Urban Climate News

Quarterly Newsletter of the IAUC

Issue No. 84 June 2022 • www.urban-climate.org • International Association for Urban Climate

From the IAUC President

Welcome to the second *Urban Climate News* for 2022. Sadly, this is my 16th and last column as President since I hand over the role of President to Ariane Middel at the beginning of September at the IAUC Virtual Poster Conference. That will be an occasion for some reflection of what we have achieved and where we are heading as an organisation, but in this column, I want to take the opportunity to thank several people who are relinquishing various roles for their contribution to our thriving organisation.

Importantly, I would like to thank my colleagues on the outgoing IAUC Executive, both of whom have provided wonderful service to the IAUC, as well as excellent advice to me as IAUC President, despite both having very busy professional lives. Ariane Middel has served as IAUC Treasurer since 2019, but of course will soon become our new President. I know that Ariane will make a terrific President of the IAUC. Andreas Christen has been IAUC Secretary alongside me since 2018. In many ways the role of Secretary is one of the most onerous in any organisation and Andreas has served in this role conscientiously, providing steadfast guidance to me and the IAUC Board throughout his term. There are several other people who are rotating off the Board this year after having served their terms. Helen Ward is one of these people who has also done a terrific job as Chair of the IAUC Awards Committee, where she has been instrumental in introducing new awards and revised and streamlined assessment processes. Matthias Demuzere has also been a Board Member since 2018 and has provided great service around engagement and outreach and especially in relation to the IAUC website. We will shortly go through an election process to replace both of these outgoing Board members. Finally in relation to the IAUC Board I would like to thank Alexander Baklanov who has served his term as the WMO representative, bringing an important WMO perspective to our deliberations as well as representing IAUC within the WMO.

I am delighted to report that there is a very healthy interest in the forthcoming **IAUC Virtual Poster Conference** that will be hosted as the University of New South Wales at the end of August. By early June 169 abstracts had been received across 21 sessions. Most pleasingly for a conference targeted at younger scientists 52% of presentations are from student participants. This conference will be an important milestone on the way to ICUC-11 to be held in Sydney in August 2023.

Once again, I thank David Pearlmutter and his editorial team for putting together another excellent newsletter that never fails to highlight the excellent work being undertaken by our community. This is Helen Ward's last *Urban Climate News* as Projects Editor. We wish to thank her for her sterling work in that role over the last six years, and are pleased to welcome Melissa Hart as her replacement.

With very best wishes and I look forward to "seeing" you at the Virtual Poster Conference.

– Nigel Tapper,
IAUC President
nigel.tapper@monash.edu

Inside the June issue...

Europe heatwave: Outdoor events banned in parts of France

June 17, 2022 — Outdoor public events have been banned in an area of France as a record breaking heatwave sweeps across Europe.

Concerts and large public gatherings have been called off in the Gironde department around Bordeaux.

On Thursday, parts of France hit 40ºC earlier in the year than ever before, with temperatures expected to peak on Saturday.

Scientists say periods of intense heat are becoming more frequent and longer lasting as a result of global warming.

Spain, Italy and the UK are also experiencing high temperatures.

In Gironde, officials said public events, including some of the official 18 June Resistance celebrations, will be prohibited from Friday at 14:00 (12:00 GMT) "until the end of the heat wave". Indoor events at venues without air-conditioning are also banned. Private celebrations, such as weddings, will still be allowed.

"Everyone now faces a health risk", local official Fabienne Buccio told France Bleu radio.

The French interior ministry warned people to be extremely careful and not expose themselves to the weather.

State forecaster Meteo France said it was the earliest hot spell ever to hit the country, which has been caused by a mass of hot air moving from north Africa.

Temperatures could hit 39ºC in Paris and droughts have also raised the risk of wildfires, the forecaster said.

"I'm 86 years old, I was born here, but I think this is the worst heatwave I've ever seen," Jacqueline Bonnaud told the AFP news agency in the southern city of Toulouse.

The increased use of air-conditioners and fans was forcing France to import electricity from neighbouring countries, grid operator RTE said.

In Spain, which has just experienced its hottest May since the beginning of the century, temperatures are

Temperatures have reached 44ºC in Montpellier in France. *Source:* https://www.bbc.com

Europe Heatwave: France heat continues to build. Outdoor events continued in other areas of France – this man cooled down at a music festival in Clisson. *Source:* https://www.bbc.com

forecast to hit highs of 43ºC this weekend, the Aemet weather service said.

There have been forest fires in Catalonia, including one which could grow to 20,000 hectares before it's contained, the regional government said.

Water is so low in large stretches of Italy's largest river, the Po, that locals can walk through the middle of the expanse of sand and wartime shipwrecks are resurfacing.

In the UK, temperatures are expected to reach 33ºC in southern England, while a level three heat-health alert has been issued for London.

Extreme heat isn't confined to Europe this week. On Wednesday a third of the entire population of the United States were advised to stay indoors due to record temperatures. In India, Delhi has recorded a maximum temperature of at least 42ºC on 25 days this summer, the India Meteorological Department reported.

Climate change is causing global temperatures to rise. Greenhouse gases, like carbon dioxide, released into Earth's atmosphere in large volumes are trapping the sun's heat, causing the planet to warm. This has brought more extreme weather, including record-breaking high temperatures across the world. *Source:* https://www.bbc.com/news/world-europe-61838543

Climate change made heatwaves in India and Pakistan "30 times more likely"

May 2022 — Extreme heat which gripped large parts of India and Pakistan was made 30 times more likely because of climate change, according to a new rapid attribution study by climate scientists.

The heat was prolonged and widespread and coupled with below-average rainfall, impacting hundreds of millions of people in one of the most densely populated parts of the world. The national meteorological and hydrological departments in both countries have been working closely with health and disaster management agencies to save lives, in line with the WMO drive to strengthen early warnings and early action and to implement heat-health action plans.

On 15 May, the India Meteorological Department said that numerous observing stations reported temperatures of between 45°C (113°F) and 50°C (122 °F). This followed a heatwave at the end of April and early May, at which temperatures reached 43-46 °C.

Temperatures also hit 50°C in Pakistan. The Pakistan Meteorological Department said that daytime temperatures were between 5°C and 8°C above normal in large swathes of the country. The hot, dry weather impacted water supplies, agriculture and human and animal health. In the mountainous regions of Gilgit-Baltistan and Khyber Pakhtunkwa, the unusual heat enhanced the melting of snow and ice and triggered at least one glacial lake outburst flood.

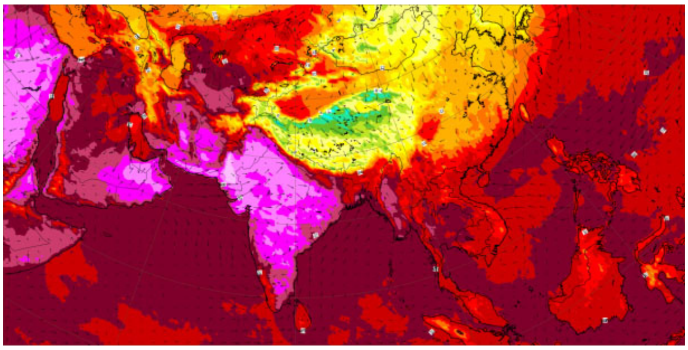
"The full health and economic fallout, and cascading effects from the current heat wave will however take months to determine, including the number of excess deaths, hospitalisations, lost wages, missed school days, and diminished working hours. Early reports indicate 90 deaths in India and Pakistan, and an estimated 10-35 percent reduction in crop yields in Haryana, Uttar Pradesh, and Punjab due to the heatwave," said the report by World Weather Attribution.

"It was the early, prolonged and dry heat that made this event stand out as distinct from heatwaves occurring earlier this century," said the study. It involved scientists from India, Pakistan, the Netherlands, France, Switzerland, New Zealand, Denmark, United States of America and the United Kingdom, who collaborated to assess to what extent human-induced climate change altered the likelihood and intensity of the heatwave.

Because of climate change, the probability of an event such as that in 2022 has increased by a factor of about 30, said the study.

The same event would have been about 1°C cooler in a preindustrial climate.

With future global warming, heatwaves like this will become even more common and hotter. At the global



Source: https://public.wmo.int

mean temperature scenario of +2°C such a heatwave would become an additional factor of 2-20 more likely and 0.5-1.5 °C hotter compared to 2022.

"Heatwaves have multiple and cascading impacts not just on human health, but also on ecosystems, agriculture, water and energy supplies and key sectors of the economy. The risks to society underline why the World Meteorological Organization is committed to ensuring that multi-hazard early warning services reach the most vulnerable," said WMO Secretary-General Prof. Petteri Taalas. "The extreme heat in India and Pakistan is consistent with what we expect in a changing climate. Heatwaves are more frequent and more intense and starting earlier than in the past," he said.

The Intergovernmental Panel on Climate Change, in its Sixth Assessment Report, said that heatwaves and humid heat stress will be more intense and frequent in South Asia this century.

India's Ministry of Earth Sciences recently issued an open-access publication about climate change in India. It devoted a whole chapter to temperature change.

The frequency of warm extremes over India has increased during 1951–2015, with accelerated warming trends during the recent 30 year period 1986–2015 (high confidence). Significant warming is observed for the warmest day, warmest night and coldest night since 1986.

The pre-monsoon season heatwave frequency, duration, intensity and areal coverage over India are projected to substantially increase during the twenty-first century (high confidence).

The heatwave was triggered by a high pressure system and follows an extended period of above average temperatures.

India recorded its warmest March on record, with an average maximum temperature of 33.1°C, or 1.86°C above the long-term average. Pakistan also recorded its warmest March for at least the past 60 years, with a number of stations breaking March records.

In the pre-monsoon period, both India and Pakistan regularly experience excessively high temperatures, especially in May. Heatwaves do occur in April but are less common. It is too soon to know whether new national temperature records will be set. Turbat, in Pakistan, recorded the world's fourth highest temperature of 53.7°C on 28 May 2017.

Heat Health Action Plans

Both India and Pakistan have successful heat-health early warning systems and action plans, including those specially tailored for urban areas. Heat Action Plans reduce heat mortality and lessen the social impacts of extreme heat, including lost work productivity. Important lessons have been learned from the past and these are now being shared among all partners of the WMO co-sponsored [Global Heat Health Information Network] to enhance capacity in the hard hit region

The South Asia Heat Health Information Network, SAHHIN, supported by GHHIN, is working to share lessons and raise capacity across the south Asia region.

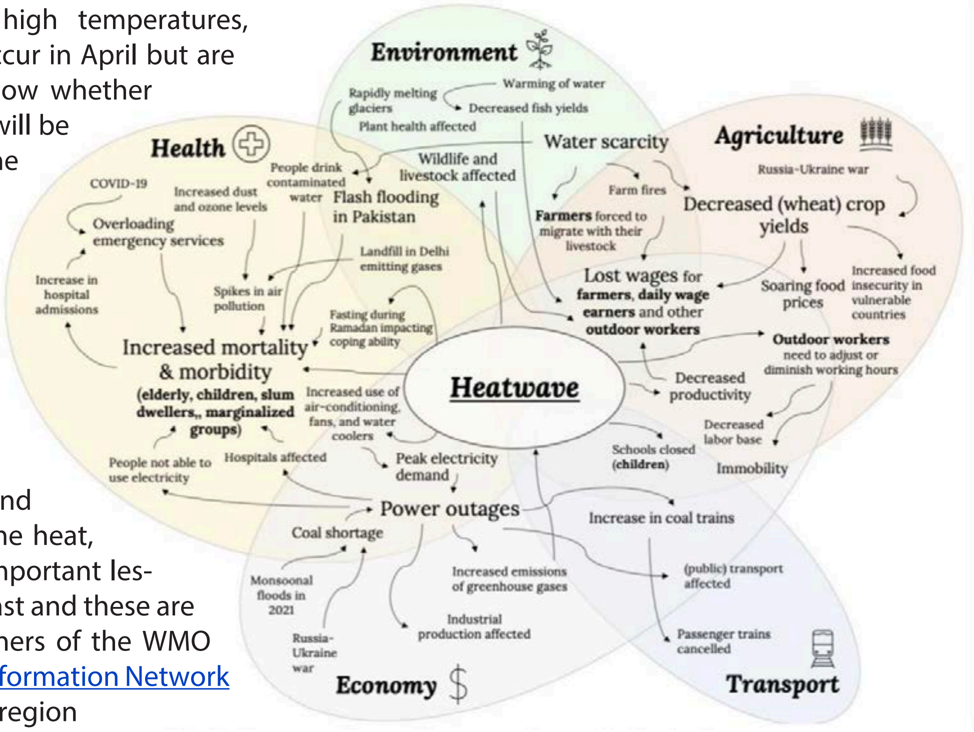
India has established a national framework for heat action plans through the National Disaster Management Authority which coordinates a network of state disaster response agencies and city leaders to prepare for soaring temperatures and ensure that everyone is aware of heatwave Do's and Don't's.

The city of Ahmedabad in India was the first South Asian city to develop and implement a city-wide heat health adaptation in 2013 after experiencing a devastating heatwave in 2010. This successful approach has been expanded to 23 heatwave-prone states and serves to protect more than 130 cities and districts.

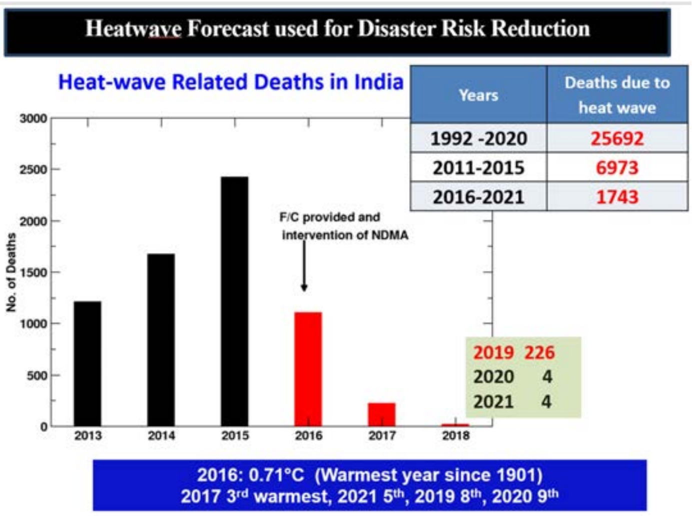
Pakistan has also made strides towards protecting public health. In the summer of 2015, a heatwave engulfed much of central and north-west India and eastern Pakistan and was directly or indirectly responsible for several thousand deaths. That acted as a wake-up call and led to the development and implementation of the Heat Action Plan in Karachi and other parts of Pakistan.

Heat Action Plans at the city, state/provincial, or federal level bring a range of authorities and actors together to better understand and more effectively predict, prepare, and respond to extreme heat risks. Heat Health Warning Systems are an integral part of these and are provided by National Meteorological Services. More information and examples of Heat Action Plans can be found at https://ghhin.org/take-action/

Civil society, such as the Red Cross Red Crescent Society and the Integrated Research and Action for Development (IRADe), also play a critical role, deploying life-saving communications and interventions to vulnerable communities. Typical plans make sure the targeted intervention is a right fit and designed for the heat vulnerable population of a city. It first identifies the heat hotspots of the city, locates the vulnerable populations in these pockets, and assesses the nature and status of their vulnerability to extreme heat. The action plans have tremendously helped in reducing excess mortality. *Source:* https://public.wmo.int/en/media/news/climate-change-made-heatwaves-india-and-pakistan-30-times-more-likely



Conceptual map of impact pathways during the heatwave.
Source: https://public.wmo.int



Source: https://public.wmo.int

Floating Cities May Be One Answer to Rising Sea Levels

An idea that was once a fantasy is making progress in Busan, South Korea. The challenge will be to design settlements that are autonomous and sustainable.

