Urban Climate News

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From the IAUC President

Colleagues – Welcome to the 57th edition of the *Urban Climate News*.

The recent ICUC-9/SUE-12 in Toulouse was an outstanding success – thanks to all who attended and contributed to a stimulating conference. I wish to particularly acknowledge the efforts of **Valéry Masson** and **Aude Lemonsu** and their local organizing team for making the conference such a great experience for the attendees. Thanks also to the joint scientific committee of IAUC and AMS BUE board members and to the evaluators of the student presentations. Many of the student presentations were outstanding. Details of the conference and our student award winners are provided in this edition of the newsletter. A unique element to the conference banquet was the presence of four caricature portrait artists – a sample of their work replaces my picture with this article.

As announced in Toulouse, the 2015 winner of the Luke Howard Award is Professor Emeritus **Anthony Brazel** of Arizona State University. Congratulations Tony! Members can read the full award citation in this edition of the newsletter. I would like to acknowledge **Jason Ching** (Chair of the Awards Committee) and the Committee members for all their work this year in support of the Luke Howard Award process.

This edition of the newsletter also marks the last for **Winston Chow** (National University of Singapore) as our "In the News" editor after seven years of service. A big thank you to Winston for his excellent work at finding so many intriguing articles over the years to share with the community. Winston will be replaced by **Paul Alexander** of the Irish Climate Analysis and Research Units; welcome Paul and thank you for agreeing to contribute to the *Urban Climate News*.

I would also like to take the opportunity to thank **Dale Cunningham**, University of Reading, for his service as webmaster over the past several years. We wish Dale well as he moves on to IT support at the ECMWF. **Sheila Bryant** from University of Reading will replace Dale.

Inside the Fall issue...

As I write this column we are expecting final submissions for proposals to host ICUC-10. Candidate cities include Hong Kong, New York, Phoenix and Singapore. The IAUC Board will be reviewing the proposals soon and subsequently the membership will be surveyed for their preferences on the location of the next ICUC. This survey will use the membership list from www.urban-climate.org so please ensure you are registered so you can participate.

– James Voogt,
IAUC President

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⊕ See full-size image

U.S. and Chinese cities leading the way to a global climate deal

September 2015 — We live in an increasingly Pacific Rim-focused world and an undeniably urban age. The United States and China are not only the two leading world powers in economic and political terms, they are the biggest carbon emitters on the planet.

Last week, we saw two major events underscore this reality, and our urgent need for cooperative action — President Xi Jinping made history by announcing China's upcoming cap-and-trade program and Pope Francis focused the attention of the world on climate change at the United Nations. In the buildup to those two events something else happened here in Los Angeles — we hosted the first-ever U.S.-China Climate Leaders Summit.

The two-day gathering was about not just climate talks, but climate action. We brought together mayors from across the United States and China — along with governors, provincial leaders and national government officials — to make firm, ambitious commitments to hit emissions targets. These agreements not only meet the goals laid out in the historic U.S.-China Joint Announcement on Climate Change — they surpass them.

These accomplishments demonstrate the importance of relationships between nations and municipalities in the fight against climate change, and underscore how they must take complementary actions to tackle this critical threat to our planet. Simply put, it is vital for nations across the world to lead and set broad goals, with global leaders using their bully pulpits to set bold targets and take unprecedented action on an international scale.

This is especially important in the lead-up to the U.N. Climate Summit in Paris, where we will have an opportunity to again make history. But once the ink is dry, and the international agreements have been signed, the work turns to cities and states. It is there that promises turn into tangible, specific progress.

For the first time in human history, cities house more than 50 percent of the world's population. We create 80 percent of global gross domestic product and are responsible for 70 percent of all greenhouse gas emissions.

While some may be daunted by the scale of these challenges, I think they actually furnish a unique opportunity to effect meaningful change. As mayors, it is our mandate to create more livable cities, but it is our calling to build a more livable world.

After all, municipalities and localities pull the levers of transportation, energy, land use and development — all of which can be used as tools to promote sustainability. That means we can chart a clear course toward greener public transit, less reliance on coal and greater energy conservation. Then, we can actually deliver on it.

The United States and China represent over 40 percent of global greenhouse gas emissions, which means the

AP Photo. ***Source:*** **politico.com**

cities in our two countries are ground zero in the fight against climate change. And if we're successful, we will be able to improve quality of life for nearly half the world's population.

We take that responsibility seriously — which is why, on the summit's opening day, leaders on both sides of the Pacific signed the U.S.-China Climate Leaders Declaration. That agreement reaches toward a more sustainable future, through verifiable actions and expanded bilateral cooperation.

In China, cities are answering their national call to action through the Alliance of Peaking Pioneer Cities (APPC). This landmark coalition of 11 Chinese localities has agreed to peak emissions ahead of China's national goal year of 2030, with some — including Beijing and Guangzhou — committing as early as 2020. At 25 percent of China's urban total, the APPC represents 1.2 gigatons of annual carbon dioxide emissions — roughly equal to the total yearly emissions of Brazil or Japan. This is a monumental step forward.

In the United States, mayors are coming together in similar fashion — setting targets ahead of our national goals and identifying steps to get there.

It's happening in Los Angeles, America's gateway to China and the Pacific Rim. There was a time when my city's smog-choked skies exemplified America's clean air crisis. Now, in less than a generation, we have cut pollutants in our air by 66 percent despite growing our population by 1 million people.

And most recently, in April, we laid out one of the most ambitious sustainable city plans of any city in America. Through that effort, we have committed to reducing greenhouse gas emissions by 45 percent by 2025 and 80 percent by 2050. We're also working to achieve zero waste and cut water imports in half by 2025. This is exciting progress for a city that is already on its way to having the largest pure electric vehicle fleet in the nation and that will be off coal within 10 years.

This kind of progress on sustainability is happening across America. In Houston, a city recognized as the oil and gas capital of the world, Mayor Annise Parker has led an effort to become the largest municipal purchaser of renewable power in the nation. As she does, the mayor is also retrofitting the city's 165,000 streetlights to energy-efficient LEDs.

Mayor Greg Stanton successfully persuaded voters in Phoenix to approve 42 new miles of light rail and expanded bus access. And in Washington, D.C., Mayor Muriel Bowser has signed an agreement to get 35 percent of all government energy from wind power.

But to realize national goals, we need more than regional solutions alone.

Cities, states and provinces must come together in order to amplify their impact. That starts by translating best practices from one city to another. Thanks to the U.S.-China Climate Leaders Summit, that's going to happen increasingly, in a bilateral way — but it's equally important that we share what works at home.

That's why, along with Mayor Michael Nutter of Philadelphia and Mayor Parker of Houston, we have assembled 31 U.S. mayors — representing over 22 million people — to work together under the Mayors' National Climate Action Agenda. Through that agenda, most participating cities have set targets to reduce greenhouse gas emissions by 80 percent by 2050.

Through this U.S. mayor-to-mayor climate action agenda, cities are tackling some of our toughest problems together, reducing emissions collectively and sharing our successes along the way. A similar domestic initiative has launched in Canada, where Vancouver Mayor Gregor Robertson created the 21-member Canadian Big City Mayors Climate Change Action resolution.

Globally, C40 cities are working together on strategies to address climate change, and former New York Mayor Michael Bloomberg's Compact of Mayors has been signed by over 150 mayors worldwide — representing more than 230 million citizens. As a member of the C40 global steering committee, I know how important it is for mayors to show global leadership.

When Presidents Barack Obama and Xi came together to make their historic accord last year, it was a hinge of history: a moment in time when we could say that two nations stepped up not to point fingers, not ask questions, but to commit to world-changing directives. As national leaders, they have asked cities and states to take the torch and carry it forward — to build on their work, to be even more ambitious, and to specify our actions.

At the U.S.-China Climate Leaders Summit, we answered that call to action with bold commitments to significantly reduce greenhouse gas emissions worldwide. But our work is far from done, and when international leaders act at the U.N. Conference on Climate Change in Paris, cities will stand ready to turn those promises into progress.

— By Eric Garcetti , Mayor of Los Angeles

Source: http://www.politico.com/magazine/story/2015/09/how-cities-can-save-the-planet-213189

New global data suggests air pollution kills 10 million people per year

September 2015 — Recently, scientists have used global atmospheric chemistry obtained from satellite data to improve our understanding of the global spread of air pollutants. They looked at seven emission source categories in both urban and rural environments, and the result is a more realistic prediction of the health effects caused by very high concentrations of particulate pollutants.

The main contributors to air pollution are ozone and fine particulate matter—that is, particles with a diameter of less than 2.5μm, and we know air pollution can influence an individual's likelihood of developing a number of diseases. Several previous studies have explored this topic at the regional level. However, both air quality monitoring and particulate matter composition vary greatly among different countries, so building a more global perspective hasn't been easy.

It's difficult to know how pollution will affect an individual's health. Existing air quality guidelines, which range from national regulatory policies to those of the World Health Organization, are often based on exposure response functions that focus on the mass of the particles. But this measurement doesn't account for differences in toxicity based on chemical differences—evidence suggests that chemical composition of pollutants dramatically influences their toxicity. As a result, it was hard to estimate the overall effects on mortality rates.

The researchers behind the new work were particularly concerned with the enhanced toxicity of carbon-containing (carbonaceous) fine particulate matter. They tested versions of their model that assumed carbon-containing particles were five times more toxic than inorganic particles. All particles, regardless of their chemistry, were also assigned the health impacts we know are caused by fine particulate matter.

The authors estimate that the effects of particle pollutants killed 3.15 million individuals in 2010, with strokes (cerebrovascular disease) and heart attacks (ischemic heart disease) contributing most heavily. Analysis of ozone related mortality revealed a total estimate of 3.30 million people dying prematurely in 2010. An additional 3.54 million deaths per year are attributed to indoor air pollution caused by the use of solid fuels such as coal.

The scientists were also able to discern patterns that indicated areas of high air pollution globally. It's no surprise that air pollution hotspots were found in many large cities—especially those in India and China. In China, air pollution is among the top causes of death—it results in more deaths than road transport injuries or HIV/AIDS by roughly an order of magnitude. India is the main contributor of premature deaths related to air pollution (0.65 million/year) in Southeast Asia, the region with the second highest premature mortality rate. The high mortality numbers in Asia strongly influence the link between global mortality and air pollution.

Next, the scientists assessed the influence of seven source categories—residential and commercial energy use, agriculture, power generation, industry, biomass burning, land traffic, and natural sources. Their findings reveal that the presence of these different sources varies regionally.

Residential and commercial use of energy—referring to small sources used for heating and cooking, waste disposal, and diesel generators—are responsible for roughly one-third of premature deaths globally. In Asia, residential and commercial use of energy is the largest contributor.

But the numbers here are highly dependent on the assumed toxicity and the large uncertainty related to heart disease. If aerosols are assigned a toxicity level five times higher, this category increases from 31 percent to 59 percent of global air pollution mortality—an enormous leap. Additionally, if the calculations are performed assuming no contribution to heart disease, the fraction only declines slightly, from 31 percent to 26 percent.

Most of us wouldn't expect agriculture to be responsible for roughly one-fifth of the global premature deaths, and it's startling to think that growing the food we eat every day can actually harm the world. But agriculture is a leading pollution source contributing to mortality in Europe, Russia, Turkey, Korea, Japan, and the Eastern US, representing over 40 percent of the pollution-driven premature deaths in many European nations.

What exactly is it about growing plants that causes pollution? Agricultural pollution is often attributed to the release of ammonia from fertilizers and domesticated animals. Ammonia released into the atmosphere can undergo several chemical reactions that affect air quality.

