Urban Climate News

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Inside the Fall issue...

From the IAUC President

Welcome to Edition 61 of the Urban Climate News. This edition includes a feature article on "Research Through Designing: Bridging the gap between urban climate science and design practice" by Sanda Lenzholzer and Robert Brown, a special report on the SEB-16 meeting in Turin, Italy and three urban project reports, two of which are by student award winners from ICUC-9 (Cho Kwong Charlie Lam, Monash University and Negin Nazarian, Singapore-MIT Alliance) and the third on a monitoring project in Ghent, Belgium (Caluwaerts et al.). Thanks to these authors and to Paul Alexander (In the News), Matthias Demuzere (Bibliography) and of course our Editor David Pearlmutter for their contributions to this edition of the *UCN*.

On the important subject of urban design and urban climate science, I had the recent pleasure of participating in the last of four meetings of the **Urban Heat Island Network**, hosted by the Science Museum of Minnesota. The UHI Network is a joint collaboration between the University of Minnesota, the Science Museum of Minnesota, University of Georgia and Georgia Institute of Technology. The network has held a series of four meetings intended "to bring together scientists and practitioners with the goal of creating more healthy and sustainable urban environments". The most recent meeting was built around a visit to a site in Minneapolis known as "Prospect North" and a subsequent design charrette that involved participants from a wide range of backgrounds. The goal of the charrette was to address urban warming at both the site scale and at the city and regional scale. As an urban climate science participant, it was an excellent opportunity for me to see the challenges that arise in designing the application of urban climate science to a site in the context of the broad range of participants that are part of the design and planning process. I would certainly encourage IAUC members to participate in such exercises – it really helps broaden the appreciation of the challenges of integrating urban climate science into the design context. And as Lenzholzer and Brown point out in their article in this issue, there are significant opportunities for providing a better "research through designing" approach, as well as development of well-evaluated numerical models that can contribute to this process. Thanks to the organizers (P. Hamilton, P. Snyder, T. Twine, B. Stone, M. Shepherd) for a well run meeting. For resources on this, and previous Urban Climate Network meetings, see http://uci.umn.edu/meetings/.

On the broad theme of urban climate, design and climate change, I am pleased to announce that IAUC will be a participant in the upcoming **Habitat III** meeting in Quito, Ecuador. Thanks to the hard work of Alexander Baklanov (WMO) who is also an IAUC Board member, a proposal for an official side event on the theme of "Building Climate Smart Cities: Integrated weather, environment and climate services for sustainable cities" was approved by the organizers. Because of the limited number of time slots and a couple of other submissions with similar themes, our topic is likely to be part of a broader event on the theme of "Climate change and urban disaster resilience" co-organized by UNESCO, UN University and WMO. This will be an exciting opportunity to help raise awareness of the IAUC and its members' research in the important context of how cities face adapting to a changing local and large scale environment. Several IAUC members, including myself, will be taking part in the event and I expect to provide a report in the winter issue of *Urban Climate News*.

(*continued on page 42*)

– James Voogt,
IAUC President

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Superblocks to the rescue: Barcelona's plan to give streets back to residents

The Catalan capital's radical new strategy will restrict traffic to a number of big roads, drastically reducing pollution and turning secondary streets into 'citizen spaces' for culture, leisure and the community

May 2016 — In the latest attempt from a big city to move away from car hegemony, Barcelona has ambitious plans. Currently faced with excessive pollution and noise levels, the city has come up with a new mobility plan to reduce traffic by 21%. And it comes with something extra: freeing up nearly 60% of streets currently used by cars to turn them into so-called "citizen spaces". The plan is based around the idea of superilles (superblocks) – mini neighbourhoods around which traffic will flow, and in which spaces will be repurposed to "fill our city with life", as its tagline says.

This plan will start in the famous gridded neighbourhood of Eixample. That revolutionary design, engineered by Ildefons Cerdà in the late 19th century, had at its core the idea that the city should breathe and – for both ideological and public health reasons – planned for the population to be spread out equally, as well as providing green spaces within each block. Reality and urban development have, however, got the best of it, and as the grid lines became choked with cars, the city's pollution and noise levels have skyrocketed. What was once a design to make Barcelona healthier, now has to be dramatically rethought for the same reasons.

According to several studies, air pollution alone causes 3,500 premature deaths a year in Barcelona's metropolitan area (with a population of 3.2 million), as well as having severe effects on local ecosystems and agriculture. Barcelona and the 35 municipalities in its surrounding area have persistently failed to meet EU-established air quality targets.

A study from the local Environmental Epidemiology Agency determined that 1,200 deaths could be prevented in the city yearly just by reaching EU-mandated levels for nitrogen dioxide levels (this would mean a five-month rise in life expectancy). Add to that an estimated 18,700 fewer asthma attacks, 12,100 fewer cases of acute bronchitis and 600 fewer cardiovascular-related hospitalisations, and the problem becomes apparent for a city with a population of 1.6 million. Traffic is also the first cause for noise pollution in the city; 61% of its residents live with noise levels higher than those deemed healthy by legislation.

A pedestrian-friendly street in the Gràcia neighbourhood. *Source:* theguardian.com

Nine blocks in Barcelona's Eixample district will make up a 'superblock', the city's new strategy for sustainability. *Source:* theguardian.com

The council also cites road accidents (9,095 last year, 27 of which were fatal), sedentary lifestyles (one in five kids in Barcelona are overweight or at risk of reaching that state), and the lack of green spaces as reasons driving the plan. The city has only 6.6 sq metres of green space per inhabitant (with the figures standing at just 1.85 in Eixample and 3.15 in Gràcia), closer to Tokyo's three than to London's 27, or Amsterdam's staggering 87.5. The World Health Organisation suggests every city should have at least 9 sq metres per capita.

Barcelona's new plan consists of creating big superilles through a series of gradual interventions that will repurpose existing infrastructure, starting with traffic management through to changing road signs and bus routes. Superblocks will be smaller than neighbourhoods, but bigger than actual blocks. This will first be applied to Eixample neighbourhood and others like Sant Martí, which largely follows the same grid pattern.

In Eixample, a superblock will consist of nine existing blocks of the grid. Car, scooter, lorry and bus traffic will then be restricted to just the roads in the superblock perimeters, and they will only be allowed in the streets in between if they are residents or providing local businesses, and at a greatly reduced speed of 10km/h (typically the speed limit across the city is 50km/h, and 30km/h in specific areas).

The objectives are ambitious; by implementing these strategies at once, the city wants to reduce car use by 21% over the next two years and increase mobility by foot, bike and public transport. Superblocks will be complemented by the introduction of 300km of new cycling lanes (there are currently around 100km), as well as an orthogonal bus network that has already been put in place, whereby buses only navigate a series of main thoroughfares. This will ensure, says Salvador Rueda, director of the city's urban ecology agency and one of the drivers of the superblocks idea, that "anyone will be less than 300 metres from a bus stop at any time – and average waiting times will be of five minutes anywhere in the city (current averages stand at 14)". In addition, "it would be an equitable network in which one could go from any point A to point B with just one transfer in 95% of the cases. Like in a game of Battleship".

> *"Our objective is for Barcelona to be a city in which to live"* —Janet Sanz

"It's no surprise that this concept was born here," said mobility city councillor Mercedes Vidal in the public presentation of the plan this month. "In a city as dense as ours, it's all the more necessary to re-conquer spaces." If all goes as planned, around seven of the 13.8 million sq metres now dedicated to motorised traffic will be freed up.

Private vehicles account for just 20% of total movements in the city today and yet they occupy 60% of roads. "We need to win the street back," says Janet Sanz, city councillor for ecology, urbanism and mobility, who emphasised the need to encourage social cohesion, coexistence and human exchanges. Recently, she remembered the spirit of Jane Jacobs and her activism for the right to the city on the 100th anniversary of the writer and urbanist's birth: "She proposed giving the street back to the neighbours. Today we work for that objective."

"This plan sums up the essence of urban ecology," Sanz adds. "Our objective is for Barcelona to be a city in which to live. Also, as a Mediterranean city, its residents spend a long time on the streets – those streets need to be second homes, or extensions of one's residence, at all times … Public spaces need to be spaces to play, where green is not an anecdote – where the neighbourhood's history and local life have a presence."

"We want these public spaces to be areas where one can exercise all citizen rights: exchange, expression and participation, culture and knowledge, the right to leisure," Rueda says.

The entire process is being conducted in nine areas at a different pace, through what Sanz called "tactical urbanism" – a gradual trial and error method of sorts, with initial measures such as changing road signs – and with an initial budget of €10m (£7.9m). Now it is time to "go from theory to action", she says.

Barcelona's Eixample district, with Antoni Gaudí's Sagrada Familia in the foreground. ***Source:*** theguardian.com

The superblocks idea was first outlined in 1987, after noise mapping revealed that levels were too high, and the first superblock was tested in 2003 in Gràcia. Many experiments, like car-free days, have also been conducted in districts like Sant Martí, which will act as the main guinea pig for superblocks. Its city councillor, Josep Maria Montaner, says it has been done in close consultation with groups of neighbours "and it will continue to be so. Neighbours need to experiment it and try the new spaces, little by little – and we hope many of the ideas for how to use them will come from them".

Rueda says superblocks go back to Cerdà's philosophy and take it to the next level, to the modern world, by making it live with and for the ecosystem. "We have, as a base (for the plan), Cerdà's Eixample, which was undermined by greed. What was green in the plan was slowly overtaken and built on. And then, when cars arrived, they slowly overtook more and more space ... We want to reclaim those green spaces and that can only be done through a drastic mobility change."

An Eixample superblock of about 400 x 400 metres, Rueda says, would be inhabited by between 5,000 and 6,000 people. That is "the same as many small towns. Everything we need to consider to face the challenges of this turn of a century – construction, economy, water, residues, metabolisms, social cohesion – should be captured in these superblocks."

"Every superblock is like a small city with its own character," the plan suggests. "Imagine what could be done. An Eixample intersection is as big as a Gràcia square," says Rueda, and he highlights that this new city structure will free up 160 intersections. "I'm already fantasising with neighbourhood-organised inflatable swimming pools in the summer," he jokes. *Source:* https://www.theguardian.com/cities/2016/may/17/superblocks-rescue-barcelona-spain-plan-give-streets-back-residents

Portland's hot spots: Urban heat islands pose threat to low-income residents

With few shade trees and a lot of pavement, Portland's hottest neighborhoods are also some of the city's poorest

September 2016 — Portland, unlike the rest of the nation, has had a relatively cool summer this year.

Even so, 2016 has so far been the hottest year on record, according to the National Oceanic and Atmospheric Administration. The past three years rank among the five hottest years since 1880, when data collection started.

As climate change quickens and its effects increase, Portland is expected to have longer, drier summers, more days that are hotter on average and more heat waves that last longer.

During heat waves, like the one Portland experienced in late August, nowhere is the effect of hot days more pronounced than in Portland's urban heat islands.

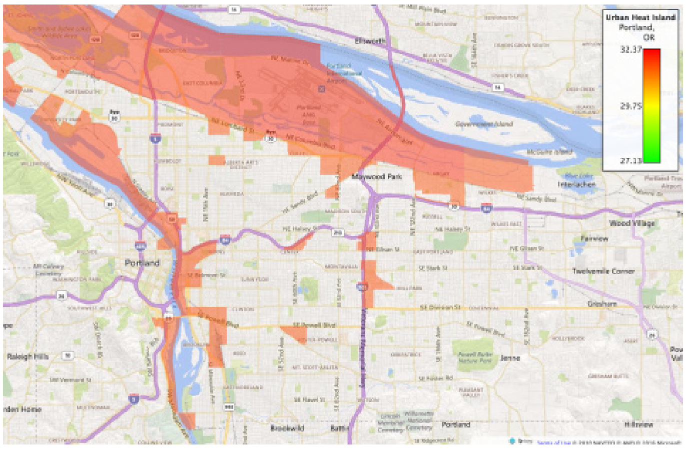
Heat islands are places in a city as small as a city block or as big as an entire neighborhood that are hotter than average recorded temperatures. The increased heat is the result of few trees and other greenery to provide canopy and shade, coupled with large swaths of pavement, parking lots, black rooftops and other materials that absorb and slowly release heat.

Heat islands are neighborhoodwide broilers. During the recent mid-August heat wave, according to the Weather Underground, the temperature in the Irvington neighborhood, on Northeast Klickitat Street between 22nd and 23rd avenues, was 100 degrees. The temperature in the Lents neighborhood, east of Interstate 205 and between Southeast Holgate and Powell boulevards, was nearly 105.

As climate change continues, the effect of urban heat islands will only become more pronounced — and more harmful to the health of people living in those neighborhoods. The city of Portland, Multnomah County and a variety of nonprofits are beginning to take steps to reduce the effect of urban heat islands, both to improve environmental health and to create equity throughout Portland.

"It is an increasingly big problem for us to confront," said Vivek Shandas, a professor in Portland State University's School of Urban Studies who developed a map charting Portland's urban heat islands. "Heat waves kill more people in the U.S. than all other natural disasters. It is a silent killer. That's the concern. (We need to identify) what can we do to help transition our neighborhoods and our entire city to be climate resilient."

"With climate change, we really have a timeline," said John Wasiutynski, director of Multnomah County's Office of Sustainability. "As the climate warms and we have these hotter summers and more extreme weather, it's going to (be) hardest on the people who are furthest on the margins. We have to get to this right now."



The interactive map at climatecope.org demonstrates human resiliency and vulnerability to heat stress and degraded air quality in Portland neighborhoods.

In 2015, Shandas, a group of researchers and PSU graduate students, began mounting small thermometers onto their cars and bikes. The thermometers were connected to a global positioning system, and as the researchers drove throughout the city, the thermometers recorded the temperature, down to the tenth of a degree, each second.

Shandas mapped the composite data, creating a map identifying the coolest and hottest places in Portland. The hottest parts of the city — Portland's urban heat islands — include areas along the Interstate 5, 84 and 205 corridors, parts of north and northeast Portland, the central eastside industrial area, parts of downtown, and almost all of Portland east of I-205.

Those parts of the city, Shandas and others said, have more asphalt and parking lots, which absorb and trap heat. During heat waves, those materials do not release the heat quickly enough, which means that over a period of days, the area can get — and feel — hotter and hotter.

"That heat will actually get massed, accumulate in those hard surfaces and radiate back into the area. There are a lot of surfaces that we need in an urban area that are absorbing the sun's rays," Wasiutynski said.

There can be as much as a 15- to 20-degree difference in cool parts of the city, such as Forest Park, or neighborhoods that are shaded with a denser tree canopy, such as Irvington or Eastmoreland, on a hot day.

"Portland has some pretty significant urban heat island effects," said Bob Sallinger, the Audubon Society of Portland's conservation director. Sallinger notes that

Portland ranks fourth in the country with the most extreme urban island heat effects, which is supported by research conducted by Climate Central.

"Portland has a reputation as a green city, but the green is not equitably distributed. To some degree, it does correlate with the amount of wealth and poverty that is in a neighborhood."

The map Shandas created detailed that correlation for the first time by overlaying the map of temperature readings with maps showing the environmental assets — such as tree canopy and bioswales — with demographic statistics such as the poverty rate, population density, the presence of racial and ethnic minorities, and the number of people who speak English as a second or third language, the number of people under age 18 and over age 65, and the number of people whose highest education is a high school diploma versus a college degree.

The connection between urban heat islands and the traditional signs of poverty and disadvantage is not an exact correlation, but one that still surprised Shandas.

"Urban heat islands," he said, "completely overlap in many ways with those communities that have the least resources."

Pointing to the harmful health effects of hotter weather, Sallinger said, "Those neighborhoods are going to suffer the most because you have higher poverty, (and they are) the least equipped to respond well."