June 2022 — Thanks to climate change, sea levels are lapping up against coastal cities and communities. In an ideal world, efforts would have already been made to slow or stop the impact. The reality is that climate mitigation remains difficult, and the 40% of humanity living within 60 miles of a coast will eventually need to adapt.

One option is to move inland. A less obvious option is to move offshore, onto a floating city.

It sounds like a fantasy, but it could be real, later if not sooner. Last year, Busan, South Korea's second-largest city, signed on to host a prototype for the world's first floating city. In April, Oceanix Inc., the company leading the project, unveiled a blueprint.

Representatives of SAMOO Architects & Engineers Co., one of the floating city's designers and a subsidiary of the gigantic Samsung Electronics Co., estimate that construction could start in a "year or two," though they concede the schedule might be aggressive. "It's inevitable," Itai Madamombe, co-founder of Oceanix, told me over tea in Busan. "We will get to a point one day where a lot of people are living on water.

"If she's right, the suite of technologies being developed for Oceanix Busan, as the floating city is known, will serve as the foundation for an entirely new and sustainable industry devoted to coastal climate adaptation. Busan, one of the world's great maritime hubs, is betting she's right.

A Prototype for Atlantis

Humans have dreamed of floating cities for millenniums. Plato wrote of Atlantis; Kevin Costner made Waterworld. In the real world, efforts to build on water date back centuries.

The Uru people in Peru have long built and lived upon floating islands in Lake Titicaca. In Amsterdam, a city in which houseboats have a centuries-long presence, a handful of sustainably minded residents live on Schoonschip, a small floating neighborhood, completed in 2020.

Madamombe began thinking about floating cities after she left her role as a senior adviser to then-UN Secretary General Ban Ki-Moon. The New York-based native of Zimbabwe had worked in a variety of UN roles over more than a decade, including a senior position overseeing partnerships to advance the UN's Sustainable Development Goals. After leaving, she maintained a strong interest in climate change and the risks of sea-level rise.

Her co-founder at Oceanix, Marc Collins, an engineer

Part of the prototype for the Oceanix floating city. *Source:* https://www.bloomberg.com

and former tourism minister for French Polynesia, had been looking at floating infrastructure to mitigate sea-level risks for coastal areas like Tahiti. An autonomous floating-city industry seemed like a good way to tackle those issues. Oceanix was founded in 2018.

As we sit across the street from the lapping waves of Busan's Gwangalli Beach, Madamombe concedes that they didn't really have a business plan. But they did have her expertise in putting together complex, multi-stakeholder projects at the UN.

In 2019, Oceanix co-convened a roundtable on floating cities with the United Nations Human Settlements Program — or UN-Habitat — the Massachusetts Institute of Technology Center for Ocean Engineering and the renowned architectural firm Bjarke Ingels Group (better known as BIG). "The UN said there's this new industry that's coming up, it's interesting," Madamombe said. "They wanted to be able to shape the direction that it took and to have it anchored in sustainability." At the Oceanix roundtable, BIG unveiled a futuristic, autonomous floating city composed of clusters of connected, floating platforms designed to generate their own energy and food, recycle their own wastes, assist in the regeneration of marine life like corals, and house thousands.

The plan was conceptual, but the meeting concluded with an agreement between the attending parties, including UN-Habitat: Build a prototype with a collaborating host government. Meanwhile, Oceanix attracted early financial backers, including the venture firm Prime Movers Lab LLC.

Busan, home of the world's sixth-busiest port, and a global logistics and shipbuilding hub, quickly emerged as a logical partner and location for the city. "The marine engineering capability is incredible," Madamombe tells me. "Endless companies building ships, naval architecture.

We want to work with the local talent."

Busan's mayor, Park Heong-joon, who is interested in promoting Busan as a hub for maritime innovation, shared the enthusiasm and embraced the politically risky project as he headed into an election. An updated prototype was unveiled at the UN in April 2022.

Concrete Platforms, Moored to the Seafloor

The offices of SAMOO, the Korean design firm that serves as a local lead on Oceanix Busan, are located high above Seoul. On a recent Monday morning, I met with three members of the team that's worked closely with BIG, as well as local design, engineering and construction firms, to bring the floating city to life.

Subsidiaries of Samsung don't take on projects that can't be completed, and SAMOO wants me to understand that they're convinced this project is doable. They also want me to understand that it's important.

"Frankly, it's not the floating-city concept we were interested in, but the fact that it's sustainable," says Alex Sangwoo Hahn, a senior architect on the project.

Floating infrastructure is nothing new in Korea. Sebitseom, a cluster of three floating islands in Seoul's Han River, were completed in 2009 and are home to an event center, restaurants and other recreational facilities. But they are not autonomous or sustainable, and they were not built to house thousands of people safely. Built from steel, they are likely to last years. But corrosion and maintenance will eventually be an issue.

Oceanix Busan must be more durable and stable. Current plans place it atop three five-acre concrete platforms that are moored to the seafloor, with an expected life span of 80 years. The platforms will be 10 meters deep, with only two meters poking above the surface. Within the platforms will be a vast space designed to hold everything from batteries to waste-management systems to mechanical equipment.

That's a lot of space, but the design and engineering teams are learning that there's never enough room to do everything. For example, indoor farming — an aspiration at Oceanix — requires large amounts of energy that must be devoted to other goals.

Dr. Sung Min Yang, the project manager on Oceanix Busan and an associate principal at SAMOO, acknowledges that — for now — the floating city won't meet all its aspirations. "We hoped to be net positive with energy, we would recycle everything and not have any waste going out," he says. "Now we are striving for net zero, but we are also looking at a backup connection to the mainland for electricity and wastewater."

Madamombe, who spends much of her time working out differences between the various teams involved in the project, isn't bothered that some of the initial vision must be reined in. She recounts a piece of advice she received from advisers from the MIT Center for Ocean Engineering: "Don't try to prove everything." She shrugs. "If we grow 50% of our food and bring 50% in, will it be a great success?" she asks. "Yes, it would be. It's a city!"

That wouldn't be the only success. Creating three massive floating concrete platforms that can safely support multi-story buildings while recycling the wastes of residents (including water) would be a major technological advance, and one that Oceanix says that it — and its partners — can pull off, and profitably market. In time, the technologies will improve, becoming more autonomous and sustainable, in line with Oceanix's earliest aspirations.

But first a prototype must be built. SAMOO estimates that constructing the first floating platforms will require two to three years as the contractors and engineers work out the techniques. Even under the best of circumstances, construction won't start until next year at the earliest, putting completion — aggressively — mid-decade.

Costs are also daunting. Estimates for this first phase of Oceanix Busan range as high as $200 million and — so far — that funding hasn't been secured. That will require private fundraising, including in Korea.

Madamombe says Busan will "help raise money by backing the project and making introductions," not by contributions. But the slow ramp-up isn't dissuading anyone. According to SAMOO, multiple Korean shipbuilding companies are interested in the project.

It's a Start

Visionaries have long dreamed of floating cities that are politically autonomous, as well as resource autonomous. One day, that dream might be achieved. But for now, Oceanix is about developing technologies that help coastal communities adapt to climate change and persist as communities.

To do that, Oceanix Busan will be directly connected to Busan by a roughly 260-foot bridge. Rather than function as an autonomous city, it will instead function as a kind of neighborhood under the full administrative jurisdiction of Busan city hall.

Of course, three platforms and 12,000 planned residents and visitors won't be enough to save Busan from climate change. Neither will the additional platforms that Oceanix hopes to see built and connected to the first three in coming years. But it's a start that can serve as a model and inspiration for other communities hoping to adapt to sea-level changes, rather than just respond to them. After all, disaster assistance and sea walls are expensive and require intensive planning, too.

Long term, humanity will need to learn to live with rising sea levels. Floating cities will be one way for coastal communities to do it. *Source:* https://www.bloomberg.com/opinion/articles/2022-06-26/floating-cities-may-be-one-answer-to-climate-change

Direct observations of CO_2 emission reductions due to COVID-19 lockdown across European urban districts

Giacomo Nicolini (giacomo.nicolini@cmcc.it)
Euro-Mediterranean Centre on Climate Change (CMCC) - Division on Impacts on Agriculture, Forests and Ecosystem Services (IAFES)

Dario Papale
University of Tuscia, Department for Innovation in Biological Agro-food and Forest systems (DIBAF)

This report is based on: Nicolini, G., Antoniella, G., Carotenuto, F., Christen, A., Ciais, P., Feigenwinter, C., Gioli, B., Stagakis, S., Velasco, E., Vogt, R., Ward, H.C., Barlow, J., Chrysoulakis, N., Duce, P., Graus, M., Helfter, C., Heusinkveld, B., Järvi, L., Karl, T., Marras, S., Masson, V., Matthews, B., Meier, F., Nemitz, E., Sabbatini, S., Scherer, D., Schume, H., Sirca, C., Steeneveld, G.-J., Vagnoli, C., Wang, Y., Zaldei, A., Zheng, B., Papale, D., 2022. Direct observations of CO2 emission reductions due to COVID-19 lockdown across European urban districts. *Sci. Total Environ*. 830, 154662. doi:10.1016/j.scitotenv.2022.154662

Introduction

The onset of the COVID-19 pandemic in Europe in early spring 2020 caused drastic changes to people's lives and socio-economic activity. The governmental actions taken to break the chain of disease transmission included the closure of schools and non-essential businesses, banning social gatherings, and enforcing home confinement. Such measures reduced mobility and economic activity, and inevitably impacted energy use and anthropogenic CO_2 emissions. They also displaced daytime populations from the work-place to residential areas, which likely impacted the spatial distribution of emissions associated with building energy use, as well as affecting emissions from transport. Assessments of national activity reductions combined with empirical relations to predict emissions suggested that CO_2 emissions of individual countries fell by up to 30% during the peak of the lockdowns in spring 2020 (Forster et al., 2020; Le Quéré et al., 2020; Liu et al., 2020). Although associated CO_2 emissions reductions at the city scale are to be expected, the magnitude and variability of these reductions cannot be simply determined from national-level changes. Quantitative estimates of urban emission reductions due to COVID-19 restrictions based on atmospheric measurements have so far only been estimated for a few cities worldwide (Gualtieri et al., 2020; Lamprecht et al., 2020; Sugawara et al., 2021; Velasco, 2021; Yadav et al., 2021).

In this study we present CO_2 fluxes measured by a network of 13 eddy covariance (EC) stations in 11 European cities, spanning several years before the pandemic until October 2020. CO_2 flux data at half-hourly resolution allowed for temporal changes in CO_2 emissions to be tracked both during the initial lockdown period and during the subsequent recovery phase when economic activities and mobility gradually resumed.

Method

We evaluated district-scale changes in urban CO_2 fluxes between 2020 and previous years using micrometeorological data from 13 urban EC stations in 11 cities across Europe: Innsbruck and Vienna (Austria), Basel (2 stations, Switzerland), Berlin (2 stations, Germany), Helsinki (Finland), Heraklion (Greece), Florence, Pesaro and Sassari (Italy), Amsterdam (Netherlands) and London (United Kingdom). These changes were analyzed in relation to the stringency of the local lockdown rules, taking into consideration the characteristics of each site in terms of local citizens' activities (e.g. commuting, economic activities, domestic heating) and urban features. All systems collected data at 10 or 20 Hz, which were processed by the researchers in charge of each station according to commonly accepted procedures (Aubinet et al., 2012) to obtain the half-hourly CO_2 fluxes used in the analysis. Data quality assurance was assessed by each group following standard quality control and filtering procedures, albeit with allowances for site-to-site variations.

Flux observations from previous years up to and including 2019 were used as a reference to compare changes before, during, and after the lockdown periods with related restrictions that affected each city. Pre-2020 records span between 2 and 14 years depending on the station. We focused our analysis on four distinct periods, defined following the daily values of the Ox-

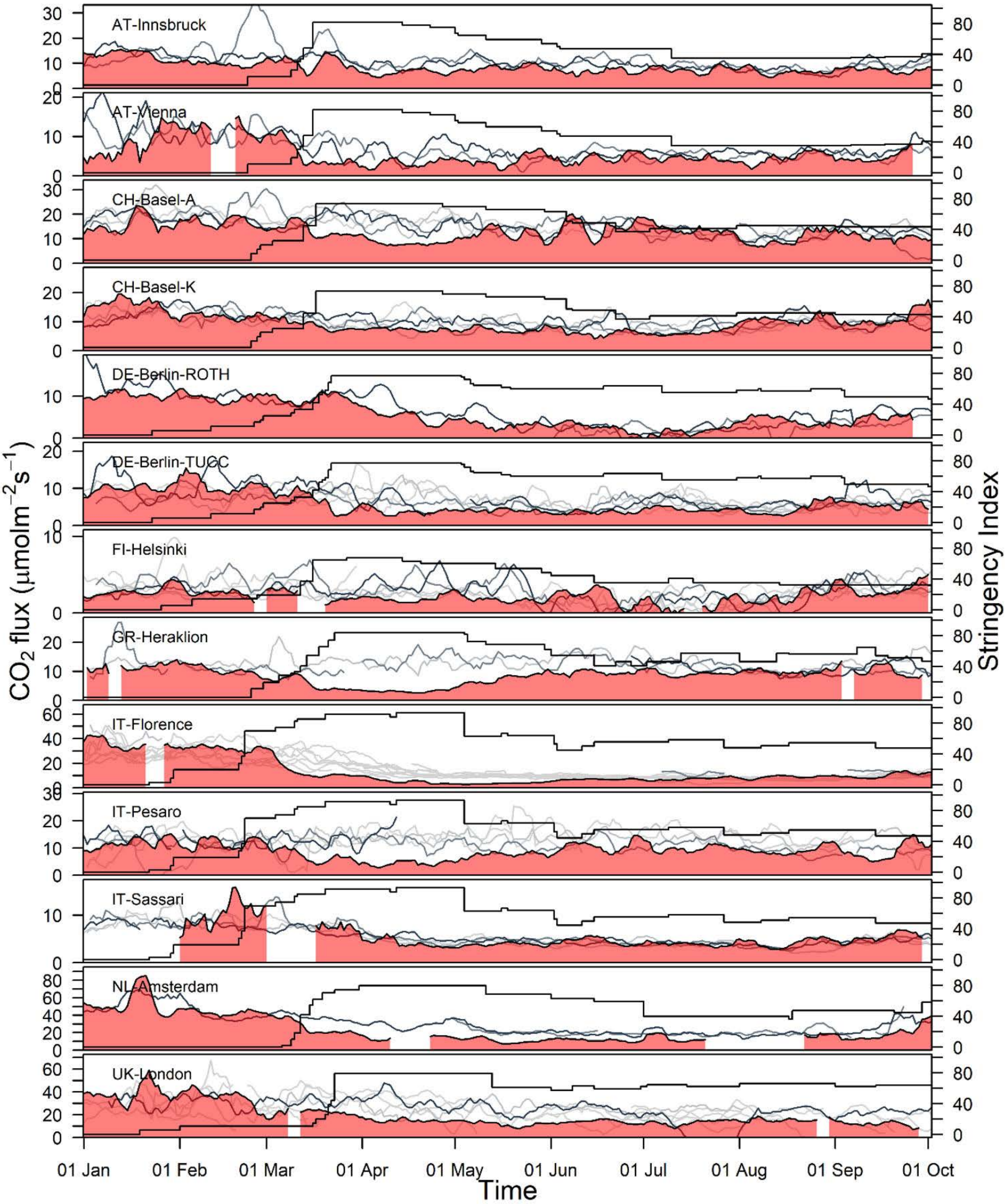


Figure 1. Daily CO_2 fluxes (μmol m^{-2} s^{-1}) from January to October 2020 (red area) and daily fluxes in previous years (grey lines). Individual previous year series are distinguished by specific grey hue: from 2019, 2018 and 2017 from dark to medium grey, from 2016 backward, light grey. Daily time series were smoothed using a 7-day moving window. The Oxford Stringency Index (0-100, black stepped curve) indicates the levels of restrictions due to the COVID-19 pandemic (0 = no restrictions, 100 = maximum restrictions).

ford COVID-19 Government Response Tracker (OxCGRT) Stringency Index (SI) (Hale et al., 2020). It ranges between 0 (no restrictions) and 100 (maximum level of restrictions). We set a minimum threshold of 65 (64.3 is the 60th quantile of the SI values for the analyzed cities over the period January - October 2020) to define the lockdown period (LOCK) in each city. Then, a pre-pandemic period (PRE) was defined lasting from January 1st to the beginning of the lockdown in each location, and two subsequent periods of 60 days each, POST1 and POST2, were identified after LOCK to evaluate the emissions recovery.

