0.3
Urban: 0.1–0.6 (City: > 0.4)



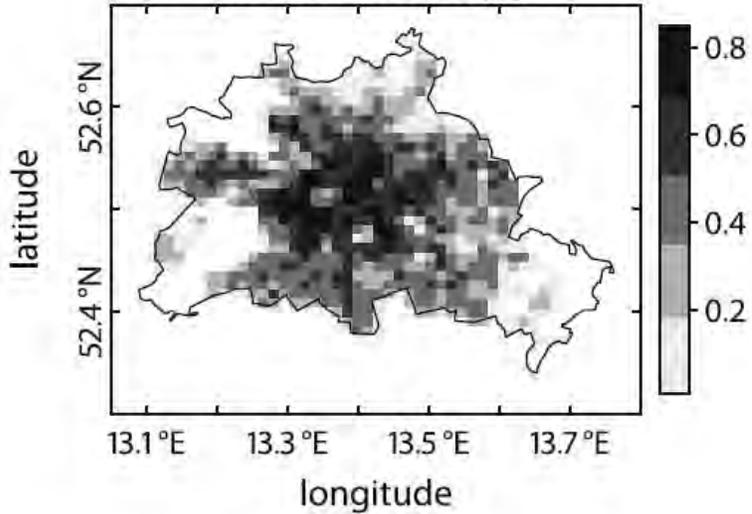
Aussenflächenindex
Verhältnis der 3D-Oberfläche zur Einheitsfläche
Suburban: 1.3–1.8
Urban: 1.5–2.0 (City: > 2)



A. Christen, A. & R. Vogt (2005): Hoch hinaus – ein 3D-Stadtmodell in meteorologischen Anwendungen. GEOMATIK SCHWEIZ 103, 360–361.

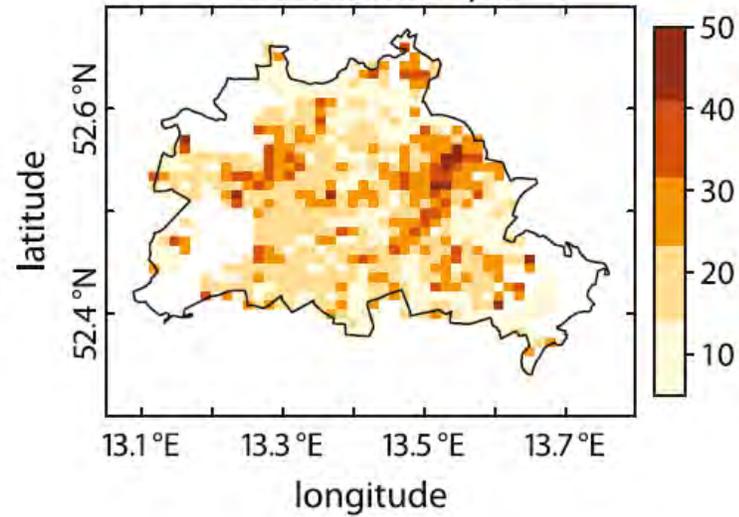
Methodischer Rahmen – Charakteristika der städtischen Morphologie

Urban fraction f_{urb}



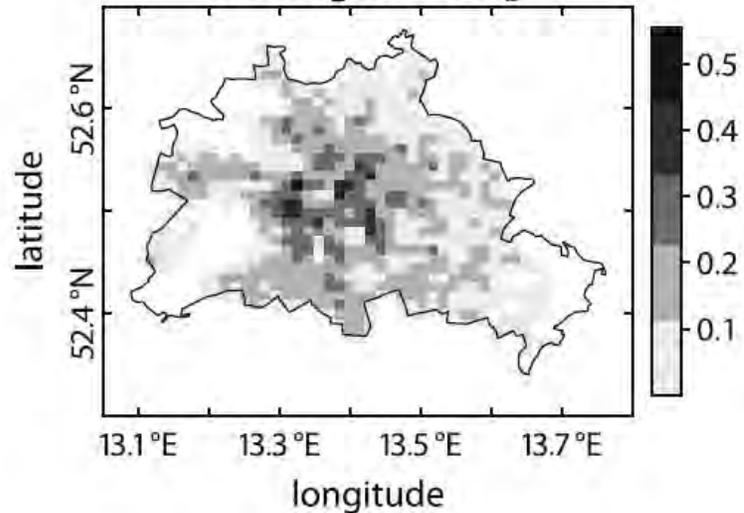
(a)

Street width \bar{W}/m

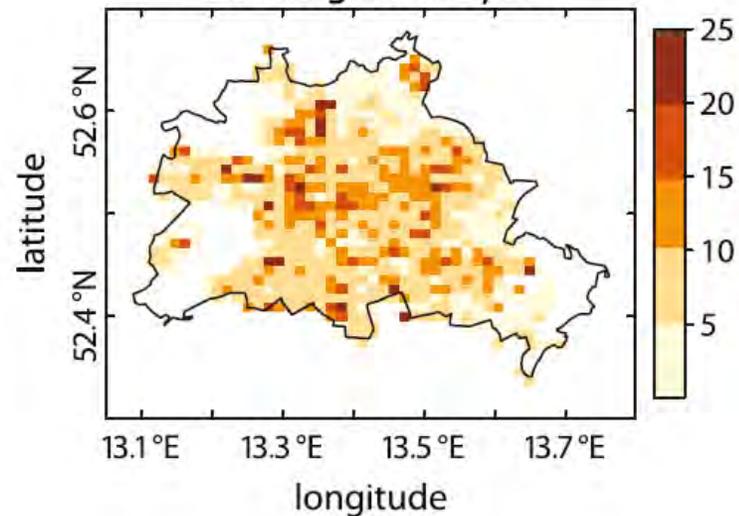


(e)

Building fraction f_b



Building width \bar{B}/m



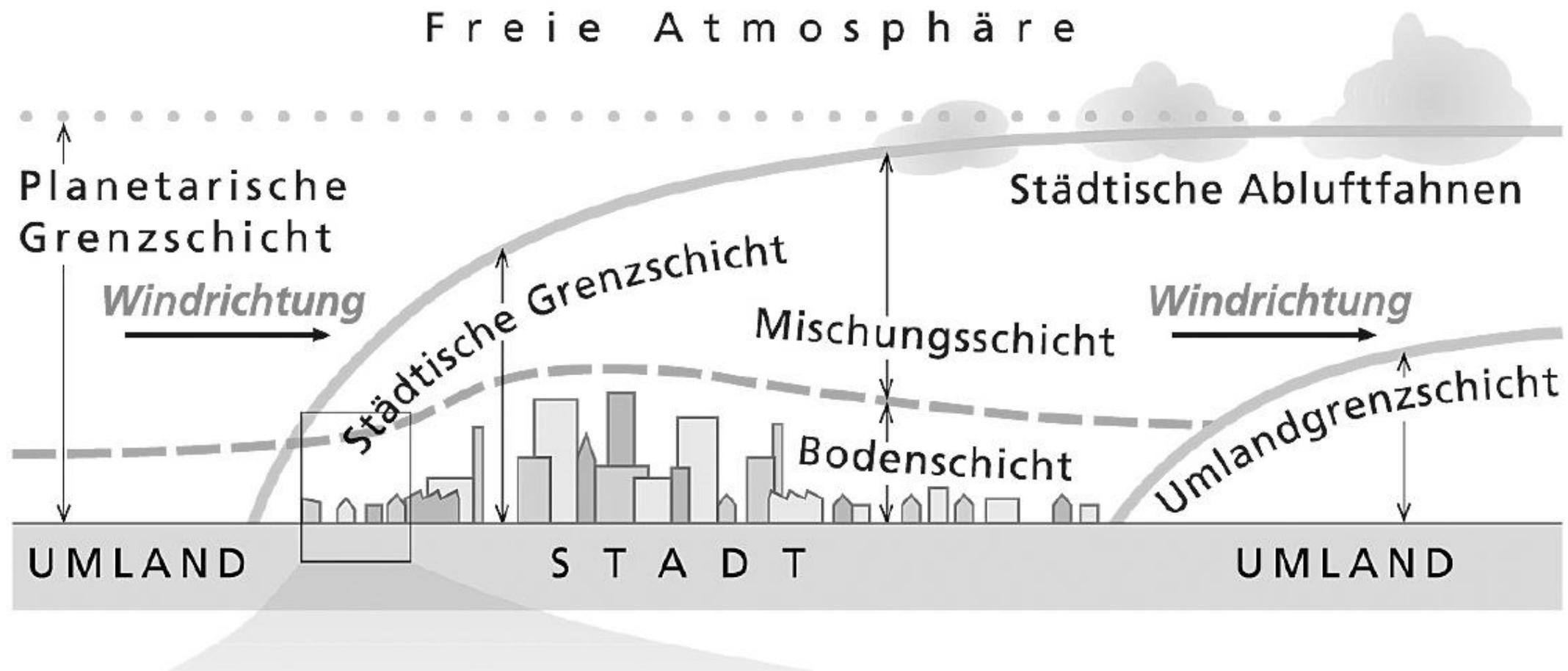
*S. Schubert and S. Grossmann-Clarke (2013):
The Influence of green areas and roof albedos
on air temperatures during Extreme Heat
Events in Berlin, Germany. Meteorologische
Zeitschrift, 22, 131–143.*

Methodischer Rahmen – Charakteristika der städtischen Morphologie



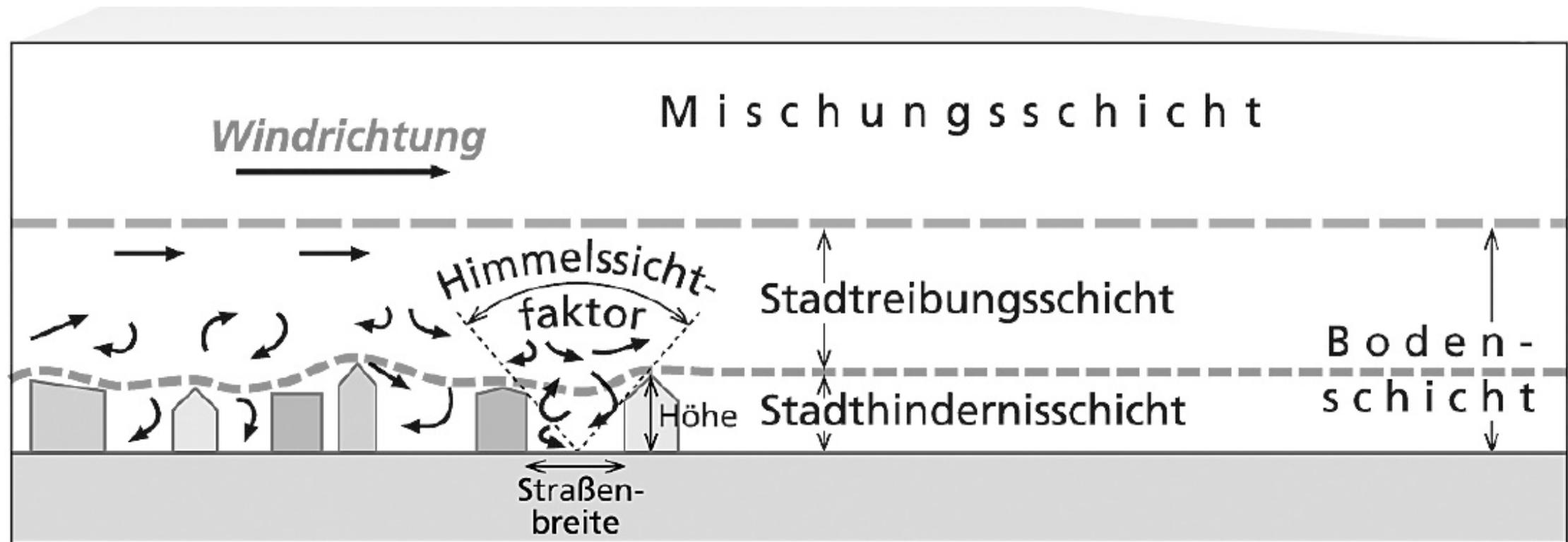
Abbildung: Prof. Dr. Dieter Scherer

Aufbau der urbanen Atmosphäre



Städtische Grenzschicht = Urban Boundary Layer (UBL)

Aufbau der urbanen Atmosphäre



Stadthindernisschicht = Urban Canopy Layer (UCL), Boden bis mittlere Höhe der Bebauung

Stadtreibungsschicht = Urban Roughness Sublayer

Aufbau der urbanen Atmosphäre - Himmelssichtfaktor

(d) Street canyon



$$\psi_{\text{sky}} = 0.23$$

(e) Intersection



$$\psi_{\text{sky}} = 0.21$$

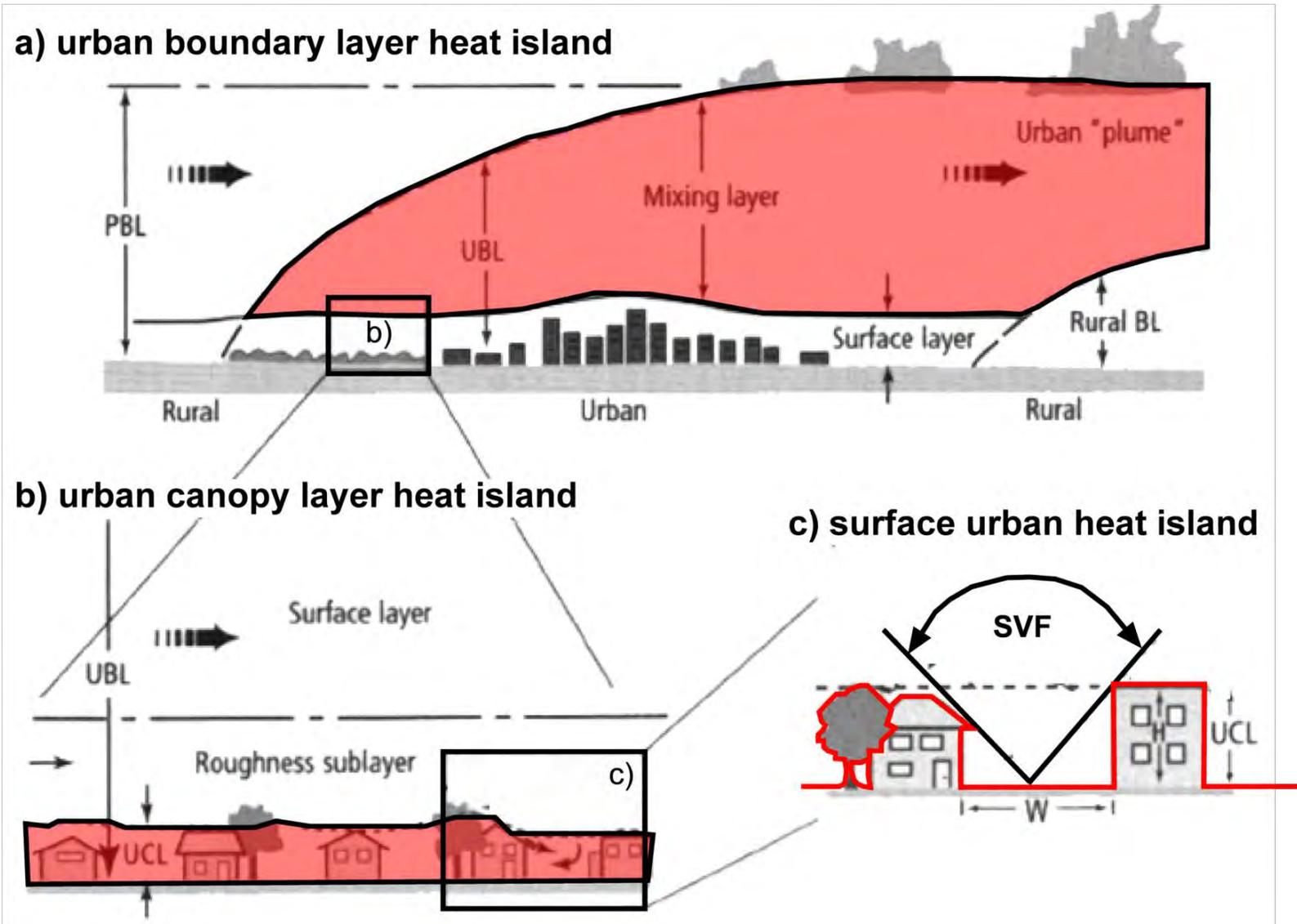
(f) Courtyard



$$\psi_{\text{sky}} = 0.15$$

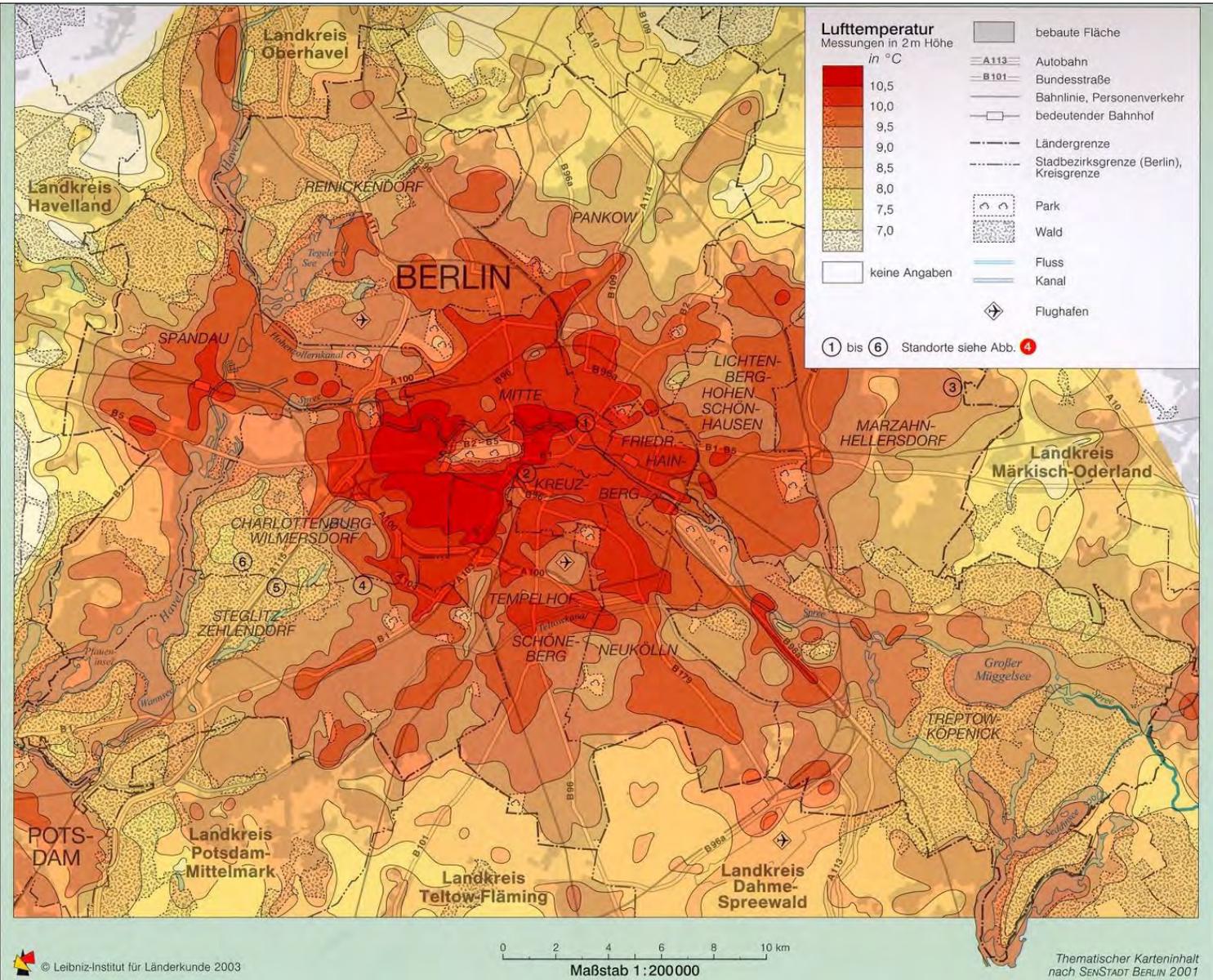
T.R. Oke, G. Mills, A. Christen, J.A. Voogt (2017): Urban Climates. - Cambridge University Press, Cambridge

Die städtische(n) Wärmeinsel(n)



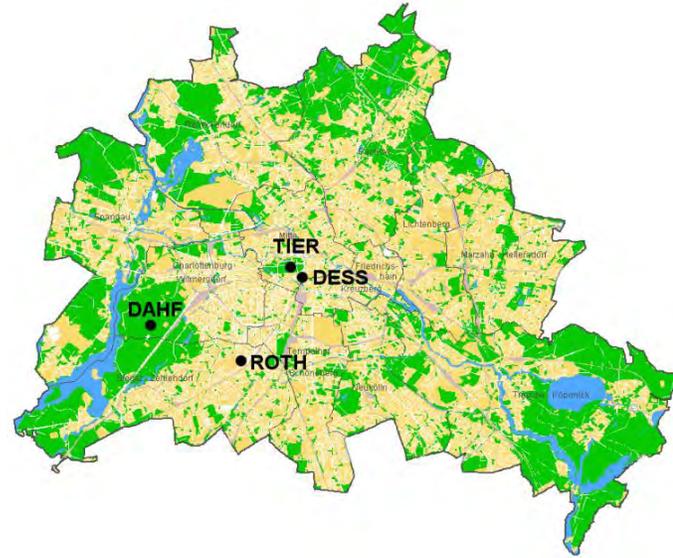
nach T.R. Oke (1997): Urban Environments. In Bailey, Oke, Rouse (Hrsg.): The surface climates of Canada. S. 303-327.