Another often overlooked contributor is natural sources—often dust and dirt. Natural sources are actually a dominant contributor to mortality in northern Africa and the Middle East. It is also a leading source in Central China. When it is assumed that particles have a single toxicity value, natural sources are responsible for about one-sixth of air pollution mortality. If differential toxicity is assumed (one where fine carbonaceous particles are five times more toxic) natural sources account for only about one-tenth of air pollution induced mortality, which is more of what we might expect.

The third largest source category contributing to premature deaths is power generation by fossil fuel fired plants. These plants release toxic chemicals such as SO_2 and NO_X. Power plant emissions are an important contributing factor in the US, Russia, Korea, and Turkey.

The other categories contribute less than 10 percent

Agriculture makes a surprisingly large contribution to global pollution. *Source:* http://arstechnica.com/

globally to the mortality numbers. While industry (an often scrutinized source) only contributes seven percent to mortality worldwide, it contributes more heavily in the Western world, where the contribution is nearly twice the global average. In this study, industry included iron and steel, chemical, pulp and paper, food, solvent and other manufacturing sectors, oil refineries, and fuel production. When differential particulate toxicity is assumed, the contribution of industry to mortality reduces by more than a factor of two.

In the US, we hear a lot about the effects of automobiles on air pollution. However, globally, traffic is only responsible for about five percent of emissions. In certain countries, such as Germany, the UK, and the USA, it is responsible for roughly one-fifth of the mortality caused by ambient fine particulate matter and ozone. Still, there seems to be a skewed emphasis on the influence of this category given the overall fraction it represents globally.

Biomass burning also contributes about five percent globally. Yet it's the main source of air pollution in large parts of Canada, Siberia, Africa, South America, and Australia. In the Southern Hemisphere, biomass burning is often a leading contributor to fine particulate matter—in some countries, it contributes over 90 percent. As of now, its health impact is unclear.

The scientists also used a business-as-usual model to predict how pollution-driven premature mortality may develop in the future assuming currently agreed upon legislation. This modeling predicts a moderate but significant increase in premature mortality in Europe and the Americas, mostly concentrated in cities. In the Southeast Asia and Western Pacific regions, the modeling projects large increases of premature deaths, bringing the total to 6.6 million a year. The overall mortality attributed to air pollution will continue to be dominated by Asia, which will account for 75 percent of the global total.

By using differential toxicity, this study provides information that can help us reevaluate our understanding of air pollution. It can help us target high-impact sources if we hope to have the largest effect on premature mortality. *Source*: http://arstechnica.com/science/2015/09/new-global-data-suggest-air-pollution-kills-10-million-people-per-year/

The Science Of Why Cities Are Warmer Than Rural Areas

Marshall Shepherd explains the Urban Heat Island effect to readers of *Forbes* magazine

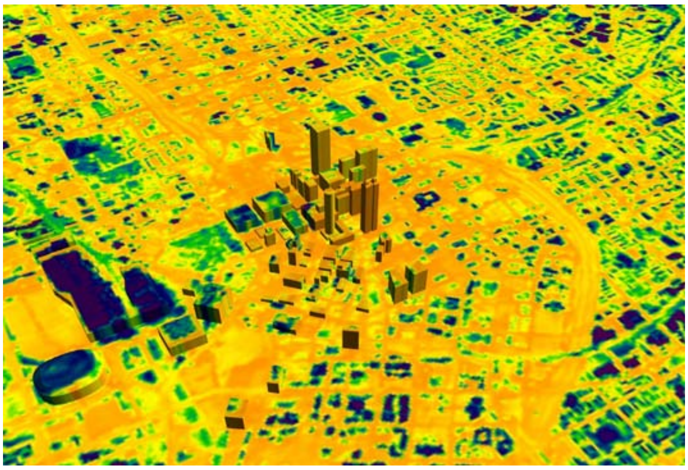
September 2015 — City regions can typically have air temperatures warmer than surrounding rural environments by anywhere from 1 to 15 degrees F. The difference is most noticeable in the evenings. During the daytime, skin or surface temperatures are even larger. This difference is known as the Urban Heat Island. There are different types of Heat Islands: Surface, Canopy or Air Temperature, and Boundary Layer (roughly lowest 1 km of the atmosphere). Herein, I will write generically about them as one entity. The Urban Heat Island or UHI was first noted by Luke Howard in 1820. According to Helmut Landsberg's classic textbook *The Urban Climate*, Howard speaking about London noted: *"…night is 2.1 degrees C warmer…in the city than in the country."*

Heat islands can lead to increases in heat related health issues and mortality, increased energy demand, higher air conditioning costs, and more air pollution and greenhouse gas emissions. So why do UHIs happen? There are several factors that cause the Urban Heat Island.

Heat-absorbing surfaces. If you think about the materials in a city (asphalt, tar roofs, concrete), they are primarily of low albedo and have heat storing capacity. Albedo is a measure of reflectivity of a material. Fresh snow has a very high albedo while dark asphalt has a low albedo. Lower albedo surfaces will absorb more solar energy than higher albedo surfaces. Therefore, roadways, rooftops, and buildings absorb heat throughout the day. These surfaces re-emit that absorbed energy at night, which maximizes the UHI during the hours after sunset. In cities with large buildings, the corridors between them are called urban canyons. Heat energy (longwave infrared) radiated from buildings can accumulate even more within these canyons. Highly reflective surfaces like "light" roadways and white roofing have been proposed as a way to reduce the urban heat island. Kanok Boriboonsomsin has referenced previous studies noting: *"…increasing the albedo of 1,250 sq km (483 sq mi) of roadways in Los Angeles by 0.25 would save cooling energy worth $15 million per year, and would reduce smog-related medical and lost-work expenses by $76 million per year."*

Lack of trees. Cities also tend to have less trees and vegetation within the central business district or city center. Less vegetation means less evapotranspiration. Like evaporation of perspiration from our skin, evapotranspiration is a cooling process. In a recent University of Georgia study, the top 50 UHIs in the United States were ranked. Louisville, Kentucky ranked #3. One reason is that the city has been slow to adopt a tree ordinance. This very attribute is why strategic greening such as greenscapes or green roofs are recommended UHI mitigation strategies.

Anthropogenic Waste Heat. Cities are notorious for a by-product of society called anthropogenic waste heat. This term is represented by the heat from industry, passing transit buses, cars, or heating-cooling systems. A review of the the difference between the theoretical energy balance of typical rural and urban energy balance model reveals an anthropogenic heat term that is not present in the rural scenario.



Atlanta thermal image at night showing the surface urban heat island. Courtesy of NASA. ***Source:*** **http://www. http://www.forbes.com**

The combination of heat-absorbing surfaces, lack of evapotranspirational cooling, and waste heat causes the Urban Heat Island.

Neil Debbage, a doctoral student at the University of Georgia, recently published a study with the writer examining whether large sprawling cities (e.g., Atlanta) or denser cities (e.g., New York) have more intense heat islands. Debbage says: *"We found that more contiguous sprawling and dense urban development both enhanced UHI intensities. In other words, it does not appear to be a simplistic either-or situation regarding sprawl or density"*

The study found that the contiguity or how the built infrastructure is connected—and disconnected by green spaces—has a great impact on heat island intensity. Ultimately, this work seeks to inform planners and stakeholders on how to strategically plan cities with heat island reduction in mind.

It is fascinating that even some cities, particularly those in arid regions like Las Vegas or Phoenix, can exhibit a cool island. These cities typically have extensive irrigation, which may help cool the city relative to the hot, sand surrounding landscape.

The impact of heat islands is not limited to temperature. UHIs may also impact air quality, wind flow, and the development of thunderstorms. Efforts like the National Science Foundation-funded Urban Climate Institute are seeking to bring together scientific expertise related to Urban Heat Islands and a host of relevant stakeholders that plan or manage cities. After all, most of us live or will live in cities. *Source*: http://www.forbes.com/sites/marshallshepherd/2015/09/25/the-science-of-why-cities-are-warmer-than-rural-areas/

The heat is on to ensure sustainable development in Asia's swelling cities

September 2015 — As countries make final preparations for this month's UN summit in New York to agree on the post-2015 development agenda, there is a growing need for policies that take an integrated approach to climate change and urban crises. Ground zero is Asia, where 60% of the world's population lives.

Asia's conurbations are transforming faster than ever, with their geographies and populations doubling in less than 10 years. As the continent consumes ever-greater natural resources and discharges more waste, cities are generally not able to keep air pollution levels within international health standards. There is now a greater incidence of illness and death among the elderly and vulnerable, including young children.

Furthermore, many Asian – and also African – cities are losing the vital contribution that green spaces make to public health, despite studies showing that parks and roadside trees are cost-effective measures against high temperatures, pollution and flooding. In Nigeria , Lagos has lost most of its central green areas, but in China, Beijing is now planting huge tree belts alongside major arteries.

As urban areas expand, data and computer models confirm how their environmental effects, including rainfall and air pollution, extend hundreds of kilometres further away. Moreover, with energy use by transport, housing and industry in urban areas responsible for more than half the global consumption of carbon-based fuels, large cities are driving greenhouse gas emissions and consequent rises in global average temperatures.

Asia's growing urban areas are increasingly affecting the climate and environment of the whole world, with serious consequences for the long-term well-being of populations everywhere. Within Asian cities near the equator, wind speeds are generally low, and they are steadily decreasing as urban areas expand, so that as global temperatures rise, they do so even faster in high-rise city developments, as studied in Hong Kong. However, climate change and urbanisation also increase the risk of very cold weather, as well as more extended periods of great heat.

Extraordinary phenomena are already being observed in inland urban areas in winter months. For instance, high concentrations of urban and rural aerosols are increasingly preventing the sun's rays reaching the ground, even causing small rivers to freeze in Delhi last year. This is affecting the economy as winter transport is sometimes severely disrupted – not only aircraft, but even trains and road traffic.

These urban crises are coinciding with natural disasters. Already, more than 90% of people affected by natural disasters – floods, cyclones, earthquakes, drought, storm surges and tsunamis – are in Asia. This is a particular problem in southeast Asia, especially the Philippines capital, Manila, which has a worsening atmospheric environment and suffers from heavy rain, mudslides, high winds and flooding in coastal areas and inland. These problems are magnified by the growing number of people living in vulnerable locations, for example next to streams, or on hillsides.

Future planning has to factor in trends showing how 100-year peak rainfall rates have doubled, while their frequency has also increased. In Malaysia, Kuala Lumpur has unique, dual-use vehicle tunnels, which are converted to huge drains when floods occur. With global warming making the atmosphere more humid, the severity and frequency of these floods is only likely to increase.

Technology is helping people to prepare for intense urban rainfall, with radar systems tracking clouds and forecasting hours in advance. Some communities are also evacuating flood-prone areas and moving populations to public refuge buildings, which are being repositioned using models of how floods build up in these areas.

Similar public sheltering facilities are being used during warm temperatures, or periods of high pollution. Although many lives have been saved, unless infrastructure is improved the impact of extreme hazards will keep growing.

Various relevant policies were discussed two months ago at a meeting of the Asian Network of Climate Science and Technology and the Beijing Association of Science and Technology.

Some far-sighted planning policies also aim to reduce the growth of large cities by creating separate new towns from between 50km and 100km away. China has just commenced its plan for integrated development of the Beijing-Tianjin-Hebei area (the so-called Jing-Jin-Ji region of 130 million people), and neighbouring areas will take over many administrative functions from Beijing.

These, and other planning policies, could reduce emissions and pollution in these satellite cities as commuting distances for car drivers are reduced. Limiting mega-city growth should also moderate the rise of peak urban temperatures.

The take-up of practical policies across Asia depends on high-level advocacy for integrated policies tackling urban crises and climate change. This needs to be combined with "bottom-up" advocacy for mitigating measures such as the preservation of green areas; greener construction with less concrete; and enhanced public transport.