The anomalies in CO_2 fluxes (FC) during each of these periods were quantified both in terms of actual flux magnitude reductions and in terms of the relative flux changes (RFC, %) computed as RFC = $(x_{2020} – x_{base}) / | x_{base} | * 100$, where x_{2020} and x_{base} are the average fluxes observed for each period in 2020 and for the corresponding period in previous years (considered as the baseline period), respectively. Negative values of RFC indicate a reduction of the CO_2 fluxes with respect to the baseline period, while positive values are associated with increased CO_2 fluxes. To help interpreting patterns and differences in the daily values and diel cycles of CO_2 fluxes, we analyzed weekday and weekend fluxes separately. This allowed us to further characterize the emissions and their respective local drivers.

Results and discussion

Figure 1 shows daily CO_2 fluxes (in µmol m^{-2} s^{-1}) over the period January - October 2020, and their relationship with the SI daily values. Flux time series from individual pre-2020 years (grey lines) provided the benchmark values against which we compared the 2020 datasets.

By comparing the time series, an anti-correlation is evident between the stringency of restriction measures and CO_2 fluxes in 2020: as soon as an SI curve started to increase (e.g. above 40, approximately at the beginning of March) the associated CO_2 flux curve started to diverge from its historical values to lower fluxes, i.e. a reduction in emissions. Daily reductions during LOCK mostly spanned between -%5 to -87% (Wilcoxon rank-sum test, $\alpha = 0.01$). The largest reductions were seen at GR-Heraklion (RFC daily means interquartile range IQ = [-75%, -46%]), IT-Pesaro ([-71%, -34%]), IT-Florence ([-66%, -37%]), DE-Berlin-TUCC ([-63%, -36%]), UK-London ([-58%, -33%]) and CH-Basel-A ([-53%, -26%]).

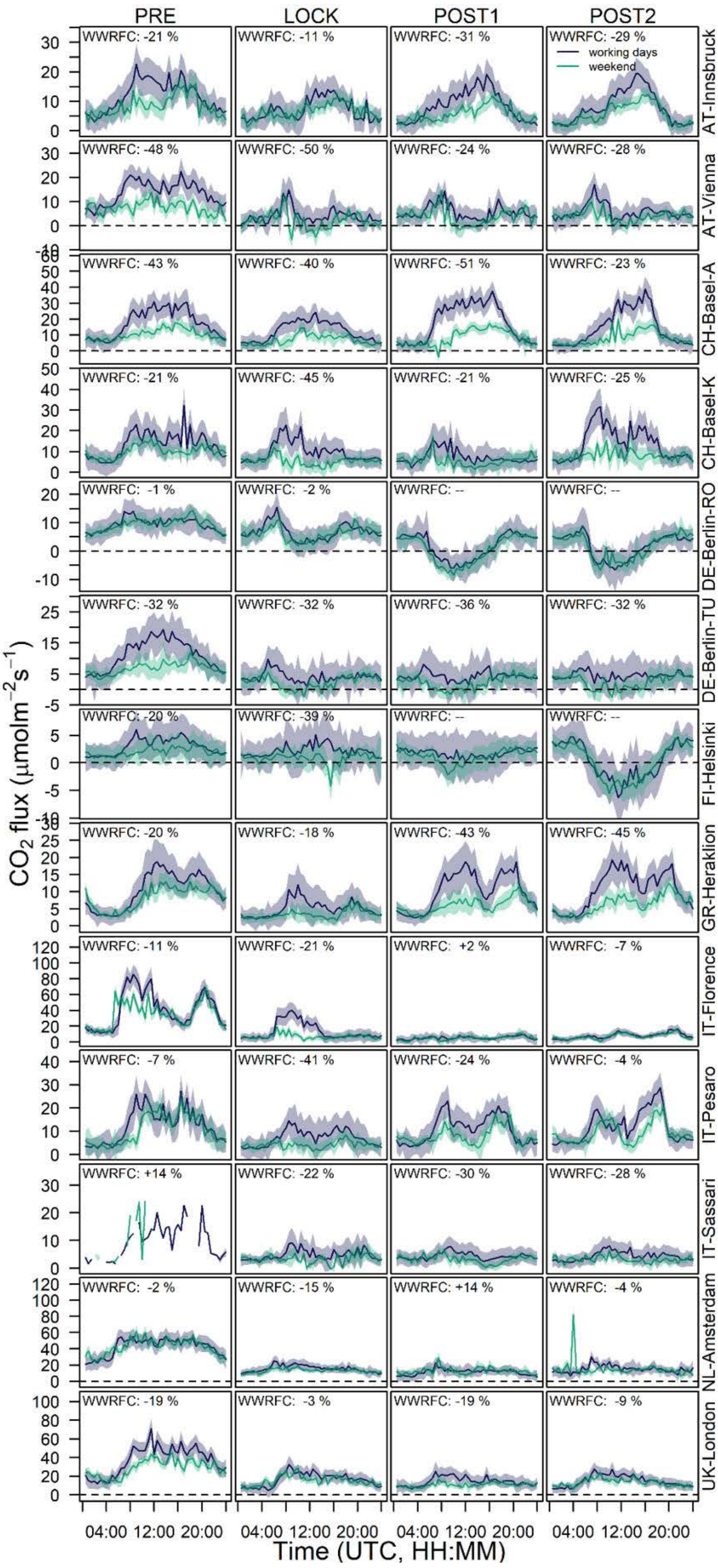
When restrictions started to ease (in general from May-June, POST1 and POST2 periods), daily CO_2 emissions began approaching historical values in many city districts like AT-Innsbruck, AT-Vienna, CH-Basel-A, CH-Basel-K, DE-Berlin ROTH, FI-Helsinki, GR-Heraklion, IT-Florence and IT-Sassari. However in the others, DE-Berlin TUCC, IT-Pesaro, NL-Amsterdam and UK-London, they remained below long-term trends up to the end of the considered period.

The analysis of diel CO_2 flux cycles confirmed significant reductions in emissions in all districts during the LOCK period compared to each previous year, ranging from -10% at CH-Basel-K to -63% at GR-Heraklion. In all cases the reductions occurred mainly during daytime, except for larger cities (AT-Vienna, NL-Amsterdam, UK-London), where restrictions had a clear effect also at night. Significant emission reductions during LOCK were observed at different hours of the day across districts, e.g. mainly in the morning at AT-Innsbruck and GR-Heraklion, and in the afternoon as e.g. in CH-Basel-K and DE-Berlin-ROTH. The diel patterns of the CO2 fluxes in the different districts fall into two main categories: a bimodal emission pattern typical of districts with heavy traffic and accompanying rush-hour peaks (e.g. DE-Berlin-ROTH, GR-Heraklion, IT-Pesaro, IT-Sassari), and a monomodal pattern with a single maximum at midday (e.g. AT-Innsbruck, NL-Amsterdam and UK-London). Among the districts showing a clear bimodal flux pattern (with morning and evening peaks), by analyzing the differences between weekdays and weekends (Fig. 2), we could identify those in which the vehicular traffic is more related to working or economic activities, as CH-Basel-K and GR-Heraklion.

In these two districts, we recorded consistent differences between weekdays and weekend fluxes, both in terms of magnitude (on average -45%, -21%, and -25% at CH-Basel-K and -18%, -43%, and -45% at GR-Heraklion during LOCK, POST1 and POST2 periods) and their diurnal pattern (Figure 2). This is likely related to the sharp reduction of commuters on the weekend. At AT-Vienna, CH-Basel-A, and DE-Berlin-TUCC differences between weekdays and weekend fluxes were also observed, yet the diel pattern remained mostly the same, which indicates that the emission driver(s) plays a role independently from the day of the week. This can be related to a different typology of traffic, characterized by a general level of car circulation. In IT-Pesaro the two-emission peak pattern occurred also on weekends, yet the peaks are shifted 1-2 hours forward compared with weekday peaks. In Pesaro, unlike in other cities, the weekend traffic pattern seems to be dominated by commuter traffic to the beach, which shows a similar rush-hour structure as weekdays.

Conclusion

Urban EC stations operating before and during 2020 presented a unique opportunity to investigate how the drastic perturbations in human activity caused by the COVID-19 pandemic have impacted local CO_2 emissions. The high temporal resolution of our EC datasets (half-hourly) allowed changes in CO_2 fluxes before,



during, and after the first COVID-19 pandemic wave to be detected precisely and in near real-time. For 9 out of 13 sites CO_2 emissions returned to pre-pandemic levels by autumn of 2020. The speed and extent of such an emission recovery varied from district to district, with the fastest and most complete recovery seen mainly in the non-residential areas and attributed to re-established vehicular traffic. The emission reductions occurred mainly during daytime, principally as a consequence of limitations on mobility. The results demonstrate that changing human behavior has a direct, immediate and significant effect on the reduction of urban CO_2 emissions, but the temporary nature of the observed emission reductions emphasizes the need to implement systemic changes in the city ecosystem and people's lifestyles to achieve an effective and sustained climate change mitigation.

The research highlights also both the importance of continuous and long-term measurements of urban emissions, and of data sharing. To this aim, the Integrated Carbon Observation System (ICOS, www.icos-ri.eu) with its recent EU H2020 project called ICOS Cities, will bring an extensive urban greenhouse gas exchange data collection for the global scientific community, available through the ICOS Carbon Portal (https://data.icos-cp.eu/portal/), which will be useful for additional analysis on the complex urban greenhouse gas exchange dynamics.

Figure 2. CO_2 flux (µmol m^{-2} s^{-1}) diurnal cycles during weekdays (dark blue-grey) and weekends (green). Weekday fluxes were averaged over Monday-Friday, weekend fluxes over Saturday-Sunday. Daily cycles are reported for the four benchmark periods: during the COVID-19 lockdowns restrictions (LOCK), before (PRE) and after it (POST1 and POST2). Shaded areas represent the standard error of the means. The CO_2 flux change between weekend and weekdays (WWRFC) is computed as $(FC_{we} - FC_{wd}) / |FC_{wd}| * 100$.

References

Aubinet, M., Vesala, T., Papale, D., 2012. Eddy Covariance: a practical guide to measurement and data analysis. Springer Netherlands, Dordrecht. doi:10.1007/978-94-007-2351-1

Forster, P.M., Forster, H.I., Evans, M.J., Gidden, M.J., Jones, C.D., Keller, C.A., Lamboll, R.D., Quéré, C. Le, Rogelj, J., Rosen, D., Schleussner, C.F., Richardson, T.B., Smith, C.J., Turnock, S.T., 2020. Current and future global climate impacts resulting from COVID-19. *Nat. Clim. Chang.* 10, 913–919. doi:10.1038/s41558-020-0883-0

Gualtieri, G., Brilli, L., Carotenuto, F., Vagnoli, C., Zaldei, A., Gioli, B., 2020. Quantifying road traffic impact on air quality in urban areas: A Covid19-induced lockdown analysis in Italy. *Environ. Pollut.* 267, 115682. doi:10.1016/j.envpol.2020.115682

Hale, T., Boby, T., Angrist, N., Cameron-Blake, E., Hallas, L., Kira, B., Majumdar, S., Petherick, A., Phillips, T., Tatlow, H., Webster, S., 2020. Oxford COVID-19 Government Response Tracker. *Blavatnik Sch. Gov*.

Lamprecht, C., Graus, M., Striednig, M., Stichaner, M., Karl, T., 2020. Decoupling of urban CO2 and air pollutant emission reductions during the European SARS-CoV2 lockdown. *Atmos. Chem. Phys.* 1–22. doi:10.5194/acp-2020-1080

Le Quéré, C., Jackson, R.B., Jones, M.W., Smith, A.J.P., Abernethy, S., Andrew, R.M., De-gol, A.J., Willis, D.R., Shan, Y., Canadell, J.G., Friedlingstein, P., Creutzig, F., Peters, G.P., 2020. Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement. *Nat. Clim. Chang.* 1–8. doi:10.1038/s41558-020-0797-x

Liu, Z., Ciais, P., Deng, Z., Lei, R., Davis, S.J., Feng, S., Zheng, B., Cui, D., Dou, X., Zhu, B., Guo, Rui, Ke, P., Sun, T., Lu, C., He, P., Wang, Yuan, Yue, X., Wang, Yilong, Lei, Y., Zhou, H., Cai, Z., Wu, Y., Guo, Runtao, Han, T., Xue, J., Boucher, O., Boucher, E., Chevallier, F., Tanaka, K., Wei, Y., Zhong, H., Kang, C., Zhang, N., Chen, B., Xi, F., Liu, M., Bréon, F.-M., Lu, Y., Zhang, Q., Guan, D., Gong, P., Kammen, D.M., He, K., Schellnhuber, H.J., 2020. Near-real-time monitoring of global CO_2 emissions reveals the effects of the COVID-19 pandemic. *Nat. Commun.* 11, 5172. doi:10.1038/s41467-020-18922-7

Sugawara, H., Ishidoya, S., Terao, Y., Takane, Y., Kikegawa, Y., Nakajima, K., 2021. Anthropogenic CO2 Emissions Changes in an Urban Area of Tokyo, Japan, Due to the SCOVID-19 Pandemic: A Case Study During the State of Emergency in April–May 2020. *Geophys. Res. Lett.* 48, 1–10. doi:10.1029/2021GL092600

Velasco, E., 2021. Impact of Singapore's COVID-19 confinement on atmospheric CO_2 fluxes at neighborhood scale. *Urban Clim.* 37. doi:https://doi.org/10.1016/j.uclim.2021.100822

Yadav, V., Ghosh, S., Mueller, K., Karion, A., Roest, G., Gourdji, S.M., Lopez-Coto, I., Gurney, K.R., Parazoo, N., Verhulst, K.R., Kim, J., Prinzivalli, S., Fain, C., Nehrkorn, T., Mountain, M., Keeling, R.F., Weiss, R.F., Duren, R., Miller, C.E., Whetstone, J., 2021. The Impact of COVID-19 on CO2 Emissions in the Los Angeles and Washington DC/Baltimore Metropolitan Areas. Geophys. *Res. Lett.* 48, 1–10. doi:10.1029/2021gl092744

Would you like your work featured in *Urban Climate News*?

If you would like to write an article for the IAUC newsletter, please contact our new Projects Editor **Melissa Hart** (melissa.hart@unsw.edu.au).

Our "Urban Project" articles usually provide a short summary of recent work and can be a good way to advertise a recent journal publication to a wide audience, perhaps including additional information, figures or photographs.

Our "Feature" articles offer the opportunity to highlight results from a particular project or collection of projects, often bringing together findings from a series of complementary publications in a concise overview.

We are always happy to receive suggestions for future issues of the newsletter – please get in touch!

