

## From the IAUC President

Welcome to *Urban Climate News*, the quarterly newsletter of IAUC. I am writing this column in Stockholm, Sweden where I have attended the *American Meteorological Society's* 18<sup>th</sup> Symposium on Boundary Layers and Turbulence. I was very pleased to see a number of presentations with urban themes by active IAUC members. The increasing growth of urban-related research is also documented in Kevin Gallo's **Feature Article** about recent urban climate trends in the literature.

**Conferences:** The Local Organizing Committee of *ICUC-7* has just published the Second Circular which can be viewed and downloaded at the official conference website (<http://www.ide.titech.ac.jp/~icuc7/>). In addition I would like to draw your attention to the upcoming PLEA meeting which will take place in Dublin in October 2008 and the AMS general meeting in Phoenix in January 2009 whose theme is "Urban Weather and Climate: Now and the Future." The meeting will also include a special symposium in honor of our past president, Tim Oke. Where not too late, please consider submitting an abstract. I am also happy to report that PLEA and AMS have agreed to serve as co-sponsors of *ICUC-7*.

This newsletter features two **Urban Project** reports on research in tropical regions, namely on energy and carbon dioxide fluxes in Singapore and the influence of urban growth on pre-monsoon rain in Kolkata, India. A third article is devoted to the need for an urban climatology applied design model. The latest addition to our **Country Report** series is a report about climate research in Hungary.

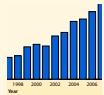
I would like to thank all of you who have participated in the recent **IAUC elections**, especially those who stood for election for the Board. I am pleased to announce that Sofia Thorsson from University of Gothenburg will join the Board and want to express my sincere thanks to Dr Wilhelm Kuttler for his excellent work during the past four years (see more details later in the newsletter). The 2007 **Luke Howard Award** has officially been presented to Dr. Masatoshi Yoshino in Japan and pictures from the ceremony are included in a short report. I would like to

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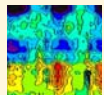
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thank Winston Chow who recently joined the newsletter team as the new sub-editor for the **Urban Climate in the News** section. Winston is a graduate student in the School for Geographical Sciences at Arizona State University. He will be happy to receive any news items at [wtchow@asu.edu](mailto:wtchow@asu.edu).

I hope that you enjoy this newsletter and remember that you are always welcome to contribute with an article, short research report, urban climate news item or conference report.

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## Breeze block blamed for urban heat in Hong Kong

May, 2008

Mong Kok and Causeway Bay are sweltering with the hottest temperatures in the city of Hong Kong, because of the urban heat island (UHI) effect.

The UHI effects on Hong Kong and other cities were explored at the Second Workshop on Earth Observation in Urban Planning and Management, which was organized by the Department of Land Surveying and Geo-Informatics (LSGI) of The Hong Kong Polytechnic University (PolyU) from May 20 to 21.

Leading experts in remote sensing, geographic information system (GIS) and urban climatology presented their latest findings, exchanged ideas and discussed various issues related to urban planning and management at this two-day workshop. Professor Tim Oke, who first put forward a theory to explain the formation of the UHI in 1982, also made a special trip from the University of British Columbia in Canada to attend this conference.

Professor Oke said the effect in Hong Kong is due to the density and height of the buildings that block the sea breeze. "It's because of the way Hong Kong is built that has caused an excess of temperature and there's no sign of this slowing down," Oke explained. "If Kowloon is made bigger through reclamation the intensity of the UHI effect will increase. The cleaner air from the harbor is being intercepted by the walls of buildings."

Experts said continued reclamation on the harbor-front has worsened the effect over the years, particularly in reclaimed areas such as Olympic station. Planners, Oke said, should build at a lower density to allow ventilation.

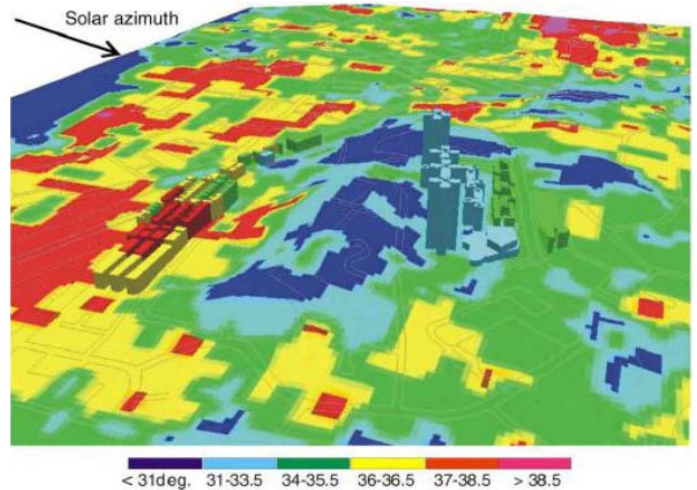
Hong Kong is one of six cities, including Atlanta and Vancouver, which experience maximum temperature differences. "Twelve degrees is the maximum difference, so Hong Kong is at the top of the scale," Oke said.

With its densely populated urban area, Hong Kong provides a typical example of the UHI effect. In studying the territory's UHI intensity last winter, PolyU LSGI Associate Professor Dr. Janet Nichol and her research team reviewed satellite images and collected ground data by making some 20 trips on special mobile vehicles in dusk and dawn. Each vehicle was equipped with two temperature sensors and a GPS receiver.

After analyzing the data, PolyU researchers found that there was an average temperature difference of 7-8°C between urban and rural areas on a winter night, and the maximum difference could be as high as 12°C. On a summer night the difference between urban and rural areas was 5-6°C. Although in most cases the land was cooler than the sea at night, Kowloon and the northern part of the Hong Kong Island were much warmer. In summer the land is significantly warmer than the sea,



Prof. Tim Oke at the Hong Kong PolyU Workshop on Earth Observation in Urban Planning & Management.



Thermal model with southward view over Kowloon Peninsula. Source: Nichol and Wong, 2005.

offering the potential for cooling sea breezes. In both summer and winter the hottest urban area is Mong Kok, closely followed by Causeway Bay. The coolest area is the rural area around Ta Kwu Ling.

Dr. Nichol said the large urban centre of Kowloon, with a population of over two million, is dominated by a strongly developed, regional scale urban boundary layer, and its urban canopy layer climate is reinforced by heating from both above and below. Reduced ventilation, high temperatures and the blocking of sea breezes by tall buildings on the newly reclaimed land, or the so called "wall effect" are contentious issues.

The UHI effect has the potential to directly influence the health and well-being of city dwellers, particularly during a heat wave, as it deprives urban residents of the cool relief found in rural areas during the night.

Sources:

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## Cities take lead on climate change

June, 2008

CAMBRIDGE, Mass.--City governments' response to climate change ranges from cutting-edge distributed energy to adding more bike lanes and trees.

Climate change experts from four cities--London, Toronto, Chicago, and New York--spoke recently about the connections between sustainable urban design, energy, the economy, and human health at the Mass Impact Symposium, organized by the Boston Society of Architects and the Massachusetts Institute of Technology.

The cities' climate action plans, some of which have yet to be fully rolled out, call for aggressive goals to measure, reduce, and monitor greenhouse gas levels--aiming for decreases of 50 to 80 percent in the next three decades.

Under that over-arching goal are dozens of programs, including promotion of green technologies to lower energy consumption in transportation and buildings. "We can't just do one thing," said Ariella Maron, deputy director of New York's Office of Long-Term Planning and Sustainability. She said the city's plan covers clean energy, efficient buildings, transportation, and avoiding sprawl--all of which impact water, land use, and air quality.

Called PlaNYC, the program stems from simple demographics: another 1 million people will join its current population of 8.25 million by 2030.

It's not just New York. Urbanization is rapidly accelerating around the world. That means the "tipping point" toward greenhouse gas reductions will come from making cities more sustainable, particularly in developing countries, said John Fernandez, an associate professor at MIT's architecture department.

More than half of the world's residents now live in cities, and 85 percent of the world's population growth will be in urban areas in the coming decades, mostly in Asia, Africa, and Latin America, Fernandez said.

### Green retrofits

Top on the list of these cities' programs is building energy efficiency. Overall, energy consumption in buildings is about one-third of all U.S. energy use, but it can be a lot higher in cities--in New York, it's 80 percent and rising.

Chicago requires city buildings requesting funding to meet the U.S. Green Building Council's Silver-level LEED certification. But while cities can make visible commitments to environment stewardship, it's typically a drop in the bucket when it comes to carbon emissions. That's because 80 percent of buildings that exist today will still be around in two decades, making technologies to retrofit existing buildings more important, city representatives said.

There are also opportunities for individuals or neighborhoods to generate their own energy. Toronto is experimenting with a program called SolarCity to encourage communities to purchase solar hot water systems.

At the end of this month, the PlaNYC program will announce details of a program to lower buildings' carbon emissions 30 percent by 2017 by promoting micro-power generation and waste-to-power technologies, Maron said.



**Will cities of the future look like Beijing, pictured here?**

Credit: Tom Krazit/[CNET News.com](http://CNET News.com)

London, meanwhile, is exploring more futuristic approaches, where whole neighborhoods would generate their own energy. Nicky Gavron, the former deputy mayor of London, said city planners envision replacing natural gas production either by producing bio-gas from organic wastes in anaerobic digesters or using waste to make synthetic gas through plasma arc gasification. The energy from waste would be used in either individual or neighborhood combined heat and power systems. "We have an opportunity to usher in a new era of municipally owned enterprises around low-carbon technologies," said Gavron.

### Not keeping pace with technology?

City governments are eager to show leadership by adopting green technologies in their own operations. Toronto's LightSavers pilot is testing to see whether more efficient LED lighting with controls can be used for street lights, parking garages, and pedestrian areas. And the FleetWise plug-in hybrid pilot has allowed the city government to improve its fuel economy by 50 percent, said Philip Jessup, director of the Toronto Atmospheric Fund. In Winnipeg, Canada, already 70 percent of taxis are hybrids.

Water treatment is an important feature of climate change response, according to planners. With more extreme precipitation, New York is enlisting trees to try to capture run-off and pollutants. The city is trying to add more green spaces to its streets and change the tree pit specifications so that they are big enough to retain more water, Maron said.

Despite the good intentions, representatives from these cities said that politics--particularly with regard to funding-- make climate change all the more challenging. To get different sources of revenue, London has taken a minority stake in an energy services company that uses savings from energy efficiency to offset upfront investments. Toronto's Atmospheric Fund was created and sustained by the savings from building energy retrofits.

Another challenge is that political institutions are falling behind the technology advances in areas like lighting and transportation, said Toronto's Jessup. "The job descriptions, the bureaucracies, have not changed fast enough for these new technologies -- so they just don't get it," he said.

## Recent trends in literature related to Urban Climate

by Kevin Gallo, NOAA/NESDIS and Board Member of IAUC

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*The editor of the IAUC newsletter, Dr. David Pearlmutter, recently requested that I might initiate discussion in this newsletter on the topic of the influence of urban areas on large scale temperature trends, and whether these urban influences and related land use effects are being adequately modeled in the latest assessments. In the process of attempting a relatively brief review of recent literature on this topic, I made a pleasant discovery that seems to be worth sharing. The original topic mentioned above will be discussed in a later newsletter.*

*What was found during my search of the recent literature, and the topic of this current newsletter contribution, was the growth in the number of publications related to urban climate in the last ten years.*

### Methodology

The [Scopus abstract and citation database](#) (Elsevier B.V. © 2008) was used to conduct the literature searches included in this analysis. Scopus includes more than 15,000 journals from over 4,000 publishers in this database as well as open-access journals, conference proceedings and trade publications.