Räumliches Muster der Lufttemperatur in Berlin



*Nationalatlas Bundesrepublik
Deutschland (2003)
Band 3 – Natur und Umwelt II:
Klima, Pflanzen- und Tierwelt*

Die städtische Wärmeinsel im Urban Canopy Layer (UCL)

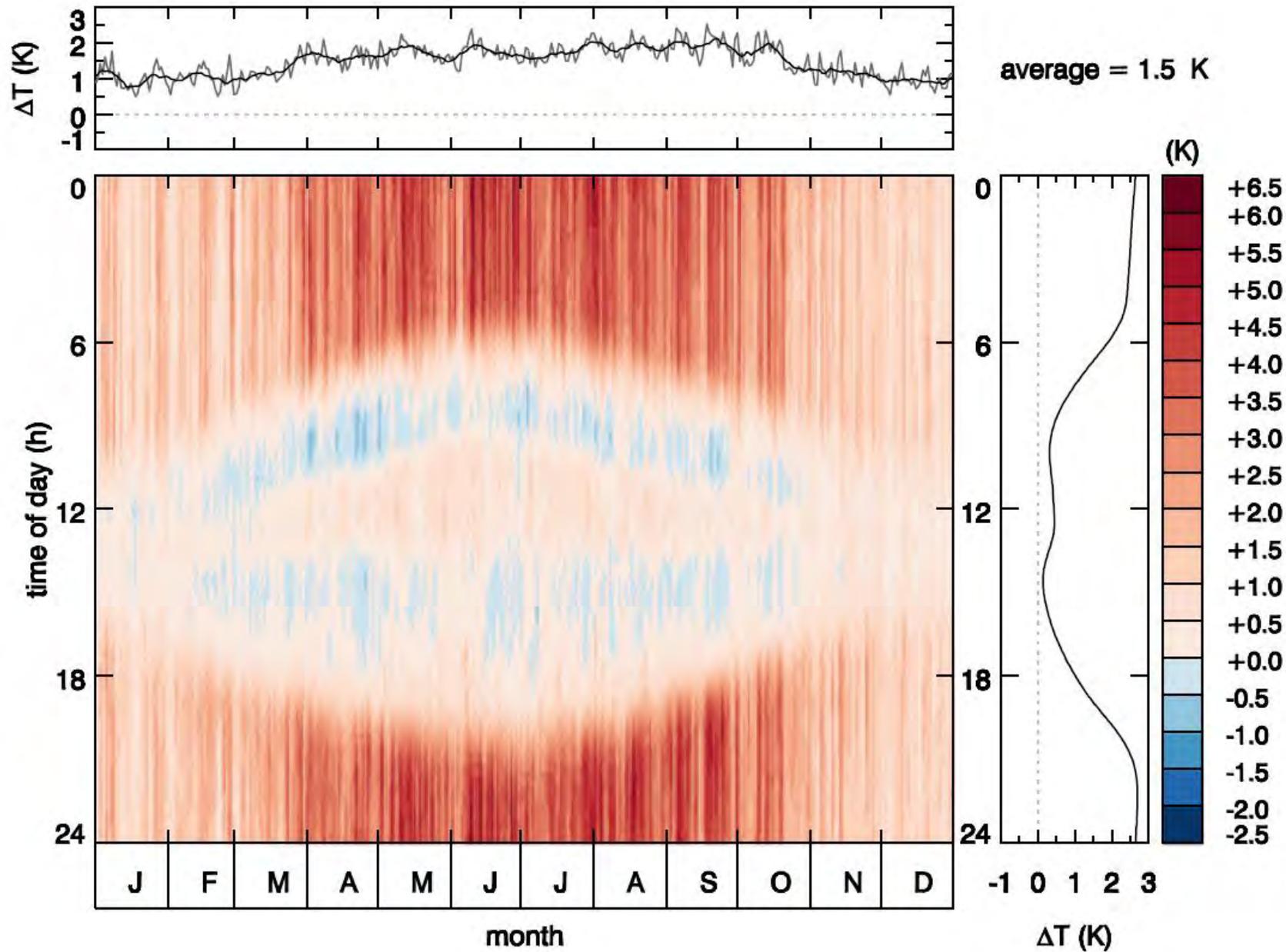


I	$\Delta \bar{T}_{u-r}^{10y}$ [K]	ΔT_{u-r}^{95p} [K]	ΔT_{u-r}^{Max} [K]
DESS	1.5	6.1	11.5
ROTH	0.8	3.7	9.0
TIER	0.5	3.4	9.1

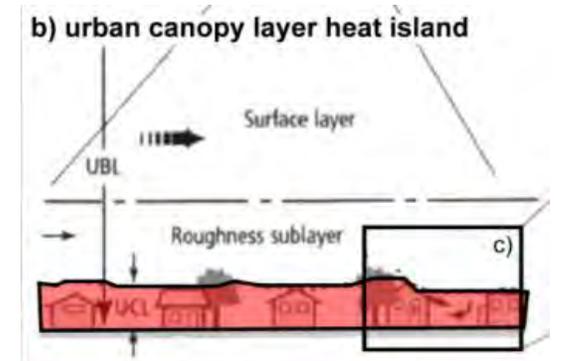


D. Fenner, F. Meier, D. Scherer, A. Polze (2014): Spatial and temporal air temperature variability in Berlin, Germany, during the years 2001-2010. Urban Climate, 10, 308-331.

Die städtische Wärmeinsel im Urban Canopy Layer (UCL)



T_a DESS - T_a DAHF



D. Fenner, F. Meier, D. Scherer, A. Polze (2014): Spatial and temporal air temperature variability in Berlin, Germany, during the years 2001-2010. Urban Climate, 10, 308-331.

Die städtische Wärmeinsel im Urban Canopy Layer (UCL)

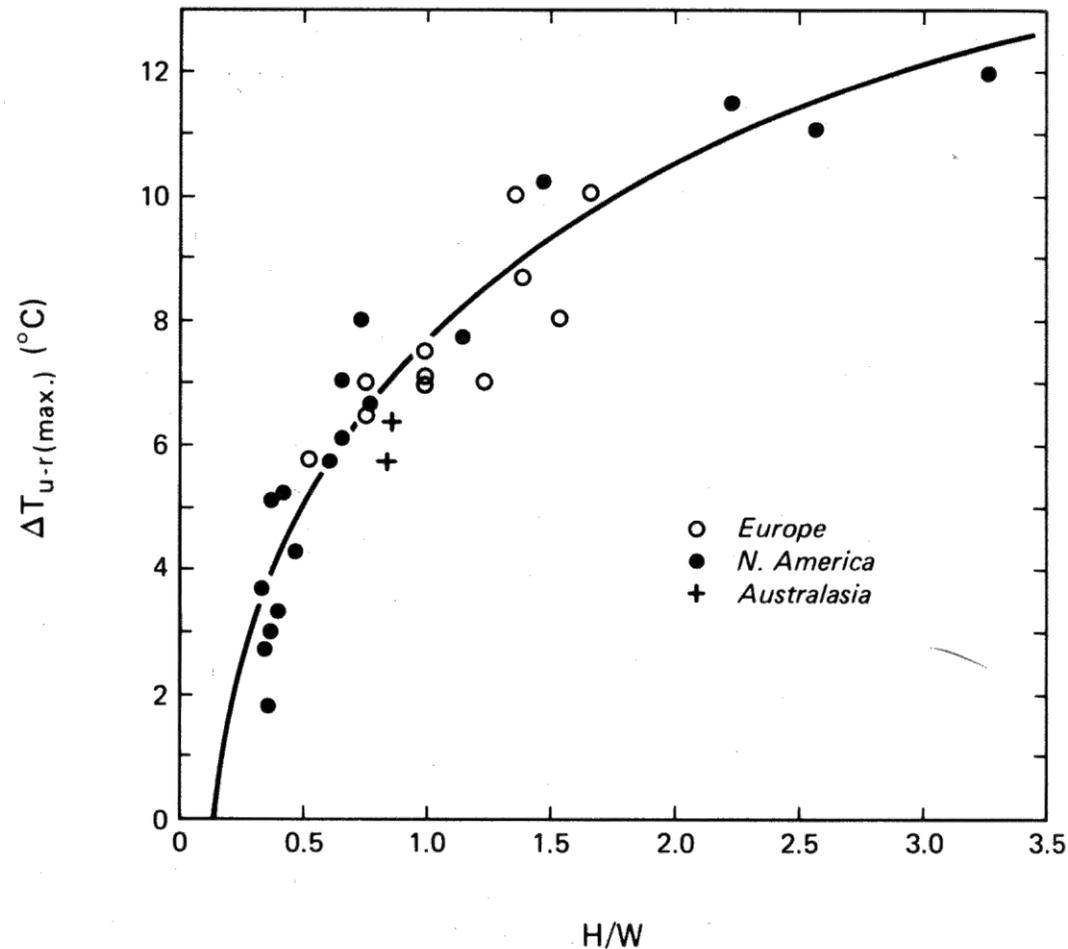
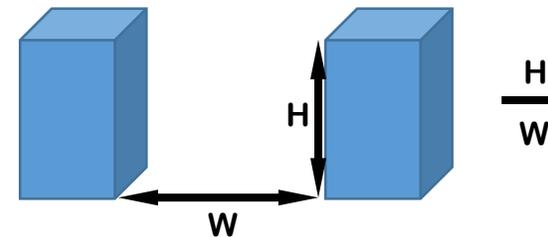


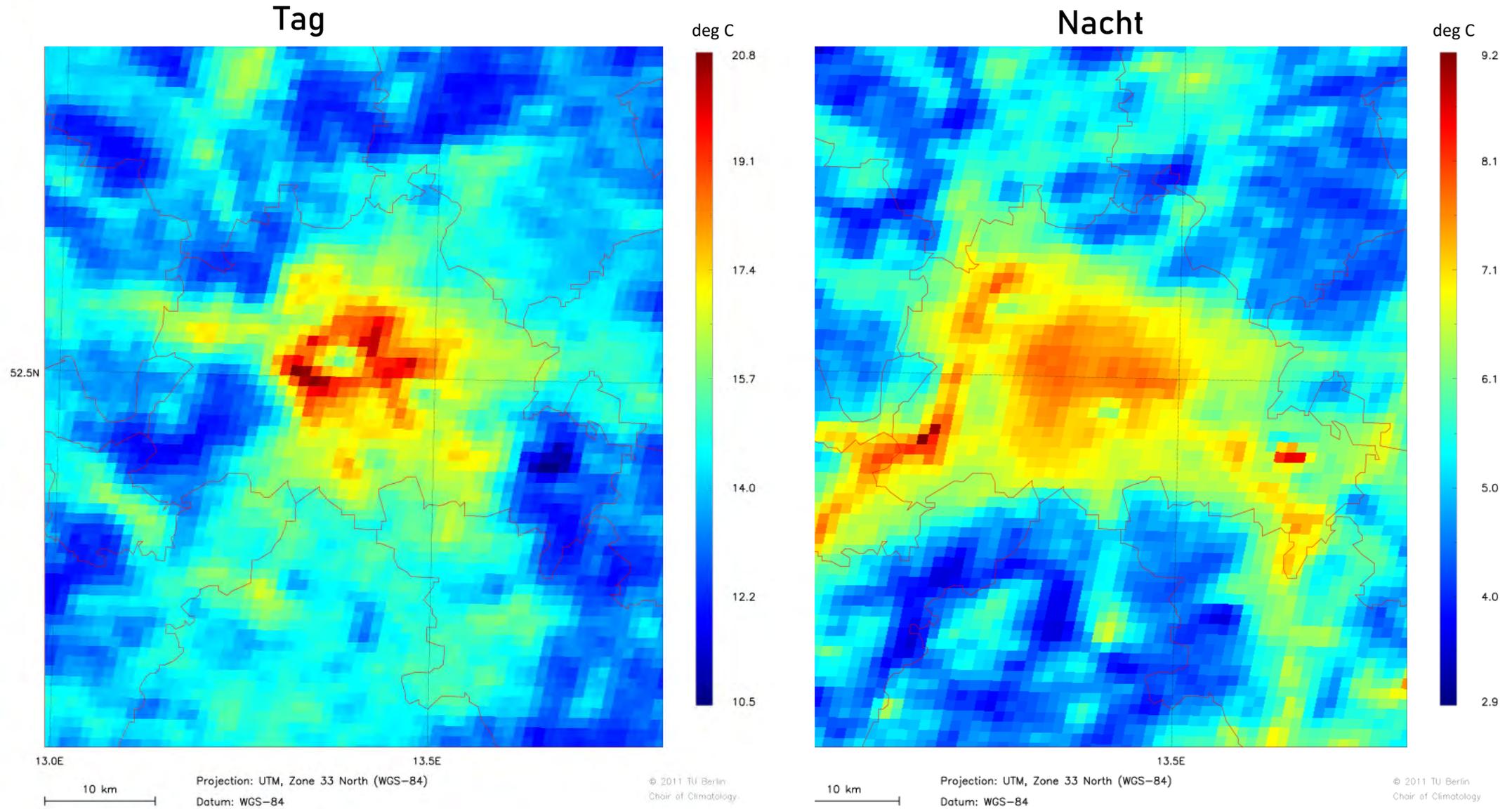
Figure 8.16 Relation between the maximum heat island intensity ($\Delta T_{u-r(max)}$) and the height to width ratio (H/W) of the street canyons in the centres of 31 cities. For the equation of the line see the text. Data from the study of Oke (1981).

Beziehung zwischen der maximalen Intensität der urbanen Wärmeinsel und dem Höhen-Breiten- Verhältnis von Straßenschluchten im Stadtzentrum



T. Oke (1981): Canyon geometry and the nocturnal urban heat island: comparison of scale model and field observations. *Journal of Climatology*, 1, 237-254 .

Die städtische Wärmeinsel im Urban Canopy Layer (UCL)



Landoberflächentemperaturen (Mittelwerte 2000-2011) MODIS-Satellitendaten

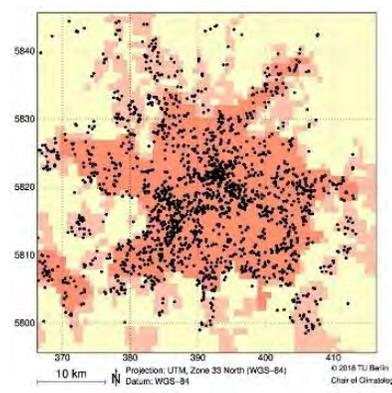
Stadtklima-Observatorium Berlin – Urban Climate Observatory (UCO) Berlin



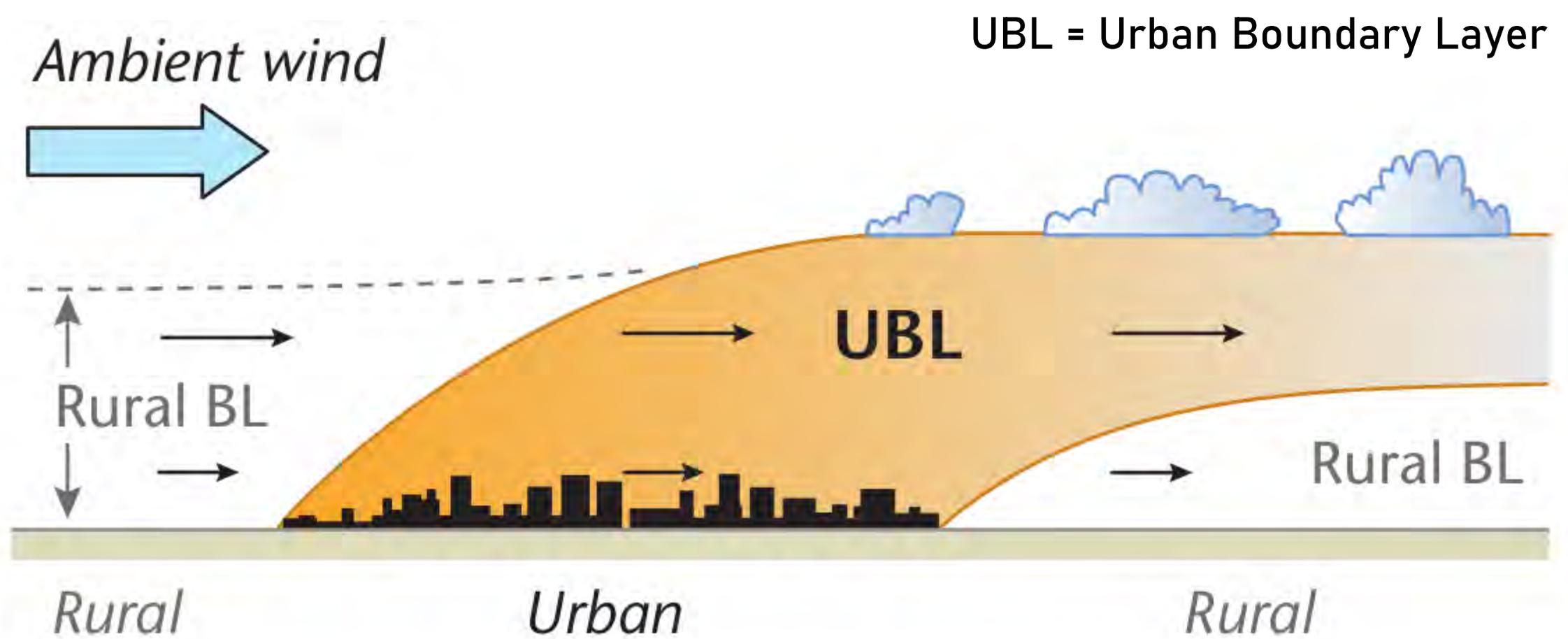
Bodengestützte Fernerkundung der urbanen Grenzschicht für Profile der Lufttemperatur, Luftfeuchte, Aerosole, Windgeschwindigkeit und Windrichtung sowie Wolken und Niederschlag



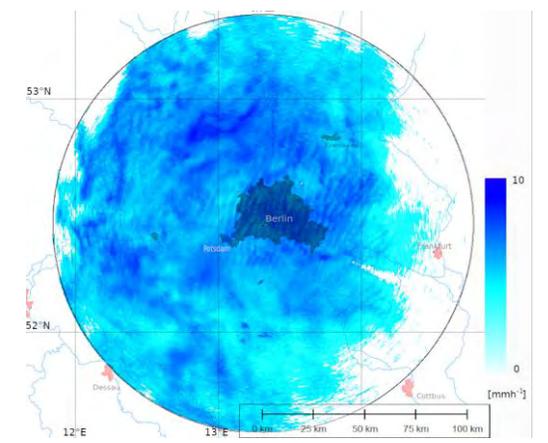
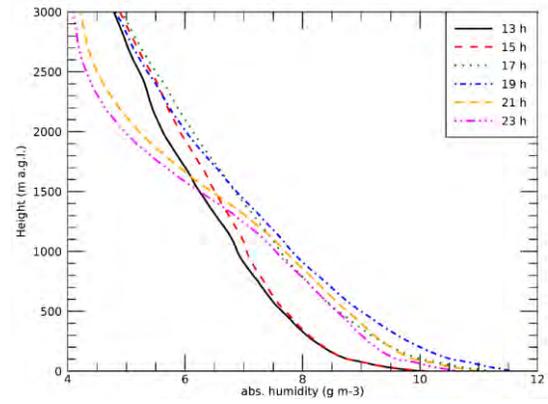
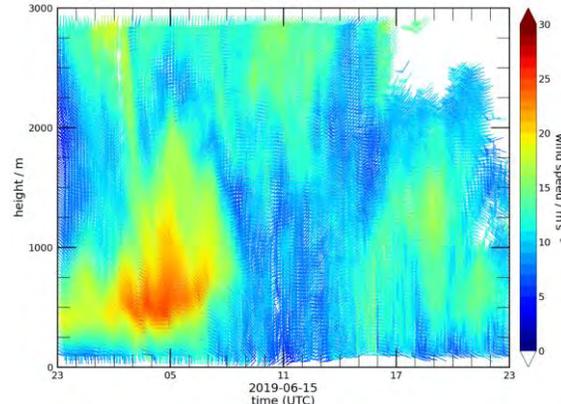
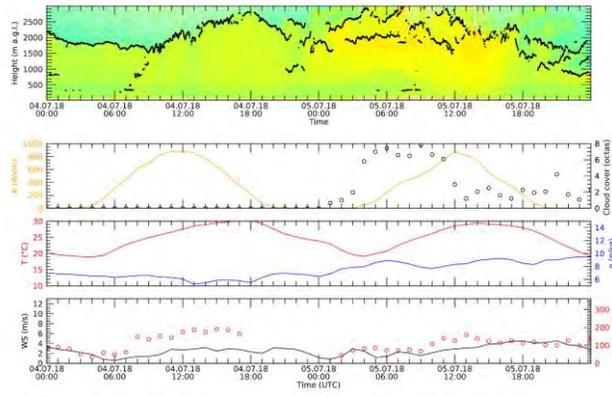
Meteorologische Türme für die lokale Erfassung der Strahlungsbilanz und des turbulenten Austauschs von Wärme, Feuchtigkeit und Kohlenstoffdioxid sowie phänologische Beobachtung



Stadtklima-Messnetz (Urban Climate Observation Network, UCON) und Bürgerwetterstationen (Citizen Weather Station, CWS) Messnetz für bodennahe Messungen im Bestand



Urban Climate Observatory (UCO) Berlin – Die Atmosphäre über der Stadt



Wolken und Aerosole
 Ceilometer
 Luft, CHM15k



**Windgeschwindigkeit
 und -richtung**
 Doppler-LiDAR
 Halo, Streamline XR

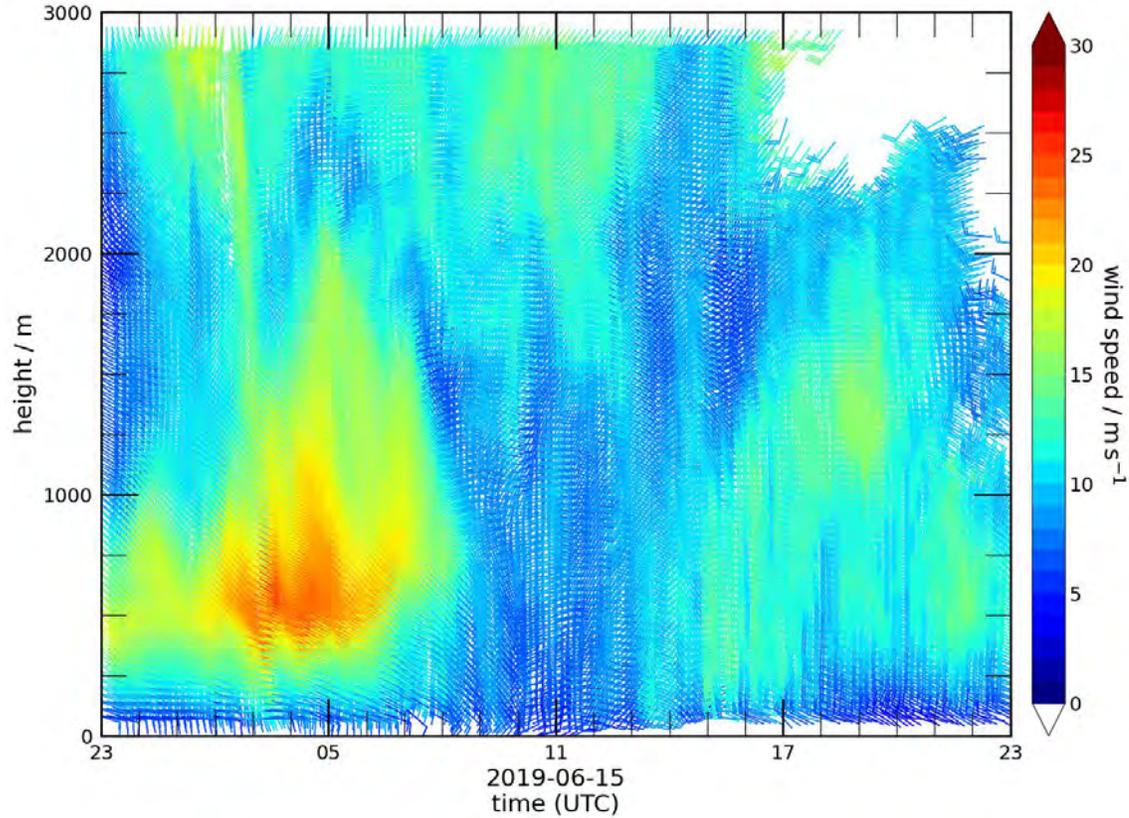


**Lufttemperatur und
 feuchtigkeit**
 Mikrowellen-Radiometer
 RPG, HATPRO-G5

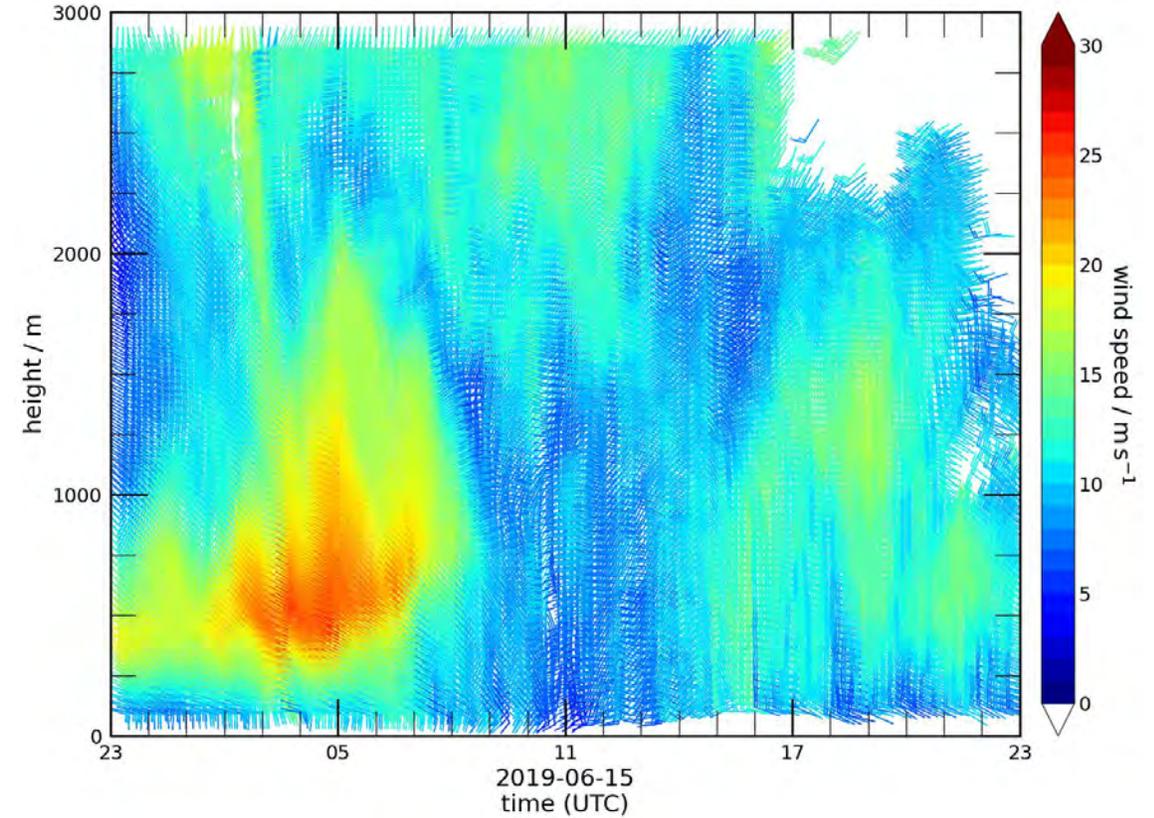


Niederschlag
 X-Band Wetterradar
 GAMIC, GMWR-25-DP

Rothenburgstraße (ROTH)