Heat waves, in addition to causing heat stroke and dehydration, can aggravate health conditions such as asthma and other cardiovascular illnesses and even cause people with already vulnerable health, such as seniors, to have strokes or heart attacks. Certain medications can reduce a person's ability to cope with heat.

Communities that are considered isolated, such as people who live alone, seniors who are often confined to their homes and seldom travel, and homeless people who live outside are at the highest risk for heat-related illness, as well as people who don't own air conditioners or who live in places where they can't easily cool off.

"It all comes together in a perfect storm," Sallinger said. "If you're (poor) and you're in an area that is covered with pavement and cement, doesn't have trees, doesn't have natural areas, doesn't have a local swimming pool … it just makes those communities more vulnerable."

Since the map of urban heat islands was launched, city planners and environmentalists have been using the map to pinpoint places throughout Portland that need the most work to reduce urban heat island effect.

Kaitlin Lovell, the manager of the science integration division of the Bureau of Environmental Services, said the map and the way it overlays with demographic data have heavily influenced the city's tree-planting program.

Ways to reduce temperatures in urban heat islands include depaving portions of parking lots, like this one near 82nd Avenue. *Source:* news.streetroots.org

"It was finally understanding how it all layered together," Lovell said. "It was a much more visual explanation of how we were already approaching our work."

Research by David Sailor, a former Portland State University professor who worked with Shandas, has done research showing that Portland's tree canopy cover is the most important factor that determines whether an area is cooler or hotter. A neighborhood with a high number of mature trees and a thicker canopy cover can cool an area by a several degrees, at least.

During the 2015-16 fiscal year, BES' Tree Program planted 3,437 trees, 504 of which were planted in east Portland and 563 in north Portland.

Trees and a robust urban canopy, Sallinger and Lovell said, is probably the most effective tool that can be used to reduce urban heat island effect. But it can take decades for a tree to mature – so there is pressure to plant now.

"Our thinking is that as the climate warms and that we have more of these intense heat waves throughout the summer, we're really going to need these trees 20 years from now in order to keep our communities livable," Wasiutynski said.

Rockwood, a neighborhood that straddles Portland and Gresham, is the poorest census tract in all of Oregon. According to the city of Gresham, the neighborhood has a canopy cover of approximately 15 percent, well below the city average of 28 percent.

In July, the city – partnering with the East Multnomah County Soil and Water District, Friends of Trees, Depave, the county, and Mt. Hood Community College – conducted an inventory of the trees already growing in Rockwood, as well as places where trees could be planted. The city will begin planting trees in the neighborhood this fall.

Other ways to reduce the temperatures produced by urban heat islands include installing eco-roofs, depaving portions of parking lots and other asphalt surfaces, and even painting roofs, streets and parking lots white so that the sun's rays are deflected and the amount of heat that is absorbed into the surface decreases.

Lovell said the bureau builds bioswales or plants street trees principally for the benefits in managing the city's stormwater in particular blocks or pieces of a neighborhood. Because of the map, Lovell said, the bureau can see that "the next block over also has a need for street trees because of urban heat islands" and extend the tree-planting and stormwater work slightly further to also address urban heat islands.

"It's one of those additional layers we (now) consider," she said. "It really helps us maximize opportunities to reduce urban heat island."

Eric Rosewall, the executive director of the non-profit Depave, which removes pavement and asphalt to install gardens and other green infrastructure, said there are ways to reduce urban heat island effects without removing, for instance, an entire parking lot.

"A better way to impact urban heat islands is to find places to insert trees so that you can expand the forest and shade the pavement," he said. "There are a lot of creative strategies … to keep some of that hard infrastructure but use it creatively and adaptively. It's an urban environment. There are going to be a lot of compromises."

Shandas is beginning to study how the height of buildings can cool local temperatures. Taller buildings provide shade, producing an effect he calls "urban canyon effect." He concludes that there are five main factors that can determine whether an area is an urban heat island: building height, the density of buildings in an area, the amount of pavement and blacktop versus tree canopy, and the height of the tree.

"Each neighborhood will have a mix of all these things," he said, and he advocates for identifying solutions that are particular to each urban heat island. "Which strategy and mix of these strategies lowers that daytime temperature?"

Portland and Multnomah County's work to reduce urban heat islands, however, will be only a small part of the effort to mitigate climate change. Lovell said there is a constant push and pull in any conversation about climate change: reducing carbon dioxide and other greenhouse gas emissions to stop climate change and reducing climate change's impacts on human health and the environment.

"We can't stop (climate change) at a local level," Lovell said. "These are efforts to build in urban resiliency to weather climate change." *Source:* http://news.streetroots.org/2016/09/01/portland-s-hot-spots-urban-heat-islands-pose-threat-lower-income-residents

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City opens seven cooling centres

With extreme heat warnings, Toronto aims to stay cool

September 2016 — Toronto is fighting back against the current heat waves with cooling centres in local areas.

With extreme heat warnings the city's Hot Weather response plan and the Office of Emergency Management opened seven cooling centres around the city.

The cooling centres feature volunteers waiting at tables and signs setup to show the public where to go. They have cold water, air-conditioning and flyers on how to beat the heat available when you arrive. The centres are available only when the city has issued extreme heat warnings and extended heat warnings.

"People come in and you can see the heat is getting to them. We get them water, sit down and talk and they leave feeling much better," one volunteer said. "People bring their pets in too, it's really helping everyone get out of the heat." There are seven such centres opened in the city. All have the same operating hours: 11 a.m. to 7 p.m. The centres will continue to stay open until the city removes the heat warnings. *Source:* torontoobserver.ca/

Electric fans might may make seniors hotter in extreme heat

September 2016 — True or false: Electric fans are a cheap and effective way to stay cool during extreme heat waves. A tiny new experiment in older adults suggests the answer may not be as simple as it seems.

It's an important issue, particularly for seniors and sick people, whose bodies struggle to adapt to extreme temperatures that are becoming more common as the climate changes. The results of the experiment suggest that fans may be less effective for those 60 and up than in younger people during triple-digit heat because older people don't sweat as much. The authors don't want anyone to stop using fans in normal hot weather, though, and they caution that their conclusions are not clear-cut because they studied so few people at just one extremely high temperature.

Perspiring is how the body avoids overheating. Sweat evaporating on the skin's surface acts like a natural air conditioner, cooling the body. Fans can boost that evaporation by blowing more air over damp skin, but older adults don't sweat as much in hot weather, depriving them of the cooling effect and making them more prone to heat-related illness.

Source: telegram.com

Galway City wins the European Green Leaf Environmental Award

September 2016 — Galway City has won the EU's prestigious European Green Leaf Environmental Award.

The City was chosen from hundreds of urban centres across Europe with populations under 100,000 as Europe's most environmentally friendly small city. The announcement was made last night in Ljubljana, Slovenia (last year's "Green Capital" winner) and the award was presented by the European Commission to the Mayor of Galway, Councillor Noel Larkin.

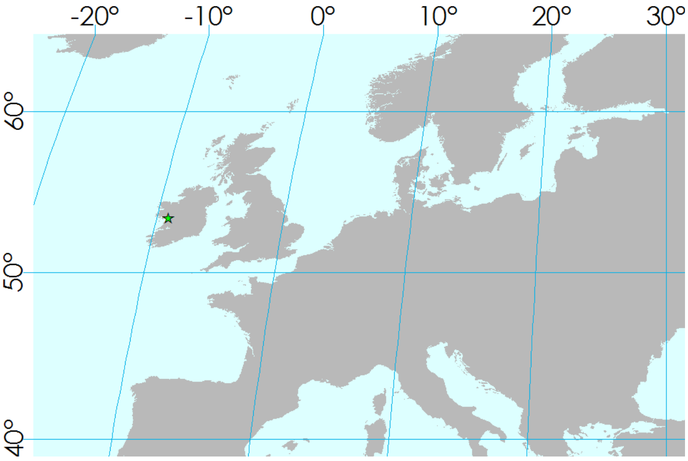
The jury particularly appreciated Galway's approach to green growth and support of SMEs, as well as their commitment to education and enthusiasm in becoming a Green Ambassador in 2017 and beyond.

Two-thirds of Europeans live in towns and cities. Their health and well-being depends on how well city authorities address environmental challenges. The European Green Leaf Award recognises the remarkable efforts of environmentally-friendly cities.

Winners of this award have to demonstrate well-established records of high environmental standards and a commitment to setting ambitious goals for future environmental progress, underpinned by the practical application of sustainable development. The schemes have a particular focus on green growth and job creation. Winners act as role models and inspire other cities to make their urban spaces sustainable and ultimately more enjoyable places in which to live, work and play.

The Jury was made up of experts from the European Commission, the European Parliament, the Committee of the Regions, the European Environment Agency, ICLEI – Local Governments for Sustainability, the Covenant of Mayors Office and the European Environmental Bureau.

Green Leaf applications are assessed on the basis of six topic areas, including climate change and energy performance, mobility, biodiversity and land use, quality of air and the acoustic environment, waste management and circular economy, and water and wastewater management. Cities are judged shortlisted for both awards following a technical evaluation. *Source:* https://ec.europa.eu/ireland/news/galway_wins_prestigious_eu_green_city_award_en. *More info on the award at:* http://ec.europa.eu/environment/europeangreencapital/europeangreenleaf/



Location of Galway, Ireland. Map by P.J. Alexander (2016) - Data obtained from Natural Earth (creative commons license).

The National University of Ireland (Galway), which is located within the city boundary. Galway was the winner of the 2016 European Green Leaf award, which is given to urban areas with a population of 100,000 or less across Europe. Image courtesy of P.J. Alexander.

Research Through Designing: Bridging the gap between urban climate science and design practice

By Sanda Lenzholzer[1] (sanda.lenzholzer@wur.nl)
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Introduction: what's the problem?

In order to improve the existing urban climate conditions and prepare cities to face the challenges of climate change, cities need to be adapted urgently. This is not a simple task because existing urban fabrics cannot be changed easily and applicable knowledge relevant for design is direly needed. A deductive, empirical science approach that would inform designers about how to make city climates more thermally comfortable would take too much time. First of all, it would involve (re)constructing cities. As a second step it would involve measuring the effect that (re)constructions had on climate to determine if the theory that was deduced held up in practice. When such (re)construction 'experiments' do not yield the expected results the costs of failure can be very high. As this is not feasible in terms of time frames and costs, quicker and simpler research approaches are needed. Apart from that of easily applicable design guidelines, prototypes or models are needed that respond to urban climate issues.

Such change-oriented research for adaptation in cities needs to include designing as a part of the research methods because adaptation designs are the object of research (Glanville & Jonas, 2007). A combination of research and designing offers the possibility to experiment with adaptation measures before they are realized.

A class of research methods that has been identified to connect research and design successfully is 'Research Through Designing' (RTD). RTD methods evolved throughout the last decades. In his seminal-work Herbert Simon proposed that "design science could ... become 'a body of intellectually tough, analytic, formalizable, partly empirical, and teachable doctrine about the design process" (Simon, in Dorst, 1997, p. 50). In the 1970s, Hillier et al. (1972) suggested to bring the scientific empirical method into design. De Jong and van der Voordt (2002, p. 455) described RTD "as the development of knowledge by designing, studying the effects of this design, changing the design itself or its context, and studying the effects of the transformations. The 'TOTE model' from systems analysis may be recognized in this: Test→ Operate→ Test→ Exit." However, the term "test" was not specified for the case of design, even though this is a very important question: how to test design? Breen (2002, p.137) came up with a more specific view: "The most 'scientific' approach would be one whereby targets and course of action are clearly specified beforehand, allowing for systematic evaluation of outcomes and the drawing up of unambiguous conclusions." Later on, such approaches were also extended to urban planning and landscape architecture (Klaasen, 2007; Lenzholzer et al., 2013). However, there is a need for more knowledge about suitable RTD methods that would lead to the identification of effective ways of designing urban environments so that urban climate is positively modified.

Amongst the broad range of RTD approaches (Lenzholzer et al., 2013), appropriate ones need to be identified for urban climate issues. The major research issues in urban climate adaptation concern physical and functional aspects. These issues call for research methods which mainly belong to the methods known from natural sciences and engineering. Such methods combining designing and empirical research have been described as (post)positivist RTD (Lenzholzer et al., 2013). Within this group of RTD projects we were interested in identifying the existing ones that address urban climate issues, and comparing and evaluating them in order to derive learnings to choose appropriate RTD methods for different research assignments. Accordingly, our research questions were the following:

1. What methods have been used in post-positivist microclimatic urban design research?
2. What are the relationships between levels of com-

plexity, spatial scale and testing methods?

3. How do RTD studies compare with other urban microclimate design-related research?

Method

The three research questions were answered through a three step process. First a comprehensive literature review identified microclimatic urban design studies that were conducted within the roughness sublayer of the city (Oke, 2004) and that used quantitative methods such as physical measurements and numerical simulations. Coarser scales of urban climate were excluded as they cannot be substantially affected by design interventions (Brown & Gillespie, 1995) and would be considered planning studies. Scopus was used to search broadly in peer- reviewed scientific journals employing terms that related urban and landscape design with urban microclimate. Searched terms related urban and landscape design with urban microclimate in 'Article, Titles, Abstracts and Keywords'. Only studies that dealt with research and design projects were selected. Many works kept reoccurring under the different search terms and at some stage the literature search was yielding no new studies. However, we were acquainted with more studies documented in peer-reviewed articles than were shown in the Scopus searches. Therefore these studies were added to the search results. Secondly, the resulting literature was divided into categories based on three criteria: the level of complexity; the scale of the project; and the method of testing and were arranged in a matrix for analysis (see Fig. 1). Finally, to compare the studies to other design-related research the methods were assessed to determine if they included design iterations and would qualify as RTD in the literal sense.

Results

Research question 1: What methods have been used in post-positivist microclimatic urban design research?

The literature search yielded 36 studies in which research and design are combined to generate new knowledge for urban microclimate responsive design. All these studies employ methods that fit the post-positivist approach as described by Creswell (Creswell, 2009). The studies represented different scale levels from small (e.g. trees in parks) up to larger scales in the urban microclimate realm such as neighbourhoods. The studies also displayed various levels of complexity. Many differences in the use of methods were found. Some studies used physical models, either 1:1 mock- ups or scale models. These physical models were then tested on their performance through measurements, either in real weather situations or in wind tunnels. Other studies – about two third of the total – used numerical simulations, mostly computer simulations.

Research question 2: What are the relationships between levels of complexity, spatial scale and testing methods?

The results of the literature research were arranged in a matrix (Fig. 1) that shows the degree of complexity on the X- axis and the testing methods used on the Y-axis, separated according to the different types of simulations to show future states (physical and computer simulations). The colour coding indicates the scale of the studies.

When scale was related to complexity levels, it appeared that on the very fine scale, two studies dealt with low complexity and four with medium complexity. On the fine scale, six studies dealt with low complexity and six with medium complexity. On the medium scale four studies dealt with low and one with medium complexity. On the coarse scale level, two studies dealt with low complexity, five with medium complexity and two with higher complexity. Four studies that dealt with wind only (and thus low complexity) could not be assigned to a scale because these wind studies were scale-less.

When plotting the degree of complexity against the type of testing method, it appeared that approximately half of the studies with low complexity were done with physical models (full scale mock-ups or scale models) and measurements and the other half with numerical simulations (see the separation of Figure 1 in two parts). The group of studies with medium complexity contained some cases where scale models and measurements were used and many more cases where numerical simulations were used. The two studies that took into account a higher complexity were both tested with computer simulations. A frequently used computer simulation tool was ENVI-met.

Research question 3: How do RTD studies compare to other microclimatic urban design-related research?