Coordinating global and regional policies should be a major theme not only at the New York conference on development issues, but at the UN's landmark climate change summit in Paris in December. Specifically, the critical issues in cities have to be dealt with through regional collaboration so that effective energy and environmental measures are implemented in both urban areas and the surrounding regions.

Collaboration and joined-up thinking are critical to ensure that Asia is able to reduce carbon emissions, raise standards of global health and achieve economic sustainability. —Lord Julian Hunt and Yuguo Li. *Source:* https://www.planning.org/

Green infrastructure for cities: It's all about trees!

By Andrew Coutts (andrew.coutts@monash.edu)
Co-operative Research Centre (CRC) for Water Sensitive Cities
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Urban green infrastructure (UGI) is becoming increasingly recognized as a tool for improving the urban ecosystem and liveability of our cities. UGI can be defined as "the network of planned and unplanned green spaces, spanning both the public and private realms, and managed as an integrated system to provide a range of benefits" (Norton et al. 2015). It includes elements such as green open space, street trees, green roofs and green walls. UGI in cities delivers multiple benefits, and this article focuses on the modifications to the urban climate that can be delivered, with the consideration of scale, the critical role of trees, and the necessity of urban water management for supporting UGI. It discusses 'on the ground' implementation of UGI in terms of providing tools and guidance for decision makers. This article is also a project report on research undertaken at Monash University, Australia within the Co-operative Research Centre (CRC) for Water Sensitive Cities (www.watersensitivecities.org.au).

Context for the CRC for Water Sensitive Cities

In Australia, many cities (e.g. Melbourne, Adelaide, Perth) have faced periods of extended drought, so urban water management is an important policy area. Urban water managers are considering alternative water sources, including stormwater, to provide an additional source of water in urban environments. Current forms of urban design with high imperviousness generate large amounts of runoff, which is efficiently and rapidly removed from the landscape via drainage networks. This leaves the urban landscape water starved, and contributes to the development of warm and uncomfortable thermal environments.

These cities also often experience heat waves, such as the January 2009 heat wave where Melbourne, for example, experienced three consecutive days above 43°C. This pushed many in the population beyond their adaptive capacity, and led to 374 excess deaths, and increases in emergency responses. With anticipated increases in the intensity, duration and frequency of heat events, along with warm and dry urban landscapes and water scarcity, the strategy of stormwater harvesting and water sensitive urban design becomes an attractive option for addressing these issues. Our focus in the Co-operative Research Centre for Water Sensitive Cities (CRC for WSC) is to quantify the benefits of water sensitive urban design and green infrastructure on human thermal comfort and heat-health outcomes.

Thermal benefits of UGI: the importance of scale

Quantifying the benefits to the urban thermal environment from GI elements really depends on the scale of assessment. At the local (neighbourhood) scale, many eddy covariance studies have shown that an increase in vegetation cover leads to an increase in evapotranspiration and this pattern is seen both within cities (Offerle et al. 2006; Christen and Vogt, 2004) and between cities (Loridan and Grimmond, 2012). Urban climate modelling studies also demonstrate increases in evapotranspiration from increasing vegetation cover (Demuzere et al. 2014), and others show resulting reductions in local scale air temperatures in response to greater vegetation cover (Rosenzweig et al. 2006). This has implications for heat-health relationships where exceeding temperature thresholds can have severe implications for mortality and morbidity. This local-scale cooling is now being used by policy makers across the globe who are setting canopy cover targets in policy documents such as Urban Forest Strategies, where improving urban climate or mitigating the urban heat island are key policy objectives, among other policy objectives related to ecosystem ser-

Table 1. Various forms of urban green infrastructure and factors that influence their cooling benefits.

			
Green open space	**Street trees**	**Green roofs**	**Green walls**
• Park design • Tree coverage • Planting density • Species • Irrigation regime • Water bodies • Surrounding urban density • Surrounding urban geometry • Met. conditions • Time of day	• Tree size • Canopy coverage • Planting density • Species • LAI • Root water availability • Tree health • Location • Urban geometry • Met. conditions • Time of day	• Substrate depth • Substrate type • Vegetation species • LAI • Water retention • Vegetation health • Roof slope • Height of building • Building insulation • Urban geometry • Met. Conditions • Time of day	• Façade or wall • Direct or support • Species • LAI • Wall coverage • Water availability • Vegetation health • Wall aspect • Wall material • Urban geometry • Met. Conditions • Time of day

vices. However, while canopy cover targets are a key driver of UGI implementation, does it matter **where** UGI is placed? Does it matter **what** UGI is used? How does 'on the ground' implementation influence the urban **climatic outcomes**?

At the micro-scale where UGI implementation occurs, many observational and modelling studies demonstrate the benefits of UGI, especially trees. While these studies quantify the thermal benefits of various forms of UGI, results are highly variable, and depend on a myriad of factors as outlined in Table 1 above. Further, at the micro-scale, human thermal comfort becomes a key measure of thermal benefit (rather than heat-health relationships, which apply at the local- to meso-scale), of which mean radiant temperature is a key component during warm sunny conditions. Factors that influence thermal benefits range from the design of the particular UGI, the location of the UGI, the surrounding urban arrangement and the meteorological conditions.

Research in the CRC for WSC has shown that trees can both reduce air temperature and improve human thermal comfort during the day. Comparing a street canyon with trees to a street without trees in Melbourne, Australia, we found that the mean air temperature in the street with trees under warm sunny conditions was up to 1.5ºC cooler during the day (Coutts et al. 2015). While air temperature reductions were modest, the shading from street trees resulted in large reductions in mean radiant temperature, and could lead to a step change in heat stress level (e.g. very strong heat stress down to strong heat stress). At night however, the UTCI was slightly higher in the street with trees due to radiation trapping and reduced ventilation, while air temperatures at night were similar or even slightly higher.

This highlights the importance of scale in quantifying the thermal benefits of UGI. While increases in vegetation cover may lead to local-scale cooling and UHI mitigation, at the micro-scale and within the street canyon, the thermal experience can be quite different. While we understand the radiative and energetic processes in simple urban canyons (Figure 1, left), once trees are added, micro-scale processes become much more complicated (Figure 1, right). Within the canyon during the day, shading from trees modifies the in-canyon thermal experience, providing most of the cooling effect (Shashua-bar and Hoffman, 2000) while transpiration likely occurs at the top of the tree (Oke et al. 1989) and adds to local-scale evapotranspiration and, in combination with radiative effects reduces heat storage and sensible heating (Figure 1). Capturing these complex micro-scale interactions and representing them in local-scale urban land surface schemes or micro-scale climate models is crucial for informing UGI implementation decisions.

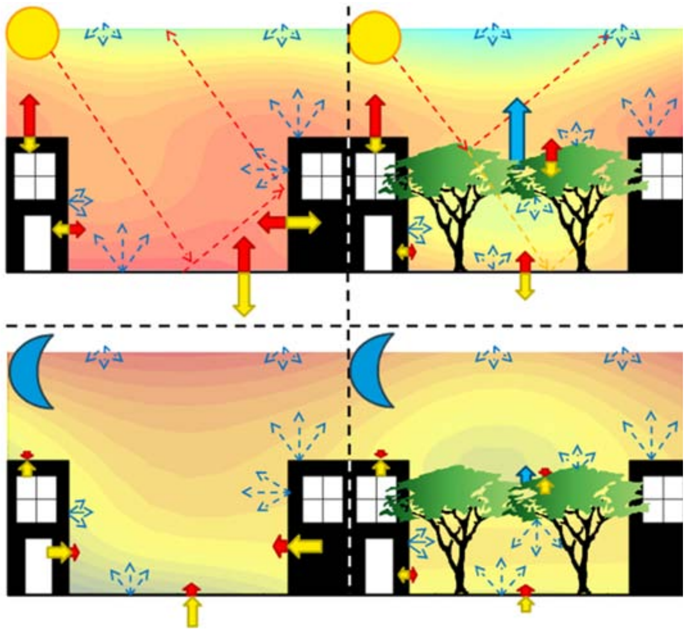


Figure 1. Radiative and energetic drivers of urban canyon micro-climate (air temperature) for a street without trees (left) and a street with trees (right) for both day and night.

It's all about trees

While there is diversity in the types of UGI that can be implemented in cities and each have their place, trees have a particularly strong role to play in creating attractive, sustainable and thermally comfortable urban environments. A key advantage of trees is their ability to provide shade, which is critical for micro-scale improvements in human thermal comfort by reducing mean radiant temperatures. Trees also have the ability to access deeper soil water sources. Further, a diversity of species allows tree selections that are 'fit for place'. Finally, people just 'get' trees. If you start talking to the community about green walls and green roofs, a large proportion of people may simply not understand their purpose or function. While some cities have set canopy cover targets, others are actively removing trees from the landscape. Given the multiple benefits of trees, if this tide cannot be stemmed, there is likely to be little appetite for the widespread implementation of green roofs and walls when trees are being removed.

Trees and the urban environment

While trees may be the critical piece of the GI options, there is still much we do not know about how trees interact with, and respond to, the unique urban environment. Urban trees are often exposed to higher urban temperatures (due to the urban heat island) and higher vapour pressure deficits (due to stormwater removal and high imperviousness) compared with rural environments. Trees (especially isolated trees) may also be exposed to intense radiative environments with reflected shortwave radiation and greater longwave radiation from roads, walls and other impervious surfaces. High heat loads need to be dissipated, but if soil water is limited, this my be difficult. On the other hand, some trees experience heavily modified photo-periods due to shading, have reduced competition, or even benefit from higher CO_2 concentrations: all of which influence tree growth rates. Just as urban micro-climates influence the experience of human thermal comfort over short distances, so too is the micro-climatic experience of trees.

How trees respond to this unique environment varies. Kjelgren and Clark (1992) compared trees, in a park, street and plaza in Seattle in 1986-87 and found that the plaza was warmer and drier than the park due to high imperviousness, and a lack of vegetation and water. The result was a greater evaporative demand on the plaza trees and in response, leaf stomatal conduction was reduced and stress was higher (more negative pre-dawn leaf water potential). In another study, however, Kjelgran & Montague (1998) compared isolated trees and grouped trees located

Figure 2. Trees are not equal. On the left, a tree in poor condition in Melbourne due to an extended drought, water restrictions, and periods of extreme heat, leading to canopy thinning and epicormic growth. On the right, a healthy tree tapping into an underground water pipe and transpiring hundreds of litres of water per day.

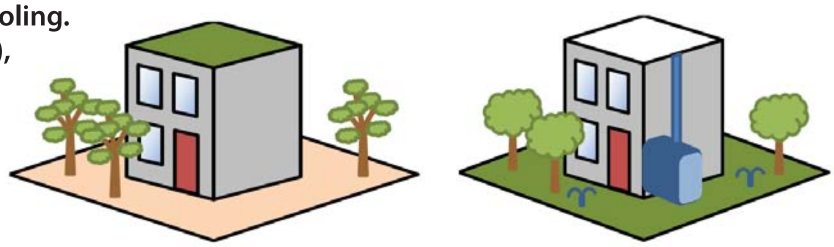
over asphalt and irrigated turf. Isolated trees and trees located over asphalt experienced greater evaporative demand, but some trees were able to meet this demand (maintaining high stomatal conductance) while others employed stomatal regulation to limit water loss. Therefore, how trees (and other UGI) respond to urban environments will influence their capacity to improve the urban climate.

