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President's Column

Elections: I would like to express my appreciation to all of you who participated in the recent IAUC elections by nominating candidates and voting, and most of all I would like to thank those of you who stood for the Board. I am pleased to announce that the two new board members, as of August 2005, are Dr. Manabu Kanda (Japan) and Dr. Jenny Salmond (UK) (see p20). Those who will be leaving the Board are Dr. Bob Bornstein, who chairs the Awards Committee and is the Treasurer of IAUC, and Dr Yasuto Nakamura who was the chair of ICUC conference in Kyoto. I want to thank both of them for their excellent work. Both have made significant contributions to the Board and have been instrumental in the initial stages of the IAUC's development.

Collaboration: The World Meteorological Organization's (WMO) Expert Team on Urban Climate and Training (ET3.9) met earlier this month in Geneva (see p2). The WMO has been a very important supporter of the IAUC and its activities. Of particular note is the support the WMO provides for the attendance of scientists at ICUC meetings and for the production of the Proceedings volumes of those conferences. The IAUC and its members also are key contributors to the work of the WMO. For example, IAUC and WMO are partners in the development of an updated urban climate bibliography (an initiative led by Dr. Jenny Salmond). Following the Geneva meeting, I am pleased to announce a new collaborative project focused on urban meteorology and climate models. Given the recent rapid development and use of models of urban atmospheric processes, an overview of urban climate models (UCM) that are currently available will be compiled. As this is a field of very active inquiry, this is to be developed in the form of a "living document" as a web-database. Information will be provided on models, their capabilities and requirements. No particular model will be endorsed. If you would be interested in working on this project, please contact me.

Support: I am pleased to announce that NOAA has become a supporter of the IAUC. They join the WMO and IUGG in this role. The IAUC also has reciprocal agreements with the AMS, IGU and ISB.

Meeting of WMO Expert Team on Urban Climatology including Training

Back row: (left to right) Yinka Adebayo, Miguel Sattler, Leslie Malone, Sue Grimmond, Tim Oke, Toshiaki Ichinose, John Nganaga. Front row: John Page, Bob Bornsetin, Buruhani Nyenzi, Roger Taesler, Gerald Mills and Maria Alcoforado (See p2).

Upcoming Announcements. In the next newsletter, more information will be provided on the ICUC6 conference from the local organizing committee, the web site is now open, and the formal announcement for this year's Luke Howard Award will be published (nominations due in October).

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WMO Meeting
Expert Team On Urban Climatology

From 23 to 25 May 2005 the WMO *Expert Team (ET) on Urban Climatology including Training* met at the WMO headquarters in Geneva, Switzerland (See photograph).

This ET fits within the WMO Commission for Climatology, which is divided into three Open Programme Area Groups (OPAGs):

- OPAG 1: Climate Data and Data Management.
- OPAG 2: Monitoring and Analyses of Climate Variability and Change
- OPAG 3: Climate Applications, Information and Prediction Services.

Each OPAG contains Rapporteurs and Expert Teams in a variety of areas. For example, this ET in located with OPAG3 which includes Agrometeorology, Climate & Hydrology and Operational Heat-Health Warnings among others. The terms of reference for this ET (Box 1), which were examined at the meeting, emphasize its role as a generator of materials for training purposes.

Much of the work schedule undertaken thus far relates to these terms of reference. A substantial part of this is the preparation of materials that continue a WMO tradition that began in the 1970's [1-3]. These include Technical Note (TN) 145 on the Economic Benefits of Climatological Services (a chapter led by Maria Alcofarado & Andreas Matzarakis), TN149 on Urban Climatology and its relevance to Urban Design (Gerald Mills) and TN150 on the Application of Building Climatology to the problem of Housing and Building for Human Settlements (John Page). The latter two are in the development stage with a planned completion date of summer 2006. In addition, Jenny Salmond is currently maintaining the Bibliography on Urban Climatology [4-8]. The latter project dovetails with a regular feature in the IAUC Newsletter compiled by Jenny. Another project that has been submitted to the WMO is an Instrumentation and Observing Methods document on **Measurement and Monitoring of the Urban Environment** (Tim Oke). This report is available as a WMO publication and it was introduced to IAUC members in a previous issue of this Newsletter.

The ET also discussed a new undertaking in the area of Urban Climate Modelling. This is a growing area of interest among National Meteorological and Hydrological Services (NMHS) as computer capacity can now include urban areas in their regional forecast models. The advantages of doing so are improved forecasts in those places where most people live. The disadvantage is the increased computer resource use that increases forecast time. A report for the ET on the issue of urban modeling is being prepared (see the President's Column). One of the projects that the ET is anxious to facilitate is a comparison of the model schemes that are currently available. Martin Best of the UK Meteorological Office gave a presentation to the ET on the requirements for such a comparison.

The ET also discussed the development and delivery of training materials for NMHS personnel. The WMO's Basic Instruction Package for training in this area (Box 2) includes components on both Urban Meteorology and Urban Hydrology [9]. Finally, the ET revisited its terms of reference to both include its training remit and broaden its scope. The proposed terms refer explicitly to Urban and Building Climate sciences and our role in facilitating training, development and application.

The existence of the ET and the inclusion of Urban Meteorology and Hydrology as components in the education of professional meteorologists provide a significant boost to our field of study. Clearly the work of this ET has a direct relevance to the IAUC and its members, who will be kept informed of developments through the newsletter.

The work of the ET was greatly eased by the support provided by the WMO staff. In particular the help of Leslie Malone of the Secretariat was invaluable.

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WMO Meeting

Box 1
Terms of Reference (Current)

- To gather and develop further training material directed towards National Meterological & Hydrological Service (NMHS) staff and local and regional planners and to produce a comprehensive package covering: Measurement and monitoring of the urban environment; Interactive nature of human activities and urban environments, including adaptation to, and mitigation of, adverse effects; Predictions of change in urban environments; Climate services related to the urban environment, with particular reference to developing countries and to cities suffering major environmental impacts
- To identify requirements for, and make recommendations on, the coordination of research for the purpose of completing the above.
- To review the availability and adequacy of distance learning material on the above.
- To produce specific guidance material aimed at local planners in developing countries covering the fundamentals of building design as they relate to local climate and building materials that are well adapted to local climates

Terms of Reference (Proposed)

ET3.9 is concerned with Urban and Building Climate (UBC) sciences. Its mandate is threefold:

- Develop the UBC **science** that is used by NMHS staff and the users of their services, including:To develop and promote guidelines for standardization of scientific communication on urban climate issues; To aid in the improvement of models of urban surface atmosphere exchanges through collaboration with other key organizations. To contribute to the science, e.g. assessing the effect of built environment and urbanization on the archived long-term climate data records; To collaborate with relevant scientific organizations (e.g. IAUC, CIB, IPCC) and their activities.

- Further the **application** of the UBC science, including: To develop and disseminate reference materials; To improve communication, coordination and collaboration with relevant international agencies and science programmes, NMHSs and WMO scientific programmes ; To develop a WMO 'vision' of the role of urban climate.

- Facilitate **training** of NMHS staff, which will help them better interact with and serve the end-users of urban meteorological, climatological and hydrological services, including: To gather and further develop training materials; To organize a series of regional training work-shops, particularly to support capacity-building in developing countries; To produce and maintain guidance materials that relate to the built environment and climate, for specific end-user applications; To explore the most efficient and cost-effective methods by which to deliver the training, and related materials and tools.