*We would also like to express our gratitude to **Helen Ward**, who has served as our Projects Editor for the last six years. Thanks Helen for your dedication and comradery, which are deeply appreciated by the urban climate community. — The Editors*

Spatiotemporal impact of vehicle heat on urban thermal environment: a case study in Hong Kong

Introduction

Anthropogenic heat (AH) is widely known as one major cause of the urban heat island (UHI) effect. But while studies have focused on the impact of *aggregated* anthropogenic heat on the urban thermal environment, the impact of individual components of AH has been less explored (Bohnenstengel et al., 2014). Vehicle heat (VH) is generally recognized as the second-largest contribution to the AH (Quah & Roth., 2012; Smith et al., 2009), and there have been only a few studies on the separate impact of VH. Zhu et al. (2017) estimated hourly gridded VH profiles in Hong Kong and found a robust correlation between VH and UHI intensity. Singh et al. (2020) integrated hourly spatial VH data into regional climate simulations and estimated the impact of VH over Singapore during April. However, the study used a mean VH profile for the entire simulation period, meaning that the differences between weekday and weekend are neglected. Until now, the spatial and temporal variations of the VH impact on the thermal environment over diverse urban landscapes still remain unclear.

In the present study, we chose Hong Kong as an example to investigate the spatiotemporal impact of vehicle heat on the urban thermal environment. The study integrated fine-resolution urban canyon parameters (Zheng et al., 2018), building heat data based on the local climate zone map, and gridded vehicle heat data (Zhu et al., 2017) into WRF-SLCUM (Weather Research and Forecasting – single-layer urban canopy model) numerical simulations.

Methodology

Numerical experiments

Three simulation scenarios were considered in summer: 1) a reference case (NoAH) without anthropogenic heat, 2) a case (BH) with the LCZ based building heat emission, and 3) a vehicle heat case (VH) with building heat and vehicle heat. Because of the sub-tropical climate of Hong Kong, building waste heat is not important in winter (Wang et al., 2018). We conducted only two simulations in winter: a reference case (NoAH) without anthropogenic heat and a vehicle heat case (VH) with vehicle heat. The simulation periods were from 1st July 00:00 (UTC) to 15th July 00:00 (UTC) and from 1st January 00:00 (UTC) to 15th January 00:00 (UTC), 2015.

Vehicle heat data

Hourly gridded vehicle heat data in Hong Kong for weekdays, Saturday, and Sunday at 800 m × 800 m resolution were adopted from Zhu et al. (2017). We resampled the original vehicle heat data (800 m × 800 m resolution) to match the innermost WRF domain (500 m × 500 m resolution) by linear interpolation. Fig. 1a shows the spatial distribution of weekly mean VH (time-averaged VH over one weekly cycle) over Hong Kong. The grids with high VH values were mainly concentrated at four core districts with dense road networks, as shown in Fig. 1b. Fig. 1c shows the temporal profile of VH in all grids (red line, right axis).

Results

Temporal variation of VH impact

We look into the temporal variation of the impact of vehicle heat during weekdays, Saturday and Sunday through the difference in the urban sensible heat flux (ΔSH^{urb}) and urban canyon air temperature (ΔT_2^{urb}). Figure 2 shows that ΔSH^{urb} is larger in the daytime, especially around or after the rush hours. The standard deviation of ΔSH^{urb} during daytime is found to be larger than that during nighttime. And it is clear that the summer standard deviations are larger than the winter ones. The changes in regional atmospheric forcing disturb the urban climate and contribute to the large variation of VH impact in summer. After adding VH profiles, WRF-simulated 2-week mean T_2^{urb} increases by 0.32 °C in summer and by 0.35 °C in winter over the VH emission area. The VH impact becomes uniform in summer with a smaller standard deviation.

Spatial variation of VH impact

Fig. 3 shows the spatial distribution of ΔT_2^{urb} over Hong Kong in summer and winter. Results at different time periods throughout the diurnal cycle are presented. VH emissions increase T_2^{urb} over most land areas (positive ΔT_2^{urb}) during all the time periods in summer. From 8 am to 10 am (Fig. 3a), 92% of the Hong Kong land area experiences a higher urban canyon air temperature, with a spatial mean of 0.12 °C. The VH impact becomes weaker on summer nights due to the weak VH emission. The VH impact on urban canyon air temperature is more noticeable and concentrated around the road network in winter (Fig. 3e – 3h). During the winter morning and afternoon rush hours (Fig. 3e and Fig. 3f), around 67% of the land area experiences increased T_2^{urb} by VH. The largest spatial mean ΔT_2^{urb} of 0.16 °C occurs during 11 pm – 1 am (Fig. 3h).

Relationship between VH impact and urban morphology

To diagnose the VH impact on the thermal environment in different urban neighbourhoods, we examine the relationship between the VH impact and urban morphology. A general increasing trend is found between ΔT_2^{urb} and the urban area fraction (FRC), and between ΔT_2^{urb} and mean building height (MH) for the entire land area in

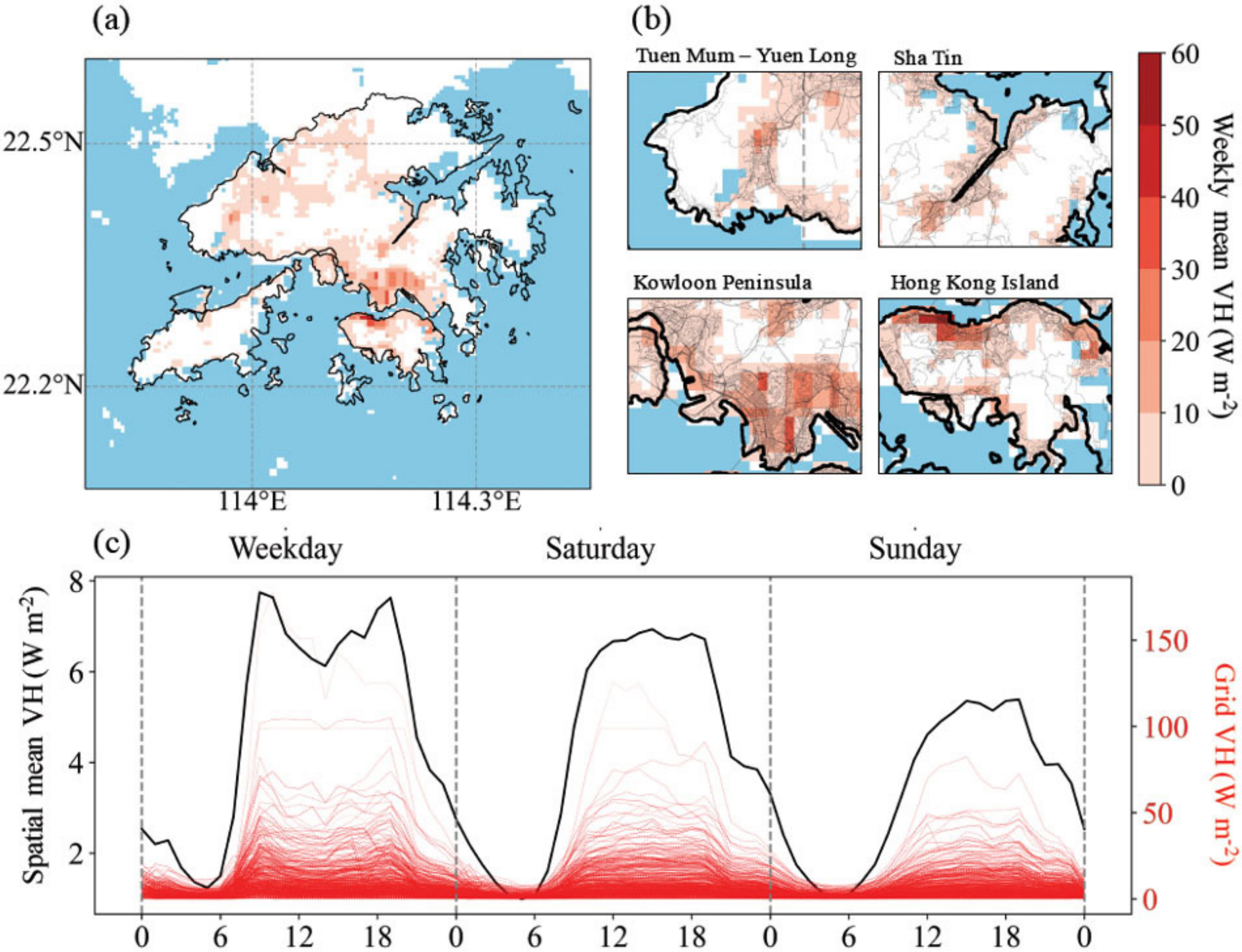


Figure 1. Spatial distribution of the weekly mean VH over (a) Hong Kong and (b) four core districts; (c) Temporal profile of VH in individual grids (red, right axis) and the spatial mean VH profile (black, left axis).

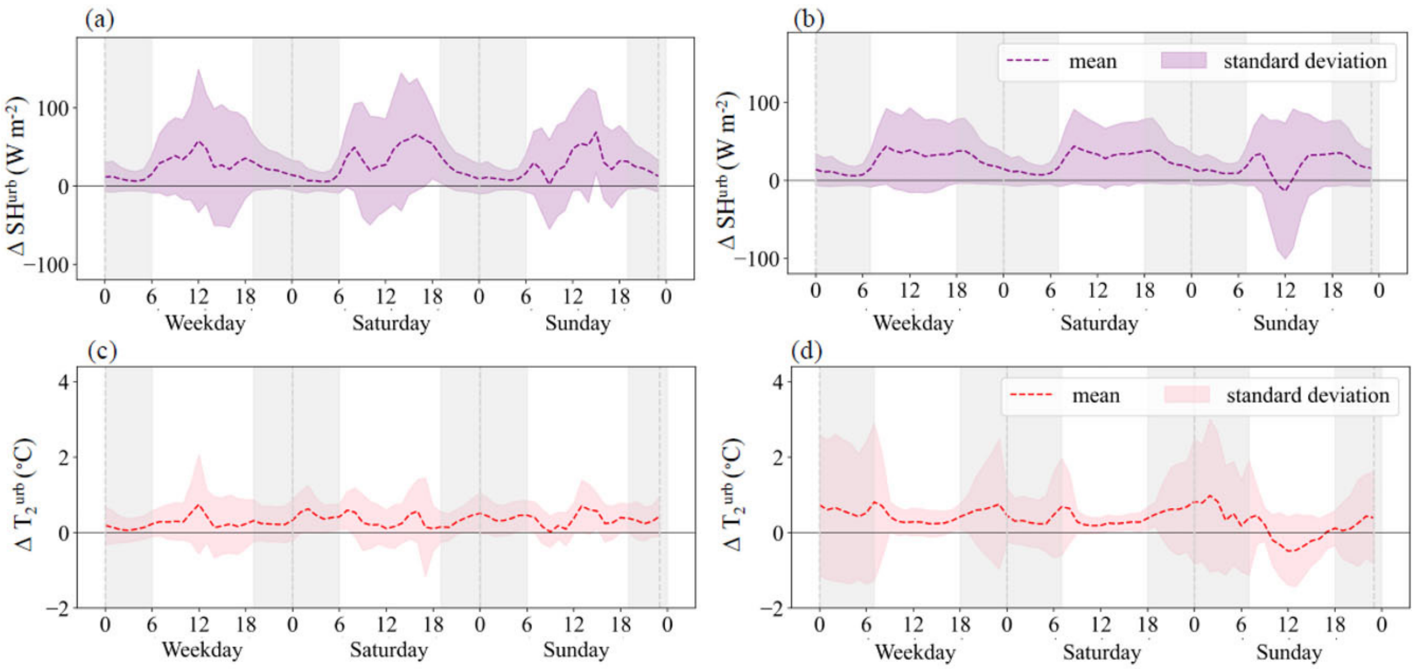


Figure 2. Differences of (a) SH^{urb} in summer, (b) SH^{urb} in winter, (c) T_2^{urb} in summer, and (d) T_2^{urb} in winter. Dashed lines represent the mean differences and the shaded areas represent one standard deviation. The grey (white) color represents the nighttime (daytime) period.

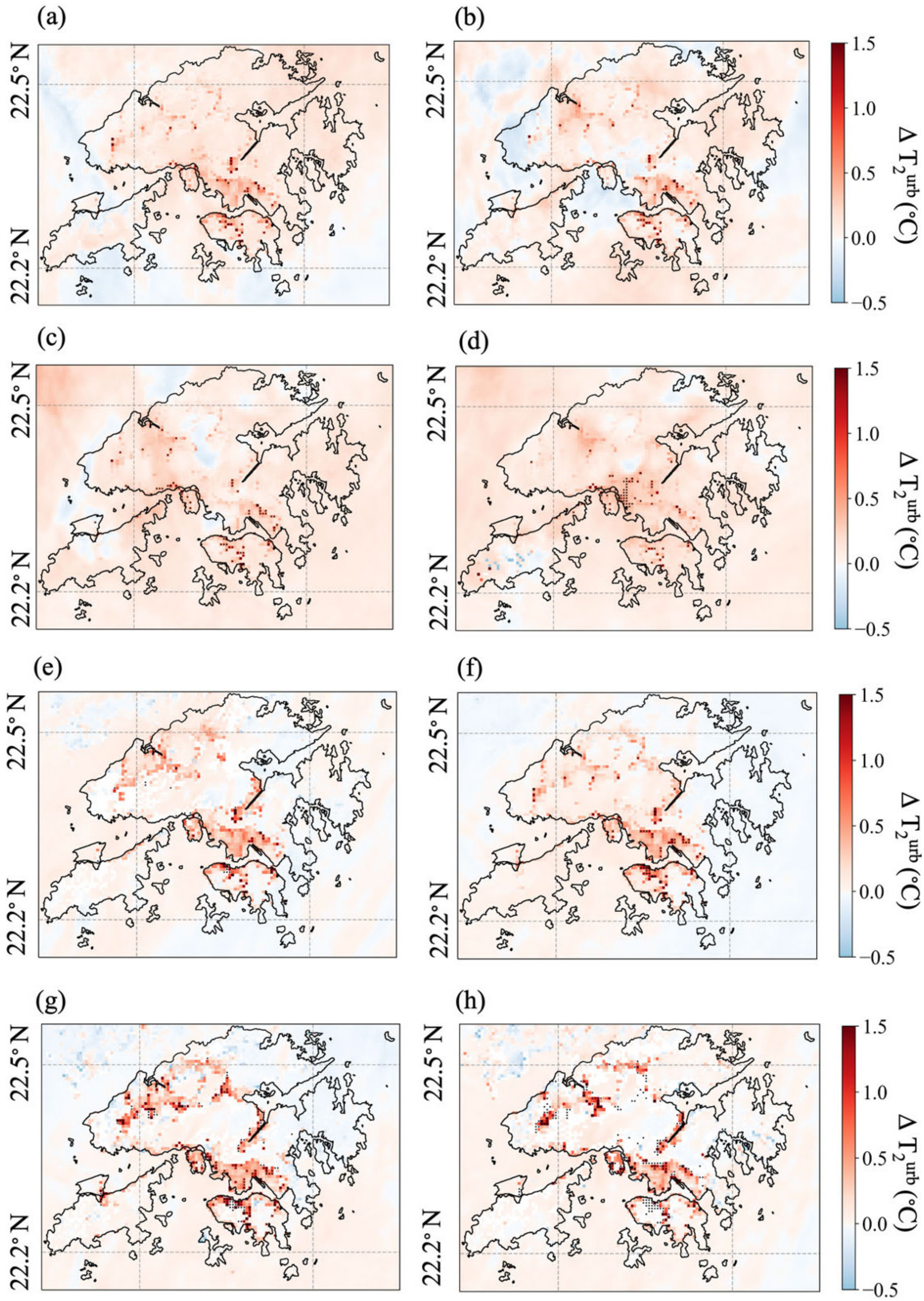


Figure 3. Spatial distribution of ΔT_2^{urb} by VH over Hong Kong in summer: (a) 8 am – 10am, (b) 5 pm – 7 pm, (c) 8 pm – 10 pm, (d) 11 pm – 1 am. Dotted areas stand for regions with impacts statistically significant at the 0.1 level. (e – h) are the same as (a – d) but for winter.

