BIBLIOGRAPHY OF URBAN CLIMATE

1996-1999

Prepared by

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Classification system

Key	Summary	Number of papers
1	Climate Change, variability and urban climate	15
2	Urban planning, urban parks, building climatology	6
3	Energy Balance, heat fluxes, turbulence, radiation	24
4	Descriptive urban effects on temperature, wind, rain, etc.	2
5	Air pollution, aerosols, fog, urban odours, noise	78
6	Urban hydrology	5
7	Urban bioclimatology, impact on health/vegetation	15
8	Urban boundary layer physics, dispersion modelling, wind tunnel	42
9	Non-specified	1
0	Pollution / instrument focus with implications for urban measurement	39
	Total	227

Developed from Jauregui, E (1996) *'Bibliography of Urban Climatology for the period 1992 – 1995',* WMO/TD-No. 759, World Meteorological Organisation, May 1996.

Summary of paper classification

1	(Chen, 1997, Lazar and Podesser, 1999, Scherer et al., 1999, Bohm, 1998, Goh and Chang, 1999, Klysik and Fortuniak, 1999, Nichol, 1998, Shahgedanova et al., 1997, Voogt and Oke, 1997, Jauregui, 1997, Taha, 1997, Camuffo et al., 1999, Ulke and Mazzeo, 1998, Gomez et al., 1998, Mills, 1997)
2	(DeSchiller and Evans, 1996, Evans and DeSchiller, 1996, Nicoletti, 1998, Papparelli et al., 1996, Golany, 1996, de Assis and Frota, 1999)
3	(Grimmond and Oke, 1999b, Ichinose et al., 1999, Iino and Hoyano, 1996, Klysik, 1996, Oke et al., 1999, Pearlmutter et al., 1999, Voogt and Oke, 1998b, Voogt and Oke, 1998a, Figuerola and Mazzeo, 1998, Spronken-Smith and Oke, 1998, Arnfield and Grimmond, 1998, Sakakibara, 1996, Eliasson, 1996a, Eliasson, 1996b, Sini et al., 1996, Kim and Baik, 1999, Jauregui and Luyando, 1998, Barradas et al., 1999, Grimmond et al., 1996, Spronken-Smith and Oke, 1999, Upmanis et al., 1998, Fujino et al., 1999, Santamouris et al., 1999)
4	(Erell and Tsoar, 1999, Lowry, 1998)
5	(Ausset et al., 1998, Bouhamra and Abdul-Wahab, 1999, Cecinato et al., 1998, Chen and Preston, 1997, Chen and Preston, 1998, de Haan et al., 1998, Duncan and Chameides, 1998, Eleftheriadis et al., 1998, Elliott et al., 1999, Fraigneau et al., 1996, Fraser et al., 1998, Fraser et al., 1999, Giugliano et al., 1998, Glowacka and Hucinska, 1999, Goss, 1997, Granier and Chevreuil, 1997, Grant and Wong, 1999, Grosjean et al., 1998, Grosjean et al., 1999, Harrison et al., 1999b, Harrison et al., 1999a, Lefevre et al., 1998, Mayer, 1999, Micallef et al., 1998, Minoura, 1999, Morawska et al., 1998, Morawska et al., 1999, Nerin et al., 1996, Offenberg and Baker, 1999a, Offenberg and Baker, 1999b, Panero et al., 1997, Pearson and Collier, 1999, Pimentel and Arbilla, 1997, Piringer et al., 1997, Piringer and Schauberger, 1999, Preston et al., 1996, Puledda et al., 1999, Rappengluck and Fabian, 1998, Rappengluck et al., 1998, Rappengluck and Fabian, 1999, Rogge et al., 1998, Rubino et al., 1996, San Jose et al., 1997, Shi et al., 1999, Simcik et al., 1999, Souza and Carvalho, 1997, Souza et al., 1999, Steil, 1998, Toriumi et al., 1999, Tripathi et al., 1996, Varshney and Padhy, 1998, Febo et al., 1996, Tomiyasu et al., 1996, Tsakiri et al., 1998, Yerrapragada et al., 1996, Zappia et al., 1998, Pankow et al., 1997, Preston et al., 1997, Tuncel and Ungor, 1996, Glovsky et al., 1997, Kavouras et al., 1998, Micallef and Colls, 1998, Pires and de Carvalho, 1999, Vasconcelos and Tavares, 1998, Colls and Micallef, 1999, Gerdes and Olivari, 1999, Hassan and Crowther, 1998b, Hassan and Crowther, 1998a, Jacovides et al., 1997, Kastner-Klein and Plate, 1999, Micallef and Colls, 1999, Namdeo et al., 1999, Rubino et al., 1998)
6	(RodriguezNavarro et al., 1997, Offenberg and Baker, 1997, Osborne et al., 1997, Suzuki et al., 1997, Wallinder and Leygraf, 1997)
7	(Bolognesi et al., 1997, Bottema, 1999, Fukuoka, 1997, Jauregui et al., 1997, Loranger and Zayed, 1997, Matzarakis et al., 1999, Rau et al., 1999, PignoletTardan et al., 1997, Johnson et al., 1997, Takagi et al., 1998, Voisin, 1997, Branisteanu and Aiking, 1998, Bruse and Fleer, 1998, Calderon et al., 1997, Hildebrandt and Sarkovich, 1998)
8	(Argentini et al., 1999, Ashie et al., 1999, Berkowicz, 1997, Bottema, 1997, Cai, 1999, Dupont et al., 1999, Gayev and Savory, 1999, Grimmond et al., 1998, Grimmond and Oke, 1999a, Herbert et al., 1998, Jacovides et al., 1998, Johnson and Hunter, 1998, Johnson and Hunter, 1999, Kambezidis et al., 1997, Louka et al., 1998, Menut et al., 1999, Plate, 1999, Rafailidis, 1997, Rotach and de Haan, 1997, Sachweh and Koepke, 1997, Smith et al., 1996, Smith and Harrison, 1996, Stettler and vonHoyningenHuene, 1996, Yadav et al., 1996, Jauregui and Romales, 1996, Mochida et al., 1997, Ca et al., 1999, Casadio et al., 1996, Noto, 1996, Saitoh et al., 1996, Baik and Kim, 1999, Buckland, 1998, Herbert et al., 1997, Kastner-Klein et al., 1997, Klemm and Ziomas, 1998, Meroney et al., 1996, Okamoto et al., 1996, Pavageau and Schatzmann, 1999, Rotach, 1997, Rotach, 1999, Vakeva et al., 1999, Trier, 1997, Boldes and Colman, 1996)
9	(Kuttler, 1999)
0	(Alexander, 1997, Boke et al., 1999, Cantrell et al., 1997, Chen and Lee, 1999, Dewulf and VanLangenhove, 1997, Donahue et al., 1998, Fenter and Rossi, 1996, Forslund and Leygraf, 1996, Fraser et al., 1997, Goss and Eisenreich, 1997, Grgic et al., 1998, Grgic et al., 1999, Jenkins et al., 1996, Kalberer et al., 1999, Karakas and Tuncel, 1997, Kawamura et al., 1996, Kawamura et al., 1999, Kawamura and Sakaguchi, 1999, Kelly and Chang, 1999, Kerminen et al., 1999, Komazaki et al., 1999, Krivacsy and Molnar, 1998, MarsiliLibelli, 1996, Narukawa et al., 1999, Querol et al., 1999, Ritter et al., 1999, Ruckert, 1996, Rudolph et al., 1996, Schauberger et al., 1999, Schauer et al., 1999, Seisel and Rossi, 1997, Smith et al., 1998, Suzuki, 1997, Toyoda et al., 1998, Vasileva and Makhova, 1996, Volkamer et al., 1998, Yu and Jeffries, 1997)

Bibliography of urban climate (1996-1999)

Alexander, M. (1997) 'Environmental fate and effects of styrene', *Critical Reviews in Environmental Science and Technology,* **27, 383-410**

Enormous quantities of styrene are produced each year. Monitoring studies show that the concentrations in air usually are less than 10 mu g/m(3) and the levels in waters are usually less than 20 mu g/l. The compound is highly reactive in air, and it readily biodegrades under aerobic conditions in soils and waters. Many evaluations have been made of the toxicity of styrene. Based on the results of these toxicological studies, information on the concentrations of the compound in natural environments, and data showing its reactivity in the air, volatilization from soil and water, and rapid biodegradation, styrene is not deemed to cause deleterious effects on nonmammalian species, mammals, or natural communities of organisms as a consequence of environmental exposures, except in the immediate vicinity of a spill. *Classification: 0.*

Argentini, S., Mastrantonio, G. and Lena, F. (1999) 'Case studies of the wintertime convective boundary-layer structure in the urban area of Milan, Italy', *Boundary-Layer Meteorology,* **93, 253-267**

The paper describes some aspects of the convective boundary- layer structure based on simultaneous sodar and tethersonde measurements during a field experiment in the urban area of Milan in the period 8 to 20 February, 1993. During this period, fog episodes and strong low-level elevated inversions (with lower boundaries < 400 m) were observed most of the time. A close agreement in the mixing height values, derived from the sodar and tethersonde profiles, has been achieved under these conditions. The validity of the similarity relationships, which have been originally derived to describe the vertical velocity variance and heat flux profiles over horizontally homogeneous terrain under quasi-stationary conditions, was evaluated when applied to the urban boundary layer. *Classification: 8.*

Arnfield, A. J. and Grimmond, C. S. B. (1998) 'An urban canyon energy budget model and its application to urban storage heat flux modeling', *Energy and Buildings,* **27, 61-68**

To obtain a local-scale urban energy balance by either measurement or modeling it is necessary to determine storage heat flux (Delta Q(s)). This flux cannot be measured directly due to the complexity of the urban surface. The Grimmond et al. Objective Hysteresis Model (OHM) [C.S.B. Grimmond, H.A. Cleugh, T.R. Oke, An objective urban heat storage model and its comparison with other schemes. Atmos. Environ., 25B (1991) 311- 326] of local-scale Delta Q(s) combines empirical equations for individual surface types in the proportion that they are present within the urban area. One surface type for which there is very limited field data is the urban canyon, which consists of the walls of adjacent buildings, the horizontal street-level area separating them (roadways, gardens, parking lots, etc.) and the enclosed air volume. Here the storage heat flux of an urban canyon and the resulting OHM parameters are investigated with a numerical model of a dry urban canyon energy budget. Substrate heat fluxes are derived from simulated surface

and substrate temperatures; the latter evolve through time according to the finite difference form of the Fourier heat conduction equation. When compared against measured fluxes, the model performed satisfactorily. Numerical experiments show significant effects on the OHM parameters due to changes in the ratio of building height to separation distance and building wall thermal properties. Effects of intermediate significance were attributable to canyon orientation, wind speed and the timing of the between-building air temperature regime. Air temperature and the timing of the wind speed curve showed only minor significance. (C) 1998 Published by Elsevier Science S.A. *Classification: 3,2.*

Ashie, Y., Ca, V. T. and Asaeda, T. (1999) 'Building canopy model for the analysis of urban climate', *Journal of Wind Engineering and Industrial Aerodynamics*, 81, 237-248

For the purpose of practical application of CFD for urban climate planning, a building canopy model coupled with CFD was developed, and the effects of building planting were discussed for the decrease of urban heat island phenomena and energy for cooling. In this paper, radiate heat exchange in the building canopy, the drag force model of building walls, the effects of heat released from air conditioning systems are presented. Numerical results show that building planting has possibilities for the reduction of air temperature by 0.4-1.3 degrees C and energy for cooling by 3-25%. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 8.*

Ausset, P., Bannery, F., Del Monte, M. and Lefevre, R. A. (1998) 'Recording of pre-industrial atmospheric environment by ancient crusts on stone monuments', *Atmospheric Environment*, 32, 2859-2863

The interaction between today's polluted urban atmosphere and materials leads to the formation of sulphated black crusts containing industrial fly-ash. While many historical documents report the existence of polluted air in towns prior to the modern industrial era, such descriptions have not so Far been substantiated by any scientific analysis of samples of older interactions. A new approach is proposed, based on the study of crusts found in Aries and Bologna, which formed in the periods 1180-1636, and 1530-1887, respectively. They are grey, mostly calcitic, and contain wood debris and micrometric siliceous or alumino-silicated spherules. The same tracers were also encountered in the smoke from experimental wood fires. This approach confirms the presence of air polluted by wood combustion in the towns of Southern France and Northern Italy during the Medieval up to pre-industrial age. Such information, near to the source, completes the evidence provided in written documents, as well as the data obtainable, farther From the sources, using core samples of glaciers, lakes and marine sediments. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Baik, J. J. and Kim, J. J. (1999) 'A numerical study of flow and pollutant dispersion characteristics in urban street canyons', *Journal of Applied Meteorology*, 38, 1576-1589

The how and pollutant dispersion in urban street canyons are investigated using a two-dimensional numerical model with the k-epsilon turbulent closure scheme. It is shown that the flow held is characterized mainly by the number and intensity of vortices produced in the street canyon. As the street aspect ratio (ratio of the building height to the width between buildings) increases, the number of vortices increases. In the upper-canyon region, the downward motion near the downwind building is stronger than the upward motion near the upwind building, and the turbulent kinetic energy (TKE) is higher near the downwind building than near the upwind building because of stronger wind shears near the downwind building. The TKE budget analysis shows that the shear production is high near the interface between the ambient flow and the street canyon how and that the turbulent dissipation is also high where the shear production is high. The horizontal advection and diffusion are found to play a crucial role in splitting the vortex into two or more. There is a critical value of the ambient wind speed above which the number and distribution pattern of vortices remain the same regardless of the ambient wind speed. For the given flow fields, two different emission sources (street-level source and advected source) are considered to examine pollutant dispersion in the street canyons that have a one-vortex flow regime and a two-vortex how regime. Results indicate that the distribution of pollutant concentration in the street canyons during each period of continuous emission and nonemission can be largely explained in terms of the vortex circulation. *Classification: 8,5.*

Barradas, V. L., Tejeda-Martinez, A. and Jauregui, E. (1999) 'Energy balance measurements in a suburban vegetated area in Mexico City', *Atmospheric Environment,* **33, 4109-4113**

A series of energy balance measurements were carried out in a suburban natural vegetated area on a lava bed (1.24 km(2)) in the south of Mexico City. These measurements were made in May tend of the dry season), and June-July (begining of the wet season) in 1995. During the dry season, net radiation (Q(N)) was mainly dissipated by sensible (Q(H)) and latent (Q(E)) heat, 69 and 25%, respectively, Sensible heat increased during the day up to 400 W m(-2) at the end of the dry season, Q(N) was dissipated by Q(H) and Q(E) by 27 and 70%, and Q(E) had a maximum value of 300 W m(-2) during the day in the wet season. The calculated Bowen ratio was 1.92 and 0.04 during the dry and wet season, respectively. Probably, seasonal differences are due to water availability and plant phenology, (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 3,7.*

Berkowicz, R. (1997) 'Modelling street canyon pollution: model requirements and expectations', *International Journal of Environment and Pollution,* **8,5, 609-619**

Dispersion of pollution from traffic in urban street canyons is governed by a complex wind flow structure, which hardly can be described by traditional Gaussian models. On the other hand, some simple rules can be used to provide rough estimates of pollution levels, especially considering the worst-case conditions. The model requirements will thus also depend on the particular application and the expectations attached to the information provided by the model. Models based on a very simple description of dispersion processes, but focusing more on parameterization of traffic emissions, are useful tools for traffic planners. More detailed studies of traffic pollution behaviour in street canyons

require models that can relate the actual pollution concentrations to the actual meteorological conditions. *Classification: 5.*

Bohm, R. (1998) 'Urban bias in temperature time series - A case study for the city of Vienna, Austria', *Climatic Change,* 38, 113-128

Compared with other large cities Vienna shows different urban development characteristics. The city has had a zero population growth during 1951-1995, a period of rapid growth elsewhere. In spite of its stagnating population of about 1,6 million Vienna has had development in other areas: a doubling of living floor space, a two and a half-fold increase in total energy consumption, a 60% rise of traffic area. In contrast, forests have been reduced by 20% and grasslands within the city borders by 30%. Of the 34 temperature recording stations in the study area of 1450 km(2), nine series passed the quality tests after careful homogenization. Three of these were in the rural environment and were used as reference series for the urban temperature excess at the other six stations in the urbanized area. The urban excess temperatures vary from site to site: from 0.2 K in suburban areas up to 1.6 K in densely built-up areas. The Vienna case study illustrates two features of more than local interest which should be considered in urban climatology as well as in time series studies where the urban temperature excess is regarded as a bias. Firstly, in a city with constant population the urban heat excess shows significant to strongly significant trends of up to 0.6 K in 45 years due to changes in urban morphology and energy consumption. Secondly, the urban heat island and its trend cannot be regarded simply for the city as a whole. There are different absolute levels, different annual variations and different increases of the urban temperature excess in different parts of a city. The urban effect is more strongly influenced by the local surroundings of the site than by the city as a whole. So, if possible, urban heat islands should not be described by a two station approach only (the typical airport-downtown comparison), nor should it rely on regression between population number and heat island. *Classification: 1,3.*

Boke, H., Gokturk, E. H., Caner-Saltik, E. N. and Demirci, S. (1999) 'Effect of airborne particle on SO2-calcite reaction', *Applied Surface Science,* 140, 70-82

In modern urban atmosphere, sulphur dioxide (SO2) attacks calcite (CaCO3) in calcareous stone-producing gypsum (CaSO4 . 2H(2)O) which forms crust at rain sheltered surfaces and accelerates erosion at areas exposed to rain. The airborne particles collected on stone surfaces have always been considered to enhance the gypsum crust formation and thus it is believed that they should be removed from the surface to decrease the effects of SO2. In this study, our aim was to investigate this event by carrying out a series of experiments in laboratory using pure calcium carbonate powder to represent calcareous stone. Sodium montmorillonite, activated carbon, ferric oxide, vanadium pentoxide and cupric chloride were mixed in the pure calcium carbonate powder as substitutes of the airborne particles in the polluted atmosphere. The samples have been exposed at nearly 10 ppmv SO2 concentrations at 90% relative humidity conditions in a reaction chamber for several days. The mineralogical composition of the exposed samples were determined by X-ray diffraction (XRD) analysis and infrared spectrometer (IR). Sulphation reaction products, calcium sulphite hemihydrate, gypsum and unreacted calcite, were determined quantitatively using IR. Exposed samples have also been investigated morphologically using a scanning electron microscope (SEM). Experimental results reveal that calcium

sulphite hemihydrate is the main reaction product of the SO2- calcite reaction. It turns out that airborne particles play an important catalytic role in the oxidation of calcium sulphite hemihydrate into gypsum, although their presence does not very significantly affect the extent of sulphation reaction. This behaviour of airborne particles is explained by the presence of liquid film on the calcium carbonate surface when a series of reactions in the gas-liquid-solid interfaces takes place. (C) 1999 Elsevier Science B.V. All rights reserved. *Classification: 0.*

Boldes, U. and Colman, J. (1996) 'About some aspects of the wake flow of a small cypress tree, in a free stream with a power law mean velocity distribution', *Journal of Wind Engineering and Industrial Aerodynamics,* **61, 25-50**

Wind tunnel tests have been conducted on a small slender cypress tree (cupressus macrocarpa), exposed to hows with a power law mean velocity distribution, with an exponent corresponding to a rough urban boundary layer. The purpose of this study was to contribute to the understanding of the nature and evolution of the turbulent motions in the near-wake region of a real tree, by analyzing overall turbulence statistics and instantaneous how velocities. The paper analyzes qualitatively the downstream evolution of the spatial distributions of functions of the turbulent variables in the wake region. The present experiments describe the features of a relatively small wake region near the canopy $0.5 < x/H < 1.36$, with significant variations in the distributions of mean velocities, autocorrelation, power density spectra and turbulence intensity. Aspects of transport processes from the mixing layer regions into the lower wake levels are analyzed. Turbulence characteristics of a relatively "quiet" downstream decreasing internal wake region, located well below the secondary maximum points of the mean velocity distributions, are described. *Classification: 8,7.*

Bolognesi, C., Gallerani, E., Bonatti, S., De Ferrari, M., Fontana, V., Valerio, F., Merlo, F. and Abbondandolo, A. (1997) 'Sister chromatid exchange induction in peripheral blood lymphocytes of traffic police workers', *Mutation Research-Genetic Toxicology and Environmental Mutagenesis,* **394, 37-44**

Traffic police workers, as a population exposed to urban atmosphere, were compared with a control population exposed to indoor air pollution levels. Sister chromatid exchanges (SCEs) as a biomarker of effect were measured in peripheral blood lymphocytes of 54 exposed subjects and 35 controls, and environmental concentration of polynuclear aromatic hydrocarbon (PAH) tracer compounds was detected by personal air samplers. The mean exposure level to benzol[a]pyrene in our group of traffic policemen (3.4 mg/m(3)) was in the range that has been estimated in urban areas in Europe during the last 10 years. No difference in SCE levels was found between exposed workers (7.36, SD 1.35) and controls (7.47, SD 1.28). No correlation was observed between SCE/cell and airborne PAH concentration in the traffic worker population. A positive regression of SCE on exposure estimate was found only in the non-smoking group of police workers. Our findings suggest that exposure to urban air pollution does not induce relevant cytogenetic effects. (C) 1997 Elsevier Science B.V. *Classification: 7.*

Bottema, M. (1997) 'Urban roughness modelling in relation to pollutant dispersion', *Atmospheric Environment,* **31, 3059-3075**

An analytical model for the evaluation of the roughness length z(0) and the displacement height z(d) of regular building groups is presented. It suggests that apart from the frontal density (ratio of building frontal area and ground surface), the streamwise building length and the building lay-out pattern are important parameters. Experimental data for the validation have been gathered from an extensive literature study, and they have been checked against experimental requirements pointed out in this paper. The overall agreement is reasonably good, but the problems in obtaining reliable experimental z(0) and z(d) data are so large that a definitive judgement, and thereby a full model optimisation, could not be made. Possible applications of this work are roughness mapping of towns, optimisation of street design with respect to air ventilation, and optimisation and tuning of wind tunnel approach flow roughness. (C) 1997 Elsevier Science Ltd. *Classification: 8,5.*

Bottema, M. (1999) 'Towards rules of thumb for wind comfort and air quality', *Atmospheric Environment,* **33, 4009-4017**

This paper discusses guidelines for improved design of buildings or town plans from air quality and wind shelter viewpoint, together with the assumptions and the (main) data used for their development. The wind shelter guidelines specify the maximum building height (for high buildings) and street length(for low-rise building groups) for which wind conditions are expected to be safe for pedestrians. The air quality guidelines for high buildings give a recommended maximum building height in relation to the height of nearby stacks. For low-rise building groups, recommendations for the lay-out of these groups are given, using street-ventilation concepts. All guidelines are made semi-quantitative where possible. Areas of conflict between the two types of guidelines are also indicated. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 7.*

Bouhamra, W. S. and Abdul-Wahab, S. A. (1999) 'Description of outdoor air quality in a typical residential area in Kuwait', *Environmental Pollution,* **105, 221-229**

This paper presents a statistical analysis of the data collected by the air pollution mobile laboratory operated by Kuwait University. The experimental work was based on operating the mobile laboratory in the Mansouriya residential area for a period of 1 month (May 1994). The site was selected to represent a typical residential area which is impacted mainly by the heavy traffic into and out of Kuwait city. The levels of carbon monoxide (CO), nitrogen oxide (NO), nitrogen dioxide (NO2) and ozone (O-3) were selected for analysis. These are the pollutants likely to result from traffic movement in any urban area. Sulphur dioxide (SO2) was also monitored during the same period. The measured variables include some meteorological parameters such as temperature, relative humidity, atmospheric pressure, solar radiation, wind speed and wind direction, which were also recorded at the same time. The study investigates the atmospheric levels of pollutants in the Mansouriya area and the expected source contributing to these pollutants. The objective of this work was to measure the atmospheric levels of pollution in terms of NO, CO, NO2, SO2 and O-3 and to compare with the international standard limits for urban areas. Another objective of the study was to study the diurnal variations of these

pollutants. The results of this study indicate that the levels of air pollutants are within the recommended range for residential areas according to US Environmental Protection Agency standards. The distribution of CO was correlated with heavy traffic movement during rush hours. However, SO2 levels also followed a similar pattern. This was attributed to heavy diesel operational equipment and trucks at the highway construction site near the area of study. The hourly distributions of CO, NO and NO2 were also compared over the days of the week. The results show that no morning peaks were detected for these gases during weekends. Correlation between O-3 levels and NO and NO2 was also carried out. The O-3 levels show a peak at the early morning hours and a major peak during midday. This is attributed to the photochemical reactions during the month of May which is the real start of summer in this area. (C) 1999 Published by Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Branisteanu, R. and Aiking, H. (1998) 'Exposure to polycyclic aromatic hydrocarbons in occupational versus urban environmental air', *International Archives of Occupational and Environmental Health,* 71, 533-536

Objectives: To evaluate the balance between occupational and environmental exposure to suspended particulate matter (SPM) and polycyclic aromatic hydrocarbons (PAHs), comparison measurements were performed in a coal-fired power plant and the urban atmosphere from the town nearby. Methods: The analysis of SPM for PAH content was done according to a high-performance liquid chromatography (HPLC)based method. The microscopic assessment was performed using scanning electron microscopy (SEM) by silver coverage of the samples derived by air filter. Results: Contrary to expectations, the results showed low levels of particle-bound PAHs in the occupational environment (<1 mg benzo(a)pyrene/m(3) air) and high levels in urban air (range 80-1250 ng benzo(a)pyrene/m(3)). The SPM collected from the power plant exhibited non-respirable characteristics (particles larger than 10 mu m), whereas urban SPM almost exclusively contained respirable airborne particles (<3 mu m). Conclusions: The PAH burden, combined with the enhanced probability of respiratory absorption, confers a much greater hazard potential to the urban SPM. Under these conditions, in areas or countries in which old technologies remain in use, occupational exposure to SPM containing PAHs might represent a severe underestimation of the total risk as it does not take into account the background air pollution. *Classification: 7,8.*

Bruse, M. and Fleer, H. (1998) 'Simulating surface-plant-air interactions inside urban environments with a three dimensional numerical model', *Environmental Modelling & Software,* 13, 373-384

In recent years high-resolution numerical simulation of surface-plant-air interactions as an important part of global circulation models (GCM) or as a tool to assist in planning decisions has experienced increased consideration. In contrast large scale phenomena described in GCMs, the lower part of the atmosphere where we live is very sensitive to small scale processes which can develop an individual local climate, different to the expected average conditions. Especially in urban areas the great variety of different surfaces and sheltering obstacles produces a pattern of distinct microclimate systems. To simulate these local effects, microscale surface-plant-air interaction schemes with a special extension to typical artificial urban boundaries are needed. The paper focuses on

the microscale numerical simulation of surface-plant-air interactions inside urban structures, especially the feedback between artificial surfaces like buildings and vegetation inside street canyons, backyards or greens. The three-dimensional non-hydrostatic model ENVI-met is presented and used to solve the basic equations forward in time and can simulate 'hard' wind field modifications (solid boundaries) like walls as well as 'soft' modifications (porous shelters) like vegetation. A case study of building a small park inside the CBD area will show what effects even small changes can have on local flow and temperature fields. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 7,8.*

Buckland, A. T. (1998) 'Validation of a street canyon model in two cities', *Environmental Monitoring and Assessment,* **52, 255-267**

A street canyon model has been formulated based on work published by Hertel and Berkowicz. An outline is given of the theoretical approach used, followed by a modelling of nitrogen oxides and carbon monoxide measurements from sites at Cromwell Road, Central London and Stratford Road, Birmingham Modelled concentrations were compared with observed mixing ratios for both sites. AT Cromwell Road, good agreement was achieved for one month but which was not reproduced as well for the other two months tested. There is uncertainty as to the effect of one of the side streets and whether the general flow is altered during periods of marked solar heating. Also emissions from vehicles may vary from those assumed. The interpretation of the Stratford Road site's results was less straightforward with complications concerning background pollutant levels and changes in emissions from interrupted traffic flow. *Classification: 8,5.*

Ca, V. T., Asaeda, T. and Ashie, Y. (1999) 'Development of a numerical model for the evaluation of the urban thermal environment', *Journal of Wind Engineering and Industrial Aerodynamics,* **81, 181-196**