Since the initial goal of this literature search was a rather focused survey of the topic of urban influences on temperature trends, the Scopus database was searched with several combinations of “keywords” that could be mentioned in either the article title, abstract, or specific list of keywords that are

usually supplied by article authors. However, only the search results for the combination of keywords “Urban and Climate” are presented.

This literature search was limited to documents published within the last 20 years (from 1988 through 2007). Two literature searches were made for each of the combinations of keywords of “Urban and Climate” that included 1) articles within all available subject area topics covered by Scopus; Life Sciences, Health Sciences, Physical Sciences, and Social Sciences (> 15,000 journals) and 2) articles limited to the journals classified within Scopus as those of the “Physical Sciences” (> 5,500 titles).

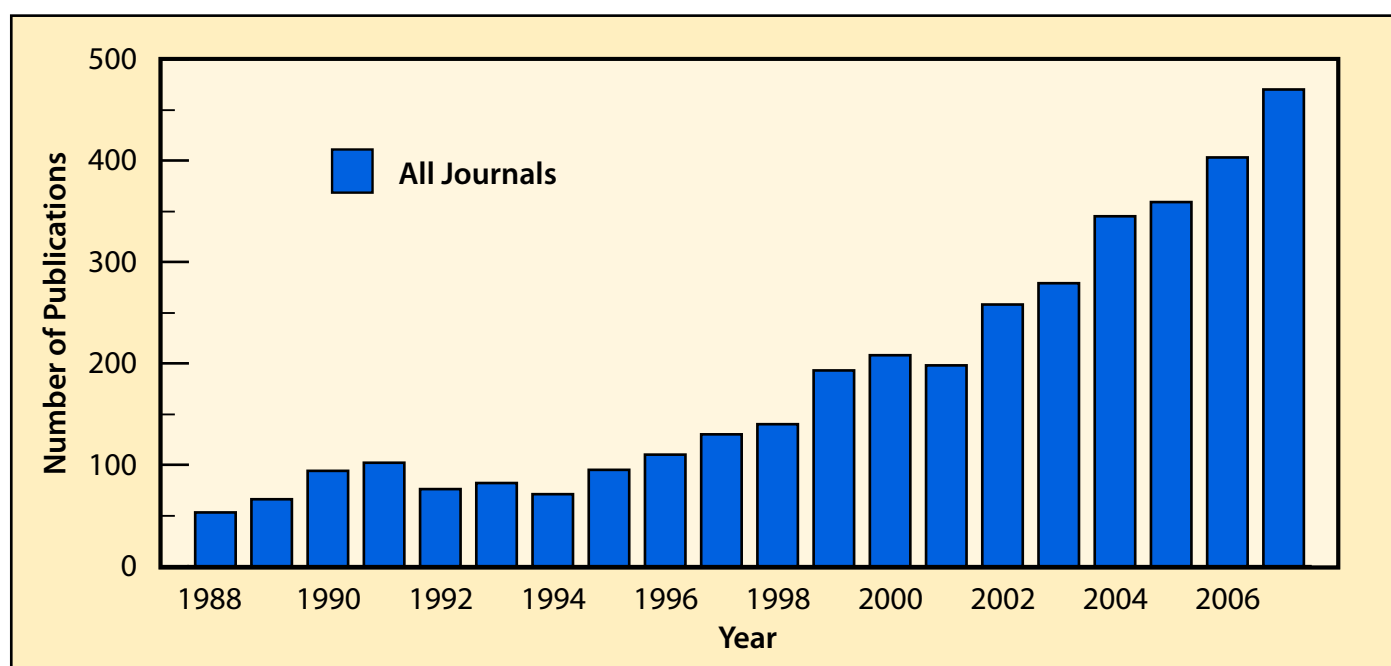


Figure 1. Number of total publications per year included in the Scopus database of Life, Health, Physical, and Social Science journals, when the database was searched for the keywords of “Urban and Climate.”

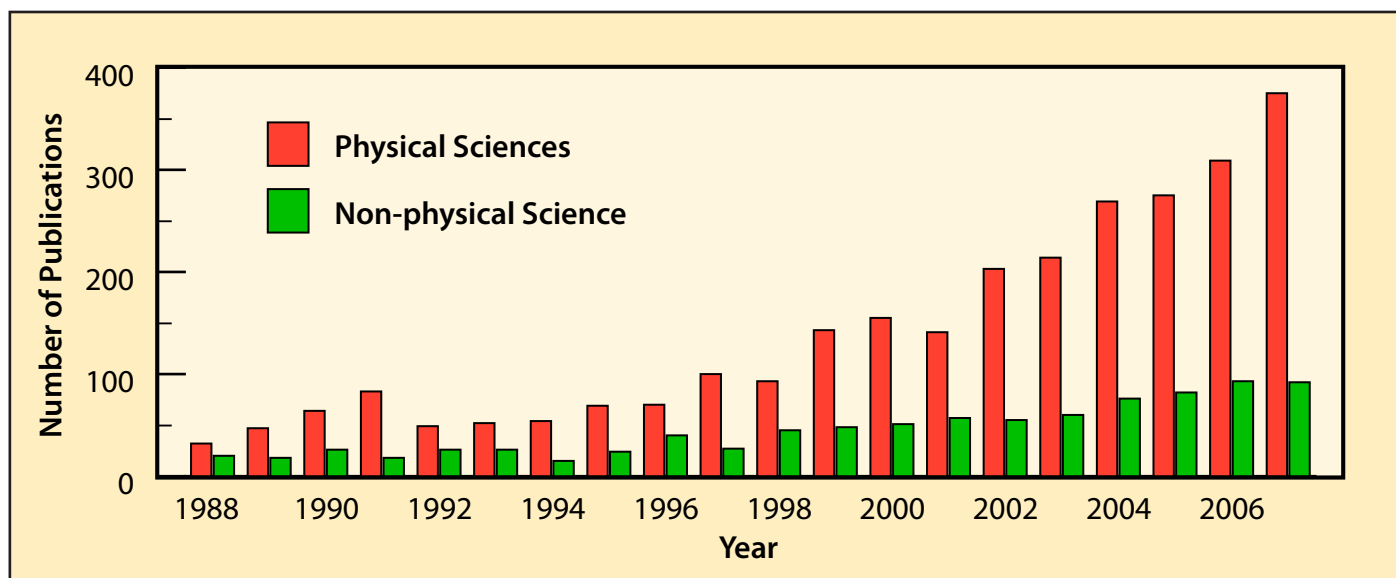


Figure 2. Number of publications per year included in the Scopus database of the Physical Science journals and Non-physical Science journals, when the database was searched for the keywords of "Urban and Climate."

## Results and Discussion

The results of the literature search of the above combinations of keywords, for all topical journals (Life, Health, Physical, and Social Sciences, designated "All Journals"), are displayed in Figure 1. Those defined as Physical Science journals, and the Non-physical Science journals (difference between "All" and Physical Science journals) are shown in Fig. 2.

Over 450 articles were found within the Scopus database (Figure 1) as published during 2007 within journals of all of the above science topics (Life, Health, Physical, and Social Sciences) included in the Scopus database. Over 350 publications were published within the Physical Science journals during 2007, thus roughly 100 were published within the Non-physical Science journals included in the Scopus database. While the number of articles was near or below 100 from 1988 through 1995, after 1995 the number of articles generally increased through 2007. As might be expected, the Physical Science Journals are the primary location of articles with the keywords of "Urban and Climate" with approximately 60 to 80% of the articles associated with these keywords during the 1988 through 2007 interval published within the Physical Science journals. The linear increase in publications per year during the 10-year interval of 1998 through 2007 was 34.0 for all science journals, 28.2 for the Physical Science journals, and 5.8 for the Non-physical Science journals.

In summary, based on the number of publications in the last 10 years it appears that the general topic of "Urban Climate" has had an increase of roughly 34 publications per year with most of the publications occurring within journals classified as Physical Science journals. Also of interest is that within this combination of keywords the increase of publications within the Non-physical Science Journals (Life, Health and Social Sciences) included in the Scopus database, has increased at a rate of nearly 6 publications per year within the last 10 years, perhaps an indication and acknowledgement of the impact of the urban climate on other disciplines as the worldwide proportion of urban population, compared to total population, is projected to increase to 61% by 2030 (United Nations, 2004).

## Acknowledgements

The manuscript contents do not constitute a statement of policy, decision, or position on behalf of NOAA or the U. S. Government.

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## Energy Balance and Carbon Dioxide Fluxes in Singapore

### Introduction

Much of the future anticipated growth in the world's urban population will occur in the (sub)tropics and result in increasing environmental problems in the developing world where most of these cities are located. Many of the environmental problems are related to the climate of these cities. It is therefore unfortunate that only a rudimentary understanding of the physical processes operating in the atmosphere of (sub)tropical cities is available. Most of the work has primarily focused on the surface energy balance (see Roth 2007 for a review). Probably the first indication of the nature of physical climatology in a (sub)tropical city has been provided by Oke et al (1992) based on a pioneering study conducted at an urban site in Mexico City in 1985. Since then eight energy balance studies have been conducted in five different (sub)tropical cities. Only one study has been measuring carbon dioxide (CO<sub>2</sub>) fluxes (Velasco *et al.*, 2005 conducted in Mexico City) and none has looked at the turbulence transfer characteristics in any detail. A new energy and CO<sub>2</sub> flux project carried out in Singapore is introduced in this report. The first measurement phase has recently been completed and selected preliminary results will be presented in the following after introducing the measurement site and experimental set-up.

### Experimental

Singapore is a small, densely populated (4.5 million as of 2006) and heavily urbanized island-state located 137 km north of the equator at the southern end of the Malaysian Peninsula. The island has undergone significant urbanization during which the amount of built-up area has almost doubled between 1995 and 2000. During the same time period, land reclamation, mainly concentrated along the southern shoreline, has increased the land area from 580 to 700 km<sup>2</sup>. The climate impact of this rapid urban development has been documented in terms of the urban heat island effect (e.g. Nieuwolt 1966, Chow and Roth 2006, Roth and Chow 2007). Significant urban influences on the climate are likely to continue as the government has urban redevelopment plans for a future population of 6.5 million.

Singapore has a wet tropical climate (Köppen



Figure 1. Location of micrometeorological flux tower (marked by red star) in a residential area of Singapore (Telok Kurau). (Source: Google Earth®).



Figure 2. View of the residential houses surrounding the tower in most directions.

classification A<sub>f</sub>) characterized by uniformly high annual temperature (~27 °C) and abundant precipitation (~2300 mm/year) throughout the year. There are two distinct wind regimes, the SW and NE monsoons. The SW monsoon, occurring between May and September, is slightly warmer compared to the December to February NE monsoon which is more cloudy and receives more precipitation. Between the monsoon seasons are shorter periods where the wind direction is variable.

The measurement site is located 6 km east of central Singapore (1°19' N, 103°54') at 3.5 m above sea level and 1.7 km from the south coast. The area, which is called Telok Kurau, has no pronounced topography and is characterized by 2-3 story high residential buildings within 1 km of the site in most directions (Figs. 1 and 2).