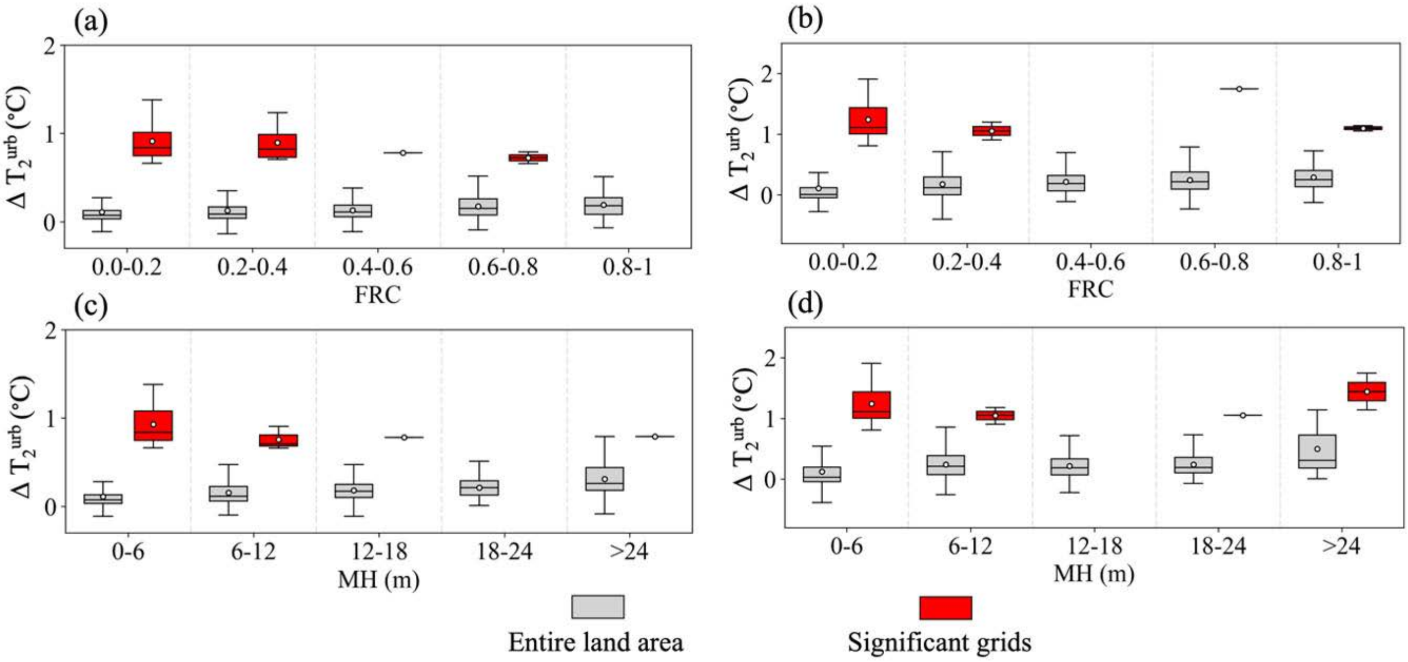


Figure 4 Distribution of ΔT_2^{urb} over different ranges of (a-b) urban area fraction (FRC) and (c-d) mean building height (MH), during 8 am – 10 am (morning rush hours) in summer (left) and winter (right). Significant grids denote the areas with vehicle heat impact statistically significant at the 90% confidence level.

summer and winter (Fig. 4). The significant ΔT_2^{urb}means the area has a high possibility to experience a warmer environment throughout the whole study period due to VH. The large value of the ΔT_2^{urb} can be found in the lowest and the highest MH groups in winter. The major reason is that the VH is released along the roads, and many highways and city circulation roads with large traffic flow are located in low urbanized areas in Hong Kong, such as along the seashore or near mountains. On top of this, part of the highly urbanized neighbourhoods and/or high-rise building areas are downtown regions with dense traffic, where the VH can be trapped among the buildings.

Comparison of VH and building heat impacts

Over the entire land area, the total ΔT_2^{urb} under the combined effect of VH and BH increases with FRC and MH in the morning and at night. This indicates a hotter thermal environment in more urbanized regions. In the morning, Fig. 5a shows that the increase of ΔT_2^{urb} is mainly caused by BH. VH contributes 45% (31%) of the total ΔT_2^{urb} for the areas with FRC of 0-0.2 (0.8-1). Similar trends are observed at night over the entire land area (Fig. 5b). Vehicle heat dominates over building heat in regulating the urban thermal environment only over a small portion of Hong Kong land area. Nevertheless, the warming effect of VH is so strong in these areas that total ΔT_2^{urb} can be three times larger than the mean ΔT_2^{urb} by anthropogenic heat over the whole Hong Kong.

Conclusions and future work

This study incorporates VH and urban landscape data into the Weather Research and Forecasting (WRF) model to estimate the VH impacts at a fine spatial resolution over Hong Kong. Results show a strong temporal variation of the VH impact at daily, weekly, and seasonal scales: 1) the increase in temperature of urban canyon air is stronger and more consistent at night than in daytime, 2) increases in sensible heat fluxes are more pronounced during weekdays than weekends, 3) the temperature change of 0.35 °C in winter is larger than that of 0.32 °C in summer. Increased air temperature over the land area by VH correlates positively with urban area fraction and building height. The relative VH impact compared to building heat demonstrates the dominative role of vehicle heat in warming low urbanized areas with highways and circulation roads.

For mitigation of and adaptation to global warming, governments have encouraged the adoption of highly energy-efficient electric vehicles (EV) as a measure to reduce greenhouse gas emissions in the past decade (International Energy Agency, 2019). By fully or partly replacing internal combustion engines with electric motors, transformation to electric vehicles can markedly cut waste heat from traffic in cities (Ribeiro et al., 2021). Promoting electric vehicles thus has potentials to reduce urban heat islands and benefit the urban thermal environment. The spatiotemporal distributions of the VH impact provide insights into the potential benefits of green transportation technology and policy in mitigating urban heat islands.

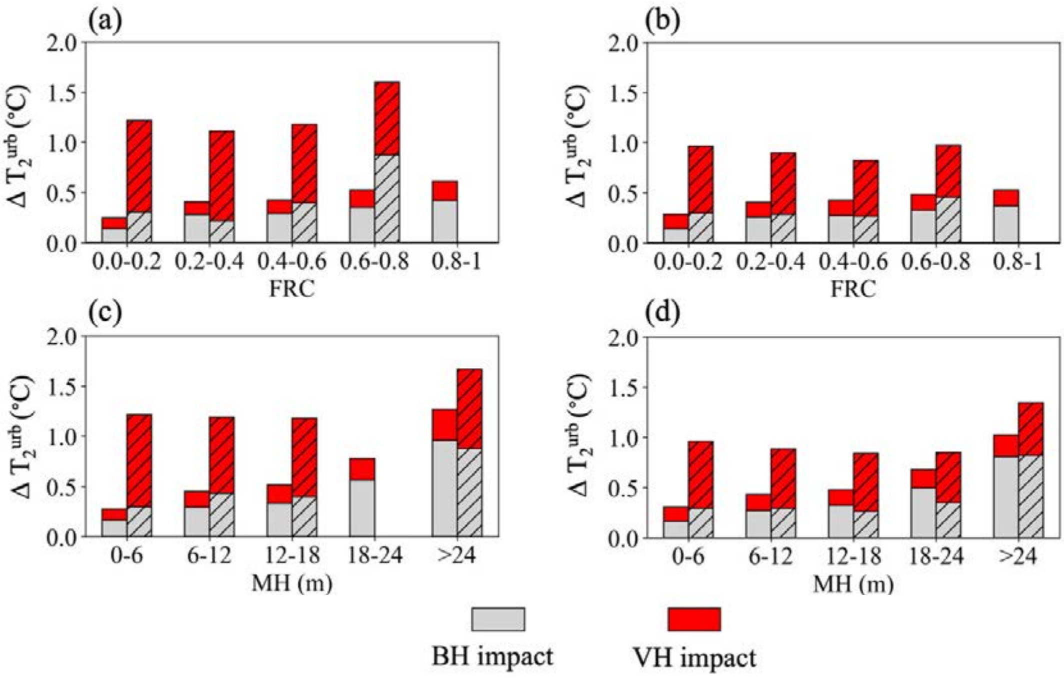


Figure 5. Relative impact of vehicle heat to building heat on ΔT2urb over different ranges of (a) and (b) urban area fraction (FRC); (c) and (d) mean building height (MH) during (left) 8 am – 10 am and (right) 11 pm – 1 am in summer. Clear bars are results over the entire land area, and shaded bars denote the results over areas with vehicle heat impact statistically significant at the 90% confidence level.

References

Bohnenstengel, S. I., Hamilton, I., Davies, M., & Belcher, S. E. (2014). Impact of anthropogenic heat emissions on London's temperatures. *Quarterly Journal of the Royal Meteorological Society*, 140(679), 687–698. https://doi.org/10.1002/qj.2144

IEA (2019). *World Energy Outlook 2019*. https://www.iea.org/reports/world-energy-outlook-2019

Quah, A. K. L., & Roth, M. (2012). Diurnal and weekly variation of anthropogenic heat emissions in a tropical city, Singapore. *Atmospheric Environment*, 46, 92–103. https://doi.org/10.1016/j.atmosenv.2011.10.015

Ribeiro, F. N. D., Umezaki, A. S., Chiquetto, J. B., Santos, I., Machado, P. G., Miranda, R. M., Almeida, P. S., Simões, A. F., Mouette, D., Leichsenring, A. R., & Ueno, H. M. (2021). Impact of different transportation planning scenarios on air pollutants, greenhouse gases and heat emission abatement. *Science of The Total Environment*, 781, 146708.

Singh, V. K., Acero, J. A., & Martilli, A. (2020). Evaluation of the impact of anthropogenic heat emissions generated from road transportation and power plants on the UHI intensity of Singapore. Technical Report Cooling Singapore, 500. https://doi.org/10.3929/ETHZ-B-000452434

Smith, C., Lindley, S., & Levermore, G. (2009). Estimating spatial and temporal patterns of urban anthropogenic heat fluxes for UK cities: The case of Manchester. *Theoretical and Applied Climatology*, 98(1), 19–35. https://doi.org/10.1007/s00704-008-0086-5

Zheng, Y., Ren, C., Xu, Y., Wang, R., Ho, J., Lau, K., & Ng, E. (2018). GIS-based mapping of Local Climate Zone in the high-density city of Hong Kong. *Urban Climate*, 24, 419–448. https://doi.org/10.1016/j.uclim.2017.05.008

Zhu, R., Wong, M. S., Guilbert, É., & Chan, P.-W. (2017). Understanding heat patterns produced by vehicular flows in urban areas. *Scientific Reports*, 7(1), 16309. https://doi.org/10.1038/s41598-017-15869-6





Xuan Chen[1] Jiachuan Yang[1] Rui Zhu[2] Man Sing Wong[2] Chao Ren[3]

[1] Dept. of Civil and Environmental Engineering, Hong Kong University of Science & Technology, Hong Kong, China
[2] Department of Land Surveying and Geo-Informatics, Hong Kong Polytechnic University, Hong Kong, China
[3] Faculty of Architecture, University of Hong Kong, Hong Kong, China

"Urban climate, urban biometeorology, and science tools for cities" session at EGU General Assembly

By Hendrik Wouters (VITO, Antwerp, Belgium) and Daniel Fenner (University of Freiburg, Germany)

Climate change strongly interacts with growing urbanisation. In the latest IPCC report AR6, cities have been highlighted as the hotspots of climate impacts. They are the places at which an increasing number of weather extremes are exacerbated. In spite of that, cities can play a crucial role in climate solutions and are the first places to reduce carbon emissions and implement adaptation strategies down to the level of individual streets and buildings. This includes city-wide adaptation strategies such as green infrastructure (including street trees, green roofs), blue infrastructure (water bodies, wetlands), building and street properties (reflective surfaces, shape, materials), but also cities' changes in energy generation (solar panels) and energy usage (traffic), and optimised spatial planning to reduce carbon emissions and air pollutants.

The urban climate community over the past 50 years has provided a vast record of those impact assessments and solutions based on scientific evidence through interdisciplinary research. The session on "Urban climate, urban bio-meteorology, and science tools for cities" held at the EGU General Assembly in May 2022 covered the latest advances of our community across five different topical domains, with over 50 presentations. For the first time, the EGU meeting was held as a fully hybrid event with on-site participation in Vienna, Austria, and virtual participation online. Due to this format, it included only short oral presentations and no poster exhibition. A full day of highly interesting and diverse talks were given during this urban climate session. To make the hybrid format a success, the convener team of Hendrik Wouters, Natalie Theeuwes, Daniel Fenner, Sorin Cheval and Matei Georgescu got support from additional chairs Harro Jongen, Jessica Keune and Nektarios Chrysolakis.

It all started with measuring our urban environment, so we highlighted "Observations, machine learning, and reconstructions" as the first topic of the session. We covered urban climate observations with 'traditional' and new techniques including crowd-sourced sensor data, satellite imagery, and machine learning that can be combined in one consistent output product with unprecedented detail. Eva Marques from the National Centre for Meteorological Research in France demonstrated the estimation of urban heat islands of cities in France from crowd-sourced thermometers embedded in personal cars, resulting in maps of unprecedented detail and coverage. However, urbanisation does not only lead to urban heat islands; Judi Lax (Tel Aviv University) and Naika Meili (National University of Singapore) independently revealed urban dry islands in response to increasing urbanisation from global observation networks. In turn, the dry islands exacerbate the decreasing trends of relative humidity under global heating. Furthermore, implications of urban humidity trends for heat stress were highlighted, as well as for the potential of novel technologies for energy and water extraction in humid climates. At the end of this topical session Dragan Milošević (University of Novi Sad, Serbia), highlighted the FAIRNESS project (FAIR NEtwork of micrometeorological measurements), a COST Action that aims at bringing together the vast amounts of micrometeorological data that are collected by different institutions in Europe and making them available as FAIR data sets.

Next, we covered the latest "Parameter databases, model development and evaluation" for urban climate modelling. This not only involved the better representation of the urban physical processes, but also a more realistic description of the urban environment as needed by our modelling tools. Jonas Kittner (Ruhr University Bochum, Germany) presented a global Local Climate Zone map at 100 m resolution, combining crowd-sourced information, machine learning, and satellite data. Such global data sets could serve as input for state-of-the-art General Circulation Models to describe urban surfaces. We further highlighted improved representation of building shapes and vertical urban structure, and trees. As such, the resolution and consistency of our urban climate models are constantly increasing, and the added value is evaluated against detailed urban climate observations. Several talks presented the latest investigations using meso- and micro-scale numerical models in different applications.

Such model developments are essential for bringing our understanding of observed urban-climate impacts to the next level, which we highlighted in our third topical session "Interactions and feedbacks". We looked at how buildings and urban trees directly impact the air we live in, and by extension, how the upper-air layers throughout the urban boundary layer and turbulent transfer are affected. We further looked how air pollutants including PM2.5 interact with urban heat islands. Finally, we highlighted how these interactions amplify to feedbacks up to the scale of cities leading to urban-induced convective clouds and precipitation, and air pollution. A talk by Irena Nimac from the Meteorological and Hydrological Service in Zagreb, Croatia, further highlighted how urban climate responds to large-scale atmospheric circulation and the North Atlantic Oscillation with respect to altered summer urban heat load.

There is increasing evidence that urban-induced climate feedbacks inevitably result in exacerbation or dampening of extreme weather events, including heat stress, extreme precipitation, and drought. This was covered in our fourth topic "Extremes, impacts and climate services". Additionally, Alexander Pasternak demonstrated that fire brigade operations can be used as a proxy for detecting extreme precipitation events for Berlin. A number of talks further highlighted urban climate risk and resilience assessments and climate services for urban resilience at the city, country, and continental levels. This also includes the Copernicus for Urban Resilience in Europe (CURE) to support urban resilience planning by interlinking the different Copernicus Core Services.

