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From the IAUC President

Colleagues, hello. This is my first occasion to write as President of the IAUC. I hope that I am as successful as previous Presidents in pursuing the objectives of the IAUC.

It goes without saying that the IAUC owes a considerable debt of gratitude to Matthias Roth, the ex-President. One of the most important activities of the association is the ICUC events, which are held each three years. ICUC-7 in Yokohama was very successful despite the very difficult economic circumstances that prevailed during its organisation. The success of the event can be attributed to the considerable efforts of the local organising committee led by Manabu Kanda and the leadership provided by Matthias. There are two other achievements that I think deserve special mention.

One of these has been the involvement of the IAUC at the 3rd World Climate Conference (WCC3), entitled '**Better climate information for a better future**.' Matthias organised a session on 'Climate and more sustainable cities' at which two White papers were presented on urban climate capabilities & needs. These formed the basis for a submission that was included in the Conference Statement (available at http://www.wmo.int/wcc3/documents/WCC-3_Statement_07-09-09_mods.pdf). Although such a statement does not, by itself, change practice, its inclusion in the over-arching documents means that the interests of urban climatologists are no longer marginal to broader concerns for climate information, which thus far have regarded urban meteorological data as fatally contaminated. Hopefully, the call for careful observations in urban areas (where most of the planet now live) complemented by metadata that describe the circumstances under which they are made, will not fall on deaf ears.

Our growing relevance as a scientific organisation of merit is apparent in our invitation to the first Global Meeting of International Forum of Meteorological Societies (IFMS), which Rohinton Emmanuel writes about in this edition. The presentation to the IFMS is available at www.ifms.org. The structure of the IAUC, which relies on the goodwill of members and operates without a budget, was commented upon favourably at this meeting. This is a tribute to the smooth running of the IAUC organisation, which to-date has been remarkably free of any acrimony. This is in large part attributable to Matthias' calm demeanour and the efficiency of Jennifer Salmond as Secretary. Two areas of the IAUC were singled out for particular mention as innovative projects that are the envy of much larger and better resourced organisations: *Urban Climate News* that has, under the editorship of David Pearlmutter, evolved into a highly professional publication and; the *Bibliography* project, overseen by Julia Hidalgo, is seen as a valuable resource other organisation would do well to imitate.

We also owe a debt of gratitude to other Board members

Inside the Spring issue...

that are stepping down at this juncture. This includes Benedicte Dousset who has been a great advocate for the IAUC for many years and Kevin Gallo who has studiously managed and maintained our most important resource, the membership information.

However, as the IAUC grows in size and scope it will have to address some challenges, some of which have already arisen and others of which can be anticipated. At the IFMS meeting, I identified the following as key:

- Adoption of a formal constitution,
- Sustaining momentum through new initiatives and volunteers,
- Needing funds to support initiatives,
- Overcoming a reliance of relatively few high profile individuals,
- Ensuring that it becomes a genuinely international organization, and
- Providing leadership in developing areas of research.

I hope that over the next three years I can address some of these issues and continue to rely on the volunteer work of IAUC members.

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International Forum of Meteorological Societies (IFMS) holds First Global Meeting (GM1) in Atlanta, USA, January 19-20, 2010

Inaugural gathering of leaders form meteorological societies aroung the world ***(Photo: Jenni Girtman, Atlanta Event Photography for AMS)***

The first ever Global Meeting (GM1) of the International Forum of Meteorological Societies (IFMS) was held in Atlanta, USA in January 2010 on the sidelines of the 90th annual meeting of the American Meteorological Society (AMS). The initiative to form the IFMS was spearheaded by the AMS, which convened a planning meeting at its 89th annual meeting in Phoenix, USA in 2009. The goal of the IFMS is to foster and encourage communication and exchange of knowledge, ideas and resources among the world's more than sixty meteorological societies. The IFMS is distinct from the World Meteorological Organization and, unlike the WMO, the IFMS will focus on advancing the goals and objectives of the world's professional and scientific societies. The IFMS is intended to be an informal mechanism that facilitates interactions among Societies and, as such, will not have any legal or official standing. Specific terms of reference can be accessed at (http://www.ifms.org/tor.html).

Nearly 20 national meteorological societies, three regional groupings of meteorological societies from Africa, Europe and Latin America and three international associations were present at GM1. A measure of the success of the IAUC is that it was invited to participate at the inaugural meeting.

Gerald Mills (President) and Rohinton Emmanuel (Secretary) represented the IAUC, and they presented an overview of the development of the organisation and the challenges that it faces. The quality of the IAUC network, the scientific content of the ICUC series and the calibre of its resources, particularly its newsletter, *Urban Climate News*, were cited as exemplars for the IFMS to emulate.

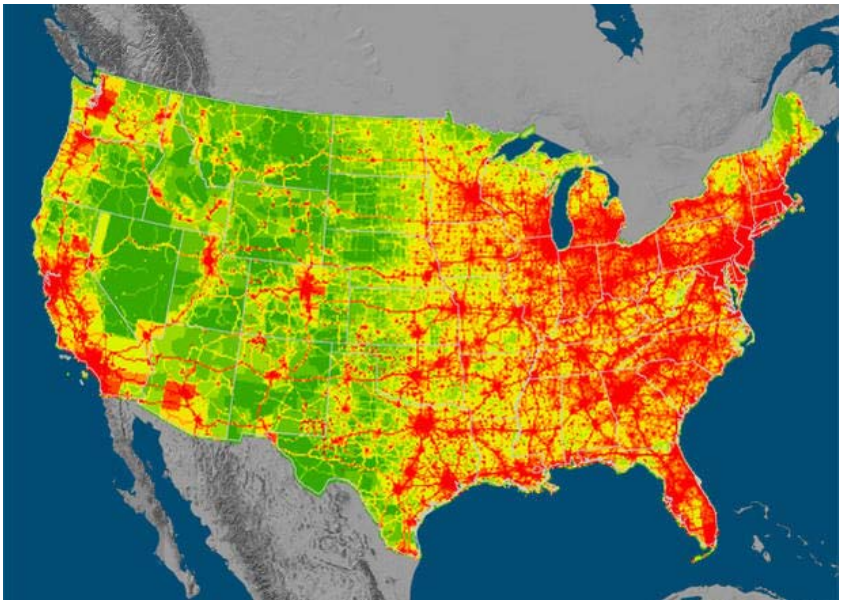
The GM1 resolved to concentrate initial activities of the IFMS on five key areas: sharing of resources, sharing of resource persons, increasing the coverage of IFMS's member societies, exploring membership benefits and coordination with the WMO. Of immediate benefit to the esteem of the IAUC is the web sharing of access to the IAUC resources including *Urban Climate News*. In addition to enhancing the profile of the IAUC, such actions will assist in a wider dissemination of IAUC resources and help the IAUC reach a wider audience, especially in the developing world.

The next IFMS meeting (GM2) will be held in China in January 2012 (*see more photos on page 25*).

If it does matter where CO_2 is released, cities are in trouble

March 2010 — There's some fascinating new research about "CO_2 domes," invisible clouds of carbon pollution that hover above urban areas. Bradford Plumer at The New Republic sets the context:

> *Does it matter where carbon dioxide is emitted? From a climate perspective, at least, the standard answer has always been, "Not really." Carbon dioxide mixes pretty evenly and uniformly throughout the atmosphere, so that the heat-trapping gases coming out of a factory in China have the same effect on global temperatures, pound for pound, as the greenhouse gases emitted by, say, cars in Delaware. (This is in contrast to a number of other air pollutants, whose effects are often localized—sulfur dioxide only causes acid rain in discrete areas.)*



Map of US CO_2 emissions *(courtesy of Purdue University Department of Earth and Atmospheric Sciences). Source:* www.grist.org

But a new study just published in Environmental Science and Technology by Stanford's Mark Jacobson adds a slight twist to this standard view. Older research has found that local domes of high CO_2 levels can often form over cities. What Jacobson found was that these domes can have a serious local impact: Among other things, they worsen the effects of localized air pollutants like ozone and particulates, which cause respiratory diseases and the like. As a result, Jacobson estimates that local CO_2 emissions cause anywhere from 300 to 1,000 premature deaths in the United States each year. And presumably the problem's much worse in developing countries.

Jacobson, a professor of civil and environmental engineering and director of the Atmosphere/Energy Program at Stanford, has been vocal about the need for a complete clean-energy transformation. His work offers a reminder that carbon pollution is a serious health problem. It makes traditional air pollution—such as particulates and ozone—more harmful, so it poses particular threats to the places with the worst air pollution—cities.

Above is a map of CO_2 released from fossil fuels (with red and yellow marking the biggest pollution points), compiled from 2002 data by the Vulcan Project at Purdue University. It's a map of emissions, which isn't quite the same as airborne concentrations, but it gives a sense of where pollution happens.

Jacobson's urban-dome research presents two implications worth teasing out:

Trouble for cap-and-trade? The new evidence adds a wrinkle to cap-and-trade plans by suggesting that it matters where pollution happens. Cap-and-trade rests on the assumption that a ton of carbon has the same impact regardless of where it's emitted, so it doesn't matter if a factory in Nashville and a power plant in Phoenix trade emission permits. It only matters where emissions can be reduced most cheaply. But, says Jacobson, "This study contradicts that assumption."

If the research proves correct, it doesn't argue against cap-and-trade so much as highlight the need for a multi-pronged approach to CO_2 regulation. The Clean Air Act can set plant-by-plant performance standards while a declining cap covers the broader economy.

Urban vs. rural. Jacobson's research also pits the interests of rural and urban communities against each other. Cities could stand to suffer more under climate change, but US senators representing large urban areas already have proportionately less power to push through legislation that would curb CO_2 pollution. California, with its 37 million residents and numerous polluted urban areas, has two senators who want to enact climate legislation; Wyoming, with 540,000 residents and vast expanses of rural land, has two senators who oppose climate legislation.

Urban and rural areas have already been at odds over climate policy—and that was before we had any evidence that cities might really get the short end of the stick. The "domes" research provides more fodder for the fight. It underscores the essential unfairness of the effects of carbon pollution, and raises the question of just how much Wyoming should have to say about the health of Californians.

Based on a commentary by Jonathan Hiskes (Grist Magazine, March 17, 2010). Source: http://www.grist.org/article/2010-03-17-if-it-does-matter-where-co2-is-released-cities-are-in-trouble

Irrigation Decreases, Urbanization Increases Monsoon Rains

December 2009 — A Purdue University scientist has shown that man-made changes to the landscape have affected Indian monsoon rains, suggesting that land-use decisions play an important role in climate change.

Monsoon rainfall has decreased over the last 50 years in rural areas where irrigation has been used to increase agriculture in northern India, said Dev Niyogi, an associate professor of agronomy and earth and atmospheric sciences. At the same time, heavily urban areas are seeing an increase in heavy rainfall.