Box 2
The Basic Instruction Package - Meteorology

To become a qualified Meteorologist, the WMO requires the completion of three components:

1. Requisite topics in mathematics and physical sciences (including mathematics and computational science, physics and chemistry) at a University level complemented by topics on communications;
2. Compulsory topics in atmospheric sciences: physical meteorology, dynamic meteorology, synoptic meteorology, climatology and atmospheric chemistry;
3. Elective fields of specialization in meteorology among which is urban meteorology and air pollution.

These components of the Basic Instruction Packages for a Meteorologist can be obtained through a 4-year University undergraduate degree in meteorology or through a master's degree in meteorology that requires a basic science degree for entry. The content of the syllabus outlined for Urban meteorology and air pollution includes: Monitoring of urban weather and climate; Thermal radiation; Atmospheric boundary layer; Buoyant plumes and dispersion of air pollutants; Urban pollution forecasts; Health effects of pollutants.

Country Report
Urban Climate Research in Germany

At the end of the 19th century, the first investigations of urban climate were conducted in Berlin, Germany. These studies explored the climatic differences between urban and rural areas (Kratzer, 1937). The most famous book is that of Benedikt Pater Albert Kratzer, published in 1937 (Kratzer, 1937).

At the end of the 1960s, climate analysis was generally accepted. An important study of that time is the analysis of the urban heat island of Freiburg (Nübler, 1979), a city in complex terrain, where the first car traverses were carried out. The impacts of the regional wind system “Höllentäler” on the urban climate of Freiburg have been analysed several times (Ernst, 1995, Gross, 1988)

Starting in the 1970’s, the Municipal Organisation of the Ruhr Area (located in State of North Rhine-Westphalia, the most densely populated region of Germany) analysed the climate characteristics of several towns and cities (Stock and Beckröge, 1983, Stock, 1992). In the 1980s a comprehensive research project called “STADTKLIMA BAYERN” (Urban Climate of Bavaria) was performed in several cities in southern Germany, which made use of different investigation methods (e.g. thermal imaging, temporary stations, car traverses, vertical soundings; for details see Mayer, 1988). After the re-unification of Germany, several cities in the former German Democratic Republic were analysed in terms of urban climate using remote sensing (especially thermal imaging) and the construction of synthetic climate function maps (VDI, 1988; Helbig et al., 1999). A more recent investigation is the project **STUTTGART 21** (Baumüller, 2000), which analysed the urban climate situation of the city of Stuttgart. In Berlin, another project (**BERLIOZ**) that focussed on the air pollution of Berlin and its surrounding suburbs (Becker et al., 2002; Corsmeier et al., 2002).

Nowadays, urban climatology is part of environmental meteorology under the aegis of the Expert Committee Environmental Meteorology (UMET) of the German Meteorological Society (www.dmg-ev.de). Several institutions of German universities carry out research projects concerning urban climate. The projects mainly focus on the urban heat island, general analysis of urban climate questions and problems, development of urban climate modelling, urban bioclimate and air pollution modelling, application methods of urban climate results for urban planning, physical modelling of urban climate, and climate change in urban areas (Mayer and Matzarakis, 2003). Emphasis is also given to the effects of cold air drainage flows (Weber and Kuttler, 2004), and country breezes (Barlag and Kuttler, 1991), and their effect on the urban climate conditions (Kuttler, 2004a, 2004b). In recent years, the importance of air pollutants and greenhouse gases (particularly particulate matter and CO_2) in urban areas, as well as their temporal and spatial quantification in terms of climate change and urban air quality, is of interest to scientists (Jung et al, 2003; Henninger and Kuttler 2004). Beside the universities, several consulting companies offer their services in urban climatology and provide job opportunities for urban climatologists. They provide not only regular services but play a vital role in the development of models (Moldenhauer, 2004) and new methods (Röckle et al., 2003). Additionally, several working groups of the German Weather Service focus on research into urban climate (Jendritzky et al., 1994).

In recent years, the modelling of meso- and microscale conditions in urban areas in terms of the thermal and air pollution component of the urban climate has improved in quality. The models

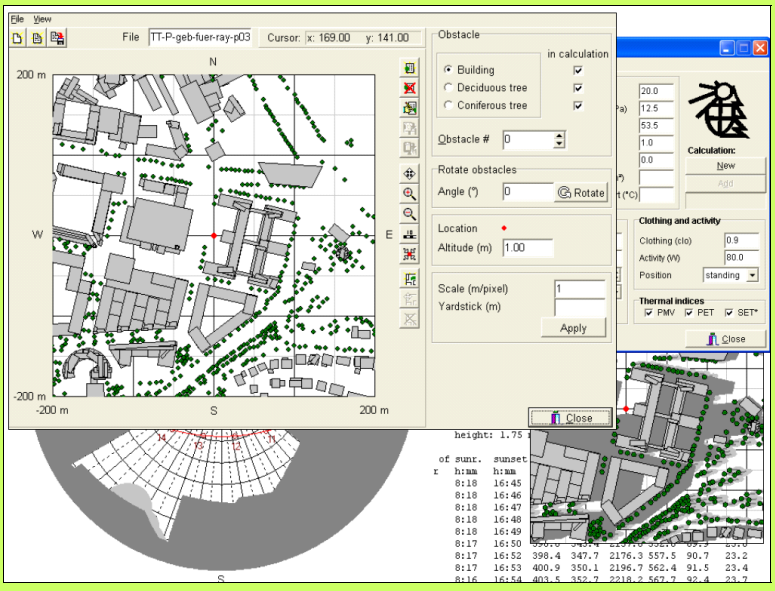

Figure 1. Exemplary input and output of the RayMan model (Matzarkis et al, 2000). See www.mif.uni-freiburg.de/rayman.

Country Report

ENVI-met, METRAS, MISKAM, UBIKLIM and RayMan are good examples. Figure 1 illustrates the application an urban climate software tools (Matzarakis et al., 2000). A listing with explanations of these urban climate models and tools can be found on the International Urban Climate Website (www.stadtklima.de or www.urbanclimate.net).

In Germany, the Internet and new media technologies are widely used to disseminate urban climate information. Examples are the International Urban Climate Website (www.stadtklima.de) (see the March, 2004 edition of this Newsletter) and the results from the **STUTTGART21** investigations (www.stadtklima-stuttgart.de). Figure 2 shows an online calculation of the wind field of the city of Stuttgart.

In Germany the strong focus of urban climate research on applied urban climatology including human-biometeorology is partly because of the legal restriction that “climate and air pollution” issues have to be implemented in regional and urban planning projects (Matzarakis, 2001; Mayer and Matzarakis, 2003). Guidelines regarding the implementation of data on climate and pollution have been published by the German Engineering Society. An important development in this area is the *Climate Booklet for Urban Development*, published by the Interior Ministry of Baden-Württemberg (Figure 3). This booklet achieved a high degree of recognition as a decision-making and technical aid for zoning and planning both within and outside the state of Baden-Württemberg. The impetus for this booklet was an amendment to Germany's existing Federal Building Law with its new requirements for consideration of climatic conditions in zoning and planning. The booklet have been has been translated into Japanese, Portuguese and English (www.staedtebauliche-klimafibel.de).