A numerical model was developed for the computation of the wind field, air temperature and humidity in the urban canopy layer and in the atmospheric boundary layer above urban areas. The model is of k-epsilon type. The ensemble-spatial averaged three-dimensional Reynolds equations, equation of continuity, turbulent kinetic energy equation (k-equation), and equation for dissipation rate of turbulent energy (epsilon-equation) ars solved together with equations of heat and moisture transfer in the air. Inside the urban canopy layer, volumes of buildings and other urban structures are accounted for by a spatial averaging procedure. With given average building height and building width for each grid mesh, effects of buildings on the momentum transfer are modelled by introducing a form drag force. Temperatures of the ground surface, building walls or roof are computed by the solution of the heat conduction equation in the ground or walls, roof. Evaporation at the ground surface is evaluated using a Bowen ratio. The exhausted heat by building air conditioning is evaluated by employing a building air conditioning model. This heat together with traffic-induced artificial heat are accounted for in the model as heal sources. A numerical model for the momentum, heat and moisture transfer in the plant canopy is also coupled to the model to investigate the effects of vegetation on the urban climate. Verification of the model against observational data in the Tokyo Metropolitan area, Japan, reveals that the model is capable of simulating the momentum,

heat and mass transfer in the urban boundary layer. Especially, the model can compute air temperature, humidity and wind velocity at the street level, which cannot be computed by a general above city atmospheric circulation model. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 8,3.*

Cai, X. M. (1999) 'Large-eddy simulation of the convective boundary layer over an idealized patchy urban surface', *Quarterly Journal of the Royal Meteorological Society,* **125, 1427-1444**

This study investigates the structure of thermal plumes driven by different patchy urban surfaces using large-eddy simulation. An idealized surface pattern with different sizes of 'park area' and 'built-up area' is assumed. These two types of urban surface correspond to 'colder' and 'hotter' areas over which different surface sensible-heat fluxes are specified. The stability parameter $Z(i)/L$ (where Z_i is the boundary-layer depth and L is the Obukhov length-scale) is large enough that a free-convection regime is considered. The study has three main aims: (i) to examine the effects of different surface patterns, including its 'skewness', on the turbulent structure and growth rate of an urban convective boundary layer (UCBL); (ii) to test the influence of model configuration, such as the domain size and the vertical resolution in the entrainment layer, on the turbulent structure of a UCBL; and (iii) to investigate the behaviour of thermal plumes in the UCBL when a weak wind shear is present. The results show that: (i) the surface pattern plays an important role in determining the power spectrum of the vertical-velocity fluctuations-the positive skewness of the surface heat-flux pattern enhances both the Lifetime of the surface-driven modes and the skewness of the vertical-velocity fluctuations, and patchy surface patterns cause higher boundary-layer growth rates for a time t within the range $4t(*) < t < 16t(*)$ (where $t(*) = Z(i)/w(*)$ and $w(*)$ is the convective velocity-scale), but contribute little at later times; (ii) the domain size must be large enough (larger than $5Z(i)$) in order to resolve correctly the surface-driven mode, and the vertical grid resolution in the entrainment layer has a small effect on the UCBL growth and on the turbulent statistics in the UCBL; and (iii) the wind is shown to have smoothing effects on the power spectrum, similar to the findings of Dornbrack and Schumann in their study of a convective boundary layer over a one-dimensional wavy terrain-for small values of the ratio $d/Z(i)$ (where d is the length-scale of the surface pattern) this effect is very significant, but for large values the effect is reduced. *Classification: 8.*

Calderon, C., Lacey, J., McCartney, A. and Rosas, I. (1997) 'Influence of urban climate upon distribution of airborne Deuteromycete spore concentrations in Mexico City', *International Journal of Biometeorology,* **40, 71-80**

The effect of an urban climate upon the spatial and temporal distribution of Deuteromycete spores was studied during 1991 using Burkard volumetric spore traps in two areas of Mexico City with different degrees of urbanization. Deuteromycete conidia formed the largest component of the total airborne fungal spore load in the atmosphere of Mexico City, contributing 52% of the spores trapped in an urban-residential area (southern area) and 65% of those in an urban-commercial area (central area). Among the most common spore types, Cladosporium and Alternaria showed a marked seasonal periodicity with significant differences in concentration ($P<0.05$) between the dry and wet seasons. Maximum conidial concentrations were found during the end of the wet season

and the beginning of the cool, dry season (October-December). Daily mean concentrations of the predominant airborne spore types did not differ significantly between the southern and central areas. Daily mean spore concentrations were significantly correlated ($P<0.05$) in southern and central areas with maximum temperature (south, $r = -0.35$; central, $r = -0.40$) and relative humidity (south, $r = 0.43$; central, $r = 0.29$) from the previous day. Moreover, multiple regression analysis of spore concentrations with several meteorological factors showed significant interactions between fungal spores, relative humidity and maximum temperature in both areas. The diurnal periodicity of Cladosporium conidia characteristically showed two or three peaks in concentration during the day at 0200- 0400, similar to 1400 and 2000-2200 hours, while that of Alternaria showed only one peak (1200 to 2000 hours) in both areas. Maximum concentrations of these spores generally occurred 2-4 h earlier in the southern than in the central area. The lag in reaching maximum concentrations in the central area probably resulted from differences in the local conditions between the study areas, and from spores transported aerially into the city from distant sources. The analysis of maximum hourly concentrations of Cladosporium and Alternaria spores during 1 month of the dry season (February), and another month of the wet season (September) showed significant differences between the two study areas. Environmental factors and sources (green areas) affected diurnal changes in conidial concentration in the southern area (urbanization index, UI, 0.25), but not in the central area (UI 0.97). In general, spore concentrations were greatest in the southern area when relative humidities were low, and temperatures and wind velocities were high. It was difficult to establish effects of climatic factors on the spore concentration in the city centre. This probably results from the large amounts of air pollution, the heat island phenomenon, and from the distant origin of trapped conidia obviating aerial transport. Nevertheless, the seasonal and diurnal distributions of conidia found were similar to those reported for other tropical regions of the world. *Classification: 7,8.*

Camuffo, D., Sturaro, G. and Valentino, A. (1999) 'Urban climatology applied to the deterioration of the Pisa Leaning Tower, Italy', *Theoretical and Applied Climatology,* **63, 223-231**

Among the peculiarities of the urban climatology, a relevant one concerns the interactions with monuments, which include stone weathering, deposition and removal of airborne pollutants. In order to know more about the case of the Pisa Leaning Tower, Italy, a field survey has been made for one year, measuring the microclimate interacting with the structure, the vertical temperature and humidity profiles, the Tower surface temperature at different locations and the concentration of particles in air. Also more general information was collected studying the meteorological parameters in the area of Pisa. The: correlation between rainfalls and wind evidenced that the windborne droplets arrive from preferential directions, determined on the regional scale by the sea shore on the: west (sea breeze) and the channelling operated by the valley of the Arno river on the west. The tilting of the Tower gives a natural shield to the southern part, which is hardly washed by rainfall. The complex balance between airborne particulate matter deposition, tower tilting, rainfall washout and surface runoff determines the pattern of the black crusts which disfigure the elegance of this historical building. The land and sea breezes transport air with different moisture content, and the urban heat island accentuates the mid day drop on relative humidity, determining condensation-evaporation cycles in the stone micropores. The

urban climatology of Pisa and the interactions with the Leaning Tower are discussed in view of the conservation of this monument. *Classification: 1,5.*

Cantrell, C. A., Shetter, R. E., Calvert, J. G., Eisele, F. L. and Tanner, D. J. (1997) 'Some considerations of the origin of nighttime peroxy radicals observed in MLOPEX 2c', *Journal of Geophysical Research-Atmospheres,* **102, 15899-15913**

The "chemical amplifier" (CA) was used to measure the concentration of the peroxy radicals present in the nighttime atmosphere at the Mauna Loa Observatory (MLO) during the Mauna Loa Observatory Photochemistry Experiment (MLOPEX 2) from April 15 to May 15, 1992. Simultaneous measurements were also made of peroxy radicals using a modified OH instrument during one period of 56-hour duration. Both instruments observe experimentally significant nighttime signals, but the magnitude oi the larger CA signal appears to result from organic peroxy radicals to which the modified OH instrument is insensitive. The data from about one half of the nights showed a decay of the radical signal from 2000 to 0400 HST the next morning. The decay rates followed roughly those expected for primary or secondary alkyl peroxy radicals. However, data from the other half of nights showed an increase in radical concentration with time, which reflected significant radical generation rates. Several alternatives are considered in explanation of the results. (1) The possible origin of the signals from the interference of HO_2NO_2, presumably transported from reservoirs at higher elevations, was considered. The data are inconclusive, and this hypothesis is tentatively rejected. (2) The nighttime chemistry of the $O-3$ and NO_3 was also considered. The observed trace gases provide in theory only a small fraction of the peroxy radical signal seen on many nights. However, the presence of 1-30 parts per trillion by volume (pptv) of CH_3SCH_3, a compound not measured but expected to be present at MLO, can react with NO_3 to produce peroxy radical signals of the magnitude observed. It is concluded that this ubiquitous compound over the oceans offers the best current hypothesis to rationalize the nighttime generation of peroxy radicals at MLO. *Classification: 0.*

Casadio, S., DiSarra, A., Fiocco, G., Fua, D., Lena, F. and Rao, M. P. (1996) 'Convective characteristics of the nocturnal urban boundary layer as observed with doppler sodar and Raman lidar', *Boundary-Layer Meteorology,* **79, 375-391**

Convective plume patterns, characteristic of clear sky and light wind daytime boundary layers over land, were observed for two nights with a tri-axial Doppler sodar operated in the central area of Rome during the summer of 1994. An urban heat island effect, combined with a continuation of a breeze from the sea late into night during both days, is believed to be responsible for the observed nocturnal convection. Estimates of the surface heat flux and the vertical velocity scaling parameter are obtained from profiles of vertical velocity variance, and the Raman lidar water vapor measurements are used to obtain the humidity scaling parameter. Convective scaling results for vertical wind and humidity fairly agree with the results of other experiments and models. On the basis of available measurements, it appears that mixed-layer similarity formulations used to characterize the daytime convective boundary layer over horizontally homogeneous surfaces can also be

applied to the nocturnal urban boundary layer during periods of reasonable convective activity. *Classification: 8,3*.

Cecinato, A., Ciccioli, P., Brancaleoni, E. and Zagari, M. (1998) 'PAH and N-PAH in the urban atmosphere of Rome and Milan', *Annali Di Chimica,* **88, 369-380**

Particulated PAH and nitrated-PAM (N-PAH) have been measured in urban areas of Pome and Milan to assess the exposure of the population to carcinogenic and mutagenic compounds. We found that the index of benz(a)pyrene equivalence of carcinogenic power and the levels of 1-nitropyrene and 2-nitrofluoranthene might represent a genotoxic risk for human health even when benz(a)pyrene does not exceed the reference levels established by Italian law. A new couple of indices (1-nitropyrene and 2-nitrofluoranthene content) is proposed to account for the risk arising from N-PAH emitted from vehicle exhaust gas or produced by photochemical reactions. *Classification: 5*.

Chen, H. Y. and Preston, M. R. (1997) 'Gas/particle partitioning behaviour of azaarenes in an urban atmosphere', *Environmental Pollution,* **97, 169-174**

The gas/particle partitioning of azaarenes in the Liverpool urban atmosphere was measured from May 1995 to April 1996. This period included one of the hottest summers and coldest winters recorded in the UK. The changes of the relative proportions of particulate and vapour phases showed a strong seasonal variation in which over 80% of azaarene compounds are associated with the particles in the winter and over 60% of azaarene compounds exist as vapour phase during the summer. The results are fitted into a gas/particle partitioning equation. Calculated vapour pressures, vaporization and desorption enthalpies are also given. Azaarene partitioning behaviour is modelled at a variety of aerosol concentrations and over a temperature range which includes normal ambient temperatures. It is hypothesised that three ring azaarene species are more likely to undergo changes in the relative proportions of particle and vapour phase material than either two or four ring compound. (C) 1997 Elsevier Science Ltd. *Classification: 5*.

Chen, H. Y. and Preston, M. R. (1998) 'Azaarenes in the aerosol of an urban atmosphere', *Environmental Science & Technology,* **32, 577-583**

The results of an extensive study of 47 azaarenes in the Liverpool urban atmosphere through the period from September 1994 to March 1996 are reported. Total suspended particles and size-fractionated particles were collected by high Volume sampling techniques and cascade impactor sampling techniques. The overall mean Sigma azaarene concentration was 2.80 ng m(- 3). The monthly mean Sigma azaarene concentrations show a very strong seasonal Variation in which the maximum concentration occurred in the winter and the minimum in the summer months, with a concentration range of 0.4-7.64 ng m(-3). There are highly significant covariations between the different ring sized group, which suggests that there are similar source strengths and transport mechanisms for these compounds. The particle size distributions indicate that the combustion of fossil fuel is probably the main source of azaarene compounds during the winter. The percentage concentrations of azaarene show that these compounds also tend to associate

with larger particles in warm periods and enrich in fine particles in cold weather conditions. *Classification: 5.*

Chen, Q. Y. (1997) 'Controlling urban climate: Using a computational method to study and improve indoor environments', *Journal of Urban Technology,* 4, 69-83

Classification: 1,2.

Chen, Y. Y. and Lee, W. M. G. (1999) 'Hygroscopic properties of inorganic-salt aerosol with surface- active organic compounds', *Chemosphere,* 38, 2431-2448

This paper investigates the hygroscopic characteristics of inorganic-salt aerosols with surface-active organic compounds (SAOCs). The experimental system includes a Tandem Differential Mobility Analyzer and a Scanning Mobility Particle Sizing System. The aerosols were prepared by mixing calcium chloride with SACs at five mass fraction of SAOCs, which are 0, 10, 16.7, 20, 25%. Four SAOCs, sodium dodecyl sulfate (SDS), sodium oleate (SO), Tween 80, and Span 80 were chosen according to the hydrophile-lipophile balance (HLB) values. First, the hygroscopic growth of SAOCs aerosol was observed. Then the hygroscopic growth of calcium chloride with SAOCs were observed from 7.5% to 85% relative humidity in this study. The results show that the maximum growth ratio of four SAOCs in only 7.5% at relative humidity of 85%. Thus, four SAOCs used in this study have low hygroscopic growth. However, the relative hygroscopic growth ratio of inorganic-salt aerosols compared with inorganic-salt aerosols with SAOCs is between 56 to 83% even at SAOCs mass fraction of 25%. The relative hygroscopic growth ratio of inorganic-salt aerosols with SAOCs appears to decrease with increasing SAOCs concentration but to increase with the HLB values of SAOCs. In other words, SAOCs may inhibit the hygroscopic growth ratio but 56 to 83% relative hygroscopic growth ratio can still be observed. Although the relative hygroscopic growth ratio appears to decrease with increasing SAOC concentration, the growth ratio tends to be at stable value as the mass fraction of SAOCs greater than 20%. Moreover, the spreading rate of SAOCs was compared with the surface growth rate of aerosols calculated in this study. The presence of surface organic film can not inhibit the absorption of water vapor by calcium chloride completely should be caused by the high surface growth rate of aerosols in phase transition period. On the contrary, the spreading rates of SAOCs are much larger than surface growth rate of calcium chloride aerosol in the stable growth period, therefore, the absorption of water vapor can be inhibited significantly by the surface organic film. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 0.*

Colls, J. J. and Micallef, A. (1999) 'Measured and modelled concentrations and vertical profiles of airborne particulate matter within the boundary layer of a street canyon', *Science of the Total Environment,* 235, 221-233

Concentrations and vertical profiles of various fractions of airborne particulate matter (suspended particulate matter (SPM), PM10 and PM2.5) have been measured over the first three metres from ground in a street canyon. Measurements were carried out using automated near rear-time apparatus called the Kinetic Sequential Sampling (KSS) system.

KSS system is essentially an electronically-controlled lift carrying a real- time particle monitor for sampling air sequentially, at different heights within the breathing zone, which includes all heights within the surface layer of a street canyon at which people may breathe. Data is automatically logged at the different receptor levels, for the determination of the average vertical concentration profile of airborne particulate matter. For measuring the airborne particle concentration, a Grimm Dust Monitor 1.104/5 was used. The recorded data also allows for time series analysis of airborne particulate matter concentration at different heights. Time series data and hourly-average vertical concentration profiles in the boundary layer of the confines of a street are thought to be mainly determined by traffic emissions and traffic associated processes. Hence the measured data were compared with results of a street canyon emission-dispersion model in time and space. This Street Level Air Quality (SLAQ) model employs the plume- box technique and includes modules for simulating vehicle- generated effects such as thermally- and mechanically-generated turbulence and resuspension of road dust. Environmental processes, such as turbulence resulting from surface sensible heat and the formation of sulphate aerosol from sulphur dioxide exhaust emissions, are taken into account. The paper presents an outline description of the measuring technique and model used, and a comparison of the measured and modelled data. (C) 1999 Elsevier Science B.V. All rights reserved. *Classification: 5,8.*

de Assis, E. S. and Frota, A. B. (1999) 'Urban bioclimatic design strategies for a tropical city', *Atmospheric Environment,* 33, 4135-4142

Some towns in the intertropical zone, such as the city of Belo Horizonte in Brazil, presented in this paper, have composed climates whose variations throughout the year require alternative design decisions, in order to make use of passive environmental resources. On the other hand, the great variation of urban settlements produces different kinds of microclimates inside the city. This paper shows the application of an urban design strategy that takes into account those climatic variations, using the city's available climatic data and physical simulations of the thermal field in urban areas, to analyze the influence of urban forms (land use, typology and building configurations) on climatic change. With the application of a thermal comfort index, it is possible to evaluate the local conditions of human bioclimatic stress. This kind of result can be applied to the city land-use legislation, bearing in mind the preservation of bioclimatic conditions in urban spaces. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 2,7.*

de Haan, P., Rotach, M. W. and Werfeli, M. (1998) 'Extension of an operational short-range dispersion model for applications in an urban environment', *International Journal of Vehicle Design,* 20, 105-114

When operationally modelling dispersion of air pollutants over a city, 'conventional' dispersion models are often used with modifications in some of the parameters, such as the roughness length. However, the presence of a roughness sublayer (RS) is usually neglected, although its turbulence structure is different from that in the surface layer. Therefore, in the present work a roughness sublayer for urban applications is introduced. The principle of the modification has already been tested by simulating two tracer experiments using a Lagrangian particle model, and it was shown that the introduction of an RS clearly improves the model performance for both experiments. In this paper, it is

shown that the same holds for the introduction of the RS in the multi-source/multi-receptor Gaussian OML model. Its performance is investigated for the city of Zurich in the year 1990, when a detailed emission inventory and observations at 29 stations are available. It is concluded that the introduction of the RS increases the physical significance of the model in urban environments and thus the credibility of its predictions. *Classification: 5.*

DeSchiller, S. and Evans, J. M. (1996) 'Training architects and planners to design with urban microclimates', *Atmospheric Environment,* 30, 449-454

The ability to design with urban microclimates depends on the architects' and planners' skills to identify significant variations of the regional climate in urban areas, develop awareness of possible future modifications produced by changes in the urban tissue and use this potential during the design process at different scales of application. Favourable urban microclimate modification or conservation of the existing climatic conditions can be achieved by appropriate climate- sensitive urban planning, and architectural projects with natural conditioning of indoor and outdoor spaces. This paper explains the objectives and methods adopted in different climate-sensitive design courses given by the authors to promote the integration of urban climate control in the planning and architectural design process, at the graduate and post-graduate level. The teaching sequence related to the design process, which is explained here, is intended to illustrate the level of information that is required by planners and architects. A summary of the course objectives, sequence and content is outlined in the appendix. *Classification: 2.*

Dewulf, J. and VanLangenhove, H. (1997) 'Analytical techniques for the determination and measurement data of 7 chlorinated C-1- and C-2-hydrocarbons and 6 monocyclic aromatic hydrocarbons in remote air masses: An overview', *Atmospheric Environment,* 31, 3291-3307

This overview is focusing on methods for the sampling and analysis of seven chlorinated C-1- and C-2-hydrocarbons and six monocyclic aromatic hydrocarbons at marine and remote continental sites and in the free troposphere. Results obtained by analysing field samples with the methods described are reported as well. According to the literature samples are taken in sample loops, by adsorption on solid matrices, by condensation in cold traps (cryogenic sampling) or whole air samples are taken in canisters. The performance of different sampling and preconcentration techniques is compared. Details on the analyses in sensu strictu (methods of injection, separation and detection) are given. Attention is paid to data on limits of detection, reproducibility and calibration. Finally, measurement results of these compounds at coastal, bay, estuarine, island, remote continental and open sea locations and in the free troposphere are presented. (C) 1997 Elsevier Science Ltd. *Classification: 0.*

Donahue, N. M., Kroll, J. H., Anderson, J. G. and Demerjian, K. L. (1998) 'Direct observation of OH production from the ozonolysis of olefins', *Geophysical Research Letters,* 25, 59-62

Ozone olefin reactions may be a significant source of OH in the urban atmosphere, but current evidence for OH production is indirect and contested. We report the first direct observation of OH radicals from the reaction of ozone with a series of olefins (ethene, isoprene, trans-2-butene and 2,3 dimethyl-2- butene) in 4-6 torr of nitrogen. Using LIF to directly observe the steady-state of OH produced by the initial ozone-olefin reaction and subsequently destroyed by the OH-olefin reaction, we are able to establish OH yields broadly consistent with indirect values. The identification of the OH is unequivocal, and there is no indication that it is produced by a secondary process. To support these observations, we present a complete ab-initio potential energy surface for the O-3-ethene reaction, extending from the reactants to available products. *Classification: 0*.

Duncan, B. N. and Chameides, W. L. (1998) 'Effects of urban emission control strategies on the export of ozone and ozone precursors from the urban atmosphere to the troposphere', *Journal of Geophysical Research-Atmospheres,* **103, 28159-28179**

An urban plume model is used to simulate the photochemistry of ozone (O-3) precursors and the concomitant generation of O-3 within an urban plume as it advects and mixes with the background atmosphere. On the basis of these calculations, we estimate the rates at which O-3 and its precursor compounds are exported to the background atmosphere and how these export rates are affected by various control strategies that might be implemented to reduce maximum O-3 concentrations within the urban plume. Two model cities with different chemical characteristics are considered: case 1, where peak O-3 concentrations during extreme air pollution episodes are more sensitive to nitrogen oxides (NOx = NO + NO2) and case 2, where peak O-3 concentrations during these episodes are more sensitive to volatile organic compounds(VOC). The model is first run for extreme meteorological conditions conducive to the generation of high O-3 concentrations to determine the most effective emission control strategies for reducing peak O-3 under these conditions. The model is then run for more typical meteorological conditions, to determine how these various emission control scenarios might affect the export of O-3 and its precursors from the urban to the rural and background atmosphere. The export of O-3 from the urban atmosphere is found to be more sensitive to NOx emissions, even for case 2 where VOC emission controls more effectively reduced peak O-3 during pollution episodes. The impact of VOC and NOx emission reductions on the export of primary and secondary O-3 precursor compounds is more complex, leading to reductions in the export of some species and enhancements in the export of others. *Classification: 5*.

Dupont, E., Menut, L., Carissimo, B., Pelon, J. and Flamant, P. (1999) 'Comparison between the atmospheric boundary layer in Paris and its rural suburbs during the ECLAP experiment', *Atmospheric Environment,* **33, 979-994**

The ECLAP experiment has been performed during the winter of 1995 in order to study the influence of the urban area of Paris on the vertical structure and diurnal evolution of the atmospheric boundary layer, in situations favourable to intense urban heat island and pollution increase. One urban site and one rural site have been instrumented with sodars, lidars and surface measurements. Additional radiosondes, 100 m masts and Eiffel Tower data were also collected. This paper gives a general overview of this experiment, and presents results of the analysis of four selected days, characterized by various wind

directions and temperature inversion strengths. This analysis, which consists in a comparison between data obtained in the two sites, has been focused on three parameters of importance to the ABL dynamics: the standard deviation of vertical velocity, the surface sensible heat flux, and the boundary layer height. The vertical component of turbulence is shown to be enhanced by the urban area, the amplitude of this effect strongly depending on the meteorological situation. The sensible heat flux in Paris is generally found larger than in the rural suburbs. The most frequent differences range from 25- 65 W m(-2), corresponding to relative differences of 20-60%. The difference of unstable boundary layer height between both sites are most of the time less than 100 m. However, sodar and temperature data show that the urban influence is enhanced during night-time and transitions between stable and unstable regimes. (C) 1999 Published by Elsevier Science Ltd. All rights reserved. *Classification: 8.*

Eleftheriadis, K., Balis, D., Ziomas, I. C., Colbeck, I. and Manalis, N. (1998) 'Atmospheric aerosol and gaseous species in Athens, Greece', *Atmospheric Environment,* **32, 2183-2191**

Measurements of aerosol species including Cl-, NO3+, SO42-, NH4+, Na+, K+, Mg2+ and Ca2+ and gaseous pollutants like HCl, HNO3, NO2, SO2 and O-3 were conducted at the centre of Athens. Results show moderate levels of pollution with aerosol species typical of dust emissions and secondary aerosol of anthropogenic origin. Most gaseous pollutants correlate well with aerosol species. There is a pronounced elevation in the concentration of acidic trace,oases Hel and HNO3, arriving at the city from the direction of the Saronikos gulf, indicating poor neutralisation of such species over the sea. On the contrary, air masses coming From inland are characterised by considerably higher ammonium aerosol. It was concluded that in addition to heavier aerosol load pollution episodes in Athens during the summer period are associated with higher concentrations of gaseous acids. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Eliasson, I. (1996a) 'Intra-urban nocturnal temperature differences: A multivariate approach', *Climate Research,* **7, 21-30**

The possibility of predicting nocturnal intra-urban air temperature differences on the basis of meteorological data from climatic stations was analysed. Three years of recording at an urban canyon and a nearby open area in the city of Goteborg, Sweden, formed the basis of the analyses. The urban canyon-urban open area temperature differences (Delta T-c-o) were best estimated when the data was first classified with reference to the amount of cloud cover and then fitted to a non-linear regression equation which included the wind speed at the urban open area (10 m level). The study shows that the degree of intra-urban temperature variations can be predicted using a fairly simple methodology. The methodology and the general pattern of the model could be helpful as a complementary tool in urban land use planning for cities with a structure similar to Goteborg. *Classification: 3,4.*

Eliasson, I. (1996b) 'Urban nocturnal temperatures, street geometry and land use', *Atmospheric Environment,* **30, 379-392**

The climate in the city of Goteborg, Sweden, was investigated for a three year period. In this paper the nocturnal temperature distribution is analysed in relation to differences in street geometry and land use. The seasonal and monthly air temperature difference between a street canyon and a nearby open area, as well as case studies of the vertical and horizontal temperature distribution within and between different urban units and urban districts are discussed. In spite of a good relationship between the local surface temperature and the sky view-factor, both continuous measurements and case studies show small variations in air temperature within the city centre. Air temperature variations between urban districts of different land use are greater. The average horizontal temperature decrease of 4 degrees C in the transition zone from the city centre to a large park southwest of the centre are, in fact, of the same order as the average urban-rural air temperature difference. *Classification: 3,4,2*.

Elliott, S., Streit, G. E., Gaffney, J. S., Bossert, J. E., Brown, M., Reisner, J. and McNair, L. A. (1999) 'Pathways for the oxidation of sarin in urban atmospheres', *Environmental Science and Pollution Research,* **6, 103-105**

The nerve agent sarin has recently been deployed by terrorists in a major city. The molecule is volatile and made its way to many victims by passing as vapor through a highly reactive medium. Here we estimate rates and pathways for the removal of gas phase sarin from a generalized urban atmosphere. Only information from the open scientific literature is used. By structure reactivity comparisons with the organophosphorus pesticides, hydroxyl radical hydrogen abstraction may occur in as little as one hour. Decomposition of side chains after hydroxyl attack leads to organic oxygenates which preserve the phosphono-fluoridate and so toxicity. The aqueous aerosol surface is contacted in minutes and offers access to a range of dissolved nucleophiles. Substitution displaces the fluoride leaving group, giving safe phosphoric acid analogs. Because of uncertainties in the electron distribution and in aqueous decay mechanisms, the time constants must be viewed as lower limits. *Classification: 5*.