"In the rural areas, we're seeing pre-monsoon greening occurring two weeks earlier than what it did 20 years back, as the demand for agricultural intensification to feed India's people increases," Niyogi said. "The landscape has also moved in some places from what was once a traditionally rural setting to large urban sprawls. Both of these phenomena have affected monsoon rains."

Niyogi used more than 50 years of rainfall data -- spanning back to 1951 -- collected by 1,803 recording stations monitored by the India Meteorological Department to determine different regions' average yearly monsoon rain totals. While the mean monsoon rainfall for the entire country remained stable, Niyogi found that rainfall averages in India's northwest region decreased by 35 percent to 40 percent from the historical mean during the past 50 years.

Analysis of soil moisture showed that before monsoon rains came, the northwest region had become as much as 300 percent wetter in recent years relative to the past 30 years, which has been attributed to irrigation from groundwater to sustain intensified agricultural production. This wetter surface causes cooling that weakens the strength of low pressure necessary for monsoons to progress into northern India.

Satellite data showed that northern India is greening sooner than it had in the past. That greening is creating a barrier for monsoons, which provide much-needed rain to replenish groundwater reserves being used for irrigation.

"In this case, you need a warm, dry surface to advance the monsoon," said Niyogi, whose findings were published in the journal *Water Resources Research*. "Because of increased irrigation, you now have a wet, green area, which does not allow the monsoon to reach far enough north."

Since that rain isn't reaching the region, more irrigation is needed to sustain agriculture there. "Unless this is checked and controlled, the problem is going to become more and more severe," Niyogi said. "With more irrigation, we will have less monsoon rain. With less monsoon rain, you will need more irrigation, and the cycle will continue."

Urban areas, on the other hand, are being pounded with rain when it comes. Niyogi said there have been storms in some urban areas that drop as much as 37 inches of rainfall in a single day.

Urban areas in northern India have been pounded with rainfall. *Source:* http://www.treehugger.com

Analysis of the areas that have received increases in heavy seasonal rainfall, based on Indian Meteorological Department and NASA satellite data, showed that those areas were experiencing fast urban growth. Areas where seasonal rainfall decreased were determined to have slow or no urban growth.

"You only see these types of heavy rainfall events in those areas with heavy urbanization," said Niyogi, whose research on the urban effect was published in the *International Journal of Climatology*. "The more urbanization spreads in those areas, the more of these heavy rain issues we'll see and the more flooding will become a problem."

Niyogi said there are two theories on why that's happening. The first says that urban landscapes create heat, which extends into the atmosphere and energizes storms. The second theory is that pollution created in urban settings interacts with passing clouds and increases rainfall.

Niyogi said the results of his study could have land-use implications elsewhere. "If urbanization is affecting the Indian monsoon season, it has the ability to affect patterns here in the United States," he said. "This likely isn't localized in India."

Chandra Kishtawal, of the Space Applications Center of the Indian Space Research Organization and a co-author on the papers, said he hopes the findings trigger discussions on the role of large-scale land-use planning in regulating climate change in India. "These kinds of things are not sustainable," Kishtawal said. "They cannot continue in the long run."

The next step in this research is to examine landscapes in the United States to see if development has affected weather patterns historically. The study is funded by the National Science Foundation CAREER program and NASA's terrestrial hydrology program.

Source: http://www.sciencedaily.com/releases/2009/12/091215121049.htm

California study suggest that the grass is not always "greener"

January 2010 — Do urban "green" spaces help counteract greenhouse gas emissions? New research has found – in Southern California at least – that total emissions would be lower if lawns did not exist.

Turfgrass lawns help remove carbon dioxide from the atmosphere through photosynthesis and store it as organic carbon in soil, making them important "carbon sinks." However, greenhouse gas emissions from fertilizer production, mowing, leaf blowing and other lawn management practices are four times greater than the amount of carbon stored by ornamental grass in parks, a UC Irvine study shows. These emissions include nitrous oxide released from soil after fertilization. Nitrous oxide is a greenhouse gas that's 300 times more powerful than carbon dioxide, the Earth's most problematic climate warmer.

In ornamental lawns, nitrous oxide emissions from fertilization offset just 10-30% of carbon sequestration. But fossil fuel consumption for management, the researchers calculated, released about four times more carbon dioxide than the plots could take up.

"Lawns look great – they're nice and green and healthy, and they're photosynthesizing a lot of organic carbon. But the carbon-storing benefits of lawns are counteracted by fuel consumption," said Amy Townsend-Small, Earth system science postdoctoral researcher and lead author of the study, forthcoming in the journal *Geophysical Research Letters*. The research results are important to greenhouse gas legislation being negotiated. "We need this kind of carbon accounting to help reduce global warming," Townsend-Small said. "The current trend is to count the carbon sinks and forget about the greenhouse gas emissions, but it clearly isn't enough."

Turfgrass is increasingly widespread in urban areas and covers 1.9 percent of land in the continental U.S., making it the most common irrigated crop.

In the study, Townsend-Small and colleague Claudia Czimczik analyzed grass in four parks near Irvine, Calif. Each park contained two types of turf: ornamental lawns (picnic areas) that are largely undisturbed, and athletic fields (soccer and baseball) that are trampled and replanted and aerated frequently.

The researchers evaluated soil samples over time to ascertain carbon storage, or sequestration, and they determined nitrous oxide emissions by sampling air above the turf. Then they calculated carbon dioxide emissions resulting from fuel consumption, irrigation and fertilizer production using information about lawn upkeep from park officials and contractors.

Freshly mowed grass. Turfgrass lawns help remove carbon dioxide from the atmosphere through photosynthesis and store it as organic carbon in soil, making them important "carbon sinks." However, greenhouse gas emissions from fertilizer production, mowing, leaf blowing and other lawn management practices are four times greater than the amount of carbon stored by ornamental grass in parks. *(Credit: iStockphoto/Nicholas Campbell) Source:* www.sciencedaily.com

"It's impossible for these lawns to be net greenhouse gas sinks, because too much fuel is used to maintain them."

The study showed that nitrous oxide emissions from lawns were comparable to those found in agricultural farms, which are among the largest emitters of nitrous oxide globally.

In ornamental lawns, nitrous oxide emissions from fertilization offset just 10 percent to 30 percent of carbon sequestration. But fossil fuel consumption for management, the researchers calculated, released about four times more carbon dioxide than the plots could take up. Athletic fields fared even worse, because – due to soil disruption by tilling and resodding – they didn't trap nearly as much carbon as ornamental grass but required the same emissions-producing care.

"It's impossible for these lawns to be net greenhouse gas sinks because too much fuel is used to maintain them," Townsend-Small concluded.

Previous studies have documented lawns storing carbon, but this research was the first to compare carbon sequestration to nitrous oxide and carbon dioxide emissions from lawn grooming practices. The UCI study was supported by the Kearney Foundation of Soil Science and the U.S. Department of Agriculture.

Source: http://www.sciencedaily.com/releases/2010/01/100119133515.htm

Climatic effects of a rapidly urbanizing metropolitan complex: the rise of Phoenix

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The global effects of land-use and land cover change (LULCC) on increased emissions of greenhouse gases have received considerable research attention. Despite rapidly increasing global urban population, the local and regional LULCC impact resulting from modification of the surface energy and water balance, such as that associated with rapidly urbanizing locales, has received commensurately less interest. In this brief note we summarize the climatic effects of LULCC over one of the most rapidly expanding urban regions of the U.S., the Greater Phoenix metropolitan area. By means of high-resolution (2-km grid spacing) numerical modeling experiments using the Regional Atmospheric Modeling System (RAMS), we present evidence illustrating the importance of landscape change on meteorology and climate over a semi-arid urban complex whose population is expected to grow for decades to come.

Introduction

A landmark threshold was established in 2008, with global urban population reaching and exceeding its rural counterpart (United Nations, 2008). While the rate of current megacity (population greater than 10 million inhabitants) growth is not overwhelming, "megacities in waiting" are expected to account for the majority of future urban growth (United Nations, 2008). In the U.S., population shifts and associated land-use change have significantly altered the nation's landscape during the twentieth century (USGS, 2006) and though not without debate, urbanization's contribution to a changing climate is receiving increased attention (Kalnay and Cai, 2003; Vose *et al*., 2004; Oleson *et al*., 2010). In addition to biogeochemical impacts associated with LULCC, biogeophysical effects, with corresponding impacts on the surface energy and water balance, require attention (Pielke, 2005). Addressing these impacts via a local to regional lens will improve our overall understanding of the full spectrum of anthropogenic climate change. This is especially critical for urban complexes where a growing share of humans will reside (domestically and globally), necessitating enhanced focus of adaptive and mitigating measures to cope with the mounting environmental challenges of the future.

The Greater Phoenix metropolitan complex is a regional manifestation of what has been and continues to occur globally. While technological progress has allowed for settlement, occupation, and continued expansion of a region deemed largely inhospitable due to its hot and arid climate, the geographic placement of this urban center makes it particularly vulnerable to hydroclimatic shifts. Understanding the consequences of this major landscape conversion on climate and hydrology is a key concern, as accelerating sprawl continues, not only in Phoenix, but throughout the U.S. and the world. Below, we summarize the modeling approach and principal conclusions drawn from recent high-resolution climate modeling work addressing this matter (Georgescu *et al*., 2009a; Georgescu *et al*., 2009b).

Discussion

The initial step toward evaluation of the effect of LULCC on climate and hydrology over Greater Phoenix required development of a consistent set of land-use and land cover (LULC) classes to be incorporated into the land surface component (LEAF-2) of our numerical model (RAMS). This task was aided by the dawn of the satellite era, and through use of *Landsat* from the early 1970s onwards, aerial photography and imagery became a critical tool in the biophysical characterization of the specific region's evolving landscape (Figure 1).