In another study in the CRC for WSC, we used a Single Plant Ecosystem model to explore the effect of these micro-climatic drivers on tree water use of *Olea Europaea* (olive tree) and found greater water use when trees were exposed to urban conditions compared to rural conditions, while trees shaded by buildings had a reduced photo-period and therefore had less demand for water because photosynthesis was reduced. Such understandings can help inform urban water management to support tree health and avoid the loss of trees or canopy cover during dry periods and heat events (Figure 2: tree in poor condition). Clearly, trees that cannot meet evaporative demands due in part to limited water supplies will not provide optimum cooling benefits, especially when they are most needed. In another CRC for WSC study, we explored the cooling effect of an isolated tree (*Lophostemon confertus*) including the water use of the tree using sap flow measurements (Figure 2: tree in good condition). We observed extraordinary water use, with the tree using around 300-350 litres per day during late summer, and peaking at 450-500 litres per day during hot, dry conditions. Further inquiries revealed a 12-inch water main running less than 3 metres alongside the tree, and it is very likely the tree is accessing this water. Adequately capturing the soil moisture regime including such things as leaking pipes, water sensitive urban design and irrigation are all needed to understand tree responses to urban environments and resulting cooling benefits of trees (and other UGI).

Ongoing research needs

Given the complexities of urban trees (and other GI) and their interactions with, and response to, the urban environment, particularly at the micro-scale, it is understandable that modelling the latent heat flux proved especially difficult in the International Urban Energy Balance Comparison project (Grimmond et al., 2011). Models need to capture important micro-scale processes, as well as the response of trees to the micro-climate and any critical feedbacks. Ongoing development in research models need to consider the representation of the interactions between urban vegetation and the built environment. Further, including irrigation in urban land

Figure 3. Designing UGI to maximise cooling. Rather than installing a green roof (left), install a white roof, harvest the stormwater and use it for street level irrigation for cooling and to support tree health so trees can provide shade (right).



surface schemes should also be considered. Just as Chen et al. (2012) stated in their paper on research priorities in observing and modeling urban weather and climate, "Other issues that need to be addressed include the difference between urban and rural vegetation due to additional stresses (e.g., pollution and heat) and how to account for irrigation in the estimate of soil moisture." Some excellent examples of ongoing research and development were presented in sessions UCP10 on urban trees, and NOMTM1 on new observation and modelling techniques at ICUC9 on work related to improving interactions between trees and the urban environment.

Science to policy: Strategic implementation

Given the different considerations in micro-scale influences of UGI and interactions between the natural and built landscape, it absolutely matters where green infrastructure is placed and what green infrastructure is implemented. Given the multiple benefits of trees, clearly they should be prioritised for implementation. In other CRC for WSC research, we compared the radiation budget and energy balance of experimental green and white roofs. We found that the green roof showed very low evapotranspiration rates, unless irrigated, and would likely provide little benefit for daytime cooling (Coutts et al. 2013). Acknowledging that green roofs provide limited benefit at street level, and provide no shade to pedestrians (notwithstanding the building insulating effects of the green roof), an alternative design scenario can be considered that encapsulates a broader picture. Rather than install a green roof, a white roof could be installed, the roof runoff harvested and then used for irrigation at street level to support cooling and tree health (Figure 3). This is an example of the strategic selection (the **what**) of UGI.

Given the highly localised benefits of UGI, implementation needs to be widespread and distributed throughout the urban environment. Implementation of UGI should also prioritise areas where UGI will deliver the 'biggest bang for buck'. This recognises also that planning-related agencies may have limited funds for implementation. Research by Norton et al. (2015), in which the CRC for WSC partnered, provides a framework for UGI implementation which suggests targeting areas that are 'hotspots', locations with a high proportion of vulnerable people (such as the elderly and those of low socio-economic status), and places where communities frequent such as transport corridors or community health facilities. This type of framework can be applied at the street scale, with trees being placed in wide, open streets with limited shade, while green walls may be more suitable in narrow streets where space may be an issue. This is an example of strategic placement (the **where**) of UGI.

Strategic implementation: Tools

A key focus for urban climatologists should be the development of user-friendly tools that can be accessible for industry. While urban climate modelling has improved considerably and many models are capable of exploring various urban design scenarios, most are not in a user-friendly and accessible format. Research groups may have the best model in the world, but if they are the only ones that can use it, then it is only of limited value. Further, governments, planners and urban developers often need rapid assessments of the impacts of various design scenarios at relevant scales. As industry focuses more on the impact of development on urban climate, it is simply not feasible for researchers to assess the hundreds of 'master-plans' or 'urban developments' that may be happening in a city with their model, and meet often very short time frames. Researchers need to meet this need with tools that balance simplicity and robustness. Policy-relevant models need to capture necessary urban processes (at the relevant scale) to ensure policy responses are in the right direction, but also simple enough that they are not too computationally expensive, can be used with a modest amount of training, and flexible in their application. That way, consultants or local government agencies can do their own assessments of say, the cooling benefits of different canopy cover targets, recognising the research and academic knowledge behind the tools.

Summary

With more and more cities looking to increase their UGI, and setting canopy cover targets for achieving multiple policy objectives, including improved urban climate, the urban climate community has a critical role to play in establishing evidence, guidance and tools to help inform decision-making and 'on the ground' implementation. Unfortunately, advice, best practice guidelines and tools that are targeted specifically at improved urban thermal environments are lacking, meaning the aims of policy makers may not be achieved, or at least not to the maximum extent possible. While the research is aimed at designing urban spaces for the population, we also need to design for trees, ensuring trees are selected and positioned in such a way that their 'Tree Thermal Comfort' is also maintained. This means that trees (and all UGI for that matter) must be supported by sufficient water, preferably from sustainable sources (stormwater, recycled water) to ensure trees are healthy, have full canopies and are actively transpiring, especially during extreme heat events when the benefits are most needed.

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Analyzing the Influence of Urban Forms on Surface Urban Heat Islands in Europe

Introduction

Increasing green urban areas and altering the form of cities are usually discussed to mitigate the urban heat island. This article summarizes our study, recently published in the *Journal of Urban Planning and Development* (Schwarz & Manceur, 2015), which explores the impacts of urban form on the surface urban heat island (SUHI) in Europe. We combined data on land surface temperatures for summer 2001 and land cover with meteorological, demographic and topographic data for European urban regions. To ensure a comprehensive view, we calculated three ways of quantifying the surface urban heat island and stratified for morning and evening, as well as for climate zones.

Several studies have already shown that composition (e.g. share of different land covers in the urban region) and configuration (spatial shape and distribution of the different patches of land covers, i.e. clusters of neighboring cells with identical land cover) influence land surface temperature (LST) in cities. However, the influence of those two factors on the SUHI itself was rarely analyzed. Four studies included composition in their analysis (Imhoff et al., 2010; Zhang et al., 2010; Peng et al., 2012; Zhang & Wang, 2008), while none considered configuration. However, even for the studies focusing on composition only, it is impossible to compare the results, as they use diverse factors for explaining the SUHI and different approaches to quantify the SUHI itself. Therefore, the aim of the study was to explain the extent of the SUHI with both composition and configuration of urban regions, while also taking into account explanatory variables that have already been discussed in earlier studies. For this study, we used remote sensing data and quantified the SUHI with several indicators in parallel, to ease comparisons and investigate the behavior of different SUHI indicators. Furthermore, these relationships were investigated separately for day and night LSTs, as diurnal dynamics of the indicators are different.

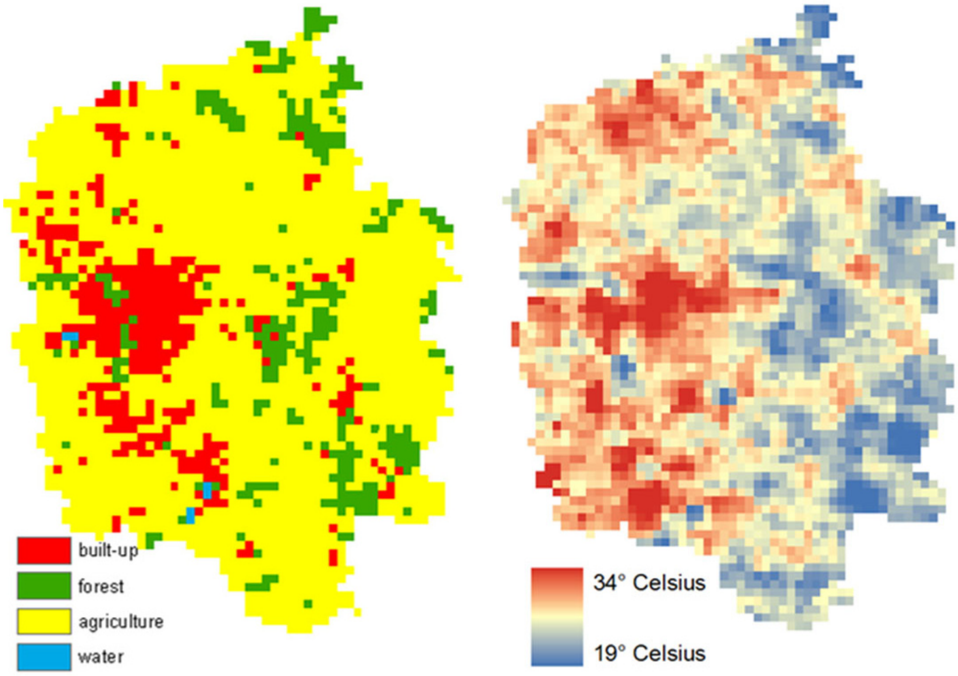

Figure 1. Visualization of exemplary input data for the Larger Urban Zone of Leipzig (Germany; 2,805 km^2): aggregated land cover classes (left) and mean LST at 10.30am in June, July and August 2001 (right). The SUHI indicators are: difference urban minus other: 1.8 K in the morning and 1.4 K in the evening; magnitude: 6.7 K in the morning and 3.2 K in the evening; Gaussian area: 3,237 km^2 in the morning and 2,996 km^2 in the evening.

Data and methods

The data base of this study combines three main data sets for the year 2001: (1) Data delivered by city administrations to the so-called Urban Audit initiative of Eurostat, providing administrative boundaries of the Larger Urban Zones, population data, and meteorological data, (2) MODIS LST from the Terra satellite, and (3) MODIS land cover maps. A total of 274 urban regions were included in the data set (Schwarz & Manceur, 2015, Fig. 1). Detailed results and data for all urban regions are available online (Schwarz & Manceur, 2014), and descriptive statistics are given in Schwarz & Manceur, 2015, Table 1.

The mean SUHIs were quantified for June, July and August 2001, and for day and night, respectively. Three indicators were chosen to quantify the SUHI in order to represent three different groups of how to quantify SUHIs (Schwarz et al., 2011):

- Difference urban minus other: difference of mean temperature of built-up pixels and mean temperature of all other pixels.
- Magnitude: difference of maximum and mean temperature in the urban region.