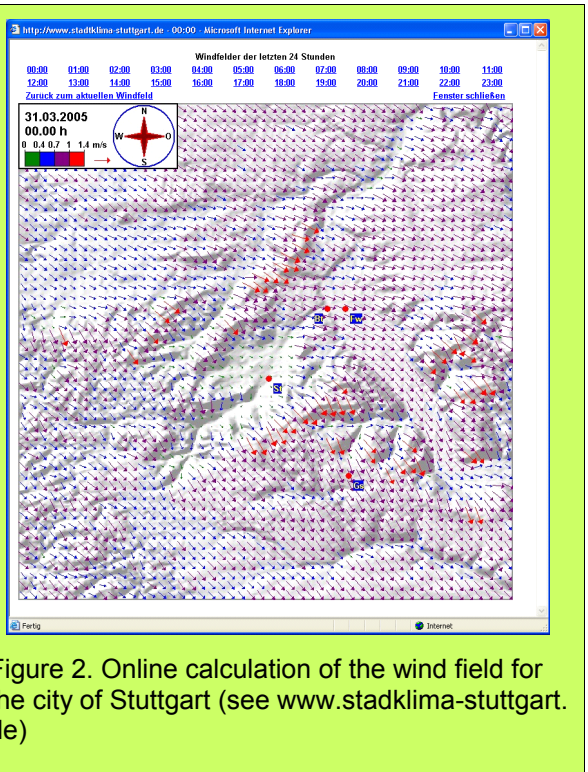

Figure 2. Online calculation of the wind field for the city of Stuttgart (see www.stadklima-stuttgart.de)

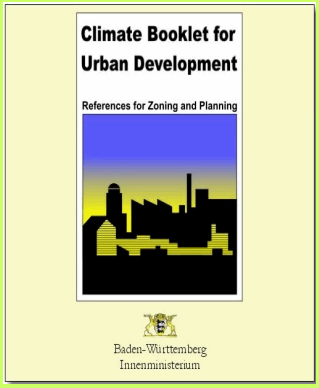

Figure 3. Climate Booklet for Urban Development (see www.staedtebauliche-klimafibel.de)

The Expert Committee on Environmental Meteorology organizes the METTOOLS conference every three years. From the last conference, which was held in October 2003 in Essen (METTOOLSV), a special issue of the Meteorologische Zeitschrift has been published. In addition, a special issue of PROMET, a journal of the German Weather Service, has been published in 2003. Together, these provide an overview of the state of environmental meteorology, including urban climatology, in Germany. The special issue is available online via the website of the German Meteorological Society (www.dmg-ev).

Future research aims to focus on the quantification of urban climate effects and their implications for environmental policy and climate change issues (Matzarakis et al., 1998; Mayer and Matzarakis, 2003). Traditional urban climate issues, such as the assessment of the effects of urban climate on humans in terms of heat stress or extreme events (Matzarakis, 2001) as well as air pollution assessment with human-biometerological methods (Mayer et al., 2004) have been carried out. Using economic values to quantify urban effects will be important for policy purposes and be of considerable scientific interest.

On a global scale, the high degree of urbanisation will urge both scientists and planners to create cities with an improved climate and less air pollution at the meso- and micro-scales. In addition, it will be of interest how to make urban climate results available for urban planners and other professionals like architects. Emphasis will also be placed on the identification of optimised urban structures and low budget urban climate modifica-

tions in order to quantify and create ideal climatic living conditions in cities. In order to reduce the urban heat island the focus will also be set on urban micro climate modelling and urban planning modification.

The examples specified above are not necessarily complete. They reflect only the personal opinions and views of the author.

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Country Report
Urban Meteorology in Argentina

Professional education and Research activities

In Argentina, the Faculty of Sciences of the University of Buenos Aires started the Licenciature in Meteorological Sciences and the Doctoral degree started in 1953. Teaching and research activities in different aspects of meteorology have been undertaken regularly since then in the Department of Meteorology (now the Department of Atmospheric and Oceanic Sciences). Since the very beginning foreign students from Spanish language countries (mainly Latin American countries) came to Buenos Aires and completed the degree courses in Meteorology. Some of them were supported by the World Meteorological Organization. In the 1970s, researchers at the University completed research on dynamical meteorology, meso-meteorology, hydrometeorology, climatology, and air pollution meteorology. Synoptic meteorology and weather forecasting were developed at the Weather Meteorological Service. Today, in the Department of Atmospheric and Oceanic Sciences, research work is done in all the areas mentioned above and also in agrometeorology, urban climatology, climatic change, atmospheric dispersion at urban and local scales, and air-sea interactions. Some of the research groups are still small, but are expected to grow as all of them include students and/or scholarship holders. In Argentina the professional degree in meteorology can only be studied at the University of Buenos Aires, but there are interdisciplinary groups conducting research studies on meteorological, climatological or micrometeorological topics at academic and scientific centres in several cities spread all over the country; for example, in the cities of Bahía Blanca, Bariloche, Córdoba, Chilecito, Mendoza, Neuquén, Puerto Madryn, Santa Fe and Tucumán.

In the field of urban climate, research activities deal with urban air quality problems and the influence of urban conditions on some meteorological parameters, such as, temperature, wind, humidity, and cloudiness.

Air Pollution Meteorology

The Argentine Republic: The Argentine territory has a surface of almost 2.8 million km^2 and extends from approximately 22ºS to 55ºS, from the tropics to the subpolar region, and from 75ºW to 55ºW. The average wind conditions are controlled by three circulatory systems: the Atlantic anticyclone that controls the eastern part of the subtropical region, the wind system that develops according to the intensity of the quasi-stationary low in the central part of the country; and the prevailing westerlies of the middle latitudes in the southern part of the country (the Patagonian region). Local winds (as Pampero, Sudestada, Zonda, land and sea breeze, valley circulations, etc.) are important in certain regions.

Air pollution potential is a measure of the atmospheric conditions that restrict the transport and dilution of pollutants, independently of the existing sources. This potential can be determined from two atmospheric parameters: mixing height and transport wind. Climatological studies on the behaviour of the height of the mixing layer and the ventilation conditions at various locations around the country have been undertaken (Ulke and Mazzeo, 1998; Venegas and Mazzeo, 1999; Gassmann and Mazzeo, 2000). The northeastern and central-eastern regions of the country have been found to have high air pollution potential during the whole year. The region with the greatest atmospheric ventilation is located south of 40ºS, where the frequency of poor ventilation conditions vary between 8.0% in summer and 10.8% in winter.

Buenos Aires: The city of Buenos Aires is part of the Metropolitan Area of Buenos Aires (Fig. 1) an area of 3880 km^2 with about 11,460,000 inhabitants (31.6% of the total population of the country).

Fig. 1. Buenos Aires City and the Metropolitan Area of Buenos Aires (Photo: NASA)

Figure 2. A partial view of Buenos Aires City.

This urban area is one of the megacities in South America and the third largest in Latin America. Buenos Aires City is located on a flat terrain close to the La Plata River. It has an extent of 202.9 km^2 and a population of three million inhabitants. La Plata River is 320 km long and its width varies from 38 km in the upper region to 230 km in the outer region. At Buenos Aires City this river has a width of approximately 42 km.

The geographical conditions in Buenos Aires, such as the flatness of terrain, do not generate complicated flow patterns. It is usually thought that this setting and the prevailing atmospheric conditions ensure good mixing in the tropospheric layers and a spreading out of pollutants. Results obtained in several studies show that this assumption is not always valid. Airflow draws clean air from La Plata River towards the city during approximately 58% of the time but wind speed in the area is lower than 4m/s during 55% of the time. Conditions for stagnation, recirculation and ventilation potential of the atmosphere were also studied in Buenos Aires (Venegas and Mazzeo, 1999). Results show that the probability of stagnations is greater during autumn and winter and a few cases of full recirculation may occur during the year. Buenos Aires experiences stagnations 10% of the time, recirculations 5% of the time and ventilation 41% of the time. Results obtained in a recent study (Ulke, 2004) of hourly daytime ventilation conditions in Buenos Aires city also show that the probability for reduced daytime ventilation during winter is high. Climatological aspects of the daytime mixing height show that mixing heights less than 1000 m occur with an annual frequency of 78%, with a frequency of 63% during summer, 76.6% in spring, 81% in autumn and 92% in winter (Ulke and Mazzeo, 1998). These results, combined with the high frequency of low wind-speeds in the area, indicate that sometimes the region may not be well ventilated.