Using a GIS database containing the main mor-

phological characteristics of the area, the mean height of buildings and trees ( $z_H$ ) was determined as 8.6 m. The plan area fraction occupied by buildings and vegetation is 0.39 and 0.12, respectively. The site-specific aerodynamic properties were assessed from analysis of surface form according to Grimmond and Oke (1999). Using several equations the aerodynamic roughness length ( $z_0$ ) is 1 m and the zero-plane displacement length ( $z_d$ ) 6 m with good agreement amongst the various equations. As determined using the logarithmic wind profile under neutral conditions,  $z_0$  was 2 m.

The main eddy covariance instrumentation was mounted at the top of a pneumatic tower (Hilomast; NL22) at a height of 20.7 m above ground (Fig. 3), i.e. about 2.4 times the mean height of the houses and trees. It consisted of a sonic anemometer (CSAT3) measuring the three-dimensional wind velocities and virtual air temperature, an open-path infrared gas analyzer (Li7500) measuring  $\text{CO}_2$  and water vapor and a radiation sensor (CNR1) measuring incoming and outgoing long- and shortwave radiation. The sonic anemometer and gas analyzer as well as the CNR1 were placed at the end of opposing booms extending approximately 0.8 m each from the tower (Fig. 4). The distance between the centre of the sonic transducers and the Li7500 head was 20 cm. The leveling of the CSAT3 was monitored with a miniature inclinometer and kept to within 1.5 degrees on average. To minimize tower interference on the flow field, the sonic anemometer head was turned into the main wind direction, i.e. towards approximately 40 degrees during the NE monsoon and towards 180 degrees during the SW monsoon periods. The sensors were connected to a data logger (CR5000, Campbell Scientific) and data sampled at 10 Hz. Other measurements conducted at the site included air temperature and relative humidity at 20 m above ground, precipitation and surface temperature.

Before turbulent fluxes were computed, wind components were rotated into a streamwise coordinate system and linear trends removed using an averaging time of 30 minutes.  $Q_H$  values were corrected to account for the use of sonic virtual air temperature (Schotanus *et al.*, 1983) and density corrections were applied to  $Q_E$  and  $\text{FCO}_2$  (Webb *et al.*, 1980). Unrealistic raw data, defined as values outside fixed threshold limits, were deleted before



Figure 3. Pneumatic micrometeorological tower with eddy covariance sensors installed at 20.7 m above ground.



Figure 4. Close-up of eddy covariance sensors installed at top of mast. CSAT3 and Li7500 are visible on r.h.s. and CNR1 on l.h.s. Thin vertical extension in center is lightning rod.

any calculations were conducted. The entire 30 min block was rejected if it contained more than 10% missing data. Similar to raw data, turbulent fluxes outside prescribed limits were rejected. Observations were conducted between 1 March 2006 and 22 March 2008. Data availability was high during most months but dropped below 30% for individual months during the NE monsoon periods when frequent rainfall affected the CSAT3 and Li7500 signals. Wind directions from 260-360 degrees were not considered because of unusually high buildings and trees in this sector. Measurements were interrupted in April 2007 for five months when the tower was hit by lightning and had to be stopped in March





Figure 5. Pneumatic mast with eddy covariance sensors at top and permanently bent middle section.

2008 after a vehicle backed into a supporting guy wire and the middle section was permanently bent (Fig. 5).

### Overall meteorology

The small variability on top of large mean values shown for temperature and humidity in Fig. 6 (left panels) is typical for a tropical climate. Similar small variability is observed for mean values across the seasons. The polar wind direction diagram in Fig. 6 (top right) shows the characteristic bimodal distribution but surprisingly during the SW monsoon period wind directions from the SE prevailed. Atmospheric stability close to the surface in cities is often near neutral or slightly unstable. The same is true at the present site, but as shown in Fig. 6 (bottom right), mean stability was slightly positive during much of the night indicating sufficient cooling after sunset to create near-surface temperature inversions.

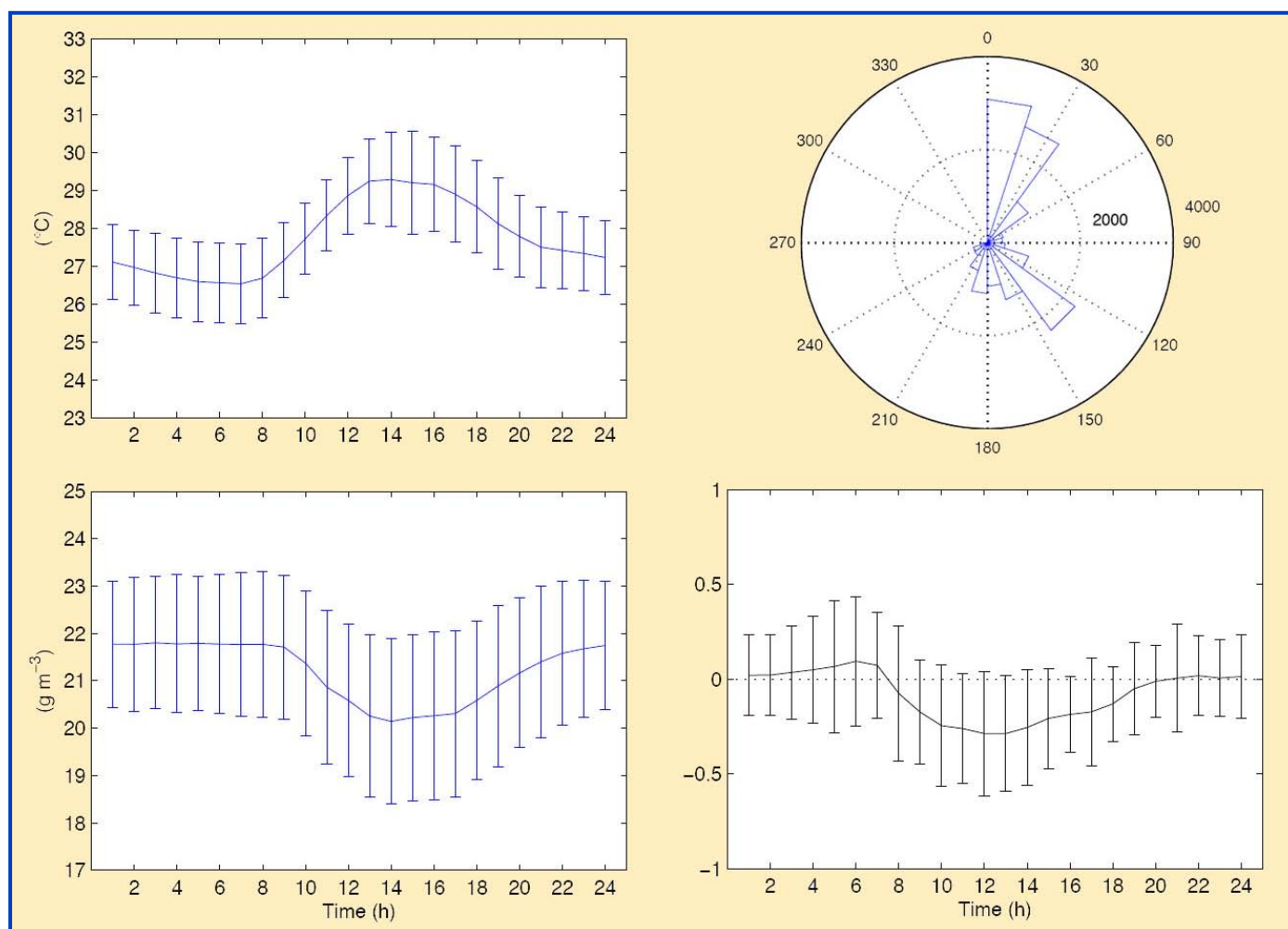


Figure 6. Ensemble hourly averaged temperature (top left), humidity (bottom left), stability  $z'/L$  (bottom right) and polar wind direction plot (top right) measured between March 2006 - March 2008. LAT = Time-1 hour. Note that wind directions between 260-360 degrees were not considered (see text).



## Energy balance and CO<sub>2</sub> fluxes

Because of the equatorial location seasonal variability in radiation is small and the ensemble mean values shown in Figure 7 are applicable to all months. Average incoming shortwave radiation is relatively large and individual values can exceed 1000 W m<sup>-2</sup> around noon on clear days. Incoming and outgoing longwave radiation is also relatively large (~420 and ~480 W m<sup>-2</sup>, respectively) because of the warm and humid air. The values are similar to those measured in Miami located just outside the tropics (25°44'N) in the summer (Newton *et al.*, 2007).

The net radiation gain during daytime is almost equally partitioned into sensible and storage (determined as the residual of the energy balance) heat during the morning hours (Fig. 8). In the afternoon and early evening the sensible heat flux remains positive while the surface starts to release heat from storage after around 5 pm. The latent heat flux is an important component during daytime but it is smaller than expected considering the abundance of rain throughout the year. One possible explanation is the large amount of sealed surfaces and an extensive drainage system to prevent flooding which efficiently discharges any surface water. In addition, a relatively low vapor pressure deficit of typically 6-10 hPa might restrict evaporation. This daily balance looks similar to that observed in cities in other climate regions.

Although seasonal variability is relatively small, differences are clearly present as demonstrated in Figure 9. The latent heat flux is systematically higher during the NE monsoon period compared to the relatively drier SW monsoon period. The opposite result is obtained for the sensible heat flux where drier conditions result in higher fluxes.

The present study provides the first systematic, long-term observations of carbon dioxide fluxes in a tropical city. Similar to results from cities in other climate regions, the flux is mostly positive, i.e. the city is a source of CO<sub>2</sub> (Fig. 10). The absolute values are slightly smaller than observed for example in Basel (Vogt *et al.*, 2006), Marseille (Grimmond *et al.*, 2004), Melbourne (Coutts *et al.*, 2007) or Tokyo (Moriwaki and Kanda, 2004). This is possibly due to the residential nature of this particular site with little heavy traffic and the absence of major local emission sources. Fluxes are highest during the early morning and late evening when the traffic volume peaks.

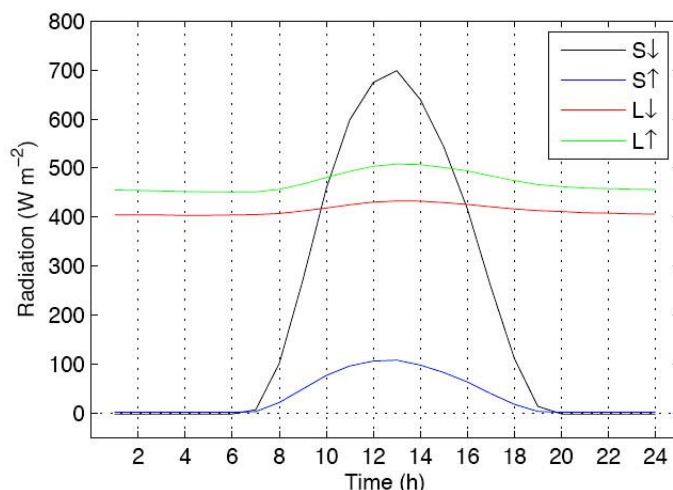


Figure 7. Ensemble hourly averaged radiation flux densities measured between March 2006 - March 2008 for all weather conditions. LAT=Time-1 hour.