Several studies dealt simultaneously with various design options, but only a few studies included iterations and testing loops as part of the research process to improve the performance of the design products according to the TOTE model. The studies that included iterations were a study on thermally comfortable squares in temperate climate zones (Lenzholzer, 2012), a study on heat in courtyards in the Nether-

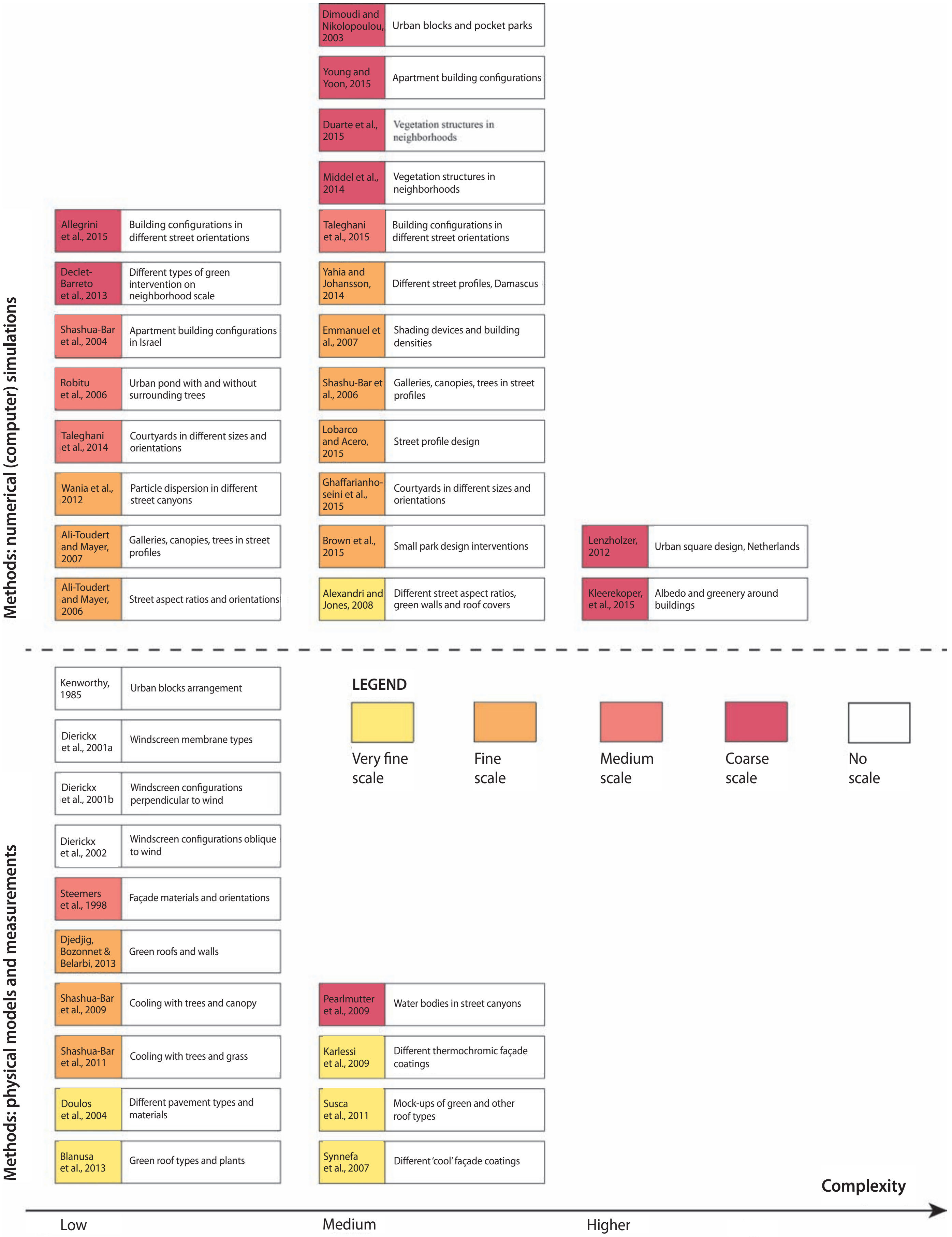

Figure 1. Overview of various (post)positivist RTD projects in landscape architecture and related disciplines for better urban microclimates.

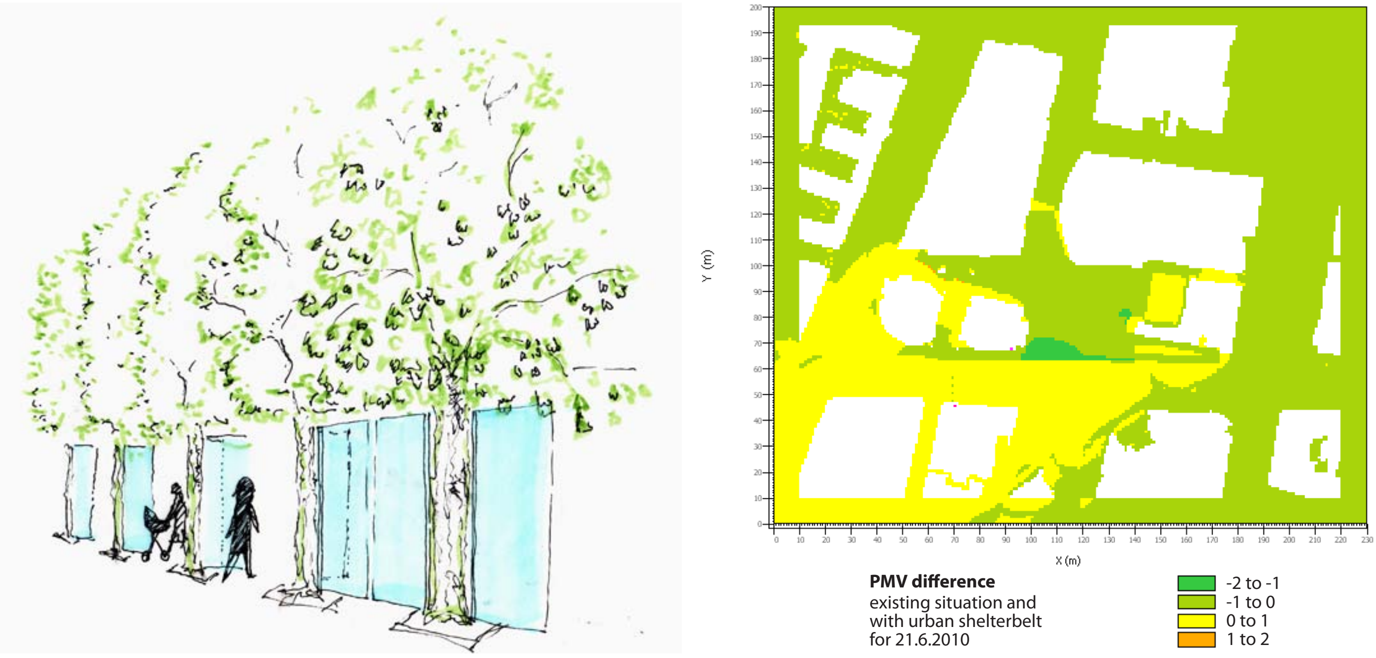

Figure 2. Left: Example of RTD process components for the study of Dutch squares (Lenzholzer, 2012). Right: an impression of the 'urban shelterbelt' and its effect on PMV in Envi-met.

lands (Taleghani et al., 2014) and a study on thermal performance of courtyards in hot and humid climates (Ghaffarianhoseini et al., 2015). Due to the iterations of designing and testing, these three studies qualify as RTD in the literal sense.

Discussion

Research question 1: What methods have been used in post-positivist microclimatic urban design research?

Urban microclimate modification is of growing importance in the context of global climate change and urban heat island intensification and clear design directives to adapt cities are required. Yet the number of studies in microclimatic urban design research to provide such design relevant knowledge was rather small (n=36).

The post-positivist methods such as measurements or numerical simulations were used to test the outcomes of design activities in the research process. Within the different simulation methods used to test the designs, numerical and computer simulations played a major role. A range of models that can simulate single parameters of design interventions was used, but in order to integrally simulate all the parameters that define thermal sensation of humans, only a few numerical models were deemed suitable. About two thirds of the numerical simulations were done with the ENVI-met software. The choice of this software seems to be motivated by the fact that ENVI-met is the only model that allows representation of three-dimensional spatial environments in high resolution, meeting the needs of architects, landscape and urban designers to test their designs. Moreover, it integrally represents all the parameters determining thermal sensation (Bruse, 2004). However, various studies also discussed the shortcomings of this software in terms of validity of the simulation results and that the simulation software is not sufficiently calibrated for all microclimate parameters (e.g. wind, turbulence, night-time situations). Many researchers are aware of these shortcomings, but the fact that this model displays the knowledge in a three dimensional way makes it the most commonly used model for spatial design.

Typical outcomes of the studies were design recommendations or 'rules of thumb'. Some recommendations were clear and directly applicable to design, but many were not explicit about how the information could be applied to design. Other studies developed 'prototypes' or spatial patterns that are generalizable design solutions for a specific type of spatial context and that were usually more fit for application. Some post-positivist methods can contribute to the generation of generalizable knowledge, but that depends on their relation to complexity and scale.

Research question 2: What are the relationships between levels of complexity, spatial scale and testing methods?

No clear relation was found between the scale of the studies and the degree of reducing complexity. On the very fine scale and the coarse scale, studies took into account higher complexity levels. But on the scales in between many more studies than expected displayed a low level of complexity.

Designing for urban microclimate involves dealing with a relatively high degree of complexity. Even in the small scale projects dynamics of microclimate required that many issues be taken into consideration (e.g. time of day or season of the year that the place will be used). Designing for different climate situations can confront the designer with wicked problems (Rittel & Webber, 1973). According to Coyne (2005), wicked problems occur through complexity of matters, not only in social contexts, but even in mathematics and natural sciences. This complexity based on the dynamic characteristic of climate was often not taken into account in the design research in this study. The studies regularly focused on one weather type (mostly hot days) or very few parameters of microclimate (e.g. wind only, air temperature only). Sometimes such reductionism is in order, for instance when climate situations in tropical regions do not change much and the designs have to be tested for these typical situations only. In most other climates it is usually necessary to test the designs on their functionality in various seasons and many studies had shortcomings in this respect. These reductionist approaches form a problem for designers because a design has to perform well in different weather and climate conditions. There were a few studies that did actually address different weather situations and seasons and took into account all parameters that matter for human thermal sensation.

Studies with a higher complexity level were not often tested with physical models although such models, when located in real-world settings, would offer more possibilities for testing on very different factors (e.g. aesthetics or compatibility with other functions).

There was a clear relation between the scale of the studies and the difference between physical and numerical testing methods. For smaller scales and low complexities it was quite simple to test design proposals and make valid and generalizable predictions about their effects. Such predictions were valid, especially when only one parameter of microclimate had to be designed for (e.g. wind). When the scale of the design proposals to be tested became somewhat broader, it was impossible to test designs physically with 1:1 models. In that case, three dimensional computer simulations were used.

Research question 3: How do RTD studies compare to other microclimatic urban design-related research?

Only three studies included design iterations as part of the research process and are thus typical examples of post-positivist RTD. These iterations involved 'preliminary tests' (e.g. Lenzholzer, 2012) and 'exclusion strategies' (e.g. Ghaffarianhoseini et al., 2015; Taleghani et al., 2014) to help set priorities, (e.g. which times of the day are most important for outdoor use, choosing spatial configurations that would be feasible) to reduce the large number of possible solutions. All three studies employed the same testing method: simulations through ENVI-met. This seems to be due to the fact that these simulations fit the iterative nature of RTD better than working with physical models and longitudinal measurements. Computer simulations were easier to change and they provide spatially explicit results quickly.

Conclusions

The main methods used in quantitative microclimatic urban design research were physical models and numerical simulations. Physical models were often tested in wind tunnels and the results were both accurate and precise but tend to be highly technical, time consuming, and expensive. The results from numerical simulations were much easier and less expensive to achieve, but they were also considered to be less accurate with several authors suggesting the need for further development and validation of the modelling software. Current improvements of modelling software open new avenues for more substantial application of the software in RTD processes.

Small scale and low complexity studies yielded outcomes that can be generalizable design guidelines or prototypes. When the scale and complexity of the design problems are coarser, though, the outcomes of the RTD represent partial knowledge that cannot be simply transferred to other sites because the boundary conditions would be very different. While they yield valid location-specific results, the generalizability of the outcomes is limited. For higher levels of complexity it might be necessary to conduct more iterations in the research and design process. When other issues need to be considered in a design that go beyond functional or physical matters, a combination with other types of RTD (e.g. constructivist or participatory) might be in order (Lenzholzer et al., 2016).

Most quantitative microclimatic urban design studies are not RTD in the literal sense, and only the three studies that included design iterations were RTD. These three studies provide a methodological model for future studies in microclimatic urban design that will investigate ways to ameliorate the negative effects of global climate change and urban climate improvement.

This contribution is an abbreviated version of the paper: Lenzholzer, S., & Brown, R. D. (2016). Post-positivist microclimatic urban design research: A review. *Landscape and Urban Planning*, 153, 111-121. (http://dx.doi.org/10.1016/j.landurbplan.2016.05.008)

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Monitoring the urban climate of the city of Ghent, Belgium

Introduction

Although the urban heat island phenomenon is well documented and studies have increased our understanding, the important measurements of meteorological and external climatic drivers across urban areas remain very limited due to the scarcity of high-density, in-situ measurement networks. Due to non-compliance with the WMO standards, especially urban long-term datasets (a year or more) are very scarce but invaluable because they allow more in-depth research on the seasonal evolution of the urban climate. Such observations also provide key information for end-users, decision-makers, stakeholders, and the public.

Recently, urban observational networks have been established; one notable example is the Helsinki Testbed (Kosinken et al. 2011). Its objectives are to (i) provide input and verification data for mesoscale weather research models, operational forecast models, and dispersion models, (ii) provide better understanding of mesoscale processes that can be adapted for developing weather forecast and dispersion modeling systems, (iii) calibrate and validate satellite data, (iv) create an integrated information system (e.g. the Helsinki Testbed data archive), (v) develop end-user products, and (vi) disseminate mesoscale meteorological and air quality data for both the public and the research community. The skeleton of the Helsinki Testbed network was established from the existing observation networks of the Finnish Meteorological Institute and the Finnish Road Administration but has been successively supplemented with other data sources (see Kosinken et al. 2011 for a detailed list of available measurements).

Another example is the Tokyo Metropolitan Area Convection Study (TOMACS, Maki et al., 2012). TOMACS aims to understand the processes and mechanisms of extreme weather, using dense meteorological observation networks designed in the Tokyo metropolitan district, to develop a monitoring and predicting system of extreme phenomena, and to implement social experiments on extreme weather resilient cities in collaboration with related government institutions, local governments, private companies, and residents. The TOMACS field campaign, using research instruments and operational meteorological networks, was carried out by fourteen research organizations in the summer of 2011-2013 targeting the life cycle and environment conditions for thunderstorm initiation, development, and dissipation – which are potential causes of natural disasters such as flooding and landslides.

Figure 1. Situation of Ghent (Google Maps).

In addition, a number of major field campaigns in urban areas have been conducted in various parts of the world (i) in the USA, for example URBAN 2000 (Allwine et al. 2002), Joint Urban 2003 (Allwine et al. 2004), Pentagon Shield (Warner et al. 2007), Madison Square Garden (Hanna et al. 2006); (ii) in Europe, e.g. ESCOMPTE (Mestayer et al. 2005), CAPITOUL (Masson et al. 2008), BUBBLE (Rotach et al. 2005), DAPPLE (Arnold et al. 2004), and REPARTEE (Harisson et al. 2012). The Ghent urban observations project presented here will result in an additional dataset for urban heat island research.