Erell, E. and Tsoar, H. (1999) 'Spatial variations in the aeolian deposition of dust - the effect of a city: a case study in Be'er-Sheva, Israel', *Atmospheric Environment,* **33, 4049-4055**

The effect of buildings on the dry deposition of dust particles was investigated in Be'er-Sheva, a desert city with about 140,000 inhabitants in southern Israel, and at two reference points in the surrounding rural area. The mineral and chemical composition of dust sampled at all sites was similar, reflecting the composition of the local loess soil, its likely origin. However, dust deposited in the traps set up in the vicinity of buildings in the city was significantly coarser than the dust which accumulated in similar traps at exposed sites in the countryside. The amount of dust (by weight) in the urban dust traps was on an average more than twice the amount deposited in the rural area. The differences in grain-size distribution and quantity of dust are attributed to the properties of the urban wind field and to various effects of human activity in the city. (C) 1999 Elsevier Science Ltd. Ail rights reserved. *Classification: 4,5*.

Evans, J. M. and DeSchiller, S. (1996) 'Application of microclimate studies in town planning: A new capital city, an existing urban district and urban river front development', *Atmospheric Environment,* **30, 361-364**

The knowledge obtained from urban thermal studies needs to be transferred to planners and architects in such a way that this can influence the approach to physical planning and be applied in practice. Three case studies illustrate the possibilities and limitations of applying urban climate control measures to improve living conditions. The climate and microclimate impact studies and design recommendations were carried out by the authors for the project of a new city, the revision of the planning code for an urban district of a large metropolitan region and an urban waterfront development. The differences between the research environment and the planning context are stressed in terms of time scale, priorities and application possibilities. *Classification: 2.*

Febo, A., Perrino, C. and Allegrini, I. (1996) 'Measurement of nitrous acid in Milan, Italy, by DOAS and diffusion denuders', *Atmospheric Environment,* **30, 3599-3609**

Measurements of the atmospheric mixing ratio of nitrous acid have been carried out by means of the differential optical absorption system (DOAS) during a wintertime field study carried out in the urban area of Milan (Italy). Preliminary laboratory calibration of the DOAS was carried out by making use of a standard source of pure HONO which provided an interference-free UV absorption spectrum of HONO and recalculation of the absorption cross-section of this compound. Very high HONO mixing ratios, up to values exceeding 10 ppb, were measured during the campaign. DOAS results were compared with those obtained by using the annular denuder technique and good agreement was observed during the whole measurement period. On the basis of these measurements, a study on the relationship between the dynamic conditions of the lower boundary layer and the temporal trend of HONO mixing ratio can be carried out, in order to obtain indications about the sources of this species in urban atmospheres. Copyright (C) 1996 Elsevier Science Ltd. *Classification: 0.*

Fenter, F. F. and Rossi, M. J. (1996) 'Heterogeneous kinetics of HONO on H2SO4 solutions and on ice: Activation of HCl', *Journal of Physical Chemistry,* **100, 13765-13775**

In order to better assess the role of nitrous acid in the chemistry of the upper troposphere and in the plumes of jet aircraft, we have studied the interaction of HONO with sulfuric acid liquid solutions (50-95 wt %) and with ice. The experiments were carried out using a Knudsen cell over the temperature range of 180-200 K for ice and 200-273 K for the solutions of H2SO4. The rate of uptake of HONO on sulfuric acid is found to vary greatly as a function of the weight percent of the solution, with an uptake probability that changes from about 0.1 at 95 wt % to less than 10(-3) for solutions under 60 wt %. HONO is adsorbed reversibly onto ice with submonolayer coverage. In the presence of HCl, the formation of ClNO is observed for both heterogeneous systems. The maximum uptake probability of HCl in the presence of HONO on the H2SO4 liquid solutions is observed at 60 wt %. The reaction takes place on ice with greater efficiency compared to H2SO4 solution experiments, which allows for the unambiguous detection of ClNO as the

reaction product. We will show the results of experiments conducted over a wide range of initial conditions (reactant concentration, temperature, water partial pressure, substrate preparation) using both steady-state and realtime detection schemes. From the data, we can draw some conclusions concerning the interfacial nature of the reaction mechanism. A few brief comments on the atmospheric implications of our results conclude the discussion. *Classification: 0.*

Figuerola, P. I. and Mazzeo, N. A. (1998) 'Urban-rural temperature differences in Buenos Aires', *International Journal of Climatology,* **18, 1709-1723**

The hourly temperature differences between Buenos Aires City and Ezeiza Airport were calculated using 3 years of data. This paper describes statistical results on the Buenos Aires urban heat island and how it varies with days of the week, seasons, cloud cover, direction and speed of wind. The average value of the maximal heat island fell in winter from 4.6 degrees C with light winds and little sky coverage to 3.6 degrees C with windy and cloudy conditions. Strong winds from the city toward rural areas and winds from the river over the city facilitated the occurrence of an inverse heat island (rural area warmer than city). The inverse heat island occurred 20% of the time over a total of 22000 hours studied. Another important factor seems to be the great activity of the city; the average value of the maximal heat island fell between weekdays and weekends 1 degrees C with weak winds and little sky coverage conditions. The hourly average values were analyzed depending on the days of the week. (C) 1998 Royal Meteorological Society. *Classification: 3,1.*

Forslund, M. and Leygraf, C. (1996) 'A quartz crystal microbalance probe developed for outdoor in situ atmospheric corrosivity monitoring', *Journal of the Electrochemical Society,* **143, 839-844**

In order to perform in situ monitoring of minute corrosion attacks during outdoor field exposures, an atmospheric corrosivity probe has been developed based on the quartz crystal microbalance. A remotely controlled computerized mobile field station was also constructed. The whole setup allows simultaneous in situ measurements of mass changes with a resolution of +/- 10 ng cm(-1), and of climatic parameters. The observed mass changes during introductory exposures of gold and copper in an urban atmosphere are both reversible and irreversible. Aided by ex situ x-ray photoelectron spectroscopy analysis, the results can be interpreted in terms of salt deposition, water adsorption, water desorption, and atmospheric corrosion effects. *Classification: 0.*

Fraigneau, Y., Gonzalez, M. and Coppalle, A. (1996) 'Turbulence effects upon the NO2/NO conversion in the vicinity of an urban area', *Science of the Total Environment,* **190, 293-300**

The dispersion and chemical transformation of nitrogen oxides have been studied in an urban atmosphere. In this work, nitric oxide is considered as being emitted from the ground. It is mixed with ambient ozone with which it reacts to produce nitrogen dioxide. Numerical integration of the transport equation of each species is carried out in the boundary layer, allowing for the effects of dipersion, macro- and micromixing and

chemistry. The results show that the influence of turbulence on chemical reactions is important close to the emission zone. It is also found that the NO/NO2 conversion is low in this region and that it grows with increasing distances. *Classification: 5.*

Fraser, M. P., Cass, G. R. and Simoneit, B. R. T. (1998) 'Gas-phase and particle-phase organic compounds emitted from motor vehicle traffic in a Los Angeles roadway tunnel', *Environmental Science & Technology,* 32, 2051-2060

The emission rates for 221 vapor-phase, semivolatile, and particle-phase organic compounds from motor vehicles plus fine particulate matter mass and some inorganic particle-phase species are calculated based on measurements made inside and outside a Los Angeles roadway tunnel in 1993. These emission rates are calculated based on fuel consumption to remove any uncertainties based on tunnel dilution rates or air circulation. The results show carbon monoxide emissions rates of 130 g L-1 of gasoline-equivalent fuel burned and volatile organic compound (VOC) emissions of 9.1 g L-1. These values are higher than predicted.by the baseline version of California's EMFAC 7G emissions inventory program but are within the coemission rate range of 108 +/- 25 g L-1 reported:by roadside remote sensing studies in Los Angeles [Singer, B. C.; Harley, R. A. J. Air Waste Manage. Assoc. 1996, 46, 581-593]. When the VOC emissions composition in the tunnel is compared td that of tailpipe emissions source test data and to the composition of additional unburned. whole gasoline, the tunnel atmosphere is found to be consistent with a linear combination of these major contributors over a fairly broad range of about 74-97% vehicle exhaust depending on the tailpipe profiles used. Fine particulate emissions within the tunnel consist largely of carbonaceous material accompanied by a significant amount of ammonium nitrate apparently formed by gas-to-particle conversion processes within the tunnel atmosphere. Certain gas- phase and particulate organic compounds traditionally thought to be the Secondary products of atmospheric chemical reactions are enriched inside the tunnel, and from this enrichment, the primary emission rates of aromatic alcohols, aliphatic dicarboxylic acids, and aromatic polycarboxylic acids are calculated. Data on petroleum biomarkers emissions rates in the tunnel can he used in the future to estimate primary vehicle exhaust fine particulate matter concentrations in the urban atmosphere. *Classification: 5.*

Fraser, M. P., Cass, G. R. and Simoneit, B. R. T. (1999) 'Particulate organic compounds emitted from motor vehicle exhaust and in the urban atmosphere', *Atmospheric Environment,* 33, 2715-2724

The emission rate of particle-phase petroleum biomarkers in vehicular exhaust compared to the concentrations of these biomarkers in ambient air is used to determine the particulate organic compound concentration due to primary particle emissions from motor vehicles in the southern California atmosphere. A material balance on the organic particulate matter emitted from motor vehicle traffic in a Los Angeles highway tunnel first is constructed to show the proportion which is solvent-extractable and which will elute from a GC column, the ratio of resolved to unresolved compound mass, the portion of the resolved material that can be identified as single organic compounds, and the contribution of different classes of organic compounds to the overall identified fraction. It is shown that the outdoor ambient concentrations of the petroleum biomarkers track primary emissions measured in the highway tunnel, confirming that direct emissions of

these compounds from vehicles govern the observed ambient petroleum biomarker concentrations. Using organic chemical tracer techniques, the portion of fine organic particulate matter in the Los Angeles atmosphere which is attributable to direct particle emissions from vehicle exhaust is calculated to vary from 7.5 to 18.3% at different sites throughout the air basin during a summertime severe photochemical smog episode. A similar level of variation in the contribution of primary motor vehicle exhaust to fine particulate organic matter concentrations during different times of day is seen. While peak atmospheric concentrations of fine particulate organic carbon are observed during the 1200-1600 PDT afternoon sampling period, only 6.3% of that material is apportioned to the directly emitted particles from vehicle exhaust. During the morning traffic peak between 0600-1000 PDT, 19.1% of the fine particulate organic material is traced to primary emissions from motor vehicles. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Fraser, R. S., Mattoo, S., Yeh, E. N. and McClain, C. R. (1997) 'Algorithm for atmospheric and glint corrections of satellite measurements of ocean pigment', *Journal of Geophysical Research-Atmospheres,* **102, 17107-17118**

An algorithm is developed to correct satellite measurements of ocean color for atmospheric and surface reflection effects. The algorithm depends on taking the difference between measured and tabulated radiances for deriving water-leaving radiances. The tabulated radiances are related to the measured radiance when the water-leaving radiance is negligible (670 nm). The tabulated radiances are calculated for rough surface reflection, polarization of the scattered light, and multiple scattering. The accuracy of the tables is discussed. The method is validated by simulating the effect of different wind speeds than that for which the lookup table is calculated, and aerosol models different from the maritime model for which the table is computed. The derived water-leaving radiances are accurate enough to compute the pigment concentration with an error of less than +/-15% for wind speeds of 6 and 10 m/s and an urban atmosphere with aerosol optical thickness of 0.20 at lambda 443 nm and decreasing to 0.10 at lambda 670 nm. The pigment accuracy is less for wind speeds less than 6 mis and is about 30% for a model with aeolian dust. On the other hand, in a preliminary comparison with coastal zone color scanner (CZCS) measurements this algorithm and the CZCS operational algorithm produced values of pigment concentration in one image that agreed closely. *Classification: 0.*

Fujino, T., Asaeda, T. and Ca, V. T. (1999) 'Numerical analyses of urban thermal environment in a basin climate - application of a k-epsilon model to complex terrain', *Journal of Wind Engineering and Industrial Aerodynamics,* **81, 159-169**

Meteorological field observations were conducted at an urban area in a basin in summer. On a calm clear day a mixing layer of about 1500 m height was generated by the thermally induced circulation over the basin. The maximum air temperature in the urban area was recorded at around 18 : 00 LST, even though the area is only a few kilometers in extent and consists of low buildings and low anthropogenic heat release, Numerical analysis was conducted, to evaluate the daytime heating process and urban effects, using a three-dimensional k-epsilon model. The 100 x 120 km computational domain was discretized horizontally using a nested grid system consisting of three overlapping grids.

The results were in good agreement with the observed values of air temperature, mixing ratio, and wind profiles, The large circulations experienced in this region were predicted with the downward wind over the lake bringing a warm and dry air mass to the ground. The air temperature in the urban area rose and maintained its high value until late afternoon, mainly due to the local circulation adding to the urban effects. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 3,8*.

Fukuoka, Y. (1997) 'Biometeorological studies on urban climate', *International Journal of Biometeorology,* **40, 54-57**

Urban-biometeorology, i.e., biometeorological study on the ur ban climate is regarded as both old and/or new science. Studies on two topics are reviewed: the thermal or chemical impact of urban climate on human health, and the relation between urban climate and vegetation. *Classification: 7*.

Gayev, Y. A. and Savory, E. (1999) 'Influence of street obstructions on flow processes within urban canyons', *Journal of Wind Engineering and Industrial Aerodynamics,* **82, 89-103**

This paper is concerned with modelling of the motion of air within the urban environment and is directed towards a deeper understanding and controlling of pollutant dispersion in individual street canyons. Some possible methodologies by which the roughness associated with obstacles, such as small buildings, kiosks, trees and stationary vehicles within the canyon may be described for incorporation into an overall canyon model, are discussed. This is illustrated by results from a simple wind tunnel experiment utilising an idealised two-dimensional street canyon in which the internal roughness is represented by an array of vertical cylinders. These reveal the presence of complex flow patterns within the roughness layer. Integrated and averaged mean Velocity and turbulence intensity parameters are presented to indicate the extent of the effect of the presence of the internal roughness upon the canyon flow regime. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 8*.

Gerdes, F. and Olivari, D. (1999) 'Analysis of pollutant dispersion in an urban street canyon', *Journal of Wind Engineering and Industrial Aerodynamics,* **82, 105- 124**

Pollutant contamination of an urban street canyon was investigated in a wind tunnel. The urban street canyon was simulated by two walls parallel to each other and perpendicular to the wind. The influence of the following parameters was studied: the landscape upstream of the canyon, the ratio between the heights of the upstream and downstream canyon walls, and the spacing between the canyon walls. The global concentration field was investigated with a video camera and digital image processing. In order to obtain local statistical properties of the concentration a photo-diode sensor was used. The velocity field was measured by use of particle image velocimetry. A strong influence of the landscape on the pollutant dispersion about the street canyon was observed. Also the ratio of wall heights turned out to be important. On the other hand, the spacing between

the walls was less important. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5,8*.

Giugliano, M., Cernuschi, S. and Marzolo, F. (1998) 'The duration of high NO2 and CO concentrations in an urban atmosphere', *Atmospheric Environment,* **32, 2923-2929**

With the principal aim of providing a more powerful assessment of exposure to polluted atmospheres, 5 years of hourly concentration data recorded at 19 monitoring stations located in the Milan area are analysed, taking into account their time structure, in order to generate statistics and simple empirical models for describing the parameters of duration events of concentrations concentrations continuously exceeding given thresholds. In particular, the main statistics of the number and duration of events for CO and NO, were described by simple models, parametrized in terms of the arithmetic average concentration of the annual time series. These findings are particularly useful for the potential utilisation of mean concentration values over long periods in roll-back models, applied to stable pollutants for evaluating the reduction of emissions required for attaining specific objectives like the compliance with standards or, as in this case, the control of critical durations. For the area considered, the roll-back approach can also be extended to evaluate the reduction of emissions on NO2 through the utilisation of a previously developed NO2-NOx statistical link. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5*.

Glovsky, M. M., Miguel, A. G. and Cass, G. R. (1997) 'Particulate air pollution: Possible relevance in asthma', *Allergy and Asthma Proceedings,* **18, 163-166**

The relative importance of air pollution in the pathogenesis of bronchial asthma has been of interest for several decades. Numerous studies on the role of gaseous air pollution containing ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide have been published. Very little attention has been focused on the role of respirable particles in the causation of asthma. In this article we summarize some of our ongoing investigations into the sources and composition of airborne particles in the Los Angeles and Pasadena atmosphere, including the search for biologically active particles that may induce asthma attacks. It is found that the urban atmosphere contains not only combustion-derived particles from diesel engine exhaust and gasoline-powered motor vehicle exhaust, bur also particles formed from biological starting materials including plant debris, cigarette smoke, wood smoke, and meat smoke as well as tire debris containing some natural rubber and paved road dust. Paved road dust is a very complex mixture of particles including garden soil, tire dust, plant fragments, redeposited atmospheric particles of all types, and pollen fragments presumably ground up by passing traffic. We have shown previously that latex allergen can be extracted from tire dust, from roadside dust, and front respirable air samples taken at Los Angeles and Long Beach. At present, work is underway to identify the larger range of allergens that may be contributed by the entrainment of paved road dust into the atmosphere. The possible importance of pollen fragments present in paved rand dust in very small particle sizes is discussed as well as their potential relevance in asthma. *Classification: 5,7*.

Glowacka, M. and Hucinska, J. (1999) 'Corrosion of historical objects made of copper alloys in an urban atmosphere in the city of Gdansk', *Corrosion Reviews,* **17, 67-75**

This paper presents two cases of corrosion damage to famous historical objects in Gdansk: the face of the clock of the Main Town Hall and the monument to King Jan III Sobieski, the latter being situated at the Wooden Market Both are made of copper alloys. Examinations performed at the Department of Materials Science and Engineering of the Technical University of Gdarisk revealed that the materials factors, i.e., plastic deformation of the rim of the face and the direct contact of the bronze monument with the supporting ferrous structure, were the main contributors to the deterioration of these objects. The results of the examinations have completed the documentation on these objects and provided necessary information with regard to conservation work. *Classification: 5.*

Goh, K. C. and Chang, C. H. (1999) 'The relationship between height to width ratios and the heat island intensity at 22 : 00 h for Singapore', *International Journal of Climatology,* **19, 1011-1023**

The statistical relationship between urban canyon height-to- width (H/W) ratios and nocturnal heat island intensities for public housing estates in Singapore has been examined. Although a number of similar studies have been conducted for temperate cities, this is a first attempt at correlating H/W to heat island intensities for a tropical city. Heat island intensities were examined specifically at 22:00 h because a previous study of Singapore's heat island determined that the heat islands were well developed by that time. A total of 17 Housing Development Board (HDB) estates were studied and at least two vehicle traverses were conducted for each estate on nights with a few days of antecedent dry weather conditions. H/W ratios for each estate were tabulated by proportion of building length. The statistical analysis demonstrates that there is a positive relationship between the heat island intensities and the median H/W, such that Delta Tu-r(max) = 0.952 (median H/W) - 0.021, statistically significant at alpha = 0.05 with a p-value of 0.001 and a correlation coefficient of 0.53. Copyright (C) 1999 Royal Meteorological Society. *Classification: 1,3.*

Golany, G. S. (1996) 'Urban design morphology and thermal performance', *Atmospheric Environment,* **30, 455-465**

Climate specialists provide us today with much data on urban climatology; but it is urban design professionals who need to apply and translate this data into a design tool. This paper summarizes an urban design view of the relationship between urban design morphology and the thermal performance of the city. Its message is that each climatic region necessitates a distinct urban form and configuration which can contribute to make a city or neighborhood cooler or warmer, as is needed. It is the urban designer's responsibility to provide these forms based on the study of the character of the local climate. *Classification: 2,3.*

Gomez, F., Gaja, E. and Reig, A. (1998) 'Vegetation and climatic changes in a city', *Ecological Engineering,* **10, 355-360**

This paper sums up the methodology used and the plan of action taken for verification of the 'heat island' in the city of Valencia. At the same time it attempts to outline the role that green areas play in the distribution and pattern of urban temperature, thus constituting basic data for 'ecological engineering' in modern city planning. (C) 1998 Elsevier Science B.V. All rights reserved. *Classification: 1,7.*

Goss, K. U. (1997) 'Particle/gas concentrations and distributions of PAHs in the atmosphere of southern Chesapeake Bay - Comment', *Environmental Science & Technology,* **31, 3736-3737**

Classification: 5.

Goss, K. U. and Eisenreich, S. J. (1997) 'Sorption of volatile organic compounds to particles from a combustion source at different temperatures and relative humidities', *Atmospheric Environment,* **31, 2827-2834**

Sorption of polar and non-polar Volatile organic compounds to particles from a combustion source has been measured at different temperatures and relative humidities in laboratory experiments. The soot particles collected from oil furnaces contained 60% (w/w) iron sulfate and 9% (w/w) carbon comparable to the chemical composition of aerosol particles. Sorption experiments were conducted with the unmodified original soot as well as with a water-extracted subsample. A decrease in the sorption with increasing relative humidity was observed for all VOCs on both sorbents. Sorption enthalpies calculated from the measured temperature dependence of the sorption coefficients suggested stronger sorption for polar compared to non-polar compounds of comparable volatility. VOC sorption coefficients normalized to the surface area of the soot were greater than have been previously reported for mineral surfaces. A comparison of sorption coefficients with field data for gas- particle partitioning indicated good agreement on the basis of a log K-p,K-s vs log P-L(o) relationship. (C) 1997 Elsevier Science Ltd. *Classification: 0.*

Granier, L. K. and Chevreuil, M. (1997) 'Behaviour and spatial and temporal variations of polychlorinated biphenyls and lindane in the urban atmosphere of the Paris area, France', *Atmospheric Environment,* **31, 3787-3802**

This paper presents the results of a five year study (1986- 1991) of the contamination of the Paris area atmosphere by polychlorinated biphenyls (PCBs) and lindane. The main processes affecting their behaviour and fate such as vapour/particle partitioning and washout are described and modelled. The spatial and temporal variations of the concentrations of the compounds are assessed. PCBs did not exhibit a clear seasonal cycle, whilst lindane showed systematically higher concentrations in Spring, reflecting the agricultural use of this pesticide. The mean annual concentration of lindane in the atmosphere was stable during the period of study. PCBs concentrations showed a twofold decrease since 1986, presumably in part because of the effectiveness of pollution

prevention measures. Recent spatial variations in PCBs or lindane were not very important and the most recent concentrations recorded (2-6 ngm(-3) for PCBs and 1.5 ngm(-3) for lindane) were in line with levels commonly reported in the literature. PCBs as a whole were predominantly in the vapour phase (78% on top of the St Jacques Tower in 1989-1990). The amount associated with the particle phase was linked to temperature and increased during winter. The behaviour of individual components showed wide differences reflecting their varying physico-chemical properties: IUPAC no. 18 was not detectable in the particle phase whilst no. 180 was for 70% in the particle phase. Lindane was found only in the vapour phase. The overall washout ratio W (ng m(-3) rain / ng m(-3) air) was 34 x 10(3) for total PCBs and 79 x 10(3) for lindane. It varied between 21 x 10(3) for component IUPAC no. 28 to 235 x 10(3) for n 180. Dry deposition amounted to 35% of the total deposition for PCBs and 1% for lindane. The associated deposition velocity for Aroclor 1254 was 0.12 cm s(- 1). (C) 1997 Elsevier Science Ltd. *Classification: 5.*

Grant, R. H. and Wong, K. L. (1999) 'Ozone profiles over a suburban neighborhood', *Atmospheric Environment,* **33, 51-63**

The development of ozone (O-3) air quality models and the measurement of O-3 dry deposition over built-up areas requires assumptions concerning the vertical distribution of O-3. However, few [O-3] profiles have been measured over urban and suburban areas. A 150 m thick layer of air over a suburban neighborhood in Lafayette, Indiana, U.S.A. was profiled for potential temperature, moisture mixing ratio, and oxidant concentrations during 38 soundings made between mid-day and early evening in late summer and early fall 1994. The residential neighborhood had 17% of the area covered by trees, with a mean vegetation canopy height of 9 m. Although some [O- 3] and oxidant concentration ([oxidant]) profiles showed a monotonic decrease or increase in concentration with height, many profiles (63%) exhibited a distinct local maximum in the profile. The local [oxidant] maxima were typically observed near the top of a relatively stable layer of air, and occurred more frequently when the local surface winds were from the agricultural rural regions to the north of the neighborhood and the air had resided within the Lafayette-Indianapolis region since the prior day. The magnitude of the local [oxidant] maximum was directly related to the 155 m [oxidant] during the mid-day and early-afternoon profiles. The presence of local maxima in many of the [O-3] profiles indicate that one cannot safely assume that [O-3] profiles monotonically decrease with decreasing height above all suburban areas. As a result, the estimation of O-3 fluxes should always include profile measurements to assure the representativeness of the calculated flux at the measurement height to surface deposition. Correlations between measures of local traffic activity, above- canopy air temperatures, the magnitude of local [O-3] maxima, and [O-3] above the canopy indicate that a change in the dominant processes producing the maxima appeared to occur around the time of plant senescence. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Grgic, I., Dovzan, A., Bercic, G. and Hudnik, V. (1998) 'The effect of atmospheric organic compounds on the Fe-catalyzed S(IV) autoxidation in aqueous solution', *Journal of Atmospheric Chemistry,* **29, 315-337**

Laboratory experiments were conducted with real atmospheric aerosol particles as well as with synthetic solutions under dark conditions, to simulate some of the chemical features of aerosols. In solutions obtained by the leaching of aerosols (size range D-ae: 0.4-1.6 mu m) that contained sufficient amounts of transition metal ions (e.g. Fe) and organic species (e.g. oxalate), S(IV) oxidation rates were significantly lower than those expected from the Fe-catalyzed S(IV) autoxidation in Milli-Q water. The results suggest that oxalate is responsible for much of the observed inhibition. Acetate and formate also inhibit the reaction, but to a much lesser extent. Oxalate has a strong inhibiting effect on the Fe-catalyzed S(IV) autoxidation at all investigated pH values (2.8, 3.7 and 4.5). It was established that Fe(III)-oxalato complexes affect the redox cycling of Fe(II)/Fe(III) and that the observed decrease of the reaction rate is caused by the reduced amount of catalytically active Fe(III) due to the complexation with oxalate. For the system Fe-S(IV)-O-2-oxalate at initial pH 3.7 the reaction rate was calculated using exponential simplification to account for oxalate influence on the amount of free Fe(III) by the following equation: $-r(S(IV)) = k \cdot [S(IV)] \cdot [Fe(III)] \cdot e(-b.[Ox])$. *Classification: 0.*

Grgic, I., Poznic, M. and Bizjak, M. (1999) 'S(IV) autoxidation in atmospheric liquid water: The role of Fe(II) and the effect of oxalate', *Journal of Atmospheric Chemistry,* **33, 89-102**

The reactivity of dissolved iron compounds towards different pollutants and photooxidants in atmospheric liquid water depends upon the oxidation state and speciation of iron. Our measurements of the oxidation state of dissolved iron eluted from aerosol particles (D-ae: 0.4- 1.6 mu m) collected in the urban atmosphere of Ljubljana showed that a large fraction of the iron content is present as Fe(II). The concentration ratio [Fe(II)]/[Fe(III)] varied between 0.9 and 3.1. The kinetics of S(IV) autoxidation catalyzed by Fe(II) under the conditions representative for acidified atmospheric liquid water and the influence of oxalate on this reaction under dark conditions was investigated. The reaction rate is the same if Fe(II) or Fe(LII) is used as a catalyst under the condition that Fe(LI) can be oxidized in Fe(III), which is the catalytically active species. Oxalate has a strong inhibiting effect on the S(IV) autoxidation in the presence of Fe(II). The reaction is autocatalytic with an induction period, that increases with higher concentrations of oxalate. The inhibiting effect of oxalate differs according to whether iron is initially in the Fe(II) or Fe(In) state. However, in both cases the inhibition by oxalate is a result of the formation of complexes with the catalyst. *Classification: 0.*

Grimmond, C. S. B., King, T. S., Roth, M. and Oke, T. R. (1998) 'Aerodynamic roughness of urban areas derived from wind observations', *Boundary-Layer Meteorology,* **89, 1-24**

This study contributes to the sparse literature on anemometrically determined roughness parameters in cities. Data were collected using both slow and fast response anemometry in suburban areas of Chicago, Los Angeles, Miami and Vancouver. In all cases the instruments were mounted on tall towers, data were sorted by stability condition, and zero-plane displacement (z(d)) was taken into account. Results indicate the most reliable slow response estimates of surface roughness are based on the standard deviation of the wind speed obtained from observations at one level. For residential areas, winter roughness values (leaf-off) are 80-90% of summer (leaf-on) values. Direct comparison of

fast and slow response methods at one site give very similar results. However, when compared to estimates using morphometric methods at a wider range of sites, the fast response methods tend to give larger roughness length values. A temperature variance method to determine z(d) from fast response sensors is found to be useful at only one of the four sites. There is no clear best choice of anemometric method to determine roughness parameters. There is a need for more high quality field observations, especially using fast response sensors in urban settings. *Classification: 8.*

Grimmond, C. S. B. and Oke, T. R. (1999a) 'Aerodynamic properties of urban areas derived, from analysis of surface form', *Journal of Applied Meteorology,* **38, 1262-1292**

Several methods to determine the aerodynamic characteristics of a site through analysis of its surface form (morphometry) are considered in relation to cities. The measures discussed include zero-plane displacement length (z(d)), roughness length (z(o)), depth of the roughness sublayer, and aerodynamic conductance. A sensitivity analysis is conducted on seven formulas to estimate z(d) and nine to estimate z(o), covering a wide range of probable urban roughness densities. Geographic information systems developed for 11 sites in 7 North American cities are used to characterize their morphometry-the height, shape, three-dimensional area, and spatial distribution of their roughness elements (buildings and trees). Most of the sites are in residential suburbs, but one is industrial and two are near city centers. This descriptive survey of urban geometric form is used, together with the morphometric formulas, to derive the apparent aerodynamic characteristics of the sites. The resulting estimates of z(d) and z(o) are compared with values obtained from analysis of wind and turbulence observations. The latter are obtained from a survey of approximately 60 field studies and 14 laboratory studies of real and scale model cities. Despite the comprehensive nature of the survey, very few studies are found to be acceptable and their scatter is large, hence they do not provide a standard against which to test the morphometric algorithms. Further, the data show only weak relations between measured z(d) and z(o) and roughness density. The relative merits of morphometric and wind-based estimates of aerodynamic parameters are discussed. Recommendations are made concerning the choice of method to estimate z(d) and z(o) in urban areas and their most likely magnitude. *Classification: 8.*

Grimmond, C. S. B. and Oke, T. R. (1999b) 'Heat storage in urban areas: Local-scale observations and evaluation of a simple model', *Journal of Applied Meteorology,* **38, 922-940**

The flux density of sensible heat to or from storage in the physical mass of the city is determined for seven cities (Chicago, Illinois; Los Angeles, California; Mexico City, Distrito Federal; Miami, Florida; Sacramento, California; Tucson, Arizona; and Vancouver, British Columbia) in North America across a 30 degrees latitudinal range. These cities have a variety of synoptic-scale climates and surface cover and structural morphologies. In all cases the "measured" storage heat flux is determined as the energy balance residual from direct observations of net all-wave radiation, and sensible and latent heat fluxes conducted using the same radiometer and eddy correlation techniques. Databases describing the surface characteristics around each site are developed from analysis of aerial photography and field surveys. Results indicate that storage heat flux is

a significant component of the surface energy balance at all sites and is greatest at downtown and light industrial sites. Hysteresis behavior, of varying degrees, is seen at all locations. A simple objective hysteresis model (OHM), which calculates storage heat flux as a function of net all-wave radiation and the surface properties of the site, is found to perform well in the mean for most cases, with the notable exception of Tucson; but considerable scatter is observed at some sites. Some of this is attributed to the moisture, wind, and synoptic controls at each of the sites, and to hour-to-hour variability in the convective fluxes that the OHM does not simulate. Averaging over 2 to 3 h may be a more appropriate way to use the model. Caution should be used when employing the OHM in windy environments. *Classification: 3*.