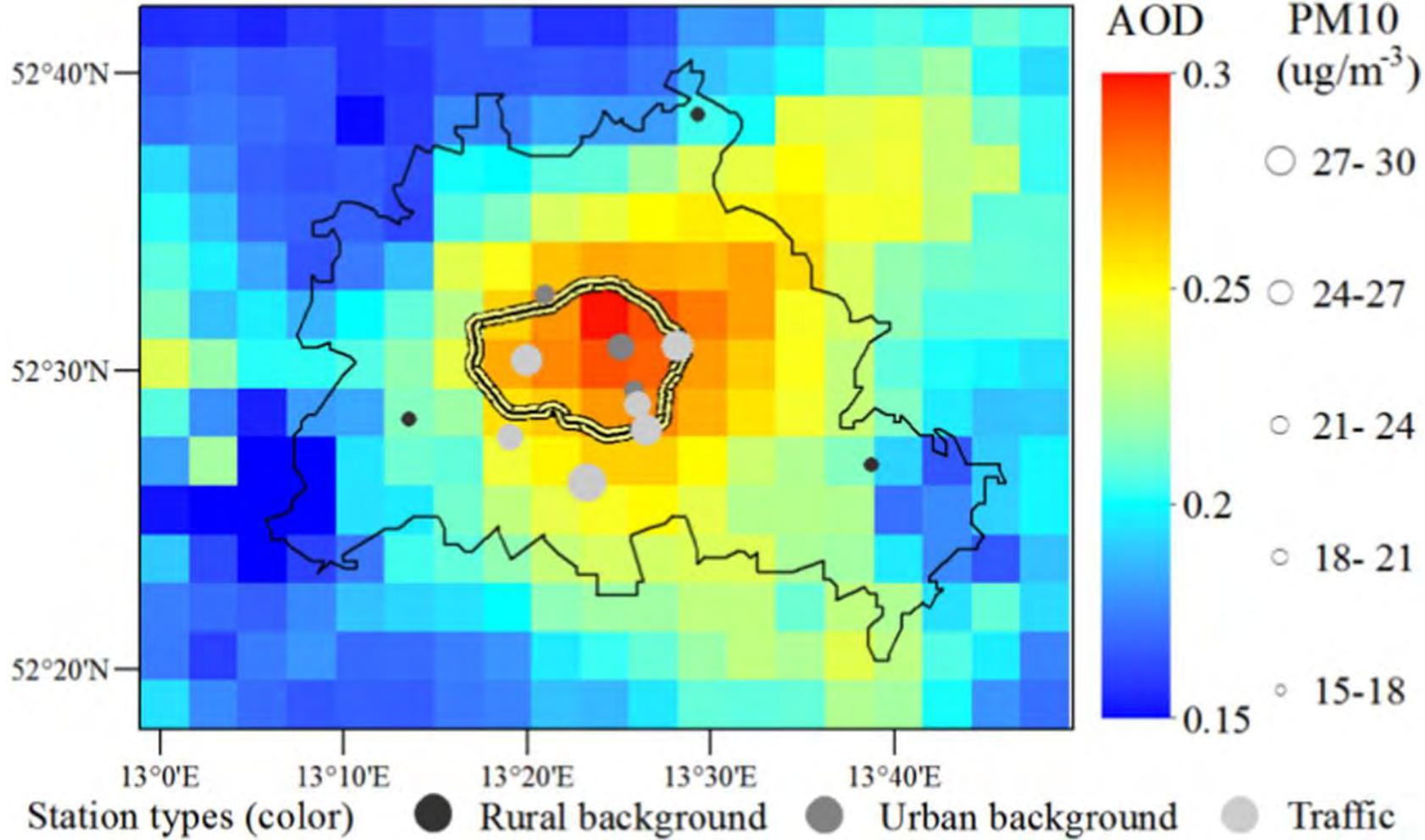
TU Campus Charlottenburg (TUCC)



Vertikales Profil (bis 3 km) der Windgeschwindigkeit und -richtung für 24 Stunden



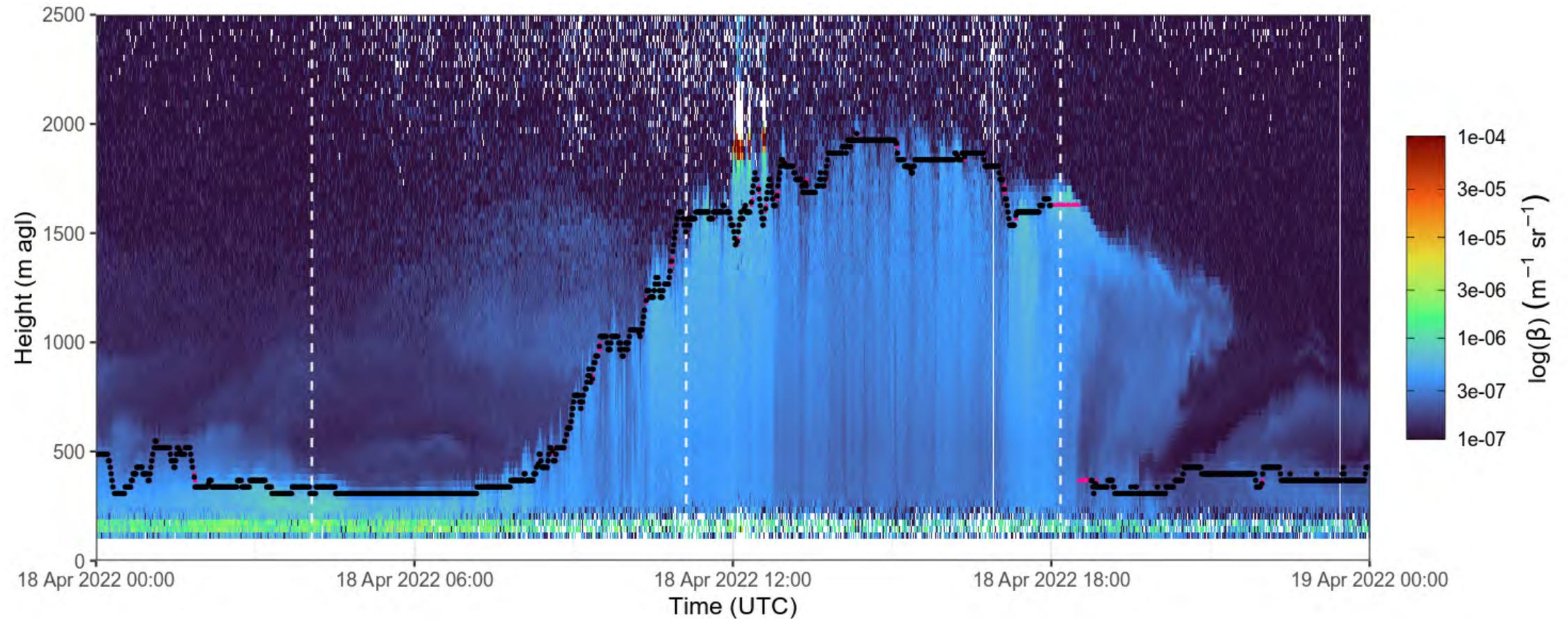
Urban Climate Observatory (UCO) Berlin – Die Atmosphäre über der Stadt



Räumliches Muster der mittleren optischen Dichte (AOD) der Atmosphäre aus Satellitendaten

Li, H., Meier, F., Lee, X., Chakraborty, T., Liu, J., Schaap, M., Sodoudi, S. (2018): Interaction between urban heat island and urban pollution island during summer in Berlin. *Science of The Total Environment* 636, 818-828.
DOI:10.1016/j.scitotenv.2018.04.254.

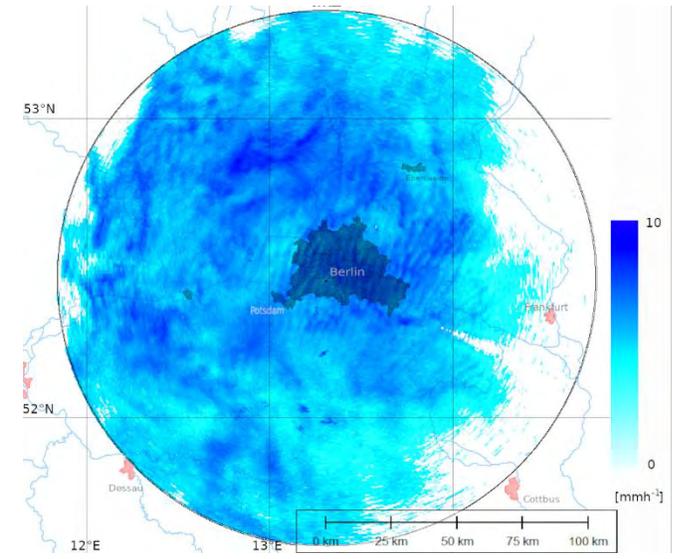
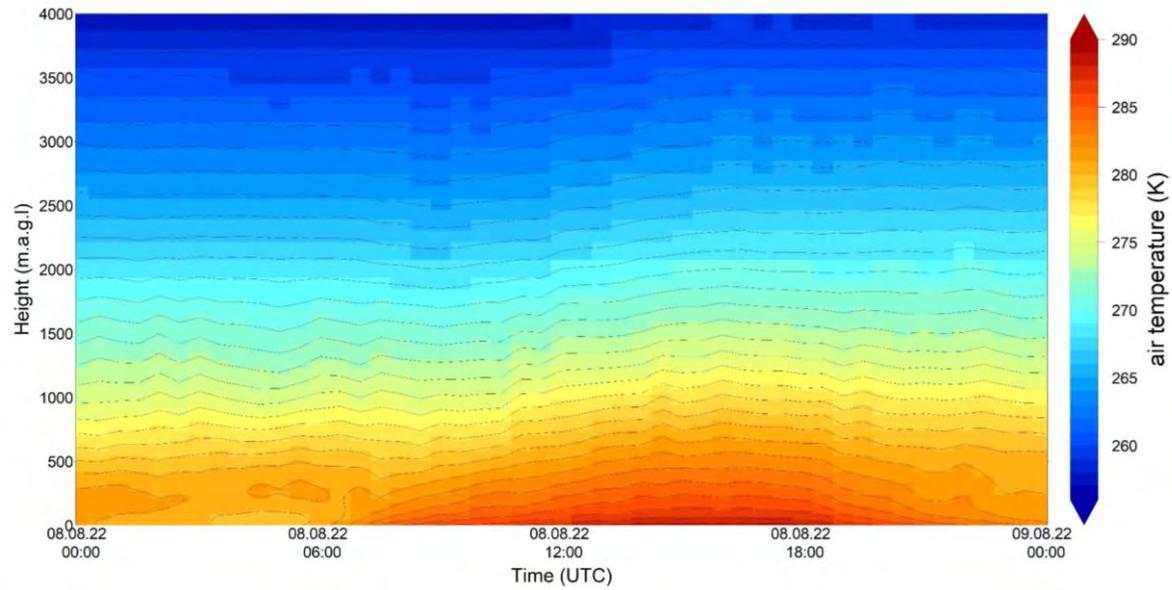
Urban Climate Observatory (UCO) Berlin – Die Atmosphäre über der Stadt



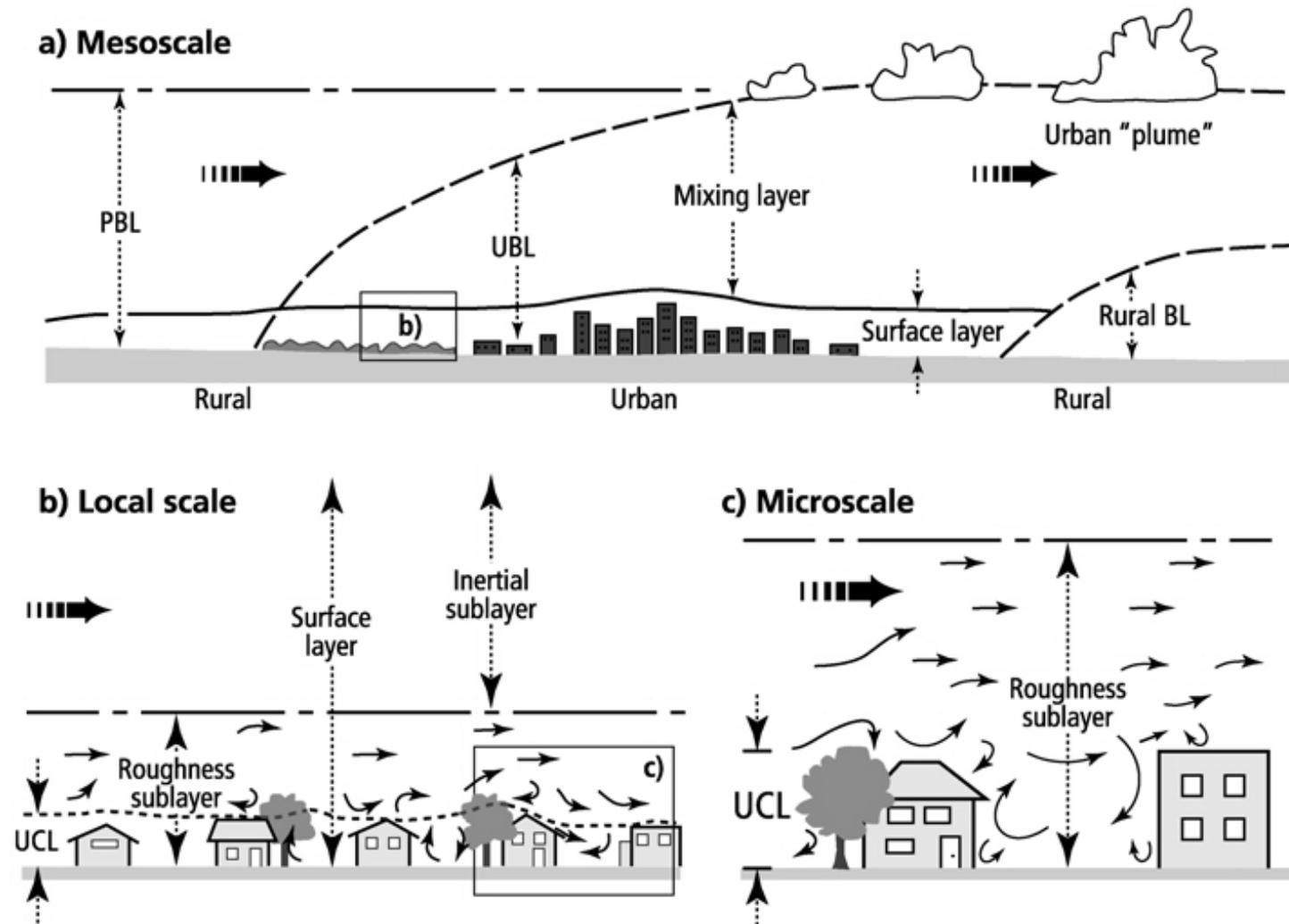
Fenner et al. (2023). Impact of a large isolated city on the mixed layer height during different weather conditions. <https://doi.org/10.5194/egusphere-egu23-11585>



Urban Climate Observatory (UCO) Berlin – Die Atmosphäre über der Stadt



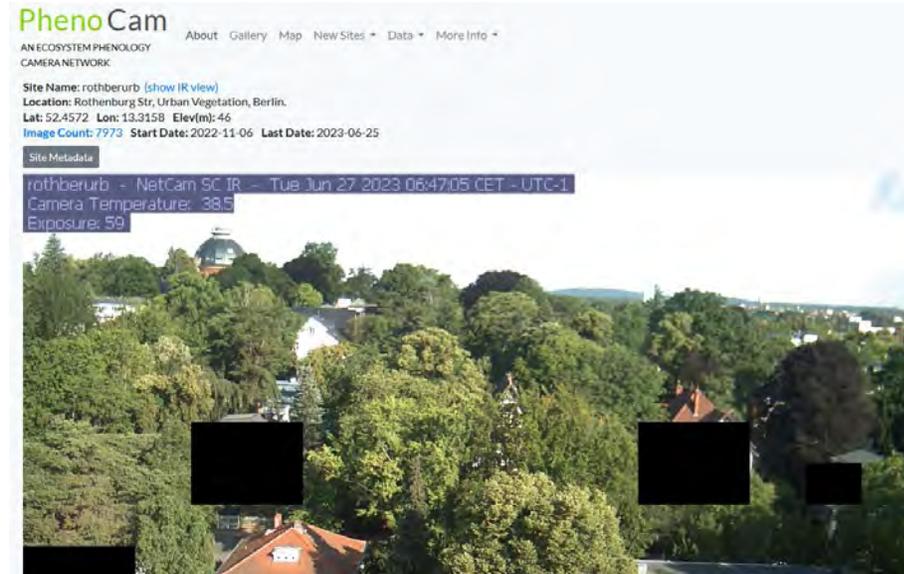
Urban Climate Observatory (UCO) Berlin – Die Skalen der urbane Atmosphäre



Grimmond, C. S. B. (2006): Progress in measuring and observing the urban atmosphere. *Theor. Appl. Climatol.* 84 (1-3): 3-22. DOI: 10.1007/s00704-005-0140-5



Rothenburgstrasse
ICOS Associated Station
seit Juni 2018



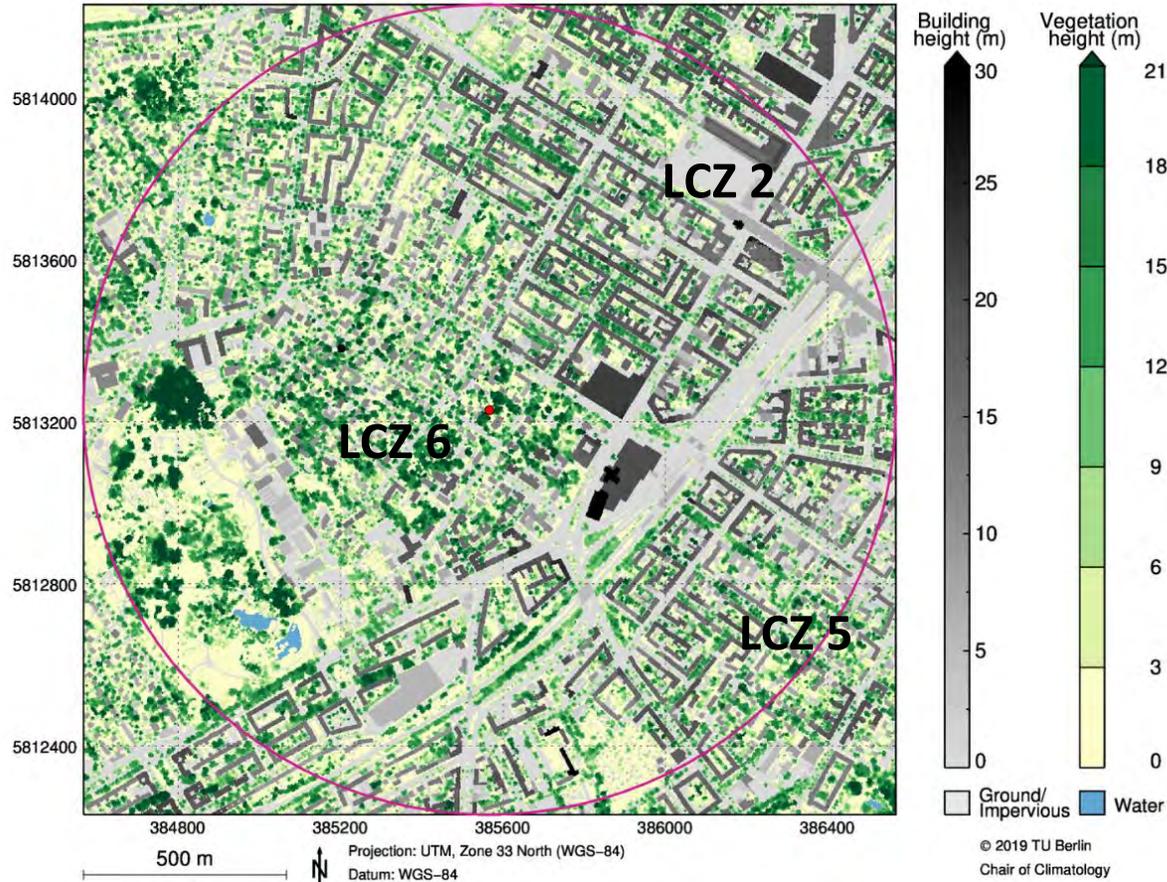
<https://phenocam.nau.edu/webcam/sites/rothberurb/>