Observations, tools and understanding of urban-climate feedbacks allow us to evaluate urban adaptation strategies, which were the focus of our last topic "Adaptation, policy and scenarios". We featured the effects of reflective surfaces, green infrastructure such as vegetation, green roofs, facade greening, replacement of pavements with grass, and also blue infrastructure such as ponds and wetlands. The speakers showcased both thermal and hydrological responses controlling urban-climate regimes, and demonstrated how integrated policy plans can mitigate the worst effects of urban-climate interacting with global-climate change. This not only includes the clean air plans, but also the effect of COVID-19 restrictions on the urban heat island during the pandemic. Highlight of the session was the invited talk by Scott Krayenhoff (University of Guelph, Canada) in which he presented numerical simulations with explicit representation of street trees and their beneficial climate effects for pedestrians. Lisette Klok and Lisanne Corpel (Amsterdam University of Applied Sciences) demonstrated urban heat-resilient planning and design standards adopted by Dutch local governments, including the proximity to green and cool spots, and the percentage shading that offset overheating outdoors and indoors.

Overall, the urban-climate session at EGU 2022 was a great success, and we are looking forward to the meeting next year.

Recent Urban Climate Publications

Adebayo KO (2022) Pandemics and management of "dangerous communities": Ebola, COVID-19, and Africans in China. *Professional Geographer* online first.

Ahamad AH, Abidin NI, Zakaria R, Aminudin E, Khan JS, Sahamir SR, Azman S, Redzuan AA, Lau SEN, Mohd Yusoff MF (2022) School building energy assessment using lean energy management strategies. *Frontiers in Built Environment* 7 679579.

Al Qassimi N, Jung C (2022) Impact of air-purifying plants on the reduction of volatile organic compounds in the indoor hot desert climate. *Frontiers in Built Environment* 7 803516.

Al-Ruzouq R, Shanableh A, Khalil MA, Zeiada W, Hamad K, Abu Dabous S, Gibril MBA, Al-Khayyat G, Kaloush KE, Al-Mansoori S, Jena R (2022) Spatial and temporal inversion of land surface temperature along coastal cities in arid regions. *Remote Sensing* 14 1893.

Alsaad H, Hartmann M, Hilbel R, Voelker C (2022) The potential of facade greening in mitigating the effects of heatwaves in Central European cities. Building and Environment 216 109021.

Al-sareji O, Grmasha R, Hashim K, Salman J, Al-Juboori R (2022) Personal exposure and inhalation doses to PM1 and PM2.5 pollution in Iraq: An examination of four transport modes. *Building and Environment* 212 108847.

Althaf P, Kannemadugu HBS, Kumar KR (2022) Hotspot analysis and long-term trends of absorbing aerosol index from dust emissions measured by the Ozone Monitoring Instrument at different urban locations in India during 2005-2018. *Atmospheric Environment* 272 118933.

Amnuaylojaroen T (2022) Prediction of PM2.5 in an urban area of Northern Thailand using multivariate linear regression model. *Advances in Meteorology 2022* 3190484.

Anderson BJ, Slater LJ, Dadson SJ, Blum AG, Prosdocimi I (2022) Statistical attribution of the influence of urban and tree cover change on streamflow: a comparison of large sample statistical approaches. *Water Resources Research* 58 e2021WR030742.

Ao X, Zhang N (2022) Parameter sensitivity analysis and optimization of the single-layer urban canopy model in the Megacity of Shanghai. *Advances in Meteorology* 2022 7351150.

Arroyo J, Spiessens F, Helsen L (2022) Comparison of optimal control techniques for building energy management. *Frontiers in Built Environment* 8 849754.

Asano Y, Nakamura Y, Suzuki-Parker A, Aiba S, Kusaka H (2022) Effect of walking in heat-stressful outdoor environments in an urban setting on cognitive performance indoors. *Building and Environment* 213 108893.

In this edition, we present a list of publications in the field of urban climate that have mainly come out between **February and May 2022**. The authors of **featured papers** recommended by the Bibliography Committee are highlighted in bold. If you believe your articles are not included, please send the references to my email address below with a header "IAUC publications" and the following format: Author, Title, Journal, Year, Volume, Issue, Pages, Dates, Keywords, URL, and Abstract.

As of this month, Dr. Julia Hidalgo and Dr. Lech Gawuć decided to leave the committee after contributing for 14 and 7 years, respectively. Thank you, Julia and Lech, for your enthusiasm and contribution to the community!

We are always looking for researchers at any career stage (especially early career) to join the committee and contribute to the IAUC community. If you are interested in joining or would like to learn more information, please feel free to let me know via the email address below.

Happy reading,
Chenghao Wang
Chair, IAUC Bibliography Committee
Stanford University (USA)
chenghao.wang@stanford.edu

The Bibliography Committee


Lilly Rose Amirtham


Anurag Bagade


Debanjali Banerjee


Shreya Banerjee


Pravin Bhiwapurkar


Peter Crank


Ahmed Eldesoky


Rohinton Emmanuel


Rafiq Hamdi


Ansar Khan


Huidong Li


Mathew Lipson


Martina Petralli


Aditya Rahul


Iara Santos

Awan A, Abbasi KR, Rej S, Bandyopadhyay A, Lv K (2022) The impact of renewable energy, internet use and foreign direct investment on carbon dioxide emissions: A method of moments quantile analysis. *Renewable Energy* 189 454-466.

Baqa MF, Lu L, Chen F, Nawaz-ul-Huda S, Pan L, Tariq A, Qureshi S, Li B, Li Q (2022) Characterizing spatiotemporal variations in the urban thermal environment related to land cover changes in Karachi, Pakistan, from 2000 to 2020. *Remote Sensing* 14 2164.

Brousse O, Simpson C, Walker N, Fenner D, Meier F, Taylor J, Heaviside C (2022) Evidence of horizontal urban heat advection in London using six years of data from a citizen weather station network. *Environmental Research Letters* 17 044041.

Buccolieri R, Carlo O, Rivas E, Santiago J, Salizzoni P, Siddiqui M (2022) Obstacles influence on existing urban canyon ventilation and air pollutant concentration: A review of potential measures. *Building and Environment* 214 108905.

Cao J, Pan Y, Yu S, Zheng B, Ji D, Hu J, Liu J (2022) Rapid decline in atmospheric organic carbon deposition in rural Beijing, North China between 2016 and 2020. *Atmospheric Environment* 276 119030.

Castillo EGD, Taquet N, Bezanilla A, Stremme W, Ramonet M, Laurent O, Xu Y, Delmotte M, Grutter M (2022) CO2 variability in the Mexico City region from in situ measurements at an urban and a background site. *Atmosfera* 35 377-393.

Chen Z, Yeh AG-O (2022) Delineating functional urban areas in Chinese mega city regions using fine-grained population data and cellphone location data: A case of Pearl River Delta. *Computers, Environment and Urban Systems* 93 101771.

Chen J, Xu C, Song M, Deng X, Shen Z (2022) Towards sustainable development: Distribution effect of carbon-food nexus in Chinese cities. *Applied Energy* 309 118470.

Chen Y, Yang J, Yang R, Xiao X, Xia J (2022) Contribution of urban functional zones to the spatial distribution of urban thermal environment. *Building and Environment* 216 109000.

Chen X, Yang J (2022) Urban climate monitoring network design: Existing issues and a cluster-based solution. *Building and Environment* 214 108959.

Chen J, Zhan W, Du P, Li L, Li J, Liu Z, Huang F, Lai J, Xia J (2022) Seasonally disparate responses of surface thermal environment to 2D/3D urban morphology. *Building and Environment* 214 108928.

Chen L. Wang X, Cai X, Yang C, Lu X (2022) Combined effects of artificial surface and urban blue-green space on land surface temperature in 28 major cities in China. *Remote Sensing* 14 448.

Collazo S, Barrucand M, Rusticucci M (2022) Seasonal forecast of the percentage of days with extreme temperatures in central-northern Argentina: An operational statistical approach. *Climate Services* 26 100293.

Cortês A, Almeida J, Tadeu A, Ramezani B, Fino M, de Brito J, Silva C (2022) The effect of cork-based living walls on the energy performance of buildings and local microclimate. *Building and Environment* 216 109048.

Cotlier IG, Carlos J. J (2022) The extreme heat wave over western North America in 2021: an assessment by means of land surface temperature. *Remote Sensing* 14 561.

Couasnon A, Scussolini P, Tran TVT, Eilander D, Muis S, Wang H, Keesom J, Dullaart J, Xuan Y, Nguyen HQ, Winsemius HC, Ward PJ (2022) A flood risk framework capturing the seasonality of and dependence between rainfall and sea levels-an application to Ho Chi Minh City, Vietnam. *Water Resources Research* 58 e2021WR030002.

Daron J, Soares MB, Janes T, Colledge F, Srinivasan G, Agarwal A, Hewitt C, Richardson K, Nepal S, Shrestha MS, Rasul G, Suckall N, Harrison B, Oakes RL, Corbelia D (2022) Advancing climate services in South Asia. *Climate Services* 26 100295.

Diaz-Esteban Y, Barrett BS, Raga GB (2022) Circulation patterns influencing the concentration of pollutants in central Mexico. *Atmospheric Environment* 274 118976.

Du S, Zhang X, Jin X, Zhou X, Shi X (2022) A review of multi-scale modelling, assessment, and improvement methods of the urban thermal and wind environment. *Building and Environment* 213 108860.

Erell E, Zhou B (2022) The effect of increasing surface cover vegetation on urban microclimate and energy demand for building heating and cooling. *Building and Environment* 213 108867.

Fang Y, Zhao L (2022) Assessing the environmental benefits of urban ventilation corridors: A case study in Hefei, China. *Building and Environment* 212 108810.

Fei F, Wang Y, Yao W, Gao W, Wang L (2022) Coupling mechanism of water and greenery on summer thermal environment of waterfront space in China's cold regions. *Building and Environment* 214 108912.

Feijoo M, Solman S (2022) Convection-permitting modeling strategies for simulating extreme rainfall events over Southeastern South America. *Climate Dynamics* online first.

Fischer E, Detommaso M, Martinico F, Nocera F, Costanzo V (2022) A risk index for assessing heat stress mitigation strategies. An application in the Mediterranean context. *Journal of Cleaner Production* 346 131210.

Gao Z, Geilfus N-X, Saiz-Lopez A, Wang F (2022) Reproducing Arctic springtime tropospheric ozone and mercury depletion events in an outdoor mesocosm sea ice facility. *Atmospheric Chemistry and Physics* 22 1811-1824.

Gao Y, Zhao J, Yu K (2022) Effects of block morphology on the surface thermal environment and the corresponding planning strategy using the geographically weighted regression model. *Building and Environment* 216 109037.

Gao W, Zheng C, Liu X, Lu Y, Chen Y, Wei Y, Ma Y (2022) NDVI-based vegetation dynamics and their responses to climate change and human activities from 1982 to 2020: A case study in the Mu Us Sandy Land, China. *Ecological Indicators* 137 108745.

García-Dalmau M, Udina M, Bech J, Sola Y, Montolio J, Jaén C (2022) Pollutant concentration changes during the COVID-19 lockdown in Barcelona and surrounding regions: modification of diurnal cycles and limited role of meteorological conditions. *Boundary-Layer Meteorology* 183 273-294.

Gouldsbrough L, Hossaini R, Eastoe E, Young PJ (2022) A temperature dependent extreme value analysis of UK surface ozone, 1980-2019. *Atmospheric Environment* 273 118975.

Gumber S, Ghosh S, Bera S, Prabhakaran V T (2022) On the importance of non-ideal sulphate processing of multi-component aerosol haze over urban areas. *Meteorology and Atmospheric Physics* 134 37.

Guo X, Huang G, Tu X, Wu J (2022) Effects of urban greenspace and socioeconomic factors on air conditioner use: A multilevel analysis in Beijing, China. *Building and Environment* 211 108752.

Guo S, Wu C, Wang Y, Qiu G, Zhu D, Niu Q, Qin L (2022) Threshold effect of ecosystem services in response to climate change, human activity and landscape pattern in the upper and middle Yellow River of China. *Ecological Indicators* 136 108603.

Guo Q, Zhou X, Satoh Y, Oki T (2022) Irrigated cropland expansion exacerbates the urban moist heat stress in northern India. *Environmental Research Letters* 17 054013.

Haid M, Gohm A, Umek L, Ward H, Rotach M (2022) Cold-air pool processes in the Inn Valley During Föhn: a comparison of four cases during the PIANO Campaign. *Boundary-Layer Meteorology* 182 335-362.

Hanberry BB (2022) Global population densities, climate change, and the maximum monthly temperature threshold as a potential tipping point for high urban densities. *Ecological Indicators* 135 108512.

Hao Z, Zhang X, Xie J, Yin K, Liu J (2022) Balance point temperature and heating degree-days in different climate conditions for building energy efficiency applications. *Building and Environment* 216 109013.

He Y, Yuan C, Ren C, Wang W, Shi Y, Ng E (2022) Urban ventilation assessment with improved vertical wind profile in high-density cities – Investigations in nighttime extreme heat. *Building and Environment* 216 109018.

Hernández-Paniagua IY, Lopez-Farias R, Pichardo-Corpus JA (2022) Application of network theory to study the spatio-temporal evolution in the ozone weekend effect in urban areas. *Atmosfera* 35 521-543.

Horn E, Proksch G (2022) Symbiotic and regenerative sustainability frameworks: moving towards circular city implementation. *Frontiers in Built Environment* 7 780478.

Hou J, Zhang Y, Xia J, Wang Y, Zhang S, Pan X, Yang M, Leng G, Dou M (2022) Simulation and assessment of projected climate change impacts on urban flood events: insights from flooding characteristic metrics. *Journal of Geophysical Research: Atmospheres* 127 e2021JD035360.

Huang JT, Wang CH (2022) Water infrastructure and the imaginary of unfinished urban modernity in Taiwan. *Professional Geographer* online first.

Huang L, Luo Y, Bai L (2022) An evaluation of convection-permitting ensemble simulations of coastal nocturnal rainfall over South China during the early-summer rainy season. *Journal of Geophysical Research: Atmospheres* 127 e2021JD035656.

Jacob J, Valois P, Tessier M (2022) Development and validation of an index to measure progress in adaptation to climate change at the municipal level. *Ecological Indicators* 135 108537.

Jeong B, Kim J, Chen D, de Dear R (2022) Comparison of residential thermal comfort in two different climates in Australia. *Building and Environment* 211 108706.

Jin L, Schubert S, Fenner D, Salim MH, Schneider C (2022) Estimation of mean radiant temperature in cities using an urban parameterization and building energy model within a mesoscale atmospheric model. *Meteorologische Zeitschrift* 31 31-52.

Johari F, Munkhammar J, Shadram F, Widén J (2022) Evaluation of simplified building energy models for urban-scale energy analysis of buildings. *Building and Environment* 211 108684.

Kamble T, Bahadure S, Punglia S (2022) Availability and accessibility of urban green spaces in a high-density city: the case of Raipur, India. *Professional Geographer* 74 290-303.

Kastner P, Dogan T (2022) Eddy3D: A toolkit for decoupled outdoor thermal comfort simulations in urban areas. *Building and Environment* 212 108639.

Kikegawa Y, Nakajima K, Takane Y, Ohashi Y, Ihara T (2022) A quantification of classic but unquantified positive feedback effects in the urban-building-energy-climate system. *Applied Energy* 307 118227.

Kitagawa YKL, Nascimento EGS, De Souza NBP, Zucatelli PJ, Kumar P, De-Almeida-Albuquerque TT, De-Moraes MR, Moreira DM (2022) Evaluation of the WRF-ARW model during an extreme rainfall event: Subtropical storm Guará. *Atmosfera* 35 651-672.