After diagnosis of a trio of suitable "wet" and "dry" monsoon seasons, high-resolution nested grid simulations were conducted using each of the landscape snapshots (Figure 1) (three nested grids were used) and forced at the lateral boundaries with corresponding data from each of the "dry" or "wet" seasons. The outer pair of grids (32-km and 8-km grid spacing, respectively, for grids 1 and 2) utilized the default RAMS landscape representation while the trio of landscape temporal snapshots was utilized within the fine grid (grid 3; 2-km grid spacing). In total, 18 experiments were performed for six different July months with the degree of climate sensitivity to LULCC more easily assessed given distinct hydrometeorological regimes (Table 1). Below, we pres-

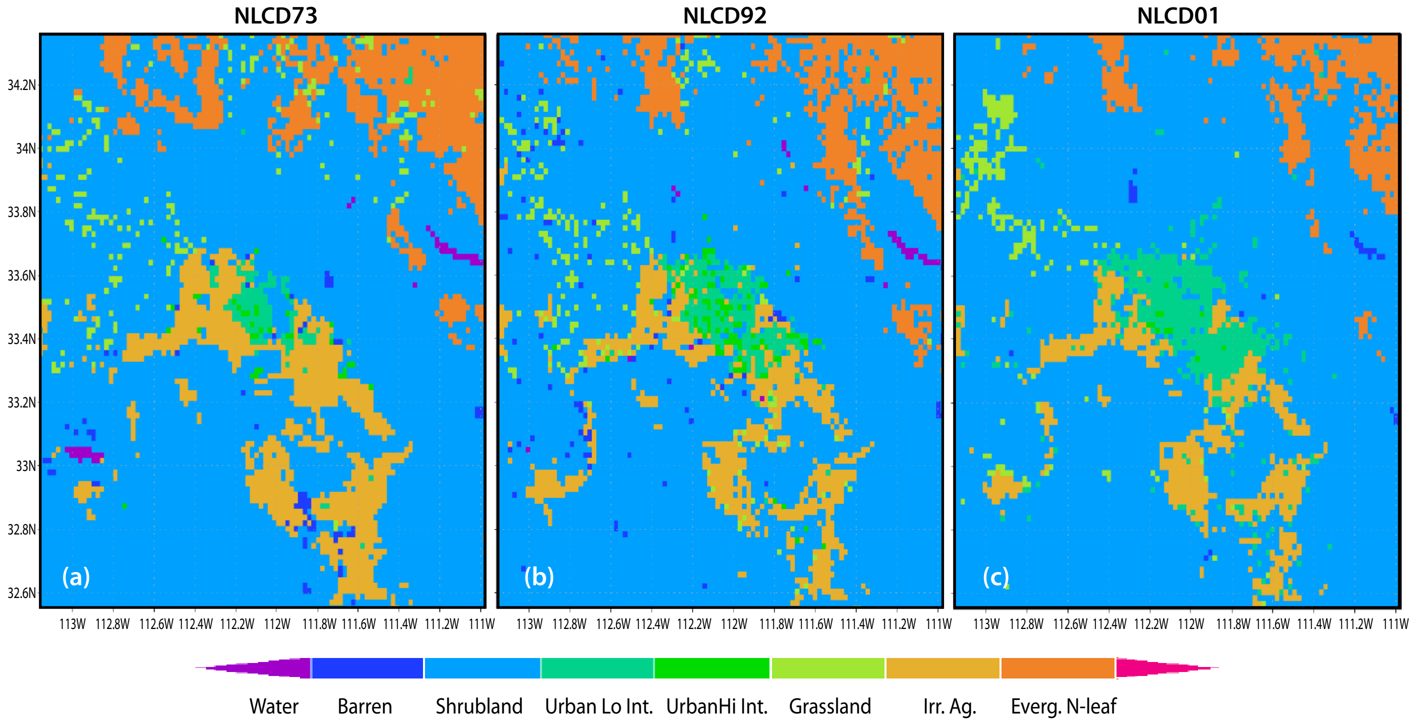

Figure 1. Dominant landscape representation for (a) NLCD1973, (b) NLCD1992, and (c) NLCD2001. Landscape representation is used as surface boundary condition for all simulations, within fine grid only (i.e. grid 3). (Figure reproduced from Georgescu *et al*., 2009b)

ent principal results as monthly (July) parameter differences between the most extreme landscape representations (i.e. NLCD01 minus NLCD73).

While the evolution of the region's modern-day landscape from its pre-sttlement state reflects both warming due to urbanization and cooling due to irrigated agriculture (Georgescu *et al*., 2008), more recent development of the metropolitan complex since the 1970's has resulted in widespread warming (Figure 2). Maximum warming exceeded 1°C and occurred over those regions experiencing the greatest urbanization (see land-use changes in Figure 1, and compare with Figure 2a in Georgescu *et al*., 2009a). Averaged over the entire month and spatial domain (roughly equivalent to a single GCM grid cell) the experiments using the NLCD01 landscape were warmer than those using the NLCD73 landscape by 0.12°C. It is important to note that our sensitivity experiments allow us to quantify the relative impact of three decades of LULCC on regional climate, distinct from other forcings (e.g. GHGs), and draws attention to considerable potential future impacts and consequences in light of continued development, population growth, and water resource concerns.

Individual from-to landscape themes, whereby the impact of those pixels undergoing a change in dominant LULC type (LEAF-2 permits subgrid-scale landscape heterogeneity, allowing for multiple cover types within each grid cell) is quantified, allowed for assessment of distinct modes of landscape change. The conversion of irrigated agriculture (note the decrease in agricultural

Table 1: Summary of all experiments performed. All simulations were initialized on June 30 00Z of the respective year and continued through July 31 12Z. * Denotes experiment used as CONTROL simulation evaluated against suitable observations of temperature and precipitation (Georgescu *et al*., 2008).**

Landscape Conditions	Year from which Initial and Boundary Conditions were used to force RAMS simulations	
	WET Years	DRY Years
NLCD73	1990, 1984, 1983	1994, 1989, 1979
NLCD92	1990***, 1984, 1983	1994, 1989, 1979
NLCD01	1990, 1984, 1983	1994, 1989, 1979

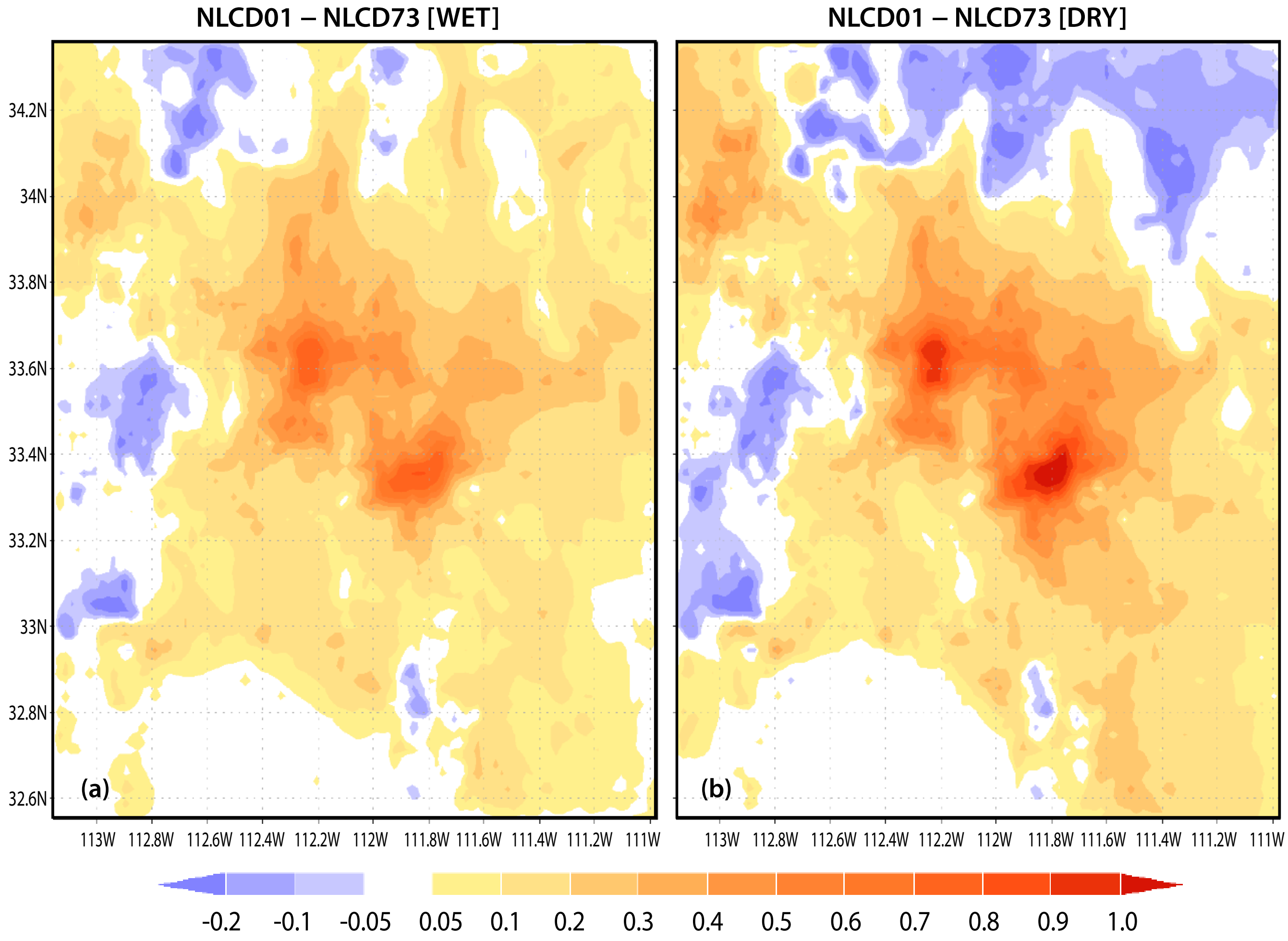

Figure 2. RAMS simulated mean monthly (July) difference (NLCD01 minus NLCD73) in first atmospheric level temperature [°C] for (a) all three WET simulations, and (b) all three DRY simulations (Figure reproduced from Georgescu *et al*., 2009a).

land at the expense of increased coverage of urban land in Figure 1) to urban land, over the diurnal time scale averaged over the course of the monthly simulations, warmed the near-surface by greater than 1.5°C (1°C) during the "dry" ("wet") experiments, with a similar magnitude (though of opposite sign) effect on near-surface dew-point (i.e., a drying, with enhancement for the "dry" experiments).

Three decades of landscape transformation and the resulting mesoscale landscape heterogeneity was responsible for the reorganization of lower tropospheric pressure gradients that modified local and regional air flow. Mesoscale circulations similar to the sea breeze were formed and enhanced on a nearly daily basis for the experiments utilizing the NLCD01 landscape, relative to its NLCD73 counterpart, assisting in the transport of both heat and moisture into the planetary boundary layer (PBL) (the effect on moisture transport is presented in Figure 3). Despite their impact on near-surface weather and climate (i.e. warming via enhanced turbulent heating and drying via mesoscale moisture transport into the upper PBL), these strengthened circulations were not found to alter precipitation.

Our simulations, however, were suggestive of rainfall enhancement (to the north and east of the urban complex) and the urban enhancement of precipitation was simulated in previous work (Georgescu *et al*., 2008). The precise physical mechanism(s) whereby precipitation was initially enhanced involves a complex interplay among scales (from the turbulent to the synoptic scale) requiring further research and highlights the nonlinearities involved in the coupled land-atmosphere system. Precipitation recycling was found to play an important role in rainfall sustenance (i.e., once the initial enhancement occurred). We note that modeled intensification of rainfall was observed only during the "dry" experiments, in agreement with previous work suggesting that convective rainfall is most sensitive to near-surface thermodynamic perturbations during dry rather than wet hydrometeorological conditions.