Urban climate in Ghent

The city of Ghent (dutch: Gent, french: Gand) forms a typical example of a small to middle size western-European city. Ghent has a population of about 250,000 inhabitants and is located in the north of Belgium, one of the most densely built-up regions of Europe. The flat topography and the fact that the city is not a coastal city (North Sea at about 50 km, Figure 1) simplify the analysis of meteorological observations. Like most cities in this region the city center is densely populated whereas at the outskirts suburban neighborhoods with detached houses and green spaces are found. The city of Ghent has a diameter of about 10 km.

In summer 2012 a temporary measurement campaign with three weather stations was undertaken by VITO (Vlaams Instituut voor Technologisch Onderzoek) in Ghent. A nighttime temperature difference up to 8 °C was measured between city center and countryside. Apart from this short observation campaign and a similar one in Antwerp, no urban observations are available in Flanders. As urban expansion, together with the associated increase in built-up areas and its consequences, are important topics in Flanders, a more thorough urban measurement campaign would be valuable. Therefore Ghent University decided to purchase six automatic weather stations to be installed in the city. For this project Ghent University received support from RMI (Royal Meteorological Institute of Belgium) and VITO, research institutes that both have extensive urban climate experience.

Locations

Six locations were selected to sample the diversity in urban characteristics in Ghent. The decision was aided by an RMI analysis (Figure 2) of the urban heat island in Ghent undertaken with the ALARO model with SURFEX. Here, we used the methodology described by Hamdi et al. (2014a) to dynamically downscale a climate change scenario at the city level. First, the regional climate simulations were performed with a new version of the limited-area model of the ARPEGE-IFS system running at 4km resolution called ALARO (Gerard et al. 2009; De Troch et al., 2013, Hamdi et al., 2014b) coupled with the Town Energy Balance scheme (TEB, Masson, 2000). Second, in order to further downscale the regional climate projections to an urban scale, at 1 km resolution, a stand-alone surface scheme, called SURFEX, was employed in offline mode using the forcing coming from the lowest model level of the 4 km regional climate simulations. In order to simulate the spatial differences of the UHI over the city of Ghent and since the computational cost for running the complete atmospheric model at 1 km horizontal resolution for climate applications is very high, these 1 km offline runs could be seen as a further physical downscaling step over our region of interest but with the correct signature of the UHI in the forcing coming from the 4 km runs. The downscaling strategy was run for a 20-year period [1991-2010] using ERA-INTERIM re-analysis data. This methodology has already been validated over Brussels and Paris (Hamdi et al., 2015; 2016).

Figure 3 shows the locations on a map of Ghent together with satellite images to illustrate the different urban environments:

- Provincie and St Bavo are close to each other in the densely built city center of Ghent
- Plantentuin is situated in a small park
- Honda is situated in the port, north of the city center
- Wondelgem represents a typical suburban neighborhood (detached housing with large green spaces in between) at the northwestern border of the city
- Melle is located southeast of Ghent in a rural environment

Weather station: sensors and communication

The six automatic weather stations are identical and measure at 2 meter height precipitation, temperature, relative humidity, and wind speed (Fig. 4). Temperature measurements are done both in passively and actively ventilated radiation shields. The actively ventilated shield (3) contains a Pt100 temperature sensor, whereas in the passively ventilated shield (1) both temperature and relative humidity are measured (HC2S3 sensor). Precipitation is measured by a rain gauge (2) (ARG100) placed at a height of 2 m. The bucket collecting the rain is tipping each 0.2 mm. Wind is measured by a sonic anemometer (4). For practical reasons it was impossible to undertake wind measurements at a larger height. All measurements are collected by the datalogger (CR6) connected to an antenna that is transferring data to a central server over the GPRS network every 5 minutes. This high rate of communication with the server is to show realtime data on the website (http://www.observatory.ugent.be/weathergent_live_eng.html).

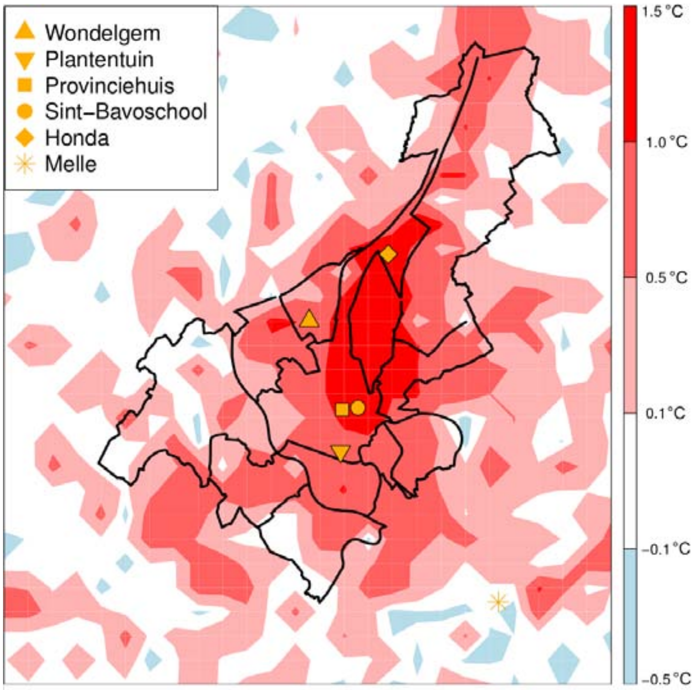

Figure 2. Map showing the differences in the nighttime minima with respect to the countryside minima, based on ALARO simulations with SURFEX as explained in the text.

The six weather stations were extensively tested: all stations were running for several months at the rural location as shown in Figure 5. After solving some small issues, the measurements of the stations were nearly identical. To illustrate this, Figure 6 shows the actively ventilated temperature during the testing period together with the calculated root mean square error (RMSE) of the measurement (calculated for each station against the measurements of the five other stations). The RMSE for 2 m temperature never exceeds 0.2°C.

First measurements

At the end of June 2016 all stations were installed at their locations, and since that time stations are continuously in operation. Although a detailed analysis is planned for later, it is interesting to show already some initial measurements.

During the second half of August, Ghent was confronted with a heat wave. The 2 m temperature for this period, together with the difference with respect to the temperature at the rural station, is shown in Figure 7.

In agreement with previous UHI campaigns in mid-latitude cities, the daytime temperature differences be-

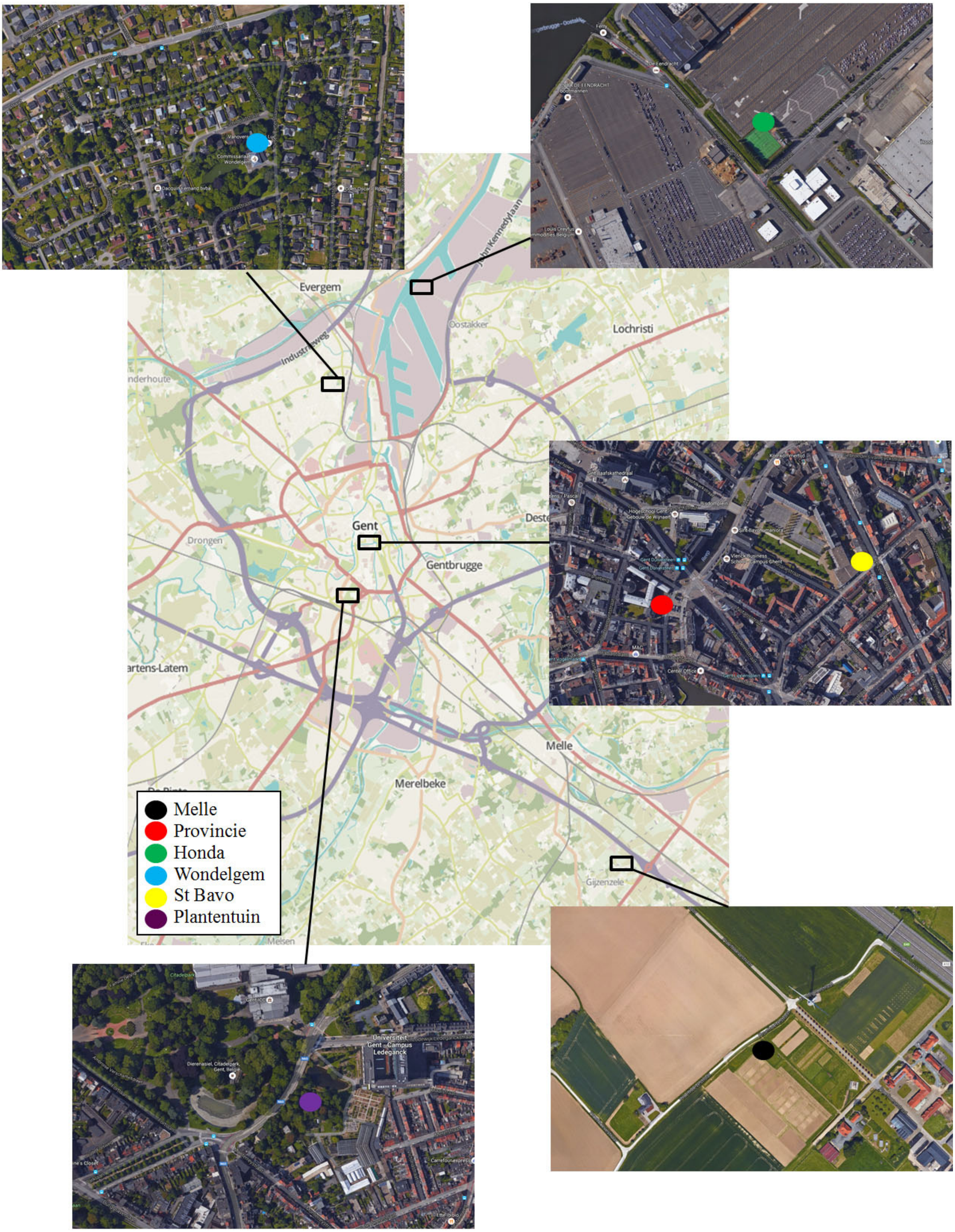

Figure 3. Map of Ghent (Openstreetmap) and satellite images (Google Maps) of the different locations of the six weather stations.

tween the locations are limited (always less than 2 °C). During the night the city does, however, experience a cooling pattern different from the surrounding countryside. The heat wave was characterized by clear and calm nights and the temperature at the rural location therefore drops sharply after sunset whereas the city cools at a much slower rate. Hourly averaged temperature differences up to 6°C were measured between city and countryside and this happened frequently, not only during this heat wave. The slowest decrease in temperature is observed in the two locations in the densely built city center (Provincie and St Bavo) and at the industrial location in the port (Honda). The latter is noteworthy because in the port we have two competing factors. The location consists of large asphalted terrains which store much heat during the day. However the terrain is quite open and the large sky view factor should enhance outgoing radiation and nighttime cooling. The measurements hint that the first effect is dominant in the port. Measurements in the botanical garden (Plantentuin) and the suburban neighborhood (Wondelgem) show a more moderate but still substantial UHI.

A final remark is that this ranking of the UHI intensity at the different locations corresponds well with the earlier shown ALARO-SURFEX analysis for Ghent (Figure 2).

Future plans

The six stations will remain for three years at their current locations. This permits us to collect a robust meteorological data set for all seasons in Ghent. At the end of this 3-year period the project will be evaluated, and based on this a decision about continuing measurements at these locations will be taken. More information and news can be found on the website: http://www.observatory.ugent.be/index_eng.html.

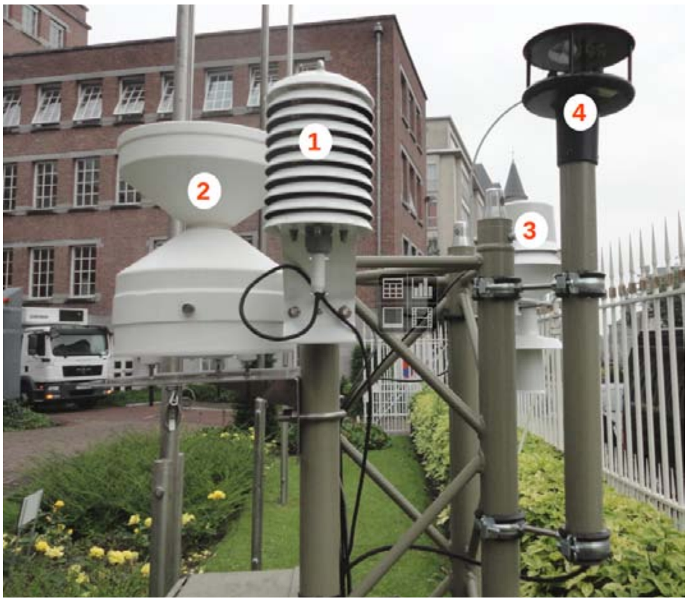

Figure 4. Detailed view of the sensors at one of the weather stations: passively ventilated radiation shield (1) with temperature and relative humidity measurement, rain gauge (2), actively ventilated shield (3) with temperature sensor, and sonic anemometer (4).

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Figure 5. The six identical weather stations during the testing period in Melle.

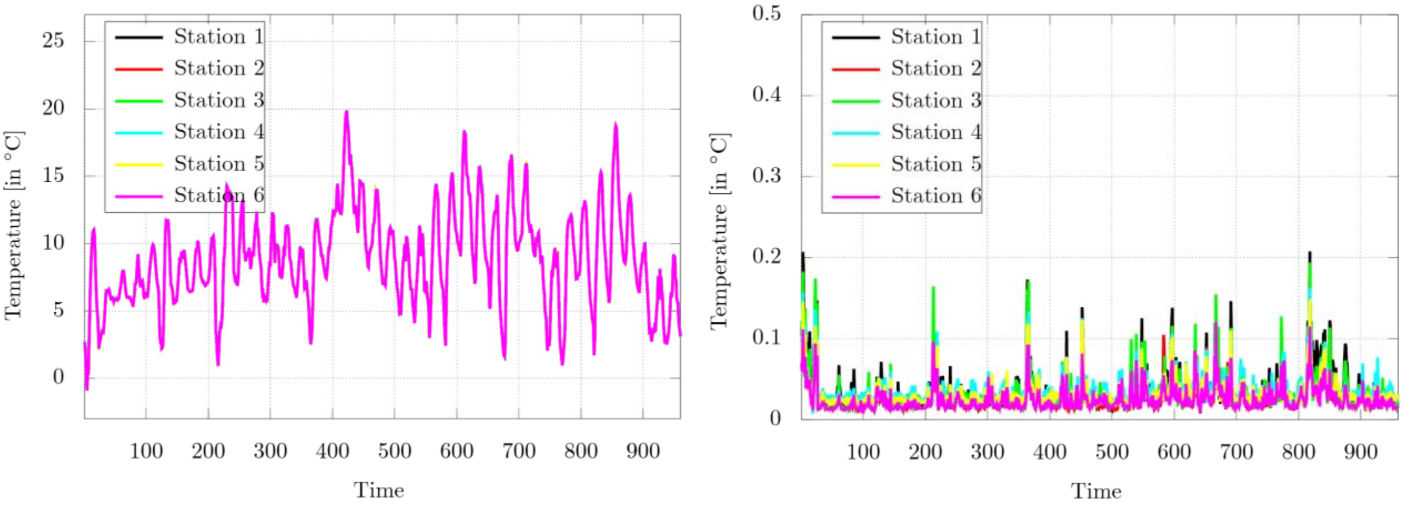

Figure 6. Hourly averaged 2m temperature (actively ventilated, left) and the root mean square error for each sensor with respect to the other five (right) for the period 17/03/16 – 25/04/16. All stations were installed at the rural location during this testing period.