Grimmond, C. S. B., Souch, C. and Hubble, M. D. (1996) 'Influence of tree cover on summertime surface energy balance fluxes, San Gabriel Valley, Los Angeles', *Climate Research*, 6, 45-57

Trees are an important but little studied component of the urban canopy which have distinct climatic effects. This study investigates the influence of trees on local-scale surface energy balance fluxes. Simultaneous energy balance observations were conducted using eddy correlation methods for 2 suburban neighborhoods with higher (30%) and lower (10%) tree and shrub cover, in the San Gabriel Valley of the Los Angeles Metropolitan Area, California, USA. Data were collected on the materials and morphology of the urban surface through a combination of aerial photo analysis and field surveys and analyzed using a geographic information system. Information on external water use was obtained from questionnaires and the analysis of water use data from bi-monthly bills. In terms of the relative partitioning of energy, the effects of the trees are as expected: at the higher tree coverage neighborhood (HTN) the latent heat flux is increased as a fraction of net all-wave radiation, so too is the storage heat flux, whereas the sensible heat flux is decreased. However, in absolute terms, all fluxes, including the sensible heat flux, are enhanced at the HTN. A combination of lower albedos and lower surface temperatures in the HTN result in reduced loss of solar and longwave radiation respectively. Thus at the HTN there is greater net all-wave radiation, hence a greater amount of energy to be dissipated. Above the canopy, temperatures are slightly greater in the neighborhood with higher tree cover. *Classification: 3,7*.

Grosjean, E., Rasmussen, R. A. and Grosjean, D. (1998) 'Ambient levels of gas phase pollutants in Porto Alegre, Brazil', *Atmospheric Environment*, 32, 3371-3379

Air samples have been collected using electropolished canisters in downtown Porto Alegre, Brazil, where ethanol is used as a vehicle fuel and methyl-tert-butyl ether (MTBE) is used as a vehicle fuel additive. The 150 volatile organic compounds (VOC) identified by GC-FID and CC-MS included 46 alkanes, 30 alkenes, 22 aromatics, 17 carbonyls, 3 alcohols, 8 bicyclic aromatics, 11 halogenated hydrocarbons and 13 other compounds. The most abundant VOC on a mass concentration basis (after:CO2, CH4 and CO) included acetylene, MTBE, ethanol, the alkanes propane, M- butane, n-pentane, isopentane, n-hexane, 2-methylpentane and indane, the alkenes ethylene and propene, and the aromatics benzene, toluene, ethylbenzene and (m + p) xylene. During the ca. one-year period studied, 20 March, 1996-16 April, 1997, ambient concentrations of VOC correlated well with those of carbon monoxide, for which vehicle exhaust emissions

account for ca. 99% of total emissions in Porto Alegre. Two VOC photochemical reactivity rankings are presented: one involves reaction with OH (product of VOC concentration and VOC-OH reaction rate constant) and the other involves production of ozone (product of VOC concentration and VOC maximum incremental reactivity coefficient). Reaction with OH is dominated by CO followed by 2-methyl-2-butene and by several other alkenes. Ozone production is dominated by ethylene and CO (about equal contribution) followed by several alkenes, alkylbenzenes and aldehydes. The two fuel oxygenates, ethanol and MTBE, play only a minor role as photochemical precursors (reaction with OH and production of ozone) in the atmosphere of Porto Alegre. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Grosjean, E., Rasmussen, R. A. and Grosjean, D. (1999) 'Toxic air contaminants in Porto Alegre, Brazil', *Environmental Science & Technology,* 33, 1970-1978

Information on ambient levels of toxic air contaminants is a critical component of programs aimed at regulating air emissions to protect public health. Yet, this information is not available in many countries. Toxic air contaminants have been measured near a busy highway in downtown Porto Alegre, Brazil, from 3/20/96 to 4/16/97. Of the 42 compounds listed in U.S. EPA Method T0-14, 21 were not detected (concentrations < 0.1 ppb), 3 were detected in only a few samples (CHCl3, HClC=CCl2, and p-dichlorobenzene), and 3 were present at concentrations typical of background locations (CH3Cl, CH3CCl3, and CFC-113). Comparisons of urban/background location concentration ratios and of urban concentrations vs those of CO indicate no local emissions for CCl4, small and variable sources for CFC-11 and CFC-12, local sources other than vehicles for CH2Cl2 and Cl2C-CCl2, and vehicles as the major source of 1,3-butadiene, styrene, and aromatic hydrocarbons. Ambient concentrations of 1,3-butadiene and aromatic hydrocarbons were well correlated to those of benzene (R = 0.92-0.98) and those of CO (R = 0.88-0.97). These correlations are used to estimate mid-1995 vehicle emission rates, e.g., (197 +/- 50) x 10(3) kg/year for 1,3-butadiene. A comprehensive comparison is made of our results (halogenated compounds measured in Porto Alegre, halogenated compounds nor detected in Porto Alegre, and aromatic hydrocarbons with focus on the toluene/benzene, (m + p)-xylene/benzene, and (m + p)- xylene/toluene ratios) with literature data for background and urban locations. *Classification: 5.*

Harrison, R. M., Jones, M. and Collins, G. (1999a) 'Measurements of the physical properties of particles in the urban atmosphere', *Atmospheric Environment,* 33, 309-321

Measurements of the physical properties of particles in the atmosphere of a UK urban area have been made, including particle number count by condensation nucleus counters with different lower particle size cut-offs; particle size distributions using a Scanning Mobility Particle Sizer; total particle Fuchs surface area using an epiphaniometer and particle mass using Tapered Element Oscillating Micro-balance (TEOM) instruments with size selective (PM,, and PM2.5) inlets. Mean particle number counts at three sites range from 2.86 x 10(4) to 9.60 x 10(4) cm(-3). A traffic-influenced location showed a substantially higher ratio of particle number to PM10 mass than st nearby background location despite being some 70 m from the roadway. Operating two condensation nucleus counters in tandem to determine particles in the 3-7 nm size range by difference showed

signficant numbers of particles in this range, apparently related to homogeneous nucleation processes. Measurements with the Scanning Mobility Particle Sizer showed a clear difference between roadside size distributions and those at a nearby background location with an additional mode in the roadside samples below 10 nm diameter. Particle number counts were found to show a significant linear correlation with PM10 mass (r(2) = 0.44; n = 44 for 24 h data at an urban background location), although during one period of high pollution a curvilinear relationship was found. Measurements of the diurnal variation in PM10 mass, particle number count and Fuchs surface area show the same general pattern of behaviour of the three variables, explicable in terms of vehicle emission source strength and atmospheric dispersion, although the surface area growth was out of phase with the particle number and mass. It appears that particle number gives the dearest indication of recent road traffic emissions. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5*.

Harrison, R. M., Shi, J. P. and Jones, M. R. (1999b) 'Continuous measurements of aerosol physical properties in the urban atmosphere', *Atmospheric Environment,* **33, 1037-1047**

Simultaneous continuous measurements have been made at an urban background site of PM,, mass by Tapered Element Oscillating Microbalance, particle number density by condensation nucleus counter and Fuchs surface area using an epiphaniometer. Concurrent measurements of gaseous NO, and CO have been used to indicate road traffic emissions, and data from a nearby meteorological station have been used for relative humidity, temperature and windspeed. The data indicate that particle number density is a far better indicator of traffic activity than PM,, mass which is strongly influenced by a high background, and also tends to peak rather later than the gaseous pollutants and particle number, presumably as a result of advection of accumulation mode aerosol. PM,, mass and Fuchs surface area generally show a very similar temporal trend, although there is a tendency for the ratio of surface area to dry particle mass to increase with relative humidity. The sampling period included bonfire night celebrations which caused substantial increases in all particle parameters, although the ratio of particle mass to number was considerably higher than for the morning rush hour road traffic-influenced peak. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5*.

Hassan, A. A. and Crowther, J. M. (1998a) 'Modelling of fluid flow and pollutant dispersion in a street canyon', *Environmental Monitoring and Assessment,* **52, 281-297**

A two-dimensional steady state numerical simulation has been carried out for a typical street canyon ventilated by a cross- wind. The PHOENICS package from CHAM was used to solve for the air flow above and within the street canyon. The k-epsilon turbulence model was used for turbulence modelling and pollutant sources were added at ground level over the road but not over the pavements. Results for the air flow showed the formation of a longitudinal vortex within the street canyon, as found by other researchers. Pollutant concentrations were predicted with the highest values occurring at the leeward walls of the upwind buildings, and the lowest values on the windward walls of the downwind buildings. The accuracy of these simulations was examined by comparing the predicted results with field observations. Reasonable agreement was obtained, confirming

the difference between concentrations on the leeward and windward walls. The results show that the dispersion characteristics can be simulated in terms oi structural configurations. *Classification: 5,8.*

Hassan, A. A. and Crowther, J. M. (1998b) 'A simple model of pollutant concentrations in a street canyon', *Environmental Monitoring and Assessment,* **52, 269-280**

A single compartment model has been constructed for predicting hourly concentrations of pollutant concentrations arising from vehicular emissions within a typical street canyon. The model takes account of traffic densities and composition to estimate pollutant emissions within the model compartment. Meteorological data on wind speed and direction are used to define the exchanges of pollutants between the compartment and the surrounding air. A parameter is also included to describe the exchange in calm conditions. The pollutant concentrations are then estimated from a steady state mass balance equation for the compartment, assuming conservation of pollutants. The model was applied to the prediction of carbon monoxide concentrations in Hope Street, Glasgow. Model parameters were fitted using field measurements, together with concurrent meteorological data and traffic flows estimated from traffic census data for Hope Street. The model accounted well for the observed variations in carbon monoxide. It was found that the model parameters varied seasonally, perhaps due to differences in atmospheric stability which have not so far been included in the model formulation. *Classification: 5,8.*

Herbert, J. M., Johnson, G. T. and Arnfield, A. J. (1997) 'Coupling of a scalar dispersion and an urban canyon energy budget model', *Mathematics and Computers in Simulation,* **43, 277-283**

The development of SCAM, a three-dimensional numerical model for the prediction of airflow and scalar dispersion in urban canyons, has been described [3]. The first application of SCAM [4] was to study the dispersion of carbon monoxide emanating from car exhausts, but the long term aim has been to develop an urban canyon energy exchange model. In this quest, SCAM represents a facility which is capable of simulating the advection and turbulent diffusion of any scalar and hence can be applied to the convective transfer of heat, provided buoyancy is ignored. In order to achieve the long term aim, SCAM must be coupled with an energy budget model which simulates the heating and cooling of the urban fabric under the full range of atmospheric environments experienced during any 24 hour period at any given location. A building facet energy budget model for an idealised building group already exists [2]. This model is based on a radiation budget model [I] which has been used by the climatological research community. This paper reports on the work achieved thus far in linking the two models. The initial formulation is two-dimensional, for clear skies and for a dry system. The crucial linkage between the models occurs at surface boundaries and the heat fluxes at these points are checked with respect to physical plausibility. *Classification: 8,5.*

Herbert, J. M., Johnson, G. T. and Arnfield, A. J. (1998) 'Modelling the thermal climate in city canyons', *Environmental Modelling & Software,* **13, 267-277**

This paper presents an approach to the numerical modelling of the wind and thermal climates, as well as the energy budgets of city canyons. The model involves the coupling of three sub- models: (a) a surface energy budget model, (b) a windfield model, based on the k-epsilon turbulence model, and (c) a scalar dispersion model. In its current formulation, the model is two-dimensional, for clear sky conditions, for dry surfaces, and is most appropriate for conditions in which forced convection dominates over buoyancy effects. The model is capable of simulating the components of the wind; spatial patterns of canyon energy budget components; subsurface and air temperature; as controlled by location, date (i.e. solar path), weather conditions in the overlying air mass, canyon geometry and orientation, surface radiative and aerodynamic properties, substrate thermal properties, and, building interior climate. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 8*.

Hildebrandt, E. W. and Sarkovich, M. (1998) 'Assessing the cost-effectiveness of SMUD's shade tree program', *Atmospheric Environment*, 32, 85-94

This paper examines key issues involved in evaluating benefits (avoided cost of energy and capacity) of tree planting programs from the perspective of electric utilities, as well as from a wider perspective of public and private entities that may benefit from such programs. The nation's largest shade tree program, sponsored by the Sacramento Municipal Utility District (SMUD) in collaboration with the Sacramento Tree Foundation (STF), is used as a case study. Results of a recent analysis of the energy benefits of SMUD's Shade Tree Program are presented, along with program modifications being implemented to improve program cost-effectiveness. A sensitivity analysis of the relative importance of major uncertainties surrounding the benefits of the Shade Tree Program is presented, and priorities for future research are discussed. (C) 1997 Elsevier Science Ltd. *Classification: 7,8*.

Ichinose, T., Shimodozono, K. and Hanaki, K. (1999) 'Impact of anthropogenic heat on urban climate in Tokyo', *Atmospheric Environment*, 33, 3897-3909

This study quantifies the contribution through energy consumption, to the heat island phenomena and discussed how reductions in energy consumption could mitigate impacts on the urban thermal environment. Very detailed maps of anthropogenic heat in Tokyo were drawn with data from energy statistics and a very detailed digital geographic land use data set including the number of stories of building at each grid point. Animated computer graphics of the annual and diurnal variability in Tokyo's anthropogenic heat were also prepared with the same data sources. These outputs characterize scenarios of anthropogenic heat emission and can be applied to a numerical simulation model of the local climate. The anthropogenic heat flux in central Tokyo exceeded 400 W m(-2) in daytime, and the maximum value was 1590 W m-2 in winter. The hot water supply in offices and hotels contributed 51% of this 1590 W m-2. The anthropogenic heat flux from the household sector in the suburbs reached about 30 W m-2 at night. Numerical simulations of urban climate in Tokyo were performed by referring to these maps. A heat island appeared evident in winter because of weakness of the sea breeze from Tokyo Bay. At 8 p.m., several peaks of high-temperature appeared, around Otemachi, Shinjuku and Ikebukuro; the areas with the largest anthropogenic heat fluxes. In summer the shortwave radiation was strong and the influence of anthropogenic heat was relatively small. In

winter, on the other hand, the shortwave radiation was weak and the influence of anthropogenic heat was relatively large. The effects of reducing energy consumption, by 50% for hot water supply and 100% for space cooling, on near surface air temperature would be at most - 0.5 degrees C. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 3.*

Iino, A. and Hoyano, A. (1996) 'Development of a method to predict the heat island potential using remote sensing and GIS data', *Energy and Buildings,* **23, 199-205**

Most studies directed to urban climate simulation have been carried out under the assumption that an urban canopy layer is a sublayer comprised of various roughnesses, and as a consequence, difficulties have arisen in obtaining a suitable heat balance for such a layer. This paper, therefore, focuses on investigating the surface temperature distributions of all urban surfaces via a new index based on sensible heat flux, named the heat island potential (HIP), which can be employed in urban development planning to evaluate the urban thermal environment. Simulation results following the use of HIP are verified by side-looking airborne multi-spectral scanner (MSS) and geographic information system (GIS) data; thereby enabling elucidation of these thermal effects on the atmosphere. In addition, a heat balance algorithm is developed which simulates urban surfaces such that construction of urban thermal images is possible. *Classification: 3.*

Jacovides, C. P., Gianourakos, G. P., Asimakopoulos, D. N. and Steven, M. D. (1998) 'Measured spectra of solar ultraviolet irradiances at Athens basin, Greece', *Theoretical and Applied Climatology,* **59, 107-119**

From a data archive of spectral energy distribution of global and diffuse solar irradiances measured in Athens during a field experiment, the impacts of changes in solar zenith angle, site altitude, and gaseous-aerosol pollutants loading, on spectral composition of ultraviolet (UV) radiation reaching the ground, has been determined for cloudless conditions. Measurements of spectral energy distribution of ultraviolet irradiance showed that in urban atmospheres there is a significant altitude effect on spectral UV irradiances which is more pronounced on shorter wavelength UVB than on longer wavelength WA. In particular the largest attenuation in the WE band, produced by the altitude effect, between the non-urban site of Mt. Hymettus and the urban site of Athens Museum, was about 27%; while the corresponding attenuation in the WA band reached 20%. Correspondingly, the respective attenuation caused by altitude effect in the diffuse UVB band was 12%; whereas the altitude effect increases WA band to as much as 9% between the summit of Mt. Hymettus and the urban site of Athens Museum. Depletion of UV irradiances by the urban atmosphere of downtown Athens was strongly related to aerosol-gaseous pollutanes loading. The spectral UV measurements were found to be sensitive to both, changes in solar zenith angle and atmospheric turbidity. The spectral ratio of diffuse-to-direct irradiance critically depends on both solar zenith angle and aerosol-gaseous pollutants loading, increasing rapidly toward the shorter wavelengths. Finally, the hypothesis that the increased levels of aerosol-gaseous pollutants may act as a filter to the transfer of UV energy to the ground is supported, by the limited set of spectral measurements used in the present work. *Classification: 3,8.*

**Jacovides, C. P., Timbios, F., Asimakopouolos, D. N. and Steven, M. D. (1997)
'Urban aerosol and clear skies spectra for global and diffuse
photosynthetically active radiation',** *Agricultural and Forest Meteorology,* **87,
91-104**

From a data archive of spectral energy distribution of global and diffuse solar irradiances measured in Athens during a field experiment, the influence of atmospheric turbidity caused by urban aerosol on spectral composition of visible radiation and transparency of urban atmosphere has been determined for cloudless conditions. The effect of urban aerosol is significant in the PAR part of solar spectrum, where attenuation of global PAR irradiance surpasses 18% on very polluted atmospheric conditions. The increase in diffuse PAR irradiance caused by urban aerosol ranges in the interval 7%- 51%. The ratio of global PAR to total global irradiance was found to depend slightly on air pollution whereas ratio's dependencies on site elevation were not identified clearly. Nevertheless, this ratio was found to be in good agreement with those reported in the literature. The ratio of diffuse-to- global PAR irradiance was found to depend on both, air mass and turbidity. For very turbid atmosphere and large air masses the 40% of PAR irradiance results from diffuse radiation. Finally, some biological implications of the results are briefly discussed. (C) 1997 Elsevier Science B.V. *Classification: 5,8.*

Jauregui, E. (1997) 'Heat island development in Mexico City', *Atmospheric
Environment,* **31, 3821-3831**

The present paper describes the climatology of the near surface urban heat island of Mexico City, using hourly data from two recently installed automatic stations at a rural and an urban site. The results show that the nocturnal heat island was more frequent (75% of the time for the period examined) than daytime cases (25%). The maximum nocturnal heat island intensity, 7.8 degrees C was observed in a dry month (February) characterized by calm clear nights. Although less frequent, the daytime heat islands did occur and may have been caused by differences in evaporative cooling from wet surface during the wet season. Midday heat islands had a frequency of 13% and an intensity of 3-5 degrees C during the wet season. The afternoon/evening heat islands had an intensity of 4-5 degrees C. They occurred during both dry and wet season with a frequency of 12% of the time in a year. The average urban/rural thermal contrasts are positive throughout the year varying from 5 degrees C at day break in the middle of the dry season to 1-3 degrees C around noon during the wet months. (C) 1997 Elsevier Science Ltd. *Classification: 1,3,4.*

**Jauregui, E., Cervantes, J. and Tejeda, A. (1997) 'Bioclimatic conditions in Mexico
City - An assessment',** *International Journal of Biometeorology,* **40, 166-177**

Bioclimatic conditions have been assessed for a large urban area located in the tropical highlands of central Mexico using the indices (in degrees C) of resultant temperature (RT) and effective temperature (ET). The well-developed heat island effect the city generates, reduces the number of nights categorized as cold (ET between 5 and 15 degrees C) to cool (ET from 15 to 18.5 degrees C). Most days fall in the cold to cool range and during the warm season (April to June) the bioclimate of Mexico City is mostly within the neutral (comfort) range. The effect of the nocturnal (to the west) and daytime (to the east of the

town) heat island is noticeable in the central and northern sectors. The daytime heat island located in these regions, albeit small (urban air temperature 2-3 degrees C greater than rural), compared with the nocturnal hear island intensity (9-10 degrees C) still adds energy to the already heated afternoon urban air: ET values in the north and central sectors approach the threshold for comfort (ET of 25 degrees C) during the warm months; around noon. It is not surprising to find that as the nocturnal heat island has increased over the years (1921-1985) as the city grew, so has the ET for the central district and indicating the dominating role of temperature in the ET index. Assessment of the diurnal cycle of bioclimatic conditions in downtown Mexico City by means of two empirical indices (effective temperature and thermopreferendum) throughout the years gave similar results to those obtained from the application of Fanger's predicted mean vote (PMV) model. An attempt has been made to characterize four bioclimatic zones in the capital city. *Classification: 7.*

Jauregui, E. and Luyando, E. (1998) 'Long-term association between pan evaporation and the urban heat island in Mexico City', *Atmosfera,* **11, 45-60**

Using a network of 16 urban/suburban and rural pan evaporation (pe) stations in Mexico City and its environs, an attempt is made to assess the comparative evaporative characteristics of different areas in a large city located in an elevated inland valley in the tropics. Significant parallel increases in pan evaporation and heat island intensity have been observed in the central and western portions of Mexico City for the period 1967-88. It is suggested that pan evaporation increase is linked to the observed increase in the intensity of the heat island related to the accelerated urbanization of the capital City. In contrast over the eastern suburbs the establishment of a large (9500 Ha) adjacent revegetation project has apparently influenced pan evaporation to decline in spite of the increasing presence of the heat island. Association of pan evaporation to other climatic elements such as insolation, precipitation and wind velocity is also explored. *Classification: 3,6,8.*

Jauregui, E. and Romales, E. (1996) 'Urban effects on convective precipitation in Mexico city', *Atmospheric Environment,* **30, 3383-3389**

This paper reports on urban-related convective precipitation anomalies in a tropical city. Wet season (May-October) rainfall for an urban site (Tacubaya) shows a significant trend for the period 1941-1985 suggesting an urban effect that has been increasing as the city grew. On the other hand, rainfall at a suburban (upwind) station apparently unaffected by urbanization, has remained unchanged. Analysis of historical records of hourly precipitation for an urban station shows that the Frequency of intense (> 20 mm h(-1)) rain showers has increased in recent decades. Using a network of automatic rainfall stations, areal distribution of 24 h isoyets show a series of maxima within the urban perimeter which may be associated to the heat island phenomenon. Isochrones of the beginning of rain are used to estimate direction and speed of movement of the rain cloud cells. The daytime heat island seems to be associated with the intensification of rain showers. Copyright (C) 1996 Elsevier Science Ltd. *Classification: 8,1.*

Jenkins, B. M., Jones, A. D., Turn, S. Q. and Williams, R. B. (1996) 'Particle concentrations, gas-particle partitioning, and species intercorrelations for polycyclic aromatic hydrocarbons (PAH) emitted during biomass burning', *Atmospheric Environment,* **30, 3825-3835**

Eight types of agricultural and forest fuels including 4 cereal crop residues and 4 wood fuels were burned in a combustion wind tunnel to simulate the open burning of biomass. Concentrations for 19 PAH species in particulate matter were found to range between 120 and 4000 mg kg(-1), representing between 1 and 70% of total PAH emission. Weakly flaming spreading fires in the cereals were observed to produce higher levels of heavier PAH than more robust fires, with greater partitioning of PAH to the particle phase. Individual species concentrations appeared well correlated within groups based primarily on molecular weight, but no single species was observed to correlate with all others to serve as an indicator of PAH emission strength. Equilibrium gas-particle partitioning did not appear to be achieved within the 3-5 s residence time prior to sampling for sampling temperatures between 32 and 87 degrees C, and in particular for the heavier species emitted from wood fuel pile fires with higher stack gas temperatures and shorter residence times. Total PAH emission, particle-phase concentrations, and fraction of PAH on particles were more strongly influenced by burning conditions than by fuel type. Copyright (C) 1996 Elsevier Science Ltd. *Classification: 0.*

Johnson, G. T. and Hunter, L. J. (1998) 'Urban wind flows: wind tunnel and numerical simulations - a preliminary comparison', *Environmental Modelling & Software,* **13, 279-286**

Previous studies have indicated that wind flow models based on the k - epsilon formulation are able to simulate the broad features of flows as observed in field programs and wind tunnel studies. k - epsilon models are increasingly being used to investigate the dispersion of pollutants and the transfer of heat within and out of urban canyons. In these situations realistic modelling requires greater fidelity on the part of the wind flow specification in that some confidence needs to be placed on the actual magnitude of the wind speeds and turbulent viscosities used in the dispersive components of the models. To this end a preliminary comparison of wind tunnel and numerical modelling was undertaken. It has demonstrated general agreement between the two types of modelling but has also indicated some differences. These are in the variation of concentration with height at the windward wall and in the concentration gradients away from the canyon boundaries. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 8.*

Johnson, G. T. and Hunter, L. J. (1999) 'Some insights into typical urban canyon airflows', *Atmospheric Environment,* **33, 3991-3999**

Previous studies have suggested that the key characteristics of wind flows within an urban canyon can be determined from the relative geometry of the canyon; in particular from the height to width ratio of the canyon, and, to a lesser extent, from the length to height ratio. Further, it is often assumed that the flow at mid-canyon is essentially two-dimensional and little influenced by along-canyon flow. Analysis of data collected from a field program indicates that within canyon flow is more complex than this and that the channelling effect of the canyon must be included in any description of the flow. It is also

shown that the relative geometry of the canyon is insufficient on its own to determine the fundamental nature of the flow. In the field program, based on a relatively long canyon, vortex- based "skimming flow" was observed. On the basis of previous wind tunnel and numerical studies, such a flow regime is not expected for this relatively low canyon, Further analysis of the wind data confirms previous work of Nakamura and Oke (1988, Atmospheric Environment 22, 2691-2700) concerning the relationship between above-roof wind direction and canyon-floor wind direction. An explanation of this relationship in terms of the channelling effect of the canyon is provided. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 8*.