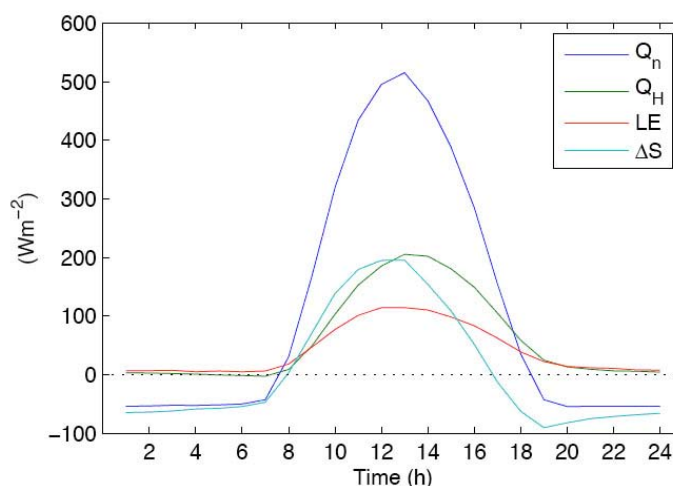
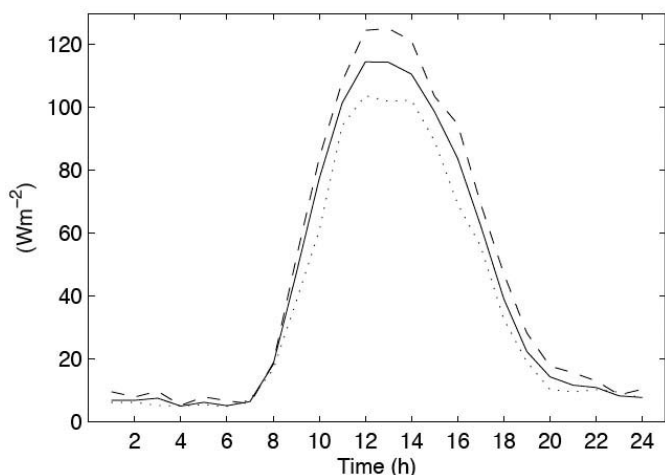


Figure 8. Ensemble hourly averaged energy flux densities (period as in Fig. 7). Q<sub>n</sub> – net radiation, Q<sub>H</sub> – sensible heat flux, LE – latent heat flux, ΔS – storage heat flux.

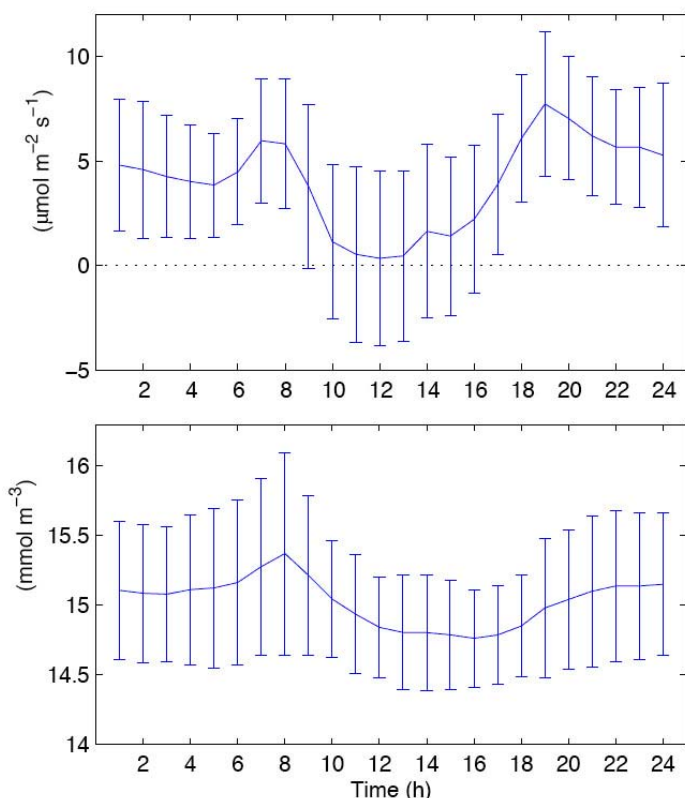
Photosynthesis during daytime contributes to low values which, however, are still positive on average. The daily variation of the CO<sub>2</sub> concentrations (Fig. 10) mirrors that of the fluxes. More work is needed to relate these daily patterns to traffic volume, atmospheric stability or mixing layer height. Similar to the energy balance fluxes, seasonal variability is low.

## Future plans

A number of publications are presently under preparation. The study will be continued in fall 2008 with an expanded scope and plans to include measurements of the spatial variability of the energy and CO<sub>2</sub> fluxes and a more detailed assessment of the various emission sources contributing to the CO<sub>2</sub> budget.



**Figure 9.** Ensemble hourly averaged latent heat flux densities (period as in Fig. 7). Solid line -all months, dotted line -SW monsoon period, dashed line -NE monsoon period.



**Figure 10.** Ensemble hourly averaged CO<sub>2</sub> flux densities (top) and concentrations (bottom), period as in Fig. 7.

## Acknowledgements

We are grateful for the help by Dr. A.N.V Satyanarayana during the early stages of the project. We would also like to thank Ms. Michelle Cher for granting access to the site and acknowledge help from Mr. Muhammad Rahiz with downloading data and obtaining meta data and from Ms. Quek See Leng and Ms. Cheah Li Min with the GIS database.

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## The Dynamic of Urban Growth in Kolkata, India and Potential Impacts on Pre-Monsoon Precipitation

### 1. Introduction

In 2008, more than half the world's population lived in urban areas and this could balloon to 81% by 2030 (Trenberth *et al.* 2007). "Urban footprints" spread well beyond the immediate vicinity of cities, affecting local to global scale atmospheric composition, surface energetics, water and carbon cycle processes, and ecosystem development. While the urban heat island (UHI) is well understood (Oke, 1987), the IPCC's recent [report](#) and a review by Shepherd (2005) have highlighted the growing body of research linking urban-related processes and regional precipitation. Very little work has been done on this topic in the rapidly urbanizing developed nations. The city of Kolkata in eastern India has been aggressively multiplying itself in the last three decades, particularly during the Indian independence phase (1940s and 1950s), and such rapid expansion continues (Chakraborty, 1990) due to the increasingly important socio-economic role that Kolkata plays in the region (Roy, 2003).

#### a. Pre-monsoon rainfall in India

The pre-monsoon (March-May) rainfall period contributes approximately 12% of the annual total rainfall in our study area (Figure 1). During the pre-monsoon season (PMS), there is relatively little influence of large-scale atmospheric phenomena like the monsoon. It is therefore an appropriate period to theoretically investigate how urban land-cover could affect precipitation in the study region. PMS rainfall is also poorly studied in the literature because of the dominant influence of the monsoon.

The PMS rainfall is characterized by local to regional forcing: i) deep convection resulting from the dryline, and ii) convection initiated at mesoscale boundaries (e.g. sea-breeze front (Lohar, 1993). Sadhukhan *et al.* (2000) showed that PMS rainfall variability is dependant on local features. An increase in PMS precipitation was noted in the 1970's and afterwards. Previous studies have theorized that land-cover dynamics related to deforestation (Sadhukhan *et al.* 2000) and irrigation (Lohar and Pal, 1995) could describe precipitation changes, yet the limited studies have been contradictory or lacked

Mean Rainfall (1951-1999) Eastern India

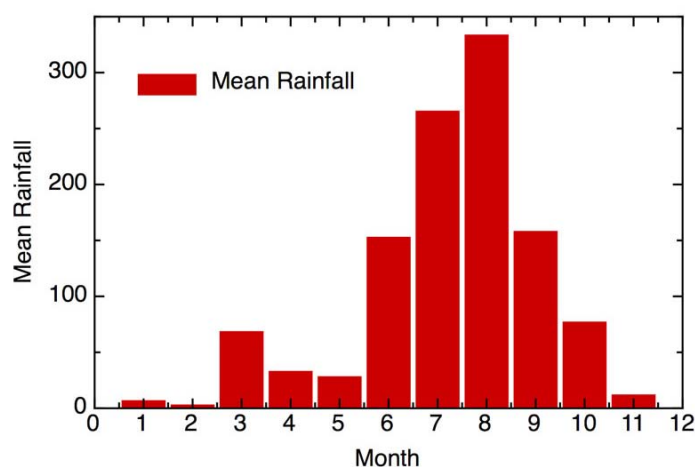


Figure 1. Mean monthly rainfall for the area (82-89°E, 19-26°N) using Legates and Willmott (1990) data set.

robustness. Further, none of these studies considered the influence of urban-related land-cover.

#### b. Research Objectives and Hypotheses

The overarching research objectives of this study are: (1) To identify possible relationships between urban land-cover dynamics and pre-monsoon season rainfall variability, (2) To project how the urban land-cover of Kolkata will grow in the next 25 years (using a cellular automata growth model, SLEUTH), and (3) To assess, using a coupled atmosphere-land surface modeling system how past, current, and future urban land-cover in Kolkata influences pre-monsoonal precipitation. Herein, we focus primarily on research objective one and offer insight into the direction of our research for the subsequent objectives.

The hypothesis underlying the first objective is that PMS rainfall at urban Kolkata stations have trended upward due to increased urban land-cover dynamics. Figure 2 is preliminary work suggesting that the urban recording station exhibits an upward trend in pre-monsoon season rainfall while other regional stations do not. This is particularly interesting since there is also no trend in the regional pre-monsoon rainfall of the East Gangetic area (Fig. 3).

### 2. Data

For the first objective, the historical maps and satellite images were used to delineate the urban land-cover growth of Kolkata city (e.g., historical paper maps, Landsat images (1990 and 2000), and topographical maps (# 79 B/6 & 79 B/7). The maps