TU Campus Charlottenburg
seit Juli 2014



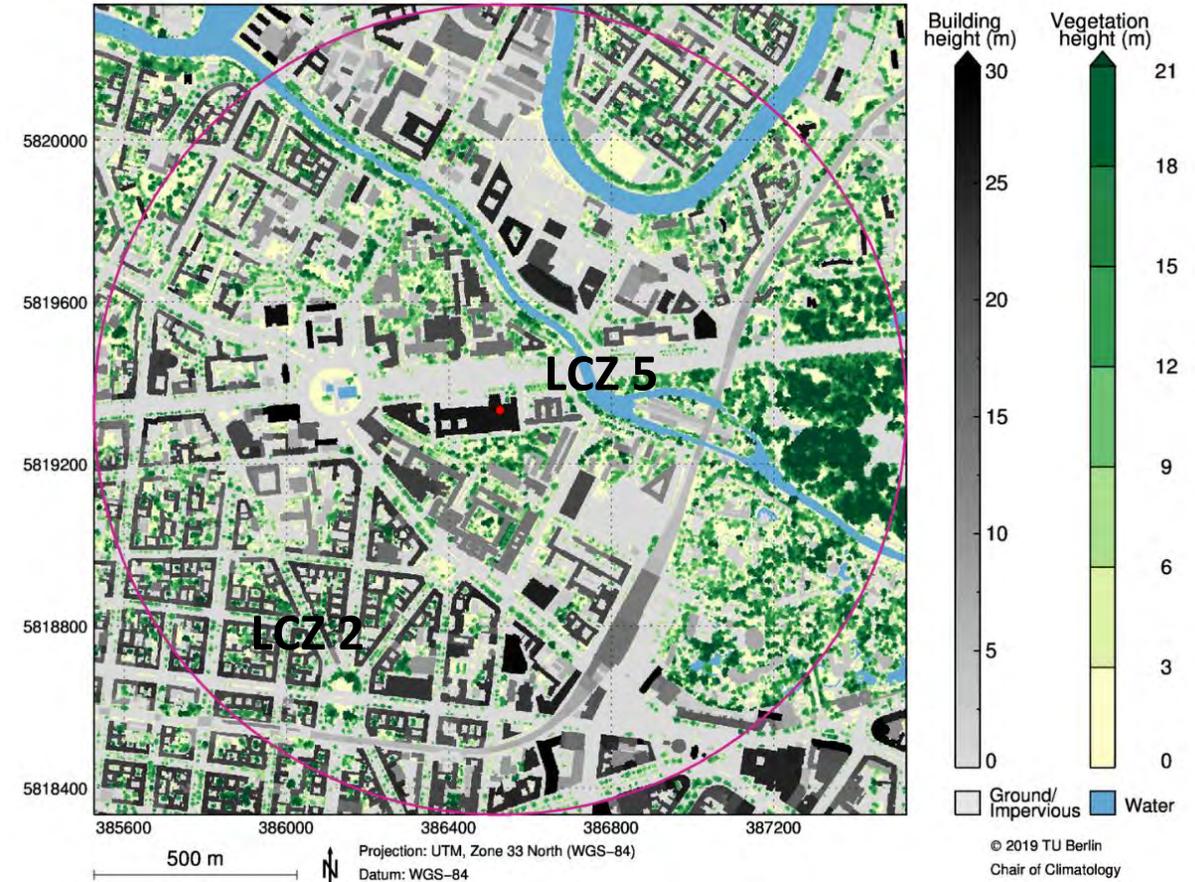
Urban Climate Observatory (UCO) Berlin – Die Messtürme in der Stadt

Rothenburgstraße (ROTH)



Mittlere Gebäudehöhe (zh): **14.0 m**
Mittlere Vegetationshöhe: **7.6 m**
Messhöhe (zm): **40.0 m**

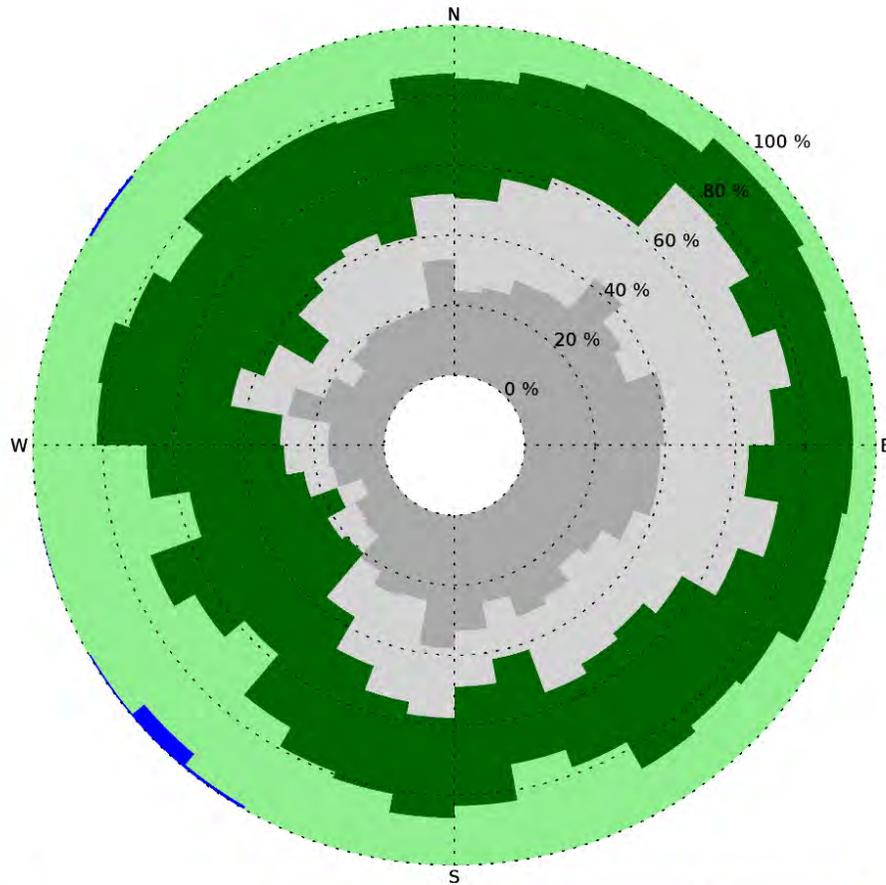
TU Campus Charlottenburg (TUCC)



Mittlere Gebäudehöhe (zh): **17.4 m**
Mittlere Vegetationshöhe: **9.7 m**
Messhöhe (zm): **56.0 m**

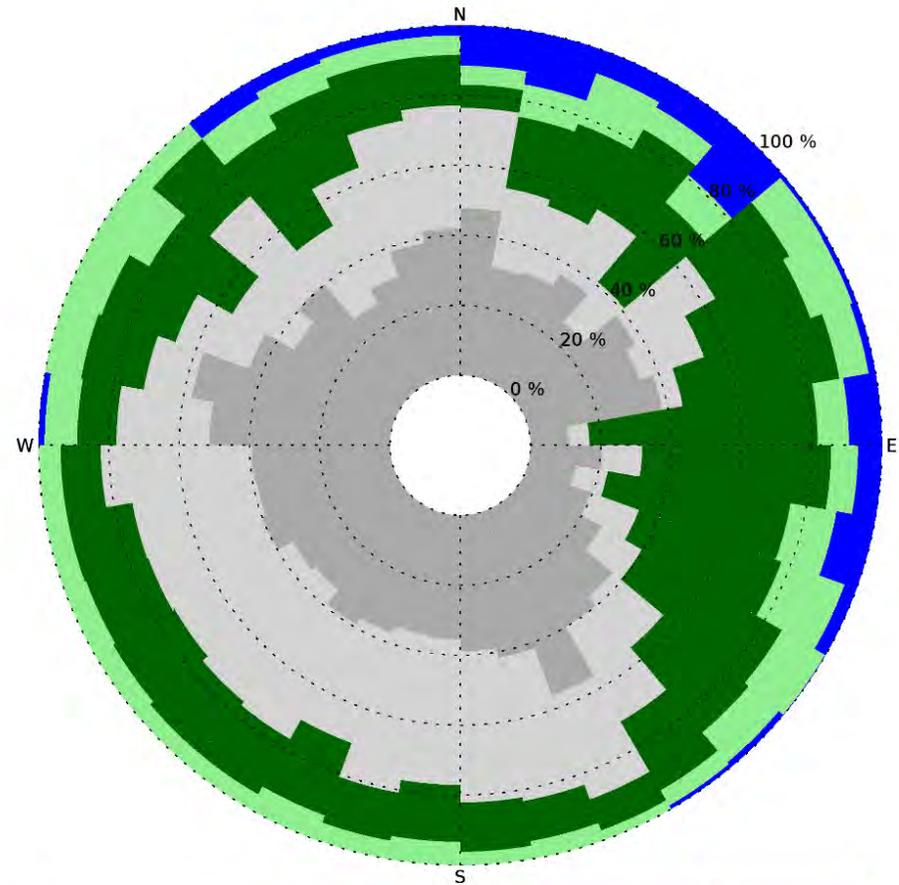
Urban Climate Observatory (UCO) Berlin – Die Messtürme in der Stadt

ROTH



Gebäude	Versiegelung	Vegetation	Wasser
22.8 %	26.3 %	50.6 %	0.3 %

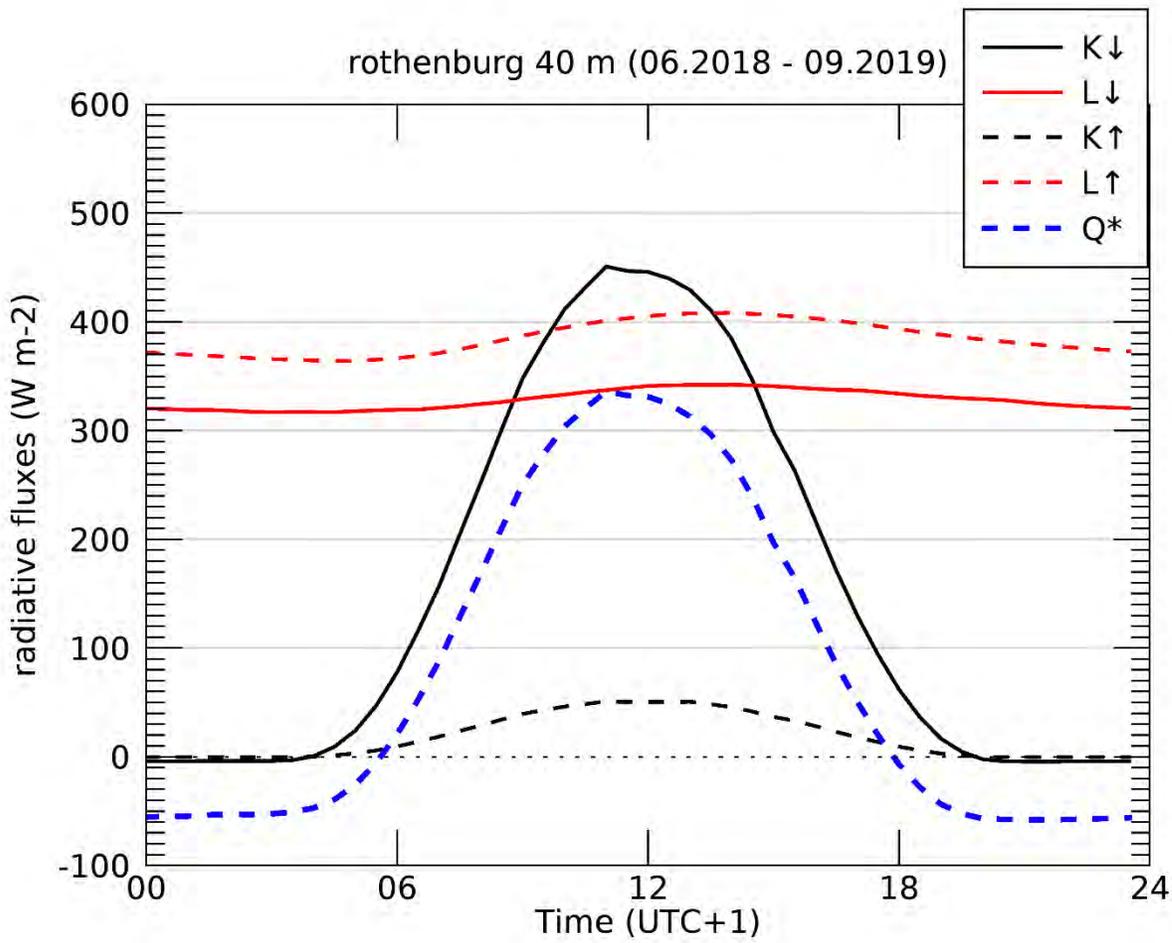
TUCC



Gebäude	Versiegelung	Vegetation	Wasser
27.2 %	35.5 %	32.6 %	4.7 %

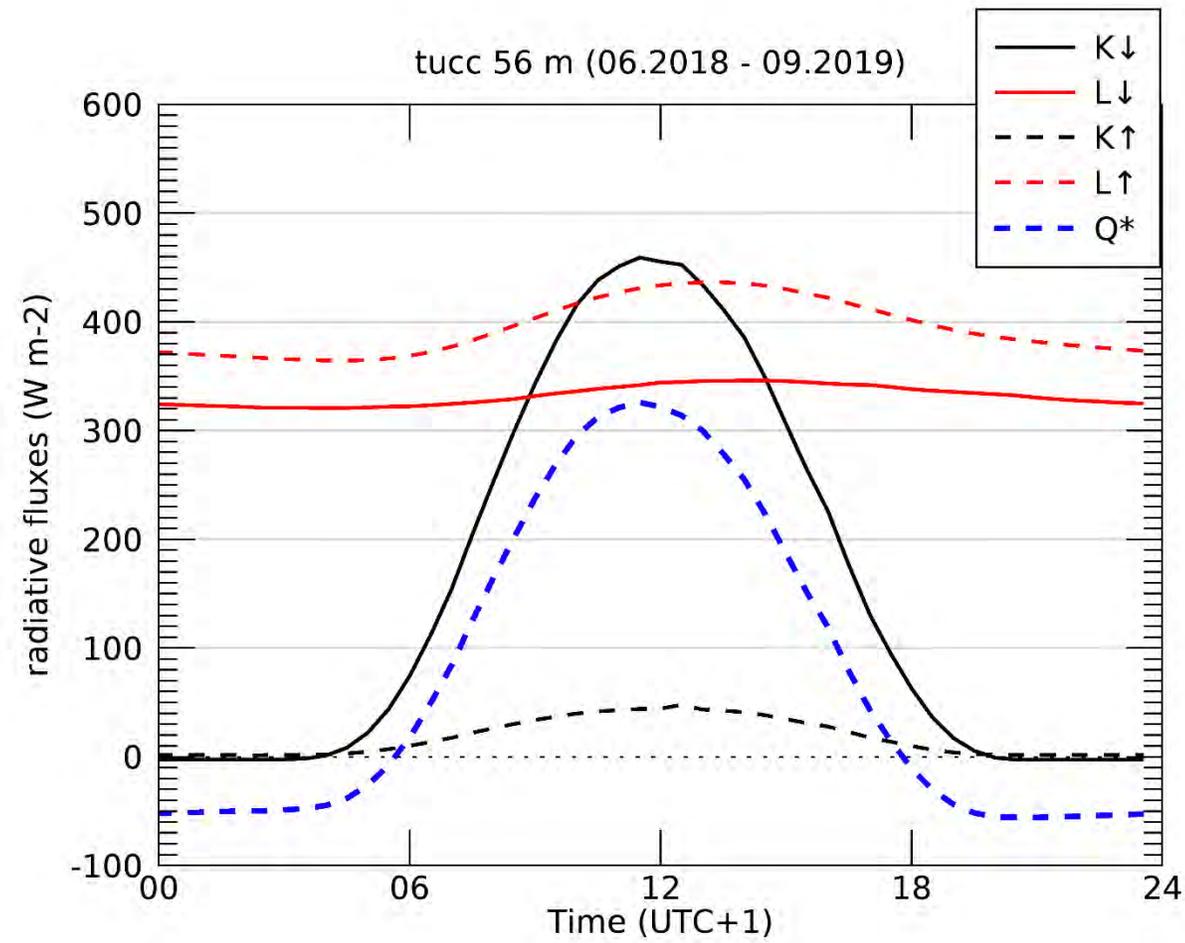
Urban Climate Observatory (UCO) Berlin – Die Messtürme in der Stadt

ROTH



Mittelwert Q* = 79.8 W m⁻²

TUCC



Mittelwert Q* = 75.0 W m⁻²

Urban Climate Observatory (UCO) Berlin – Die Messtürme in der Stadt

ROTH – Messhöhe 40 m ü. G.



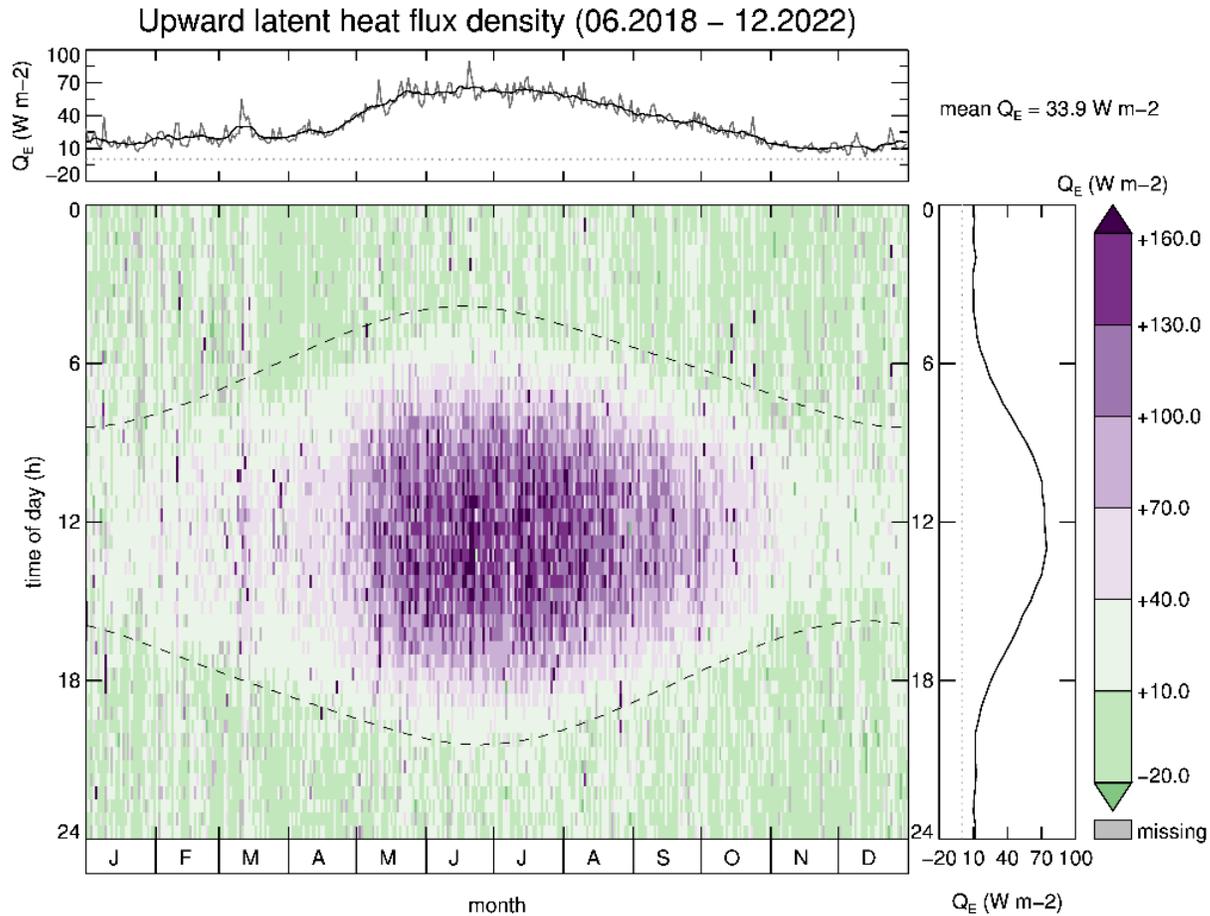
VAR	MISS	BAD	GOOD
Q_H (%)	4.97	8.61	86.42
Q_E (%)	6.51	16.81	76.68
CO ₂ (%)	6.24	14.10	79.66

TUCC – Messhöhe 56 m ü. G.