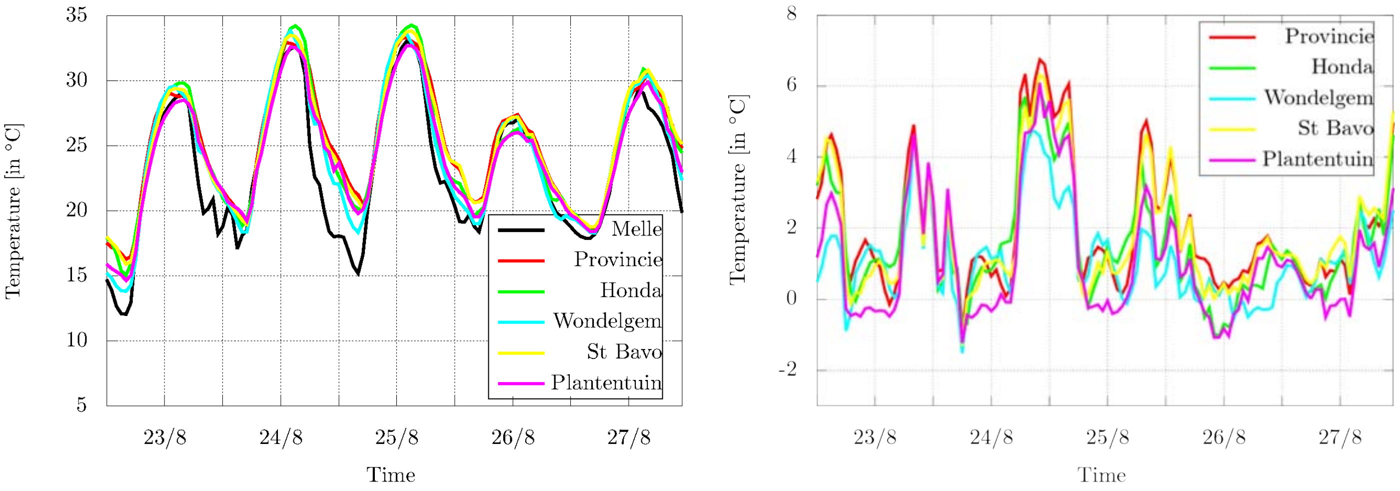

Figure 7. Actively ventilated temperatures (left) and differences (right) with respect to rural location measured during the heat wave in August. The values are averaged over 1 hour.

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Assessment of cultural differences of thermal perception by UTCI during a heatwave

Introduction

Improving visitors' thermal comfort is important for tourism. It helps the tourism industry advertise tourist attractions to potential overseas visitors. In addition, it assists urban planning in response to climate change. Studies in tourism climatology usually focus on the perspective of tourism staff and business operators, and seldom explore the thermal perceptions of tourists on-site (Denstadli et al., 2011). Compared with local visitors, overseas visitors also tend to have different expectations and perceptions of the climate of tourist destinations (de Freitas, 2003).

As a way to assess visitors' thermal comfort, it is uncertain how the Universal Thermal Climate Index (UTCI) would perform as a thermal index in the temperate climate of Australia, as it was developed in Europe (Jendritzky et al., 2012). Furthermore, UTCI validation studies during heatwaves have been rare, as these studies seldom encountered heatwaves (Bröde et al., 2012a, Pantavou et al., 2013, Park et al., 2014). Incorporating clothing behaviour from other countries is also necessary to make UTCI more relevant for policy application. The discrepancy between thermal indices and survey results in previous studies highlights the need to improve the current design of thermal indices (Nikolopoulou et al., 2001). Without validating the thermal indices with survey data, the guidelines offered by thermal indices might not be useful for policy makers and the general public. Cultural differences in thermal perception were previously observed in Lam et al. (2016a) using apparent temperature. The aim of this study is to use UTCI to examine the differences in thermal perception and clothing behaviour between visitors from different origins, who visited the Royal Botanic Garden Melbourne (RBGM) during the Australian summer in 2014.

Methods and materials

The method used in this study is based on the work published in Lam et al. (2016a; 2016b). This study was conducted in RBGM in Melbourne, Australia (37°50'S, 144°58'E). Melbourne has a warm temperate climate with occasional very hot spells associated with the arrival of hot, dry continental air. The study period spanned 5 – 16 February, 2014. Thermal comfort surveys ($n = 2198$) were compared with the meteorological measurements in RBGM.

Meteorological measurement – Automatic weather stations were established in RBGM ($n = 4$) in February 2014 (Figure 1). Campbell Scientific weather stations (CR211X data loggers) were set up at the Visitor Centre and Tea Room in RBGM. In those sites, Vaisala HMP155 Probes, Met One 014A-L anemometers and 150 mm diameter black globe thermometers were used to measure air temperature, relative humidity, wind speed and black globe temperature respectively. Kestrel Heat Stress Tracker 4400s also recorded the same meteorological variables at Fern Gully and Guilfoyle's Volcano. Campbell Scientific and Kestrel weather stations were calibrated in laboratory settings to ensure there were no significant differences in measured temperature and relative humidity.

Figure 1. The locations of weather stations and survey sites in RBGM. (nearmap – January 2014)

Thermal comfort survey – The survey examined visitors' thermal perceptions indicated by the Actual Sensation Vote (ASV) and clothing insulation (clo) (details in Lam et al., 2016a). The ASV measures visitors' self-perceived thermal comfort, ranging from hot (+3) to cold (-3), with 0 being neutral (Nikolopoulou et al., 2001). A higher ASV therefore means a hotter perceived environment. One clo refers to the amount of clothing required to keep a person sitting comfortably at 21°C (Parsons, 2014). A one-way ANOVA compared the statistical significance of differences in visitors' thermal perception and clothing using a threshold of $p < 0.05$.

UTCI calculation – The UTCI was chosen as the thermal index for this study to be applied in an Australian context. The index was calculated using a Visual Basic code (ClimateCHIP, 2015) modified from the FORTRAN code on the UTCI website (ISB Commission 6, 2014). The UTCI is a function of air temperature, relative humidity, wind speed at 10 m above ground, as well as mean radiant temperature (T_{mrt}), which was derived from black globe temperature. Since the weather stations were 1.3 m above ground, Equation 1 was used to convert the stations' wind speed (v) to 10 m above ground (Bröde et al., 2012b):

$$v_{10m} = v_{xm} \times log(10/0.01)/log(x/0.01) \quad [1]$$

where x is the height of the weather station.

Equation 2 was used to calculate T_{mrt} according to Ramsey and Bernard (2000):

$$T_{mrt} = 100\times \{[(T_g+273)/100]^4 + WF \times (T_g-T_a)\}^{0.25} - 273 \quad [2]$$

$$WF1 = 0.4 \times (|T_g-T_a|)^{0.25}$$

$$WF2 = 2.5\times v^{0.6}$$

If $WF1>WF2$,then $WF = WF1$, otherwise $WF = WF2$

where WF is the weighting factor (dimensionless), T_g is the globe temperature, T_a is the air temperature, v is the wind speed (m/s), and T_{mrt} is the mean radiant temperature.

Results

Meteorological conditions during the survey period – Table 1 summarizes the recorded meteorological conditions during the days when the surveys were conducted in RBGM (5-16 February, 2014). There was no rainfall throughout the survey period except for 16 February (4.2 mm, mainly in the early morning). Heatwaves are defined as 'periods of three or more consecutive days when each day exceeds the calendar-day 90th percentile' (Perkins and Alexander, 2013: 4512). In this study, 7 February (36.7°C), 8 February (41.0°C) and 9 February (40.6 °C) constituted the heatwave period.

Cultural differences in thermal perception and clothing behaviour – Thermal perception differed between RBGM visitors from different countries as shown by one-way ANOVA. Figure 2 shows RBGM visitors' mean thermal sensation across different UTCI ranges according to various areas of origin. Chinese and European tourists were selected to compare with local Australian visitors. When UTCI was from 21.7°C to 37.7°C (no thermal stress to strong heat stress), Chinese visitors (ASV: 0.77 ± 1.17, n = 131) felt significantly cooler than Australian (ASV: 1.18 ± 1.04, n = 999), North American (ASV: 1.28 ± 0.97, n = 80) and European visitors (ASV: 1.47 ± 0.95, n = 323), F (4, 1599) = 12.36, $p < 0.001$. However, when UTCI exceeded 37.7°C (very strong heat stress), Chinese visitors (2.64 ± 0.792, n = 47) felt significantly hotter than Australian visitors (1.92 ± 1.02, n = 266), F (4, 442) = 7.07, $p < 0.001$. The mean thermal sensation of Chinese visitors did not differ significantly from either European or North American visitors at this UTCI range.

During the heatwave, the differences in thermal perception between visitors from various origins appeared to be less pronounced (Figure 2). In contrast to the entire survey period, Chinese visitors felt significantly hotter than Australian visitors during the heatwave. However, the mean thermal sensation of European (ASV: 2.18 ± 0.90, n = 120) and North American visitors (ASV: 1.92 ± 0.81, n = 25) did not differ significantly from either Chinese or Australian visitors. When UTCI was from 37.7 to 41.7°C (very strong heat stress), Chinese visitors (ASV: 2.80 ± 0.63, n = 10) felt significantly hotter than Australian visitors (1.77 ± 1.09, n = 73), F (4, 117) = 2.76, p = 0.031. Similarly, significant differences of thermal sensation between Chinese and Australian visitors were also observed when UTCI was between 45.7°C and 49.7°C (extreme heat stress).

Table 1. Meteorological conditions during the survey in RBGM. The data are based on the weather station at the Visitor Centre.

Date (2014)	**Air temp** (°C)			**Relative humidity** (%)			**Wind speed** (m/s)			**Solar radiation** (W/m^2)	
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Max
5 Feb	21.0	11.7	31.2	61.7	30.1	81.5	1.0	0.0	2.3	297.5	993.0
7 Feb*	25.5	18.5	36.7	55.1	22.8	83.8	0.8	0.0	1.8	276.4	1009.7
8 Feb*	27.1	17.0	41.0	58.8	20.2	92.6	0.3	0.0	1.2	290.9	985.0
9 Feb*	27.4	18.2	40.6	40.4	14.1	70.4	1.5	0.0	2.6	262.2	973.8
12 Feb	21.3	15.5	26.4	75.7	57.3	94.5	0.4	0.0	1.4	222.9	900.2
14 Feb	22.4	17.5	25.7	76.4	57.1	92.9	0.2	0.0	0.7	135.1	508.2
15 Feb	23.0	19.9	29.0	75.9	55.2	88.9	0.4	0.0	1.1	164.4	1012.5
16 Feb	19.1	16.3	22.9	76.4	56.1	94.8	1.1	0.5	1.8	201.1	1033.4

* *Heatwave period*

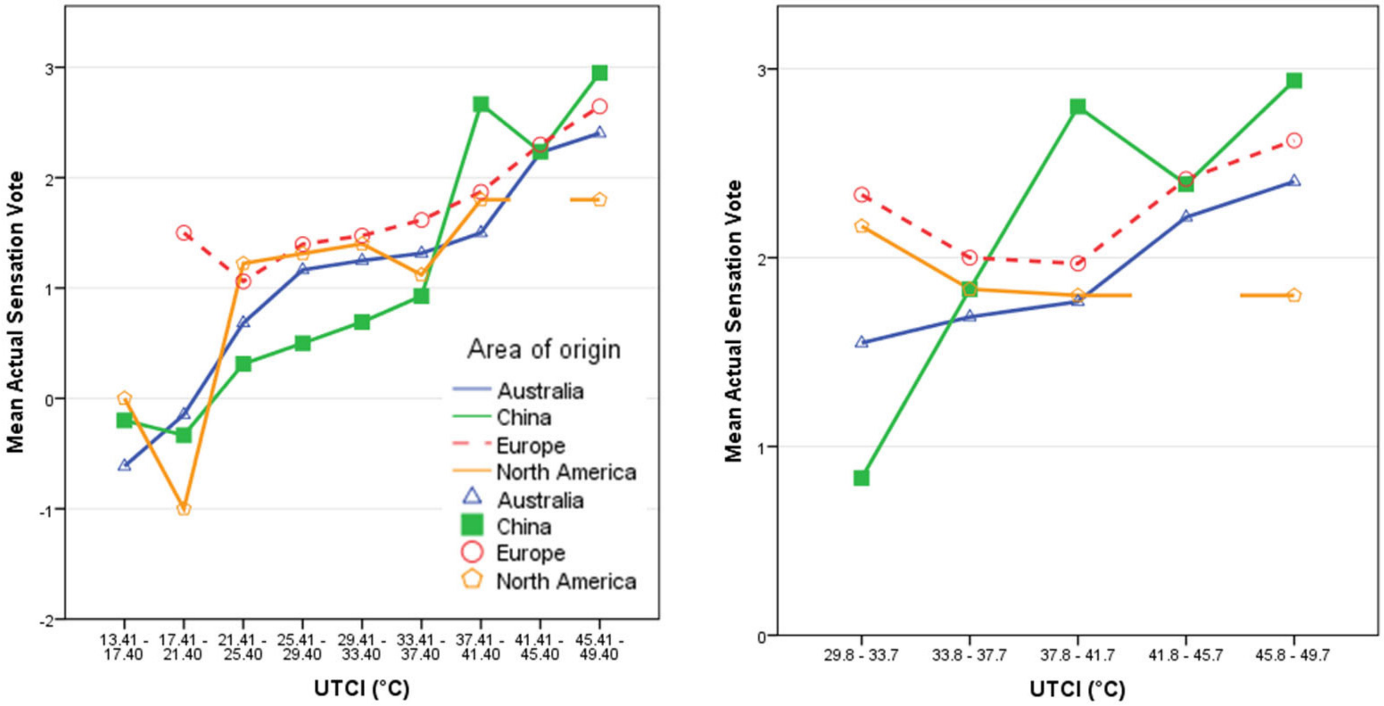

Figure 2. Visitors' thermal perception from selected area of origin in RBGM during the entire survey period (left) and the heatwave (right).

Chinese visitors generally wore more clothing than other visitors across the whole survey period, as indicated by higher mean clothing insulation values (clo) (Figure 3). While Chinese visitors wore more clothes, it is interesting to note that they only felt hotter than other visitors once UTCI exceeded 37.7°C (very strong heat stress). In particular, Chinese visitors (0.42 ± 0.13 clo, *n* = 47) wore significantly more clothing than European (0.33 ± 0.10 clo, *n* = 103) and North American visitors (0.30 ± 0.75 clo, *n* = 10F (4, 442) = 7.60, *p* < 0.001. During the heatwave, Chinese visitors also wore significantly more clothing than other visitors (Figure 3). It is noteworthy that the clothing worn by Australian visitors did not change much across different UTCI ranges during the heatwave. The results highlight cultural differences in clothing behaviour.