Johnson, R., Macina, O. T., Graham, C., Rosenkranz, H. S., Cass, G. R. and Karol, M. H. (1997) 'Prioritizing testing of organic compounds detected as gas phase air pollutants: Structure-activity study for human contact allergens', *Environmental Health Perspectives,* **105, 986-992**

Organic compounds that are used or generated anthropogenically in large quantities in cities can be identified through their presence in the urban atmosphere and in air pollutant source emissions. Compounds identified by this method were screened to evaluate their potential to act as contact allergens. The CASE and MULTICASE computer programs, which are based on the detection of structure-activity relationships (SAR), were used to evaluate this potential. These relationships first are determined by comparing chemical structures to biological activity within a learning set comprised of 458 compounds, each of which had been tested experimentally in human trials for its sensitization potential. Using the information contained in this learning set, CASE and MULTICASE predicted the activity of 238 compounds found in the atmosphere for their ability to act as contact allergens. The analysis finds that 21 of 238 compounds are predicted to be active contact allergens (probability >0.5), with potencies ranging from mild to very strong. The compounds come from chemical classes that include chlorinated aromatics and chlorinated hydrocarbons, N- containing compounds, phenols, alkenes, and an S- containing compound. Using the measured airborne concentrations or emission rates of these compounds as an indication of the extent of their use, together with their predicted potencies, provides an efficient method to prioritize the experimental assessment of contact sensitization of untested organic compounds that can be detected as air pollutants. *Classification: 7,5*.

Kalberer, M., Ammann, M., Arens, F., Gaggeler, H. W. and Baltensperger, U. (1999) 'Heterogeneous formation of nitrous acid (HONO) on soot aerosol particles', *Journal of Geophysical Research-Atmospheres,* **104, 13825-13832**

The reaction of nitrogen dioxide (NO2) to nitrous acid (HONO) on suspended soot aerosol particles was investigated using NO2 labeled with N-13 (a radioactive isotope with a half-life of 10.0 min) at low concentrations of 2-115 ppb. HONO is thought to be an important compound in the troposphere since it is accumulating during the night and photolyzed in the morning after sunrise, producing OH, the most important oxidant in the troposphere. On soot, NO2 was rapidly reduced to MONO, presumably by a reactive surface site on the soot particle surface. No HNO3 was formed as a reaction product, indicating that a disproportionation of NO2 to HONO and HNO3 with surface- adsorbed water is not the dominant process on soot. The reaction rate is drastically reduced after the

first few seconds because of consumption of the reactive surface sites giving a maximum of similar to 1 x 10(15) HONO molecules cm(-2) particle surface area. For a reaction time of 20 s the amount of HONO increased with increasing relative humidity up to 30%, showing that H2O is necessary for the reaction. Above 40% relative humidity the HONO production decreased again because of competition of H2O adsorbing on the particle surface. In aging experiments, O-3 oxidized the same particle surface sites as NO2, but simultaneous mixing of O-3, NO2 and the aerosol showed that the O-3 oxidation is slower than the fast reaction of NO2 to MONO. It is concluded that the NO2 to HONO reaction on soot rapidly saturates and is not the main source of HONO in the polluted boundary layer. *Classification: 0.*

Kambezidis, H. D., DjepaPetrova, V. and Adamopoulos, A. D. (1997) 'Radiative transfer .1. Atmospheric transmission monitoring with modeling and ground-based multispectral measurements', *Applied Optics,* **36, 6976-6982**

Existing solar radiative codes such as LOWTRAN allow us to model the radiative properties of the atmosphere and its constituents for standard atmospheric conditions. The increase in urbanization and air pollution has led to changes in the distribution, type, and concentration of the atmospheric constituents, affecting spectral atmospheric transmission and modifying weather and climate. This requires knowledge of the real optical properties of atmospheric transmission. We have developed a model For the radiative properties of atmospheric transmission, with ground-based multispectral measurements of direct solar radiation in the 310-830-nm range. An application of this model to Athens' urban atmosphere is described. The radiative properties of a U.S. Standard Atmosphere are also simulated by use of the LOWTRAN7 code; simulations and calculations are compared. The total ozone retrieval scheme and the algorithm for retrieving the spectral transmission function and optical thickness, considering multiple scattering, are given. Results for the spectral atmospheric transmission and aerosol and gas transmission functions as well as optical- thickness measurements for the Athens area are also presented as an application of the proposed methodology. (C) 1997 Optical Society of America. *Classification: 8.*

Karakas, D. and Tuncel, S. G. (1997) 'Optimization and field application of a filter pack system for the simultaneous sampling of atmospheric HNO3, NH3 and SO2', *Atmospheric Environment,* **31, 1657-1666**

Optimization and field application of a filter pack system for the simultaneous collection of atmospheric gas-phase HNO3, NH3 and SO2 have been studied. A Teflon prefilter was used to remove particulate matter. Nylon filter, oxalic-acid-treated Whatman 41 filter and sodium-carbonate-treated Whatman 41 filter were used for the collection of HNO3, NH3 and SO2, respectively. For the collection of gas-phase HNO3, nylon filters had better efficiency and capacity as compared to NaCl- impregnated Whatman 41 filters for long sampling periods of more than 30 h. All treated filters and nylon filters worked with the collection efficiencies of greater than 95%. About 2% of the gas-phase ammonia has been retained by the nylon filters during simultaneous collection experiments done in the laboratory but the retained ammonia on the nylon tilter sometimes reached to about 25% of the gaseous total ammonia collected on the oxalic-acid-impregnated filter in the field experiments. Other than ammonia no significant retention or volatilization from the filter

pack system was observed during the simultaneous experiments carried out in an urban atmosphere. (C) 1997 Elsevier Science Ltd. *Classification: 0.*

Kastner-Klein, P., Plate, E. and Fedorovich, E. (1997) 'Gaseous pollulant dispersion around urban-canopy elements: wind tunnel case studies', *International Journal of Environment and Pollution,* **8, 727-737**

There is an evident lack of reliable and detailed in situ measurement data for verifying numerical predictions of atmospheric dispersion in the urban environment on sub-meso scales. Wind-tunnel studies of dispersion around typical elements of the urban canopy (isolated buildings, groups of buildings, street canyons) could provide valuable substitutes for field datasets. They can achieve a high resolution of the measured concentration fields, and may be used for evaluation of numerical models and for expert estimates of air quality in the urban environment. This paper presents results of several case studies of gaseous pollutant dispersion in a neutrally stratified wind-tunnel flow. The following cases have been investigated: (1) Point source: (a) isolated rectangular building, and (b) isolated U-shaped building; (2) Line source in a street canyon: effects of the upwind building configuration and the roof shape; (3) Line source in a city quarter (four blocks separated by two perpendicular canyons with rectangular cross-sections). For the case of a line source in a street canyon, the wind-tunnel results are compared with numerical model calculations. *Classification: 8,5.*

Kastner-Klein, P. and Plate, E. J. (1999) 'Wind-tunnel study of concentration fields in street canyons', *Atmospheric Environment,* **33, 3973-3979**

The paper presents results from a case study of gaseous pollutant dispersion in street canyons. Tracer-gas experiments were performed in a neutrally stratified wind tunnel. Vehicle emissions were simulated as line sources. Concentration profiles along building walls were measured. A two-dimensional street canyon was considered as the reference case. The influence of systematic parameter variations on the concentration field is studied and discussed. Building dimensions, upwind building configuration, wind direction and roof geometry were found to be important parameters. Data sets from the study may be used for evaluation of numerical models and for expert estimates of air quality in the urban environment (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5,8.*

Kavouras, I. G., Stratigakis, N. and Stephanou, E. G. (1998) 'Iso- and anteiso-alkanes: Specific tracers of environmental tobacco smoke in indoor and outdoor particle-size distributed urban aerosols', *Environmental Science & Technology,* **32, 1369-1377**

Branched iso- and anteiso-alkanes were conjointly used, with n- alkanes and PAHs, as specific molecular markers to trace environmental tobacco smoke (ETS) in particle-sized aerosols collected in the indoor and outdoor urban atmosphere. GC/MS and GC-FID were used for the determination of iso-, anteiso-, and n-alkanes and PAHs. The branched alkanes (ranging from C-29 to C-33) were detected only in particles in the accumulation range mode (<1.5 mu m) in both indoor and outdoor samples. The concentrations of iso-

and anteiso-alkanes in the indoor aerosols (0.75-8.53 ng/m(3)) were higher than those measured in outdoor samples (0.77-1.51 ng/m(3)). The indoor aerosol pattern of iso-, anteiso-, and their calculated diagnostic concentration ratios were characteristic for ETS. The compound distribution pattern of indoor n-alkanes (ranging from C-21 to C-33) was of biogenic origin, and the use of odd-to-even predominance running ratio curves indicated their cigarette smoke origin. The corresponding outdoor pattern and concentration ratios, although less characteristic than the indoor ones, also indicated ETS as the main source of these compounds. The distribution study of the branched alkanes between gas and particulate phase in indoor aerosol demonstrated their presence only in the particles. On the other hand, PAHs in the gas phase gave a compound pattern more characteristic of ETS components than the PAHs present in the particulate phase. Iso- and anteiso-alkanes, due to their specificity, their nonreactive character, their association with the accumulation range mode particles, and therefore, their long atmospheric residence time, are the most suitable tracers for particulate ETS emissions in the indoor and outdoor urban atmosphere. *Classification: 5,7.*

Kawamura, K. and Sakaguchi, F. (1999) 'Molecular distributions of water soluble dicarboxylic acids in marine aerosols over the Pacific Ocean including tropics', *Journal of Geophysical Research-Atmospheres,* **104, 3501-3509**

Remote marine aerosols collected over the western North to equatorial Pacific (34 degrees N-14 degrees S, 140 degrees E- 150 degrees W) were studied far low molecular weight dicarboxylic acids using a capillary gas chromatography (CC) and GC/mass spectrometer, and for total carbon and nitrogen contents. Homologous series of dicarboxylic acids (C2-C10) including keto- and hydroxy-dicarboxylic acids were detected in the samples with a concentration range of 10-250 ng m(-3) (average 63 ng m(-3) and median 44 ng m(-3)). Their molecular distributions showed a predominance of oxalic acid (C2), followed by malonic acid (C3) The smallest diacid (C2, 6.5-161 ng m(-3) with average 40 ng m(-3) and median 17 ng m(- 3))composed 45-75% (average 65%) of the total diacids. The diacids showed higher concentrations in the western Pacific rim near Japanese islands and showed lower concentrations in the central and tropical Pacific. However, relative abundances of the diacid-carbon in the total aerosol carbon (1.1-15.8%) were found to be higher in the equatorial central Pacific. These diacids are probably in situ produced in the Pacific atmosphere by photochemical oxidation of gaseous and particulate precursors. Results of principal component analysis of individual diacid, coupled with an information on photochemical reactions, further support that C2 and C3 diacids are likely produced by the oxidation of C4 and longer-chain diacids, whereas longer-chain (C5-C10) diacids are produced through the oxidation of semivolatile fatty acids which are also oxidation products of unsaturated fatty acids. Concentrations of total C (0.069-5.27 mu g m(-3) with average 0.39 mu g m(-3) and median 0.15 mu g m(-3)) and total N (0.026-1.44 mu g m(-3) with average 0.12 mu g m(-3) and median 0.077 mu g m(-3)) were generally higher over the western Pacific. *Classification: 0.*

Kawamura, K., Semere, R., Imai, Y., Fujii, Y. and Hayashi, M. (1996) 'Water soluble dicarboxylic acids and related compounds in Antarctic aerosols', *Journal of Geophysical Research-Atmospheres,* **101, 18721-18728**

Antarctic aerosols collected at Syowa Station were studied for water soluble organic compounds by employing a water extraction and dibutyl ester derivatization and using a capillary gas chromatography (GC) and GC/mass spectrometry (GC/MS). Total carbon and nitrogen were also determined. A homologous series of alpha,omega-dicarboxylic acids (C-2-C-11), omega- oxocarboxylic acids (C-2-C-9), and alpha-dicarbonyls (C-2-C-3) were detected, as well as pyruvic acid and aromatic (phthalic) diacid. Succinic (C-4) or oxalic (C-2) acid was found to be the dominant diacid species, followed by azelaic (C-9), adipic (C- 6), or malonic (C-3) acid, Concentration range of the total diacids was 5.9-88 ng m(-3), with an average of 29 ng m(-3). Highest concentrations were observed in the summer sample with a predominance of succinic acid (61.5 ng m(-3)), which comprised approximately 70% of the total diacids and accounted for 3.5% of total aerosol carbon (1020 ng m(-3)). The succinic acid (C-4) is likely produced by photooxidation of 4-oxocarboxylic acids, which are present in the atmosphere as intermediates of the photooxidation of unsaturated fatty acids. These results indicate that the Antarctic organic aerosols originate from marine-derived lipids and are transformed largely by photochemical oxidations. omega-Oxocarboxylic acids (C-2-C-9, 0.36-3.0 ng m(-3)) also showed the highest concentration in the summer sample, again suggesting a secondary production in the atmosphere of the Antarctic and in the Southern Ocean. *Classification: 0.*

Kawamura, K., Yokoyama, K., Fujii, Y. and Watanabe, O. (1999) 'Implication of azelaic acid in a Greenland ice core for oceanic and atmospheric changes in high latitudes', *Geophysical Research Letters,* **26, 871-874**

Greenland ice core (450 years) has been studied for low molecular weight dicarboxylic acids (C-2-C-10) using a capillary gas chromatography and mass spectrometer. Their molecular distribution generally showed a predominance of succinic acid (C-4) followed by oxalic (C-2), malonic (C-3), glutaric (C-5), adipic (C-6), and azelaic (C-9) acids. Azelaic acid, that is a specific photochemical reaction product of biogenic unsaturated fatty acids, gave a characteristic historical trend in the ice core; i.e., the concentrations are relatively low during late 16th to 19th century (Little Ice Age) but become very high in late 19th to 20th century (warmer periods) with a large peak in 1940s AD. Lower concentrations of azelaic acid may have been caused by a depressed emission of unsaturated fatty acids from seawater microlayers due to enhanced sea ice coverage during Little Ice Age. Inversely, increased concentrations of azelaic acid in late 19th to 20th century are likely interpreted by an enhanced sea-to-air emission of the precursor unsaturated fatty acids due to a retreat of sea ice and/or by the enhanced production due to a potentially increased oxidizing capability of the atmosphere. *Classification: 0.*

Kelly, N. A. and Chang, T. Y. (1999) 'An experimental investigation of incremental reactivities of volatile organic compounds', *Atmospheric Environment,* **33, 2101-2110**

California has adopted a set of VOC reactivity factors fbr regulatory purposes that is based on a model of the ozone formation process. These incremental reactivity factors (derived by Carter) describe the amount of ozone each exhaust VOC will form under a certain set of conditions in an urban atmosphere. The main objective of this study is to measure reactivity factors using smog chamber experiments, and to compare the

measurements to the Carter factors. A new facility was constructed explicitly for this study. The facility has four identical smog chambers and a temperature-controlled enclosure for the chambers. The chambers are irradiated using a set of filtered xenon are lamps to approximate "sunlight". The reactivities of 14 individual VOCs representative of those found in automobile exhaust and several mixtures of VOCs have been measured. The measured and Carter-reactivity factors were highly correlated, suggesting that the chemical model used by Carter accounts for the reactivities of a wide range of compounds with dramatically different uncertainties in their mechanisms. The measured results, in general, are consistent with the Carter-reactivity factors for comparing the relative reactivities of VOCs in the atmosphere. However, additional kinetic and mechanistic studies of many VOC species including aromatic isomers are needed to improve reactivity scales. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 0.*

Kerminen, V. M., Teinila, K., Hillamo, R. and Makela, T. (1999) 'Size-segregated chemistry of particulate dicarboxylic acids in the Arctic atmosphere', *Atmospheric Environment,* **33, 2089-2100**

Gas-particle interactions of low-molecular-weight dicarboxylic acids were studied at a coastal Arctic site during the summer. Size segregated measurements with a Berner low-pressure impactor displayed up to four modes for ionic compounds: an Aitken mode, an accumulation mode, and two supermicron modes. The lower supermicron mode was ascribed to sea-salt, whereas the upper mode consisted mostly of species associated with continental particles. All four modes could be identified for oxalic acid, with the lower supermicron mode being the dominant. Malonic acid displayed a supermicron mode but was not found in the submicron size range. Succinic acid had an accumulation mode and, in a few samples, a supermicron mode. Glutaric acid displayed sometimes and accumulation mode, sometimes a supermicron mode, and occasionally both. The most probable formation pathway for submicron oxalic and glutaric acid was condensation from the gas phase, even though production in cloud droplets cannot be ruled out either. A slightly different formation pathway may have been important for submicron succinic acid production. Supermicron oxalic acid was probably formed by condensation from the gas-phase, by heterogeneous reactions occurring on the surface of pre- existing sea-salt and continental particles, or in cloud droplets. A larger mass median diameter for supermicron malonic and glutaric acid might be indicative of liquid-phase production in aqueous sea-salt particles. Evidence on possibly substantial sampling artifacts related to measuring dicarboxylic acids using filters were also obtained. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 0.*

Kim, J. J. and Baik, J. J. (1999) 'A numerical study of thermal effects on flow and pollutant dispersion in urban street canyons', *Journal of Applied Meteorology,* **38, 1249-1261**

This study investigates thermal effects on the flow and pollutant dispersion in urban street canyons. A two-dimensional numerical model with a k-epsilon turbulent closure scheme is developed, and the heat transfer between the air and the building wall or street-canyon bottom is effectively represented by a wall function. For each of seven cases with different aspect ratios (building height/width between buildings = 0.5, 1, 1.5, 2, 2.5, 3, and 3.5), four thermal situations (no heating, upwind building-wall heating, street- canyon

bottom heating, and downwind building-wall heating) are considered. In the cases of upwind building-wall heating, one vortex appears regardless of aspect ratio. When the aspect ratio is greater than or equal to 1.5, the upward motion forced by upwind building-wall heating overcomes the downward motion that appears in the cases of no heating. In the cases of street-canyon bottom heating, when the aspect ratio is less than 3, flow patterns are similar to those in the cases of upwind building-wall healing. This similarity is because the maximum temperature axis is shifted toward the upwind side by the horizontal motion. However, when the aspect ratio is 3 or 3.5, the horizontal velocity is not strong enough ro shift the maximum temperature axis toward the upwind side. When the maximum temperature axis is located near the center of the street canyon, two counterrotating vortices appear side by side in the lower layer due to the thermal upward motion around the axis, while the vortex in the upper layer is little influenced by bottom hearing. With downwind building-wall heating, two counterrotating vortices appear except in the 0.5 aspect ratio case. To a large extent, the vortex in the upper layer is mechanically induced by the ambient wind, while the vortex in the lower layer is thermally induced by downwind building-wall heating. The dispersion of pollutants released at the street level is shown to be quite dependent upon aspect ratio and hear source location. The vortex number and intensity greatly influence the residue concentration ratio (ratio of the total pollutant amount remaining in the street canyon to the total amount of pollutants emitted) by controlling the travel pathway and escape time of pollutants. *Classification: 3,5,8.*

Klemm, O. and Ziomas, I. C. (1998) 'Urban emissions measured with aircraft', *Journal of the Air & Waste Management Association,* **48, 16-25**

Detailed knowledge of the quantity and composition of urban emissions is a prerequisite for successful application of atmospheric models to predict transport and distribution of primary and secondary air pollutants in the troposphere. We investigate the prospects and limitations of aircraft measurements in the determination of emission fluxes from urban areas: Our analysis focuses on data collected in September 1994 in and around Athens, Greece. Generally, emission fluxes from cities can be quantified with aircraft and with the minimum acceptable precision (uncertainty better than a factor of 2) only under very favorable meteorological conditions, namely in a homogeneous flow field in a well-mixed boundary layer. Better accuracy can be achieved only through ensemble averaging of repeated measurements. From our measurements in the Athens area, we deduced relative emission ratios of pollutant; gases. With the support of ground-based measurements in a street canyon, the emission ratios NO_x/CO, SO_2/CO, and volatile organic compounds/CO (34 individual VOCs) could be determined with high precision. These results are very useful in analyzing differences between various existing emission inventories. Our data for VOCs reveal that the non-traffic emissions are of the same magnitude as the emissions originating from traffic. *Classification: 8,5.*

Klysik, K. (1996) 'Spatial and seasonal distribution of anthropogenic heat emissions in Lodz, Poland', *Atmospheric Environment,* **30, 3397-3404**

An inventory of heat fluxes from different types of neighbourhood has been made for the 214 km(2) of Lodz. Mean annual heat flux over the 80 km(2) urbanised area is 28.5 W m(- 2), ranging from 12 W m(-2) in July to 54 W m(-2) in January. New areas of blocks

of flats (about 30 km(2)) have a mean annual flux of 35 W m(-2) (73 W m(-2) in winter, and 14 W m(-2) in summer). Values of anthropogenic heat flux calculated in the central districts of the city, where there are industrial factories and residential dwellings, have a mean annual Aux of 40 W m(-2) (71 W m(-2) in January and 18 W m(-2) in July). The large anthropogenic heat emissions are important contributors to the city's climate in winter. Copyright (C) 1996 Elsevier Science Ltd. *Classification: 3*.

Klysik, K. and Fortuniak, K. (1999) 'Temporal and spatial characteristics of the urban heat island of Lodz, Poland', *Atmospheric Environment,* **33, 3885-3895**

The investigations which have been conducted out for many years permit the statement that in the climate of Poland the occurrence of the UHI is the most important feature of urbanized areas; Over 80% of nights are characterized by surplus heat in towns, amounting to 2-4 degrees C, and sporadically to 8 degrees C and more. A distinct annual course of the UHI intensity is observed; the greatest differences occur during summer nights when skies are clear. In winter, favorable conditions for the existence of the UHI occur less frequently, and the intensity of the UHI is smaller. In the daytime the city is very often colder than its surroundings. Two types of spatial structure of the heat island have been observed: multi-cellular type, occurring on windless conditions (0-1 m/s), and a more simple general type with the 2-4 m/s wind. The distribution of temperature on the night of February 2/3 and 5/6 1996 is presented; the UHI reached an extremely high intensity then (up to 12 degrees C). (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 1,3*.

Komazaki, Y., Hiratsuka, M., Narita, Y., Tanaka, S. and Fujita, T. (1999) 'The development of an automated continuous measurement system for the monitoring of HCHO and CH3CHO in the atmosphere by using an annular diffusion scrubber coupled to HPLC', *Fresenius Journal of Analytical Chemistry,* **363, 686-695**

An automated continuous measurement system for the monitoring of formaldehyde (HCHO) and acetaldehyde (CH3CHO) in the urban atmosphere was developed by using an annular diffusion scrubber in conjunction with a high-performance liquid chromatograph (HPLC). With this technique, atmospheric HCHO and CH3CHO were effectively collected by the annular diffusion scrubber which consists of a porous polytetrafluoroethylene (PTFE) tube disposed concentrically within a Pyrex-glass tube and a scrubbing solution. 2,4-Dinitrophenylhydrazine (DNPH) was selected as the scrubbing solution for collecting HCHO and CH3CHO, which are derivatized to 2,4-dinitrophenylhydrazone- formaldehyde (DNPH-HCHO) and 2,4-dinitrophenylhydrazone-acetaldehyde (DNPH-CH3CHO), respectively. An aliquot of the sample solution was automatically injected into an HPLC equipped with a semi-micro ODS column and a UV-VIS detector for separating and determining DNPH-HCHO and DNPH-CH3CHO. All the operations are sequenced by a programmable controller, and automated continuous measurements are performed with a typical temporal resolution of 1 h. The collection efficiencies of HCHO and CH3CHO were about 97% and 93%, respectively, at an air flow rate of 0.2 L/min. The lower detection limits (3 sigma of the blank hydrazones) of HCHO and CH3CHO were 0.05 ppbv and 0.10 ppbv, respectively, in the case of 12-L air sample volume. Analytical response of a standard solution of DNPH-HCHO and DNPH-

CH3CHO by the HPLC during a 10-day continuous measurement was unchanged and the relative standard deviation (RSD) was < 1.0%. Interferences from O-3 and NO2 were insignificant in this annular diffusion scrubber method. Both for HCHO and CH3CHO measurements, concentrations from this developed system well agreed with those measured by a DNPH Silica cartridge method. *Classification: 0.*

Krivacsy, Z. and Molnar, A. (1998) 'Size distribution of ions in atmospheric aerosols', *Atmospheric Research,* **46, 279-291**

The aim of this paper is to present data about the concentration and size distribution of ions in atmospheric aerosol under slightly polluted urban conditions in Hungary. Concentration of inorganic cations (ammonium, sodium, potassium, calcium, magnesium), inorganic anions (sulfate, nitrate, chloride, carbonate) and organic acids (oxalic, malonic, succinic, formic and acetic acid) for 8 particle size range between 0.0625 and 16 mu m were determined. As was the case for ammonium, sulfate and nitrate, the organic acids were mostly found in the fine particle size range. Potassium and chloride were rather uniformly distributed between fine and coarse particles. Sodium, calcium, magnesium and carbonate were practically observed in the coarse mode. The results obtained for the summer and the winter half-year were also compared. The mass concentrations were recalculated in equivalents, and the ion balance was found to be reasonable in most cases. Measurement of the pH of the aerosol extracts indicates that the aerosol is acidic in the fine mode, but alkaline in the coarse particle size range. (C) 1998 Elsevier Science B.V. *Classification: 0.*

Kuttler, W. (1999) 'International Conference on Urban Climatology (ICUC '96) Essen, Germany', *Atmospheric Environment,* **33, 3877-3877**

Classification: 9.