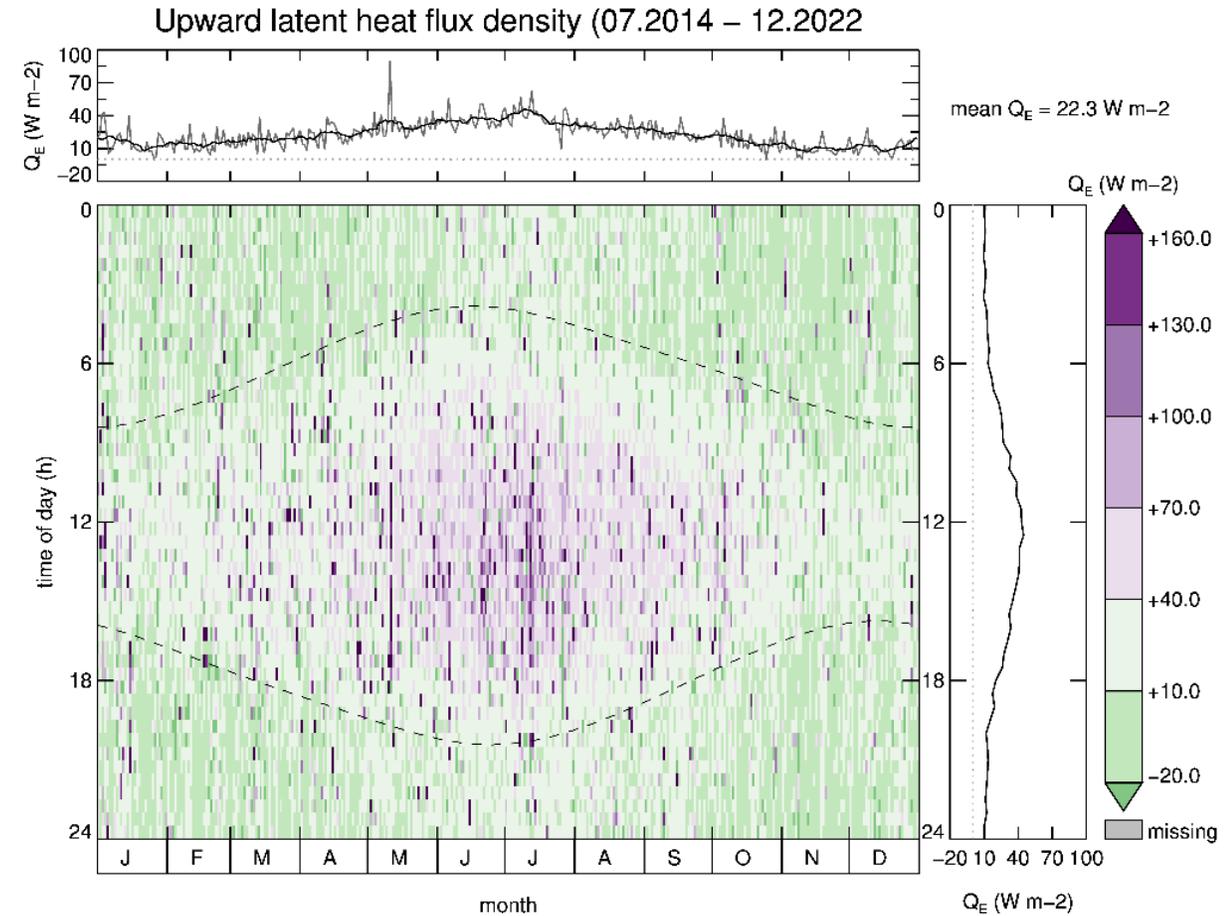


VAR	MISS	BAD	GOOD
Q_H (%)	10.16	6.49	83.35
Q_E (%)	10.79	8.88	80.33
CO ₂ (%)	10.59	6.87	82.54

Urban Climate Observatory (UCO) Berlin – Die Messtürme in der Stadt

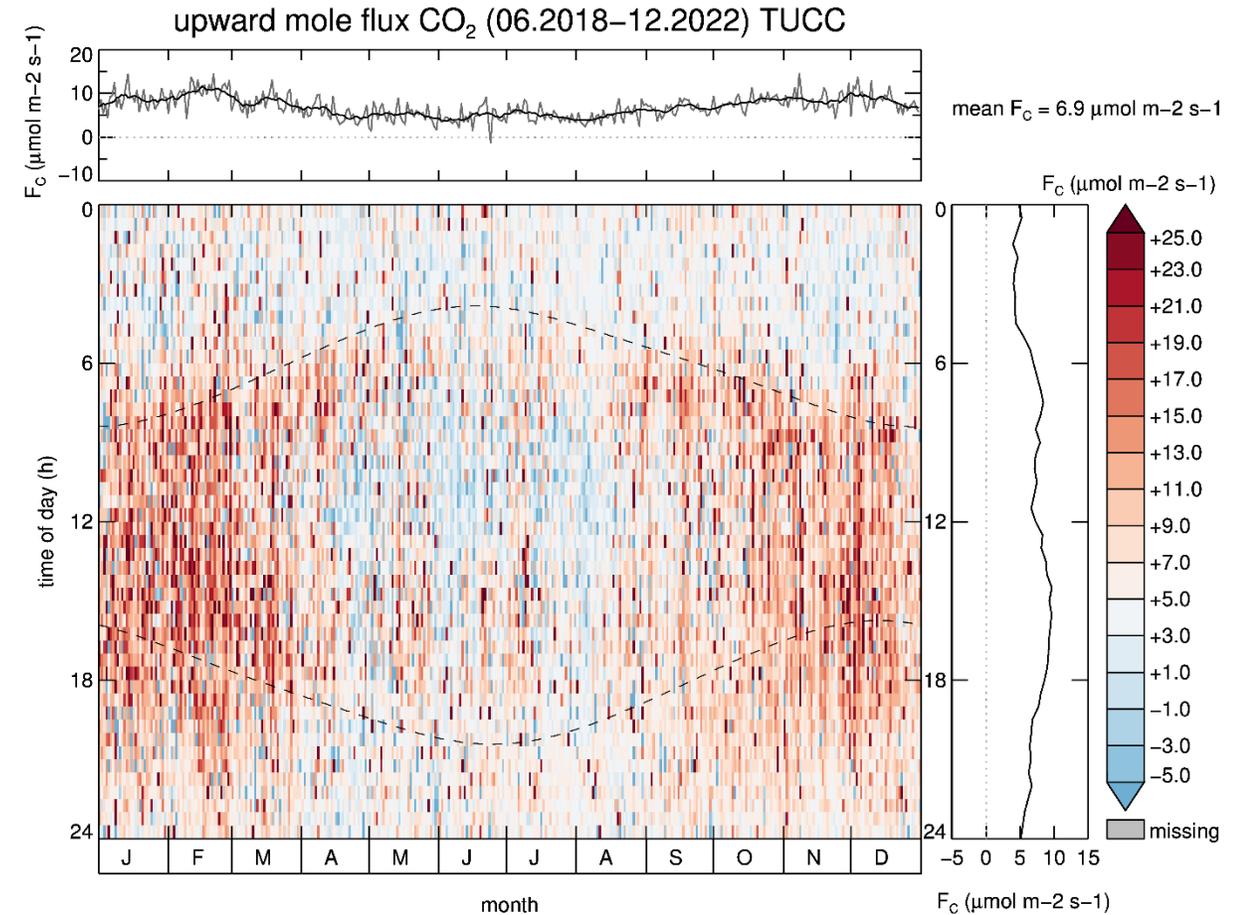
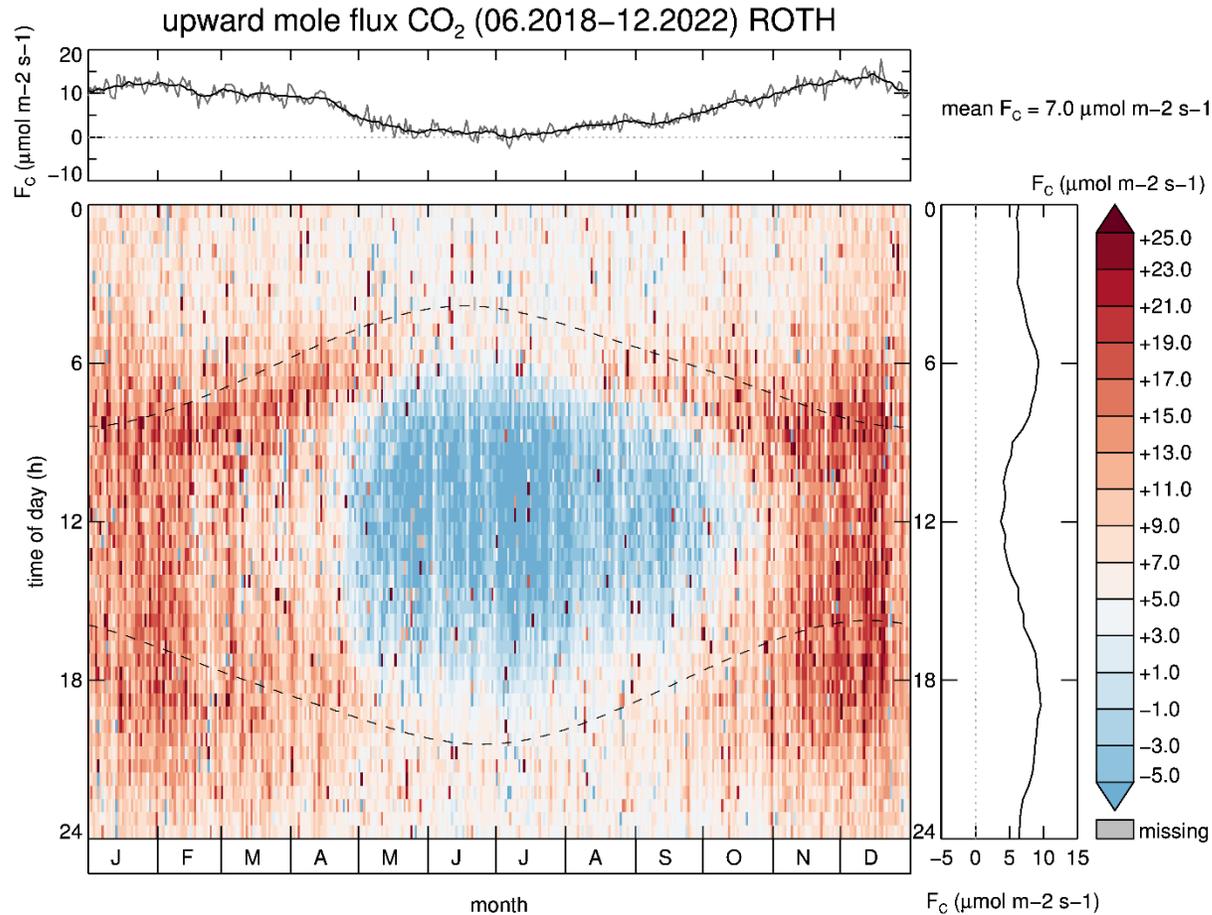


Rothenburgstrasse (ROTH)



TU Campus Charlottenburg (TUCC)

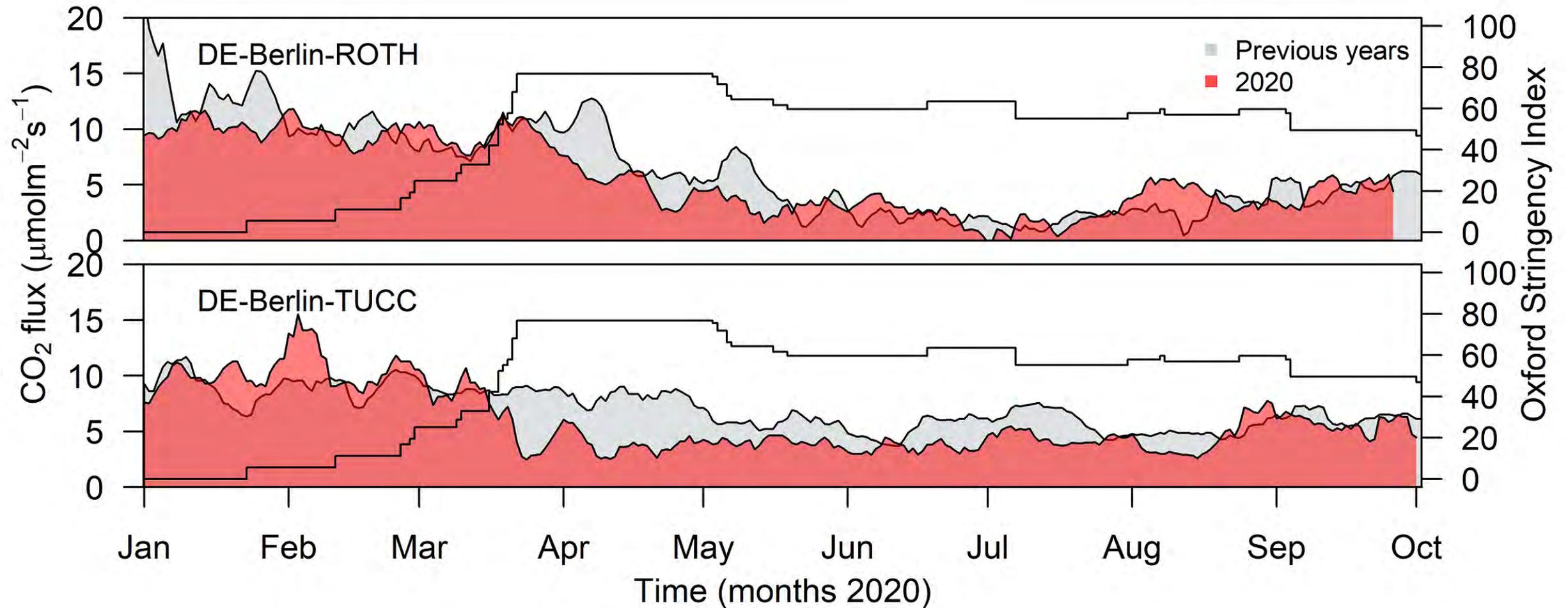
Urban Climate Observatory (UCO) Berlin – Die Messtürme in der Stadt



Mittelwert $F_C = 7.0 \mu\text{mol m}^{-2} \text{s}^{-1}$
Jahreswert $F_C = 9.7 \text{ kg CO}_2 \text{ m}^{-2} \text{ y}^{-1}$

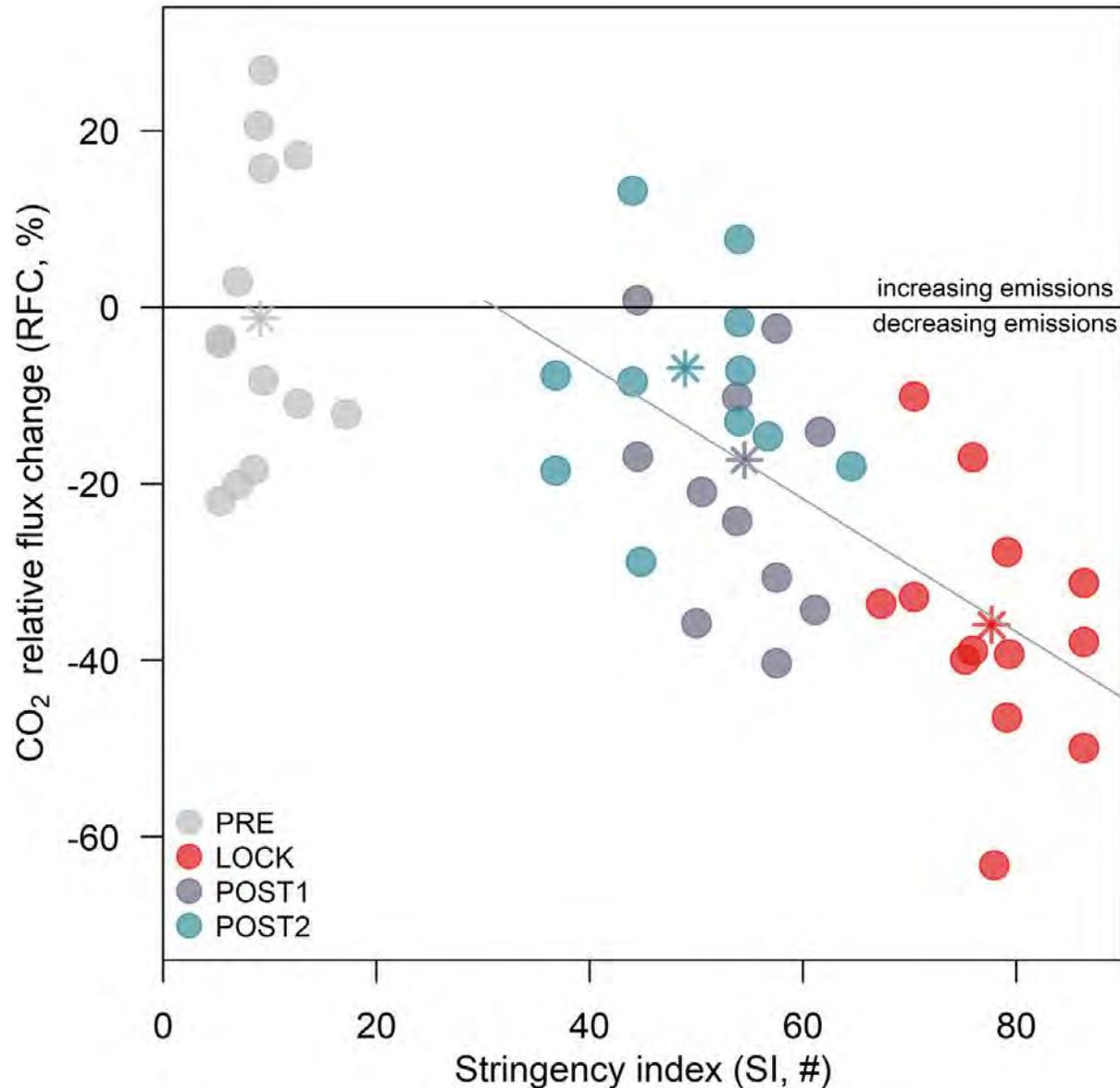
Mittelwert $F_C = 6.9 \mu\text{mol m}^{-2} \text{s}^{-1}$
Jahreswert $F_C = 9.6 \text{ kg CO}_2 \text{ m}^{-2} \text{ y}^{-1}$

Urban Climate Observatory (UCO) Berlin – Die Messtürme in der Stadt



Nicolini et al. (2022): Direct observations of CO₂ emission reductions due to COVID-19 lockdown across European urban districts. *Science of The Total Environment* 830. DOI:10.1016/j.scitotenv.2022.154662

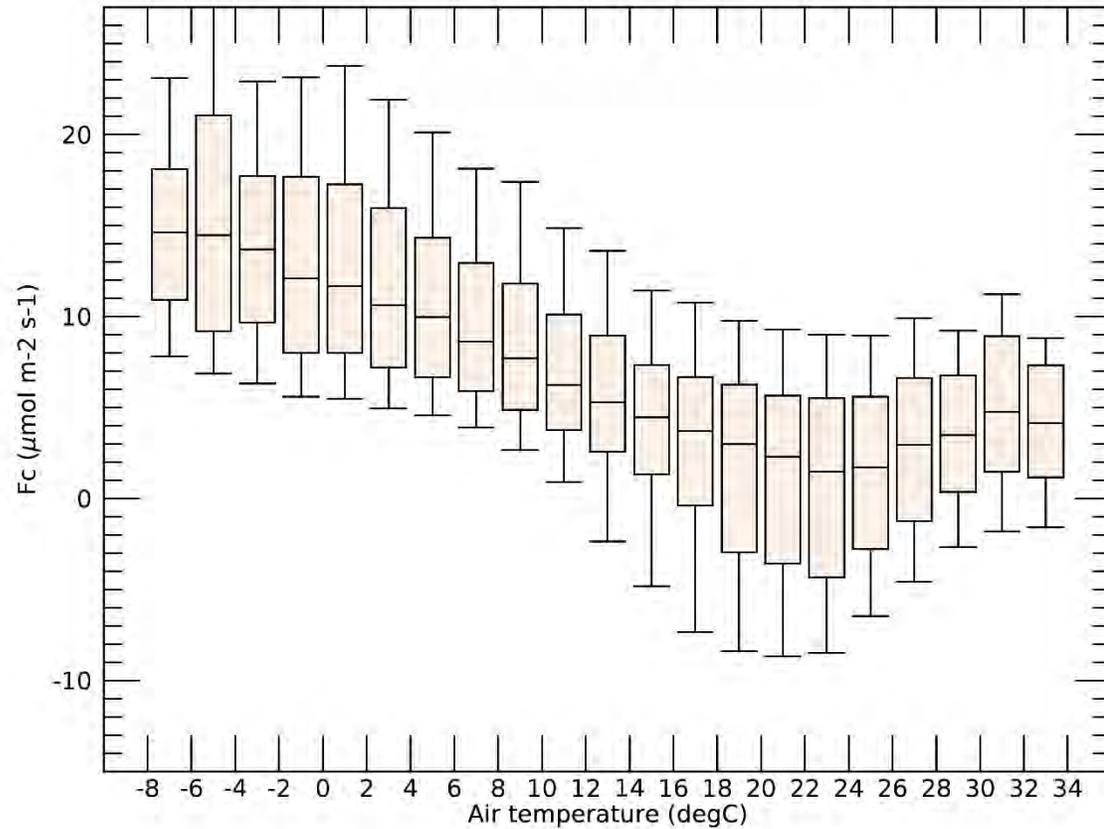
Urban Climate Observatory (UCO) Berlin – Die Messtürme in der Stadt



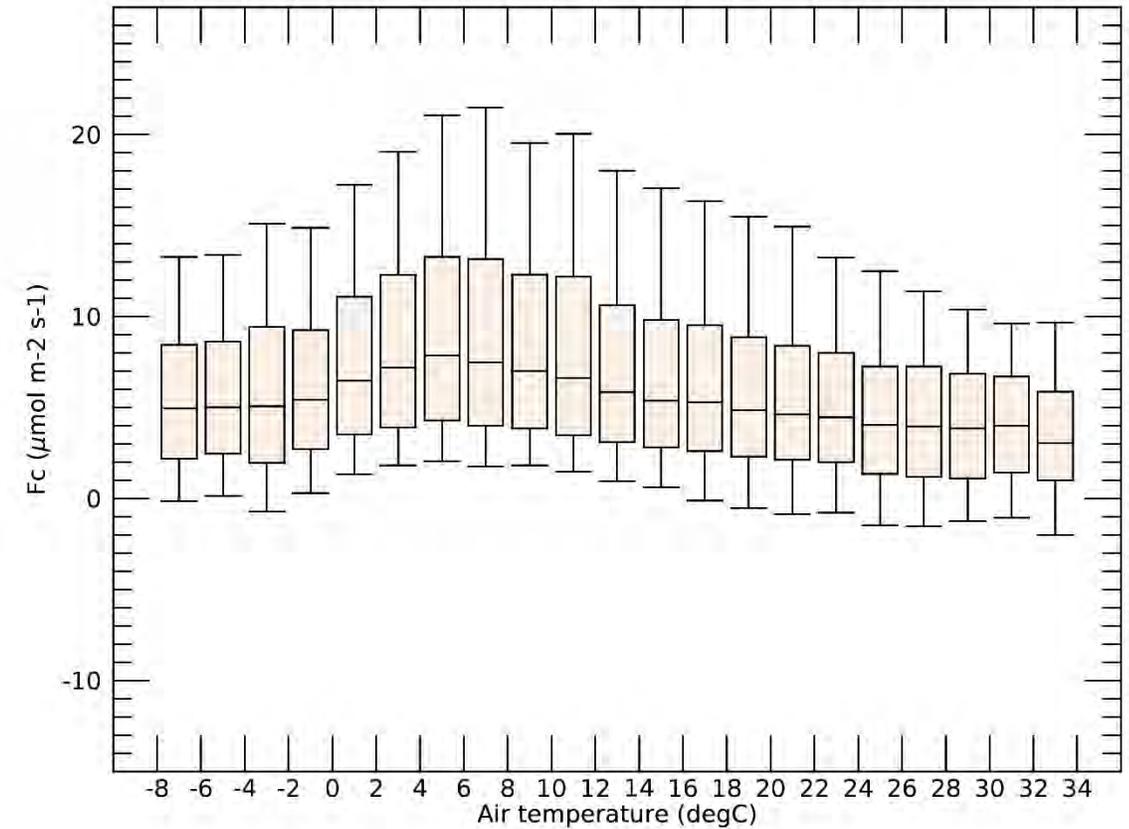
Nicolini et al. (2022): Direct observations of CO₂ emission reductions due to COVID-19 lockdown across European urban districts. *Science of The Total Environment* 830. DOI:10.1016/j.scitotenv.2022.154662

Urban Climate Observatory (UCO) Berlin – Die Messtürme in der Stadt

UCO Berlin ROTH (06.2018 - 08.2021) - 40 m

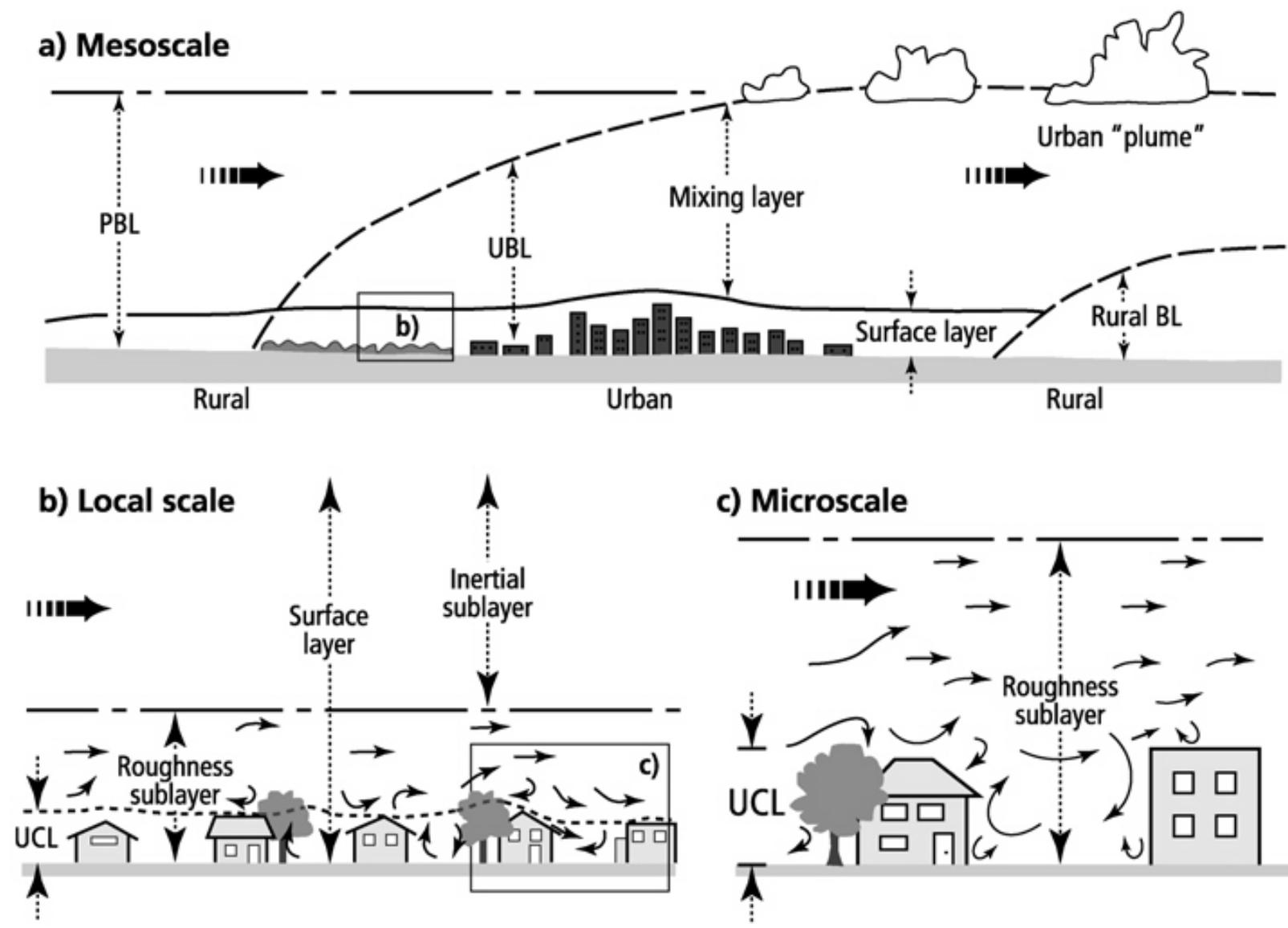


UCO Berlin TUCC (07.2014 - 05.2021)