Mean Pre-Monsoon (March-May) Rainfall

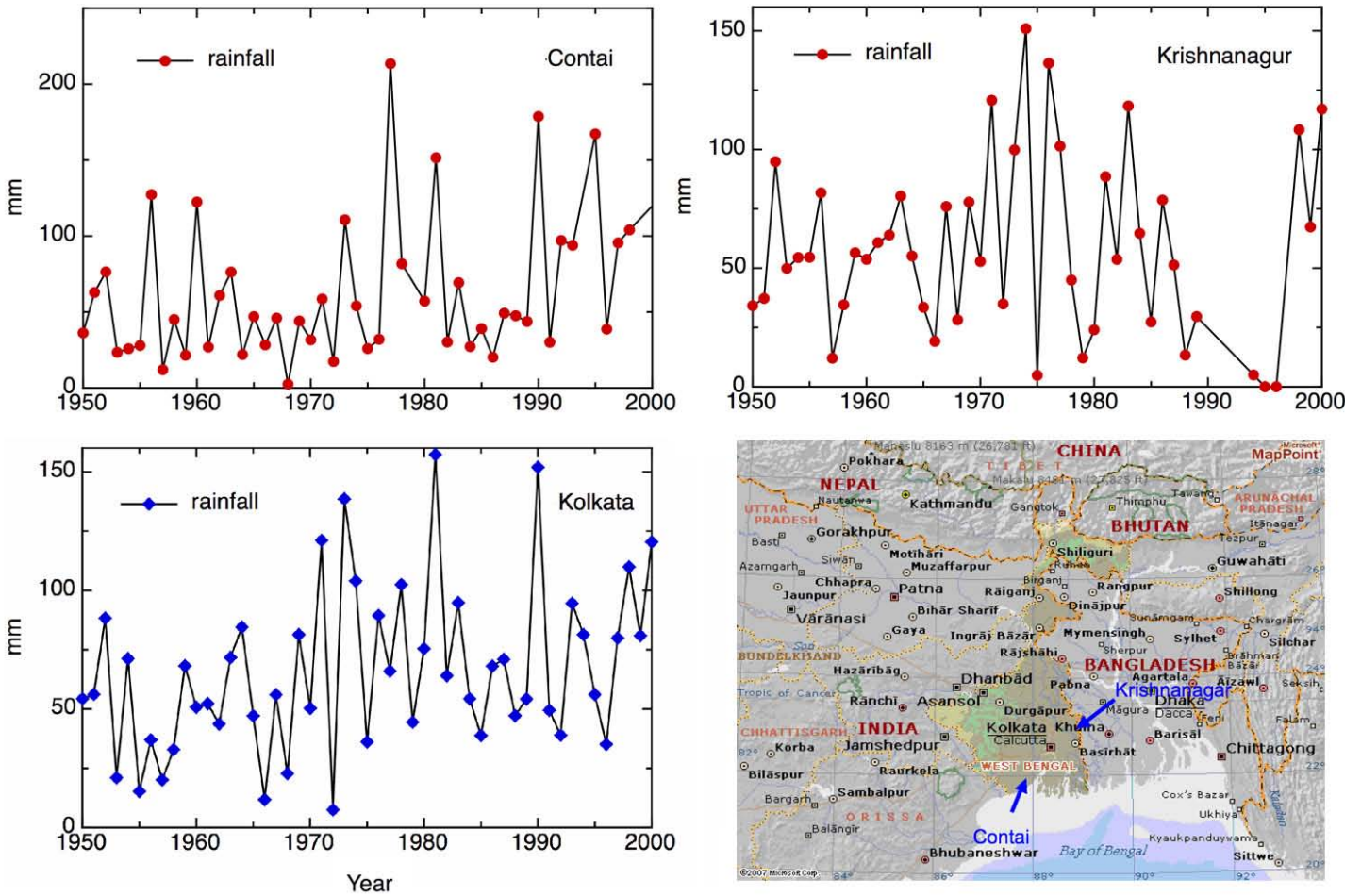


Figure 2. Time series of pre-monsoon rainfall at coastal (Contai), urban (Kolkata), and non-urban (Krishnanagar) stations, with map of station locations in India.

Pre-Monsoon (March-May) Rainfall over East India

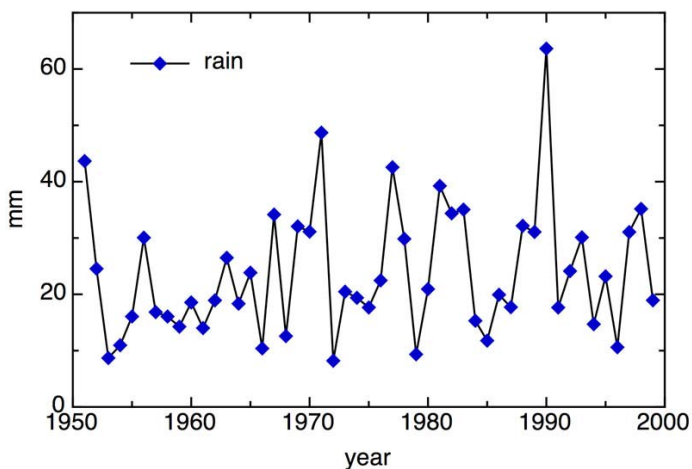


Figure 3. Time series of area-averaged pre-monsoon mean rainfall (mm) for the East Gangetic region (1951-1999), using the Legates and Willmott (1990) data set.

used for the first objective will also be used to prepare the layers for the SLEUTH model.

Data from Tropical Rainfall Measuring Mission (TRMM) Multi-Satellite Product, Legates-Willmott surface dataset, and the Indian Meteorological Department will be used to examine the spatio-temporal variability of pre-monsoon rainfall. For the third objective data will be acquired from the European Center for Medium Range Weather Forecasting (ECMWF) to initialize the meteorological conditions for WRF. Standard United States Geological Survey surface characteristics distributed with WRF-NOAH and remote sensing analysis from the previous objectives will be used for land surface initialization.

### 3. Methods

Table 1 summarizes the methodology used in support of the three research objectives.

**Table 1: Summary of methodology in support of research objectives**

<p><b>Objective 1</b></p>	<ul style="list-style-type: none"> <li>• Digitization and georectification of historical maps and satellite imagery</li> <li>• Trend analysis for Kolkata urban land-cover over a 300-year period (time series, decadal trends, etc.) (See Figure 4 and Table 2)</li> <li>• Trend analysis of national, East Gangetic, and local (e.g. urban Kolkata, non-urban Kolkata area) pre-monsoonal rainfall over a 50-100 year period</li> <li>• Mann-Kendall statistical testing on rainfall data on individual and regional levels to assess significance of trends</li> <li>• Statistical correlation analysis to identify urban land-cover dynamics - PMS relationships</li> </ul>
<p><b>Objective 2</b></p>	<ul style="list-style-type: none"> <li>• Pre-processing of relevant GIS data and layers for SLEUTH cellular automata modeling</li> <li>• Assessment of Kolkata's past, current, and future land-cover growth and governing factors</li> </ul>
<p><b>Objective 3</b></p>	<ul style="list-style-type: none"> <li>• WRF-NOAH mesoscale modeling simulations under three Kolkata land-cover scenarios: Kolkata 1950, Kolkata 2000, and Kolkata Future (circa 2025).</li> <li>• Statistical analysis of spatio-temporal changes in pre-monsoon rainfall, convergence, sensible/latent heat fluxes, a boundary layer structure as a function of land-cover scenarios. Validation using available data will also be conducted.</li> </ul>

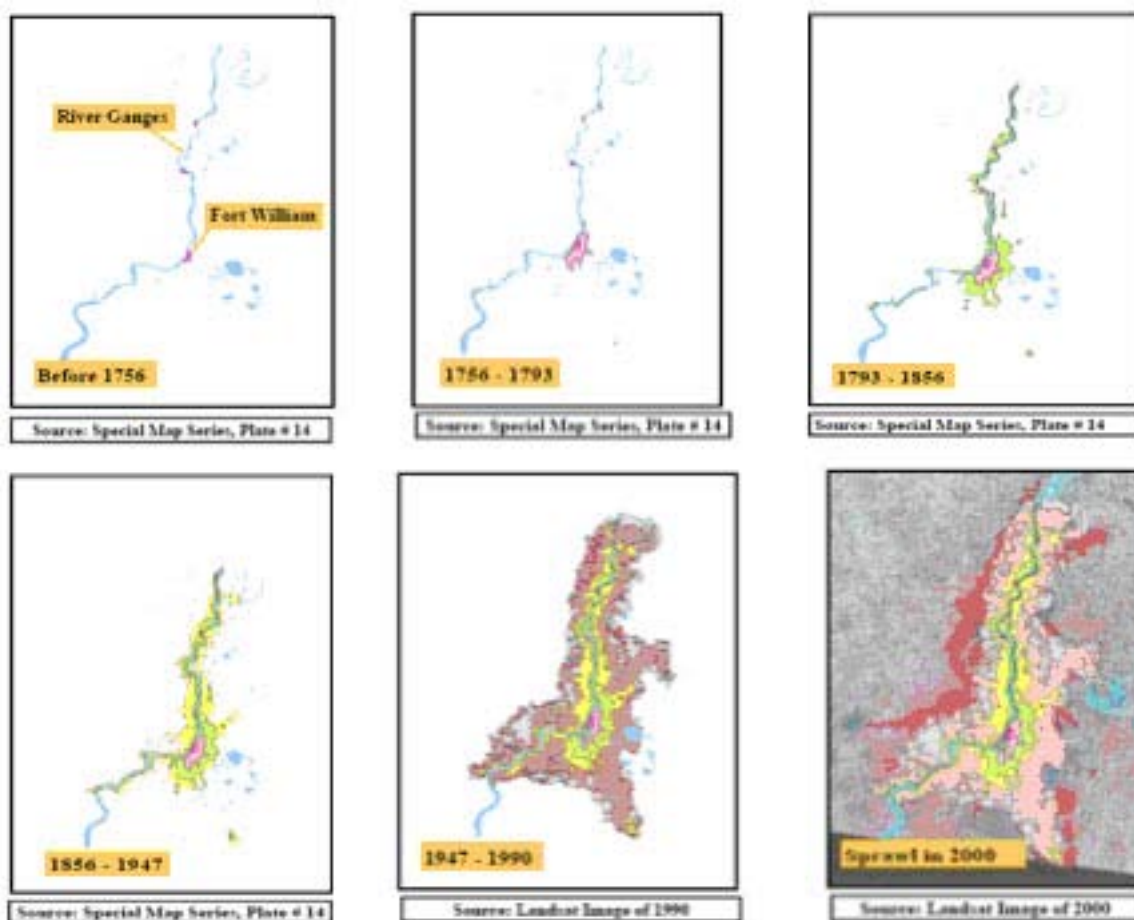


Figure 4. Digitized maps from traditional cartographic and satellite sources of Kolkata illustrating urban land-cover growth in phases.

**Table 2: Time series of urban land area change for Kolkata (square kilometers).**

Years	Total Area (sq. km)	Change in area	Sq. km change/year
Before 1756	3.46		
1756-1793	33.57	30.11	0.8137
1793-1856	135.88	102.31	1.6239
1856-1947	361.27	225.39	2.4768
1947-1990	1363.36	1002.09	23.3044
1990-2000	1658.12	294.76	29.476

#### 4. Significance of Research

The study represents possibly the most thorough spatio-temporal evaluation of Kolkata's urban dynamics, spanning several centuries and one of the first studies investigating effects of Kolkata on PMS rainfall. The study represents one of the first attempts to use the urban growth model, SLEUTH on any city in India. The use of this model will help others to conduct similar application on cities around the world, which are as flat as Kolkata (<10 meters). The knowledge gained regarding the future growth of the city will benefit the government, the real estate industry and even the common people immensely as all development decisions can be taken keeping the direction of future growth in mind. Finally, the study is providing a prototype methodology for studying future urban land-cover growth scenarios and how they will affect hydroclimates in developing countries.

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## The need for an urban climatology applied design model

Urban climatology research has provided a good appreciation of topics such as energy budget models, classifications of urban layers, field measurements and simulations (Landsberg, 1973; Oke, 1984; Golany, 1996; Eliasson, 2000; Arnfield, 2003; and Oke, 2006). Many studies have carried out excellent work from the physical, mathematical and meteorological points of view. However, much less work has been done with respect to applied urban climatology experiments and methodologies, planning and design (Fathy, 1973; Rahamimoff, 1984; Bitan, 1988; Pearlmutt et al., 1999; Nikolopoulou and Steemrs, 2003; and Ali-Toudert and Mayer, 2007).

There is a requirement for a much broader multidisciplinary approach that includes groups such as architects, landscapers, urban designers, planners, econo-sociologists and psychologists. Such an approach would, for example, not only be able to model an urban canyon's complete energy balance but also quantify the design benefits of this model in terms of urban thermal comfort, energy saving and climate change. The need is for a model that translates all of the passive solar design knowledge, urban heat island mitigation methodologies and precedents experience to the urban realm and the actual construction regulations, to the developments of communities and urban growth - an ordinance to regulate the fabric form that is capable of enhancing the canopy layer climate by delivering opportunities for people to obtain their own thermal comfort. The need is for an urban climatology planning and applied design model.