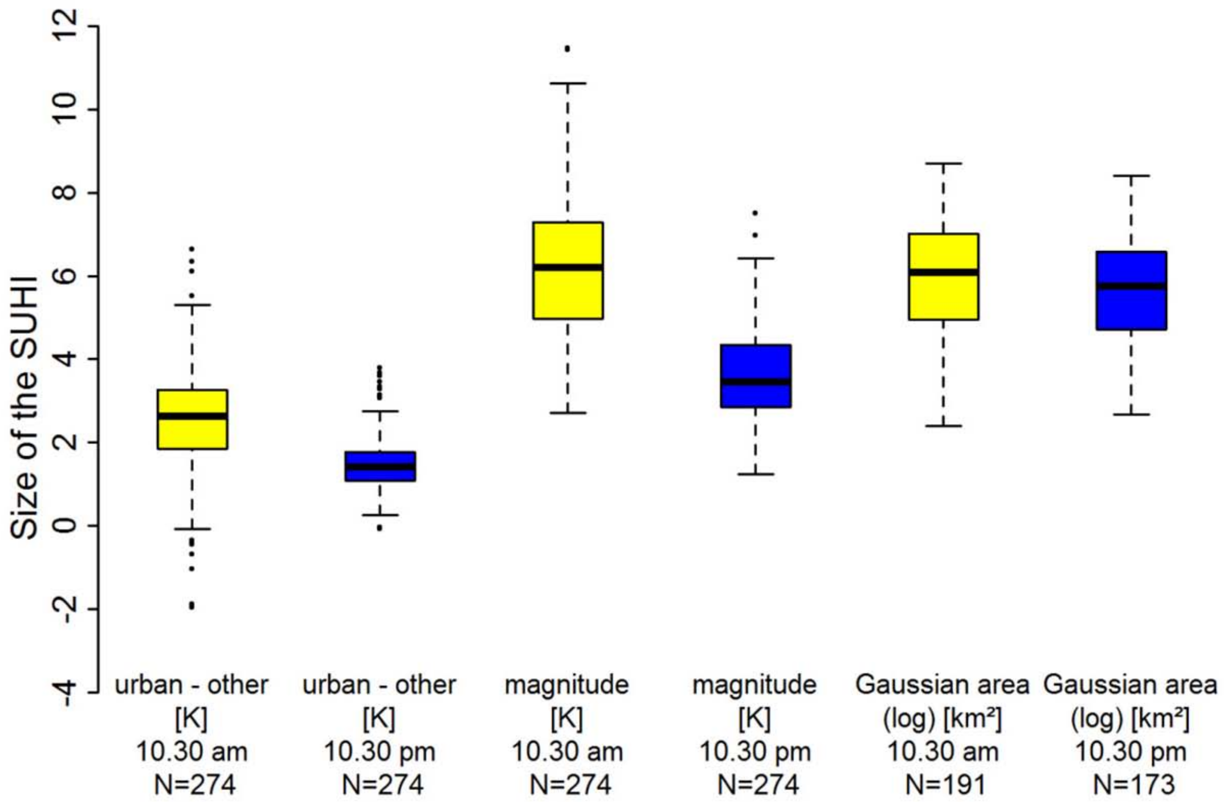

Figure 2. Size of the SUHI for three different indicators.

• Gaussian area: area under a Gaussian bell that is fitted to the LST after subtracting the rural background.

MODIS land cover data for 2001 was used to quantify urban form based on the classification of land cover types of the International Geosphere-Biosphere Programme. The 17 land cover classes were summarized into five categories: built-up, forest, agriculture, water, and barren (see example in Figure 1). For quantifying the spatial configuration of cities, a variety of landscape metrics is available (Schwarz, 2010). The following landscape metrics were included in the analysis: number of patches, mean patch size, median patch size, edge density, area-weighted mean patch fractal dimension, size of the urban region, area-weighted mean shape index (see definitions given in Schwarz & Manceur, 2015, Table 2). Due to the focus of the research question, the spatial configuration was only quantified for the land cover categories of 'built-up' and 'forest' as these two relate to urban form and urban green, respectively. Further explanatory variables regarding location and population were included. Pearson correlations were used to determine high linear association between explanatory variables within the four groups of composition, configuration, population and location. Absolute correlations above 0.8 implied that one of the two variables in question was removed.

The statistical analysis consists of fitting linear models for each dependent variable (i.e. each SUHI indicator) individually, differentiated also by climate zones (subtropics with winter rainfall, temperate oceanic and temperate sub-continental climate) and once as a whole sample, thus without differentiating climate zones. An exhaustive and efficient search for the best linear model was run to determine the best performing combinations of explanatory variables. In order to account for model uncertainty, the three best performing models were used. Furthermore, the importance of explanatory variables was determined as the number of times a variable was selected in all of the three final models. Explanatory power of the linear models was quantified as the percentage of variance explained, as measured by R^2.

Results and discussion

The SUHI varies considerably between different European cities, indicators and times of day (Figure 2). Both the median and the variance of the SUHI are higher during the day than at night for all indicators. Correlations between SUHI indicators for either morning or evening temperatures are below 0.5 and thus rather low.

First, the explanatory power of the three most parsimonious statistical models is approximately the same for each indicator, climate zone and time of day (Schwarz

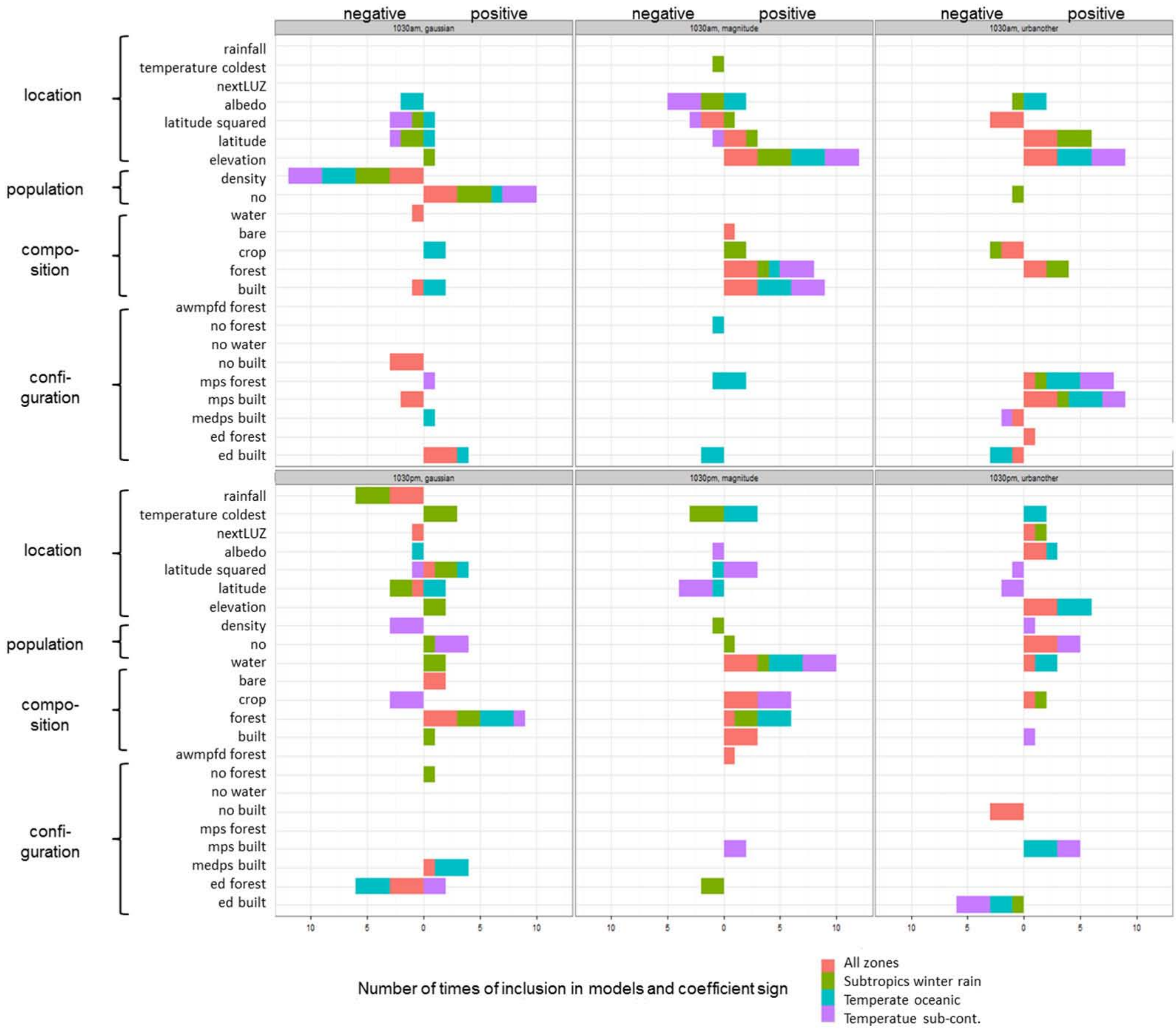

Figure 3: Number of times the explanatory variables were included in the best regression models, by climate zone and time of day. (Configuration: ed built=edge density built-up; ed forest=edge density forest; medps built=median patch size built-up; mps built=mean patch size built-up; mps forest=mean patch size forest; no built=number of built-up patches; no forest=number of forest patches; awmsi forest=AWMSI forest. Composition: built=built-up; forest=forest; crop=cropland; bare=bare land. Location: rainfall=rainfall in 2001; temperature coldest=temperature in coldest month; elevation=elevation; latitude=latitude; latitude squared=latitude^2; albedo=albedo; nextLUZ=distance to next LUZ. Population: no=population number; density=population density.)

and Manceur 2015, Fig. 3). For the daytime SUHI, the adjusted R^2 for all climate zones varies between 50 and 62%. However, the explanatory power of the models is much lower for the nighttime SUHI (between 18 and 43% for all climate zones combined). Especially the commonly used indicator of 'difference urban minus other' can hardly be explained for summer evenings. Second, the question of which variables best explain the extent of the SUHI has to be answered for each indicator separately, as the patterns are strikingly different (see below). Thus, it is essential for comparisons of different studies to clearly distinguish different SUHI indicators used. Together with the rather low correlation among SUHI indicators, this furthermore suggests that the indicators measure different aspects of the SUHI phenomenon and should be used in concert.

No general combination of explanatory variables explains the SUHI as measured by different indicators. Instead, rather specific combinations of explanatory variables were found to be relevant in explaining the variation in the different ways of quantifying surface urban heat islands. Furthermore, the sign of the standardized regression coefficient implies the direction of influence of explanatory variables: Positive (negative) standardized regression coefficients mean that the SUHI increases (decreases) with increasing values of the explanatory variables. Figure 3 summarizes the frequency of the variables' inclusion in the models, differentiated for positive and negative effects. The maximum number of possible inclusions is three, as for each combination of SUHI-indicator, climate zone (including one dataset with all climate zones combined), and time of day, the three best models were analyzed.

The relative importance of the 'configuration' and 'composition' explanatory variables varies strongly between the SUHI indicators: for the 'difference urban minus other', mostly location- and configuration-related explanatory variables are relevant, for magnitude composition- and location-related variables, while Gaussian area is mainly explained by population-related explanatory variables. Compact urban form (with larger built-up patches) increases the SUHI measured as the difference of urban and other temperatures and also increases mean LST, but was not a significant predictor for other SUHI indicators. More sprawled development thus would help mitigating the urban heat island. However, results for the two other indicators do not support this finding, as they measure different aspects of the urban temperature patterns and are hardly related to the spatial configuration of the city. Increasing the share of built-up area and forest both increase the surface urban heat island. More built-up areas increased the mean temperature in the region, while more forest unsurprisingly decreased the overall temperature.

The patterns of influence found in this study for the other explanatory factors are mostly in line with the findings already discussed in the literature regarding population number (log-linear relationship), population density (strong decreasing effect mainly for Gaussian area), latitude and albedo (rather complex relationships) and elevation (increasing effect on the SUHI, strongly correlated with the distance to the coast).

Further research should take into consideration the influence of spatial scale on the relationship between composition and configuration on the one hand, and the different SUHI indicators on the other. Furthermore, future research should investigate the influence of elevation on the extent of the SUHI for inter-city comparisons, which proved to be an important explanatory variable in the present study. Finally, the indicator 'difference urban minus other' should be investigated more thoroughly, especially for evening temperatures, as the explanatory variables included in this study failed to explain this indicator satisfactorily.