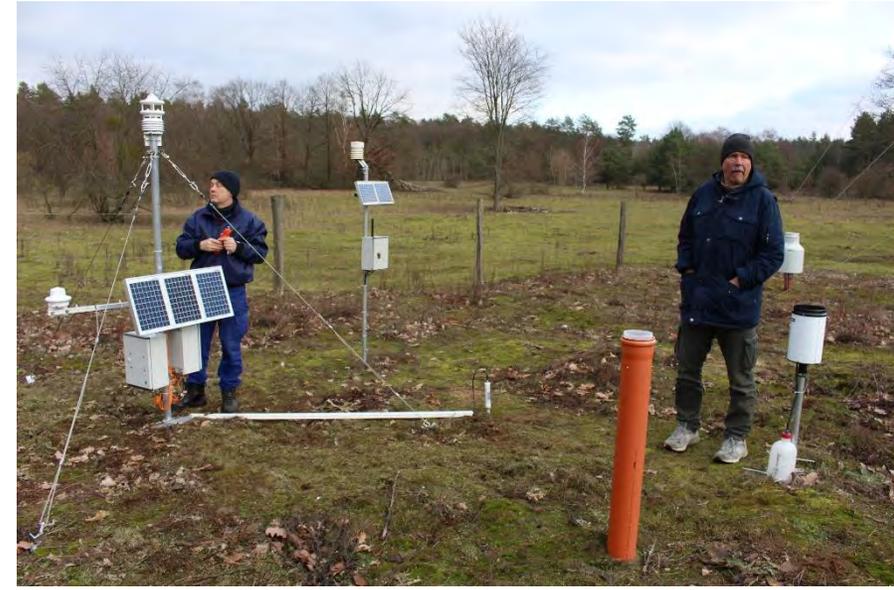
Lufttemperatur versus CO₂ Flussdichte

Urban Climate Observatory (UCO) Berlin – Die Skalen der urbane Atmosphäre



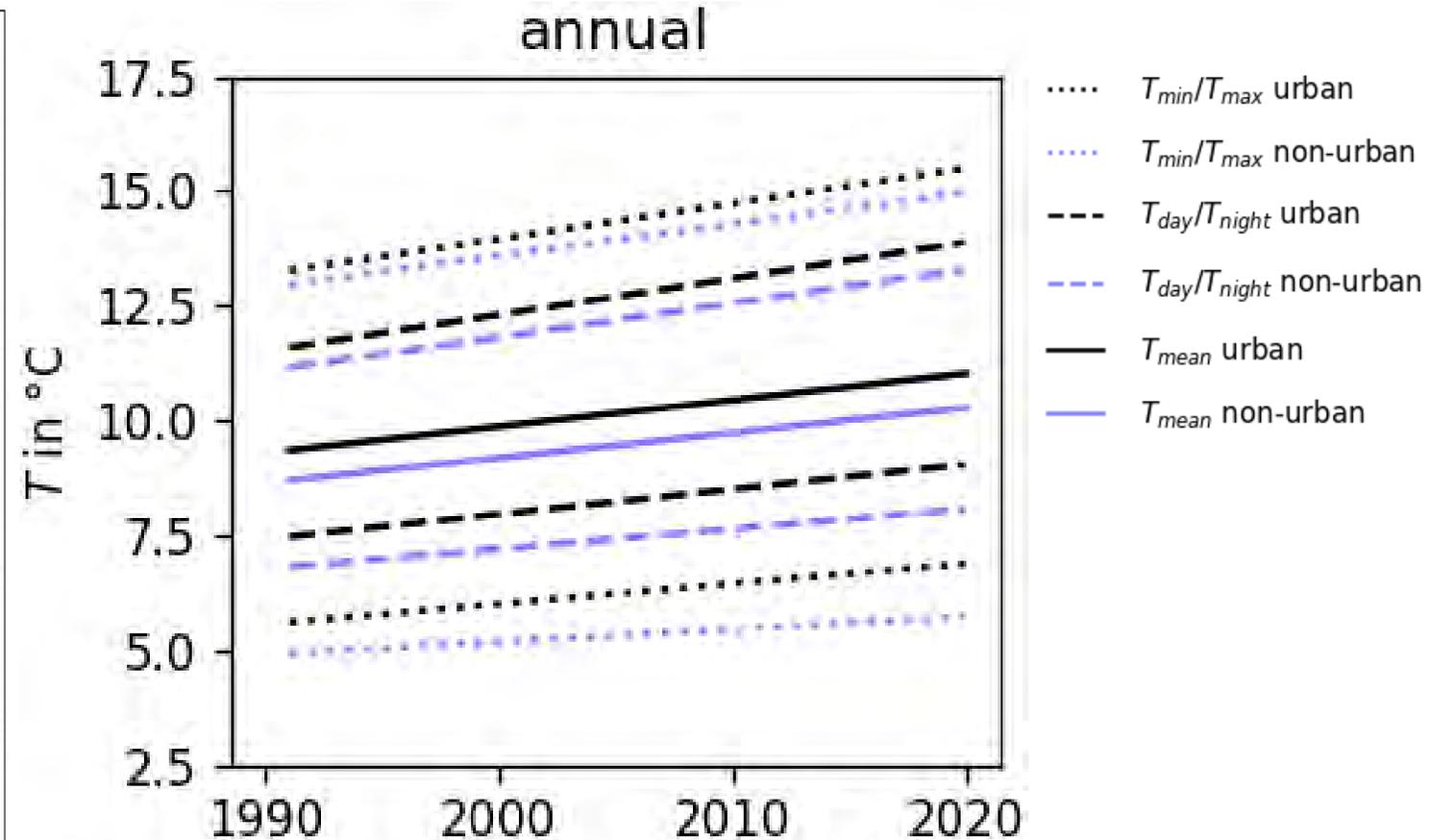
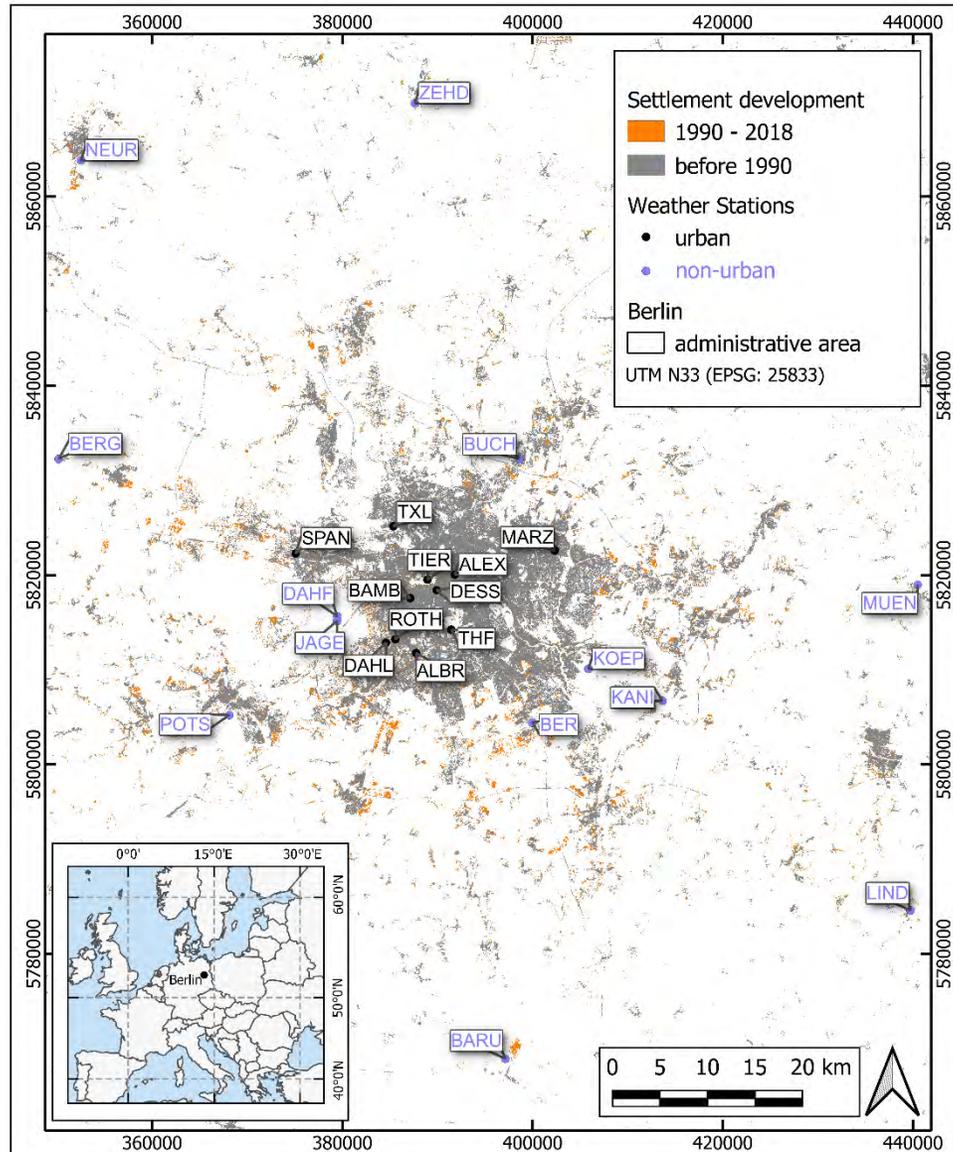
Urban Climate Observatory (UCO) Berlin – Die Atmosphäre in der Stadt

- Stadtklima-Messnetz: TU-Berlin, FU-Berlin, Deutscher Wetterdienst + Bürgerwetterstationen



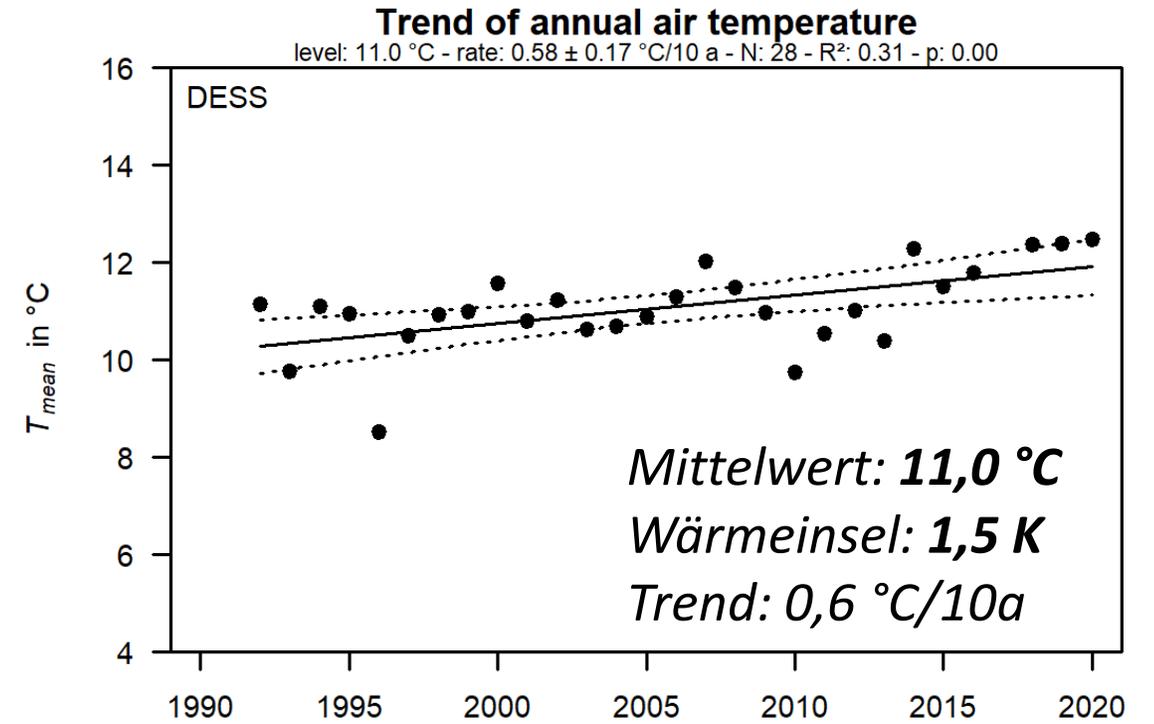
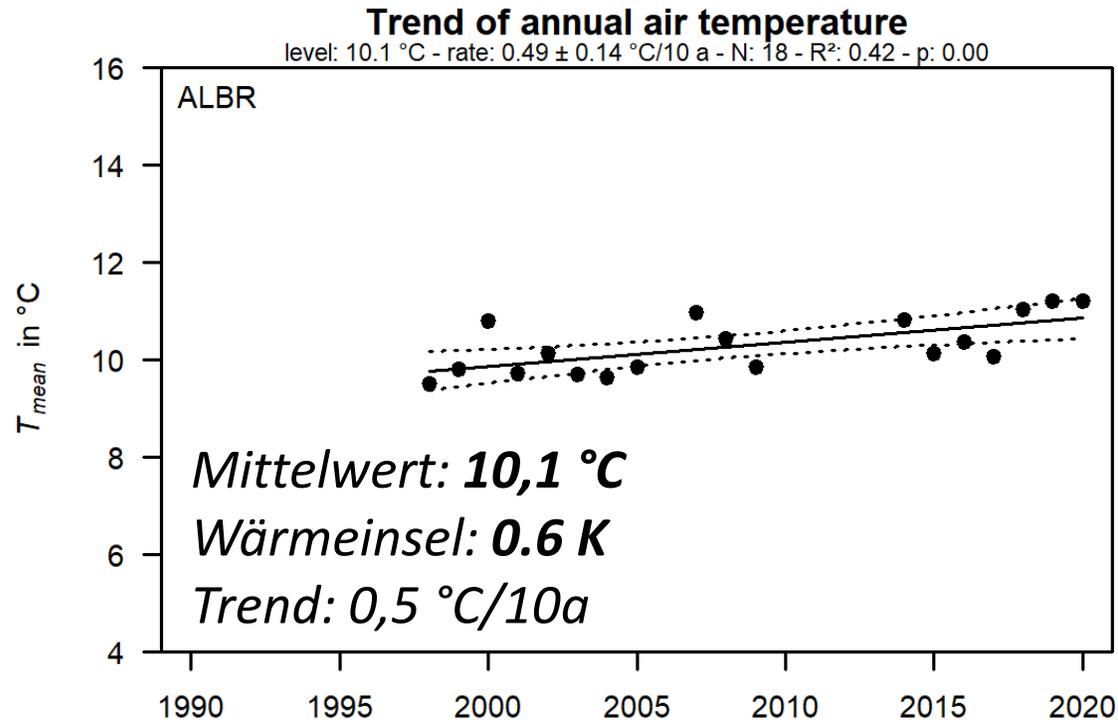
- Fenner, D., F. Meier, D. Scherer, A. Polze (2014): Spatial and temporal air temperature variability in Berlin, Germany, during the years 2001-2010. *Urban Clim.* 10 (2): 308-331.
- Meier, F., D. Fenner, T. Grassmann, M. Otto, D. Scherer (2017): Crowdsourcing air temperature from citizen weather stations for urban climate research. *Urban Clim.* 19: 170-191.
- Rost, A. T., V. Liste, C. Seidel, L. Matscheroth, M. Otto, F. Meier, D. Fenner (2020): How Cool Are Allotment Gardens? A Case Study of Nocturnal Air Temperature Differences in Berlin, Germany. *Atmosphere* 11 (5): 500.

Urban Climate Observatory (UCO) Berlin – Klimawandel in der Stadt



Trend Jahresmittelwert der Lufttemperatur
1991-2020 (11 urbane und 13 nicht-urbane Stationen)

Urban Climate Observatory (UCO) Berlin – Klimawandel in der Stadt



Urban Climate Observatory (UCO) Berlin – Wie kühl sind Kleingartenanlagen?




Article

How Cool Are Allotment Gardens? A Case Study of Nocturnal Air Temperature Differences in Berlin, Germany

Annemarie Tabea Rost*, Victoria Liste, Corinna Seidel, Lea Matscheroth, Marco Otto*, Fred Meier and Daniel Fenner

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 * Correspondence: annemarietost@gmail.com (A.T.R.); marco.otto@klima.tu-berlin.de (M.O.)

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Abstract: Urban green infrastructures have been extensively studied for their ability to mitigate the urban heat island (UHI) effect. However, allotment gardens (AGs)—a prominent type of urban green infrastructure within many European cities—have not yet been comprehensively investigated concerning their microclimates. In this study, nocturnal air temperatures (T_n) in 13 AG complexes (AGCs) were measured during the summer of 2018 in Berlin, Germany. These were compared to measurements in densely built-up urban areas (URB), two large inner-city parks and rural areas (RUR). On average, the assessed AGCs were 2.7 K cooler at night than URB. Most of the investigated AGCs (11/13) displayed a larger mean T_n difference to URB ($\Delta T_{n,URB}$) than the examined urban parks. RUR showed the largest differences to URB ($\Delta T_{n,RUR}$), indicating a UHI effect. Furthermore, the influence of land surface characteristics of the AGCs on $\Delta T_{n,AGC}$ was analyzed. $\Delta T_{n,AGC}$ decreased significantly as the floor space index around AGCs increased. The analysis of the shape complexity also produced a significant positive correlation with $\Delta T_{n,AGC}$. In contrast, size and distance to the city center of an AGC decreased significantly with increasing $\Delta T_{n,AGC}$. This study provides first insights into the microclimate of AGs and influencing variables concerning T_n .

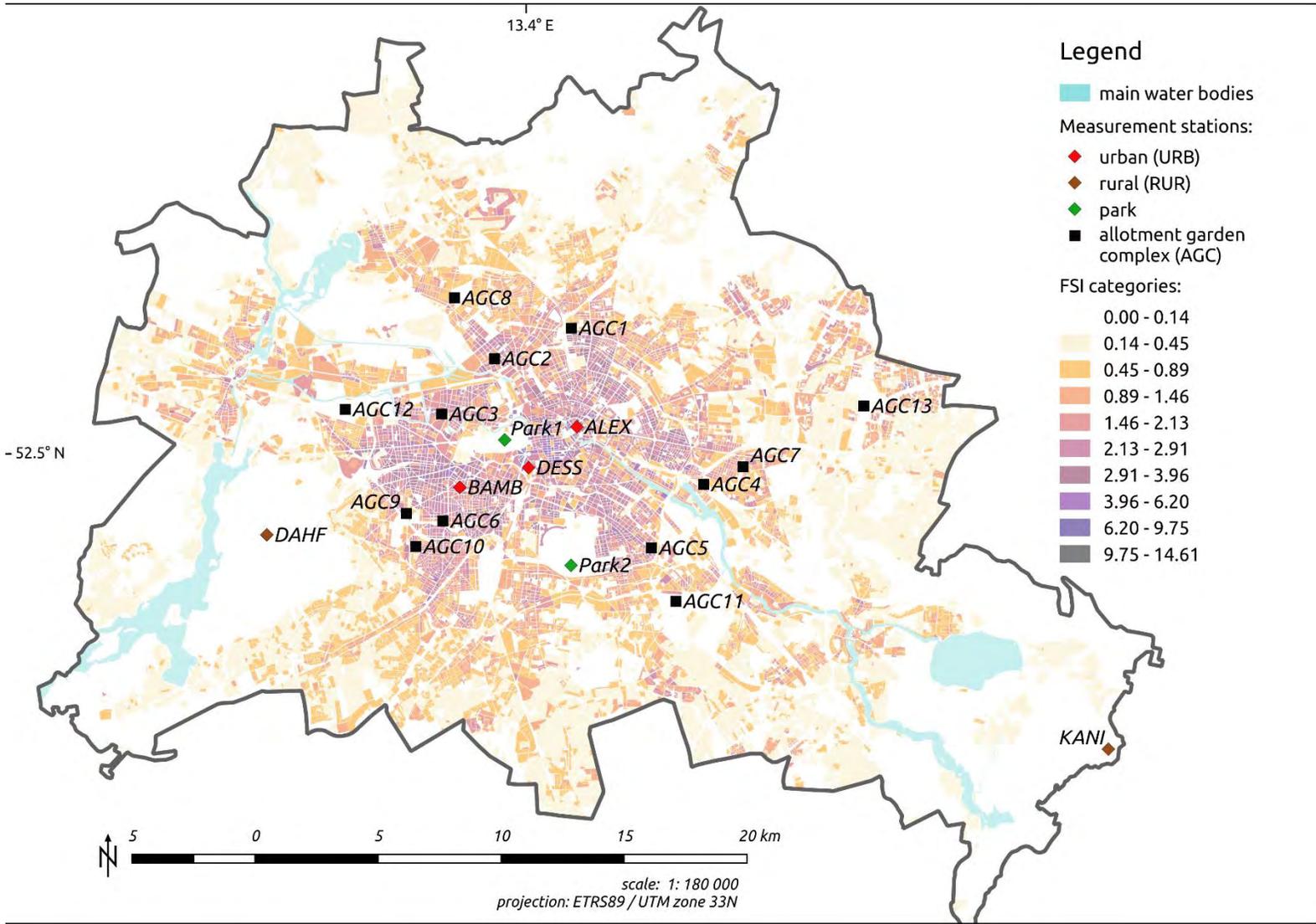
Keywords: allotment gardens; community gardens; urban green infrastructure; urban climate; microclimate; air temperature; Berlin; urban heat island

1. Introduction

The distinctive features of urban areas [1] result in an altered energy exchange compared to their rural surroundings. Urban areas are characterized by a lower albedo, higher thermal conductivity and higher heat capacities of building materials [2]. Further, they show reduced convective cooling, as well as lower evapotranspiration rates [2]. This leads to the well-studied phenomenon of the urban heat island (UHI) with generally higher air temperatures (T) in urban areas in comparison to the surrounding rural areas [2,3].