In estimating time-averaged concentrations of pollutants at particular receptor points with respect to a particular emission point, the frequency that the wind blows from specific directions during the averaging time is of obvious importance. For this reason the frequency distribution of steadiness of wind direction, on the basis of hourly wind data, was studied (Venegas et al., 2001). Every wind direction showed periods of persistence (≥ 6 hours). The highest annual frequency (1.03%) of long persistence periods was associated with eastern winds and the longest period of persistence lasted 32 hours with winds from ESE.

Urban-rural temperature difference in Buenos Aires City

One of the most noticeable consequences of urban growth is the consistent rise in the urban temperature. Several studies have examined the urban effect on temperature at Buenos Aires (Camilloni and Mazzeo, 1987; Barros and Camilloni, 1994; Camilloni and Barros, 1997; Figuerola and Mazzeo, 1998; Camilloni, 1999; Bejarán and Camilloni, 2003). The analysis of three years of hourly urban-rural temperature differences in Buenos Aires showed that the average value of the maximal temperature difference occurred in winter, and ranged from 4.6ºC with weak winds and little cloud cover, to 3.6ºC during windy and cloudy sky conditions. Strong winds from the city towards the rural areas and winds blowing from the river towards the city facilitated the occurrence of an inverse heat island (rural area warmer than the city). The inverse heat island occurred 20% of the time during the three years.

In a recent study an objective synoptic climatological method was applied to identify homogeneous air masses or weather types affecting Buenos Aires during winter, and the results were related to the urban heat island intensity. These results indicated that the mean urban heat island intensity was highest a few hours before sunrise when conditions were dominated by coldest air mass associated with cold-core anticyclones, weak winds and clear skies. From this study, it could be seen that the warmest air mass was the only one that presented a mean negative urban-rural temperature difference during the afternoon, with the smallest diurnal cycle of the urban heat island intensity probably due to the prevailing high humidity and cloudy skies.

Urban Air Pollution

Since 1983, the city of Buenos Aires has an Environmental Pollution Prevention Code (which has been recently up-dated). In other large cities of the country, significant commitments to environ-

Country Report

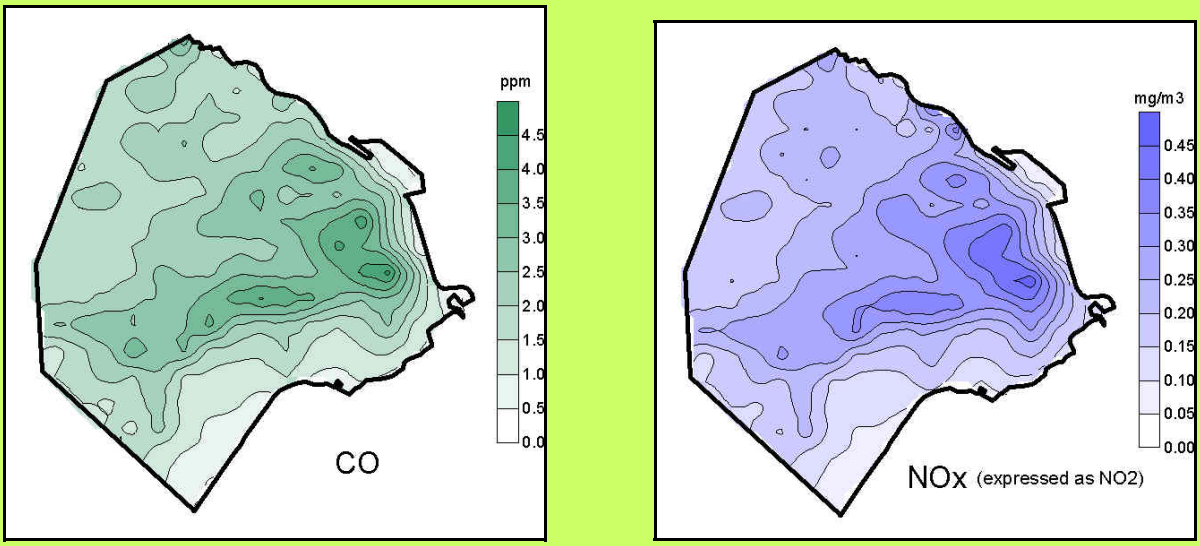

Fig. 2 Mean hourly concentration in Buenos Aires at evening rush hour (8:00 pm)

mental protection started mainly at the beginning of 1990s. Since then, several important cities, such as Córdoba, Mendoza, Bahía Blanca and La Plata have started air quality monitoring programmes or air quality measurement campaigns and air pollution studies (Colombo et al., 1999; Bilos et al., 2001; Olcese and Toselli, 2002, 2004,).

At present Buenos Aires City has no air quality monitoring network system. The City Government has only one air quality monitoring station located near an avenue with high traffic volume during the morning and evening rush hours. Reports on data registered at this site reveal that nitrogen oxides (expressed as NO_2) concentrations may exceed the air quality standard. In recent years, several studies on air pollution have been carried out in the city at different sites and periods. Some results of air quality monitoring campaigns carried out in the city and modelling studies have been presented and discussed in Bogo et al. (1999, 2001, 2003), Venegas and Mazzeo (2000, 2005) and Mazzeo and Venegas (2002, 2004).

At the Department of Atmospheric and Oceanic Sciences, we developed and applied an urban atmospheric dispersion model, named DAUMOD (Mazzeo and Venegas, 1991). In recent years this model has been improved and successfully evaluated (Venegas and Mazzeo, 2002). Fig. 2 shows the model estimations of mean hourly background concentrations of CO and NO_x (expressed as NO_2) in Buenos Aires at rush hour (8:00 pm). Both concentration patterns show large spatial variability, related to the distribution of area source emissions (mainly mobile sources).

Ongoing research activities of the Air Pollution Modelling Group at the University include the incorporation of atmospheric removal processes (dry + wet deposition of contaminants) and simplified chemical reactions, into the urban atmospheric dispersion model. We are also interested in atmospheric dispersion processes at local scale, especially within street canyons.

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Minor Correction

In Issue 9 of the IAUC Website, the Project report entitled MITIGATION OF THERMAL STRESS BY A LARGE RESTORATION OF INNER-CITY RIVER (CHEONG-GYE STREAM IN SEOUL) by Toshiaki Ichinose contained a small error (made by the editor) in the reference to a website.

The web site of Seoul Metropolitan Government is:
http://www.metro.seoul.kr/kor2000/chungaehome/en/seoul/main.htm

Project Report

Monitoring and Prediction of Urban Climate after the Restoration of a Cheong-gye Stream in Seoul Korea

This article reports the preliminary results for the ongoing project *Monitoring and Prediction of Urban Climate after the Restoration of a Cheong-gye Stream* conducted by the Meteorological Research Institute (METRI)/Korea Meteorological Administration (Principle Investigator, Dr. Jae-Cheol Nam). Of interest in this study are: the mitigation of the thermal environment by Cheong-gye stream restoration in Seoul, Korea, which involves intensive observations in Cheong-gye stream area; the characteristics of the urban atmosphere and the urban influence on weather and climate; the development of a high resolution micro-scale model based on the Computational Fluid Dynamics (CFD); and the analysis of the urban thermal environment using the satellite image and geographical information systems. The meteorological observations of the Cheong-gye stream area (Ichinose 2005), the development and application of the CFD model (Baik 2005), and the analysis of the temperature environment using satellite imagery are performed through a collaboration with Seoul National University (Prof. Jong-Jin Baik), Kyungil University (Prof. Myung-Hee Jo), National Institute for Environmental Studies (NIES) in Japan (Dr. Toshiaki Ichinose), and Tokyo Metropolitan University (Prof. Takehiko Mikami).