For spatial planners, the target should not be to lower the urban heat island effect as such, as this might lead to mitigation measures that increase overall temperatures. Practitioners should rather aim at increasing human well-being by lowering mean or maximum temperatures in a city. As location and population number are given for a specific city, our results indicate that spatial planning should try to have (1) as little built-up areas as possible in small patches that show patterns of urban sprawl, and (2) a high share of forests in large areas.

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A grand event in Toulouse

Ninth worldwide gathering of IAUC held on July 20-24, 2015

Five full days. Hundreds of delegates, from every continent. Over 300 oral presentations, and nearly as many posters. New initiatives and ongoing discussions, about issues, topics and fields of knowledge that scarcely existed a decade ago.

The International Conference on Urban Climate (ICUC) remains the IAUC's main event, and the recently held ICUC9 in Toulouse, France was a clear indication that urban climate is a field which has come into its own.

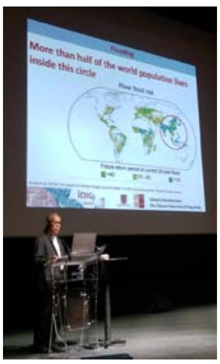
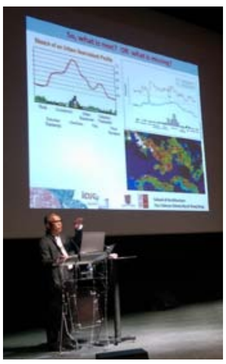
No longer a peripheral aspect of meteorology or planning or some other subject, urban climatology can rightly be considered an independent and vital realm of academic study and applied endeavor. And by evolving as a community which is both coherent and multi-faceted, the IAUC is taking on a role in society that is unique and indispensable.

This message was reinforced from the opening of the conference – which was masterfully organized and elegantly hosted from start to finish by **Valéry Masson** and **Aude Lemonsu** of Météo-France. That organization's Head of Research, **Philippe Bougeault**, stressed the importance of urban climatology with respect to global climate change: anticipating the UN Climate Change Conference in Paris in December, he said that better design of buildings and cities is central to meeting greenhouse gas reduction goals, and ICUC provides an interdisciplinary forum to address this. **Dev Niyogi**, who chairs the Board on Urban Environment at the AMS, cited ICUC as the most important meeting on urban climatology at different scales and offered a reminder that "cities have a bigger atmospheric footprint than a spot on a map would suggest."

Continuing on this theme was **Deon Terblanche**, Director of the Atmospheric Research and Environment branch of WMO, who stated that energy and urban issues are the new focus: "Cities are complex, and investments are needed to examine both the physical environment and socio-cultural issues in urban areas. Since urban environments are not isolated, but rather integrated in a global setting, they compete for water and other resources. Rapid urbanization, then, will require *new* climatic services." Further illustrating the scope of the challenge, he cited projections showing the population of Africa growing from 1 to 4 billion by the year 2100, adding 2 billion new residents of cities. The UN Conference on Housing and Sustainable Development (HABITAT III) is especially focusing on the confluence of urbanization and climate change, he said, and from this perspective the WMO considers the ICUC of global importance.

* * *

The conference sessions were organized along several running themes, as outlined in the Table on the following page. Prominent among these was the scientific study of ***urban climate-related processes***, particularly focusing on heat island characteristics, influences of urban vegetation, and flow patterns related to pollutant dispersion and air quality. New ***observation and modeling techniques*** were also prominently on display, as were


strategies for ***climate change mitigation and adaptation*** in urban environments and for the enhancement of ***climatically-responsive urban design***. Beyond this focus on the physical environment, a number of sessions investigated issues related to ***human bioclimatology and public health***, and to the ***transfer of urban climate knowledge*** to planners and policy makers.

A series of sessions was devoted specifically to the emerging possibilities for generating and applying ***geospatial data*** to urban climate problems. Within this, special attention was given to recent developments in the classification of urban terrain using Local Climate Zone (LCZ) schemes, and a highly-attended workshop was dedicated to the WUDAPT initiative (see Issue 56, page 20). According to **Gerald Mills**, our knowledge is especially limited when it comes to describing the large and medium-size tropical zone cities, whose population is largely poor and rapidly expanding. He maintained that existing models generalize the characteristics of cities and are thus transferable, but only to the level of detail at which cities differ – and thus the goal of this ambitious project is to develop a global geographical database of the world's cities for urban climate applications. The project generated great interest at the conference, and its initiators are encouraging members of the urban climate community to participate by visiting www.wudapt.org and classifying their own cities.

The program of oral presentations (which can be downloaded from the ICUC9 website at www.meteo.fr/icuc9/programme.html) was interspersed with a series of stimulating plenary talks. The first of these was by **Edward Ng**, an architect from the Chinese University of Hong Kong, who described the climate-related threats facing Asian cities: increased risk of flooding, elevated nighttime temperatures and associated health effects. While climate action plans are abundant, he said, their implementation is often not a high priority and they are stymied by the fact that climatologists and planners do not share a common language. He presented examples of climatically-responsive urban plans in Hong Kong and

ICUC-9 Oral presentations by themes and topics (number of presentations)

Climate change mitigation & adaptation in urban environments (42)

Cities inside climate models and downscaling methods (6)
Climate modeling: methodologies for impact studies (6)
Climate Impact studies and adaptation strategies (4)
Urban air pollution mitigation strategies (3)
UHI mitigation strategies:
- Urban expansion and climate change links (3)
- Urban planning (6)
- Watering process studies (6)
- Vegetation management processes (2)
- Vegetation based strategies (5)

Transfer of urban climate knowledge to urban planners (37)

Public policies and practices (5)
Governance challenges in urban planning & adaptation (5)
Development/amendment of urban planning regulation (5)
Weather forecasting for city actors (5)
Indicators and climate maps:
- Risks and vulnerability (4)
- Urban planning (3)

Warning plans and decision support tools (10)

Study of urban climate processes (77)

UHI characteristics:
- Link with boundary layer (5)
- Vertical and horizontal structure (6)
- UHI micro-scale variability (6)

Observations of surface energy and water balances (3)
Air quality in the urban boundary layer: processes (9)
Observations of greenhouse gases fluxes (6)
Radiation processes (3)
Influence of mesoscale flows (3)
Impact of cities on precipitation (7)
Influence of urban vegetation:
- Urban trees (9)
- Parks and green roofs (6)

Flows and dispersion:
- Pollutant dispersion in urban canopy (3)
- Effects of atmospheric stability (6)
- Turbulent and dispersive fluxes in urban canopy (5)

Geospatial datasets (37)

Surface UHI from satellite (4)
Local climate zones:
- WUDAPT (6)
- Methodologies and maps (3)
- Inter and infra-LCZ temperature variability (6)

New remote sensing technology and data (2)
Urban databases and link with models (7)
Urban climatology studies:
- Temperate and cold climate cities (3)
- Tropical and arid climate cities (6)

New observational and modeling techniques and methods to study urban climates (67)

Urban canopy parameterizations:
- Urban vegetation (7)
- Development and sensitivity (5)

Statistical models (4)
Computational Fluid Dynamics models (4)
Large Eddy Simulation models (6)
Wind tunnel and scale models (6)
Urban climate measurement networks (8)
Field campaigns (6)
Mesoscale and numerical weather prediction models (10)
New sensors / new methods:
- CO2 and mobile measurements (7)
- UBL and UHI (4)

Bioclimatology and public health (25)

Modeling of outdoor microclimate and comfort (6)
Indoor comfort and link with outdoor conditions (3)
Observation/surveys of outdoor comfort (4)
Health (6)
Human perception and new indicators (6)

Urban design with climate (43)

Impact of urban form on comfort:
- Tropical and arid climate cities (6)
- Temperate and cold climate cities (7)
- Theoretical studies (3)

Impact of urban form on outdoor ventilation (5)
Building climate and energy consumption:
- New models (4)
- Temperate and cold climate cities (7)
- Tropical, continental and arid climate cities (5)

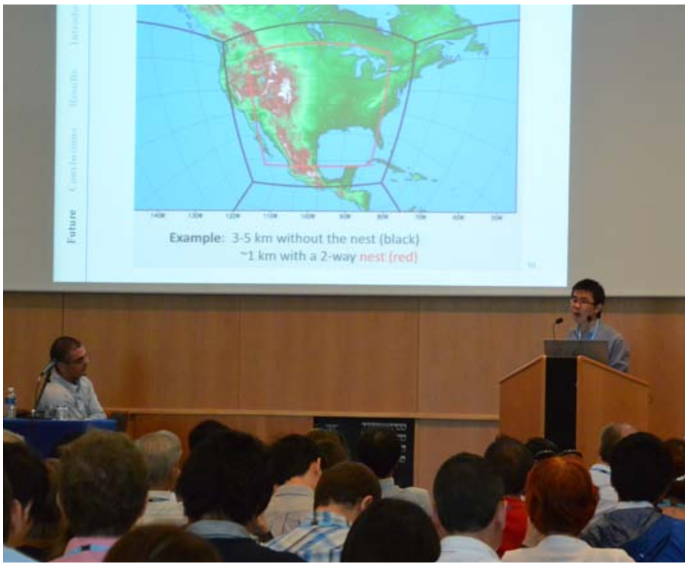
Energy demand at city scale (6)

Interdisciplinarity (11)

Environmental scholarship and collaborations (2)
Multicriteria environmental perception (9)

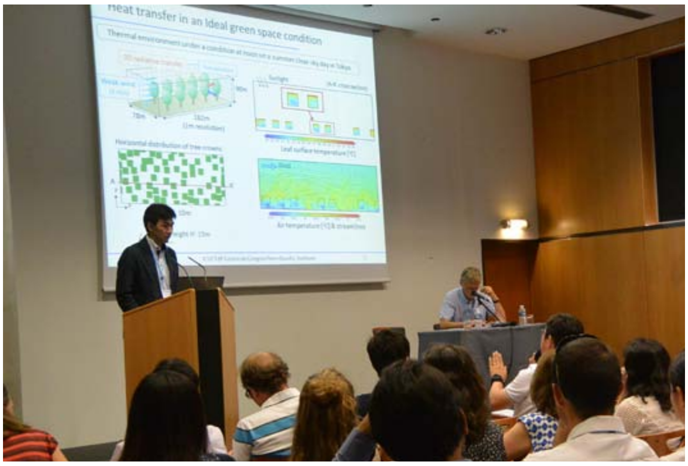
elsewhere, employing principles that have been gleaned from actual practice: promoting green space based on win-win scenarios; use of climatic land-use maps; and waterways, building permeability and ventilation.

In another plenary lecture, the venerable **Bob Bornstein** discussed his ongoing work on the influence of cities on thunderstorms and precipitation. Prof. Bornstein is a research meteorologist from San Jose State University in the US, and he has been examining the link between cities and thunderstorms for years. Based on observations and computer simulations, he has identified cases in which lines of thunderstorms split as they approach New York City, and he believes there is a comparable effect in Washington D.C. His research has suggested that due to UHI effects, urbanized terrain can act like a chimney – drawing air into the city and generating an updraft of warm air which cools as it rises, condensing into clouds and forming thunderstorms. This is a dynamic that he observed vividly in weather data from the



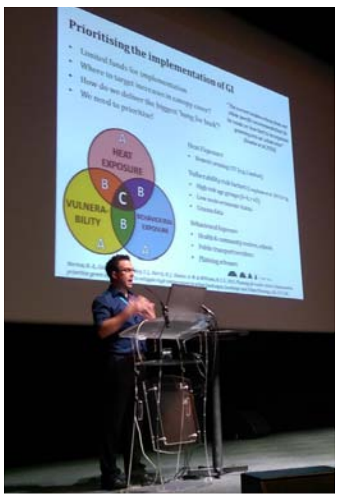
city of Atlanta at the time of the 1996 Olympics, and he is currently researching the phenomenon in east Asian cities, examining the urban effects on thunderstorms in South Korea.