Such a model should illustrate the dimensions and relationships between fabric proportions, aspect ratios, and closure ratios of clusters. Also the pattern types, such as those shown in Figures 1 and 2, are dependent on the function of the pattern. For example, should it be residential then specific population densities could be estimated. The importance of population density in urban planning relates to urban heat island mitigation to provide a certain quality of life (Harlen et al, 2006). Finally the integration between fabric and vegetation, including urban trees, is a key consideration in many cases. A passive urban design technique would involve positioning particular types of trees in city zones and structuring the public green areas to embed



Figure 1. Centre and main axes to the park of the first garden city, Hampstead (1909). Source: Google© 2008

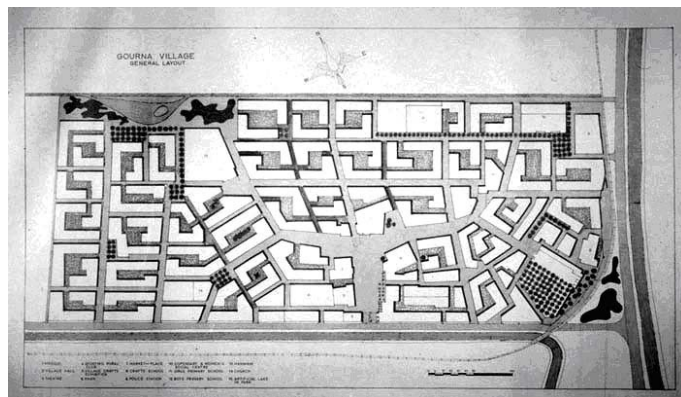


Figure 2 Centre and main urban space of Al-Gourna Village form the 1960s (Fathy, 1973).

them into the whole pattern. An urban climate design model is thus an interaction between specific passive tools and the expected urban form – as outlined in Figure 3.

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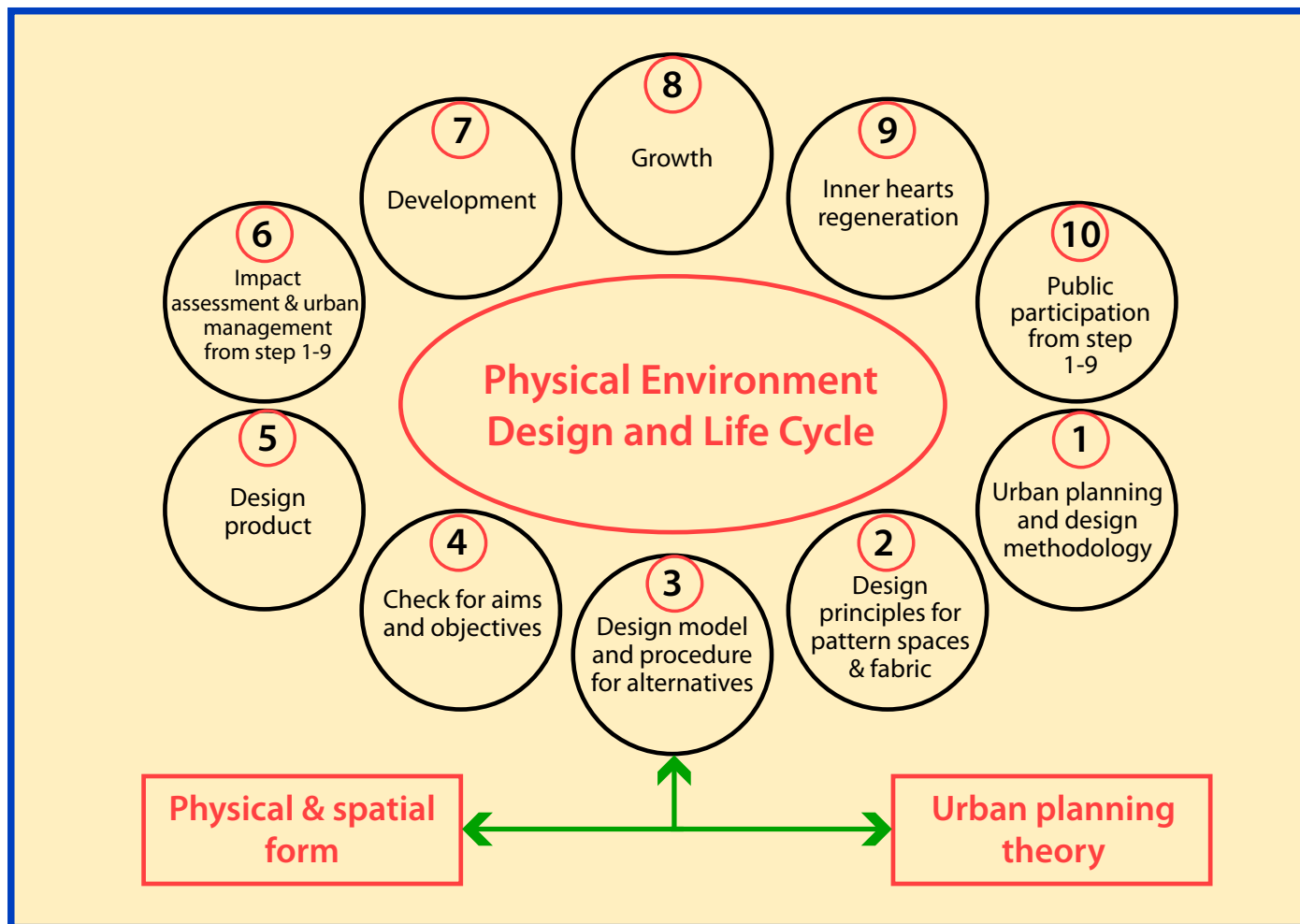


Figure 3. The need for the missing loop of urban form – a climatologically interconnected design model.

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## Urban Climate Research in Hungary

This is a short summary of the recent urban climate work carried out in Hungary, concentrating on research activity on meteorological parameters. Institutions of three cities have ongoing urban climate investigations (Fig. 1). As medium-sized cities (pop. about 200,000) Szeged and Debrecen are situated on flat terrain, so they are particularly suitable to draw general conclusions on climate modifications caused by urbanization (Fig. 2). Budapest has partly hilly regions, but its size (about 2 millions) motivates this type of research, too.

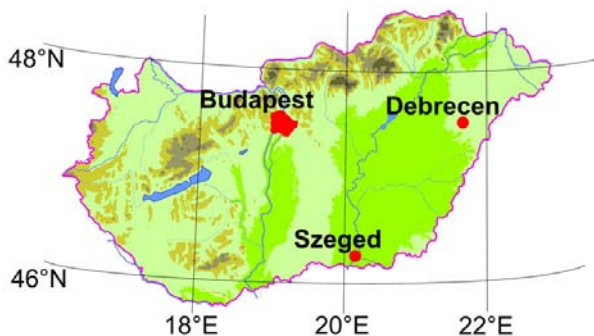


Figure 1. Location and topography of Hungary and cities with urban climate investigations

### Detection and modeling of surface air UHI patterns

The work at the Department of Climatology and Landscape Ecology, Univ. Szeged and the Department of Meteorology, Univ. Debrecen are focused on the detection and modelling of spatial and temporal variations in nocturnal urban temperature fields using mobile measurements.

In Szeged, Unger et al. (2000) examined the spatial and quantitative influence of urban factors on the temperature field. The results indicated isotherms increasing in regular concentric shapes from the suburbs towards the inner urban areas with a seasonal variation in the UHI magnitude. In the city centre the mean intensity can reach 3.1°C and 2.1°C in the non-heating and heating

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seasons, respectively. Strong relationships exist between urban thermal excess and the distance from the city centre, as well as built-up ratio, but the role of water surface is negligible. Unger et al. (2001) focused their efforts on investigating the development of the UHI along a representative urban cross-section. The seasonal profiles follow remarkably well the general cross-section of the typical UHI with its characteristic parts as 'cliff', 'plateau' and 'peak' (Fig. 3). As the normalized values showed, the form of the seasonal mean UHI profile is independent of the climatological conditions, and is determined to a high degree by urban surface factors. As a conclusion, a modified model describing the temperature variable for cities situated in simple geographical environments was suggested.

Bottyán et al. (2005) examined the spatial distribution of mean UHI intensity with special regard to land-use fea-

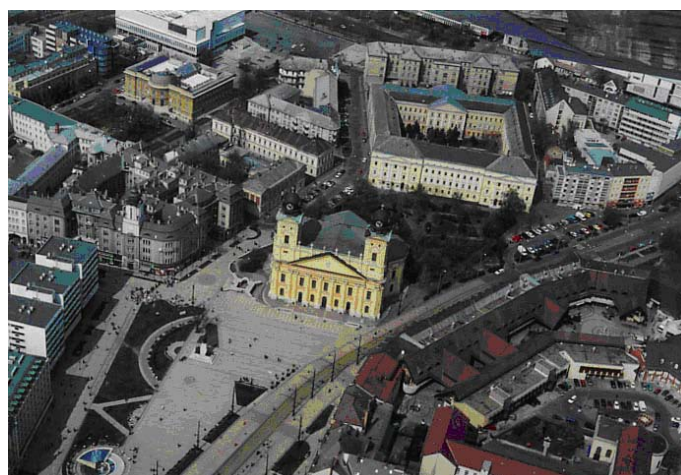


Figure 2. Aerial views of historic central parts of Szeged and Debrecen



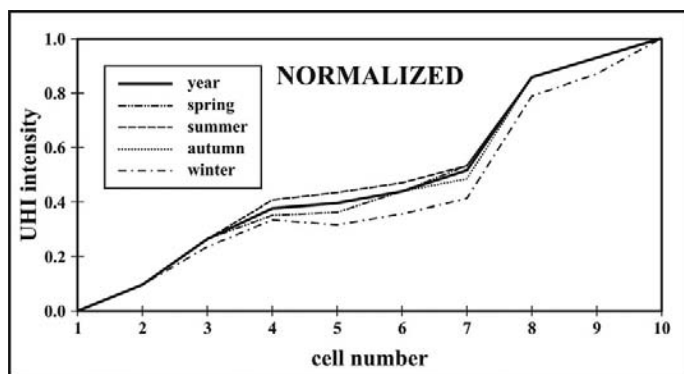


Figure 3. Seasonal cross-section profiles of the normalized UHI in Szeged

tures such as built-up ratio and its areal extensions in Debrecen using multiple linear regression analysis. As the measured and predicted mean UHI patterns show, there is an obvious connection between the spatial distribution of urban thermal excess and the examined land-use parameters.

The spatial distribution of the annual mean UHI intensity was simulated by a multiple variable empirical model based on temperature and easily determinable urban surface cover datasets (evaluating from Landsat images) for Szeged and Debrecen (Balázs et al., 2008). This model was verified by independent datasets from three other settlements. In order to get some impression on the mean UHI patterns in other cities with no temperature measurements available, the model was extended to the urban areas of four other cities situated in geographical environments similar to that of Szeged and Debrecen. The main shortcoming of typical empirical models, namely that they are often restricted to a specific location, is overcome by the obtained model since it is not entirely site-specific, but rather more region-specific.

At the Department of Fluid Mechanics of Technical University in Budapest, Kristóf et al. (2006) adapted a general-purpose CFD software to simulate atmospheric flow induced by the UHI effect. Non-hydrostatic formulation of the governing equations has been employed with a realizable  $k$ - $\epsilon$  turbulent model. Compressibility and thermal stratification effects were taken into account by utilizing a novel system of transformations to the field variables and in addition consequential source terms to the standard set of transport equations. The model was used for simulating UHI circulation in Szeged (Fig. 4). Data on urban surface geometry as well as temperature patterns were taken from on site measurements. The distributions of anthropogenic heat sources and the field variables of flow structure were obtained from the simulation model.