The climatic effects simulated in this work likely represent underestimates as our version of RAMS did not include a comprehensive urban canopy parameterization as well as important forcings such as anthropogen-

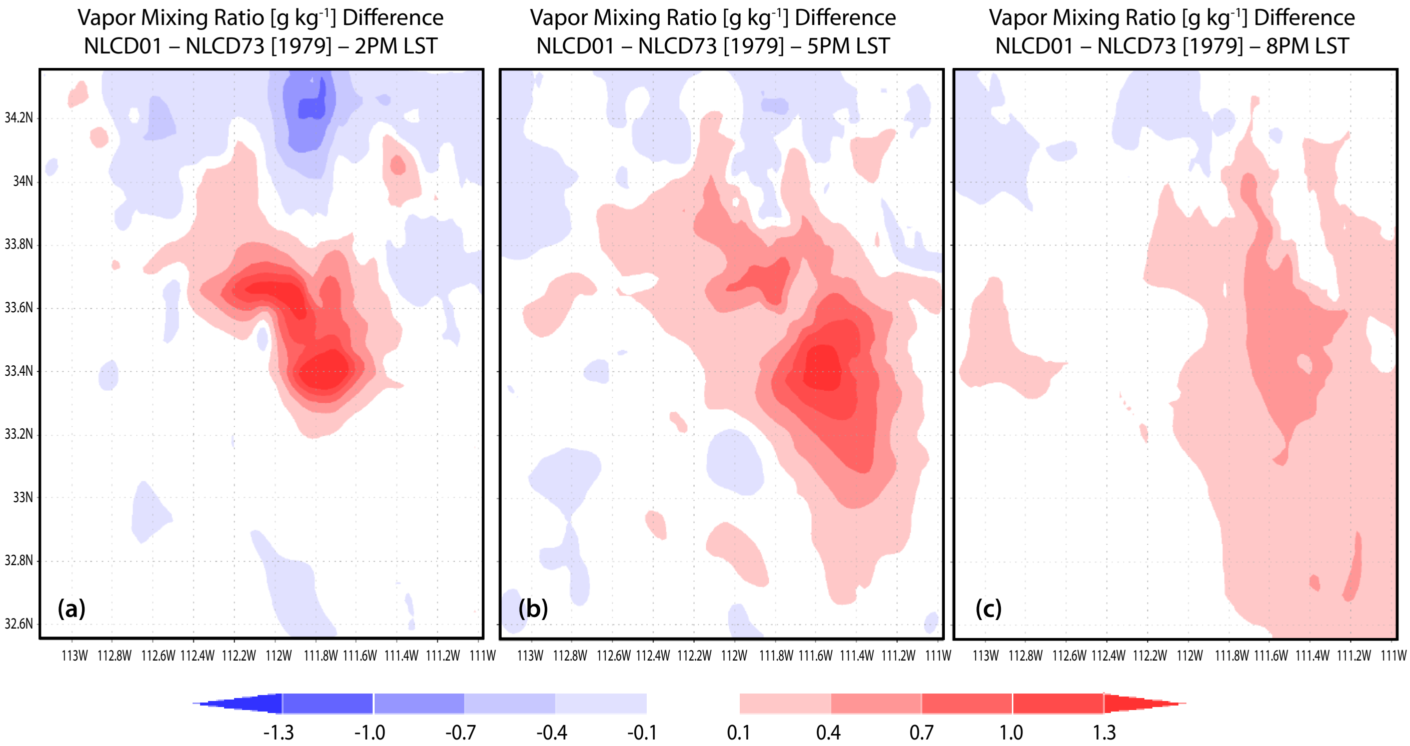

Figure 3. RAMS simulated differences in monthly averaged water vapor mixing ratio (g kg-1) (NLCD01 – NLCD73) at 1330-m (near the top of the PBL) altitude at (a) 1400 LST, (b) 1700 LST, and (c) 2000 LST for 1979 (one of three "dry" simulations). The simulated impact resulting from the (nearly) daily recurrence of mesoscale circulations on the evolution of water vapor transport is evident. (Figure reproduced from Georgescu *et al*., 2009b)

ic heat release (expected to promote further warming). Future refinements (using the Weather Research and Forecasting modeling system) will account for the presence of and interaction between building structure(s) and the overlying atmosphere, anthropogenic heat release, and additional capabilities that will help us refine still outstanding questions related to urban-induced rainfall over this relentlessly expanding urban complex.

Acknowledgments

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Benefits and opportunities of the adaptation of geoinformatical software in outdoor human comfort studies

1. Introduction

Because of the rapidly growing global population, more and more people have to live or work in urban areas – and the importance of thermal comfort investigations of urban public areas with recreational purposes continues to grow. There are many more factors that influence thermal comfort conditions in the open-air than indoors, as several studies have pointed out (Höppe, 2002; Nikolopoulou and Steemers, 2003; Thorsson et al. 2004; Knez and Thorsson, 2006). If the study concentrates on whether an urban public area is appropriate for recreation, more specified and more detailed information is needed about the investigated area on the one hand and about the visitors on the other hand.

The aim of the present paper is to recommend a methodology for the thermal comfort investigations of open public green areas (squares and parks) in urban environments. There is an emphasis on the advantages of using the geoinformatical software *ArcView* GIS 3.3, which could be a valuable tool to collect, process and visualize the data. The opportunities coming from adapting this software will be demonstrated through a study in which the data were collected using human monitoring and environmental monitoring.

2. Steps of the human comfort study carried out in Szeged

The study in Szeged (Hungary) aimed to reveal the recreational aspects of the area usage according to the thermal conditions. It was conducted in 2008 between 10 April and 15 May on every Tuesday, Wednesday and Thursday from 12 to 3 p.m.

A green area adjacent to the automatic meteorological station by the University of Szeged (on the Ady Square) was selected as the study area (Fig. 1). The main part is a great grassy area surrounded by a morphological step. Several old trees can be found on the northwestern side and there are 10 benches on the site, 8 along the pavement and 2 on the grass. The area is regularly visited by a high number of students throughout the academic year, which makes it suitable for this kind of comfort studies using meteorological measurements and human monitoring. The topography of the study area was mapped as a preliminary step prior to the field measurements. This

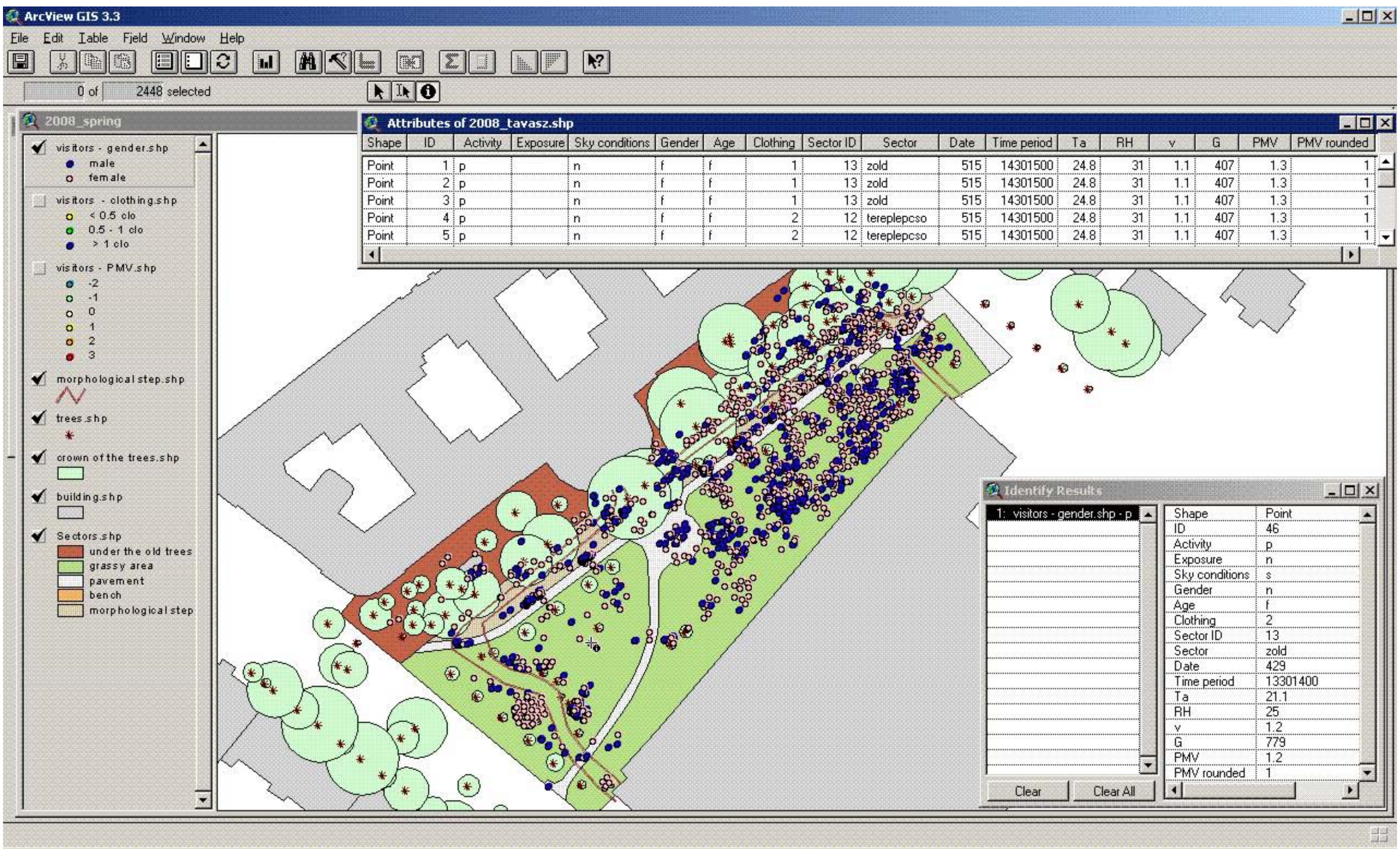

Figure 1. The investigated area in *ArcView*: green points mark the visitors' locations; the connected attribute table contains all of the observed and measured information (according to the whole dataset).

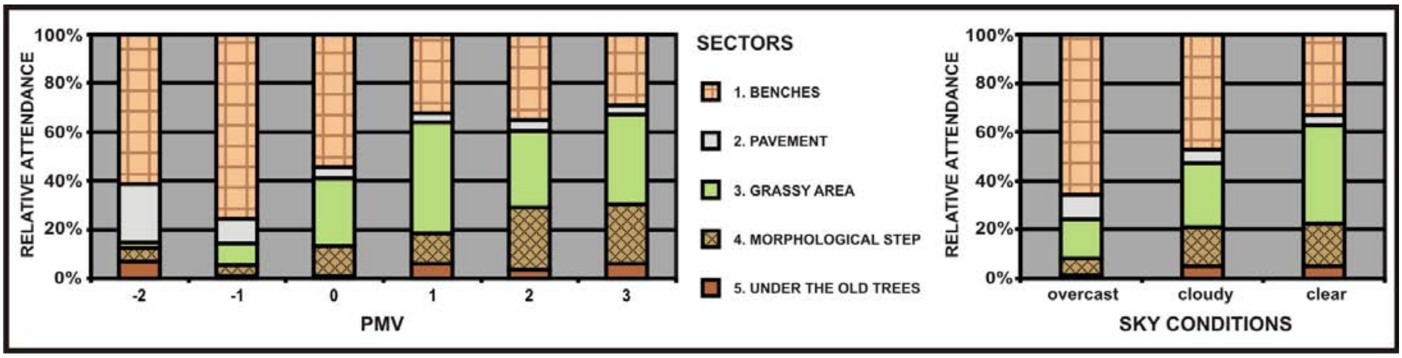

Figure 2. Relative attendance of the sub-areas according to the thermal and sky conditions.

consisted of recording the exact coordinates (x, y, z) of artificial and natural objects and different surface covers, as well as the measurement of the heights of trees and buildings. Besides full and trunk heights, trunk circumference and the crown radius of the trees were also registered. The georeferenced map of the study area was created with the *ArcView* GIS 3.3 software based on these data.