Lee Chapman, from the University of Birmingham in the UK, delivered an especially thought-provoking talk on the current and future possibilities of employing dense meteorological networks in and around cities. Thanks to recent advances in communications technology, more and more cities have established local measurement networks that include hundreds of weather stations, providing unprecedented coverage of temperature and other data across the urban area. At the same time, there are trade-offs between the reliability of such networks and the long-term cost of their deployment and maintenance. On one hand, the "internet of things" – that is, networks of physical objects which can auto-



matically collect and exchange data – is a game-changer in the way we can monitor the urban environment. On the other hand, our ability to track urban climate trends over time depends on the long-term sustainability of the network – which means that funding must continuously be available for its ongoing maintenance. According to Chapman, this poses a dilemma because neither public nor private bodies are typically willing to make such extensive commitments. His proposed solution involves "crowdsourcing," or harvesting data that is routinely collected throughout the city by individuals or groups using inexpensive equipment. He called for the testing of this approach as a sustainable alternative to the strict reliance on "standard" weather stations, suggesting that issues of data quality using non-standard sources have been successfully addressed in other fields, and could be solved by urban climatologists as well.

"Green infrastructure for cities" was the topic of the final plenary address, given by **Andrew Coutts** from Monash University in Melbourne, Australia. As summarized in this Issue's Feature article (see page 7), Coutts' presentation offered an overview of work that his team has conducted on the climatic benefits and challenges of urban trees. His central message was that trees are crucial for city climate moderation, but that they need full,

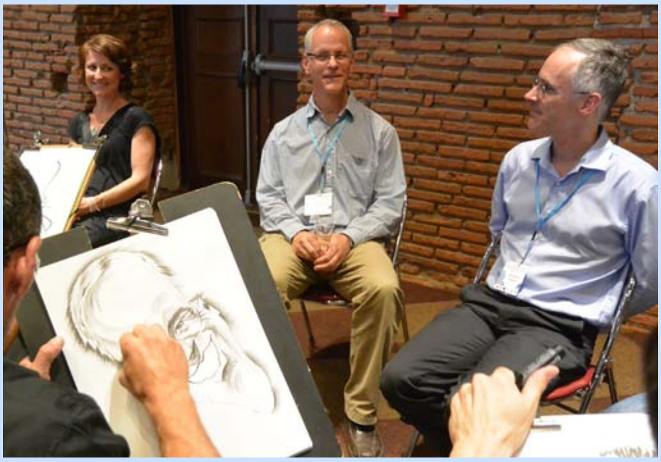


transpiring canopies to provide this service. A problem arises because of the fact that during the hottest days of the year, when evaporative cooling is needed most, stomatal control in some tree species may limit transpiration, and in turn cooling. He suggested that better tools are needed to represent the effects of trees in urban modeling, especially in manner which is relevant and accessible for urban planners and policy makers.

For both seasoned ICUC veterans and first-time attendees, the atmosphere in Toulouse during ICUC9 will surely be the source of fond memories for years to come. Beyond the stimulating hours spent at the Centre de Congrès Pierre Baudis, delegates were treated to a sumptuous reception at City Hall and a Conference Dinner at the majestic Hotel Dieu, built in the 13th century on the banks of the Garonne River.

A highlight of the after-dinner ceremony was the presentation of two Luke Howard Awards, to **Manabu Kanda** for 2014 (see Issue 56, page 34) and to **Tony Brazel** for 2015 (see this issue, page 30). Congratulations are due to both of these inspiring figures for their life's work in urban climatology, and to IAUC President **James Voogt** for his stewardship of the organization over the last year and a half. And to the French team, led by **Valéry and Aude**, *merci beaucoup* – many thanks for a job well done!

— *David Pearlmutter, Editor*



IAUC/AMS student presentation awards for ICUC-9/12th SUE

Nearly 200 student presentations were made at ICUC-9/12 SUE, a significant fraction of the total conference presentations. The quality of the presentations was very high, making assessment of the awards by the committee very difficult. We thank all the students for their hard work and their important contributions to making ICUC-9/12 SUE a very successful conference. Thanks also to the session chairs for their input and a special thanks to our evaluators for the significant time they devoted to attending and evaluating oral and poster presentations: Andreas Christen, Julie Futcher, Jorge Gonzalez, Simone Kotthaus, Chandana Mitra, Ting Sun, Zhihua Wang, Helen Ward, and Curtis Wood.

The William P. Lowry Awards

These awards are made possible by the sons of William (Bill) P. Lowry: Samuel C. Lowry and Porter P. Lowry II, September, 2005. The awards honor Prof. Lowry's lifetime contributions to the fields of urban climatology and bioclimatology, and to encourage, celebrate, and modestly support outstanding and pertinent work.

The William P. Lowry Graduate Student Prize (best presentation in urban biometeorology/bioclimatology):

Stephanie Jacobs, Monash University (Australia), Comparison of modelled thermal comfort during a heatwave in Melbourne, Australia

The William P. Lowry Methodology Prize:

Brian Bailey, University of Utah (USA), for his presentations "Incorporating resolved vegetation in city-scale simulations of urban micrometeorology and its effect on the energy balance" and "Understanding and eliminating instabilities and 'rogue trajectories' in lagrangian stochastic particle dispersion models".

The William P. Lowry Student Travel Award:

Jesús Gómez Velázquez, Universidad Autónoma Benito Juárez de Oaxaca, Mexico

Japan Prize

The Japan Prize honors presentations given by researchers from developing countries. The awards are made possible by Professor Y. Nakamura and seven of his colleagues from Japan.

Patricia Drach, UFRJ (Brazil), Effects of urban form and atmospheric stability on local microclimate

Chaaruchandra Korde, Green Bam Solutions, New Delhi & Airef Engg. Pvt Ltd. (India), Bamboo structures: A perspective for climate change mitigation

Shweta Bhati, Indian Institute of Technology Delhi (India), The impact of land use/land cover on WRF model performance in a sub-tropical urban environment

Best Oral Presentations

Alex Bjorkegren, King's College London (UK), Calculation of the CO2 storage term in an urban environment: results and guidelines from Central London

Marco Giometto, EPFL (Switzerland), Large-eddy simulations to characterize the role of turbulent and dispersive production, transport and dissipation of TKE over and within a realistic urban canopy

Janina Konarska, University of Gothenburg (Sweden), Transpiration of urban trees and its impact on nocturnal cooling in Gothenburg, Sweden

Qi Li, Princeton University (USA), Large eddy simulation and bulk parameterization of momentum and heat transport in urban canopies: challenges and applications

Michael Schmutz, Universität Basel (Switzerland), Seasonal and inter-annual variation of CO2 flux and concentration in Basel

Natalie Theeuwes, Wageningen University (The Netherlands), A breath of fresh air in urban heat island studies

Best Poster Presentations

Mikhail Varentsov, Lomonosov Moscow State University (Russia), Investigation of urban heat island of Norilsk and Apatity cities in Russian Arctic with usage experimental measurements and remote sensing

Shang Wang, University of Hong Kong, Experimental study on the suitability of acrylic and copper globe thermometer for diurnal outdoor mean radiant temperature measurement

Yuan Shi, The Chinese University of Hong Kong, Intraurban variability of particulate air pollution in Hong Kong - exploring the influence of building morphology in high density urban environment by using traverse measurement

Shi-Qi Yang, Albert-Ludwigs-University Freiburg (Germany), Linking human-biometeorological thermal conditions with Köppen-Geiger climate classification – The example of China

Michael Alonzo, University of California, Santa Barbara (USA), Mapping urban ecosystem structure and function using hyperspectral imagery and airborne lidar

Tom Valterri Kokkonen, University of Helsinki (Finland), Long-term variability of suburban energy and water exchanges in Vancouver

Julien Le Bras, Météo France, Fast urban heat island modeling

IAUC/AMS student presentation awards (cont.)

Oral Presentation Awards

Veronica Bellucco, University of Sassari (Italy), An empirical approach to estimate the biogenic components of CO2 flux over different ecosystems

Maxime Daniel, CNRM-GAME/Météo-France, Watering practices and urban thermal comfort improvement under heat wave conditions

Cho Kwong Charlie Lam, Monash University (Australia), Visitor perception of thermal comfort in two contrasting public landscape gardens during extreme heat events

Negin Nazarian, University of California San Diego (USA), Pollutant Exchange and Breathability in Urban Street Canyons

Ayako Yagi, Tokyo Institute of Technology, (Japan), Analysis of spacing of streaky structures within surface layer above real urban

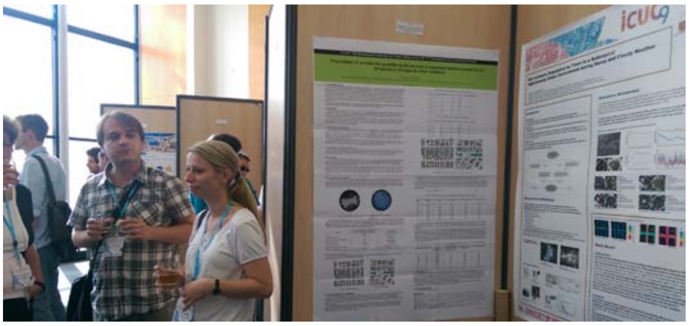
Bin Zhou, Potsdam institute for Climate Impact Research (Germany), Cities as urban clusters: an empirical and large sample study of urban heat island intensity

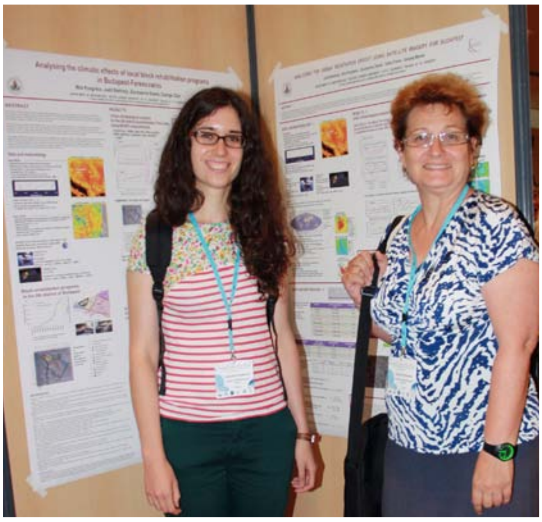
Poster Presentation Awards

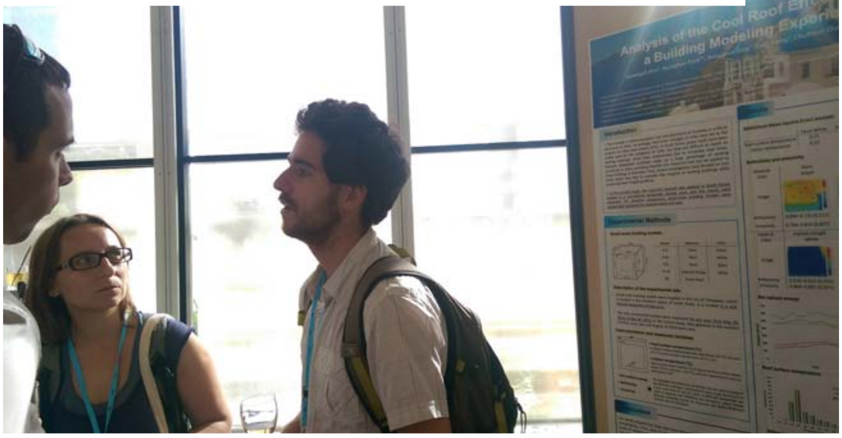
Shintaro Kobayashi, University of Tokyo (Japan), CFD analysis of urban wind environment with actual inflow obtained by Doppler lidar measurement

Luis Enrique Ortiz, City College of New York (USA), Modeling New York City impacts on local and suburban weather during the July 2010 heat wave

Alexandre Philip, CNRM-GAME (France), The impact of vertical resolution in mesoscale model AROME forecasting of radiation fog








AMERICA'S
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MONASH University

Toulouse

Recent Urban Climate Publications

In this edition a list is presented of publications that have generally come out between **June and August 2015**. 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**.