In this report the following are discussed:

- Mitigation of thermal environment by Cheong-gye stream restoration,
- Characteristics of thermal environment in Seoul,
- Urban influence on weather and climate,
- CFD modeling,
- Analysis of the urban thermal environment using the satellite images and GIS.

Mitigation of thermal environment by Cheong-gye stream restoration

The Cheong-gye stream restoration is not just a part of Seoul's urban planning but a larger initiative of interest to the entire nation as a symbolic project to revive an important part of Korea's historical and natural heritage at the start of the 21st century. When the Cheong-gye stream restoration is completed (Fig. 1) in September 2005, the thermal environment of Seoul will be changed. The restored Cheong-gye stream area is expected to help mitigate Seoul's thermal stress, change hydrology, and street-level wind fields. Intensive observations in the urban area have been performed to understand these changes. Specifically, a long-term meteorological monitoring system was constructed in the Cheong-gye stream area to quantitatively evaluate the land-use change effects on the urban meteorology. A third intensive observation is scheduled for August 2005. The post-restoration effects monitoring will be carried out until 2006.

Characteristics of Seoul's thermal environment

To investigate the spatial and temporal structure of the urban heat island in Seoul, temperature data were measured at 32 automatic weather stations (AWSs) in the Seoul metropolitan area with 12 additional stations using portable devices to measure temperature and relative humidity in the Cheong-gye stream area in Seoul. Fig. 2 shows the distribution of air temperature in the Seoul metropolitan area averaged for the summertime of 2003 (June-August). A relatively warm region extends in the east-west direction, with warm areas evident in the industrial and commercial areas with tall buildings and heavy traffic. A relatively cold region is observed in the mountain

Fig. 1. The view of Cheong-gye stream before and after restoration.

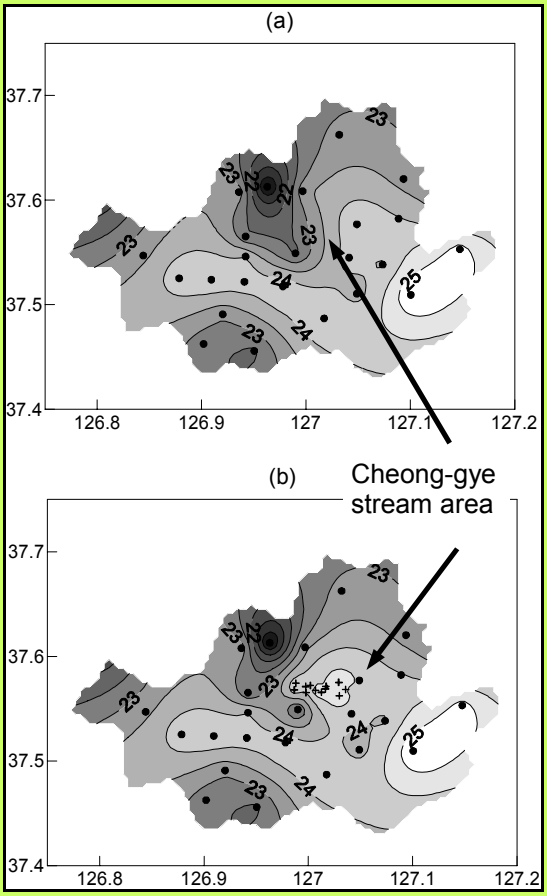


Fig 2. Distribution of air temperature
a. Without monitoring system and
b. With air temperature with monitoring system in the Cheong-gye stream area in the Seoul metropolitan area averaged for the summertime of June 2003 to August 2003. The symbol ● denotes the location of the automatic weather stations (AWSs) in Seoul and + denotes the 12 measurement points of air temperature and relative humidity in the Cheong-gye stream area. The isotherm interval is 0.5 °C.

area and near the borders of Seoul except near the southwestern and southeastern borderlines where the sprawling expansion of urbanization has already occurred. Fig. 2(b) shows the additional warm core in the Cheong-gye stream area. The urban heat island is closely linked to land-use type, weather and human activities related with anthropogenic heat release, and topography. Similar to previous studies for Seoul and other cities, the intensity of urban heat island is stronger in the nighttime than in the daytime, decreases with increasing wind speed, and is pronounced for clear skies (e.g. Oke, 1987; Kim and Baik, 2002, 2004).

A heat budget model has been developed to evaluate the thermal environment of an urban area. The model incorporates land cover types including lawn, park, forest, asphalt, built-up area, water and so on. To examine the performance of the model, meteorological data and surface energy fluxes were observed in Haenam and Seoul, representing land cover types that are primarily grass and built-up, respectively. A sensitivity analysis of the model was performed based on surface parameters (albedo, evaporation efficiency, soil heat capacity) and atmospheric conditions (sunshine, wind speed). Of these parameters, those associated with sunshine played a great part in determining the modeled thermal environment. A comparison with observations suggests that the heat budget model simulates the diurnal variation of surface energy flux (Fig. 3).

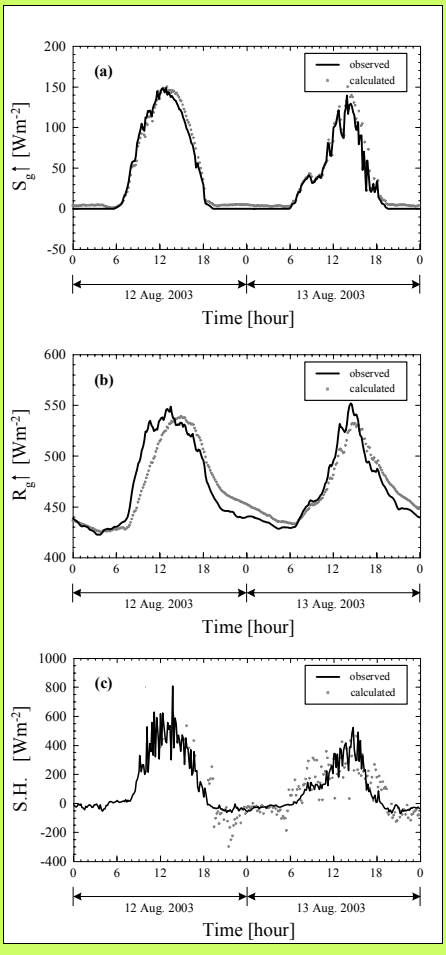
Fig. 3. Comparision of observed and calculated energy fluxes:

a. upward shortwave radiative flux,

b. upward longwave radiative flux, and

c. sensible heat flux for built-up area at Seoul for the period of 12-13 Aug. 2003.

The measurement of sensible heat flux was made at 1.5 m height.