Human monitoring consisted of unobtrusive observations of people lingering on the site. The presence was measured cumulatively in half-hour periods. The locations of the visitors staying there in a given half-hour period were marked with ID numbers on a map of the area. (People only passing through the area were not included.) Each half hour between 12 and 3 p.m. on each measurement day had its own map which included the individuals' exact locations. Each of these had a connected table containing the marked visitors' gender (male / female), age (child, young / middle aged / old), position (sun / penumbra / shade), clothing (<0.5 clo, 0.5-1 clo, 1 clo<) and type of activity (active / passive). The ID counters started from 1 in every half hour period so the absolute cumulative attendance could be easily derived at the end of the given period. The observations produced 2448 datasets on the whole.

To describe the thermal conditions 10-minute averages of air temperature T_a (°C), air humidity *RH* (%), wind velocity *v* (m/s) and global radiation *G* (W/m^2) were obtained from a QLC50 type station by the site. As a first step of data processing, Fanger's Predicted Mean Vote (*PMV*) was calculated using the radiation and bioclimate model RayMan.

The tables of the collected personal characteristics were digitized in Microsoft Excel, then the half-hour averages of measured and calculated objective parameters were attached to these subjective data according to the time of the measurement. The investigation maps were digitized within *ArcView*. As a result, cumulative attendances were represented on a layer, which showed peoples' locations (Fig. 1). The attribute tables of this layer contained the marked visitors' ID numbers, the time intervals of the observations, and additionally the subjective and objective parameters which had been summarized earlier.

Due to the integrated data processing with *ArcView*, we are able to select anyone from the visitors of the area. We can query the selected visitors' personal data (gender, age, clothing, position, activity) and location, the time period (day, half hour) when they stayed in the area, and the thermal characteristics of the given time period (T_a, *RH*, *v*, *G*, *PMV*). The software makes it possible to select, aggregate or divide visitors into different groups according to any (combinations) of the above mentioned information (Fig. 1). The selection and aggregation can be made also on the basis of the registered visitors' locations. To study the spatio-temporal patterns of the area's

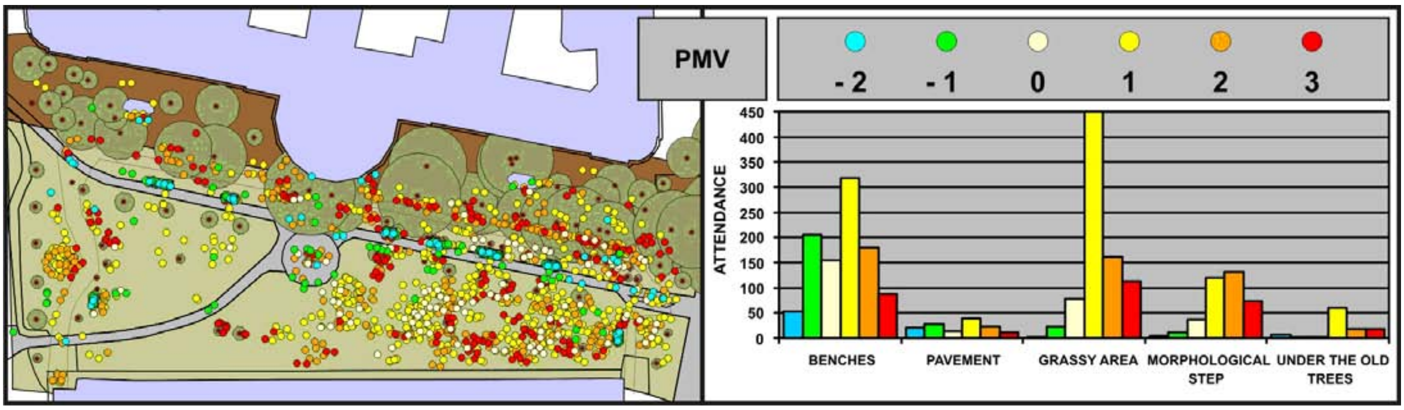

Figure 3. Spatial usage of the area (absolute attendance of the sectors) according to the thermal conditions.

Table 1: Summary of statistical measures describing relationships between the attendances of the sectors and the recorded characteristics during the study period .

		PMV	clothing	activity	age	gender	position
Sample size	*n*	2448	2448	2448	2448	2448	2133
Significance level	*α*	0.000	0.000	0.000	0.000	0.038	0.000
Cramer's-V	*V*	0.212	0.196	0.299	0.113	0.064	0.415
Contingency coefficient	*C*	0.391	0.267	0.286	0.191	0.064	0.506

usage, sectors (sub-areas) should be created according to various categories, for example shading, surface cover, function etc. After that, it is easy to get information in what circumstances (in what time, by what thermal conditions) what kind of visitors (according to given personal parameters) took a seat in the given sub-areas (for example on the benches). These evaluations are of great importance in the field of urban human comfort investigations.

3. Spatial usage of the area

In order to study the spatial patterns of the area usage, five sectors were defined. 1st: the 10 benches, 2nd: the pavement, 3rd: the great grassy area stretches on the southeastern side, 4th: the northwestern side of the morphological step, 5th: the sub-area under the tall, old trees. All sectors had the highest number of visitors (absolute attendance) by clear sky and slightly warm thermal conditions (PMV = 1), but the relative attendance of the selected sub-areas showed remarkable tendencies according to the PMV and the amount of sunshine (Fig. 2).

The relative usage of the benches was dominated by overcast-cloudy sky and by lower PMV values. However, with warmer (PMV > 0) and more sunny situations the greater proportion of visitors stayed on the grass. At the same time, the relative attendance of the morphological step and the shady sector under the old trees become higher. Physical adaptation of people in the cases of sunny warm-hot circumstances is indicated by the increasing percentage of subjects on the shady-penumbra sectors 4 and 5 (Fig. 2).

To illustrate these graphical results also in a spatial manner, a map was created with *ArcView* which shows the area usage according to the thermal conditions (Fig. 3). The seating capacity of the benches is obviously limited, so in case of warmer conditions (which can be characterized by greater number of visitors) more and more subjects had to take seats in the other sectors. On the other hand, higher *PMV* values were associated with sunny conditions and many people came into the area to sunbathe. Furthermore the nature and extent of the grassy sector permitted attendance to take place even in greater bunches (Fig. 3). The relationship between the PMV values and the attendance of the particular sectors can be described statistically with Cramer's V (*V*) and with the Contingency coefficient (*C*). According to these two statistical measures, the relationship is significant ($\alpha = 0.00$) and moderately weak ($V = 0.212$ and $C = 0.391$).

The markers showing the visitors' locations (2448 on the whole) on the area map can be colored according to any of the recorded subjective characteristics (e.g. clothing, activity, age, gender or position) with the *ArcView*. This method is very suitable to illustrate the results of the statistical tests using *C* and *V* values (Table 1). The relationship between the visitors' clothing and the attendance of the mentioned sectors is significant, but not strong. The passive and active subjects' area usage shows remarkable differences supported by the moderately weak *C* and *V* values, due to the more active subjects preferring the pavement for walking and the large grassy area for playing. Nearly all of the elderly (old and middle aged) subjects sat on the benches or stayed on the pavement and nearby. There was only a slight difference in the spatial usage of the study area according to the gender of the visitors, as the values of the *C* and *V* are very low (Table 1). The shading conditions provided by the selected sectors showed the best correlation with the spatial usage of the area ($V = 0.415$ and $C = 0.506$) due to the given sub-areas having different vegetation and exposure to the sun.

4. Significance of the investigation design and the *ArcView* program

The presented study consisted of a preliminary survey of the sample area, meteorological measurements near the site (environmental monitoring) and simultaneous observations of the visitors (human monitoring). This investigation design is very useful for the thermal comfort examination of a small urban square, since in a relatively short time a lot of information can be obtained by using tables of personal characteristics in each half hour. By recording the visitors' exact spatial locations besides their personal characteristics, we had wide-ranging possibilities for the data processing and the representation of the results. It is important to note that the presented observation method can cope only with "resting place conditions" and mainly sedentary visitors, as marking the spatial position of too many active subjects can not be accomplished.

Data were integrated with *ArcView* as digitization of the subjects' exact locations required this geoinformatical application. All data derived from the environmental and human monitoring were joined to the markers signing the individuals according to their ID numbers as well as the certain half-hour periods. The resulting format facilitated the data analysis. The presence can be showed on the whole or can be separated and presented according to any of the objective or subjective parameters. Consequently, the spatio-temporal presence of certain groups, additionally the attendance of particular subareas in accordance with the meteorological conditions became easily to analyze. The software facilitates selection of visitors for further descriptive and inferential statistical treatment, on the basis of the individuals' characteristics, or on the basis of their locations.

Fig. 3 clearly illustrates the benefits of a map constructed with geoinformatical software in terms of the interpretation of statistical results. Graphs combined with these area usage maps are more expressive than the pure statistical measures (commonly used by theoretical sciences) without graphical illustrations. It is especially important in the course of discussion with urban planners and civic designers aiming to construct more comfortable urban areas. The importance of the topic is obvious, as the efficiency, well-being and health of citizens are positively (or negatively) influenced by the thermal comfort conditions, so by obtaining and maintaining comfortable conditions urban life quality will be enhanced (Mayer, 2008). The adopted methods can be extended with interviews, questionnaires, as well as with mobile meteorological measurements. Processing such data with *ArcView* has additional inherent opportunities, and could be adapted by experts working in the field of applied urban climatology.

5. Conclusion

This article described the methodology and some representative results from an outdoor thermal comfort study carried out in the center of Szeged. The study design proved to be appropriate to record a lot of subjective information about the visitors. Measurement of the climate parameters on the site with simultaneous human monitoring makes it possible to look into the connections between the area–climate–human attitude complex. These results are important to reveal beneficial coherences which can be used in the process of urban planning – civic designing.

Acknowledgements

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Spatial distribution of environmental noise and total particle number concentrations in urban areas

Introduction

Urban areas are prone to significant concentrations of different environmental stressors due to the large number of emission sources, e.g. traffic, industry and households. Two stressors receiving increased attention during recent years are particulate air pollution and environmental noise. In a number of studies both were associated with significant effects on human health (e.g. Oberdörster and Utell, 2002, Babisch *et al*., 2005, Muzet, 2007).