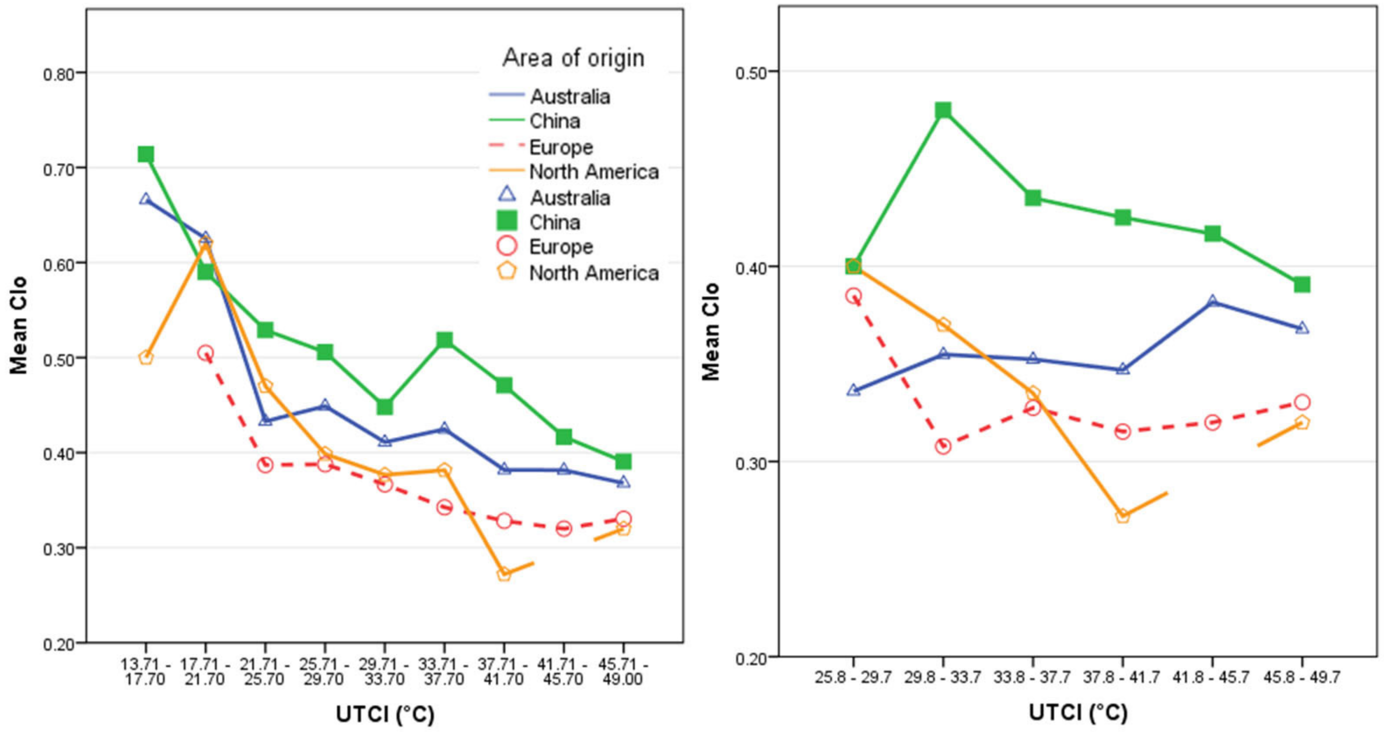

Figure 3. Clothing insulation (clo) of visitors from different origins for each UTCI range at RBGM during the entire survey period (left) and the heatwave (right).

Discussion and conclusions

This study reveals that visitors from different origins had different thermal perceptions and clothing behaviour in RBGM under both heatwave condition and the entire survey period. It was found that the underlying results and conclusion are insensitive to whether apparent temperature (Lam et al., 2016b) or UTCI (this study) is used. Compared to apparent temperature, UTCI has the additional component of solar radiation in its calculation. Even when solar radiation was included, it did not seem to change the results of how visitors from different origins perceived thermal comfort in RBGM.

European, North American and Australian visitors felt significantly hotter than Chinese visitors when UTCI was between 21.7°C and 37.7°C. This finding is in agreement with a Melbourne study conducted by Kenawy and Elkadi (2013). They stated that people from America, Northwestern Europe and Australia had a higher mean ASV than those from Asia in summer (assessed by the physiologically equivalent temperature, PET). Australian visitors were likely to be acclimatized to the Australian summer. Acclimatization can also explain why the mean ASV of Australian visitors was lower than that of Chinese visitors.

Due to the scope of this study, it was not possible to examine visitors' thermal perception in subsequent summers. Visitors might exhibit a different pattern of thermal perception during summers with less extreme weather. Future studies can compare survey results from multiple summers, which would be helpful to understand the inter-annual variation of thermal perception.

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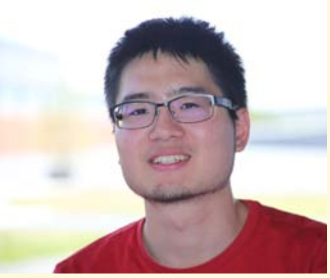

A comprehensive evaluation of breathability and thermal comfort in the urban canopy

Introduction

Climate and environmental challenges are among the important criteria for evaluating the "livability" of future cities. However, climate analysis in the complex and constantly-changing environment of cities is intricate in its nature: environmental challenges should be evaluated from different points of reference (indoor vs outdoor environment, street vs city scale); and the interdependence of various parameters (such as air flow, temperature, and pollution concentration) should be included. Additionally, for these climatological analyses to be effective, they should be made available and accessible across different fields and communities (including architects, urban planners, and policy makers).

We aim to move towards a comprehensive urban climate analysis by taking these levels of complexity into account. Accordingly, we employ the numerical modeling approach and identify three main tools that are core to the comprehensive urban climate analysis: 1) detailed indoor-outdoor energy balance modeling for representative urban climate zones, 2) high resolution atmospheric flow modeling in microscale, and 3) three-dimensional mean radiant temperature and thermal comfort modeling in urban streets. These tools are then employed to a) evaluate pollutant concentration and thermal field in urban streets and quantify the role of non-uniform surface heating, and b) obtain methodologies for guideline maps of thermal comfort and breathability by characterizing the street-scale flow under unstable atmospheric stratification. Additionally, detailed analysis of urban microclimate can be used for enhancing the parameterization of meso-scale models. Accordingly, the comprehensive results obtained from this evaluation are of particular importance not only for urban flow, thermal and dispersion modelling; but also can be further explored to link the urban design to micro-scale climate as well as human health and comfort.

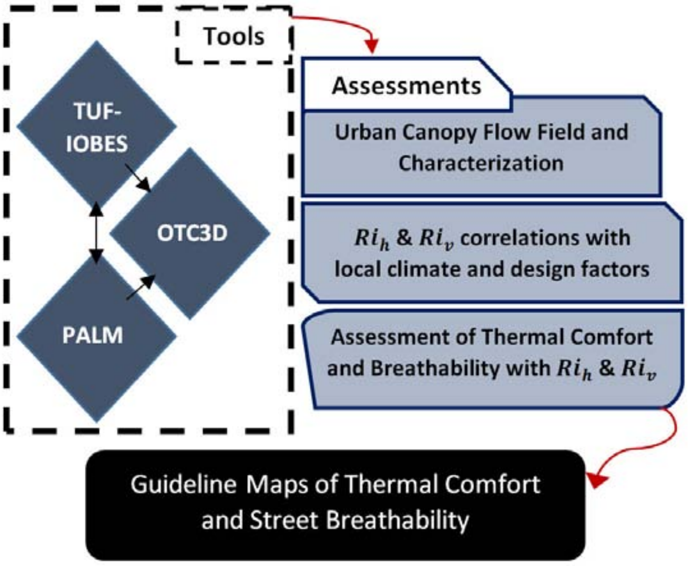

Figure 1. Flowchart of the research methodology for obtaining guideline maps of thermal comfort and city breathability. TUF-IOBES stands for Temperature of Urban Facets – Indoor Outdoor Building Energy Simulator, PALM is the PArallelized Large-Eddy Simulation Model for Atmospheric Flows, and OTC3D stands for the Outdoor Thermal Comfort model in 3D urban environments.

Methodology and tools

Figure 1 shows an overview of the research methodology in this analysis. In summary, we employ a detailed urban energy balance model (TUF-IOBES) to incorporate the diurnal and spatial variations of surface heating in the atmospheric flow simulations of urban areas (PALM). Subsequently, we obtain the detailed spatial distributions of flow field, temperature, pollutant concentration and turbulent fluxes, and evaluate the effects of realistic thermal forcing in urban canyons. In parallel, we use the parameterization method introduced by Nazarian & Kleissl (Nazarian, 2016a) to comprehensively characterize the flow field under unstable conditions, and evaluate the sensitivity of non-dimensional numbers to the design and climate factors.

In the next phase, we use the detailed distribution of surface and air temperatures, wind flow, and pressure fields to calculate the thermal comfort index, Standard Effective Temperature (SET), in the 3D urban canyon, and evaluate the correlation of SET and pollutant concentration with the previously defined characterization methods. Following this methodology, we can produce the guideline maps of thermal comfort as varied by various climate and design factors, and compare with guidelines given for air quality and city breathability.

An indoor-outdoor building energy simulator – In order to represent the realistic 3D distribution of heating in urban areas, we extract the temporally and spatially resolved (gridded) sensible heat boundary conditions from a detailed urban energy balance model. Temperature of Urban Facets-Indoor Outdoor Building Energy Simulator (Yaghoobian, 2012) used for this purpose is a building-to-canopy model that simulates indoor and outdoor building surface temperatures and heat fluxes to estimate cooling/heating loads and energy use of buildings in a 3D urban area. The model dynamically solves for indoor and outdoor energy processes, including effects of real weather conditions, indoor heat sources, building and urban material properties, composition of the building envelope (e.g. windows, insulation), and waste heat from air-conditioning systems on urban canopy temperature. Additionally, we plan to expand this model to arbitrary geometries by adopting an efficient model of 3D radiative transfer which could also incorporate the effect of vegetation on radiation balance in urban areas.

Computation Fluid Dynamics model of urban flow – We use Large Eddy Simulations as a superior method for evaluating turbulence characteristics and dispersion behavior in the street canyon. Accordingly, a series of fluid flow and thermal field simulations are performed using the PArallelized Large-eddy simulation Model (PALM) developed at the Leibniz University of Hannover (Raasch, 2001; Letzel, 2008; Maronga, 2015) with realistic thermal boundary conditions extracted from TUF-IOBES. PALM solves the filtered, incompressible Boussinesq equations, the first law of thermodynamics, the equation for subgrid-scale (SGS) turbulent kinetic energy (TKE), and passive scalar (pollutant) equation. TUF-IOBES, PALM and the coupling of the two have been previously validated (Yaghoobian, 2012; Park, 2012; Yaghoobian, 2014).

Three-dimensional model of outdoor thermal comfort – OTC3D is a model of evaluating the 3D distribution of Outdoor Thermal Comfort in urban environments (Nazarian, 2016c). Thermal comfort is measured in terms of different indices that incorporate the physiological response of humans to microclimate parameters, such as wind flow, air temperature, humidity, and radiation exposure. One such index is Standard Effective Temperature (SET), which can be calculated as:

$$H_{sk} = h_s\,(t_{so} - SET) + wh_{e,s}\,(P_{s,sk} - .5P_{SET}) \qquad [1]$$

where H_{sk} is the heat loss from skin, h_s is the standard heat transfer coefficient, t_{so} is the standard operative temperature, w is the fraction of the wetted skin surface, $h_{e,s}$ is the standard evaporative heat transfer coefficient, $P_{s,sk}$ is the water vapor pressure at skin assumed to be that of saturated water vapor at t_{so}, and P_{SET} is the saturated water vapor pressure at Standard Effective Temperature. In this model, SET is analyzed as a steady-state condition without significant heat storage within the body. Therefore, H_{sk} is assumed to be zero. For SET calculation in this study, the spatial variation of urban microclimate parameters are provided from a coupled CFD analysis of the flow and thermal field in an idealized configuration.

In order to accurately calculate the standard operative temperature (t_{so}) in Equation 1, the mean radiant temperature (T_{mrt}) which accounts for the pedestrian exposure to the net radiation, should be predicted accurately. However, the complexity of the T_{mrt} calculation results in simplified models for pedestrian radiation exposure. For instance, T_{mrt} is sometimes assumed to be equal to T_{air}, the visibility of urban surfaces and the reflected solar radiation from them are often neglected, and/or the spatial variation of sky view factor is oversimplified. Therefore, the accuracy of many similar thermal comfort models suffers from inaccurate prediction of human radiation exposure from the urban surfaces as well as the sky.

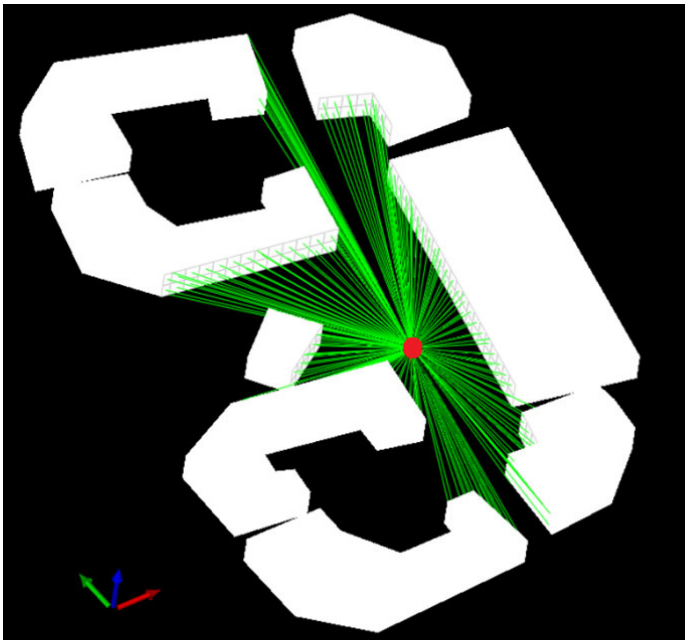

Figure 2. Plan view example of visibility modelling for a pedestrian positioned at the red dot mark. Green arrays indicate surfaces visible to the pedestrian.

Accordingly, OTC3D introduces a comprehensive and detailed model for the T_{mrt} calculation that represents the spatial variability of radiation exposure, and consequently thermal comfort in the urban streets. To do so, OTC3D includes a detailed model of mean radiant temperature that incorporates a) the visibility of urban surfaces to the pedestrians at any point (Figure 2), b) the spatial distribution of sky view factor, and c) inter-building shadowing and shortwave radiation effects on thermal comfort. Although we analyzed an idealized configuration in this study, we have expanded this model to evaluate thermal comfort in arbitrary urban configuration with Level of Detail 1 (LOD1). An example of detailed visibility analysis for a residential building in the Sengkang area of Singapore is shown in Figure 2.

Assessment of simulation cases

All simulations presented here are performed over an array of uniformly spaced obstacles with a canyon aspect ratio (canyon height-to-width) of 1, corresponding to a roughness plan aspect ratio λ_p of 0.29 and frontal aspect ratio λ_f of 0.25, representing the compact low-rise urban zone with no vegetation (Stewart, 2011). Figure 3 represents the schematic of the computational domain and key boundary conditions. Periodic boundary conditions are used in horizontal directions, and for the top boundary condition a sink term of heat and pollutant fluxes are imposed corresponding to the diurnal variation of surface fluxes. The focus of this study is on unstable atmospheric stratification and the simulations are done for a temperate mid-latitude climate, while the results can be expanded to various locations and time of the year using the characterization method further explained below.

Characterization of urban flow under unstable atmospheric stratification – Traditionally, the bulk Richardson number in the vertical direction Ri_v is used to indicate the atmospheric stability:

$$Ri_v = gH(\overline{T_H} - \overline{T_G}) / U_b^2 T_a \qquad [2]$$

where g is gravitational acceleration (9.81 m s^{-2}), T_a and T_H indicate the air temperature at a reference height and roof level, respectively, T_G is the temperature of the ground surface inside the building canyon, H is the building height, and U_b is the bulk wind velocity with zero wind angle from the east-west axis ($\cos\theta=1$). This definition alone neglects the horizontal temperature gradient, and falls short in comprehensive characterization of the flow. Therefore, a horizontal Richardson number is also defined (Nazarian, 2016a) to convey more information about the directionality of thermal forcing in relationship to the canyon vortex:

$$Ri_h = [gH(\overline{T_L} - \overline{T_W}) / U_b^2 T_a] (H/W) \qquad [3]$$

where W is the canyon width, and T_W and T_L are the surface temperature at the windward and leeward walls, respectively. Accordingly, Ri_v is used to indicate atmospheric stability due to the temperature difference in a vertical direction and incorporates the effect of ground and roof heating in the building canyon, while Ri_h conveys information regarding the directionality of thermal forcing by comparing the ratio between thermal forcing and inertial forcing in the canyon as well as incorporating the effect of canyon aspect ratio H/W.