Kocifaj M, Bara S (2022) Diffuse light around cities: New perspectives in satellite remote sensing of nighttime aerosols. *Atmospheric Research* 266 105969.

Kolbeck L, Vilgertshofer S, Abualdenien J, Borrmann A (2022) Graph rewriting techniques in engineering design. *Frontiers in Built Environment* 7 815153.

Lawani K, Hare B, Cameron I, Homatash H, Campbell J (2022) Designing drone game for construction site inspection. *Frontiers in Built Environment* 7 771703.

Li Y, Li J, Yang Z, Chen T, Wang J, Ma J, Gao H, Huang T (2022) The transition from a nitrogen oxides-limited regime to a volatile organic compounds-limited regime in the petrochemical industrialized Lanzhou City, China. *Atmospheric Research* 269 106035.

Li M, Peng Y, Wu Y, Xu J, Tan T, Guo H, Lu W, Yeh AGO, Xue F (2022) Role of the built environment in the recovery from COVID-19: evidence from a GIS-based natural experiment on the city blocks in Wuhan, China. *Frontiers in Built Environment* 7 813399.

Li Y, Zhao X, Deng X, Gao J (2022) The impact of peripheral circulation characteristics of typhoon on sustained ozone episodes over the Pearl River Delta region, China. *Atmospheric Chemistry and Physics* 22 3861-3873.

Li L, Zhan W, Du H, Lai J, Wang C, Fu H, Huang F, Liu Z, Wang C, Li J, Jiang L, Miao S (2022) Long-term and fine-scale surface urban heat island dynamics revealed by landsat data since the 1980s: a comparison of four megacities in China. *Journal of Geophysical Research: Atmospheres* 127 e2021JD035598.

Li H, Zhao Y, Sützl B, Kubilay A, Carmeliet J (2022) Impact of green walls on ventilation and heat removal from street canyons: Coupling of thermal and aerodynamic resistance. *Building and Environment* 214 108945.

Li C, He H-D, Peng Z-R (2022) Spatial distributions of particulate matter in neighborhoods along the highway using unmanned aerial vehicle in Shanghai. *Building and Environment* 211 108754.

Liang MS, Huang GH, Chen JP, Li YP (2022) Energy-water-carbon nexus system planning: A case study of Yangtze River Delta urban agglomeration, China. *Applied Energy* 308 118144.

Liu Y, Wang B (2022) Impact of hydroclimate change on the management for the multipurpose reservoir: a case study in Meishan (China). *Advances in Meteorology* 2022 6953306.

Liu N, Dobbs GR, Caldwell PV, Miniat CF, Sun G, Duan K, Nelson SAC, Bolstad PV, Carlson CP (2022) Inter-basin transfers extend the benefits of water from forests to population centers across the conterminous US. *Water Resources Research* 58 e2021WR031537.

Liu Y, Luo Z, Grimmond S (2022) Revising the definition of anthropogenic heat flux from buildings: role of human activities and building storage heat flux. *Atmospheric Chemistry and Physics* 22 4721-4735.

Liu Z, Li X (2022) The impact of sensor layout on Source Term Estimation in urban neighborhood. *Building and Environment* 213 108859.

Liu Z, Zhan W, Lai J, Bechtel B, Lee X, Hong F, Li L, Huang F, Li J (2022) Taxonomy of seasonal and diurnal clear-sky climatology of surface urban heat island dynamics across global cities. *ISPRS Journal of Photogrammetry and Remote Sensing* 187 14-33.

Lonsdale JA, Leach C, Parsons D, Barkwith A, Manson S, Elliott M (2022) Managing estuaries under a changing climate: A case study of the Humber Estuary, UK. *Environmental Science and Policy* 134 75-84.

Lou S, Li DHW, Alshaibani KA, Xing H, Li Z, Huang Y, Xia D (2022) An all-sky luminance and radiance distribution model for built environment studies. *Renewable Energy* 190 822-835.

Loya-González D, Cantú-Silva I, González-Rodríguez H, López-Serna D, Alfaro-Barbosa JM (2022) Seasonal variation of atmospheric bulk deposition along an urbanization gradient in Nuevo Leon, Mexico. *Atmosfera* 35 577-599.

Lu B, Li Q (2022) Influence of atmospheric stability on air ventilation and thermal stress in a compact urban site by large eddy simulation. *Building and Environment* 216 109049.

Luan Q, Cao Q, Huang L, Liu Y, Wang F (2022) Identification of the urban dry islands effect in beijing: evidence from satellite and ground observations. *Remote Sensing* 14 809.

Lumbreras M, Diarce G, Martin-Escudero K, Campos-Celador A, Larrinaga P (2022) Design of district heating networks in built environments using GIS: A case study in Vitoria-Gasteiz, Spain. *Journal of Cleaner Production* 349 131491.

Ma S, Li Y, Zhang Y, Wang L-J, Jiang J, Zhang J (2022) Distinguishing the relative contributions of climate and land use/cover changes to ecosystem services from a geospatial perspective. *Ecological Indicators* 136 108645.

Mao X, Wang L, Pan X, Zhang M, Wu X, Zhang W (2022) A study on the dynamic spatial spillover effect of urban form on PM2.5 concentration at county scale in China. *Atmospheric Research* 269 106046.

Mao P, Zhang J, Li M, Liu Y, Wang X, Yan R, Shen B, Zhang X, Shen J, Zhu X, others (2022) Spatial and temporal variations in fractional vegetation cover and its driving factors in the Hulun Lake region. *Ecological Indicators* 135 108490.

Masoumi-Verki S, Haghighat F, Eicker U (2022) A review of advances towards efficient reduced-order models (ROM) for predicting urban airflow and pollutant dispersion. *Building and Environment* 216 108966.

Matthews B, Schume H (2022) Tall tower eddy covariance measurements of CO2 fluxes in Vienna, Austria. *Atmospheric Environment* 274 118941.

Meier R, Davin EL, Bonan GB, Lawrence DM, Hu X, Duveiller G, Prigent C, Seneviratne SI (2022) Impacts of a revised surface roughness parameterization in the Community Land Model 5.1. *Geoscientific Model Development* 15 2365-2393.

Meili N, Paschalis A, Manoli G, Fatichi S (2022) Diurnal and seasonal patterns of global urban dry islands. *Environmental Research Letters* 17 054044.

Meng Y, Sun W (2022) Reduced Air Pollution during the Prevailing of COVID-19 Pandemic: Five Years Observation and Path Analysis in the Fenwei Plain, Northwest China. *Advances in Meteorology* 2022 4051221.

Miller DL, Wetherley EB, Roberts DA, Tague CL, McFadden JP (2022) Vegetation cover change during a multi-year drought in Los Angeles. *Urban Climate* 43 101157.

Miller DL, Alonzo M, Meerdink SK, Allen MA, Tague CL, Roberts DA, McFadden JP (2022) Seasonal and interannual drought responses of vegetation in a California urbanized area measured using complementary remote sensing indices. *ISPRS Journal of Photogrammetry and Remote Sensing* 183 178-195.

Mir KA, Purohit P, Cail S, Kim S (2022) Co-benefits of air pollution control and climate change mitigation strategies in Pakistan. *Environmental Science and Policy* 133 31-43.

Moreira GdA, Sanchez-Hernandez G, Guerrero-Rascado JL, Cazorla A, Alados-Arboledas L (2022) Estimating the urban atmospheric boundary layer height from remote sensing applying machine learning techniques. *Atmospheric Research* 266 105962.

Motamedi F, Nadoushan MA, Jalalian A (2022) Evaluating the rate of atmospheric dust deposition in Isfahan city. *Atmosfera* 35 601-609.

Mushore TD, Mutanga O, Odindi J (2022) Determining the Influence of Long Term Urban Growth on Surface Urban Heat Islands Using Local Climate Zones and Intensity Analysis Techniques. *Remote Sensing* 14 2060.

Nicolini G, Antoniella G, Carotenuto F, Christen A, Ciais P, Feigenwinter C, Gioli B, Stagakis S, Velasco E, Vogt R, Ward HC, Barlow J, Chrysoulakis N, Duce P, Graus M, Helfter C, Heusinkveld B, Jarvi L, Karl T, Marras S, Masson V, Matthews B, Meier F, Nemitz E, Sabbatini S, Scherer D, Schume H, Sirca C, Steeneveld G-J, Vagnoli C, Wang Y, Zaldei A, Zheng B, Papale D (2022) Direct observations of CO_2 emission reductions due to COVID-19 lockdown across European urban districts. *Science of the Total Environment* 830 154662.

de Oliveira-Junior JF, Correia Filho WLF, Monteiro LdS, Shah M, Hafeez A, de Gois G, Lyra GB, de Carvalho MA, Santiago DdB, de Souza A, Mendes D, Costa CEAdS, Blanco CJC, Zeri M, Pimentel LCG, Jamjareegulgarn P, da Silva EB (2022) Urban rainfall in the Capitals of Brazil: Variability, trend, and wavelet analysis. *Atmospheric Research* 267 105984.

Omidvar H, Sun T, Grimmond S, Bilesbach D, Black A, Chen J, Duan Z, Gao Z, Iwata H, McFadden JP (2022) Surface Urban Energy and Water Balance Scheme (v2020a) in vegetated areas: parameter derivation and performance evaluation using FLUXNET2015 dataset. *Geoscientific Model Development* 15 3041-3078.

Ouyang W, Liu Z, Lau K, Shi Y, Ng E (2022) Comparing different recalibrated methods for estimating mean radiant temperature in outdoor environment. *Building and Environment* 216 109004.

Plevris V, Lagaros ND, Zeytinci A (2022) Blockchain in Civil Engineering, Architecture and Construction Industry: State of the Art, Evolution, Challenges and Opportunities. *Frontiers in Built Environment* 8 840303.

Prăvălie R, Sîrodoev I, Nita IA, Patriche C, Dumitraşcu M, Roşca B, Tişcovschi A, Bandoc G, Săvulescu I, Mănoiu V, Birsan MV (2022) NDVI-based ecological dynamics of forest vegetation and its relationship to climate change in Romania during 1987–2018. *Ecological Indicators* 136 108629.

Qi Q, Meng Q, Wang J, He B, Liang H, Ren P (2022) Applicability of mobile-measurement strategies to different periods: A field campaign in a precinct with a block park. *Building and Environment* 211 108762.

Rajeswari JR, Srinivas V C, Venkatraman B (2022) Impact of urbanization on boundary-layer parameters and mesoscale circulations over tropical coastal city, Chennai. *Meteorology and Atmospheric Physics* 134 3.

Ren X, Wu J, Gong C, Gao W, Zhao D, Ma Y, Xin J (2022) The relationship between PM2.5 pollution and aerosol radiative forcing in a heavy industrial city, Taiyuan, in China. *Atmospheric Research* 267 105935.

Ren J, Yang J, Zhang Y, Xiao X, Xia J, Li X, Wang S (2022) Exploring thermal comfort of urban buildings based on local climate zones. *Journal of Cleaner Production* 340 130744.

Reyna MA, Schwander S, Avitia RL, Bravo-Zanoguera ME, Reyna ME, Nava ML, Siqueiros M, Osornio-Vargas ÁR

(2022) Particulate matter air pollution effects on pulmonary tuberculosis activation in a semi-desert city on the US-Mexican border. *Atmosfera* 35 545-556.

Robbiati F, Cáceres N, Hick E, Suarez M, Soto S, Barea G, Matoff E, Galetto L, Imhof L (2022) Vegetative and thermal performance of an extensive vegetated roof located in the urban heat island of a semiarid region. *Building and Environment* 212 108791.

Rodriguez-Gomez C, Echeverry G, Jaramillo A, Ladino LA (2022) The negative impact of biomass burning and the Orinoco low-level jet on the air quality of the Orinoco River basin (edited by Dr. M. Grutter). *Atmosfera* 35 497-520.

Rojas NY, Villamil F, Rosas I, Méndez-Espinosa JF, Schauer JJ (2022) Incremental excess of PM components and sources between two adjacent sites of Bogotá, Colombia. *Atmosfera* 35 557-575.

Roncancio DN, Stewart ID (2022) Urban climatic maps for environmental planning in Manizales, Colombia. *Cybergeo: European Journal of Geography* 1013.

Sakellaris IA, Bartzis JG, Neuhauser J, Friedrich R, Gotti A, Sarigiannis DA (2022) A novel approach for air quality trend studies and its application to european urban environments: The ICARUS project. *Atmospheric Environment* 273 118973.

Sarvari H, Chen Z, Chan DWM, Lester EA, Yahaya N, Nassereddine H, Lotfata A (2022) A Global Survey of Infection Control and Mitigation Measures for Combating the Transmission of COVID-19 Pandemic in Buildings Under Facilities Management Services. *Frontiers in Built Environment* 7 644104.

Sharma P, Peshin SK, Soni VK, Singh S, Beig G, Ghosh C (2022) Seasonal dynamics of particulate matter pollution and its dispersion in the city of Delhi, India. *Meteorology and Atmospheric Physics* 134 28.

Shi Y, Zhang Y (2022) Urban morphological indicators of urban heat and moisture islands under various sky conditions in a humid subtropical region. *Building and Environment* 214 108906.

Shi C, Guo N, Zeng L, Wu F (2022) How climate change is going to affect urban livability in China. *Climate Services* 26 100284.

Si W, Yin Y, Hu Y, Kang X, Xu Y, Shi A, Zhang B, Liu J (2022) Analysis on factors affecting the cooling effect of optical shielding in pavement coatings. *Building and Environment* 211 108766.

Stache E, Schilperoort B, Ottelé M, Jonkers H (2022) Comparative analysis in thermal behaviour of common urban building materials and vegetation and consequences for urban heat island effect. *Building and Environment* 213 108489.

Steensen BM, Marelle L, Hodnebrog O, Myhre G (2022) Future urban heat island influence on precipitation. *Climate Dynamics* online first.

Su Y, Wang Y, Wang C, Zhou D, Zhou N, Feng W, Ji H (2022) Coupling relationships between urban form and performance of outdoor environment at the pedestrian level: A case study of Dalian, China. *Building and Environment* 213 108514.

Suberi HK (2022) Research Analysis of Built Environment as a System: Implementing Research Through Design Methodology. *Frontiers in Built Environment* 7 649903.

Tan Z, Wang A, Morakinyo T, Yung E, Chan E (2022) Assessing the mitigation performance of building setback from street and the combination with roadside tree planting. *Building and Environment* 212 108814.

Toesca A, David D, Kuster A, Lussault M, Johannes K (2022) An urban thermal tool chain to simulate summer thermal comfort in passive urban buildings. *Building and Environment* 215 108987.

Toy S, Çağlak S, Esringü A (2022) Assessment of bioclimatic sensitive spatial planning in a Turkish city, Eskisehir. *Atmosfera* 35 719-735.

Tsirantonakis D, Chrysoulakis N (2022) Earth Observation Data Exploitation in Urban Surface Modelling: The Urban Energy Balance Response to a Suburban Park Development. *Remote Sensing* 14 1473.

Tsiringakis A, Theeuwes N, Barlow J, Steeneveld G-J (2022) Interactions Between the Nocturnal Low-Level Jets and the Urban Boundary Layer: A Case Study over London. *Boundary-Layer Meteorology* 183 249-272.

Vahmani P, Luo X, Jones A, Hong T (2022) Anthropogenic heating of the urban environment: An investigation of feedback dynamics between urban micro-climate and decomposed anthropogenic heating from buildings. *Building and Environment* 213 108841.

Vidal DG, Dias RC, Teixeira CP, Fernandes CO, Filho WL, Barros N, Maia RL (2022) Clustering public urban green spaces through ecosystem services potential: A typology proposal for place-based interventions. *Environmental Science and Policy* 132 262-272.