Since the bibliography committee members Janos Unger and Julien le Bras are resigning from the committee, I would like to thank them for their years of dedication. In addition, it is my pleasure to introduce two new volunteers: Iara Santos (TUM, Germany) and Marie-Leen Verdonck (Ugent, Belgium). Welcome to the committee! 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,

Matthias Demuzere

Department of Earth and Environmental Sciences, KU Leuven, Belgium

matthias.demuzere@ees.kuleuven.be

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The 31st annual conference on Passvie and Low-Energy Architecture (PLEA2015) was recently held in Bologna, Italy with a strong emphasis on climate issues and a pointed message: "In order to cope with the complexity of the society-nature system, interconnections are needed between the urban scale and the building scale." Indeed, one of the five main themes around which PLEA was organized was "Post Carbon Cities" - focusing on how we can make our urban environment more resilient. See more at: www.plea2015.it

Upcoming Conferences...

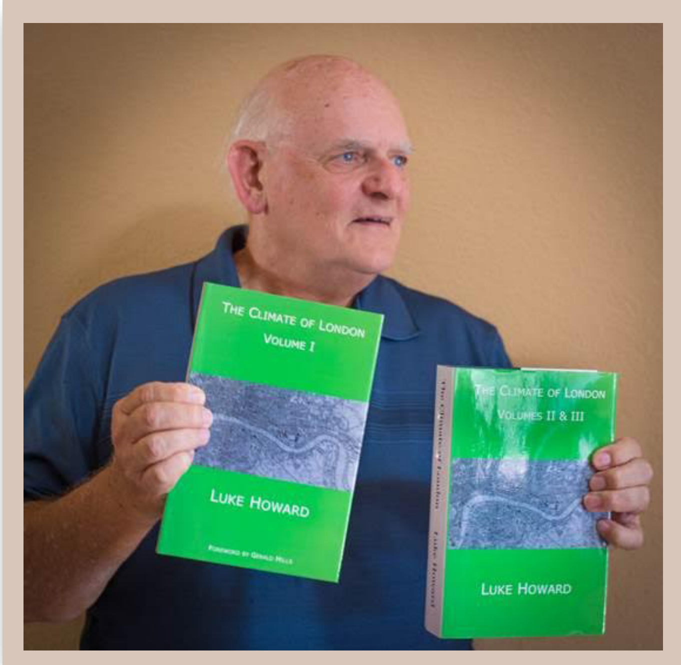
EAST & CENTRAL AFRICA URBAN AND INFRASTRUCTURE DEVELOPMENT CONFERENCE
Kampala, Uganda • October 14-15, 2015
http://uidc.siup.ac.ug/

INTERNATIONAL WINTER CITIES SYMPOSIUM (IWCS 2016)
Erzurum, Turkey • February 10-12, 2016*
http://wintercities2016.atauni.edu.tr/eng/
* *Abstract submission deadline extended to **Oct. 30th**!*

ROME2015 SCIENCE SYMPOSIUM ON CLIMATE
Rome, Italy • November 19-20, 2015
http://www.rome2015.it/

INTERNATIONAL CONFERENCE ON COUNTERMEASURES TO URBAN HEAT ISLANDS
NUS, Singapore • May 30-June 1, 2016
http://www.ic2uhi2016.org/

Anthony Brazel honored with 2015 Luke Howard Award



The IAUC is pleased to recognize Professor Emeritus **Anthony Brazel** of Arizona State University as recipient of the 2015 Luke Howard Award. Professor Brazel has spent half a century engaged in and building a stellar record including: (a) research contributions that encompass a wide range of urban climate issues, (b) public service activities that highlight societal issues associated with urbanization and climate change, and (c) proactive service to numerous scientific communities and the public sector that are engaged in understanding and responding to urban sustainability requirements in climate change situations.

His research encompasses issues of desertification and habitation in arid climates, suburbs, the surface energy balance and urban heat island processes. It incorporates fieldwork and the rigorous use of remote sensing and *in situ* measurements to characterize the urban area (and other microclimates) in locations ranging from Alaska to the Middle East and Phoenix. His many applied studies on topics such as air quality aspects, heat island mitigation strategies, urban sustainability, and heat stress risks in urban areas have beneficial societal impacts. He was an early user of computers for his studies, before digital technologies became ubiquitous, continuing along these lines with significant contributions to improving weather forecasting in urban areas, helping understand relationships between urban parameterizations and climate, and recently, providing comparative analyses of global climate models. Always interested in promoting research for the good of society, he wrote about enhancing the accountability of universities to serve the public and is engaged in NSF's prestigious urban Long Term Ecological Research (LTER) program on human-climate interactions in cities. The range of his research interests is broad, it encompasses both traditional (technical) and non traditional (cultural) aspects of urban climate research that have both societal and policy implications. The latter includes contributions on the vulnerabilities of different classes and ethnic groups to climate change due to inequalities in society. Given his broad range of research interest and expertise, he has not surprisingly engaged in a wide range of multidisciplinary research collaborations that include bioacoustics, biometeorology, microclimates, heat related morbidity, and especially sustainability aspects of urban climates in arid cities. Results from his prodigious research portfolio have led to over a hundred scientific and social-scientific papers in prestigious journals, and according to Web of Science and Google Scholar, he has more than 1500 and 3400 lifetime citations.

His influence on urban climate is international, extensive, and reaches into all levels from academia to state and governmental agencies. He has mentored more than a hundred graduate students to whom he was either advisor or on their committees. In recognition of this service, the ASU Geography Department recently established (2007) the Anthony J. Brazel scholarship award for PhD students. The emergence of ASU as a leading academic institute in urban climate is due in part to Tony's various leadership roles in the Geography Department (now School of Geographical Sciences and Urban Planning). He served for two decades as Arizona's State Climatologist, successfully forging coalitions to address issues significant to the well being of the state. He is sought out to perform technical reviews and consults for at least eight governmental agencies including NOAA, NASA, USEPA, NSF, (and NATO) and reviews articles on a range of subjects, including, but not limited to urbanization-related subject matter, by at least 22 Journals. He has generously served the AMS on its Board of the Urban Environment (BUE), and the Board of Urban Climatology (BUC), and served the IAUC on its Scholarship Committee.

Many organizations have recognized Tony's achievements: notably, the AMS recently bestowed on him its Helmut Landsberg Award, the AAG honored him with a Lifetime Achievement Award, and he is a Fellow of AAAS. His role as President and Fellow of the Arizona-Nevada Academy of Science earned him their Outstanding Service Award. To these honors, the IAUC is pleased to add its recognition of Professor Brazel's contributions to the field of urban climate with the 2015 Luke Howard Award.

Respectfully,
Jason Ching, Interim Chair of Awards Committee

Meet new board member Aya Hagishima

It is a great honour for me to be given the chance to serve as an IAUC board member. My fascination with urban climatology dates back to my graduation thesis project on mobile measurements of the urban heat island in Fukuoka, Japan, when I was a student in the architecture department. Since then, my research interests have gradually spread from the architectural environment to various other areas, including surface energy balance measurement in COSMO and real buildings, wind tunnel experiments on surface drag and evaporation, and large-eddy simulation of the flow around urban canopies. I owe much of the pleasure and stimulation of my academic experience to communication with many people from various regions and academic backgrounds in the IAUC community. The IAUC is indeed an interdisciplinary melting pot of people from a broad range of backgrounds, both cultural and academic, and the ICUC-9 conference held in Toulouse made me realize afresh its value.

This broad and inclusive nature is something particularly important to me. In recent years, my laboratory has had several Ph.D. students from Malaysia, most of whom are now continuing their research on urban climatology in their home country, using their doctoral studies as a platform to generate new work on the tropical climate context and challenging themselves to bring fresh ideas and inspiration to the field. Even though the resources available for such research are limited and they rarely have occasion to communicate with fellow urban climatology researchers, these scholars are highly motivated to seek ways of connecting their knowledge of urban climatology with their climate and society. Considering the huge urban population in emerging countries, where economic growth tends to be prioritised over environmental issues, engaging researchers, policymakers, and citizens in such areas is of critical concern to our discipline and our world. I hope that the IAUC community further increases its diversity, welcoming more people from such regions in the near future and enriching the group as a whole. Although I can't draw a clear map for all my personal hopes as a board member, the first step is surely open communication with a diverse, broad-ranging group spanning the globe.

IAUC Board, July 2015 (from left): Alexander Baklanov, David Sailor, Jason Ching, Hiroyuki Kusaka, Andreas Christen, Aya Hagishima, Aude Lemonsu, Rohinton Emmanuel, Valéry Masson, James Voogt, Sue Grimmond, Curtis Wood, Tim Oke, Matthias Roth, Nigel Tapper, Gerald Mills.

Board Members & Terms

- Tim Oke (Univ. of British Columbia, Canada): President, 2000-2003; Past President, 2003-2006; Emeritus President 2007-2009*
- Sue Grimmond (King's College London, UK): 2000-2003; President, 2003-2007; Past President, 2007-2009*
- Matthias Roth (National University of Singapore, Singapore): 2000-2003; Secretary, 2003-2007; Acting-Treasurer 2006; President, 2007-2009; Past President, 2009-2011*
- Gerald Mills (UCD, Dublin, Ireland): 2007-2011; President, 2009-2013; Past President, 2014-
- James Voogt (University of Western Ontario, Canada), 2000-2006; Webmaster 2007-2013; President, 2014-
- Andreas Christen (University of British Columbia, Canada): 2012-2016
- Rohinton Emmanuel (Glasgow Caledonian University, UK): 2006-2010; Secretary, 2009-2013
- Jason Ching (EPA Atmospheric Modelling & Analysis Division, USA): 2009-2013*
- David Pearlmutter (Ben-Gurion University of the Negev, Israel): Newsletter Editor, 2009-*
- Aude Lemonsu (CNRS, France): 2010-2014; ICUC-9 Local Organizer, 2014-2015*
- David Sailor (Portland State University, USA): 2011-2015; Secretary, 2014-
- Alexander Baklanov (University of Copenhagen): 2013-2017
- Curtis Wood (Finnish Meteorological Inst., Finland): 2013-2017
- Valéry Masson (Météo France, France): ICUC-9 Local Organizer, 2014-2015*
- 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

* *appointed members*

IAUC Committee Chairs

Editor, IAUC Newsletter: David Pearlmutter
Bibliography Committee: Matthias Demuzere
Nominating Committee: Tim Oke
Chair Teaching Resources: Gerald Mills
Interim-Chair Awards Committee: Jennifer Salmond
WebMaster: James Voogt

Newsletter Contributions

The next edition of ***Urban Climate News*** will appear in late December. Items to be considered for the upcoming issue should be received by **November 30, 2015** and may be sent to Editor David Pearlmutter (davidp@bgu.ac.il) or to the relevant section editor:

News: Paul Alexander (paul.alexander@nuim.ie)

Conferences: Jamie Voogt (javoogt@uwo.ca)

Bibliography: Matthias Demuzere (matthias.demuzere@ees.kuleuven.be)

Projects: Sue Grimmond (Sue.Grimmond@kcl.ac.uk)

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.