Linking urban microclimate with design factors and local climate – In order to draw conclusions from the microclimate analysis that can be further used for alternative urban planning strategies, it is important to quantify the modification of prescribed Richardson numbers due to such design and climate factors as wind speed, surface material properties and urban built-up density. Both Richardson numbers depend on the free-stream conditions above the building canopy, such as air temperature, and wind speed and direction. Additionally, design factors alter the flow characterization in the street canyon. For instance, surface temperatures depend on the material properties of surfaces (such as wall and ground albedo, α_w and α_g), and the horizontal Richardson number varies with canyon aspect ratio (H/W). Accordingly, this study quantifies the effect of various parameters on the prescribed characterization method, and thereby qualitatively links urban microclimate with design and local climate factors.

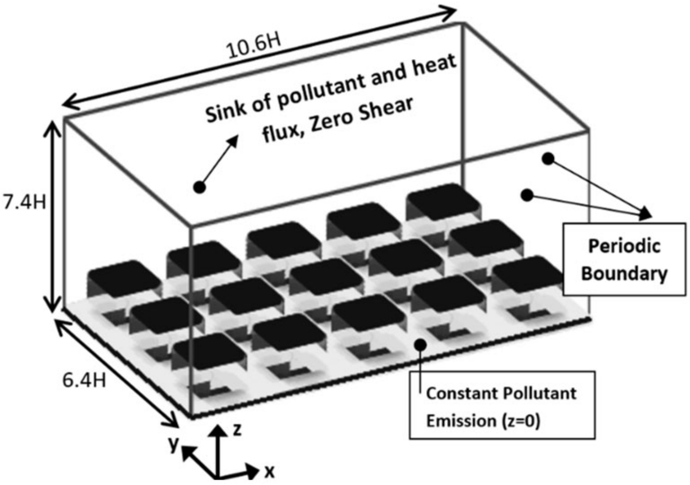

Figure 3. Schematic of the computational domain and boundary conditions for LES analysis (Nazarian, 2016b).

Comprehensive evaluation of urban microclimate

The following sections describe examples of results obtained for a comprehensive evaluation of urban microclimate. The effects of realistic thermal forcing on the spatial variability of flow, dispersion and thermal fields in the three-dimensional street canyon configuration are discussed, followed by a focus on the practical relevance of these findings on analyzing the effects of design on city breathability and comfort.

Urban flow under realistic surface heating – Figure 4 shows contour plots of mean velocity magnitude superimposed by velocity vectors, followed by plots of dimensionless temperature and pollutant concentration. The results are reported for different Richardson numbers due to the variation of surface heating (corresponding

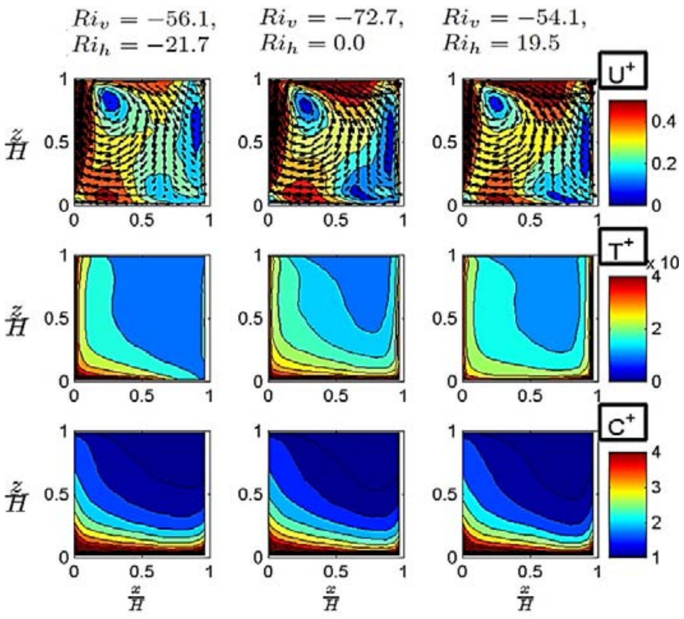

Figure 4. Contour plots of flow properties at different flow conditions in the vertical plane (x- z) in the center of the building canyon for U_b=0.5 m s^{-1}.

to assisting, opposing, and no-horizontal-heating conditions). It can be seen that the modification of flow and thermal fields by horizontal heating in the spanwise canyon is pronounced, and the thermal field is strongly correlated with the sign of Ri_h. For the dispersion field, however, the vertical temperature gradient and overall heating of urban surfaces dominate the distribution and the eventual removal of the pollutant from the building canyon.

Air quality and thermal comfort in urban canyon – We aim to translate the results obtained from urban flow simulations into metrics of "city breathability" and "thermal comfort" as a function of Ri_h and Ri_v. For quantifying city breathability, we examine the pollutant concentration at pedestrian level (z=1.5-2 m), as well as the Air Exchange Rate from the horizontal and vertical ventilating faces of the canyon (Nazarian, 2016b). For example, Figure 5 shows how pollutant concentration varies with Richardson numbers. We observe that the vertical atmospheric instability (indicated by Ri_v) has the most notable correlations with the concentration in the building canyons. However, when the ratio of Ri_h and Ri_v is high (for instance in morning hours and lower instability conditions), the sign and magnitude of Ri_h influence the concentration in the canyon.

Similar to city breathability, we can evaluate a metric of thermal comfort (SET) against Richardson numbers. Similar results to Figure 5 can be obtained for SET; however, since Ri_h and Ri_v are changing dynamically throughout the day and do not occur independently of each other, it is more informative to show the scattered map of SET and pollutant concentration as a function of both Richardson numbers (Figure 6). It is interesting to note that unlike the concentration map that is mostly dependent on Ri_v in the street canyon, the thermal comfort is mostly affected by the time of the day, and shading distribution inside the canyon, best indicated by Ri_h.

Conclusions

The current study describes the framework of comprehensive urban microclimate analysis. Detailed simulations of flow field and energy balance in an idealized urban environment are performed, which can be used to extract qualitative and quantitative information to be provided to designers and urban planners, and thereby remove the need for detailed modeling. The study also aims to extend the analysis of thermal comfort from solely evaluating the air temperature or flow field, and use comprehensive metrics of thermal comfort, such as SET. Spatial and temporal variability of microclimate parameters and detailed Mean Radiant Temperature at all pedestrian positions is considered. The correlation between SET and pollutant concentration with previously defined buoyancy parameters, Ri_h and Ri_v, is then inves-

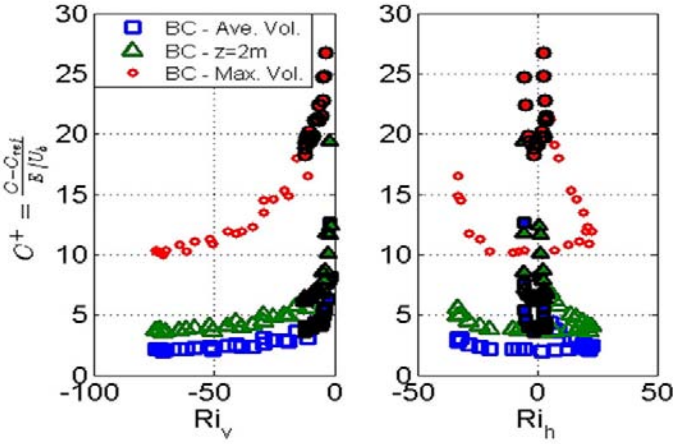

Figure 5. Variation of dimensionless concentration with Richardson numbers in the volume between the buildings in the spanwise canyon (BC).

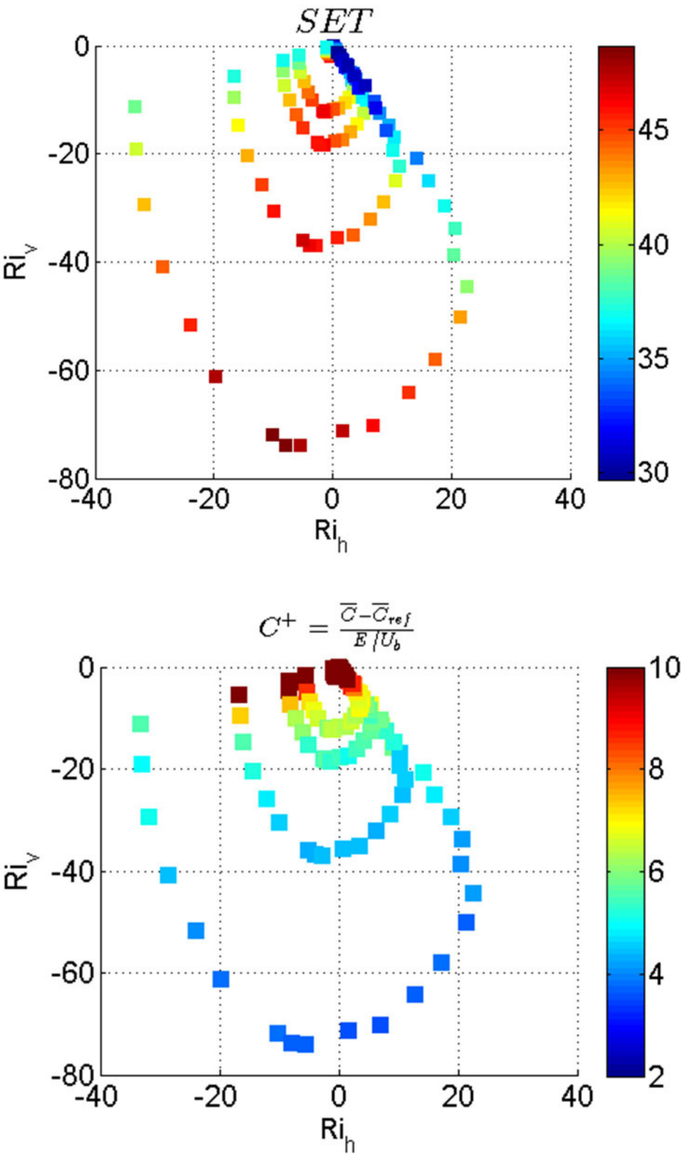

Figure 6. Maps of normalized SET (top) and concentration (bottom) with horizontal and vertical Richardson numbers.

tigated. Since the defined buoyancy parameters Ri_h and Ri_v depend on ambient conditions (ambient air temperature, wind speed, and wind direction) as well as material properties (such as surface albedo), quantifying the change in breathability and thermal comfort in street canyons based on these parameters aims to improve our understanding of the effect of design on urban microclimate. Ultimately the goal is to inform urban designers and architects of the impact of the environmental effects of their design on comfort and breathability, without the explicit need for detailed numerical modelling.

Acknowledgment

We thank Professor Omduth Coceal from University of Reading for providing the DNS data used to validate the LES simulations. Funding was received from the National Science Foundation, Environmental Sustainability CAREER award number CBET-0847054, as well as from the National Research Foundation Singapore under its Campus for Research Excellence and Technological Enterprise programme.

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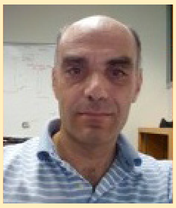

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Sustainability in Energy and Buildings

SEB-16 brings together researchers and practitioners in the city of Turin, Italy

Following the success of earlier events in the SEB series, the **Eighth International Conference on Sustainability in Energy and Buildings (SEB-16)** took place in the vibrant city of Turin, Italy on September 11-13, 2016. The gathering was organized by the Politecnico di Torino in partnership with KES International.

SEB-16 brought together participants and presentations from a broad range of sustainability and energy related fields, all relevant to the main theme of Sustainability in Energy and Buildings – and with a prominent focus on urban-scale issues. The areas of interest included the sustainable design and of buildings, neighbourhoods and cities (built and natural environment); optimization and modelling techniques; smart energy systems for smart cities; green information communications technology; and a broad range of solar, wind, wave and other renewable energy topics.

The aim of the conference was to provide a forum for researchers, together with government and industry professionals, to discuss the future of energy in buildings and cities from both a theoretical and practical perspective. As such, discussion was devoted not only to the simulation of energy performance but to the implementation of real world solutions. The conference was thus an exciting chance to present, interact, and learn about the latest research in Sustainability in Energy and Buildings. In addition to presentations of full and short papers in general tracks and invited tracks, the conference also included expert keynote talks, doctoral student poster sessions and workshops.

The keynote speakers addressed a number of thought-provoking questions related to the future of energy consumption in cities, and the many climate-related implications. Dr. **Giovanni Federigo De Santi** of the European Commission's Joint Research Centre presented his insights for a sustainable energy transition from a behavioral perspective. He stressed that meeting the EU's climate objectives for 2030 and beyond will require a major transformation in urban energy networks, using smart grid technologies to integrate "prosumers" – i.e. consumers who are taking control of their energy consumption and self-production. According to Dr. De Santi, shedding light on the way that people actually make choices is already contributing to successful energy and climate policy at the European level. In another keynote address, American architect **John Boecker** spoke of Integrative Thinking and Regeneration as a means for increasing socio-ecological vitality. In Boecker's view, Regenerative Development and Design is an integrative process that goes beyond building, engaging stakeholders to serve as co-designers and active participants in the evolutionary transformation of their unique community.

Dr. **Dirk Pietruschka** of the Institute for Applied Research (IAF) and Centre for Sustainable Energy Technology (zafh.net) in Germany gave a keynote on the use of 3D city modeling for predictive decision making and control of decentralized urban energy systems and their intelligent interaction with smart grids. Due to the increased share of locally-generated renewable energy in cities, there is a significant change in focus from centralized to decentralized supply structures – and as emphasized by Dr. Pietruschka, the strongly fluctuating nature of these energy sources requires intelligent control systems to stablilize the energy distribution networks. In turn, energy modelling combined with weather forecast data are required well in advance for intelligent load and storage management – and 3D city models can play a key role.

A number of prizes were awarded for outstanding work presented at the conference.

The SEB16 Prize Committee awarded the Best Research Paper award to:

"Energy analysis of a transcritical CO2 supermarket refrigeration system with heat recovery" by Alessio Polzot, Paola D'Agaro, Giovanni Cortella.

The Best Poster in the Doctoral Track Session Award was judged to be:

"Characterization and assessment of a hybrid cooling system integrated in buildings" by Amaia Zuazua Ros.

The Best Invited Session prize went to "Smart strategies for existing and historic building retrofitting," organised by Dr Elisa Di Giuseppe.

The Georgios Kazas Award went to:

"The use of multi-detail building archetypes in urban energy modelling" by Claudia Sousa Monteiro, André Pina, Carlos Cerezo, Christoph Reinhart, and Paulo Ferrão.

More details on SEB-16 can be found at the conference web site (http://seb-16.sustainedenergy.org/).

SEB-16 brought together participants and presentations from a broad range of sustainability and energy related fields, all relevant to the main theme of Sustainability in Energy and Buildings – and with a prominent focus on urban-scale issues.

Recent Urban Climate Publications

In this edition a list is presented of publications that have generally come out between **June and August 2016**. As usual, papers published since this date are welcome for inclusion in the next newsletter and IAUC online database. Please send your references to the email address below with a header "IAUC publications" and the following format: Author, Title, Journal, Year, Volume, Issue, Pages, Dates, Keywords, URL, and Abstract. In order to make the lives of the Bibliography Committee members easier, please send the references **in a .bib format**.