Lazar, R. and Podesser, A. (1999) 'An urban climate analysis of Graz and its significance for urban planning in the tributary valleys east of Graz (Austria)', *Atmospheric Environment,* **33, 4195-4209**

In Graz, the capital of the Austrian province of Styria, located southeast of the main ridge of the Alps, an extensive urban climate analysis was successfully completed in 1995. In the following paper the most important features of the Graz city climate like the different local wind systems, the heat islands as well as the fog and inversion conditions shall be described and illustrated with the help of maps and diagrams. Furthermore, the description of the spreading conditions of air pollutants in selected inversion weather situations will shall play an important role. The results of the study, above all the map of city climatopes are based on the latter a map of planning tips serve as an important basis for urban planning and have already been used for the setting up of a land-use and development plan. Finally the paper will focus its interest on the exceptional quality of the tributary valleys east of Graz, where as a consequence of their highly significance for fresh air supply, a zoning into areas of restricted and banned construction has been carried out. This inclusion of climatological results in urban planning is unique within Austria

and is now also being practised in other cities of the province of Styria. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 1,2.*

Lefevre, R. A., Gregoire, M., Derbez, M. and Ausset, P. (1998) 'Origin of sulphated grey crusts on glass in polluted urban atmosphere: stained glass windows of Tours Cathedral (France)', *Glastechnische Berichte-Glass Science and Technology,* **71, 75-80**

The grey crusts covering some places of the weathered stained glass windows of Tours Cathedral were studied by Analytical Scanning Electron Microscopy. These crusts are constituted by a gypsum cement embedding many particles: microspherules (fly ash generated by combustion processes, rounded particles of leached glass, hypersiliceous spherules from tuffeau stone); angular fragments of leached glass; organic objects; siliceous and sulphated aggregates. The particles contained in the sulphated black crusts covering the stone, in the air and in the rain in Tours were studied simultaneously and compared with those of the stained glass windows' grey crusts. Zn all cases, similar kinds of fly ash are present demonstrating the action of atmospheric microparticulate pollution both on the stained glass windows and on the stone. Furthermore, the presence of hypersiliceous particles in crusts on glass and in the rain suggests transfers from stone to glass by rainwater run-off and possibly directly from the atmosphere. The presence of leached glass in the sulphated crusts on glass leads also to conclude on the modifying of the glass surface by the action of the rainwater run-off. Moreover, calcium and sulphur needed to form superficial gypsum crusts come both from the nearby calcareous stone, from the atmospheric gases and particles, and probably partially from calcium contained in unweathered glass. *Classification: 5.*

Loranger, S. and Zayed, J. (1997) 'Environmental contamination and human exposure to airborne total and respirable manganese in montreal', *Journal of the Air & Waste Management Association,* **47, 983-989**

Methylcyclopentadienyl manganese tricarbonyl (MMT) is an organometallic compound used as an octane improver in unleaded gasoline. The combustion of MMT leads to the formation of manganese (Mn) oxides, mainly Mn_3O_4. The objective of this study is to assess the variations over time and space of respirable (Mn-R) and total (Mn-T) Mn in the urban atmosphere and to evaluate human exposure by inhalation. Two sampling sites were selected on the island of Montreal based on their local traffic density (municipal botanical garden, C- = 10,000- 15,000 vehicles d(-1); Montreal Waterworks, C+ = 100,000- 130,000 vehicles d(-1)). Air samplings were made during the day at stations located 10 m from the road using portable pumps, some of which were equipped with a cyclone. Mn-R and Mn-T and other metals were measured on Teflon filters by neutron activation. Mn exposure doses by inhalation were calculated using Monte-Carlo simulations. Mn-R and Mn-T average concentrations were significantly higher at site C+ (Mn-R = 0.024 mu g m(-3); Mn-T = 0.050 mu g m(-3)) than at site C- (Mn- R = 0.015 mu g m(-3); Mn-T = 0.027 mu g m(-3)). Temporal profiles at sites C+ and site C- were similar, with a coefficient of correlation of 0.24 for Mn-R and 0.26 for Mn-T. Trend analyses (ARIMA) also showed that the period of the week (work days vs. off days) was significantly related to Mn-R and Mn-T variations at both sites. The average exposure dose by inhalation to Mn-R and Mn-T ranged from 0.001 to 0.030 mu g kg(-1) day(-1)

and 0.001 to 0.05 mu g kg(-1) day(-1). Mn-R and Mn-T concentrations reflected a positive relationship with traffic density. However, it remains difficult to attribute these results directly to the combustion of MMT in unleaded gasoline. On average, the Mn-R and Mn-T inhalation doses were 2 to 15 times lower than the reference dose (RfC) proposed by the U.S. Environmental Protection Agency (EPA) for the general population. *Classification: 7.*

Louka, P., Belcher, S. E. and Harrison, R. G. (1998) 'Modified street canyon flow', *Journal of Wind Engineering and Industrial Aerodynamics,* **74-6, 485-493**

The objective of the present work, is to investigate the turbulent airflow in street canyons and in particular, its coupling to the turbulent airflow above roofs. Understanding this coupling is crucial to understanding of how pollution is ventilated out of the street into the layer aloft. A held experiment between two long farm buildings forming a street was performed. Preliminary results are shown here. The distribution of the exit velocity, i.e. vertical velocity at roof-level, across the street showed that the how within the street is greatly affected by the pitched roofs. A channelling flow regime is evident when the wind is parallel to the street axis. The velocity spectra measured at a height 2.26 times the buildings' height approach the inertial sub-range behaviour; a - 2/3 slope at high frequencies is observed and the ratio of the vertical to horizontal spectra is close to the usual 4/3 value. This means that the airflow is not affected by the individual buildings at this level. In addition, the turbulence velocity spectra show that within the street the energy is partitioned in a greater range of eddies than over rural terrain. Above the roofs the spectral peak shifts towards higher frequencies as the roof-level is approached suggesting the confinement of eddies dose to the roofs. Taken together these results suggest to us that roof geometry influences the eddy size distribution. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 8.*

Lowry, W. P. (1998) 'Urban effects on precipitation amount', *Progress in Physical Geography,* **22, 477-520**

Major reviews of urban effects on local climate, extending from Kratzer in 1937 through to Landsberg in 1981, have dealt primarily with radiation, temperature, wind, and air quality. To a much lesser extent they have examined moisture-related elements including humidity, cloud, precipitation, and storminess. Selecting air temperature to represent the former group and precipitation amount to represent the latter, the author asserts that, because of the intrinsic physical differences between them, there are necessarily important differences in the methods to be used for their proper observation, analysis, presentation, and interpretation pertaining to urban effects. The principal differences are based in the fact that temperature is continuous in both time and space, whereas precipitation is continuous in neither. The author maintains that because of these differences, urban climatologists have had much greater success in specifying and explaining urban effects on temperature than on precipitation amount. Further, he makes the case that, lack of recognition that methods used for the study of urban effects on temperature are too often inappropriate for study of urban effects on precipitation amount, has led to a state of affairs where there remains basic uncertainty about the specification of urban effects on precipitation amount, and even greater uncertainty about their explanation. In making that case, the author includes 1) an historical perspective, 2) a critical evaluation of methods,

3) an overview of the status of urban precipitation climatology, and 4) recommendations concerning future research. *Classification: 4,6.*

MarsiliLibelli, S. (1996) 'Simplified kinetics of tropospheric ozone', *Ecological Modelling,* **84, 233-244**

Though air quality modelling has reached a stage of extreme complexity, this simple model is intended to demonstrate how the basic mechanism of tropospheric ozone can be explained with a very simple dynamics, if the model is adjusted to the field situation with the aid of an efficient parameter calibration algorithm. The scope of this paper is to propose a simple kinetic model to describe the interactions of NO, NO2 and O-3 in a polluted urban atmosphere where the presence of free radicals disrupts the basic Leighton cycle, which otherwise provides a stable cycle among these three species. The key feature of the model is the inclusion of the free radical concentrations, which are extremely difficult to measure, in the reaction kinetics. The model thus obtained is very simple and easy to calibrate. After describing its structure, it is tested with data taken from a smog chamber and a real urban environment, in which the kinetics of the pollutants are known to prevail over air mass movements. In both cases, a satisfactory agreement between data and model response is obtained, with consistent parameter values. *Classification: 0.*

Matzarakis, A., Mayer, H. and Iziomon, M. G. (1999) 'Applications of a universal thermal index: physiological equivalent temperature', *International Journal of Biometeorology,* **43, 76-84**

The physiological equivalent temperature, PET, is a thermal index derived from the human energy balance. It is well suited to the evaluation of the thermal component of different climates. As well as having a detailed physiological basis, PET is preferable to other thermal indexes like the predicted mean vote because of its unit (degrees C), which makes results more comprehensible to urban or regional planners, for example, who are not so familiar with modern human-biometeorological terminology. PET results can be presented graphically or as bioclimatic maps. Graphs mostly display the temporal behaviour of PET, whereas spatial distribution is specified in bioclimatic maps. In this article, some applications of PET are discussed. They relate to the evaluation of the urban heat island in cities in both temperate climates and warm climates at high altitude. The thermal component of the microclimate in the trunk space of a deciduous forest is also evaluated by PET. As an example of the spatial distribution of PET, a bioclimatic map for Greece in July (Mediterranean climate) is presented. *Classification: 7.*

Mayer, H. (1999) 'Air pollution in cities', *Atmospheric Environment,* **33, 4029-4037**

Air quality in cities is the result of a complex interaction between natural and anthropogenic environmental conditions. Air pollution in cities is a serious environmental problem - especially in the developing countries. The air pollution path of the urban atmosphere consists of emission and transmission of air pollutants resulting in the ambient air pollution. Each part of the path is influenced by different factors. Emissions from motor traffic are a very important source group throughout the world. During transmission, air pollutants are dispersed, diluted and subjected to photochemical

reactions. Ambient air pollution shows temporal and spatial variability. As an example of the temporal variability of urban air pollutants caused by motor traffic, typical average annual, weekly and diurnal cycles of NO, NO2, O-3, and O-x, are presented for an official urban air-quality station in Stuttgart, southern Germany. They are supplemented by weekly and diurnal cycles of selected percentile values of NO, NO2, and O-3,. Time series of these air pollutants give information on their trends. Results are discussed with regard to air pollution conditions in other cities. Possibilities for the assessment of air pollution in cities are shown. In addition, a qualitative overview of the air quality of the world's megacities is given. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Menut, L., Flamant, C., Pelon, J. and Flamant, P. H. (1999) 'Urban boundary-layer height determination from lidar measurements over the Paris area', *Applied Optics,* **38, 945-954**

The Paris area is strongly urbanized and is exposed to atmospheric pollution events. To understand the chemical and physical processes that are taking place in this area it is necessary to describe correctly the atmospheric boundary-layer (ABL) dynamics and the ABL height evolution. During the winter of 1994-1995, within the framework of the Etude de la Couche Limite Atmospherique en Agglomeration Parisienne (ECLAP) experiment, the vertical structure of the ABL over Paris and its immediate suburbs was extensively documented by means of Lidar measurements. We present methods suited for precise determination of the ABL structure's temporal evolution in a dynamic environment as complex as the Paris area. The purpose is to identify a method that can be used on a large set of lidar data. We compare commonly used methods that permit ABL height retrievals from backscatter lidar signals under different meteorological conditions. Incorrect tracking of the ABL depth's diurnal cycle caused by limitations in the methods is analyzed. The study uses four days of the ECLAP experiment characterized by different meteorological and synoptic conditions. (C) 1999 Optical Society of America. *Classification: 8.*

Meroney, R. N., Pavageau, M., Rafailidis, S. and Schatzmann, M. (1996) 'Study of line source characteristics for 2-D physical modelling of pollutant dispersion in street canyons', *Journal of Wind Engineering and Industrial Aerodynamics,* **62, 37-56**

The University of Hamburg initiated a wind tunnel study of car exhaust dispersion from street canyons in an urban environment to investigate how pollution dispersion is affected by street geometry. Particular emphasis at the beginning of this work was put on the design of a line source to represent traffic exhaust. Pollution dispersion was studied in two dimensions (i.e., infinite-length streets were assumed). The case of an isolated street canyon in open country was examined first, The same street canyon geometry was subsequently studied in an urban environment, i.e., with additional canyons of similar geometry upstream and downstream of the test street. The dynamic and dispersion characteristics of the flow in the two cases were quite different. In the canyon amidst open country we observed better canyon ventilation than in the urban roughness case. *Classification: 8,5.*

Micallef, A. and Colls, J. J. (1998) 'Variation in airborne particulate matter concentration over the first three metres from ground in a street canyon: Implications for human exposure', *Atmospheric Environment,* **32, 3795-3799**

This note presents vertical concentration profiles of various size fractions of suspended particulate matter, measured over the first three metres from ground in a street canyon, using a novel sampling system. The daily average percentage difference of airborne particulate matter concentration between receptor heights 0.81 and 2.88 m, with the lower height taken as reference, was more than 35% for PM10 and more than 12% for the inhalable fraction, for 5 out of the 7 days of measurement. These preliminary measurements, carried out during June-August 1997, consisting of 37 h of data, corroborate the idea put forward by Cells and Micallef (Atmospheric Environment 31, 4253-4254), that different height groups of the population are exposed to different concentrations. Air-quality standards, based on human exposure estimates, should take this variation into account. These measurements also have implications for the siting of urban air quality monitoring systems. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5,7.*

Micallef, A. and Colls, J. J. (1999) 'Measuring and modelling the airborne particulate matter mass concentration field in the street environment: model overview and evaluation', *Science of the Total Environment,* **235, 199-210**

This paper discusses the outline structure and preliminary evaluation of an emission-dispersion model for predicting the temporal and spatial distribution of vehicle-derived airborne particulate matter mass concentration in street canyons. The model is called Street Level Air Quality (SLAQ). SLAQ is semi- empirical, in that it uses not only results from field and wind tunnel experiments but also theory and models derived from multiple runs of numerical routines in order to simulate the basic physical processes within the street canyon. A combination of a plume model, for the direct contribution of vehicle exhaust, and a box model for the recirculating part of the pollutants in the street, is used to predict concentration for receptors within the canyon. Emission rates of vehicle- derived particulate. matter are calculated within SLAQ, which serve as input to the dispersion module. Exhaust emission rates are scaled element by element along the street for each of the lanes according to the direction of traffic flow to account for modal operation of vehicles near signalised intersections. This refinement allows SLAQ to account for non-uniformity in along- canyon emission rates and to model a street that has several intersections along its length. Thermal turbulence due to environmental surface sensible heat and vehicle-generated heat is accounted for in the model. Other features of SLAQ include correction for the urban heat island effect, dry deposition, wet deposition, particle settling and estimation of wind direction standard deviation, when this latter data is not available. SLAQ has been evaluated in a street in Loughborough, Leicestershire, United Kingdom and a correlation coefficient of 0.8 between the modelled and measured concentrations has been obtained. (C) 1999 Elsevier Science B.V. All rights reserved. *Classification: 5,8.*

Micallef, A., Deuchar, C. N. and Colls, J. J. (1998) 'Indoor and outdoor measurements of vertical concentration profiles of airborne particulate matter', *Science of the Total Environment,* **215, 209-216**

Vertical concentration profiles of various particle size ranges of airborne particulate matter were measured from ground level up to 3 m, in outdoor and indoor environments. Indoor measurements were carried out in an electronics workshop, while two outdoor environments were chosen: a street canyon cutting across a town and an open field situated in a semi-rural environment. The novel measurement technique employed in this experimental work, which can also be used to determine vertical concentration gradients of pollutants other than airborne particles in different environments, is given particular attention. Analyses of the collected data for the environments considered are presented and some conclusions and plausible explanations of the profiles are discussed. The workshop and street canyon environments exhibited larger concentrations and vertical concentration gradients as compared to the sports field. This indicates that people breathing at different heights are subjected to different concentrations of airborne particulate matter, which has implications for siting air pollution monitors intended for protection of public health and estimation of human exposure. (C) 1998 Elsevier Science B.V. *Classification: 5.*

Mills, G. (1997) 'An urban canopy-layer climate model', *Theoretical and Applied Climatology,* **57, 229-244**

This paper outlines a computer simulation model designed to assess the thermal characteristics of the urban canopy layer (UCL). In contrast to other UCL models, the layer simulated here includes both closed volumes (buildings) and open volumes (canyons). The purpose of the model is to allow the comparison of the climate impacts of different building group configurations. Traditional boundary-layer theory is applied to the surface urban boundary layer (UBL) which lies above the UCL and the derived relations are used to parameterize exchanges of momentum and heat across the UBL/UCL interface. The exterior energy budgets of the roof, walls and floor of the canopy are solved using an equilibrium surface temperature method. The open canopy and interior building air temperatures are found which are in agreement with the surface exchanges. Using measured data for Los Angeles in June, the output of the model is examined. The results show some agreement with measurement studies and suggest that the density of structures can have a substantial impact on UCL/UBL interaction. *Classification: 1,8.*

Minoura, H. (1999) 'Some characteristics of surface ozone concentration observed in an urban atmosphere', *Atmospheric Research,* **51, 153-169**

Some characteristics of surface ozone concentration were obtained from continuous observation, with time resolution of 1 s. These are compared with the concentrations of NO and NO2 and meteorological conditions which were observed simultaneously. The observed concentrations of O-3 and NO showed a hyperbolic relationship approximately described as [O-3] X [NO] = 21.6 ppb(2). This is consistent with a proposal that the photochemical reaction in the O-3-NOx system was dominant in controlling the O-3 concentration near the surface layer. An inverse linear relationship of [O-3] + [NO2] = 30 ppb is also recognized, and the background O-3 concentration in the Nagakute area is

estimated to be about 30 ppb from this relation. The yearly average background O-3 concentration calculated from the equation for transportation by wind approximates the value obtained above. The positive dependency of O-3 production on solar radiation and the negative relationships of NO2 concentration due to the NO2 photolysis process were recognized and both the dependencies on the solar radiation became very close during the winter season. The summer maximum cannot be explained by seasonal variations in the background O-3 concentration the sensitivity to solar radiation intensity, and the photochemical reaction only in the O-3-NOx system. (C) 1999 Elsevier Science B.V. All rights reserved. *Classification: 5*.

Mochida, A., Murakami, S., Ojima, T., Kim, S. J., Ooka, R. and Sugiyama, H. (1997) 'CFD analysis of mesoscale climate in the Greater Tokyo area', *Journal of Wind Engineering and Industrial Aerodynamics,* **67-8, 459-477**

The results of CFD analyses of mesoscale climate in the Tokyo area are presented. Here, the model for geophysical flow problems developed by Mellor and Yamada is used for turbulence closure. In the First half of the paper, the accuracy of CFD analyses is examined by comparing their results with the measured data. The topography and present land-use situation in Japan are incorporated into the predictions by using the numerical data-base provided by the National Land Agency of Japan. For comparison, a computation which does not consider the effects of the distribution of land-use conditions at the present is also carried out. In the latter part, urban climates during the 1930s and the 1990s are analysed by the CFD method developed here. By comparing the results of these analyses, the effects of urbanization on heat island circulations over the Tokyo area are investigated. *Classification: 8,1*.

Morawska, L., Thomas, S., Bofinger, N., Wainwright, D. and Neale, D. (1998) 'Comprehensive characterization of aerosols in a subtropical urban atmosphere: Particle size distribution and correlation with gaseous pollutants', *Atmospheric Environment,* **32, 2467-2478**

This paper presents results of two years of monitoring and research on urban particulates with a focus on submicrometer particles, conducted as a part of an ongoing program on comprehensive characterization of fine airborne particulates and their effect on environmental and human exposures. A large number of data has been collected by the Air Monitoring and Research Station operating in the centre of the subtropical city of Brisbane. The Station is equipped in instrumentation for measurements of particle size distributions in submicrometer and supermicrometer ranges in addition to the standard instrumentation for monitoring of the criteria pollutants (PM10, ozone, sulphur dioxide, nitrogen oxides and carbon monoxide). The focus of this paper is on presenting results related to characterization of particle size distribution and concentration trends in the study period,correlation between particle characteristics measured by different instruments, correlation between particle and gaseous data and preliminary conclusions on source characteristics and source contribution for the investigated area.The average submicrometer particulate concentration in the study period was 7.4 x 10(3) particles cm(-3), and the average number median diameter was 40 nm. The best correlated data are those ibr submicrometer particles and carbon monoxide and nitrogen oxides, suggesting the same source type. The lack of correlation between submicrometer and

supermicrometer particle concentration data implies different sources for particles in these two ranges. Particle spectral analysis and correlation with gaseous data, indicate that motor vehicle emissions constitute the main source of ultrafine particles in the study area. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5*.

Morawska, L., Thomas, S., Jamriska, M. and Johnson, G. (1999) 'The modality of particle size distributions of environmental aerosols', *Atmospheric Environment,* **33, 4401-4411**

Knowledge of the distribution of airborne particulate matter into size fractions has become an increasing area of focus when examining the effects of air pollution. While total number and mass concentrations may play an important role in exposure and risk assessment analyses, often an understanding of the particle size distributions provides more information on the type of atmospheric processes resulting in the distributions. The modality of the particle size distribution is one such aspect that has been associated with the aerosol formation mechanisms. The aim of this work is to provide a detailed analysis of the modal characteristics of a large number of particle size spectra collected over a period of three years for a range of ambient aerosol types. Measurements of over 6000 size distributions in the size range 0.016-30 mu m were made using a scanning mobility particle sizer and an aerodynamic particle sizer for various ambient aerosols including: traffic influenced, urban, vegetation burning influenced, marine, modified background and suburban. Advanced data analytical procedures were adopted to combine the distributions from the two instruments for the calculation of the volume size distributions to allow clear interpretation of the modal characteristics. It was determined that, while in most cases there is a distinct nuclei mode in the number size distribution, this does not translate to a nuclei mode in the volume size distribution. Furthermore, while many of the number size distributions were different for each aerosol studied, the volume distributions were similar. This finding has serious implications for the setting of mass-based air quality standards. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5*.

Namdeo, A. K., Colls, J. J. and Baker, C. J. (1999) 'Dispersion and re-suspension of fine and coarse particulates in an urban street canyon', *Science of the Total Environment,* **235, 3-13**

Dispersion of fine and coarse particulates in the near-field of vehicles has not received as much attention as gaseous pollutants emitted from motor vehicles. Recent studies have pointed to evidence that fine particles in the air could be significant contributors to respiratory and cardiovascular diseases and mortality. This has increased our need to know more about the way particulates disperse in the near-field, especially in street canyons, where pollutants tend to build up to high levels. Movement of vehicles is known to re-suspend particulates deposited on road surfaces resulting in increased pollution levels. This paper presents the results of a study on dispersion of particulate pollution from motor vehicles in urban areas. Levels of airborne fine and coarse particulate matter were measured using two aerosol spectrometers in an urban street canyon in Nottingham, UK. Detailed information on traffic flow and vehicle classification was collected using video recording and sample surveys. The monitoring survey was conducted for one 24-h period in January 1998. There was no direct correlation between fine particulates and traffic volume for 15-min averages. However, there was good correlation between coarse

particulates and traffic volume. This prompted a study on the micro-level, at very short time scale, of the effect of vehicle movements on dispersion of particulate pollution in the near-field. Autocorrelation analysis proved that, although there was strong periodicity in traffic flow data, there was none in the levels of coarse and fine particles, suggesting that these levels do not follow the traffic flow pattern. This was confirmed by cross-correlation analysis, which showed no systematic relationship between particulates and traffic volume at different lags. (C) 1999 Elsevier Science B.V. All rights reserved. *Classification: 5,8.*

Narukawa, M., Kawamura, K., Takeuchi, N. and Nakajima, T. (1999) 'Distribution of dicarboxylic acids and carbon isotopic compositions in aerosols from 1997 Indonesian forest fires', *Geophysical Research Letters,* **26, 3101-3104**

Fine aerosol particles collected in Southeast Asia during 1997 Indonesian forest fires were studied for the concentrations of total carbon (TC), water-soluble organic carbon (WSOC) and low molecular weight dicarboxylic acids (C-2-C-12) as well as carbon isotopic ratios of TC (delta(13)C(TC)). TC and WSOC showed a large increase during the heavy forest fire event. At the same period, dicarboxylic acids, dominated by oxalic (C-2) followed by succinic (C-4) and malonic (C-3) acids, also showed a concentration increase. Furthermore, the delta(13)C(TC) showed a decrease from ca. -25.5 to -27.5 parts per thousand during an intensified forest fire event, suggesting an addition of organic aerosols derived from C3 plants whose delta(13)C are lighter. These results indicate that the aerosol particles in Southeast Asia were significantly affected by the combustion processes of vegetations during the 1997 Indonesian forest fires that were extensively induced by El Nina event. *Classification: 0.*

Nerin, C., Martinez, M., Pons, B. and Zufiaurre, R. (1996) 'Gas-chromatographic determination of chlorobenzenes and HCHs in an urban atmosphere', *Fresenius Journal of Analytical Chemistry,* **354, 61-65**

The atmospheric impact of an old factory situated in an urban area has been studied, Two coupled cartridges of Tenax and polyurethane foam (PUF) have been used for trapping hexachlorocyclohexane and chlorobenzene isomers from air. The atmosphere in an urban area of high population density has been monitored, The results are shown, Some considerations about atmospheric conditions and concentrations in the air are included, too. *Classification: 5.*

Nichol, J. E. (1998) 'Visualisation of urban surface temperatures derived from satellite images', *International Journal of Remote Sensing,* **19, 1639-1649**

A model for interpolating 2D thermal satellite data over a 3D urban surface is described, which combines the ViSC and GIS functions inherent in a modern GIS interface. Vertical surfaces are represented as spatial entities whose temperature attributes are determined from image data supplemented by field sampling in urban canyons. Thus a model representing the temperature of the complete urban surface is created, for which the viewpoint can be varied according to Sun angle and azimuth at the time of imaging and the viewing angle required by the user. Due to the close correspondence between surface

and air temperature the model indicates micro-scale climatic variations due to variations in building geometry and surface materials which are not readily apparent from st two-dimensional perspective. It also illustrates the magnitude of systematic error introduced by the nadir viewing angle of satellite sensors. *Classification: 1,3.*

Nicoletti, M. (1998) 'Architectural expression and low energy design', *Renewable Energy,* **15, 32-41**

The passive approach to the themes of energy savings is essentially based on the morphologic articulations of the constructions. The experience of Studio Nicoletti in low energy building is exemplified by five groups of designs based on different typologies. Cool air stored in the heart of buildings. Tall buildings: energy savings based on minimization of the structural materials and bioclimatic systems. Double skin for cooling the external envelope of the buildings. Urban climate: climatization of large urban fragments, protected either by a glass envelope or a bioclimatic pergola. Integration of various methods including extensive use of natural lighting like in the design for the New Acropolis Museum in Athens. (C) 1998 Published by Elsevier Science Ltd. All rights reserved. *Classification: 2.*

Noto, K. (1996) 'Dependence of heat island phenomena on stable stratification and heat quantity in a calm environment', *Atmospheric Environment,* **30, 475-485**

Dependence of heat island atmosphere on stable stratification and the heat quantity is elucidated by (i) visualizing and measuring the thermal flow over a heated source in a calm and stratified conditions in a laboratory experiment, (ii) finding new type of Bow patterns, (iii) determining flow states by the PSD gradients, (iv) comparing with the existing results, and (v) discussing physically to extend the laboratory experiment to a real urban atmosphere. The heat quantity transferred from urban areas makes flow patterns tall. The stable stratification suppresses the plume height, increases the swaying amplitude and turbulence, and produces a vortex pair near the plume top. With increasing the heat quantity and/or decreasing the stable stratification, the plume changes from the type of the steady fumigation with local circulations accumulating heat, which agrees well with Oke's model, to the types of fumigation with the swaying motion, the mushroom, the maximum amplitude of the swaying motion, having a glasses-like vortex pair, and shedding vortices upwards, wherein the last two types of plumes the urban heat easily dissipates upwards. The results agree well with heat island phenomena which occur during night in winter and gigantic columns of clouds which occur during daytime in summer. *Classification: 8,3.*

Offenberg, J. H. and Baker, J. E. (1997) 'Polychlorinated biphenyls in Chicago precipitation: Enhanced wet deposition to near-shore Lake Michigan', *Environmental Science & Technology,* **31, 1534-1538**

To determine if elevated levels of atmospheric contaminants in urban areas enhance atmospheric deposition to adjacent surface waters, precipitation was sampled at three stations along a transect from Chicago, IL, across southern Lake Michigan. Rainwater was collected during several storms in July 1994 and January 1995 in southern Chicago aboard the R/V Lake Guardian positioned 15 km east of downtown Chicago and at a rural

site along the southeastern shore of the lake as part of the study Atmospheric Exchange Over Cakes and Oceans (AEOLOS). Total PCB concentrations in Chicago precipitation ranged from 4.1 ng/L (January 19, 1995) to 189 ng/L (July 21, 1994) and were 2-3 orders of magnitude higher than the measured regional background concentrations. Concentrations of PCBs in urban precipitation were dominated by particle-bound congeners, implying PCB enrichment in rainwater due to efficient scavenging of highly contaminated particulate matter from the urban atmosphere. PCB levels in precipitation falling over southern Lake Michigan were from two to as much as 400 times greater than the measured regional background concentration, indicating that the "urban plume" of Chicago increases atmospheric deposition of contaminants to Lake Michigan over spatial scales of tens of kilometers. Enriched urban precipitation extending out over Lake Michigan provides 50-400% greater PCB wet deposition loadings than background precipitation. *Classification: 6,5*.

Offenberg, J. H. and Baker, J. E. (1999a) 'Aerosol size distributions of polycyclic aromatic hydrocarbons in urban and over water atmospheres', *Environmental Science & Technology,* 33, 3324-3331

Aerosol mass size distributions of 41 polycyclic aromatic hydrocarbons (PAHs)were measured during 20 different 12-h periods in urban Chicago and over Lake Michigan during July 1994 and January 1995. Geometric mean aerodynamic equivalent diameters (GMDs) range from 0.72 to 2.39 mu m for particulate matter and from 0.33 to 9.85 pm for individual PAHs. GMDs of the less volatile PAHs are larger in the urban atmosphere than over the water during the summer. Geometric standard deviations of the particle size distributions, however, are larger at the urban location for many PAHs, indicating a broader mass size distributions. GMDs of unsubstituted PAHs (except perylone) are well correlated with their log subcooled liquid vapor pressures (p(l)(o) Pa), following the form: $GMD = m(g) \log p + b(g)$. Values for m(g) and b(g) range from 0.03 to 0.88 and from 0.83 to 8.80, respectively. Higher molecular weight PAHs are sorbed to the finest sized aerosols, but more volatile PAHs are associated with larger particles. The slope (m(g)) and intercept (b(g)) of these regressions are interdependent in these field data and follow the model: $b(g) = m(h)m(g) + b(h)$, where $m(h) = 9.55$, $b(h) = 0.61$, and $r(2) = 0.98$, suggesting that all GMD vs log p regressions for a class of semivolatile compounds tend to intersect at the same point (-m(h), b(h)). This may allow the size distributions of the entire class of PAHs to be estimated by measuring the distribution of one PAH that is sufficiently removed from this intersection point. PAH size distributions change downwind of urban emission sources due to selective deposition of larger aerosols during atmospheric transport. *Classification: 5*.