While traffic is a major source of particles and noise (e.g. De Kluizenaar *et al*., 2007), there is little insight into the spatio-temporal covariation of both on the urban scale. Weber and Litschke (2008) looked into the variation of noise and particle mass in cities; however, the present project deals with the spatial distribution of particle number concentration and environmental noise.

Study area and methods

Measurements were performed within a busy urban street canyon and its surrounding neighbourhood in Essen, Germany. The street canyon 'Gladbecker Straße' (federal road B224) is characterised by a long-term average daily traffic intensity (ADT) of about 49,000 vehicles 24 h^{-1} (cf. Weber *et al*., 2006 for details on the study area and canyon meteorology).

To study the spatio-temporal variability of particle number concentration and ambient noise, both quantities were gathered at 50 fixed measurement points (MP) along the 3.5 km measurement route during four consecutive days from Monday 28 July to Thursday 31 July, 2008. This results in a spatial resolution of about one measurement every 70 m.

Total particle number concentration (TNC) was measured by a handheld condensational particle counter (CPC, TSI Inc., USA, Model 3007). According to the manufacturer, the CPC is able to measure particles above a cut-off of 10 nm. The CPC measures the total number concentration with a time resolution of 1 s.

Ambient noise was evaluated by a handheld noise level meter (Norsonic, Norway; Mod. Norsonic 118). The device is able to sample the noise level with a resolution of 1 s.

Results and discussion

Particle number

The temporal variation of particle number concentrations in urban atmospheres, e.g. the day-to-day variability, is generally large as a consequence of changes in background concentrations and dependence on time of day (e.g. traffic intensity, atmospheric stability). The diurnal course of TNC at the container site is characterised by a clear peak during the morning rush-hour with concentrations of up to 32,000 cm^{-3} on average (Fig. 1). Distinct morning rush-hour peaks of particle number caused by the combination of the daily peak in traffic intensity and stable atmospheric stratification during the early morning hours were reported from a number of street canyon and curbside studies (e.g. Wehner *et al*., 2002, Morawska *et al*., 2008). Afterwards, in consequence of a growing atmospheric mixing layer and decline in the number of passing vehicles, TNC concentrations decrease to about 13,000 cm^{-3} at noon.

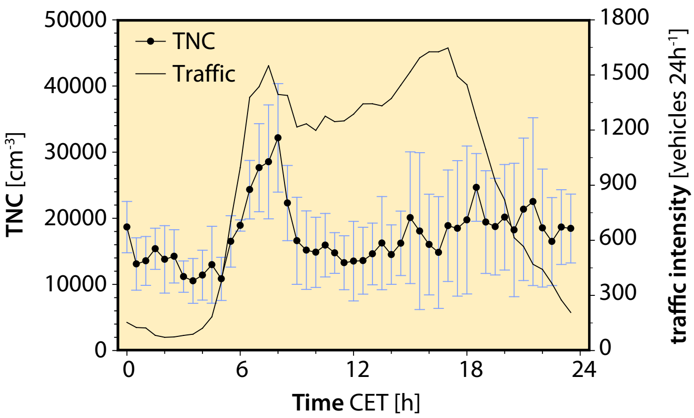

Figure 1. Average diurnal course of TNC (circles) and traffic intensity (solid line) from the container site for the study period from 28 to 31 July, 2008. The vertical error bars indicate standard deviations.

Average particle number concentrations measured by handheld CPC during twelve mobile measurements vary between 12,500 cm^{-3} and 29,500 cm^{-3} on average (Table 1). However, the 20 s maximum TNC along the measurement route can reach concentrations > 100,000 cm^{-3} (Table 1). These estimates are comparable to measurements conducted in Montreal, Canada (Weichenthal *et al*., 2008). During walking along a busy two-lane road, average particle number concentration in the size range $0.02 < D_p < 1$ µm of 25,000 cm^{-3} with a maximum of 89,000 cm^{-3} were observed during the morning hours. Higher particle numbers were reported from a study conducted in London, UK (Kaur *et al*., 2005).

Environmental noise

Average values of L_{eq} during the 12 measurements vary by about 5.3 dB(A). In relation to the human sense of hearing, which perceives a 10 dB noise increase as a doubling of loudness, the estimated range of 5.3 dB corresponds to approximately one-third of a doubling of loudness on the logarithmic dB-scale. It becomes obvious that background variability and dependence on

Table 1: Average and median values of TNC and L_{eq} for the 12 measurements based on the 20 s measurements at 50 MP. Spearman R denotes rank-correlation coefficients for TNC vs. L_{eq} respectively.

Measurement	TNC [#cm^{-3}]			L_{eq} [dB(A)]			Spearman R
	Average	Median	Max.	Average	Median	Max.	
1	15902	10549	63568	70.6	57.3	85.7	0.57
2	18511	11798	62026	72.3	58.9	86.1	0.69
3	22953	18823	60976	69.4	58.0	90.4	0.28#
4	20773	16964	48952	70.3	58.5	80.5	0.54
5	17393	18101	30423	68.7	60.6	77.9	-0.21#
6	15724	9714	78670	69.2	56.4	77.1	0.28
7	12459	8574	53963	69.5	59.3	79.2	0.73
8	15240	11809	63785	68.9	56.1	79.3	0.40
9	19878	16362	56596	73.1	59.8	84.1	0.30
10	21899	20402	52637	67.8	59.5	76.4	0.52
11	29479	19512	110648	69.9	55.1	79.2	0.64
12	21401	14212	79341	70.1	57.5	80.1	0.74

not significant for $p < 0.05$

time of day (e.g. traffic intensity) seem to have a higher impact on variations in TNC than L_{eq}.

Spatial distribution of noise and particles

The spatial distribution of both quantities is significantly coupled to road traffic on B224 (Fig. 2). The values at every single MP in the vicinity of the major road (MP 15, 21, 25, 29, 49, 50) as well as the contiguous MP along the street canyon (MP 33 to 43) are considerably elevated above those located at some distance to B224. The classified average number concentrations of MP (Fig. 3) situated at some distance to B224 fall within the lowest concentration class (12,000 to 19,000 cm^{-3}). Within the street canyon TNC reaches maxima of up to 40,000 cm^{-3}. On average the street canyon TNC are larger by a factor of up to 2.4 in comparison to the local background on residential streets in the neighbourhood. Since road traffic is a significant source of (ultrafine) particles it is obvious that the exposure towards high concentrations is closely coupled to the proximity of measurements to roads (e.g. Weichenthal *et al.*, 2008, Morawska *et al.*, 2008).

The spatial distribution of TNC closely corresponds to significant elevations of ambient noise at the near-road measurement points. All MP close to B224 are characterised by average noise levels above 70 dB(A) while those in the built neighbourhood are between 50 and 55 dB(A).

Besides the spatial distribution of TNC and L_{eq} on the local scale, a general positive relationship between TNC and L_{eq} is present in the data (Fig. 4).

The close spatio-temporal covariation of both quantities is supported by a correlation analysis (Table 1). Except measurement day 2 (29 June 2008), significant positive correlations between TNC and noise are demonstrated by Spearman rank-correlation coefficients. The

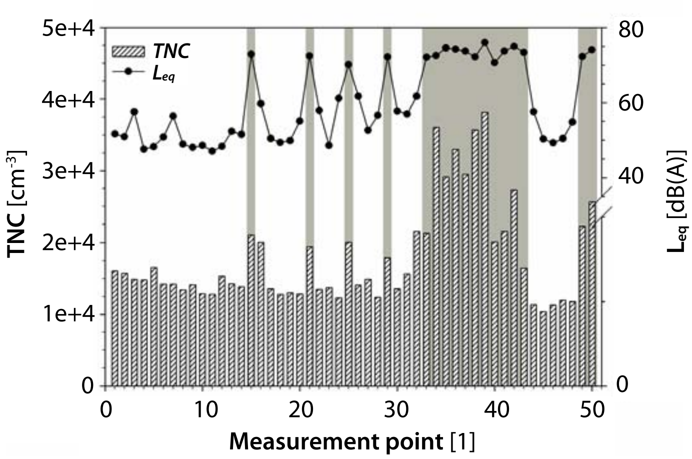

Figure 2. Median TNC and L_{eq} at the 50 measurement points along the route. Grey shadings indicate the points that are situated in close proximity to road traffic on B224.

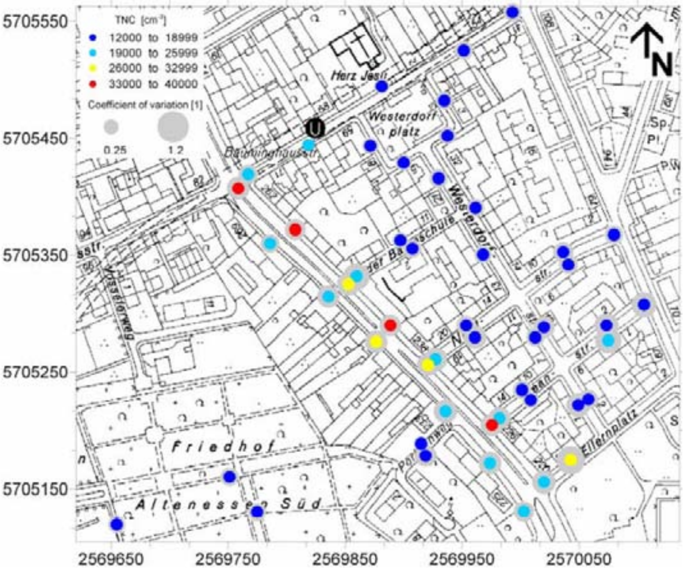

Figure 3. Spatial distribution of TNC in the study area binned into different concentration classes.

correlation coefficients are principally larger than 0.5, indicating a strong positive relationship between TNC and L_{eq} on the local urban scale. The lower correlation on 29 June 2008 is attributed to the state of the boundary layer on that day (see Weber, 2009 for details).

The future

The present results indicate the spatio-temporal distribution of noise and particles to be closely coupled to road traffic emissions. Future research should tend to verify the present results in a long-term campaign with a number of fixed measurement sites at urban/suburban locations. Generally, it would be advantageous to incorporate effects of ambient noise in future cohort studies on particle health effects in urban atmospheres, since both stressors are characterised by a similar spatio-temporal variation on the local urban scale.