Wallenberg N, Lindberg F, Rayner D (2022) Locating trees to mitigate outdoor radiant load of humans in urban areas using a metaheuristic hill-climbing algorithm - introducing TreePlanter v1.0. *Geoscientific Model Development* 15 1107-1128.

Wang G, Zhang Q, Luo M, Singh VP, Xu C-Y (2022) Fractional contribution of global warming and regional urbanization to intensifying regional heatwaves across Eurasia. *Climate Dynamics*

Wang H, Kong X, Luo J, Li P, Xie T, Yi X, Wang F, Xiao J (2022) A Novel Approach for Monitoring the Ecoenvironment of Alpine Wetlands using Big Geospatial Data and Cloud Computing. *Advances in Meteorology* 2022 7451173.

Wang D, Jensen MP, Taylor D, Kowalski G, Hogan M, Wittemann BM, Rakotoarivony A, Giangrande SE, Park JM (2022) Linking synoptic patterns to cloud properties and local circulations over southeastern Texas. *Journal of Geophysical Research: Atmospheres* 127 e2021JD035920.

Wang F, Wang W, Zhao D, Liu J, Lu P, Rose NL, Zhang G (2022) Source apportionment and wet deposition of atmospheric poly- and per-fluoroalkyl substances in a metropolitan city centre of southwest China. *Atmospheric Environment* 273 118983.

Wang W, Wang D, Chen H, Wang B, Chen X (2022) Identifying urban ventilation corridors through quantitative analysis of ventilation potential and wind characteristics. *Building and Environment* 214 108943.

Wang P, Yu P, Lu J, Zhang Y (2022) The mediation effect of land surface temperature in the relationship between land use-cover change and energy consumption under seasonal variations. *Journal of Cleaner Production* 340 130804.

Wang R, Min J, Li Y, Hu Y, Yang S (2022) Analysis on Seasonal Variation and Influencing Mechanism of Land Surface Thermal Environment: A Case Study of Chongqing. *Remote Sensing* 14 2022.

Wang H, Li B, Yi T, Wu J (2022) Heterogeneous Urban Thermal Contribution of Functional Construction Land Zones: A Case Study in Shenzhen, China. *Remote Sensing* 14 1851.

Wang R, Wang M, Zhang Z, Hu T, Xing J, He Z, Liu X (2022) Geographical Detection of Urban Thermal Environment Based on the Local Climate Zones: A Case Study in Wuhan, China. *Remote Sensing* 14 1067.

Wang Z, Sun D, Hu C, Wang Y, Zhang J (2022) Seasonal Contrast and Interactive Effects of Potential Drivers on Land Surface Temperature in the Sichuan Basin, China. *Remote Sensing* 14 1292.

Weger M, Baars H, Gebauer H, Merkel M, Wiedensohler A, Heinold B (2022) On the application and grid-size sensitivity of the urban dispersion model CAIRDIO v2.0 under real city weather conditions. *Geoscientific Model Development* 15 3315-3345.

Wu T, Zhu X, Wang P, Adiya S, Avirmed D, Dorjgotov B, Li R, Wu X, Lou P (2022) Climate warming in the Qinghai-Tibet Plateau and Mongolia as indicated by air freezing and thawing indices. *Ecological Indicators* 138 108836.

Xiao J, Yuizono T (2022) Climate-adaptive landscape design: Microclimate and thermal comfort regulation of station square in the Hokuriku Region, Japan. *Building and Environment* 212 108813.

Xie Y, Wang X, Wen J, Geng Y, Yan L, Liu S, Zhang D, Lin B (2022) Experimental study and theoretical discussion of dynamic outdoor thermal comfort in walking spaces: Effect of short-term thermal history. *Building and Environment* 216 109039.

Xie L, Bulkeley H, Tozer L (2022) Mainstreaming sustainable innovation: unlocking the potential of nature-based solutions for climate change and biodiversity. *Environmental Science and Policy* 132 119-130.

Xu L, Xu X, Ding C, Liu J, Zhao Y, Yu K, Chen J, Liu J, Qiu M (2022) Spatial-temporal prediction of the environmental conditions inside an urban road tunnel during an incident scenario. *Building and Environment* 212 108808.

Yang B, Yang C, Ni L, Wang Y, Yao Y (2022) Investigation on thermal environment of subway stations in severe cold region of China: A case study in Harbin. *Building and Environment* 212 108761.

Yang W, Zhang J, Krebs P (2022) Low impact development practices mitigate urban flooding and non-point pollution under climate change. *Journal of Cleaner Production* 347 131320.

Yang L, Yu K, Ai J, Liu Y, Yang W, Liu J (2022) Dominant Factors and Spatial Heterogeneity of Land Surface Temperatures in Urban Areas: A Case Study in Fuzhou, China. *Remote Sensing* 14 1266.

Yang Q, Huang X, Tong X, Xiao C, Yang J, Liu Y, Cao Y (2022) Global assessment of urban trees' cooling efficiency based on satellite observations. *Environmental Research Letters* 17 034029.

Yao H, Cheng X, Wei S, Lv Y, Li A, Shen X (2022) Sampling method for long-term monitoring of indoor environmental quality in residential buildings. *Building and Environment* 215 108965.

Zeng Y, Chen J, Jin N, Jin X, Du Y (2022) Air quality forecasting with hybrid LSTM and extended stationary wavelet transform. *Building and Environment* 213 108822.

Zhan C, Xie M (2022) Land use and anthropogenic heat modulate ozone by meteorology: a perspective from the Yangtze River Delta region. *Atmospheric Chemistry and Physics* 22 1351-1371.

Zhang A, Xia C, Li W (2022) Relationships between 3D urban form and ground-level fine particulate matter at street block level: Evidence from fifteen metropolises in China. *Building and Environment* 211 108745.

Zhang K, Garg A, Mei G, Jiang M, Wang H, Huang S, Gan L (2022) Thermal performance and energy consumption analysis of eight types of extensive green roofs in subtropical monsoon climate. *Building and Environment* 216 108982.

Zhang X, Han L, Wei H, Tan X, Zhou W, Li W, Qian Y (2022) Linking urbanization and air quality together: A review and a perspective on the future sustainable urban development. *Journal of Cleaner Production* 346 130988.

Zhang T, Hong B, Su X, Li Y, Song L (2022) Effects of tree seasonal characteristics on thermal-visual perception and thermal comfort. *Building and Environment* 212 108793.

Zhao R, Liu S, Liu J, Jiang N, Chen Q (2022) Generalizability evaluation of k-ε models calibrated by using ensemble Kalman filtering for urban airflow and airborne contaminant dispersion. *Building and Environment* 212 108823.

Zheng Z, Yan D, Wen X, Wei Z, Chou J, Guo Y, Zhu X, Dong W (2022) The effect of greenhouse gases concentration and urbanization on future temperature over Guangdong-Hong Kong-Macao Greater Bay Area in China. *Climate Dynamics* online first.

Zheng Z, Dong W, Yan D, Guo Y, Wei Z, Chou J, Zhu X, Wen X (2022) Relative contributions of urbanization and greenhouse gases concentration on future climate over Beijing-Tianjin-Hebei region in China. *Climate Dynamics* 58 1085-1105.

Zheng X, Montazeri H, Blocken B (2022) Impact of building façade geometrical details on pollutant dispersion in street canyons. *Building and Environment* 212 108746.

Zhong H-Y, Sun Y, Shang J, Qian F-P, Zhao F-Y, Kikumoto H, Jimenez-Bescos C, Liu X (2022) Single-sided natural ventilation in buildings: a critical literature review. *Building and Environmen*t 212 108797.

Zhou Y (2022) Understanding urban plant phenology for sustainable cities and planet. *Nature Climate Change* 12 302-304.

Zhou Q, Qu S, Ding J, Liu M, Huang X, Bi J, Ji J, Kinney P (2022) Association between PM2.5 and daily pharmacy visit tendency in China: A time series analysis using mobile phone cellular signaling data. *Journal of Cleaner Production* 340 130688.

Zhu Y, Liao J, Gong W, Wu H, Huang Y, Liu Y, Zhao M (2022) Air Pollutants Sources in Winter in Chang-Zhu-Tan Region of China. *Advances in Meteorology* 2022 9717192.

Upcoming Conferences...

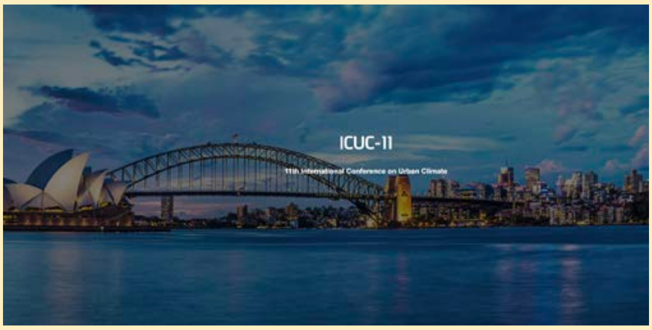
The information in this list is current as of the publication date of the newsletter, but readers should check for updated information online in the event of schedule changes due to the COVID-19 pandemic.

BOCHUM URBAN CLIMATE SUMMER SCHOOL
Ruhr Univ. Bochum, Germany • September 26-29, 2022
http://www.climate.ruhr-uni-bochum.de/bucss

36TH PLEA CONFERENCE ON SUSTAINABLE ARCHITECTURE AND URBAN DESIGN
Santiago, Chile • November 23-25, 2022
https://plea2022.org/

AMERICAN GEOPHYSICAL UNION FALL MEETING
Chicago, USA and Online • December 12-16, 2022
https://www.agu.org/Fall-Meeting/
Abstract deadline: August 3, 2022

CALL FOR PAPERS: SPECIAL ISSUE ON "REMOTE SENSING OF THE URBAN ENVIRONMENT: BEYOND THE SINGLE CITY" IN REMOTE SENSING OF ENVIRONMENT
https://www.journals.elsevier.com/remote-sensing-of-environment/forthcoming-special-issues/remote-sensing-of-the-urban-environment-beyond-the-single-city
Submission Deadline: January 31, 2023 (Please email an abstract in advance of a full manuscript to the guest editors and EiC for preliminary evaluation)

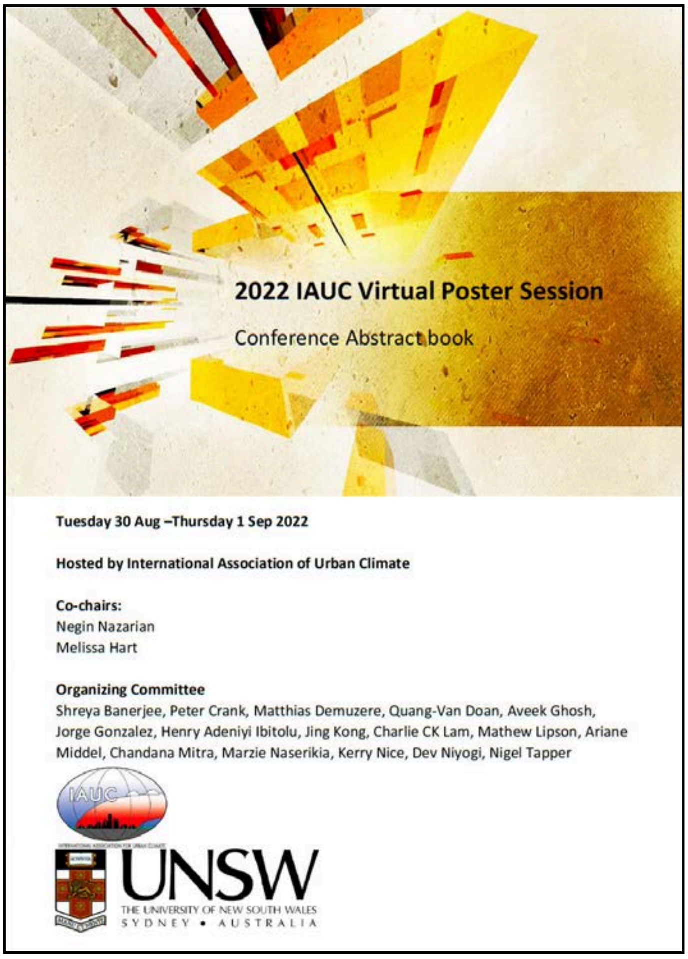


INTERNATIONAL CONFERENCE ON URBAN CLIMATE (ICUC-11)
Sydney, Australia • August 2023
https://conference.unsw.edu.au/en/icuc11

CALL FOR PAPERS: SPECIAL ISSUE ON "RECENT PROGRESS IN ATMOSPHERIC BOUNDARY LAYER TURBULENCE AND IMPLICATIONS TO SURFACE-ATMOSPHERE EXCHANGE" IN JGR ATMOSPHERES
https://agupubs.onlinelibrary.wiley.com/hub/jgr/journal/21698996/features/call-for-papers
Open for Submissions: September 1, 2022
Submission Deadline: 31 August 2023

Registration is open for the first-ever IAUC Virtual Poster Conference

The IAUC will be hosting an online conference from August 30th to September 1st, 2022, in which posters contributed by the community will be presented on urban climate-related themes. About 175 poster presentations have been included in the conference Book of Abstracts, along with a number of presentations by invited keynote speakers. Registration for the conference is now open at https://iaucposter2022.com.



IAUC Board Members & Terms

- **President**: Nigel Tapper (Monash University, Australia), 2018-2022
- **Secretary**: Andreas Christen (Albert-Ludwigs Universität Freiburg, Germany), 2018-2022
- **Treasurer**: Ariane Middel (Arizona State University, USA), 2019-2022
- Alexander Baklanov (WMO, Switzerland), *WMO Representative*, 2018-2022**
- Matthias Demuzere (Ruhr-University Bochum, Germany and CEO and Founder Kode), 2018-2022
- Jorge Gonzalez (CUNY, USA): *ICUC10 Local Organizer*, 2016-2021
- Melissa Hart (University of New South Wales, Australia), 2020-24
- Simone Kotthaus (Institut Pierre Simon Laplace, France), 2020-24
- Vincent Luo (University of Reading, UK), 2021-25
- Dev Niyogi (Purdue University, USA): *ICUC10 Local Organizer*, 2016-2021
- Negin Nazarian (University of New South Wales, Australia): *ICUC-11 Local Organizer, 2020-24*
- David Pearlmutter (Ben-Gurion University, Israel), *Newsletter Editor*, 2008-*
- David Sailor (Arizona State University, USA), *Past Secretary* 2014-2018*
- Natalie Theeuwes (Royal Netherlands Meteorological Institute, the Netherlands), 2021-25
- James Voogt (University of Western Ontario, Canada), *Past President*: 2014-2018*
- Helen Ward (University of Innsbruck, Austria), 2019-2022

* non-voting, ** non-voting appointed member

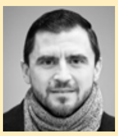
IAUC Committee Chairs

- **Editor, IAUC Newsletter**: David Pearlmutter
  - News Editor: Dragan Milosevic
  - Urban Projects Editor: Helen Ward
  - Conferences Editor: Joe McFadden
- **Bibliography Committee**: Chenghao Wang
- **Teaching Resources**: Gerald Mills
- **Awards Committee**: Helen Ward

Urban Climate News – The Quarterly Newsletter of the International Association for Urban Climate

Editor: David Pearlmutter
davidp@bgu.ac.il

Urban Projects: Helen Ward
Helen.Ward@uibk.ac.at



News: Dragan Milosevic
dragan.milosevic@dgt.uns.ac.rs

Conferences: Joe McFadden
mcfadden@ucsb.edu

The next edition of *Urban Climate News* will appear in late September. Contributions for the upcoming issue are welcome, and should be submitted by August 31, 2022 to the relevant editor.

Submissions should be concise and accessible to a wide audience. The articles in this Newsletter are unrefereed, and their appearance does not constitute formal publication; they should not be used or cited otherwise.

Bibliography: Chenghao Wang and BibCom members
chenghao.wang@stanford.edu