Please note that we are still supporting (young) researchers to join and contribute to the Committee. If you are interested to join or would like to receive more information, please let me know via the email address below.

Regards,

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WUDAPT Workshop: Various Applications of WUDAPT Products

Chinese University of Hong Kong
5-6 December 2016

The World Urban Database and Access Port Tools (WUDAPT) initiative (http://www.wudapt.org) is a community-driven data collection initiative that draws upon the considerable network of urban climate scientists around the world.

Various applications of WUDAPT products will be discussed and shared in this workshop. The invited speakers will show how the WUDAPT products can be implemented in climate modeling simulations benefitting climate-sensitive urban design and planning.

The workshop goal is to use WUDAPT methods to provide a map of the urban landscapes of each city and assess their climate effects. This will serve as a useful reference and basis to local government and researchers for future urban development.

Papers and posters are invited on WUDAPT applications, result validation methods, urban morphology detection and the global carbon project. Registration is open until 30 September.

Please click here for more workshop details, programme and registration.

Enquiries: Miss Sze-Wai Wong (szewai@cuhk.edu.hk)

Upcoming Conferences...

WUDAPT WORKSHOP: VARIOUS APPLICATIONS OF WUDAPT PRODUCTS
CUHK, Hong Kong • December 5-6, 2016
http://www.wudapt.org

13TH SYMPOSIUM ON THE URBAN ENVIRONMENT AT THE AMS 97TH ANNUAL MEETING
Seattle, WA USA • January 22–26, 2017
https://annual.ametsoc.org/2017/index.cfm/programs/conferences-and-symposia/13th-symposium-on-the-urban-environment/

JOINT URBAN REMOTE SENSING EVENT (JURSE 2017)
Dubai, UAE • March 5-7, 2017
http://jurse2017.com/

GREEN INFRASTRUCTURE: NATURE BASED SOLUTIONS FOR SUSTAINABLE & RESILIENT CITIES
Orvieto, Italy • April 4-7, 2017
http://www.greeninurbs.com/finalconference/

Calls for Papers: AAG 2017

Boston, MA, USA • 5-9 April 2017

Session Title: Sustainable approaches to urban weather and climate

Sponsored by Climate Specialty Group

Organizers:

Mr. Austin Bush (Auburn University - atb0020@tigermail.auburn.edu)

Dr. Winston Chow (National University of Singapore – winstonchow@nus.edu.sg)

Session Description:

By the middle of this century, an additional 2.5 billion people will live in cities; this rapid development will result in tremendous multi-scale changes to the urban system along different environmental aspects, including direct modifications to near-surface weather and climates (e.g. increased thermal warmth from the heat island, and reduced air quality from air pollution), and heightened exposure of its residents towards regional and global climate hazards.

As such, geographical research examining the science and social sciences of urban climate will have greater relevance for urban stakeholders, in particular research addressing long-term resilient and/or sustainable solutions. Post-COP21 and the Paris Climate Agreement, there is renewed importance for stakeholders to include climate sustainability into their planning schemes, and to work in close coordination with local governments, businesses and organizations. There is now greater cognizance of the significant role of cities as laboratories to test and implement solutions at efficient scales, thus translating collective knowledge into action.

Thus, research directly addressing topics of sustainable urban weather and climates would be important for academic discussion. The main objective of this session is to highlight recent geographical investigations into sustainability in urban weather and climates; in particular, papers addressing issues of sustainability and resilience in urban weather and climate are welcome.

Papers may address, but need not be limited to, the following themes:

- Evaluation of urban resilience towards climate-related hazards, such as analyses of urban vulnerability towards climate change, and subsequent responses towards adaptation and mitigation of these hazards;

- Comparative case studies into urban climate phenomena, such as the urban heat island (UHI), urban precipitation or air pollution across a spectrum of geographical scales;

- Communication and incorporation of geographical research into planning, policy-making and urban stakeholder undertakings.

Please register and submit your abstract through the AAG Annual Meeting Abstract Submission Console (http://www.aag.org/cs/annualmeeting/call_for_papers). Please send your AAG program identification number (PIN) by October 27th 2016 to the organizers thereafter to enable us to include your paper in this session.

Calls for Papers: AAG 2017

Boston, MA, USA • 5-9 April 2017

Special Session on urban climatology in Asia

Sponsored by Climate Specialty Group, Asian Geography Specialty Group, and Regional Development and Planning Specialty Group

Organizers:

Dr. Winston Chow (National University of Singapore – winstonchow@nus.edu.sg)

Dr. Chandana Mitra (Auburn University – chandana@auburn.edu)

Session Description:

An important aspect of this "Asian Century" is the rapid urbanisation currently taking place throughout the continent; for instance, the United Nations projected that ten out of the largest 15 (including the top seven) urban agglomerations on the planet will be located in Asia by 2030. The development of these megacities, and all urban areas of different spatial extents, leads to inadvertent modifications towards weather and climate across multiple geographical scales. These alterations include the urban heat island (i.e. increased urban warmth relative to the city's surroundings), and air pollution due to emissions arising from anthropogenic activities. Academic research – mainly through the field of urban climatology – into the physical mechanisms, biophysical impacts of, and suggested adaptation towards these phenomena is relatively well-developed; however, there is still a predominant bias of such studies either being based at or originating from, North American or European cities. A concern about this spatial disparity in studies is that such research findings may not be as successfully applied in Asian cities, where there may be substantial differences in climate, demographic and socio-economic contexts.

With this geographical disparity in mind, the primary objective of this session is to highlight current urban weather and climate research taking place in Asia. We aim to provide a forum for geoscientists to share their scientific and social scientific knowledge, exchange ideas for policies towards urban resilience arising from applications of research, and ultimately develop a network of individuals or groups focusing on Asian urban climates for potential future collaborations.

We welcome papers that address (but need not be limited to) the following themes:

- As one of the featured themes of AAG2017, current assessment or novel developments in methodological techniques within urban meteorology and climatology dealing with research uncertainties for spatio-temporal contexts;

- Case studies into urban climate phenomena that apply observational, remote sensing, or modelling methodologies across a spectrum of geographical scales;

- Communication and incorporation of geographical research into planning, policy-making and urban stakeholder undertakings in Asian cities.

Interested participants should register and submit your abstract (max 250 words) through the AAG Annual Meeting Abstract Submission Console (http://www.aag.org/cs/annualmeeting/call_for_papers). Please send your AAG program identification number (PIN) by October 27th 2016 to the organizers thereafter to enable us to include your paper in this session.

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Finally, in IAUC business we will be conducting an election for two IAUC Board Members very shortly. This number has increased by one due to the recent resignation of Board member Curtis Wood of the Finnish Meteorological Society, which opens an additional spot on the Board.

Five nominations have been received; see below for details of the candidates and their statements. This information will also be provided online along with the electronic ballot once voting begins.

IAUC Board Election 2016 - Candidate nomination statements

R Leena JARVI

Department of Physics
University of Helsinki
FINLAND

Statement:

I have been working with urban climate since 2006 when I started my doctoral studies in meteorology at the University of Helsinki. I finished my PhD in 2009 on the topic of urban eddy covariance and air quality measurements and analysis in Helsinki. After finishing my studies, I worked as a research associate in King's College London, UK, extending my previous expertise with measurements to urban land surface modeling. Currently I work as a university researcher at the Division of Atmospheric Sciences of University of Helsinki where I lead the urban meteorology group focusing to examine the urban climate using both experimental and theoretical methods. I'm also the principal investigator of the urban eddy covariance measurements station located in Helsinki, which is also a supporting ecosystem station in ICOS (Integrated Carbon Observation System).

I am especially interested on how different urban land covers and emission sources affect the urban climate. In my work I have mainly been focusing on urban eddy covariance measurements of heat, water, greenhouse gases and aerosol particles and the usability of the measurement technique in urban environments. I've also contributed to development of the Surface Urban Energy and Water balance Scheme SUEWS. In IAUC, I would particularly like to promote the collaboration between air quality and urban climate groups as well as urban climate community connections to global level research infrastructures.

Joe MCFADDEN

University of California
Santa Barbara, CA
USA

Statement:

I am volunteering to serve on the Board because the IAUC has been enormously helpful to my career and to my students, and I'd like to contribute in return. IAUC is an amazingly effective and efficient scientific organization, focusing on the most important things to enable research progress, and making them happen with a minimum of resources. It has directly improved my projects and fostered lasting collaborations and friendships. The first thing I recommend to a new student is to join IAUC, and the newsletter (and bibliography!) is required reading in my group. I am active in the urban climate community, serving as chair of the Urban Areas and Global Change sessions at AGU, on the Urban Ecosystems editorial board of Frontiers in Ecology and Evolution, and our group presented results from both Minneapolis and Los Angeles at ICUC-9. I received my Ph.D. from U.C. Berkeley on micrometeorological flux measurements over vegetation, and did my postdoc at Colorado State University on land surface and mesoscale modeling of landcover change. In 2004, soon after starting as a faculty member, I began to focus on urban areas beginning with the KUOM tall tower flux site that I established in Minneapolis-Saint Paul. More recently, I served as Vice Chair of Geography, and then as Visiting Professor at ETH Zürich while on sabbatical. I currently have field and remote sensing projects in the Los Angeles conurbation, in mid-sized coastal urban areas, and recently in European cities via collaborations.

Shiguang MIAO
China Meteorological
Administration (CMA)
Beijing, CHINA

Statement:

I am Senior Scientist and Acting Director of the Institute of Urban Meteorology (IUM), China Meteorological Administration, in Beijing, which is dedicated to urban research and operational weather forecast for Beijing. I received my Ph. D in Atmospheric Sciences at Nanjing University in 2003. I am Chair of the Committee for Urban Meteorology of the Chinese Meteorological Society, and member of the Board on the Urban Environment of the American Meteorological Society. My research interests include observational analysis and numerical modeling of urban land and boundary layer, and urbanization impacts on severe weather. I have supervised numerous graduate students, and am Adjunct Professor in Applied Meteorology at the Nanjing University of Information Science and Technology. I have contributed to and led international urban research projects.

China has experienced unprecedented, rapid urbanization, which is connected to weather disasters, climate change, and air quality problems. In the last two years, I worked with international groups to organize the Study of Urban-impacts on Rainfall and Fog/haze (SURF) field programs in Beijing. In a broader context, urban weather and climate research in China has significantly advanced, and the efforts in improving real-time urban weather forecasting at IUM is at the forefront of these important activities.

I participated in the last five ICUC conferences, and thoroughly enjoyed working with the IAUC community. I am interested in fostering cross-disciplinary collaborations between the Chinese urban research community and the IAUC community. It would be a great honor to further contribute to IAUC as a Board member.

Ariane MIDDEL
Arizona State University
Tempe AZ
USA

Statement:

Trained as engineer/computer scientist in Germany, my first contact with urban climate research dates back to 2009 when I started a Postdoctoral Scholarship at Arizona State University to investigate the impact of urbanization on outdoor water use through climate modeling. This initial contact shaped my academic career significantly. I moved away from geovisualization and focused on understanding urban climate dynamics to develop climate adaptation and heat mitigation strategies, addressing the challenges of sustainable urban form, design, and landscapes in the face of climatic uncertainty. My research is at the local and microscale – the scales that are most relevant for urban planning and design – and combines field work and modeling. Most recently, I investigating the impact of shade on thermal comfort.

After joining IAUC in 2011, I attended ICUC-8 in Dublin and ICUC-9 in Toulouse. ICUC has become my KEY conference – a venue where I meet new and existing collaborators from around the globe; find inspiration for future research; am amongst friends; and have a hard time organizing my conference schedule, because every presentation sounds interesting! I truly feel at home in the IAUC community and am thankful for how the community embraces interdisciplinary to create a vibrant, collaborative environment. I would like to play a more active role in this community that coined my research through joining the IAUC Board, attracting researchers from related disciplines who add new perspectives and enrich our understanding of urban climate issues. I am looking forward to meeting you all at ICUC-10 in New York!

Gert-Jan STEENEVELD
Wageningen University
THE NETHERLANDS

Statement:

In 2007, I obtained my PhD on the "Understanding and Prediction of Stable boundary Layers over land". Since then, urban climate emerged as one of my new research interests since the 2006 European heat wave made The Netherlands aware that the urban microclimate seriously affects citizens and urban infrastructure. My research contributions contains e.g. numerical modelling using the WRF mesoscale model, amongst others in the PILPS-URBAN model comparison study. In addition, urban temperature observations by high-resolution networks as well as by crowdsourcing of weather amateur data and smartphone battery data was explored. Currently my research team works on understanding the "the windy city". Moreover, I serve in the Dutch and European Meteorological Societies.

As a newbe at the ICUC-7 in Dublin, I learnt about the essence of IAUC, the constructive attitude of the community, and the myriad of aspects covered by IAUC. I find it important that meteorological research has impact on neighbouring disciplines, as geography, urban design, and on society. Hence, much of my research and teaching are in cooperation with colleagues in urban design, hydrology, geo-information, and citizens! Thus it's a pleasure to co-host the eWUDAPT workshop in 2017. In my view, IAUC has a key position to catalyse joint research efforts from available strong disciplinary knowledge. As an IAUC board member, I will make effort to advance the IAUC, the research and (not to forget) education in urban climate, and to bring communities. I look forward to a constructive and inspiring collaboration.

IAUC Board Members & Terms

- Gerald Mills (UCD, Dublin, Ireland): 2007-2011; President, 2009-2013; Past President, 2014-2018 (nv)
- James Voogt (University of Western Ontario, Canada), 2000-2006; Webmaster 2007-2013; President, 2014-2018
- Andreas Christen (University of British Columbia, Canada): 2012-2016
- Rohinton Emmanuel (Glasgow Caledonian University, UK): 2006-2010; Secretary, 2009-2013; Past Secretary 2014-2018 (nv)
- David Pearlmutter (Ben-Gurion University of the Negev, Israel): Newsletter Editor, 2009-*
- Aude Lemonsu (CNRS, France): 2010-2014; ICUC-9 Local Organizer, 2013-2018 (nv)
- David Sailor (Arizona State University, USA): 2011-2015; Secretary, 2014-2018
- Alexander Baklanov (University of Copenhagen): 2013-2017
- Curtis Wood (Finnish Meteorological Inst., Finland): 2013-2017
- Valéry Masson (Météo France, France): ICUC-9 Local Organizer, 2013-2018 (nv)
- Fei Chen (NCAR, USA): 2014-2018
- Edward Ng (Chinese University of Hong Kong, Hong Kong): 2014-2018
- Nigel Tapper (Monash University, Australia): 2014-2018
- Aya Hagishima (Kyushu University, Japan): 2015-2019
- Jorge Gonzales (CUNY, USA): ICUC-10 Local Organizer, 2016-2021
- Dev Niyogi (Purdue University, USA): ICUC-10 Local Organizer, 2016-2021

* *appointed members*
nv = non-voting

IAUC Committee Chairs

Editor, IAUC Newsletter: David Pearlmutter
Bibliography Committee: Matthias Demuzere
Chair Teaching Resources: Gerald Mills
Chair Awards Committee: Nigel Tapper
Webmaster: James Voogt

Newsletter Contributions

The next edition of ***Urban Climate News*** will appear in late December. Contributions for the upcoming issue are welcome, and should be submitted by November 30, 2016.

Editor: David Pearlmutter (davidp@bgu.ac.il)
News: Paul Alexander (paul.alexander@nuim.ie)
Conferences: Jamie Voogt (javoogt@uwo.ca)
Bibliography: Matthias Demuzere (matthias.demuzere@ees.kuleuven.be)

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.