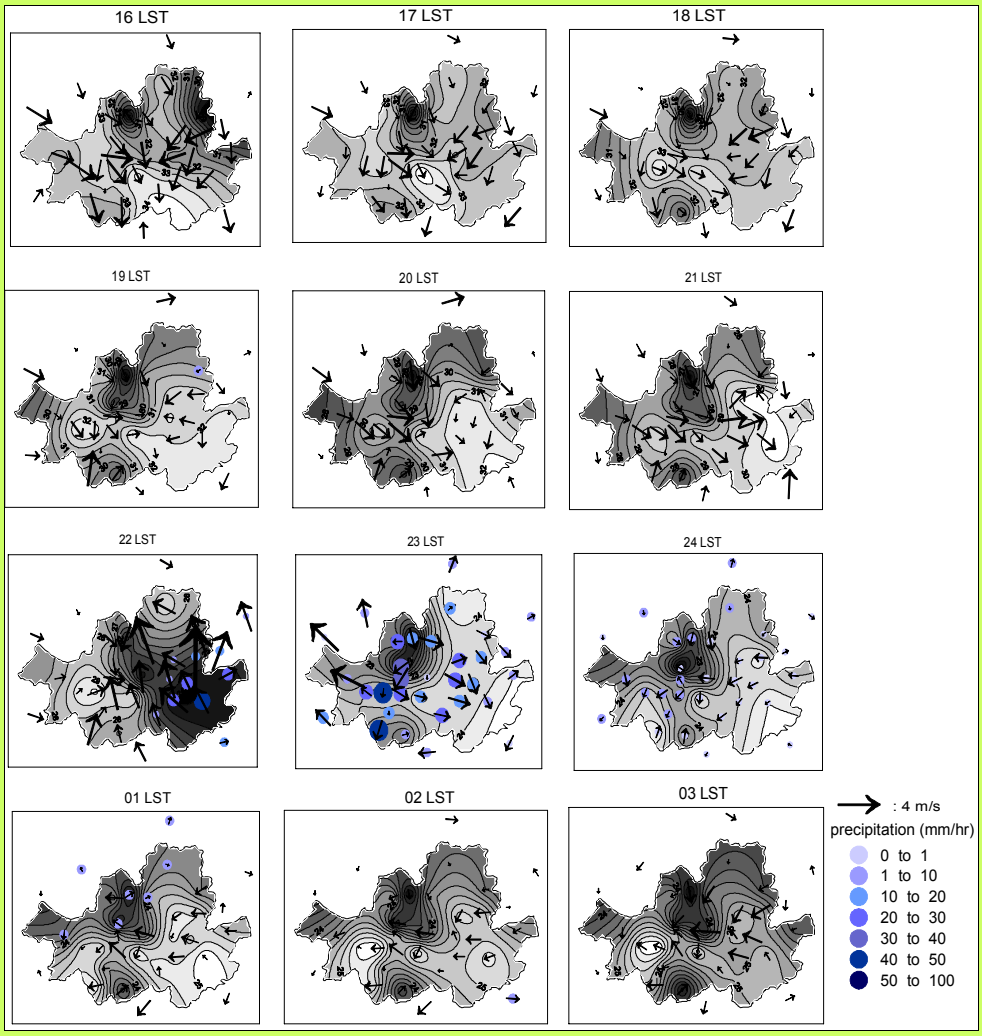


Fig. 4. Spatial distributions of temperature, wind and precipitation from 16LST on August 4 to 03LST on August 5, 2005.

Urban influence on weather and climate

The effect of urbanization on the spatial and temporal characteristics of precipitation in Seoul has also been investigated. Surface meteorological station data for Seoul and four nearby for the period of 1961 to 2003 (over 43 years) were used in conjunction with data from 31 Automatic Weather System (AWS) in Seoul in August 2004. The results show that, over the 40 years, the yearly precipitation increased but the number of rainy days decreased in Seoul. The daily precipitation intensity has increased; notably rainy days with over 20 mm h^{-1} have increased. Analyses indicate that the frequency of heavy rainfall has apparently increased since 1990. This is explained by the effect of urbanization on the intensity of convective precipitation (Baik et al. 2001).

Heavy rainfall events often occur in the afternoon and early morning during the summer season when the atmosphere is unstable, in association with the approach, or the passage, of a front. The observed time of heavy rainfall event is most common in the nighttime (19-24 LST) to late daytime (13-18 LST). A case study was conducted for the period 3 to 6 August 2004 to understand the characteristics of the spatial and temporal distribution of precipitation in Seoul.

A rain storm was formed by the urban heat island in the region of north-east of Seoul (downwind side) between 22-24 LST on 4th August (Fig. 4). The localized strengthening of the convection due to the strong urban heat island caused the precipitation. The results of analysis in this study indicate that the substantial changes observed in precipitation in Seoul seem to be linked with the accelerated increase in the urban sprawl in recent decades, which in turn has induced an intensification of the urban heat island effect. Therefore, the change of precipitation properties is induced by urbanization and we conclude that the urban heat island can change local weather and climate.

Project Report

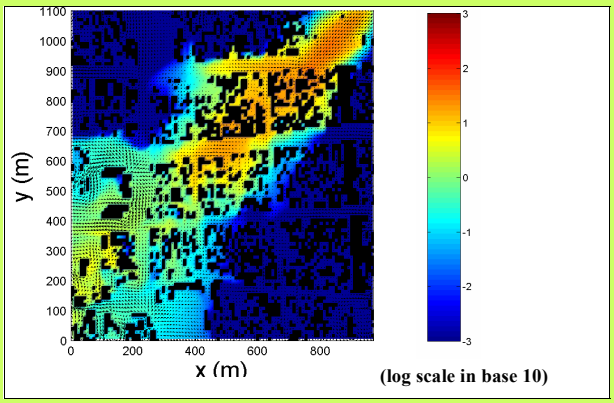


Fig. 5. The concentration of pollutant field at t= 1800 sec simulated by CFD modeling in Cheong-gye stream area.

CFD modeling

A three-dimensional computational fluid dynamics (CFD) model with the *k*-ε turbulence closure scheme based on renormalization group theory was developed. The developed CFD model was then applied to investigate flow regimes for the street and building aspect ratios of Seoul and to simulate flow and pollutant dispersion around the Cheong-gye stream area. The effects of ambient wind direction on flow and pollutant dispersion around this area were also investigated (Fig. 5).

Analysis of the urban thermal environment using the satellite images and GIS

Landsat TM images, NDVI, and the distribution of surface temperature with topography in Seoul were analyzed temporally and spatially. Land-use type was classified and related to the temperature characteristics. The spatial pattern of surface temperature was compared to NDVI and change of geographical characteristics such as land-use type using satellite images in 1987 and 2003 (Fig. 6).

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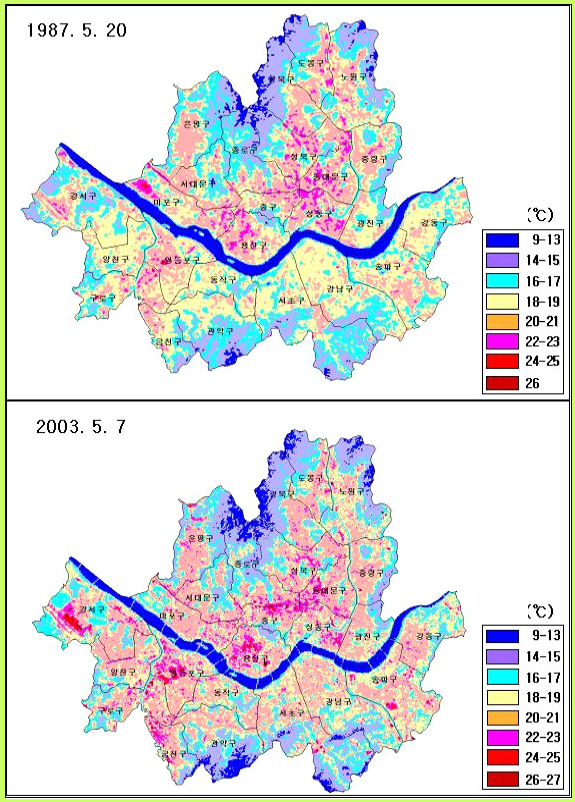


Fig. 6. Surface temperature changes due to the urbanization in Seoul between 1987 and 2003. This temperature field retrieved from Landsat TM data.