#### Urban surface geometry versus UHI

Based on the available scientific literature Unger (2004) provided a comprehensive review on intra-urban

sky view factor (SVF) – temperature relationship. The obtained results are rather contradictory. The explanation may be that previous investigations were limited to the central or only specific parts and comparisons were often based on element pairs measured at some selected sites. The study in Szeged utilized a large number of areal means of numerous measurements of SVF and air temperature related to almost a whole city. There was a strong relationship in the intra-urban variations of these variables, that is, urban surface geometry is a significant determining factor of the air temperature distribution inside a city if the selected scale is appropriate. Therefore, investigation of a sufficient number of appropriate-sized areas covering the largest part of a city or the entire city is needed to draw well-established conclusions on the studied relationship.

The use of high resolution 3D urban raster and vector databases in urban climatology was presented by Gál et al. (2008). Results from the applied vector and raster based methods to the calculation of continuous SVFs showed similar values. Furthermore, they evaluated the relationship between urban geometry, quantified by SVF, and intra-urban nocturnal temperature variations using areal means in the whole urban area of Szeged. The usefulness of using areal means in SVF–temperature relations was confirmed. The vector and the raster approaches to the derivation of areal means of SVF were both shown to be powerful tools to obtain a general picture of the geometrical conditions of an urban environment.

Gál and Unger (2008) presented an urban roughness mapping method in a large study area of Szeged. With this procedure the potential ventilation paths of the city can be located. The calculations of the roughness parameters were based on a 3D building database; this new approach using the lot area polygons provided more detailed results than other recent studies. The detected ventilation paths could play a significant role in the development of the UHI circulation and result in the reduction of air pollution in the central parts of the city (Fig. 5). Based on the results, the areas can be marked out where the city government should keep the advantages of the ventilation paths considering the human comfort aspects of the urban climate.

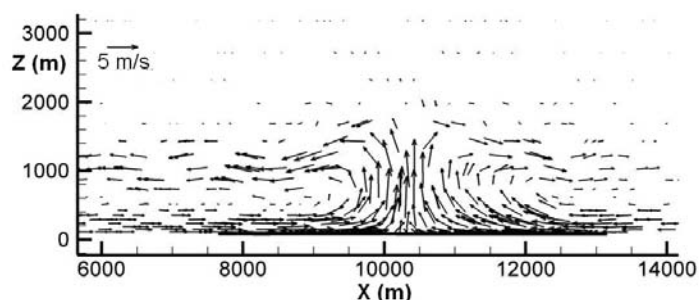
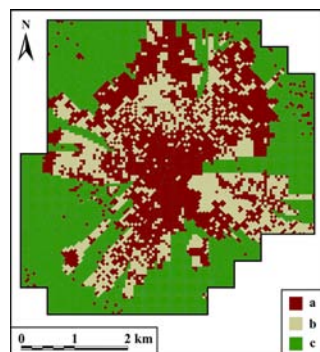


Figure 4. Cross-section of the 3D velocity field in Szeged obtained from the simulation model

**Figure 5. Composite map with the cells of the 50m x 50m mesh: (a) cells that do not fulfill, (b) cells that partly fulfill and (c) cells that fulfill the criteria for elements of possible ventilation paths**



### Human comfort in urban environments

At first, Unger (1999) evaluated differences in the annual and diurnal variation of human bioclimatic characteristics between urban and rural environments over a 3-year period using simple indices for the available data set (thermohygrometric index THI, defined by air temperature and relative humidity and the number of "beergarden days" defined by air temperature at 2100 hours). In urban and rural areas, "hot" THI conditions characterized 6% and 1% of the year, "comfortable" conditions 30% and 20%, "cool" conditions 10% and 12%, and "cold" conditions 54% and 66%, respectively. The beergarden days appeared from May until October and the city had almost twice as many pleasant evenings as the rural areas. Consequently, the city favourably modified the main climatological elements within the general climate of its region, therefore, periods likely to be comfortable were found more frequently in the city centre than in rural areas.

Compared to open landscapes the complex urban surface creates an environment with special microclimatic characteristics, which have a dominant effect on the energy balance of the human body. As a second step, outdoor thermal comfort conditions were examined through two field-surveys in Szeged (Gulyás et al., 2006). Since the sample area is located in a heavily built-up city centre, radiation fluxes are mainly influenced by narrow streets and several 20-30 m tall trees. Human-biometeorological assessment of the microclimate of complex urban environments was given through the application of the thermal index PET by the utilization of the RayMan model. Firstly, bioclimatic conditions of sites located close to each other but shaded differently by buildings and plants were compared. The resulting differences in the PET index amongst these places can be as high as 15-20°C due to the different irradiation. Secondly, the investigation of different modelled environments by RayMan (only buildings, buildings + trees and only trees) showed significant alterations in the human comfort sensation between the situations.

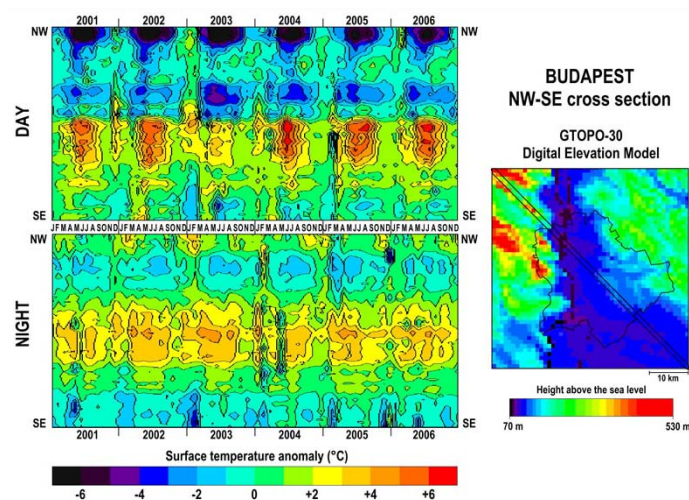
### Surface UHI detection using remote sensing

In the frame of the urban climate research at the Department of Meteorology, Eötvös Loránd University,

Budapest, remotely sensed thermal information is used. The surface temperature is determined from the day-time and night-time measurements of seven spectral bands of sensor MODIS (Moderate Resolution Imaging Spectroradiometer): channels 20, 22, 23, 29, 31, 32 and 33. MODIS is a cross-track scanning multi-spectral radiometer with 36 electromagnetic spectral bands from visible to thermal infrared, and the horizontal resolution of the infrared measurements is 1 km. Sensor MODIS is carried on-board on the satellites Terra and Aqua, which were launched on 705 km height polar orbits in December 1999 and May 2002, respectively. Both satellites are part of the Earth Observing System Program of NASA.

50x50 pixel representations of selected Central European urban agglomerations (including their rural environment) are determined from a satellite image tile containing 1200x1200 pixels using sinusoid projection. The representative areas are divided into urban and rural pixels in the case of each city with more than 1 million inhabitants. In order to separate urban and rural pixels, the 1-km gridded MODIS Land Cover Product is used. The urban built-up part of the selected representative area is defined within a 15-km radius circle around the city center, while rural surrounding pixels may be found within a 15-25 km radius ring around the city center. Since the topography significantly affects the UHI, hilly regions have to be eliminated. For this process, the GTOPO30 global digital elevation model with horizontal grid spacing of approximately 1 km is used (USGS, 1996). In these studies urban and rural pixels are within the  $\pm 50$  m and  $\pm 100$  m range of the city mean elevation value, respectively.

UHI intensity of the selected large cities is defined as the difference between the spatial averages of the obtained urban and rural surface temperatures. Annual mean night-time UHI intensity is around 2-3°C (Dezső et al., 2005). Basically, more populated cities exhibit



**Figure 6. Annual variation of monthly mean surface temperature in the NW-SE cross-section of Budapest based on day-time and night-time MODIS remote observations (2001-2006)**





Figure 7. Panorama of Budapest with hilly western parts and flat eastern parts

more intense heat islands. Orographical modification, distribution of land cover types of rural surroundings (i.e., portions of cropland, grassland, and forest), and urban air quality disturb this relationship. Analyzing the 6-year-long time series of satellite-based observations, the results suggest that the annual variation of monthly mean UHI intensity is larger in day-time than in night-time (Pongrácz *et al.*, 2006). The most intense UHI effect occurred on summer days when monthly mean UHI intensity is around 4-6°C. Direct solar radiation and thermal inertia can be considered as possible reasons. UHI intensity is larger in night-time than in day-time in the spring and autumn months, which is in contrast with the summer UHI intensities. This considerable difference can be explained partly by shorter day-time lengths in these equinox seasons than in summer, and partly by the relatively high values of air humidity and the often occurring cloudy weather.

Furthermore, spatial structures of the UHI effect between 2001 and 2006 were analyzed and compared depending on seasons (Dezső *et al.*, 2005; Pongrácz *et al.*, 2006). In order to analyze the temporal variation of the UHI structure of the Central European agglomeration areas, time series of the monthly mean differences of surface temperature of each pixel and the rural mean along the major cross-sections were compared (Pongrácz *et al.*, 2006). The characteristic cross-sections were selected on the basis of the representativeness of geographical and orographical features of the cities and their surroundings. In case of Budapest the downtown regions (administrative and commercial center) can be clearly recognized due to the positive anomaly values larger than 5-6°C, and 3-4°C in day-time and night-time, respectively (Fig. 6). Annual variation of the monthly mean values is more pronounced in day-time than in night-time. The maximum anomaly occurs in the summer months in both cases. The difference between the warmest and the coldest surface temperature exceeds 15°C in summer. The western part of the city is hilly and covered by forests, so its surface is relatively cold (Fig. 7). The downtown area (located on the left bank of the river Danube and characterized by 25-30 m high buildings from the late 19th century), can become very hot on summer days.

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2nd circular

The 7<sup>th</sup>  
International Conference on Urban Climate



Yokohama, Japan 2009



June 29 (Monday) - July 3 (Friday), 2009



## Invitation

The International Association for Urban Climate (IAUC) warmly invite you to attend the Seventh International Conference on Urban Climate (ICUC-7) to be held in Yokohama, Japan from June 29 to July 3, 2009. ICUC-7 is the continuation of a series of similar conferences starting in Kyoto, Japan in 1989, followed by those in Dakha, Bangladesh in 1993, Essen, Germany in 1996, Sydney, Australia in 1999, Lodz, Poland in 2003, and Göteborg, Sweden in 2006. The success of this series helped to create a cohesive international community of urban climatologists.

The aims of the conference are to provide an international forum where urban climatologists meet and discuss developments in research and the applications of climatic knowledge to the design of better cities. ICUC-7 wishes to cater to the interests of a diverse community of meteorologists, climatologists, hydrologists, ecologists, engineers, architects and planners and others interested in these topics. On behalf of the organisers we are honoured to invite you to attend the Seventh International Conference on Urban Climate in Yokohama, Japan in 2009.

Dr. Manabu Kanda, ICUC-7 Local Organizer  
Dr. Matthias Roth, President of IAUC

## Meeting venue

The conference will be held in the new PACIFICO YOKOHAMA - Pacific Convention Plaza Yokohama- (<http://www.pacifico.co.jp/english/index.html>) located in Yokohama on the Bay of Tokyo. The conference venue and hotels can be easily reached by direct bus from Narita International Airport which serves the greater Tokyo area.