UHI intensity, defined as the difference in T between the city and the surrounding rural area, varies in time and space. It is influenced by seasons, time of day, meteorological, geographical and physical properties. This includes land use patterns, such as local climate zones (LCZs) [1,4–6]. The UHI effect is especially prominent during nights with calm and clear weather conditions [7,8]. Under these conditions, the energy budget of the canopy layer can be simplified to be primarily determined by the outgoing longwave radiation [7,8]. The loss of longwave radiation from storage is strongly

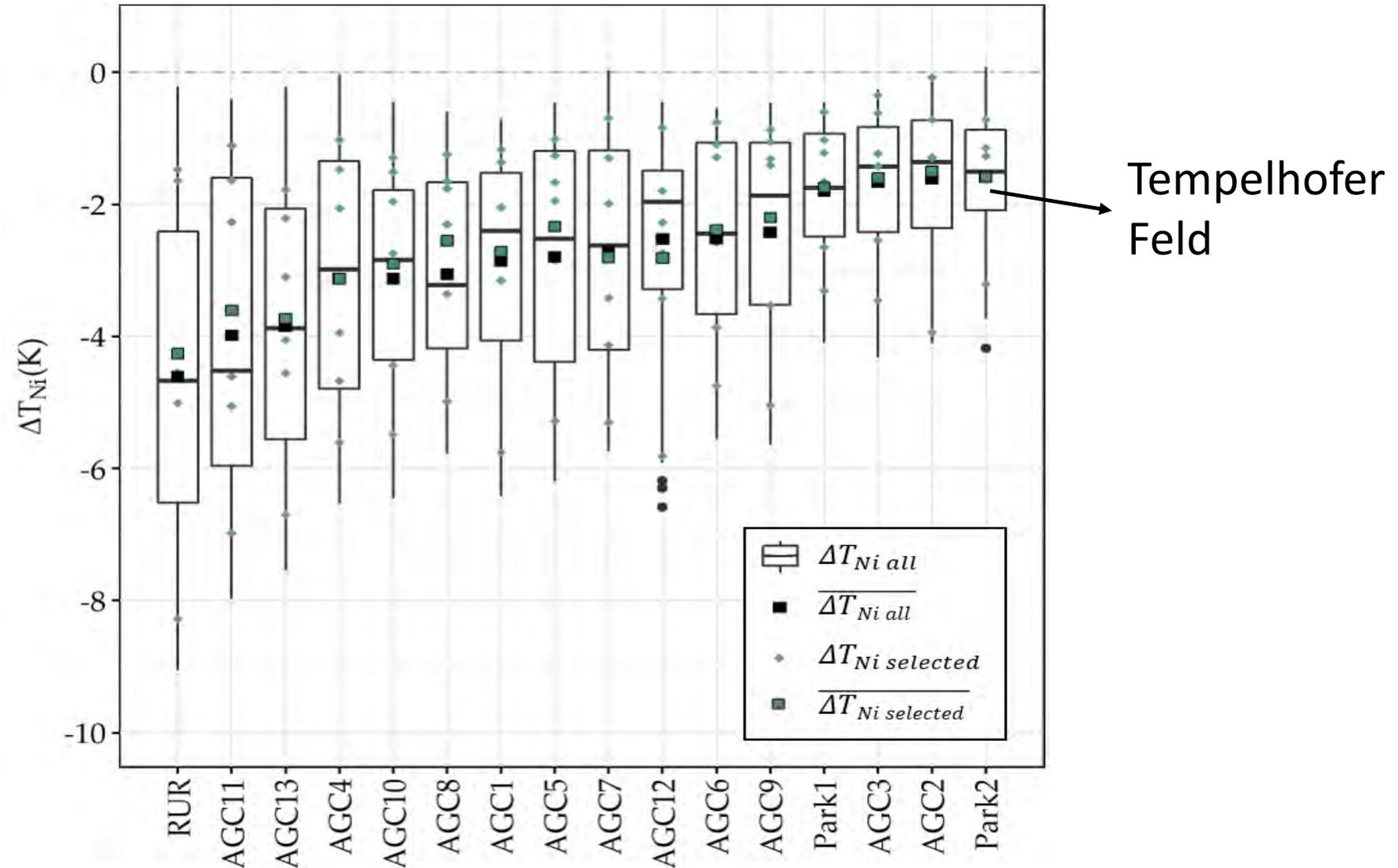
Atmosphere 2020, 11, 500; doi:10.3390/atmos11050500 www.mdpi.com/journal/atmosphere



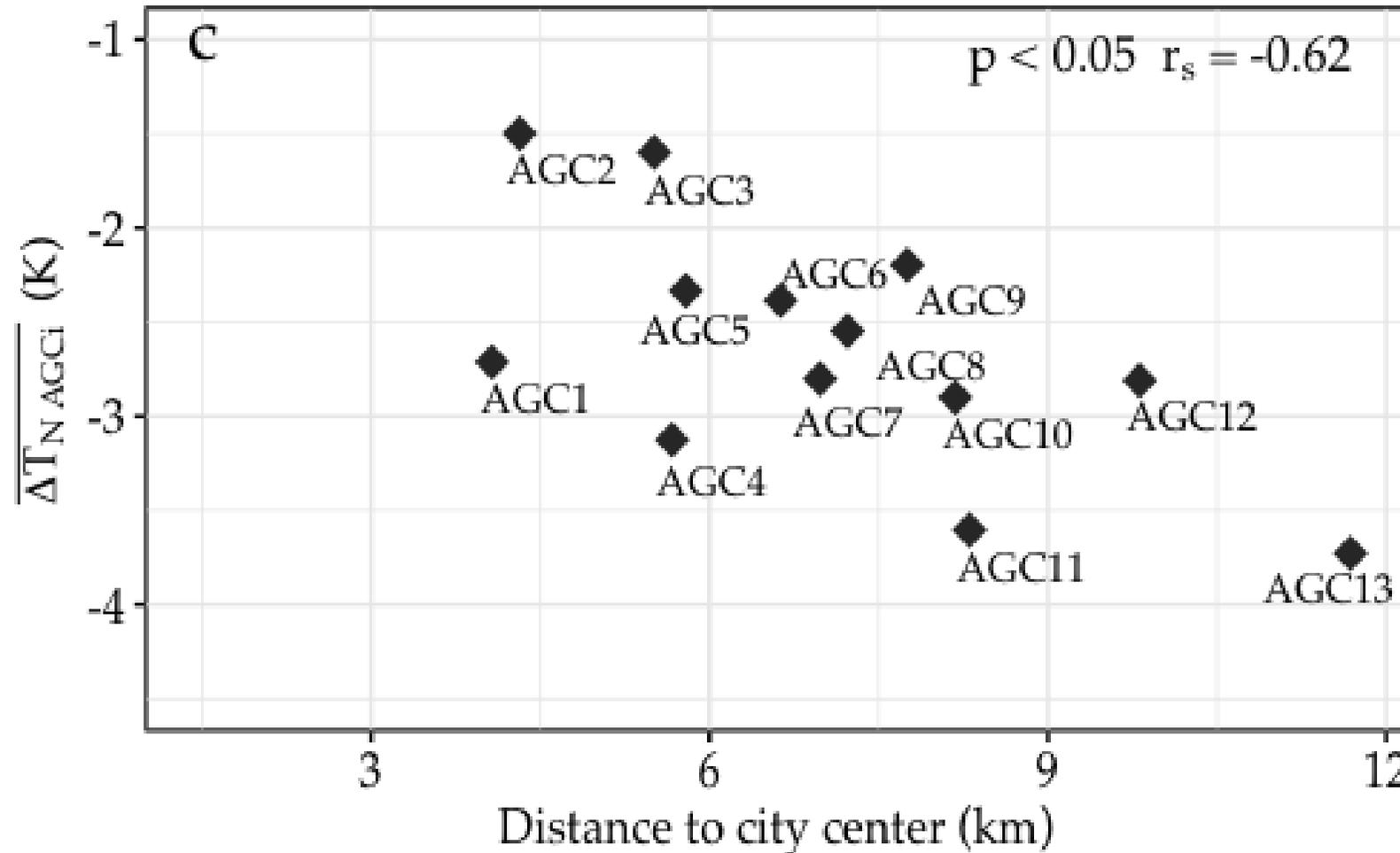
Rost, A. T., V. Liste, C. Seidel, L. Matscheroth, M. Otto, F. Meier, D. Fenner (2020): How Cool Are Allotment Gardens? A Case Study of Nocturnal Air Temperature Differences in Berlin, Germany. Atmosphere 11 (5): 500.

Urban Climate Observatory (UCO) Berlin – Wie kühl sind Kleingartenanlagen?

- 39 Standorte in 15 Kolonien
- August-September 2018
- Mittlerer Kühleffekt: 2,7 °C

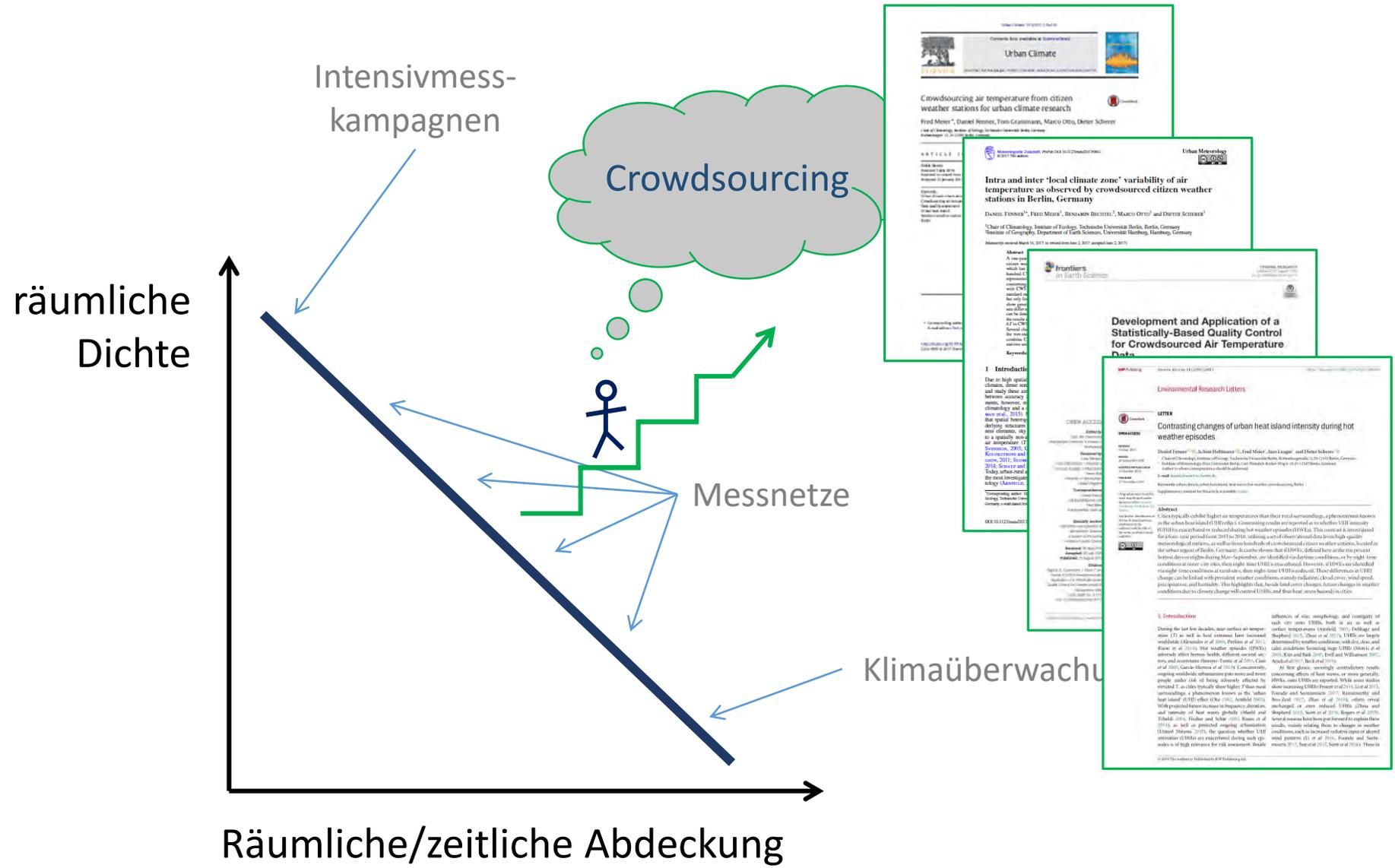


Urban Climate Observatory (UCO) Berlin – Wie kühl sind Kleingartenanlagen?



Rost, A. T., V. Liste, C. Seidel, L. Matscheroth, M. Otto, F. Meier, D. Fenner (2020): How Cool Are Allotment Gardens? A Case Study of Nocturnal Air Temperature Differences in Berlin, Germany. Atmosphere 11 (5): 500.

Urban Climate Observatory (UCO) Berlin – Die Atmosphäre in der Stadt vermessen



Urban Climate Observatory (UCO) Berlin – Die Atmosphäre in der Stadt vermessen

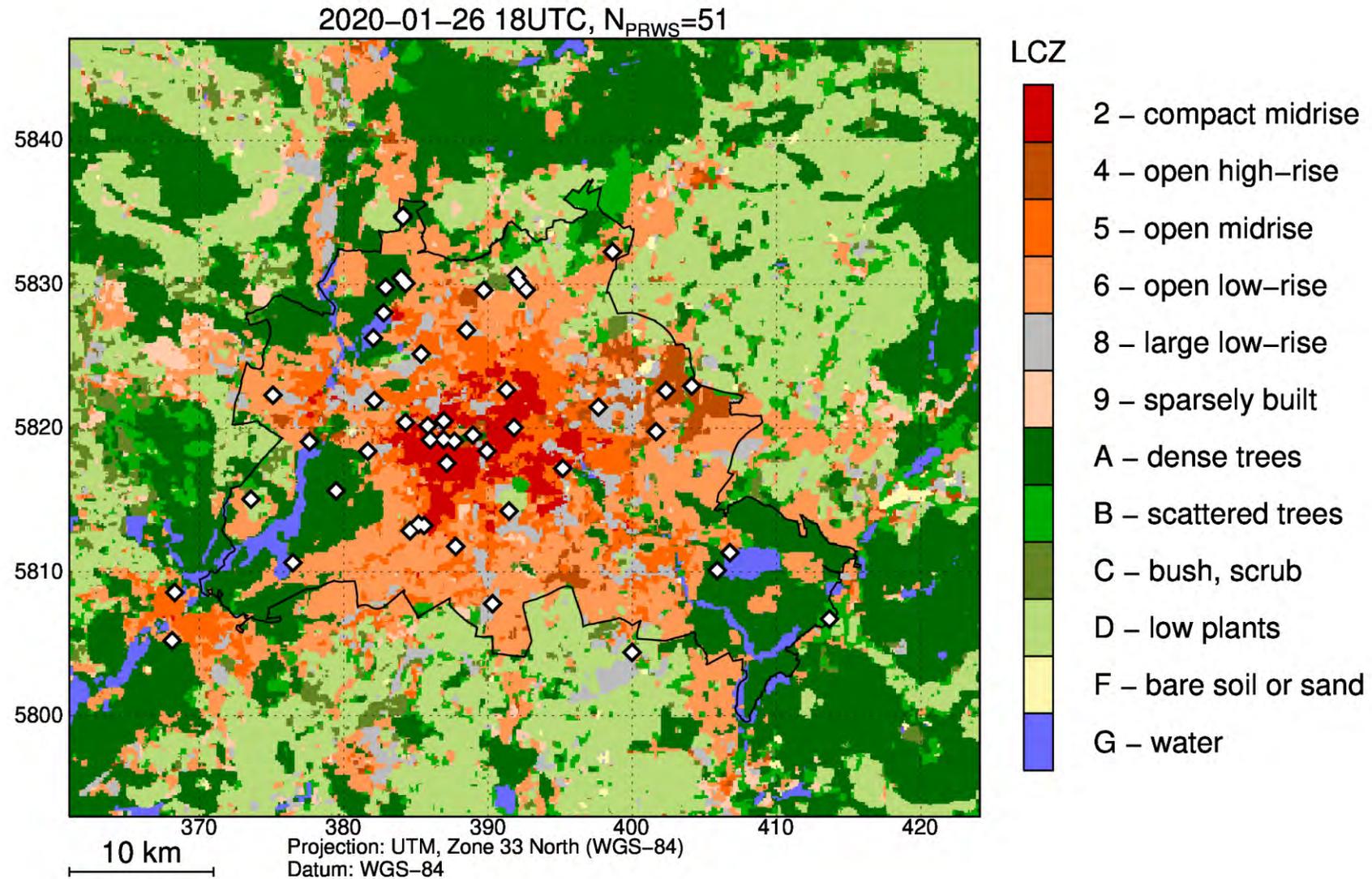


Abbildung: Daniel Fenner, Dissertation, TU Berlin

Urban Climate Observatory (UCO) Berlin – Die Atmosphäre in der Stadt vermessen

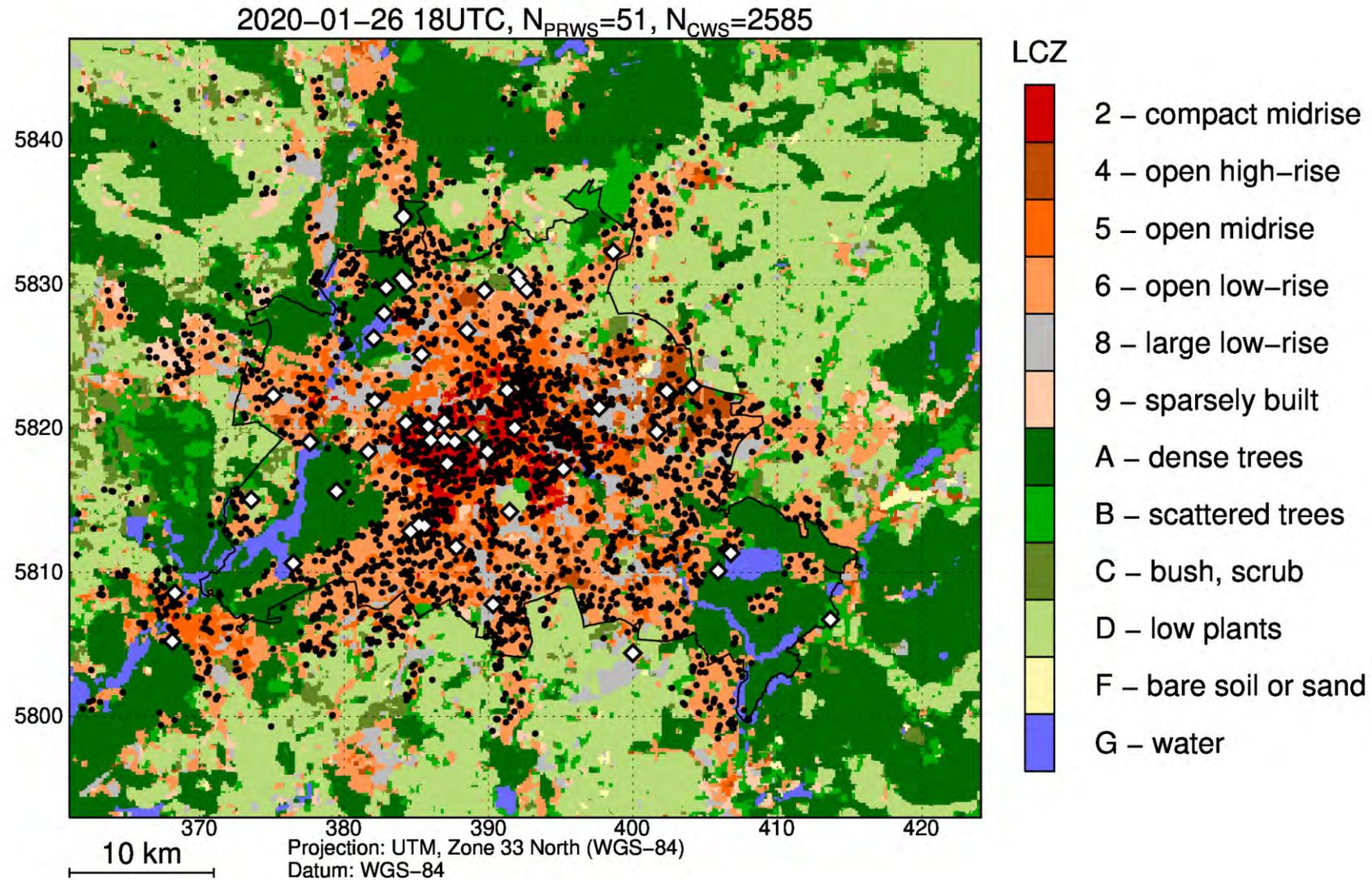
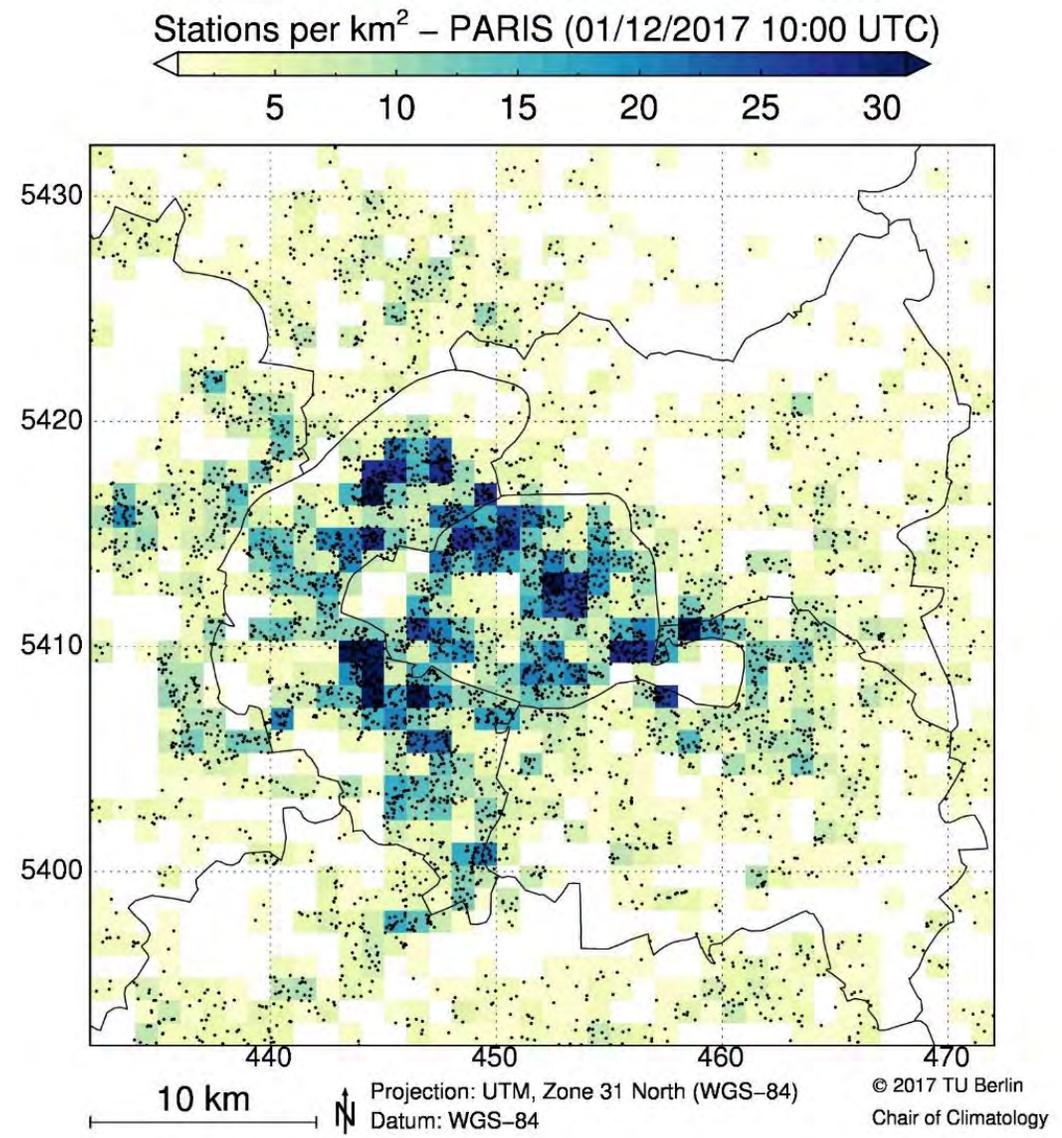
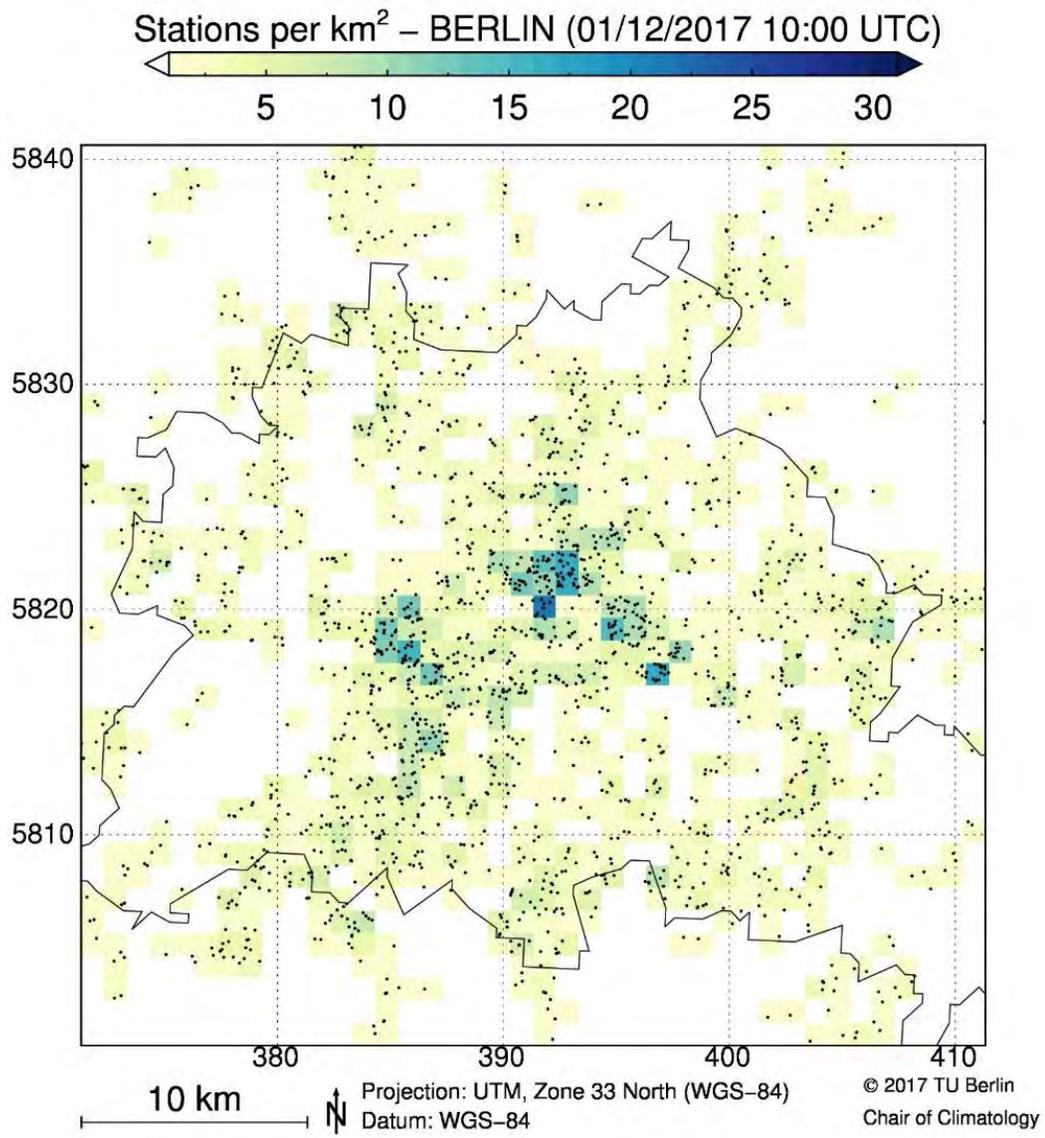