Offenberg, J. H. and Baker, J. E. (1999b) 'Influence of Baltimore's urban atmosphere on organic contaminants over the northern Chesapeake Bay', *Journal of the Air & Waste Management Association,* 49, 959-965

Air and precipitation samples were collected along an urban to over-water to rural transect across the northern Chesapeake Bay as a preliminary investigation into the spatial extent of elevated atmospheric concentrations of urban-derived persistent organic pollutants. Air samples were collected daily from June 3-9, 1996, along the transect as part of the Atmospheric Exchange over Lakes and Oceans project. Total (gas + particle bound)

atmospheric polycyclic aromatic hydrocarbon concentrations [C-PAK] ranged from 0.4 to 114 ng/m(3), and gas phase polychlorinated biphenyl concentrations [Sigma-PCB] ranged from 0.02 to 3.4 ng/m(3). Strong concentration gradients were found for both PAHs and PCBs, with the highest concentrations in the city and the lowest at the downwind rural site. Gas and particle bound PAHs varied independently in the city possibly due to strong but geographically separated emission sources. A precipitation event collected during westerly winds contained fourfold higher Sigma-PAH and twelvefold higher Sigma-PCB concentrations at the over-water site than at the rural background location, further indicating that the urban plume extends from Baltimore, MD, over the northern Chesapeake Bay over a spatial scale of approximately 30 km. *Classification: 5.*

Okamoto, S., Lin, F. C., Yamada, H. and Shiozawa, K. (1996) 'Evaluation of a two-dimensional numerical model for air quality simulation in a street canyon', *Atmospheric Environment,* **30, 3909-3915**

For many urban areas, the most severe air pollution caused by automobile emissions appears along a road surrounded by tall buildings: the so-called street canyon. A practical two- dimensional numerical model has been developed to be applied to this kind of road structure. This model contains two submodels: a wind-field model and a diffusion model based on a Monte Carlo particle scheme. In order to evaluate the predictive performance of this model, an air quality simulation was carried out at three trunk roads in the Tokyo metropolitan area: Nishi-Shimbashi, Aoyama and Kanda-Nishikicho (using SF6 as a tracer and NOx measurement). Since this model has two- dimensional properties and cannot be used for the parallel wind condition, the perpendicular wind condition was selected for the simulation. The correlation coefficients for the SF6 and NOx data in Aoyama were 0.67 and 0.62, respectively. When predictive performance of this model is compared with other models, this model is comparable to the SRI model, and superior to the APPS three-dimensional numerical model. Copyright (C) 1996 Elsevier Science Ltd. *Classification: 8,5.*

Oke, T. R., Spronken-Smith, R. A., Jauregui, E. and Grimmond, C. S. B. (1999) 'The energy balance of central Mexico City during the dry season', *Atmospheric Environment,* **33, 3919-3930**

The first measurements of the energy balance fluxes of a dry, densely built-up, central city site are presented. Direct observation of the net radiation, sensible and latent heat flux densities above roof-top in the old city district of Mexico City allow the heat storage flux density to be found by residual. The most important finding is that during daytime, when evaporation is very small (< 4% of net radiation), and therefore sensible heat uses dominate (Bowen ratio > 8), the uptake of heat by the buildings and substrate is so large (58%) that convective heating of the atmosphere is reduced to a smaller role than expected (38%), The nocturnal release of heat from storage is equal to or larger than the net radiation and sufficient to maintain an upward convective heat flux throughout most nights. It is important to see if this pattern is repeated at other central city, or dry urban sites, or whether it is only found in districts dominated by massive stone structures. These findings have implications for the height of the urban mixing layer and the magnitude of the urban heat island. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 3.*

Osborne, P. J., Preston, M. R. and Chen, H. Y. (1997) 'Azaarenes in sediments, suspended particles and aerosol associated with the River Mersey estuary', *Marine Chemistry,* **58, 73-83**

The distributions of a variety of azaarenes in suspended particulate material and sediments in the River Mersey estuary and two tributary canals are described. Azaarene concentrations in the local urban atmosphere are also provided. Total azaarene concentrations (the sum of the concentrations of 48 individual azaarenes) range from 2-364 ng . g(-1) for estuarine suspended material and 128-2451 ng . g(-1) for canal sediments. Atmospheric aerosol concentrations fell within the range 1 to > 9 ng . m(-3). Whilst sediments and suspended matter showed concentrations similar to those previously reported, the atmospheric concentrations were considerably higher and it is hypothesised that deposition of aerosols is a major source of azaarenes to this estuarine system. Down estuary removal of the lower molecular weight azaarene species from the particulate fraction is reported and attributed to selective solubilisation of these molecules. Seasonal variations in both the total and relative azaarene concentrations occur with the greatest abundance of all species in the colder months when post- depositional alteration is least and inputs from combustion sources are greatest. A clear seasonal variation in atmospheric aerosol azaarenes is reported and this appears to be reflected in the sedimentary record. (C) 1997 Elsevier Science B.V. *Classification: 6,5.*

Panero, C., dePablo, F., Sanchez, J. M. and Tomas, C. (1997) 'Statistical modelling and prediction of pollutants in the urban atmosphere of Salamanca, Spain', *International Journal of Biometeorology,* **40, 223-233**

The primary aim of the present work is to describe and analyze the temporal trends of concurrent hourly observations and its daily averaged series of the pollutants CO, NO2, NO and SO2 in the urban area of the City of Salamanca (environmental survey station SA001) for the period between 1 December 1993 and 30 November 1994. Using daily series corresponding to different meteorological variables recorded at the same site for the same period (wind direction, relative humidity, pressure, radiation, temperature and wind speed), linear regression techniques are used to study the relationships of these variables with each of the pollutants on both an individual and multivariate basis. The results obtained explain 40% of the variance of the series for NO2 and 66% in the case of SO2. Finally, in the modelling phase it was observed that the series of pollutants themselves have sufficient "information" to enable, by means of autoregressive and integrated moving average techniques (A.R.I.M.A.), the determination of future pollution. Once predicted, these were contrasted with the measured or observed values to check the goodness of the model. *Classification: 5.*

Pankow, J. F., Thomson, N. R., Johnson, R. L., Baehr, A. L. and Zogorski, J. S. (1997) 'The urban atmosphere as a non-point source for the transport of MTBE and other volatile organic compounds (VOCs) to shallow groundwater', *Environmental Science & Technology,* **31, 2821-2828**

Infiltration and dispersion (including molecular diffusion) can transport volatile organic compounds (VOCs) from urban air into shallow groundwater. The gasoline additive methyl-tert-butyl ether (MTBE) is of special interest because of its (1) current levels in some urban air, (2) strong partitioning from air into water, (3) resistance to degradation, (4) use as an octane- booster since the 1970s, (5) rapidly increasing use in the 1990s to reduce CO and O-3 in urban air, and (6) its frequent detection at low microgram per liter levels in shallow urban groundwater in Denver, New England, and elsewhere. Numerical simulations were conducted using a 1-D model domain set in medium sand (depth to water table = 5 m) to provide a test of whether MTBE and other atmospheric VOCs could move to shallow groundwater within the 10-15 y time frame over which MTBE has now been used in large amounts. Degradation and sorption were assumed negligible. In case 1 (no infiltration, steady atmospheric source), 10 y was not long enough to permit significant VOC movement by diffusion into shallow groundwater. Case 2 considered a steady atmospheric source plus 36 cm/y of net infiltration; groundwater at 2 m below the water table became nearly saturated with atmospheric levels of VOC within 5 y. Case 3 was similar to case 2, but considered the source to be seasonal, being "on" for only 5 of 12 months each year, as with the use of MTBE during the winter fuel-oxygenate season; groundwater at 2 m below the water table became equilibrated with 5/12 of the "source-on" concentration within 5 y. Cases 4 and 5 added an evapotranspiration (ET) loss of 36 cm/y, resulting in no net recharge. Case 4 took the ET from the surface, and case 5 took the ET from the capillary fringe at a depth of 3.5 m. Net VOC mass transfer to shallow groundwater after 5 y was less for both cases 4 and 5 than for case 3. However, it was significantly greater for cases 4 and 5 than for case 1, even though cases 1, 4, and 5 were all no-net recharge cases. The mechanism responsible for this effect was the dispersion acting on each downward infiltration event, and also on the ET-induced flow. The ability of MTBE to reach groundwater in cases 2-5 is taken as evidence of the potential importance of urban air as a non-point source for VOCs in shallow urban groundwater. Two subcases were run for both case 4 and case 5: subcase a (water and VOCs move with ET) and subcase b (water only moves with ET). *Classification: 5,6*.

Papparelli, A., Kurban, A. and Cunsulo, M. (1996) 'Strategies for bioclimatic design in an urban area of an arid zone: San Juan (Argentina)', *Landscape and Urban Planning,* **34, 19-25**

Bioclimatic building design requires accurate site-specific climatic data. Owing to the substantial climatic variations in densely built urban environments with respect to the macroscale suburban terrain (Mazzeo, N., 1984. Aplicaciones del diagnostico climatologico a problemas relacionados con el urbanismo. Universidad de Buenos Aires, Buenos Aires; Taesler, R., 1984. Urban climatological methods and data. World Meteorological Organization, No. 652, Mexico) and taking into account that, in many cases, the available information is gathered by meteorological stations far from actual building sites, an exact study of urban climatic conditions becomes necessary. The objective of the present work is the determination of bioclimatic design strategies for the urban area of San Juan city, taking into account temperature and relative humidity data obtained for this area through mobile measurements. *Classification: 2*.

Pavageau, M. and Schatzmann, M. (1999) 'Wind tunnel measurements of concentration fluctuations in an urban street canyon', *Atmospheric Environment,* **33, 3961-3971**

A wind tunnel study was performed to examine some turbulent characteristics and statistical properties of the concentration field developing from the steady release of a tracer gas at street level in a canyon amidst urban roughness. The experiment was conducted with the approaching wind direction perpendicular to the street axis and, with a street width to building height aspect ratio equal to one. Concentration time series were recorded at 70 points within the test street cross-section and above. Mean concentrations, variances and related turbulent quantities, as well as other statistical quantities including quantiles were computed. Concentration spectra and autocorrelation functions were also examined. The emphasis is put here on the results concerning mean concentrations and the variance of concentration fluctuations. The main objective of this paper is to put forward potential benefits of the experimental approach taken in this study. Through a simple and already widely studied configuration it is aimed to show how, for modelling purposes, this approach can help improving our understanding of the mechanisms of dipersion of pollution from car exhausts in built-up areas and, with further measurements, how it could assist in drawing specifications for siting monitoring networks. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 8,5.*

Pearlmutter, D., Bitan, A. and Berliner, P. (1999) 'Microclimatic analysis of "compact" urban canyons in an arid zone', *Atmospheric Environment,* **33, 4143-4150**

While the modifying effects of a city's surface on its climate are well documented, there remains a need for useful micro- scale analyses of thermal comfort conditions which may be applied to urban design. In the present study, empirical data taken from extensive full-scale measurements in a number of low-rise urban street canyons in the arid Negev region of Israel are integrated with an energy-balance model representing the thermal exchanges between a pedestrian and the street canyon environment. Analysis of microclimatic parameters and overall energy balance suggests that in summer, overheating within the canyon is sensed primarily as a nocturnal phenomenon, and that during hours of substantial heat stress in a desert climate, the compact canyon is in fact a potential "cool island", mainly due to internal solar shading. In winter, a compact geometry was found to provide relatively warm conditions, with the key Factor being protection from strong winds during cold night hours. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 3.*

Pearson, G. N. and Collier, C. G. (1999) 'A pulsed coherent CO2 lidar for boundary-layer meteorology', *Quarterly Journal of the Royal Meteorological Society,* **125, 2703-2721**

The design and experimental characterization of a compact CO_2 pulsed Doppler lidar for boundary-layer meteorology are described. Examples of the predicted and demonstrated performance of the system with respect to signal-to-noise ratio and Doppler measurement accuracy are presented. An experimental dataset from the lidar is analysed with different signal processing parameters in order to elucidate the effects of accumulating different

numbers of successive lidar pulses and varying the length of the range gate. Typical system parameters are shown to be a range capability of between 3 and 4 km (dependent upon atmospheric conditions) and a velocity accuracy of less than or equal to 0.5 m s(-1) with 112 m range gates. *Classification: 5.*

PignoletTardan, F., Depecker, P. and Gatina, J. C. (1997) 'Modelization of the thermal behaviour of an urban space: calculation of the structure and of the ambient air thermal response', *Revue Generale De Thermique,* 36, 534-545

This paper presents theoretical modelling works on the thermal behaviour of an urban space (street). A calculation code, named Codyflow, has been developed in order to simulate the thermal response of an urban system to climatic solicitations. The model allows us to take into consideration, on the one hand, the radiative flux soliciting the urban canyon, on the other hand, heat transfers inside the system. The airflow solicitation, which plays a part in the convective exchanges and in the ambient air temperature, is calculated by the CFD code Fluent. Some simulation results, obtained by the code Codyflow, are presented. They bring to the fore the influence of many factors on the thermal response of the urban canyon: the geometrical configuration, the used materials (through their thermophysical characteristics) and the airflow solicitation. These results allow us to predict the thermal behaviour of urban spaces for the benefit of architects and urban designers in the conception phase of an urban plan. *Classification: 7,3.*

Pimentel, A. S. and Arbilla, G. (1997) 'Simulation of the urban atmosphere chemistry polluted by alcohol fueled automobiles', *Quimica Nova,* 20, 252-260

Numerical modeling studies of urban atmospheres were performed with a photochemical box submodel which incorporates primary emission rates, temperature and solar irradiance rate coefficients, Actinic flux calculations were made far an appropriate latitude for Rio de Janeiro and initial concentrations and emission rates were taken from experimental data. The relative importance of individual reactions is discussed as well as the effect of enhanced aldehyde emissions from vehicles using ethanol and ethanol-containing fuel. *Classification: 5.*

Pires, M. and de Carvalho, L. R. F. (1999) 'The presence of carbonyl compounds in indoor air of Sao Paulo city', *Quimica Nova,* 22, 487-496

The presence of low carbonyl compounds (C-1-C-4) and glutaraldehyde was observed in 14 work-locations in Sao Paulo city, Brazil, during January to July 1997 period. The quantification of other carbonyls was not possible due to a sampling artifact caused probably by undesirable reactions between the ambient ozone and the organic substract of C-18 cartridge used to collect carbonyls. High indoor concentrations, compared to outdoor levels, were observed for all compounds. Formaldehyde was the most abundant species (29 ppb) followed by acetone and acetaldehyde (25 and 17 ppb) with a small contribution of propanal, crotonaldehyde and C-4 isomers (0.7 to 1.5 ppb) when related to the total indoor carbonyls level. Glutaraldehyde was observed only in two different occupational locations in a hospital at high concentrations (121 ppb), In general, high individual carbonyl levels as well as total carbonyls levels found in several locations

indicated an unpropitious air quality for the occupants of these non-industrial sites. *Classification: 5,7.*

Piringer, M., Ober, E., Puxbaum, H. and KrompKolb, H. (1997) 'Occurrence of nitric acid and related compounds in the northern Vienna basin during summertime anticyclonic conditions', *Atmospheric Environment,* **31, 1049-1057**

Atmospheric concentrations of ozone, nitric acid and particulate nitrates were measured during photochemically active periods in summer 1986 and 1987 near Vienna, Austria. Field data were taken on tower stations at different levels. On a summit 575 m asl and 10 km downwind of Vienna peak 4-h averages of 139 ppb ozone, 5.1 ppb nitric acid and 3.3 ppb ammonium nitrate were recorded in the urban plume at noon. Eighty-six per cent of daytime concentrations of ozone and 66% of daytime nitric acid were found to be present in the consecutive night in the mixed layer above an inversion indicating that it can act as a reservoir for reactive photochemical pollutants. In the late evening hours a slight increase in concentration of HNO3 was observed at tower stations, which can be attributed to a nighttime formation. Copyright (C) 1997 Elsevier Science Ltd. *Classification: 5.*

Piringer, R. and Schauberger, G. (1999) 'Comparison of a Gaussian diffusion model with guidelines for calculating the separation distance between livestock farming and residential areas to avoid odour annoyance', *Atmospheric Environment,* **33, 2219-2228**

Complaints by the neighbourhood due to odour pollution from livestock farming an increasing. Therefore, some countries have already developed guidelines to address odour from livestock. These guidelines are in use to assess the necessary separation distance between livestock buildings and residential areas such that odour is not felt as an annoyance. In all these guidelines, the separation distance is calculated as a function of the rate of pollution. These are mainly power functions with an exponent between 0.3 and 0.5. The Austrian regulatory dispersion model, a Gauss model, is used to calculate the frequency distribution of the dilution factor for 12 classes of distances between 50 and 500 m downwind from the source. These data were fitted to an extended Weibull distribution of the dilution factor to determine the exponent of the power function describing the separation distance as a function of the emission. The exponent has a value of about 0.72. This result, achieved with a wind and stability statistics representative for the Austrian flatlands north of the Alps, indicates a stronger dependance of the separation distance from the odour emission than suggested by the guidelines. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Plate, E. J. (1999) 'Methods of investigating urban wind fields - physical models', *Atmospheric Environment,* **33, 3981-3989**

For evaluation of environmental problems in urban areas, models are needed. Physical models and mathematical models are the tools of the trade. Both types of models have advantages and limitations. The emphasis here is on boundary layer wind tunnels, which

are well suited for the study of many urban climate situations. The boundary layer flow along the floor of a meteorological wind tunnel is a real flow which approximately represents a scaled down version of the atmospheric boundary layer under conditions of neutral stratification Therefore, important practical problems involving urban atmospheric conditions can be studied in such wind tunnels by means of geometrically similar models of the urban area. Such problems involve wind forces on structures, pedestrian comfort, and diffusion processes from point sources, such as chimneys, tunnel exhausts and gaseous spills, or from line sources, such as traffic lines. The investigation of these processes in a wind tunnel must be seen, however, as one link only in a chain of actions. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 8.*

Preston, M. R., Chen, H. Y. and Osborne, P. J. (1996) 'The use of azaarenes as indicators of combustion sources to the urban atmosphere and estuarine systems', *Abstracts of Papers of the American Chemical Society,* **212, 90-ENVR**

Classification: 5.

Preston, M. R., Chen, H. Y. and Osborne, P. J. (1997) In *Molecular Markers in Environmental Geochemistry,* **Vol. 671, pp. 332-345.** *Classification: 5,6.*

Puledda, S., Paoletti, L. and Ferdinandi, M. (1999) 'Airborne quartz concentration in an urban site', *Environmental Pollution,* **104, 441-448**

The International Agency for Research on Cancer, IARC, has recently classified crystalline silica as carcinogenic to man. This new assessment calls for the determination of the concentration levels of crystalline silica to which the general population is exposed to. This paper reports the results of the determinations of airborne quartz - the most common form of crystalline silica - in a site of the metropolitan area of Pome, Italy. We studied the respirable fraction of the airborne particulate (PM10) sampled in spring 1996 with a cascade impactor, by means of a scanning electron microscope equipped with an X-ray microprobe. Ten components were identified of which 3.7% on the average was total silica (crystalline and amorphous). On the basis of these data we started a methodical study of quartz concentrations in the historical series of the PM10 daily sampled with an Airborne Particles Monitor (APM) apparatus at the above-mentioned site. PM10 was collected on cellulose filters which were then incinerated in oxygen plasma at low temperature to eliminate the organic component. The residue was deposited on silver membrane filters that were then read with a conventional X-ray diffractometer to determine quartz amounts. Twenty eight filters were analysed which corresponded to four weeks representative of the four seasons of 1994, the year when samples started to be systematically collected. Results show that the mean weekly concentration of airborne quartz ranged between 0.6 and 1.5 mu g/Nm(3), which corresponded to 1.7% and 3.4% of total PM10, respectively. These data are substantially in agreement with our previous data obtained with electron microscopy, and show that the quartz levels present in the urban atmosphere under study were approximately 100-fold lower than the threshold limit value (TLV), currently suggested by the American Conference of Governmental Industrial Hygienists (ACGIH) for the workplaces, namely 100 mu g/Nm(3) - threshold that is

currently applied in Italy. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Querol, X., Alastuey, A., Lopez-Soler, A., Plana, F., Mesas, A., Ortiz, L., Alzaga, R., Bayona, J. M. and de la Rosa, J. (1999) 'Physico-chemical characterisation of atmospheric aerosols in a rural area affected by the aznalcollar toxic spill, south-west Spain during the soil reclamation activities', *Science of the Total Environment,* **242, 89-104**

High levels of atmospheric contamination due to the re- suspension of pyrite particles from the mining waste slurry were recorded in the Guadiamar valley (the Guadiamar is a tributary of the Guadalquivir river) after the toxic spill of Aznalcollar, north of the Donana Natural Park (SW Spain). Major high-particulate events occurred during the extraction of the pyrite-rich mud layer, which covered an extensive area of the valley downstream of the confluence of the Agrio and Guadiamar rivers. This study deals with the monitoring of the ambient air quality at two stations near the village of Aznalcazar in the central part of the flooded area. Although the Spanish legal limit for atmospheric particles and lead in environmental air were not exceeded, high daily levels of total suspended particles (TSP) and of some elements with an environmental significance (As, Cd, Cu, Mn, Ni, Pb, Sn, Tl and Zn) were recorded at Aznalcazar and in the Guadiamar valley during soil reclamation (July-August 1998). Despite a progressive decrease in TSP levels through September-October 1998, background was higher than the levels for the May-June period. Evolution of levels for most of the elements studied showed a similar trend. The exceptions were copper, which was partially increased by other emission sources such as fumigation activities, and sodium, which remained at relatively constant levels during the study period because of its marine origin. The physico-chemical characterisation of the atmospheric particulates allowed us to determine the major grain size modes of the pyrite related elements and the solubility of the potentially toxic elements, and to identify the major particulate types present in the atmosphere in the area. Secondary and tertiary aromatic amines (i.e. alkyldiphenylamines and phenylcarbazoles, respectively) were identified in the suspended particles and in the vapour phase collected at the same station as the TSP samples. As some of these aromatic amines had been previously identified in the pyrite sludge, it is assumed that fine sludge particles containing aromatic amines were re-suspended in the atmosphere. The highest concentrations of aromatic amines in the particulate phase were recorded in August 1998 during the pyrite slurry extraction in the proximity of the Aznalcazar sampling site. Despite a sharp drop in the suspended particles of the aromatic amine concentrations, a significant concentration was detected in the vapour phase (<1.2 mm) during autumn, probably because of longer residence time in the atmosphere. Although health hazards associated with the presence of these aromatic amines are unknown, their acute toxicity exceeded that of urban aerosols. (C) 1999 Elsevier Science B.V. All rights reserved. *Classification: 0.*

Rafailidis, S. (1997) 'Influence of building areal density and roof shape on the wind characteristics above a town', *Boundary-Layer Meteorology,* **85, 255-271**

Flow characteristics in the lower part of the atmospheric boundary layer developing immediately above building roofs have been studied by physical modelling under neutral

stratification conditions. The vertical profiles of velocity, turbulence intensity and Reynolds stress were measured in detail above a model urban fetch consisting of parallel street canyons. Two different street densities and roof shapes were tested. It is found that the influence of the buildings on the oncoming wind remains confined to within three overall building heights above ground. Furthermore, the effect on the wind at roof level from the areal building density is relatively weak, but strong from the roof shape. Thus, altering roof shape can have a much more beneficial impact on urban air quality than increasing the spacing between buildings. Moreover, these findings yield a novel methodology for reliable prediction of urban air quality, by combining numerical mesoscale wind flow models with physical street canyon pollution dispersion models. *Classification: 8.*

Rappengluck, B. and Fabian, P. (1998) 'A study of BTEX-ratios in the urban area of Munich/Germany using rapid gas chromatography', *Environmental Science and Pollution Research,* **5, 65-70**

During October 1993 rapid in-situ quasi-continuous GC/FID measurements of aromatic compounds (BTEX) were carried out at two urban sites in Munich/Germany. A cycle time of 10 min allowed determination of shorttime BTEX emission variations and their impact on selected BTEX ratios. The ethylbenzene/Sigma m/p-xylene ratio showed the smallest variations even in case of rapid changes in the BTEX-mxture. It appeared to be almost independent of the emission strength. Therefore this ratio is suggested to be primarily dependent on photochemical processes in urban environments. It provides an indicator for the impact of anthropogenically related hydrocarbon chemistry leading to the formation of secondary pollutants. *Classification: 5.*

Rappengluck, B. and Fabian, P. (1999) 'Nonmethane hydrocarbons (NMHC) in the Greater Munich Area Germany', *Atmospheric Environment,* **33, 3843-3857**

During several field campaigns in the years 1993-1997 quasi- continuous measurements of NMHC data were obtained at various locations (urban/suburban/rural) within the Greater Munich Area (GMA) by means of on-line gaschromatographic methods. Though limited to NMHC between C-6 and C-9 it comprises the first comprehensive data base for this region that features high temporal resolution. The results for the downtown area show relatively low NMHC values compared to other cities worldwide. Propene-equivalent analysis suggests that aromatic compounds such as toluene and m & p-xylenes play a major role in the formation of urban photochemical smog in the GMA. Since aromatic compounds were found to be ubiquitous at all measurement sites (altogether 8 sites) the pattern of these NMHC were investigated thoroughly. The results suggest that aromatic compounds are most effective in the urban/rural transition zone where VOC-limitation of ozone formation can be expected. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Rappengluck, B., Fabian, P., Kalabokas, P., Viras, L. G. and Ziomas, I. C. (1998) 'Quasi-continuous measurements of non-methane hydrocarbons (NMHC) in the greater Athens area during MEDCAPHOT-TRACE', *Atmospheric Environment,* **32, 2103-2121**

During the comprehensive field campaign MECAPHOT-TRACE (20 August to 20 September 1994) quasi-continuous measurements of NMHC in the range of C-4-C-12 were carried out for the first time in the Greater Athens area simultaneously at two sites, by means of on-line gas;chromatographic methods. The results show a heavy load of hydrocarbons in ambient air, especially during stagnant weather conditions that favour the development of land-sea-breeze circulations. Overall the urban hydrocarbon mix reflects the emission of traffic. This influence is confirmed through correlation analyses of hydrocarbon ratios, especially aromatic compound ratios, and their dependence on both wind direction and wind velocity at a suburban receptor site. The ethylbenzene/m-xylene-ratio turned out to be a good indicator for the impact of anthropogenically related hydrocarbon chemistry leading to the formation of secondary pollutants. Episodes will be discussed that elucidate the importance of hydrocarbons in the course of ozone formation. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5*.

Rau, M., Winkler, C. and Kunz, R. (1999) 'Biometeorological assessment of urban climate', *Gefahrstoffe Reinhaltung Der Luft,* 59, 343-348

Because of increasing structural concentration in urban overcrowded areas the investigation of bioclimatic load and air pollution gains more and more in significance. The following contribution describes the procedure for calculating the thermal situation in built-up areas and the assessment according to the method of Fanger (PMV-values). For the determination of PMV-values the wind field, air temperature field, the humidity and the short and long wave radiation fluxes are required. These parameters are calculated with the microscale, prognostic model MIMO, switched with a radiation model. From the solar and terrestric radiation fluxes the mean radiation temperature is derived which forms the base in the conditional equation for PMV-values beside the meteorological parameters wind, air temperature and humidity. *Classification: 7,1*.