### Upcoming Conferences...

**CLIMATE CHANGE AND URBAN DESIGN**  
The Third International C.E.U. Congress  
Oslo, Norway • 14-16 September 2008  
<http://www.ceunet.org>

**PASSIVE & LOW-ENERGY ARCHITECTURE**  
25th PLEA International Conference  
Dublin, Ireland • 22-24 October 2008  
<http://www.plea2008.org>



## Scientific Program

The focus is on original research into the physical, biological and chemical atmospheric processes operating in built areas, the weather, climate and surface hydrology experienced in built areas, the design and testing of scale, statistical and numerical models of urban climates or reports on the application of climatic understanding in architectural design or urban planning. Papers may relate to new concepts, methods, instruments, observations, applications, forecasting operations, scenario testing, projections of future climates, etc. Special sessions that focus on major field or other projects may be proposed. Hence appropriate topics include, but are not restricted to:

- Airflow over cities including turbulence, urban roughness and drag, changes of wind speed and direction, urban circulation systems, wind engineering
- Urban impacts on surface moisture, dew, evaporation, humidity, fog, cloud and precipitation
- Exchanges of heat, mass and momentum between the urban surface and its boundary layer
- Short- and long-wave radiation in polluted air, urban visibility
- Urban heat islands, their nature, genesis and mitigation
- Remote sensing of cities and urban climate
- Interactions between urban climate and the emission, dispersion, transport, transformation and removal of air pollutants
- Models of the urban atmosphere at all scales
- Forecasting urban weather, comfort, hazards, air quality
- Topoclimatology of cities including the effects of coasts, valleys and other landforms
- Climates of impervious surfaces such as streets, highways, runways and parking lots

- Climatic performance of urban trees, lawns, gardens, parks, irrigation, rivers, lakes and reservoirs
- Climate sensitive urban design and planning
- Building climates (interior and exterior) and the climatic performance of built features
- Urban bioclimates relevant to the functioning of plants, wildlife and humans
- Cities and global change

## Registration and Accommodation

Online registration and hotel booking at the conference rate will be processed by the JTB-GMT travel agency. Early registration fees will be cheaper!

- >Early online registration: February 1 - March 31, 2009
- >Late online registration: April 1 - May 31, 2009
- >Onsite registration: June 28 - July 3, 2009

### Registration fees

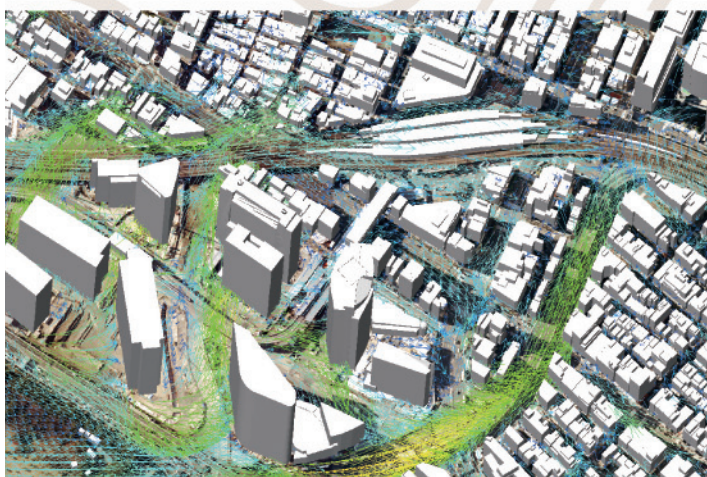
	Early (online)	Late (online)	Onsite
	February 1 - March 31	April 1 - May 31	
Full registraion	60,000 JPY	65,000 JPY	70,000 JPY
Student/Regired person registration	35,000 JPY	40,000 JPY	45,000 JPY
Accompanying person	10,000 JPY	12,000 JPY	15,000 JPY

Fees for delegates from less developed countries (LDC) or non-OECD countries will be available upon request. Fees include access to all sessions, CD-ROM proceedings/program, on-site internet access, ice-breaker, all coffee breaks and an evening Tokyo Bay cruise (300 persons maximum).

## Social Program

- June 28 (Sun) : Welcome reception
- June 29 (Mon) : Ice breaker
- June 30 (Tue) : Tokyo Bay cruise
- July 1 (Wed) : Conference banquet

Conference banquet attendance is on a self-financing basis at present. In addition, tours including visits to the nearby historic seaside town of Kamakura with its famous Buddha statue, Kabuki theater/Ginza district in Tokyo or Shinjuku/Tokyo Metropolitan Government building will be offered on a self-financing basis.



### Upcoming Conferences...

**URBAN WEATHER & CLIMATE: NOW AND THE FUTURE**  
AMS 89th Annual Meeting  
Phoenix, Arizona, USA • 11–15 January 2009  
<http://www.ametsoc.org/meet/annual/index.html>

The meeting will include a special symposium in honor of IAUC past president, Prof. Tim Oke. For additional information, please contact Sue Grimmond ([Sue.Grimmond@kcl.ac.uk](mailto:Sue.Grimmond@kcl.ac.uk)).



## International Scientific Committee

The committee will be composed of the board members of the International Association for Urban Climate (IAUC) (<http://www.urban-climate.org/>).

## Local Organizing Committee

Manabu Kanda (Tokyo Institute of Technology), Chairman

## Conference Website

<http://www.ide.titech.ac.jp/~icuc7/>

Please browse above site frequently to check for latest updates.

## Contact Information

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PACIFICO YOKOHAMA  
(meeting venue)

## Abstract Submission

- > **Abstract submission:** **Deadline: December 15, 2008**  
 Short abstract (maximum 200 words) can be submitted online after September 1, 2008 (<http://www.ide.titech.ac.jp/~icuc7/>).
- > **Notification of acceptance:** **Scheduled for February 28, 2009**  
 Notification of decision will be sent by e-mail from the secretariat of ICUC7.
- > **Submission of extended abstract:** **Deadline: May 15, 2009**  
 Manuscript should be prepared in MS Word editor (preferable) or as PDF file. Text, including illustrations and references, should be no longer than four (4) pages. The manuscript can be submitted online after February 1, 2008.



### Upcoming Conferences...

**URBANISATION AND CLIMATE CHANGE**  
 31st International Geographical Congress  
 Tunis • 12-15 August 2008  
<http://www.igc-tunis2008.com/>

This congress will include the theme of "Urbanisation and Climate Change" as part of a special inter-disciplinary session which is being co-sponsored by IAUC.



## Recent publications in Urban Climatology

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Thanks to everyone for their contribution. Papers published up until June 2008 are listed here. Micro-meteorologists, designers and modelers sure will find interesting topics in this edition.

Soon we will be putting together the complete 'Urban Climate' bibliography for the period 2005-2007 for publication on the IAUC website. All readers are invited to send any peer-reviewed references to be included in this database.

Papers published since June 1, 2008 are welcome for inclusion in the next newsletter.

Please note that my e-mail has changed and from now on send your references to [jhidalgo@labein.es](mailto:jhidalgo@labein.es) with a header "IAUC publications" and the following format:

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**Keywords:**

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**Abstract:**

Happy reading,

Julia Hidalgo

[jhidalgo@labein.es](mailto:jhidalgo@labein.es)



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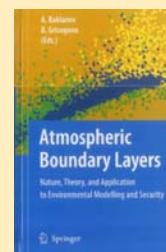
Ziehn, T. & Tomlin, A. (2008), Global sensitivity analysis of a 3-dimensional street canyon model Part I: The development of high dimensional model representations, *Atmospheric Environment* **42**(8), 1857-1873.

#### Recently Published...

#### Atmospheric Boundary Layers: Nature, Theory and Applications to Environmental Modelling & Security

Alexander Baklanov and Branko Grisogono, Editors

<http://www.springer.com/geosciences/meteorology/book/978-0-387-74318-9>



This book presents a set of peer-reviewed papers following the NATO Advanced Research Workshop (ARW) "Atmospheric Boundary Layers: Modelling and Applications to Environmental Security" held in Dubrovnik, Croatia in April 2006 (see the ARW website: <http://pbl-nato-arw.dmi.dk>).

## Presentation of 2007 Luke Howard Award

The Luke Howard Award is given annually to an individual who has made outstanding contributions to the field of urban climatology in a combination of research, teaching, and/or service to the international community of urban climatologists. The presentation of this award for 2007 to **Prof. Yoshino** (IAUC Newsletter #26) occurred at the annual conference of the Meteorological Society of Japan, May 21, 2008 in Yokohama, Japan. Manabu Kanda, the Chair of IAUC Awards Committee, had the opportunity to formally make the award to Prof. Yoshino. The prize is an IAUC edition of Howard's monumental work in this area, *THE CLIMATE OF LONDON*.



The winner of the IAUC's 2007 Luke Howard Award, Masatoshi Yoshino (Prof. Emeritus of the University of Tsukuba and Senior Programme Advisor at the United Nations University) receives a copy of *THE CLIMATE OF LONDON*. Pictured with the Chair of the Awards Committee, Manabu Kanda (left). Prof Yoshino gave a short speech, in which he encouraged young researchers in the field.

## New IAUC Board members

We would like to thank everyone who has participated in the voting for the new IAUC Board members. It is my great pleasure to inform you that **Dr. Sofia Thorsson**, University of Gothenburg, Sweden has been elected to the Board of IAUC for a 4-year period starting in August 2008. She will replace Wilhelm Kuttler whose term on the Board has come to an end. The Board would like to take this opportunity to thank Wilhelm for his contribution to the association. The Board would also like to thank all the other candidates who generously agreed to stand for this position.

Jennifer Salmond, IAUC Secretary

## Board Members & Terms

- Toshiaki Ichinose (National Institute for Environmental Studies, Japan): 2007-2011
- Benedicte Dousset (Hawai'i Institute of Geophysics and Planetology, USA): 2006-2010
- Rohinton Emmanuel (University of Moratuwa, Sri Lanka): 2006-2010
- Kevin Gallo (National Oceanic and Atmospheric Administration (NOAA), USA): 2006-2010
- Dr. 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.
- Wilhem Kuttler (University of Essen, Germany): 2004-2008
- Sven Lindqvist (Göteborg University, Sweden): ICUC-6 Local Organizer, 2004-2006\*
- Gerald Mills (UCD, Dublin, Ireland): 2007-2011
- 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
- Jennifer Salmond (University of Birmingham, UK): 2005-2009; Secretary, 2007-2009
- James Voogt (University of Western Ontario, Canada), 2000-2006; Webmaster 2007-\*

\* 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  
 Chair Awards Committee: Manabu Kanda  
 WebMaster: James Voogt

## Newsletter Contributions

The next edition will appear in early October. Items to be considered for the next edition should be received by **August 31, 2008**. The following individuals compile submissions in various categories. Contributions should be sent to the relevant editor:

**News:** Winston Chow ([wchow@asu.edu](mailto:wchow@asu.edu))

**Conferences:** Jamie Voogt ([javoogt@uwo.ca](mailto:javoogt@uwo.ca))

**Bibliography:** Julia Hidalgo ([jhidalgo@labein.es](mailto:jhidalgo@labein.es))

**Projects:** Sue Grimmond ([Sue.Grimmond@kcl.ac.uk](mailto:Sue.Grimmond@kcl.ac.uk))

General submissions should be relatively short (1-2 A4 pages of text), written in a manner that is accessible to a wide audience and incorporate figures and photographs where appropriate. In addition we like to receive any images that you think may be of interest to the IAUC community.