ICUC-6

ICUC-6
Sixth International
Conference on Urban Climate
Göteborg, Sweden
June 12th - 16th, 2006

The IAUC members have selected Göteborg (Gothenburg), Sweden as the site for the sixth International Conference on Urban Climate. Further details will become available at the conference website www.gvc.gu.se/icuc6, which is also accessible via the IAUC website (www.urban-climate.org).

Call for papers

ICUC-6 welcomes papers seeking to understand the nature of the atmosphere in urban environments or to the application of such knowledge to the better design and operation of settlements. Scales of interest range from individual built elements (roofs, walls, roads) through whole buildings, streets, factories, parks, clusters of buildings and neighborhoods, to whole cities and urban regions and their impacts on weather and climate at scales up to those of global change. The focus can be original research into the physical, biological and chemical atmospheric processes operating in built areas; the weather, climates 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. Sessions that focus on major field studies or other projects or topics may be proposed. For further information please visit the website or email Professor Sven Lindqvist, chair of the local organizing committee (sven@gvc.gu.se) or Prof. Sue Grimmond (grimmon@indiana.edu), President IAUC.

The deadline for submission of abstracts is 10th November, 2005. Abstracts will be submitted via the web. 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, and wind engineering
- Anthropogenic Heat
- Building climates (interior and exterior) and the climatic performance of built features
- Carbon exchanges in urban areas
- Cities and global change
- Climate-sensitive urban design and planning
- Climates of paved surfaces such as roads, streets, highways, runways and parking lots
- Climatic performance of urban trees, lawns, gardens, parks, green roofs, irrigation, rivers, lakes and reservoirs
- Emergency response planning
- Exchanges of heat, mass and momentum between the urban surface and its boundary layer
- Forecasting urban weather, comfort, hazards, and air quality
- Interactions between urban climate and the emission, dispersion, transport, transformation and removal of air pollutants
- Models, and their evaluation, of the urban atmosphere at all scales and urban surface-atmosphere exchanges
- Remote sensing of cities and urban climate
- Road climatology in cities, including influence from traffic and other city related-objects
- Short- and long-wave radiation in polluted air and urban visibility
- Topoclimatology of cities, including the effects of coasts, valleys and other landforms
- Urban biometeorology relevant to the functioning of plants, wildlife and humans
- Urban climates in high latitude settings
- Urban heat islands, their nature, genesis and mitigation
- Urban impacts on surface moisture, dew, evaporation, humidity, fog, cloud and precipitation

Report from the ICUC-6 Organization Committee

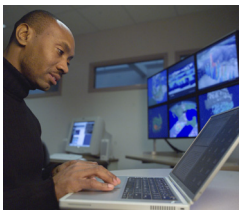
Online submission of abstracts now available.
Please visit (www.gvc.gu.se/icuc6).

Program changes
All **main authors** need to pay an abstract fee of 470 SEK.
Additional abstracts submitted by the same main author will be free of charge.

Hope to see you all in June 2006,
Local Organization Committee

Urban Climate News

We invite submission to the "News" section. Submission materials could include but are not limited to: upcoming papers, field experiment information, awards, data or document availability announcements, etc.



Please submit your "news item" to Dr. J. Marshall Shepherd (marshall.shepherd@nasa.gov).

Climate – Urban Development Booklet

The potential for incorporating climate information into urban planning is demonstrated by "Climate Booklet for Urban Development", published by the Interior Ministry of Baden-Württemberg (See p7). This booklet achieved a high degree of recognition as a decision-making and technical aid for zoning and planning both within and outside the state of Baden-Württemberg. The impetus for this booklet was an amendment to Germany's existing Federal Building Law with its new requirements for consideration of climatic conditions in zoning and planning. The "Climate Booklet for Urban Development" is now available (in German and English) online on the internet at the following address: www.staedtebauliche-klimafibel.de. For more information, contact Prof. Juergen.Baumueller u360400@stuttgart.de.

Helsinki Urban Modeling Workshop

The Finnish Meteorological Institute (FMI), Vaisala Oyj and partners have finalized plans to launch an advanced mesoscale weather observation network in the Greater Helsinki area in Finland. The Helsinki Testbed will promote the measurement and understanding of fine-scale weather phenomena, i.e. local weather. The Helsinki Testbed project concentrates on small-scale weather observation and forecast networks in high-latitude conditions. Of special interest are weather events that take place within a 50-kilometer (30-mile) region, and last up to a few hours. These weather phenomena are too big to be observed from one point, but too small to be studied in detail with a traditional network for weather observations. Typical small-scale weather phenomena in Helsinki include sea breeze, fog, snow bands, urban heat islands and thunderstorms.

To help ensure that the Testbed will provide useful data for atmospheric modelers, the Helsinki Urban Modeling Workshop will be held on 15-16 June 2005 at Vaisala Oyj and the Finnish Meteorological Institute. For more information on the workshop goals, organization, arrangements and schedule details, contact Bob Bornstein. Travel funds are not available for attendees. Space is very limited. If you cannot come, please send him the name of a colleague that might come in your place; the planning committee will attempt (based on space availability) to accommodate your recommendation.

Workshop Organizers:Prof. Robert Bornstein (pblmodel@hotmail.com), Prof. Sergej Zilitinkevich (Sergej.Zilitinkevich@fmi.fi), Dr. Walter Dabberdt (Walter.Dabberdt@Vaisala.com), Dr. Sylvain Joffre (SylvainJoffre@fmi.fi) and Dr. Ari Karppinen (Ari.Karppinen@fmi.fi)

The Impacts of the Urban Environment on Precipitation and Climate Modeling.

A Review of Current Investigations of Urban-Induced Rainfall and Recommendations for the Future by J. Marshall Shepherd (NASA/GSFC) is in press at the journal *Earth Interactions*. The goal of this paper is to provide a concise review of recent (~1990-present) studies related to how the urban environment affects precipitation. In addition to providing a synopsis of current work, recent findings are placed in context with historical investigations such as METROMEX studies. Both observational and modeling studies of urban-induced rainfall are discussed. Additionally, a discussion of the relative roles of urban dynamic and microphysical (e.g. aerosol) processes is presented. The paper closes with a set of recommendations for what observations and capabilities are needed in the future to advance our understanding of the processes.

On Inclusion of Urban Landscape in Climate Models: How Can Satellite Data Help? By Menglin Jin (University of Maryland) and Marshall Shepherd (NASA/GSFC) is in press at the Bulletin of the American Meteorological Society. This paper summarizes discussions on the topic presented at the 2003 Fall AGU meeting session "Human-induced Climate Variations Linked to Urbanization: From Observations to Modeling." The paper is a companion to one that appeared in *EOS* (Volume 85, 227-228) that summarized the meeting discussions on the observational components.

Urban Climate News

World Environment Day (WED)

This UNEP event is celebrated on the 5th of June every year in more that 100 countries around the world. The city of San Francisco, California, hosted this year's international event. It was the first time the event took place in the United States. The programming for "Green Cities" spanned the first five days in June. Each day focused on a specific theme: Urban Power, Cities on the Move, Redesigning Metropolis, Pure Elements, and Flower Power.