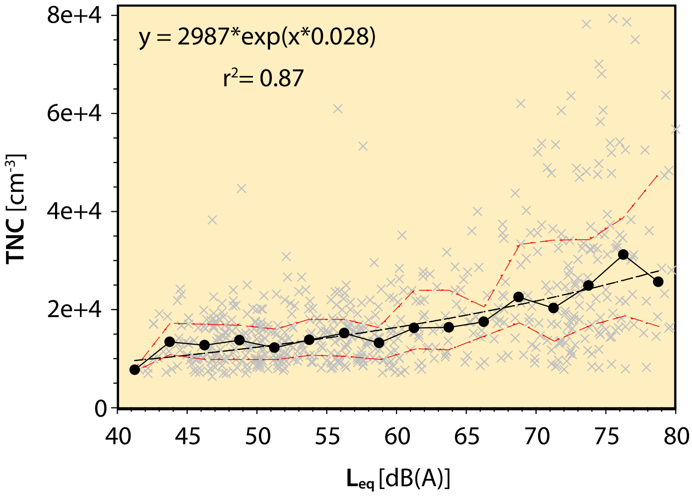

Figure 4. Scatterplot of the variation of particle number concentration TNC with environmental noise L_{eq} (crosses). The data is also binned into 2.5 dB(A)-classes to evaluate median TNC concentrations (circles) and the interquartile range (between red dashed lines indicating the 25 and 75 percentile). The black dashed line depicts an exponential fit to the data (n = 500).

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Country Report: New Zealand 2010

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Over the last five years urban climate research in New Zealand has really started to take off, particularly in the area of urban air pollution. Working together, multidisciplinary teams of academics, medics, consultants and regional councils from across the country have pulled together to make some significant progress unravelling some of the key issues surrounding air pollution and health in New Zealand. This report is an update to that published in 2004 by Rachel Spronken-Smith, and thus focuses on more recent activities over the last 5 years.

Perhaps most notably since 2004, the 'Health and Air Pollution in New Zealand' (HAPiNZ) study was published in 2007. Led by Gavin Fisher (Endpoint, Auckland), this study sought to identify and quantify the risk to New Zealanders from air pollution (Fisher *et al.*, 2007). A huge undertaking, this study examined each link in the air quality chain from emissions through to determining the economic impacts of negative health outcomes associated with pollution. It revealed that despite New Zealand's 'clean green image,' periods of poor air quality had measurable health effects on the population and was associated with significant health risk and economic loss. The report suggests that previous studies may have under-estimated the impact of vehicle emissions and smoke from domestic fires (still a common form of domestic heating throughout New Zealand) on both health and the economy, especially in Auckland. Part of the HAPiNZ project focused on student health and pollution exposure in and out of a school in Christchurch and found that indoor and outdoor levels varied under different conditions (Kingham et al., 2008a) with some evidence of measurable health effects in school children (Epton *et al.*, 2008; Cavanagh *et al.*, 2006). In addition, the pollution estimates (Kingham *et al.*, 2008b) derived as part of HAPiNZ were used to show that air pollution in New Zealand affects different groups unequally adding to the environmental justice debate (Pearce and Kingham, 2008; Kingham *et al.*, 2007; Pearce *et al.*, 2006).

Figure 1. Air quality sampling whilst on a bicycle (Photo S. Kingham)

Building on this work, a newly funded, multi-million dollar research programme known as "Healthy Urban Atmospheres" (http://www.niwa.co.nz/our-science/atmosphere/research-projects/all2/healthy-urban-atmospheres#null) led by Guy Coulson (NIWA) aims to develop the tools to assess and manage air quality within urban areas in an integrated framework with other sustainability concerns such as climate change and social equity. The research, which commenced in October 2008, has three key themes:

- determining the contribution of exposure in different environments to total exposure by developing methods for high resolution spatial and temporal measurements of population exposure to pollutants in a range of microenvironments (home, work, school, commuting, leisure etc.)

• providing the science for the next generation of air quality management by investigating new ways of quantifying and assessing pollutants and their effects, and developing and refining new and existing tools for air quality management

• integrating air quality management into a wider sustainability framework by examining the links, co-benefits, conflicts and trades-offs between different environmental and social management strategies – particularly climate change, energy, transport and housing.

New Zealand's air quality modelling capacity is also developing, led by Peyman Zawar-Reza (University of Canterbury) (Zawar-Reza & Sturman, 2008). For example, high-resolution modelling of air flow over Auckland using WRF has enabled identification of the impact of complex land-sea breeze systems on dispersion of urban emissions, including recirculation of shipping emissions back to land (Khan *et al*., 2009).

In Auckland, new light-weight portable ozone and nitrogen dioxide monitors developed by David Williams (University of Auckland) and Aeroqual Ltd (www.aeroqual.com) have the potential to revolutionise the way we monitor pollutants in urban areas (Williams *et al.,* 2009a; 2009b). Pilot studies around a complex intersection in Auckland have shown detailed 3-dimensional patterns of pollutant dispersion in time and space (Salmond *et al*., 2009). Wintertime air pollution issues in small townships in rural New Zealand, often located in areas of complex terrain, also continue to be on the research agenda. Mulliner *et al*. (2007) explored trends in particulate pollution in Mosgiel, a township located near Dunedin, whilst further south Conway *et al*. (2007) examined spatial patterns of particulates during winter in Invercargill. Alexandra, a small town in an inland basin of Central Otago, has been the subject of recent research. In winter months particulates can exceed the national standards over 40% of the time (Tate *et al*., 2008), with both observational and modelling research showing that the complex meteorology, combined with high emissions from domestic heating, are the main causative factors (West, 2008).

The last three years have also seen a focus on human exposure to air pollution.

Teams of researchers from across New Zealand have been exploring very high resolution (metre/second scale) variations in personal exposures to urban air pollutants, and notably vehicle emissions. The research exploits new developments in miniaturised air quality and meteorological instrumentation and data collection techniques. The overall aim of this work is to determine how personal exposure is influenced by urban meteorology and the built environment, vehicle fleet composition, modes and route of transport, urban design and personal physiology. Intensive observational campaigns have been designed to inform future personal exposure modelling, scenario modelling and an investigation into how personal exposures relate to current population-wide measures of air quality, such as data from fixed monitoring stations. For example funded projects led by Ian Longley (NIWA) and Kim Dirks (University of Auckland) have examined the relationship between spatial variability of carbon monoxide within the city and human uptake in the form of carboxyhaemoglobin. Studies

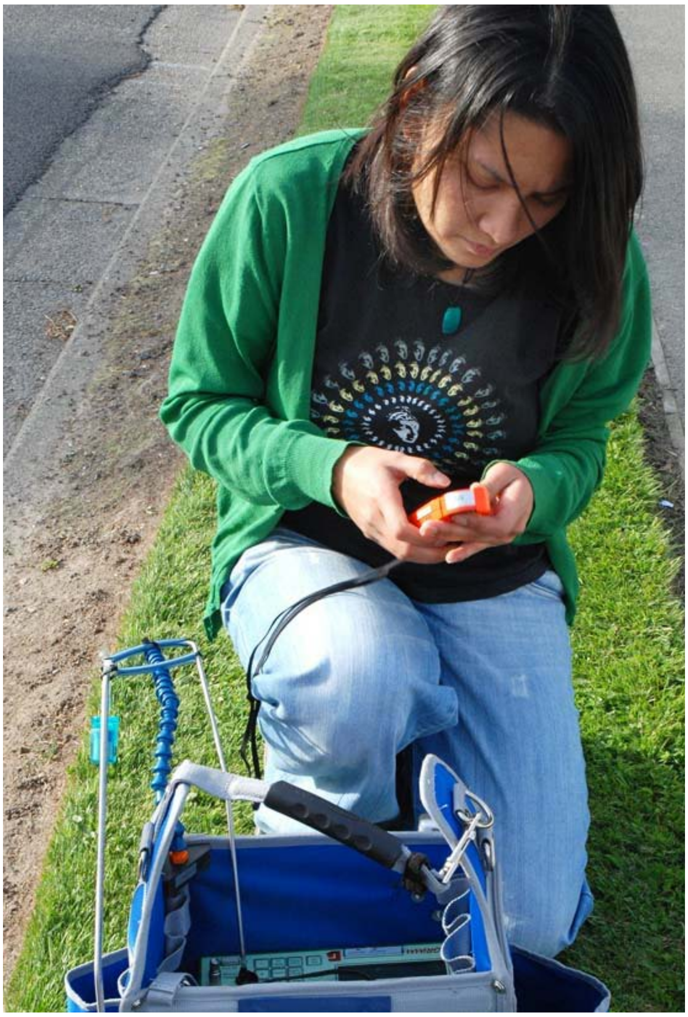

Figure 2. Personal sampling kit for pedestrians (Photo S. Kingham)

show that despite subject variability, carboxyhaemoglobin levels are a good biomarker for exposure to air pollution (Dirks *et al*., 2009).

Other studies led by Simon Kingham (University of Canterbury) have examined the inter-mode variability of pollutant exposure during the morning and evening commute to work. In 2009 the team completed two intensive campaigns of personal exposure observations during commuting activities in Christchurch and Auckland. The unique feature of this study was the simultaneous measurement of multiple pollutants (CO, PM, PNC) at 1 or 6 second resolution over a given route but on four different modes of transport. The study design permits comparison of mode independently of variation in background air quality or meteorology, and independently of route, whilst the very high temporal resolution (supported by GPS and automatic continuous photo-capture) permits inspection of the causes of fine-scale variation (e.g. close encounters with gross emitters, trapping of pollutants in vehicle cabins, etc). The results show that overall exposure to carbon monoxide is much higher in Auckland than Christchurch. However, transport by car consistently resulted in higher mean and cumulative exposure to carbon monoxide compared to bike and bus transport modes (Kingham *et al*., 2009). Initial analysis is also revealing significant variation in exposure, especially to ultrafine particles, between enclosed (i.e. vehicular) and open modes of transport, with concentrations strongly elevated above those reported by monitoring stations. This has significant implications for both air quality management and healthy, sustainable urban transport choices, as exposure in busy traffic is greatly under-represented or unconsidered in current policies. The team plans to continue to explore this valuable dataset and generalise its results.

NIWA have been trialling high resolution measurements of spatial variation of pollutants from a carborne mobile monitoring platform (Olivares *et al.*, 2008, Smith and Olivares 2008). The system is able to produce maps of spatial variation at a scale of about 100m. It will be used for exposure mapping, understanding transport and processing of pollutants and the representivity of fixed point monitors.

Philippa Howden-Chapman (Otago University) has led a multi disciplinary project on Heating, Housing and Health as part of the He Kainga Oranga Healthy Housing Research Centre. This project was a randomised interventional community trail conducted in 408 households with an asthmatic child where the intervention was the replacement of existing unflued gas or small portable electric heaters with new heat pumps, wood pellet burners or flued gas heaters. The results found significant improvements in health from the replacement heaters including fewer days off school, less wheezing at night, and less night coughing (Howden-Chapman *et al*., 2008, Gillespie-Bennett *et al*., 2008).

Nested within this study Robyn Phipps (Massey University) led a team to conduct week long measurements of the indoor air quality in 56 homes drawn from the above study. Their results found very high levels of nitrogen dioxide, and concerning levels of carbon monoxide, and formaldehyde associated with operation of unflued gas heaters (Boulic *et al*. 2008; Phipps & Boulic, 2008).