Abbildung: Daniel Fenner, Dissertation, TU Berlin

Urban Climate Observatory (UCO) Berlin – Die Atmosphäre in der Stadt vermessen

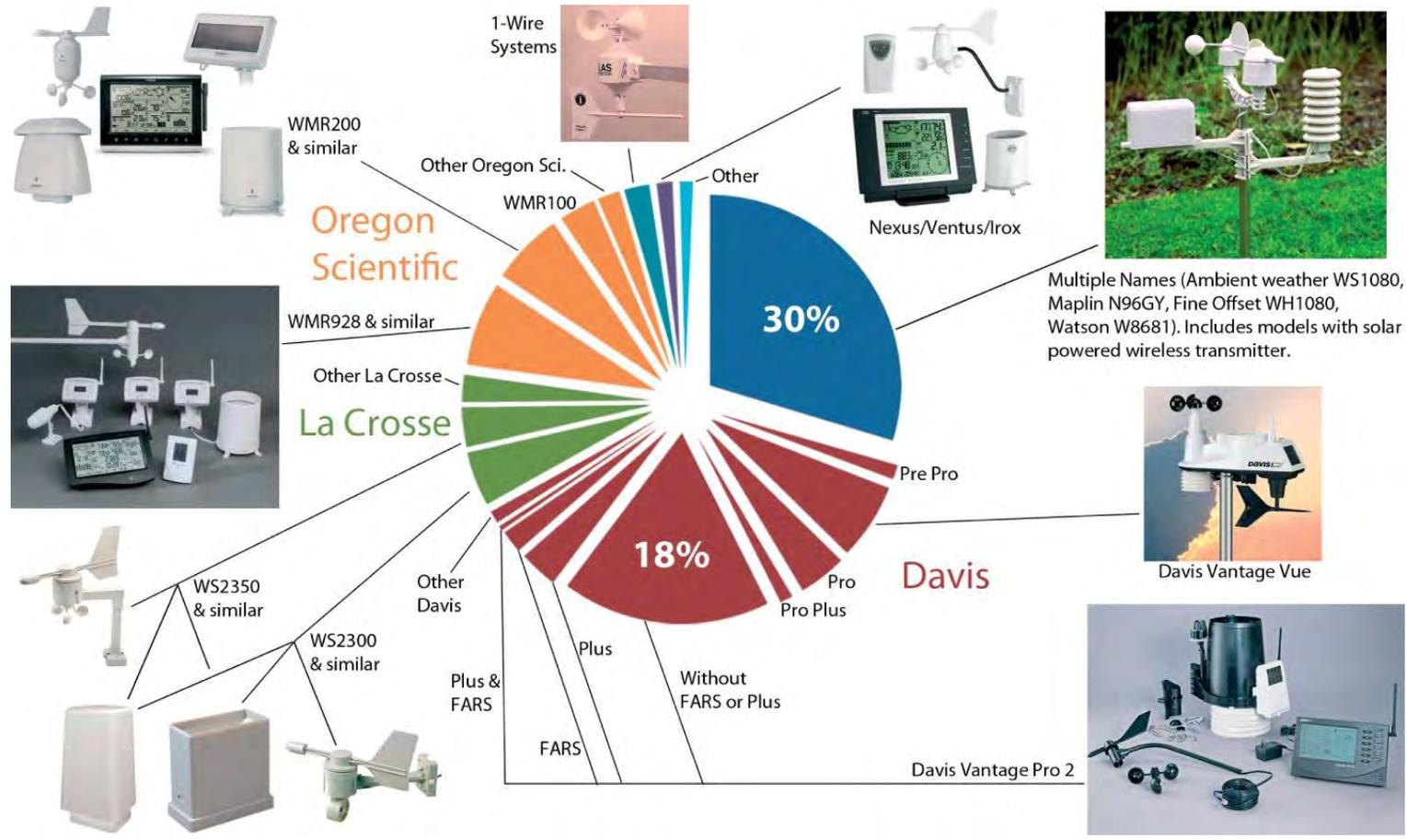


Urban Climate Observatory (UCO) Berlin – Die Atmosphäre in der Stadt vermessen

- Citizen Weather Observer Program (<http://wxqa.com/index.html>)
- Weather Observations Website (<https://wow.metoffice.gov.uk/>)
- Weather Underground/Wundermap (<https://www.wunderground.com/wundermap>)
- Netatmo/Netatmo Weathermap (<https://weathermap.netatmo.com/>)
- Opensensemap (<https://opensensemap.org/>)
- PWS Weather (<https://www.pwsweather.com/>)
- Tempest WX (<https://tempestwx.com/map>)
- Ambient Weather (<https://ambientweather.net/>)
- WeatherLink (<https://www.weatherlink.com/map/>)
- FieldSense (<https://fieldsense.dk/en/>)
- ...

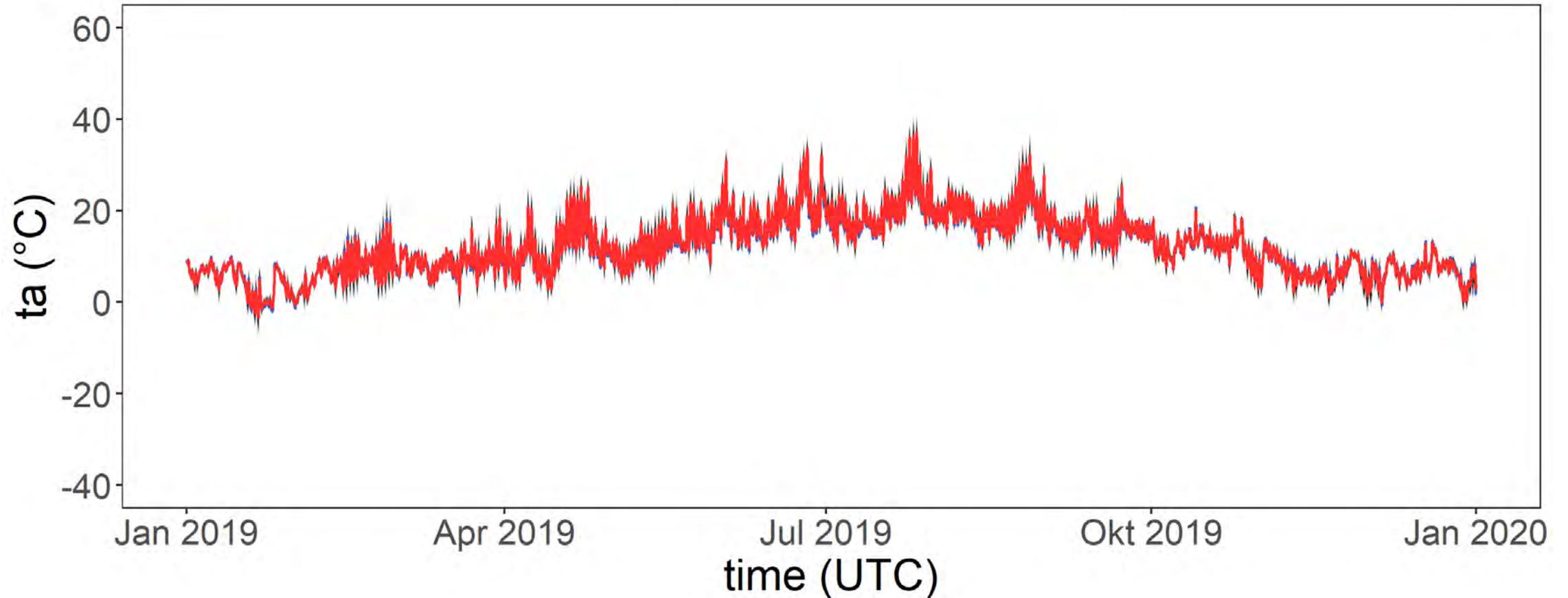


Urban Climate Observatory (UCO) Berlin – Die Atmosphäre in der Stadt vermessen



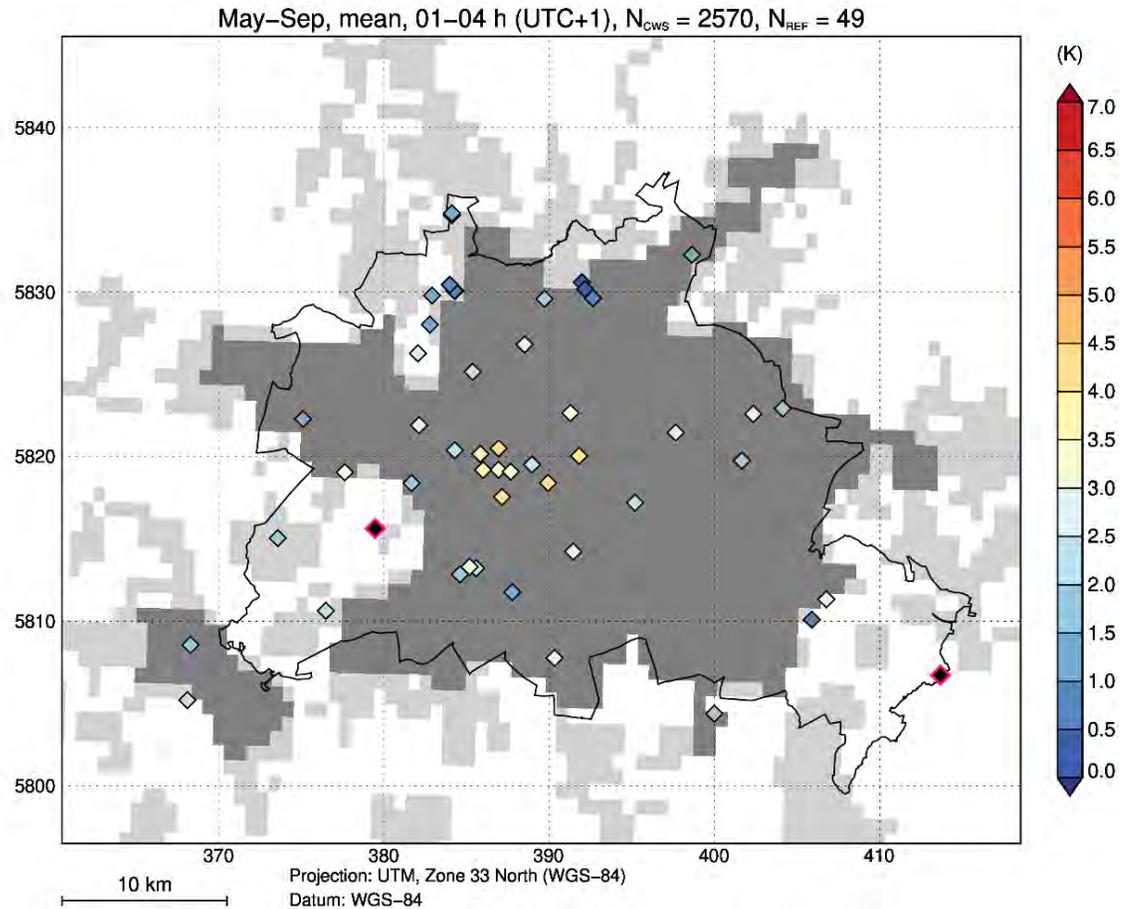
Bell, S., Cornford, D., and Bastin, L. (2013): The state of automated amateur weather observations. *Weather*, 68 (2), 36–41. doi:10.1002/wea.1980.

Netatmo Urban Weather Station in Berlin-Spandau (eigenes Foto)

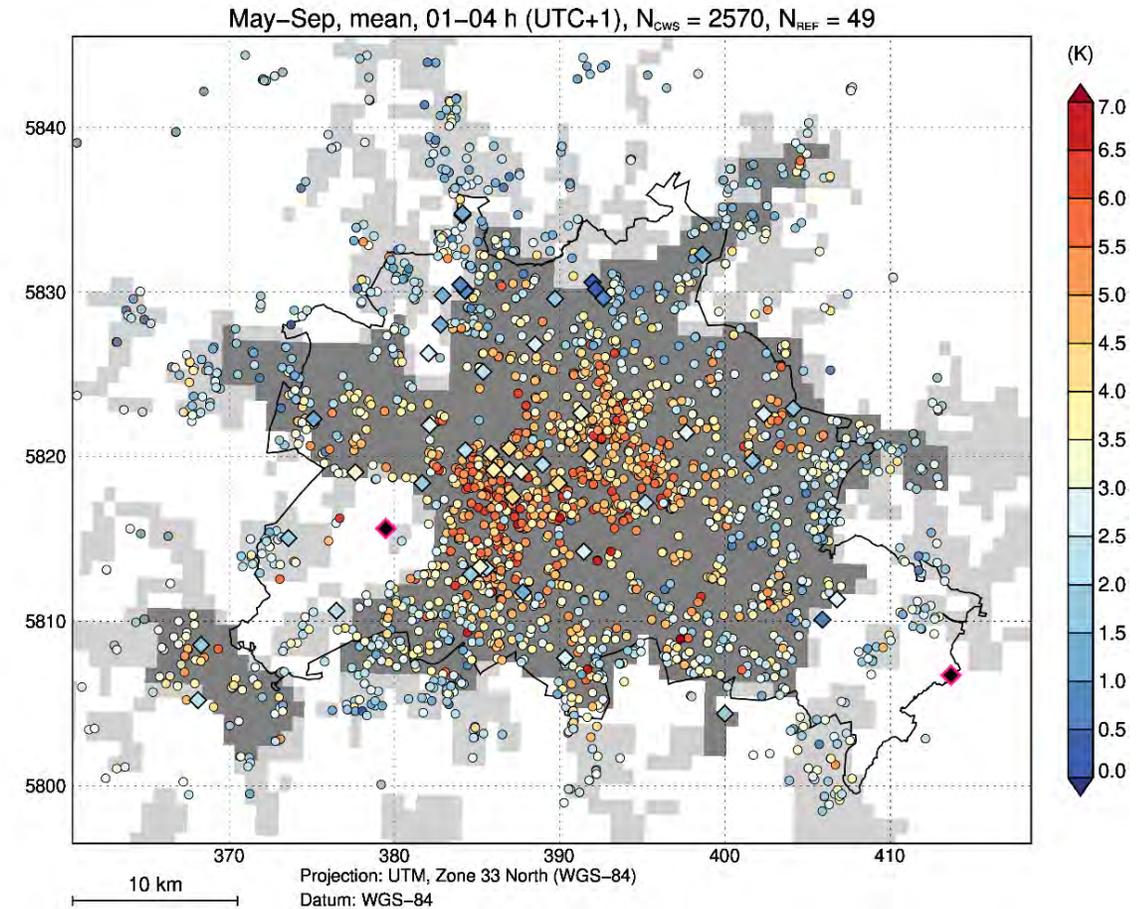


Fenner, D., Bechtel, B., Demuzere, M., Kittner, J. and Meier, F. (2021): CrowdQC+ - A quality-control for crowdsourced air-temperature observations enabling world-wide urban climate applications. *Front. Environ. Sci.* 9: 720747. DOI: 10.3389/fenvs.2021.720747

Urban Climate Observatory (UCO) Berlin – Die Atmosphäre in der Stadt

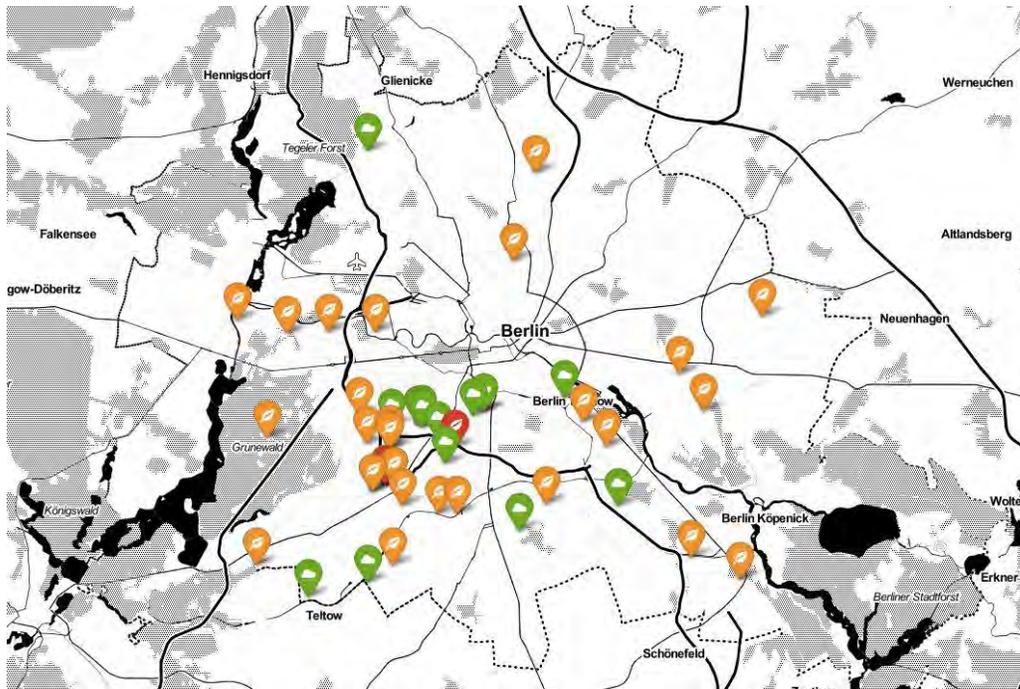


Urban Climate Observation Network (UCON)



Citizen Weather Station (CWS) Network

Urban Climate Observatory (UCO) Berlin – Bürgerwissenschaften



<https://messi.openuco.berlin>

www.openuco.berlin

Foto: Saskia Uppenkamp

https://uco.berlin/

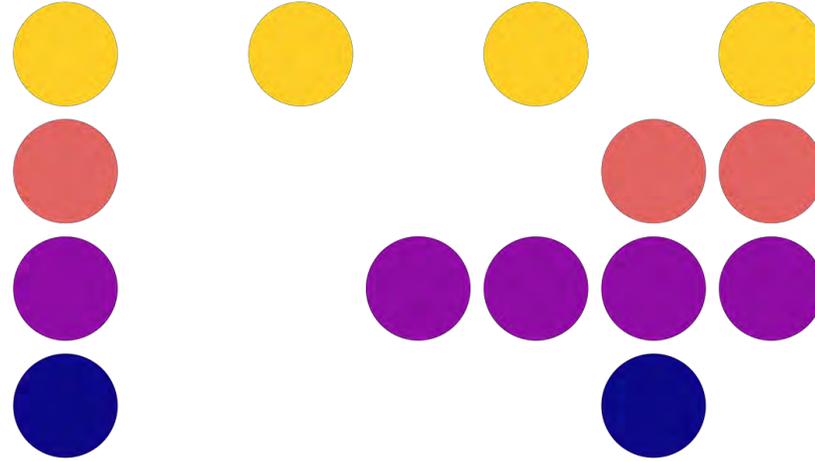
The screenshot displays the Urban Climate Observatory Berlin website. The header includes the logo and the text "Stadtlima-Observatorium Berlin" with a language selector set to "EN". A left sidebar contains navigation links: "Menü minimieren", "Home", "Daten", "Datenportal", "Radarkarte", "Observatorium", "Über uns", "Messnetz", "Messtürme", and "Fernerkundung".

The main content area features a search bar with the placeholder "Suchbegriff eingeben...". Below it are filters for "Spätestes Startdatum" and "Frühestes Enddatum", each with a "Wähle ein Datum" button. Further down are dropdown menus for "Wähle featureType", "Wähle Institution", "Wähle Ort", and "Wähle Variable". At the bottom of the filter section are three buttons: "FILTER ZURÜCKSETZEN", "+ FILTER HINZUFÜGEN", and "- FILTER ENTFERNEN".

To the right is a map of Berlin with numerous blue location pins. Below the map is a table of data entries. The table has columns for "Datenprovider (Abkürzung)", "Institution (Abkürzung)", "Ort", "Aggregation", "Variable", "Einheit", "Höhe (m ü.G.)", "Zeitintervall", "Start", "Ende", and "Download".

Datenprovider (Abkürzung)	Institution (Abkürzung)	Ort	Aggregation	Variable	Einheit	Höhe (m ü.G.)	Zeitintervall	Start	Ende	Download
DWD	DWD	Ahrensfelde	time: sum	Höhe des gefallenen Schnees	cm		30 d	1934-01-01	2022-12-31	[Download] [Info]
DWD	DWD	Ahrensfelde	time: sum	Höhe des gefallenen Schnees	cm		30 d	2022-06-18	2023-10-31	[Download] [Info]
DWD	DWD	Ahrensfelde	time: sum	Höhe der Schneedecke	cm		30 d	1934-01-01	2022-12-31	[Download] [Info]

Urban Climate Observatory Berlin



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für Ökologie, Technische
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in Kooperation mit Daniel Fenner
(Universität Freiburg), Rütger
Rollenbeck (Fellow Berlin
University Alliance), Henning
Rust und Uwe Ulbrich (Freie
Universität Berlin).



ICOS



universität freiburg



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Webseite: www.uco.berlin