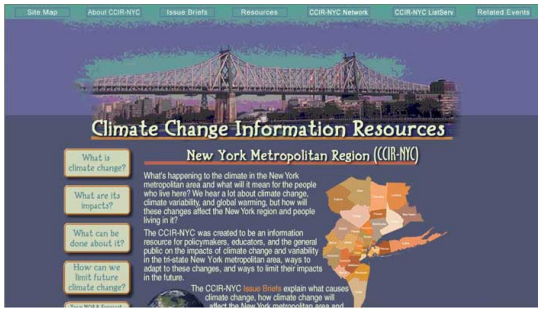
Protestors demand action on climate change outside San Francisco's City Hall (Source: www.unep.org/wed/2005/images)

Nature in the Metropolis

In the recent edition of **Science** (Vol 308) Peter Crane (Director of the Royal Botanic Gardens, UK) and Ann Kinzig (Assoc. Professor of Urban Ecology at Arizona State University, US) wrote an Editorial on **Nature in the Metropolis**. They suggest that the urban focus of WED is because *Cities are where people concentrate, and what we find there—business, universities, government, and media—shapes public perceptions and political agendas...Now and into the future, we will be Homo urbanus: the city deweller.*

The Editorial draws attention to the role of cities as drivers of global change and the potential for sustainable cities. Moreover, it points out that for most in the future, their direct contact with nature now occurs in an urban, rather than rural, setting. In fact, they suggest that what remains of habitats and biodiversity within the city will assume disproportionate importance and may be of national or global significance.

Climate Change Information Resource



Posted during May on the on the NASA website is an article by **Krishna Ramanujan** (Goddard Space Flight Centre**)** on the Climate Change Information Resource, which explains how climate change affects New York City. The text below is from the NASA website (www.nasa.gov/vision/earth/lookingatearth/).

With over half the world's people now living in cities, it's important for us to better understand how climate changes might affect urban areas. Now, a new highly-researched Web site provides scientific answers to basic questions about climate change, and how such changes might impact New York City. While the site is specifically focused on the Big Apple, some of the lessons learned here apply to other urban areas. The site is written in easy-to-follow language, and is intended for use by decision-makers, students, climate experts and everyone in between. Named the Climate Change Information Resource, New York Metropolitan Region (CCIR-NY), the site was unveiled on March 29th and can be found at ccir.ciesin.columbia.edu/nyc. The site was made possible by a grant from the National Oceanic and Atmospheric Administration (NOAA) to the Center for International Earth Science Information Network (CIESIN). NASA's Goddard Institute for Space Studies (GISS), New York, N.Y. and Hunter College, also in New York City, collaborated on the project. In fact, NASA provided the science that is used to answer basic and specific questions regarding climate change in the New York Metropolitan region.

"The purpose of this site is to inform decision makers, educators and the general public in urban areas about climate variability and change," said Cynthia Rosenzweig, a senior researcher at NASA GISS, and a co-principal investigator on the CCIR-NY project. "Since many cities are located in coastal areas, useful information is provided about the potential for flooding of transportation infrastructure, saltwater intrusion into wa-

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ter supplies, and erosion of public beaches. Knowledge of climate can also improve public health responses to heat stress and air quality, especially for the elderly and poor. While the site is focused on New York City, the information found here may apply to other cities."

The researchers developed a series of questions concerning climate change and then set out to answer them in a way that might be accessible to a wide-ranging audience. For example, the first section titled Climate Change Overview provides a page of answers each to questions about the general climate system, past and future changes, the available data on climate change, global climate models and future projections. Other sections include Regional Impacts, Preparing for a Different Future: Adaptation, and Limiting Future Climate Change: Mitigation. For each question raised within these sections, there is a web page of information, which can be printed like a tear sheet or an independent fact sheet. The site also includes a resources section with an "online library" of web links, a bibliography, and fact sheets.

The development of this site was highly researched to understand the type of information most important to users. During the planning stages, the site's developers ran focus groups, and held numerous meetings with an advisory group that included officials and decision makers from city, county, state and federal levels. Representatives from the Environmental Protection Agency, the National Parks Service, and the New York State Department of Environmental Conservation took part in this committee. This advisory group helped the site's creators steer the content so it included the most useful and relevant information for the public.

Figure 1. Areas at risk from a 10-foot flood. Blue represents coastal areas vulnerable to a flood that reaches a height of ten feet. The likelihood of such a flood occurring is increasing. Source: Gornitz, Sea Level Rise and Coasts, in *Climate Change and a Global City*, 2001.

This map is taken from the fact sheet on climate sheet on coastal communities and coastal environments. The map is taken from Gornitz, V. (2001) Sea-level rise and coasts, p21-46 in Rosenzweig, and Solecki (eds) **Climate Change and a Global City: An Assessment of the Metropolitan East Coast Region**. Columbia Earth Institute, New York, 210pp.

IAUC Committee Reports

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This has been a great year for urban climate publications. We have seen a wide range of interesting papers spanning the breadth of the subject from cities around the world. Thanks to everyone who has collected and sent in references. Look out for the complete 2003 and 2004 bibliographies on the IAUC website in the near future!

Please send any further papers published since January 1 2004 for inclusion in the next newsletter to j.salmond@bham.ac.uk. As before, please mark the header of your email with 'IAUC Publications 2004'. In order to facilitate entering the information into the data base please use the following format:

Author:
Title:
Journal:
Volume:
Pages:
Dates:
Keywords:
Language:

We look forward to hearing from you soon!

Jennifer Salmond
University of Birmingham
j.salmond@bham.ac.uk

Recent publications in Urban Climatology
(Languages are specified where the publication is known to be in a language other than in English.)

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Board Information

Board Changes

Voting for the Board replacement has ended on 5 June. We would like to thank everyone who has participated in the vote for the new IAUC Board members.

It is my great pleasure to inform you that Jennifer Salmond (University of Birmingham, UK) and Manabu Kanda (Tokyo Institute of Technology, Japan) have been elected to the Board of IAUC for a 4-year period stating in August. They will replace Bob Bornstein (San Jose State University, USA) and Yasuto Nakamura (Prefectural University of Kumamoto, Japan) whose terms will soon come to an end. The Board would like to take this opportunity to thank Professors Bornstein and Nakamura for their many contributions to the association as inaugural Board members. The Board would also like to thank all the other candidates who have generously agreed to stand for this position.

Matthias Roth
Secretary, IAUC
geomr@nus.edu.sg

New Board Members

Jennifer Salmond

Manabu Kanda

Newsletter Contributions

The IAUC Newsletter is published bi-monthly. The next publication will occur in early August. Any items to be considered for the August edition should be received by **July 31, 2005.**

The following individuals compile submissions in various categories. Contributions should be sent to the relevant editor:

News:	Marshall Shepherd (marshall.shepherd@nasa.gov
Conferences:	Jamie Voogt (javoogt@uwo.ca)
Websites:	Gerald Mills (gerald.mills@ucd.ie)
Bibliography:	Jennifer Salmond (j.salmond@bham.ac.uk)
Urban Projects:	Sue Grimmond (grimmon@indiana.edu)

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.

IAUC Information

Non-Voting members of the Board:
Past Secretary: John Arnfield, USA.
Past President: Tim Oke, Canada.
Local Organizer ICUC5: Kazimierz Klysik Poland.
Local Organizer ICUC6: Sven Lindqvist, Sweden.

IAUC Committee Chairs

Editor IAUC Newsletter: Gerald Mills
Chair Bibliography Committee: Jennifer Salmond
Chair Membership Committee: Janet Barlow
Chair Teaching Resources: Gerald Mills
Chair Awards Committee: Bob Bornstein
WebMasters: James Voogt

Board Members & Terms

President: Sue Grimmond (USA), 2007
Secretary: Matthias Roth (Singapore), 2007
Janet Barlow (UK), 2007
Ariel Bitan (Israel), 2006
Bob Bornstein (USA), 2005
Krzysztof Fortuniak (Poland), 2007
Wilhelm Kuttler (Germany), 2008
Gerald Mills (Ireland), 2007
Yasuto Nakamura (Japan), 2005
James Voogt (Canada), 2006