Philippa Howden-Chapman is also principal Director of the Centre for Sustainable Cities. This new (2009) initiative is a National inter-disciplinary research centre which aims to promote innovative solutions to urban development issues taking into consideration the connections between transport, design, energy use, health and governance (http://sustainablecities.org.nz/).

In summary, the research community in New Zealand is working together to develop some innovative research agendas with respect to improving our understanding of the linkages between air pollution and human health.

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ASSOCIATION OF AMERICAN GEOGRAPHERS (AAG) ANNUAL MEETING
Washington, DC USA • April 14-18, 2010
http://www.aag.org/

INTERNATIONAL SYMPOSIUM ON COMPUTATIONAL WIND ENGINEERING
Chapel Hill, NC USA • May 23-27, 2010
http://www.cwe2010.org

ICLEI RESILIENT CITIES: WORLD CONGRESS ON CITIES & ADAPTATION TO CLIMATE CHANGE
Bonn, Germany • May 28-30, 2010
http://resilient-cities.iclei.org/bonn2010/

INTL. CONFERENCE ON HARMONISATION WITHIN ATMOSPHERIC DISPERSION MODELLING
Paris, France • June 1-4, 2010
http://www.harmo.org/harmo13

AMERICAN GEOPHYSICS UNION (AGU): Urban Emission Inventory and Flux Measurements
Taipei, Taiwan • June 22-25, 2010
http://www.agu.org/meetings/wp10/index.php

URBAN ENVIRONMENTAL POLLUTION (UEP)
Boston, USA • June 20-23, 2010
http://www.uep2010.com

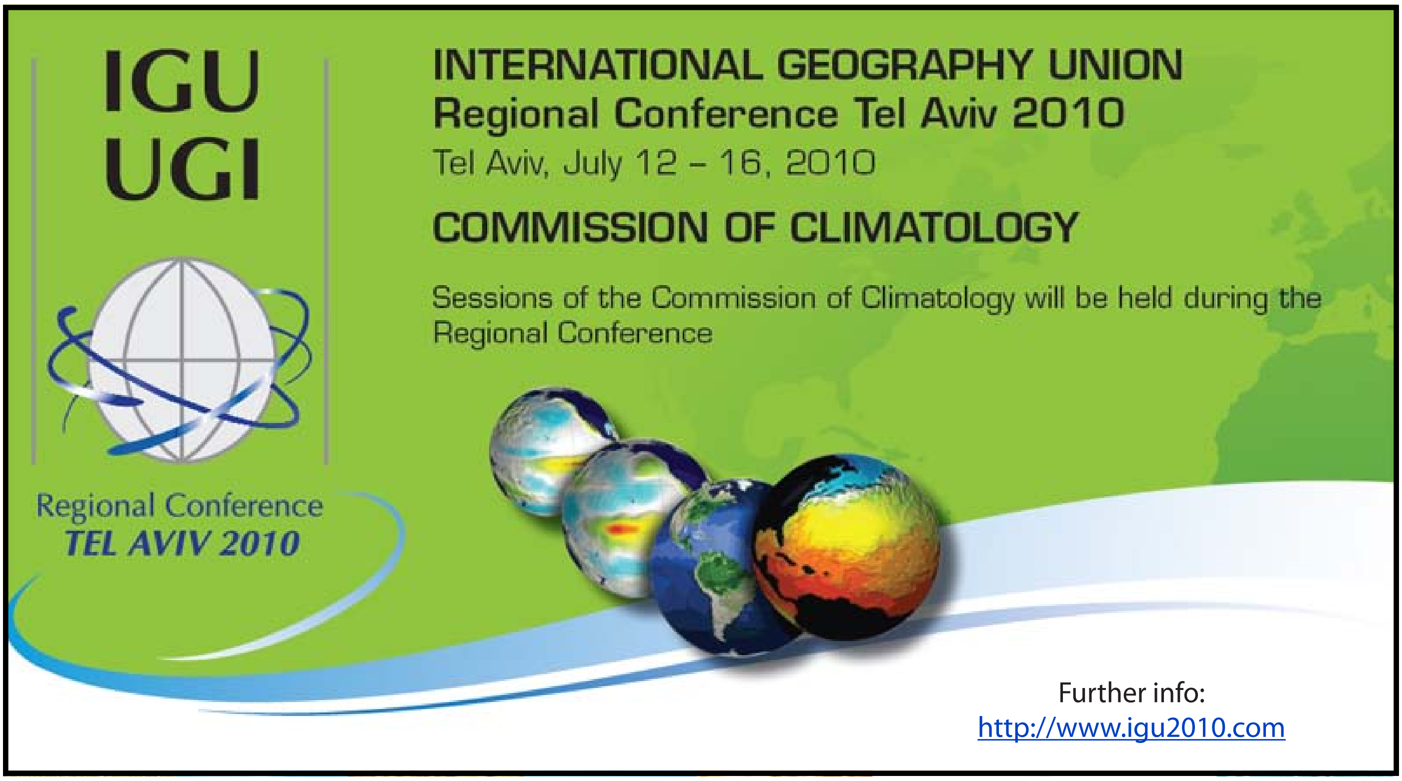
WORLD CITIES SUMMIT: LIVABLE AND SUSTAINABLE CITIES FOR THE FUTURE
Singapore • June 28-30, 2010
http://www.worldcities.com.sg/index.html

2010 INTERNATIONAL CLIMATE CHANGE ADAPTATION CONFERENCE
Queensland, Australia • June 29 - July 1, 2010
http://www.nccarf.edu.au/conference2010

5TH INTERNATIONAL CONFERENCE ON FOG, FOG COLLECTION AND DEW
Münster, Germany • July 25–30, 2010
http://www.fogconference.org/

AMS SYMPOSIUM ON THE URBAN ENVIRONMENT
Keystone, Colorado USA • August 2-6, 2010
http://www.ametsoc.org/MEET/fainst/201029agforest19blt9urban.html

CONFERENCE ON URBANIZATION AND GLOBAL ENVIRONMENTAL CHANGE: Opportunities and Challenges for Sustainability in an Urbanizing World
Tempe, Arizona, USA • October 15-17, 2010
www.ugec2010.org • ugec2010@asu.edu



Recent publications in Urban Climatology

Thanks to everyone for their contributions; in this edition papers published until February 2010 are listed. The bibliographic database at http://www.urban-climate.com/bibliography/ is now updated and we are also slowly including the 1996-2004 bibliographic database compiled by Jennifer Salmond.

As usual, all readers are invited to send any peer-reviewed references published since March 1st 2010 for inclusion in the next newsletter and the online database. Please send me your references to jhidalgo@labein.es with a header "IAUC publications" and the following format: Author, Title, Journal, Volume, Pages, Dates, Keywords, Language and Abstract.

Happy reading,

Julia Hidalgo

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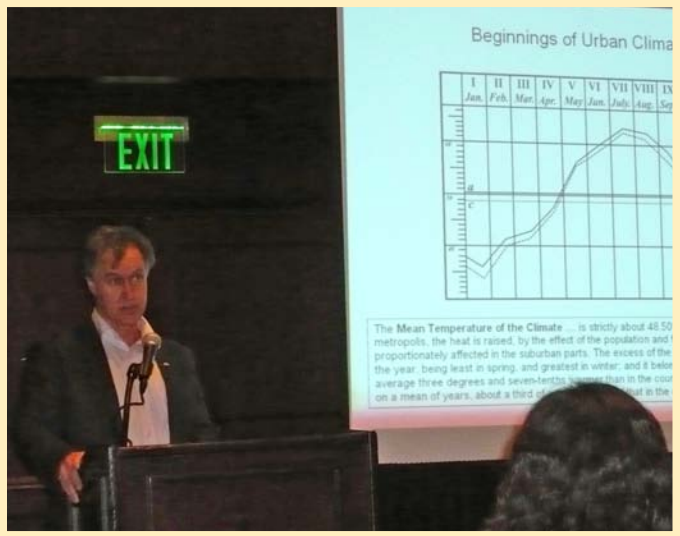
IAUC joins in First Global Meeting of Forum for Meteorological Societies

(*See full report on page 2*)



IAUC president Gerald Mills representing the urban climate community at the first global meeting of the Internation Forum of Meteorological Societies (IFMS). The meeting was held in Atlanta, GA (USA) on January 19-20, 2010, and the IAUC was among nearly 20 national, regional and international societies invited to participate in founding the new collaborative framework.

Presentation at the IFMS meeting by Walt Dabberdt, president of the American Meteorological Society (AMS), which spearheaded the initiative to establish the new global forum for meteorological societies around the world.

IFMS meeting report and photos courtesy of Rohinton Emannuel, IAUC Secretary

Board Members & Terms *(to be updated in June 2010)*

- Toshiaki Ichinose (National Institute for Environmental Studies, Japan): 2007-2011
- Benedicte Dousset (Hawai`i Institute of Geophysics and Planetology, USA): 2006-2010
- Rohinton Emmanuel (Glasgow Caledonian University, UK): 2006-2010; Secretary, 2009-2011
- Kevin Gallo (National Oceanic and Atmospheric Administration (NOAA), USA): 2006-2010
- Petra Klein (University of Oklahoma, USA): 2007-2011
- Sue Grimmond (King's College London, UK): 2000-2003; President, 2003-2007; Past President, 2007-2009*
- Manabu Kanda (Tokyo Institute of Technology, Japan): 2005-2009, ICUC-7 Local Organizer, 2007-2009.*
- Sofia Thorsson (University of Gothenburg, Sweden): 2008-2012
- Gerald Mills (UCD, Dublin, Ireland): 2007-2011; President, 2009-2011
- Tim Oke (University of British Columbia, Canada): President, 2000-2003; Past President, 2003-2006; Emeritus 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*
- Jennifer Salmond (University of Birmingham, UK): 2005-2009; Secretary, 2007-2009
- James Voogt (University of Western Ontario, Canada), 2000-2006; Webmaster 2007-*; 2009-2013
- Jason Ching (EPA Atmospheric Modelling & Analysis Division, USA): 2009-2013
- David Pearlmutter (Ben-Gurion University of the Negev, Israel): Newsletter Editor, 2009-*

* appointed members

IAUC Committee Chairs

Editor IAUC Newsletter: David Pearlmutter
Bibliography Committee: Julia Hidalgo
Membership Committee: TBA
Nominating Committee: Tim Oke
Int. Representative Committee: TBA
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 June. Items to be considered for the upcoming issue should be received by **May 31, 2010** and may be sent to David Pearlmutter (davidp@bgu.ac.il) or to the relevant editor:

News: Winston Chow (wtchow@asu.edu)
Conferences: Jamie Voogt (javoogt@uwo.ca)
Bibliography: Julia Hidalgo (jhidalgo@labein.es)
Projects: Sue Grimmond (Sue.Grimmond@kcl.ac.uk)

General submissions should be short (1-2 A4 pages of text), written in a manner that is accessible to a wide audience, and incorporate figures and photographs. Images you think would be of interest to the IAUC community are welcome.