Ritter, D., Knebel, J. W., Aufderheide, M. and Mohr, U. (1999) 'Development of a cell culture model system for routine testing of substances inducing oxidative stress', *Toxicology in Vitro,* 13, 745-751

The toxicological model of oxidative stress is a mechanism which is currently thought to be involved in the formation and development of many serious human diseases. Little is known about cellular responses to oxidative damage and the related specific toxicological properties of substances such as chemicals or components of the polluted urban atmosphere. On the basis of biological pathways involved in cellular antioxidative mechanisms, we developed a biological model For studying the oxidative properties of substances. This includes human lung cells and methods for biochemical analysis of cellular endpoints. Antioxidative and glycolysis-related enzyme activities (glutathione peroxidase, glutathione reductase, superoxide dismutase, catalase. phosphofructokinase. enolase. glucose-6-phosphate dehydrogenase),ATP/ADP/AMP and glutathione (oxidized and reduced) are determined. Routine testing of substances with high reproducibility and fast screening is provided bq adapting methods for biochemical analysis to determinations using cells grown on microtitre plates. First experiments with standard model substances inducing oxidative stress such as H2O2 and tert-butylhydroperoxide show that enzymatic activities can be measured with good reproducibility and their changes can be followed

kinetically. The results indicate the relevance of the determined parameters for such toxicological events and the usefulness of the: biological indicator system for routine testing. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 0.*

RodriguezNavarro, C., Sebastian, E. and RodriguezGallego, M. (1997) 'An urban model for dolomite precipitation: Authigenic dolomite on weathered building stones', *Sedimentary Geology,* **109, 1-11**

Formation of authigenic dolomite within alteration crusts developing on limestone surfaces of a historical building is confirmed by XRD, polarising microscopy, and SEM with EDX data. Two different types of authigenic dolomite occur: limpid stoichiometric dolomite and Ca-rich 'protodolomite'. The presence of gypsum, calcite, pollution-derived particles, clay minerals, and organic material within the crusts confirms their recent formation, together with that of dolomite, in a micro- environment of high evaporation and ionic concentrations. Such environments are typically found in many urban centres. On the basis of these findings an 'Urban Model' for dolomite precipitation is proposed. There are two sources of Mg: (1) dissolution of nearby dolostones overlying the limestones, as a result of leaching by atmospheric SO_2, oxidised and hydrolysed as H_2SO_4; and (2) Mg-rich metallic atmospheric particles. Elevated Mg/Ca values are achieved by precipitation of gypsum, which removes Ca from the solution. 'Protodolomite' then precipitates and later recrystallises as limpid dolomite due to changes in the pore fluids, related with the environmental conditions. CO_3^{2-} and CO_3H^- are provided by leaching of both the limestone support and the nearby dolostones. Additional sources of CO_2 are provided both by the polluted urban atmosphere, rain water, and the degradation of organic material within the crust. Organic matter (fungi and bacteria), pollution-derived particulate matter and clays seem to play a key role in promoting dolomite precipitation in this micro- environment by altering kinetic barriers and providing active sites for dolomite nucleation. Finally, the formation of urban dolomite is compared with Recent dolomites forming in natural environments with alternating evaporative/fresh-water conditions. *Classification: 6.*

Rogge, W. F., Hildemann, L. M., Mazurek, M. A., Cass, G. R. and Simoneit, B. R. T. (1998) 'Sources of fine organic aerosol. 9. Pine, oak and synthetic log combustion in residential fireplaces', *Environmental Science & Technology,* **32, 13-22**

Combustion of wood in residential fireplaces contributes approximately 14% on an annual average of the total primary fine particle organic carbon (OC) emissions to the Los Angeles urban atmosphere and up to 30% of the fine particulate OC emissions on winter days. This paper presents comprehensive organic compound source profiles for smoke from bu ming pi ne, oak, and synthetic logs in residential fireplaces. Mass emission rates are determined for approximately 200 organic compounds including suites of the n-alkanes, n-alkenes, cyclohexylalkanes, n-alkanals, n-alkanoic acids, alkenoic acids, dicarboxylic acids, resin ac ids, hydroxylated/methyoxylated phenols, ligna ns, substituted benzenes/benzaldehydes, phytosterols, polycyclic aromatic hydrocarbons (PAHs), and oxy-PAHs. Wood smoke constituents reflect to a great extent the underlying composition of the wood burned: pine and oak logs produce smoke that is enriched in lignin decomposition products, pine smoke is enriched in resin acids and their thermal alteration

products, while smoke from the synthetic log burned here bears the major signature of the petroleum products combined with traces of the sawdust components from which it is made. Resin acids are discussed as potential wood smoke tracers in the environment, and it is shown that the time series of resin acids concentrations in the Los Angeles atmosphere follows the extreme seasonal variation in wood use reported in previous emissions inventories for the Los Angeles urban area. *Classification: 5.*

Rotach, M. W. (1997) 'Towards a meteorological pre-processor for dispersion models in an urban environment', *International Journal of Environment and Pollution,* 8, 548-556

The main results from an extensive observational study in an urban roughness sublayer are presented and discussed in view of possible applications in the context of meteorological pn- processing for dispersion modelling. These findings mainly concern the turbulence structure, the height variation of Reynolds stress, and the implications for scaling within the upper part of the roughness sublayer (i.e. above roof level). In order to estimate average flow and dispersion parameters closer to the surface (i.e. within the canopy) from information above roof level, characteristic scaled profiles extending down to about a mid canyon level may be used. Using the above information, a method to estimate meteorological parameters in an urban environment crucially depends on the knowledge of a friction velocity in the inertial sub-layer, i.e. at the upper end of the roughness sublayer. This can be inferred from on- site measurements within the roughness sublayer (if available) by using the height dependence of Reynolds stress, or by relating remote (e.g. airport) measurements to the urban surface using information on the different surface roughness. Once this friction velocity is established, the local scaling approach within the upper part of the roughness sublayer allows - in conjunction with the stress profile - the determination of dispersion parameters, such as the velocity variances at any height within the roughness sublayer above roof level. Finally, the characteristic scaled profiles may be used if information on dispersion parameters is required closer to the surface. *Classification: 8,5.*

Rotach, M. W. (1999) 'On the influence of the urban roughness sublayer on turbulence and dispersion', *Atmospheric Environment,* 33, 4001-4008

The concept of the urban roughness sublayer is discussed and this lowest atmospheric layer over a rough surface is shown to have a non-negligible vertical extension over typical urban surfaces. The existing knowledge on the turbulence and flow structure within an urban roughness sublayer is reviewed, focusing on the height dependence of turbulent fluxes and a scaling approach for turbulence statistics, such as velocity variances, in the above-roof part of the roughness sublayer, Finally, the implication of this turbulence and flow structure upon dispersion characteristics is investigate;, The most prominent difference of explicitly taking into account the roughness sublayer in a dispersion simulation (as compared to assuming a 'constant flux layer') is a clearly enhanced ground level concentration far downwind from the source. For the example of a tracer release experiment over a (sub) urban surface (Copenhagen) it is shown that introducing the roughness sublayer clearly improves the model performance. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 8,5.*

Rotach, M. W. and de Haan, P. (1997) 'On the urban aspect of the Copenhagen dataset', *International Journal of Environment and Pollution,* **8, 279-286**

It was one of the findings from the model validation exercise during the third workshop 1994 in Mol that there was a common tendency for all models under consideration to underestimate the observed concentrations in the case of the Copenhagen dataset. It is argued here that this is due to the fact that this experiment was performed over a rough suburban surface. In such circumstances, a roughness sublayer covers the lower part of the surface layer wherein surface: layer scaling cannot be valid owing to the presence of roughness elements and the resulting disturbances of the flow. A two-dimensional (u and w) Lagrangian stochastic dispersion model is used to demonstrate the effect of the modified turbulence structure within the urban roughness sublayer for the example of the Copenhagen dataset. If a roughness sublayer is included by modifying the turbulence and flow structure in the lowest metres of the domain according to observed (urban) roughness sublayer characteristics, it is shown that the model performance is considerably improved. The overall performance measures (such as rms difference, fractional bias, etc.) become significantly better when taking the roughness sublayer into account. Similarly, it is shown that the evolution of ground-level concentrations with distance from the source is simulated more realistically for most of the individual experiments. *Classification: 8.*

Rubino, F. M., Colombi, A., Floridia, L., Tavazzani, M. and Occhipinti, E. (1996) 'Time and spatial dependence of the concentration of automotive- related pollutants in the urban atmosphere surrounding "Grattacielo Pirelli" of Milano (Italy)', *Annali Di Chimica,* **86, 565-575**

Air quality inside buildings, whether naturally or mechanically ventilated, is strongly dependent on that of ambient external air in the surrounding atmosphere. This paper describes results obtained in the analysis of urban air quality in the neighbouring of a tall, multistorey building with mechanical ventilation, with regard on its impact in indoor air quality. Within the study, the concentration of carbon monoxide and of total and grossly speciated classes of airborne organic vapours was measured at various heights between street level and the top of the tower building (approximately 100m) and could be traced as the contribution of time-dependent pollutant production from urban outdoor sources (mainly vehicular traffic) and of conditions influencing pollutant diffusion from street level upwards. In particular, a steady concentration decrease with increasing height of the concentration of carbon monoxide could be measured in the immediate neighbouring of the tower building. The metods employed in the analysis of environmental data may be employed in the evaluation of indoor air quality, to assist the choice of the best action to mitigate the influence of outdoor air quality at the supply point of the mechanical ventilation system with respect to indoor air quality (IAQ) in the building. *Classification: 5.*

Rubino, F. M., Floridia, L., Tavazzani, M., Fustinoni, S., Giampiccolo, R. and Colombi, A. (1998) 'Height profile of some air quality markers in the urban atmosphere surrounding a 100 m tower building', *Atmospheric Environment,* **32, 3569-3580**

Air quality inside buildings, whether naturally or mechanically ventilated, is strongly dependent on that of ambient external air in the surrounding atmosphere. This paper describes results obtained in the assessment of urban air quality influence in the neighbouring of a tall, multistorey building with mechanical ventilation on its indoor air quality. Within the study, which lasted for more than 30 of continuous monitoring, the concentrations of carbon monoxide (CO), of total and grossly speciated classes of airborne organic vapours and of PM10 airborne particulate were measured both outdoors, at ground and at various heights between street level and the top of the tower building (approximately 100 m) and inside the building. The daily variation of airborne pollutants in the urban atmosphere in the neighbouring of the tower building was traced as the contribution of both time-dependent pollutant production from urban outdoor sources (mainly vehicular traffic) and of the variation of meteoclimatic conditions influencing pollutant diffusion from street level upwards. In particular, a steady concentration decrease with increasing height of the concentration of automotive-related pollutants, such as of PM10 airborne particulate, of a mixture of volatile aromatic compounds (TAAC) and of CO could be measured in the immediate neghbouring of the tower building (values of 40 mu gm(-3) of PM10 airborne particulate decreasing to 32 mu gm(-3) at 80 m; of 5 mg of benzene equivalents m(-3) at ground level with a 30% decrease at 100 m height; of 3 mgm(-3) of CO decreasing to 2.2 mgm(-3) at 100 m). The acquired information was employed to advice the building management on the improvement of indoor air quality attainable by moving the air feed grid of the HVAC system to a higher level from ground. An example is reported, which shows the improvement of the indoor air quality in a three-storey peripheral building of the same complex subject to scheduled refurbishing, obtained by moving the HVAC air feed point, originally at + 4m in an internal courtyard, to the building roof, at about + 11m. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 5,8*.

Ruckert, J. (1996) 'Stress-corrosion cracking of copper alloys', *Werkstoffe Und Korrosion-Materials and Corrosion,* **47, 71-77**

Stress-corrosion cracking (SCC) occurs if three factors are simultaneously present: a susceptible material, a specific corrosive medium. and tensile stresses. All copper alloys and copper itself are susceptible to SCC - but in a different extend. The most susceptible alloys are brasses with copper contents below 80%. For a long time only ammonia and its derivatives were considered to cause SCC of copper alloys. Only in recent years other mediums have been reported to produce SCC - especially nitrites. With the exception of some rare SCC- cases of copper and zinc-free copper alloys SCC-failures of brasses prove the highest importance in practice. This is due to the high susceptibility and the large use of brass. Besides clear failures by ammonia and nitrite increasing cases of SCC influenced by outdoor environment - mainly industrial or urban atmosphere - can be stated. The reason could be the general atmospheric pollution by sulphur and nitrogen oxides. Failures of this kind may appear after long times of service - e.g. after several years. The risk of SCC can be reduced by minimizing tensile stresses or by choosing other materials than brass. *Classification: 0*.

Rudolph, J., Koppmann, R. and PlassDulmer, C. (1996) 'The budgets of ethane and tetrachloroethene: Is there evidence for an impact of reactions with chlorine atoms in the troposphere?' *Atmospheric Environment,* **30, 1887-1894**

In a number of recent papers evidence has been presented that reactions with Cl atoms substantially contribute to the turnover of organic compounds in certain regions of the marine atmosphere. However, the impact of this possible sink mechanism for organic compounds on global or hemispheric scales is still unknown. Based on the budgets of organic substances which react with Cl-atoms much faster than with OH-radicals it is possible to derive upper limits for the average tropospheric Cl-atom concentration. The rate constants for the ethane and tetrachloroethene reaction with Cl are by a factor of 200-300 higher than those with OH-radicals, this reaction being their only significant established sink in the troposphere. From several series of measurements in the remote troposphere we derived an estimate of mean tropospheric distributions and seasonal cycles of tetrachloroethene and ethane. Together with OH-fields from model calculations we calculated the removal of ethane and tetrachloroethene by OH-radicals. Within the uncertainties the calculated removal agrees with the known emissions of these substances. In spite of the substantial uncertainties of these budgets, the relatively high reactivity of these substances towards Cl-atoms allows to estimate useful upper limits of the removal rates by Cl-atoms and thus of the average tropospheric Cl-atom concentration. For the Northern Hemisphere a plausible upper limit of less than 1000 Cl-atoms cm(-3) can be derived. Due to higher uncertainties in the budgets for the Southern Hemisphere, the upper limit of the Cl- atom concentration in the Southern Hemisphere is nearly 2000 Cl-atoms cm(-3). Nevertheless, these results show that on a global scale the Cl-atom-induced reactions for most organic trace gases are of minor importance. *Classification: 0.*

Sachweh, M. and Koepke, P. (1997) 'Fog dynamics in an urbanized area', *Theoretical and Applied Climatology,* **58, 87-93**

Investigations into regional and temporal variations of fog frequency in the metropolitan area of Munich, Germany, reveal a fog maximum zone in the rural outskirts while the urban area itself represents a local fog minimum. This is an element of urban climate. It can be explained by the typical land use - dependent mesoscale thermal structure and the resulting circulation pattern during winter anticyclonic conditions with widespread fog cover. The phenomenon of a fog maximum zone near an urban area is transferable to large cities in environments which are favourable to radiation fog. *Classification: 8.*

Saitoh, T. S., Shimada, T. and Hoshi, H. (1996) 'Modeling and simulation of the Tokyo urban heat island', *Atmospheric Environment,* **30, 3431-3442**

Rapid progress in industrialization and urbanization has resulted in the concentration of economic growth and social functions in the urban areas. In most urban cities, it has become more and more certain that the increase of energy consumption is causing environmental problems including the temperature rise in the urban atmosphere (urban heat island) and air pollution. The present paper reports on the results of field observation and three-dimensional computer simulation of the urban hear island in the Tokyo metropolitan area. The three-dimensional governing equations for the urban atmospheric boundary layer were formulated by virtue of the vorticity- velocity vector potential method. Particular attention was focused on the representation of a buoyancy term in the equation of motion in the vertical direction, thereby describing the cross-over effect and stratified inversion layer near the ground surface. The vorticity-velocity potential method

is superior from the viewpoint of numerical stability and suitable for the simulation of an urban heat island. A survey on the energy consumption was first made in the Tokyo metropolitan area. Next, these data were used for the three- dimensional simulations. In order to evaluate the validity of the present model to simulate the urban heat island, the simulation was carried out by initializing it with the same meteorological conditions as those used for the observation day. The simulation results were then compared with the field observation data for the surface temperature. Quite a good agreement was obtained between the present simulation and the observed data, thereby assuring the present model. Further future prediction of the urban heat island was performed for an energy release rate five times as much as the present rate, which corresponds to the year 2031 if the present consumption rate is maintained until then. Copyright (C) 1996 Elsevier Science Ltd. *Classification: 8,3,1.*

Sakakibara, Y. (1996) 'A numerical study of the effect of urban geometry upon the surface energy budget', *Atmospheric Environment,* **30, 487-496**

This numerical study investigates the effect of urban canyon geometry upon the thermal environment using a parking lot model and an urban canyon model in identical meteorological conditions. The urban canyon model assumes two buildings on opposite sides of a street, no windows or interior anthropogenic heat source, an infinitely long east-west oriented canyon, and waterproof surfaces. The simulated surface temperatures agree well with those obtained by field measurement. The energy balance of the urban canyon is represented by that of the canyon top, which is an imaginary surface. The urban canyon, whose top surface is a plane above the canyon at the same level as the roof surface of the budding absorbs more heat in the daytime and releases more at night than the parking lot. The urban thermal environment depends on an urban geometry which particular to the urban canyon model produces reduced small sky view factors and complicated daytime shadow patterns. The results show that this urban geometry contributes to urban heat island formation. *Classification: 3,2.*

San Jose, R., Prieto, J. F., Castellano, N., Arranz, J. M. and Gonzalez, R. M. (1997) 'Urban ozone modelling by using a prognostic Eulerian air quality system: Madrid case study', *International Journal of Environment and Pollution,* **8, 646-653**

Air quality models are essential tools in the understanding of pollutant dynamics in the urban atmosphere. In this contribution we present an air quality system (ANA), which is composed of a meteorological module that uses a three- dimensional approach with terrain-following coordinates and the non-hydrostatic approach, and a detailed emission model (250 x 250 m) that includes the anthropogenic and biogenic emissions over the area of study (the Madrid area of 80 x 100 km). The biogenic emissions and the land-use classes are obtained by using LANDSAT-5 satellite imagery. A photochemical module based on the CBM-IV scheme and the SMVGEAR numerical method for solving the atmospheric chemistry are used. The results are compared with data obtained from the Madrid Municipality ozone network. The simulated ozone values for a five-day period (5-9 June 1995) compare well with those observed on the ozone network stations. *Classification: 5.*

Santamouris, M., Papanikolaou, N., Koronakis, I., Livada, I. and Asimakopoulos, D. (1999) 'Thermal and air flow characteristics in a deep pedestrian canyon under hot weather conditions', *Atmospheric Environment,* **33, 4503-4521**

The present paper reports the results of a specific experiment carried out in a deep pedestrian canyon in Athens, Greece. The air flow inside and outside the canyon as well as the air and surface temperatures inside the canyon are measured for a period of seven continuous days during the whole day and night period. The air flow characteristics inside the canyon are analyzed. For perpendicular wind speeds, the air flow inside the canyon is characterized by either a circulatory vortex driven by the ambient air flow or a double vortex flow where the upper one is driven by the ambient air flow and the lower one is driven in the opposite direction by the circulation above. When the ambient air blows parallel to the canyon, the measured wind data inside the canyon indicate a flow in the same direction. When the air flows at a certain angle to the canyon axis, the measured data indicate that a spiral vortex is induced along the canyon length. The spatial and temporal variation of the surface and air temperature distribution inside the canyon is analyzed. The heat island intensity in the canyon is estimated based on measurements from a reference station. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 3,8.*

Schauberger, G., Piringer, M. and Petz, E. (1999) 'Diurnal and annual variation of odour emission from animal houses: a model calculation for fattening pigs', *Journal of Agricultural Engineering Research,* **74, 251-259**

Odour emission from livestock buildings adjacent to residential areas may constitute an environmental nuisance and dispersion models are of interest in the regulation of air pollutants. To apply dispersion models to odour emissions, the odour concentration and the volume flow of the outlet air must be known. In this paper, the odour concentration of the outlet air is determined by combining a steady-state balance model to calculate the outlet air temperature and the volume flow with a simple model for the odour release inside the livestock building. The results show a distinct diurnal and annual variation of the odour concentration due to the variability of the volume flow. The mean odour concentration during daytime in the summer months lies in a very narrow range close to the overall minimum. Odour concentration derived from odour emission and the maximum volume flow of the animal house is useful for model calculations. During a clear-sky summer period, the model predicts a nighttime odour concentration of about 4.6 times the daytime concentration due to the reduced volume flow at night. To improve the calculation of odour concentrations by dispersion models, the annual and diurnal variation of the odour release has to be taken into account. The model suggests that long-term measurements of the odour emissions of animal houses are necessary for regulatory and legal purposes. (C) 1999 Silsoe Research Institute. *Classification: 0.*

Schauer, J. J., Kleeman, M. J., Cass, G. R. and Simoneit, B. R. T. (1999) 'Measurement of emissions from air pollution sources. 1. C-1 through C-29 organic compounds from meat charbroiling', *Environmental Science & Technology,* **33, 1566-1577**

A dilution source sampling system was used to quantify the organic air pollutant emissions from commercial-scale meat charbroiling operations. Emission rates of gasphase volatile organic compounds, semivolatile organic compounds, and high molecular weight particle-phase organic compounds were simultaneously quantified on a single compound basis Fine particle mass emission rates and fine particle elemental chemical composition were measured as well. Emission rates of 120 organic compounds, spanning carbon numbers from C-1 to C-29 were quantified including n-alkanoic acids, n-alkenoic acids, carbonyls, lactones, alkanes, aromatics, polycyclic aromatic hydrocarbons, alkenes; and steroids. Ethylene, formaldehyde, and acetaldehyde were found to he the predominant light gasphase organic compounds emitted from the charbroiling operations. n-Alkanoic acids, n-alkenoic acids, and carbonyls made up a significant fraction of the quantified semivolatile and particle-phase organic compound emissions. Meat charbroiling is one of the few sources identified to date that. contributes to the high molecular weight aldehydes measured in the urban atmosphere. Semivolatile and particle-phase organic compounds were collected for quantification by two simultaneous sampling protocols: (1) quartz fiber filters followed by polyurethane foam (PUF) cartridges, and (2) XAD-coated annular denuders followed by quartz fiber filters and PUF cartridges. Good agreement was observed for the total mass emissions collected by the two different sampling procedures; however, the partitioning of the semivolatile organic compounds between the gasphase and particle phase, as-measured; by the two sampling procedures, showed significant differences for n- alkanoic acids, indicating that significant artifact adsorption of these compounds occurs to the filter in the filter/PUF sampling system. *Classification: 0.*

Scherer, D., Fehrenbach, U., Beha, H. D. and Parlow, E. (1999) 'Improved concepts and methods in analysis and evaluation of the urban climate for optimizing urban planning processes', *Atmospheric Environment,* **33, 4185-4193**

Planning processes are strongly influenced by an increased awareness of environmental issues concerned by projected land- use transformations. A research project was carried out to produce climate maps for the region of Basel/Switzerland to enable planning authorities taking care of the urban climate and its interrelations with urban structures. Main focus was given to develop and implement a methodology meeting not only the regional requirements of Basel. The new approach is not depending on subjective criteria or manual interventions and ensures its applicability for other regions. Three basic concepts were developed or improved in this study. A new definition of 'climatopes' was introduced, and methods were developed for their digital determination by objective criteria. This definition of climatopes requires adequate information on land-use, which is provided by introducing the concept of 'areal types'. In contrast to 'traditional' land-use classes directly derived from satellite images, areal types are complex aggregates reflecting not only different physical surface properties, but also socioeconomic aspects of land-use. 'Ventilation classes' are the second component required to delineate climatopes. They summarize the combined influencing factors of terrain features and land-use structures on wind field and urban ventilation. Their determination is based on topographic information and surface properties derived from a digital terrain model and from land-use data. The spatial distribution of climatopes was computed for Basel. Various quality assessment procedures and the application of climatopes for an automated generation of planning guidelines demonstrate the applicability of the concepts. Climate maps containing the results of the analysis and evaluation of the urban climate of Basel

were estimated by the involved planners to be a valuable tool meeting their practical requirements to a high degree. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 1,2.*

Seisel, S. and Rossi, M. J. (1997) 'The heterogeneous reaction of HONO and HBr on ice and on sulfuric acid', *Berichte Der Bunsen-Gesellschaft-Physical Chemistry Chemical Physics,* **101, 943-955**

The heterogeneous reactions of HONO with HBr on ice, solid and supercooled liquid H2SO4 solution (40-95 wt%) were studied in the temperature range 180 to 200 K for the solid substrates (ice, H2SO4) and 210 to 270 K for the liquid solutions of H2SO4 using a Knudsen flow reactor. The uptake coefficient of HONO onto frozen aqueous HBr solutions at 190 K was determined and resulted in a mean value of gamma = (2.3 +/- 1.2) 10(-2). On ice the HBr uptake rate is high with a mean value of gamma = 0.32+/-0.12 between 180 and 200 K and is unaffected by the presence of HONO. The uptake of HONO onto ice is a function of the HBr concentration in the condensed phase and for the highest HBr flows used an uptake coefficient of gamma = 2.2.10(-2) was found. On frozen H2SO4 solutions the uptake coefficient of HBr varies with the concentration of the solution from about 0.25 at 10 wt% to less than 1.10(-4) in the absence and 5.10(-4) in the presence of HONO at 95 wt%. The uptake of HONO in the presence of HBr was found to vary with the HBr concentration and to be approximately a factor of two lower than on the ice surface. On liquid H2SO4 the uptake coefficients of HBr and HONO both strongly depended on the concentration of the solution. HONO shows the greatest interaction at 95 wt% with gamma = 2.10(-2) and decreases to about 5.10(-3) at 40 wt%. In comparison HBr only shows a weak interaction of gamma of approximately 5.10(-4) at 95 wt% and a strong interaction of gamma = 4.10(-2) at 40 wt%. On all three substrates the concurrent uptake of HONO and HBr was found to be reactive forming the only identified bromine containing reaction product BrNO. The variation of the substrates from strong acid liquid to solid neutral provides information about the nature of the heterogeneous interaction. *Classification: 0.*

Shahgedanova, M., Burt, T. P. and Davies, T. D. (1997) 'Some aspects of the three-dimensional heat island in Moscow', *International Journal of Climatology,* **17, 1451-1465**

The thermal climate in Moscow was studied for 1990. Air temperatures near the surface were analysed for a number of locations representing different land-use types. The urban-rural temperature differences ranged mainly between 1 degrees and 3 degrees C, with an absolute maximum of 9.8 degrees C. In summer, the heat island intensity exceeded 3 degrees C on 29 per cent of all early morning observations, confirming the widely held view that anticyclonic conditions generate strong heat islands. Temperature variations within the city were small, with a notable exception of the urban park; in winter, the lee periphery of the city was often warmer than the urban centre. Vertical temperature profiles in the lowest 500 m were studied using data obtained at the Ostankino TV tower at seven levels. Although the daytime profiles throughout the year and the nocturnal profiles in winter confirmed observations elsewhere, the nocturnal summer profiles were unlike those registered in other urban areas with an unexpectedly high frequency of strong ground-based inversions. In July and August, ground-based inversions were registered on

57 per cent of all nocturnal observations. This phenomenon can be explained by the 'open' street geometry that is typical of Moscow and a reduced (in comparison with winter) input of artificial heat. (C) 1997 by the Royal Meteorological Society. *Classification: 1,3.*

Shi, J. P., Khan, A. A. and Harrison, R. M. (1999) 'Measurements of ultrafine particle concentration and size distribution in the urban atmosphere', *Science of the Total Environment,* **235, 51-64**

Particle size distributions were measured at three adjacent sites in Birmingham: a busy roadside (A38); 30 m away from the road and a nearby urban background site. Two scanning mobility particle sizers (SMPS), an electrical low pressure impactor (ELPI), a condensation particle counter and a thermophoretic precipitator were employed to measure and collect particles. Excellent agreement on the number weighted size distribution was found between the SMPS and ELPI, as well as with sizes measured by transmission electron microscopy. The average number concentration at roadside measured on four separate days was between 1.6 and $1.9 \times 10^{(5)}$ cm$^{(-3)}$ with similar size distributions and more than half of measured particles smaller than 30 nm. Traffic was the main source of ultrafine particles at the roadside. A 24-h average of $2.68 \times 10^{(4)}$ +/- 1.29 $\times 10^4$ cm$^{(-3)}$ was measured, which is close to that in Hughes et al. (Physical and chemical characterization of atmospheric ultrafine particles in the Los Angeles area. Environ Sci Technol 1998; 32:1153-1161) in Pasadena, CA,USA. Total particle number concentration declined dowmvind of the traffic, faster than the mass concentration. Model calculations show that dilution with background air is the main mechanism for the rapid drop in particle number concentration and change in particle size distribution when moving away from traffic. (C) 1999 Elsevier Science B.V. All rights reserved. *Classification: 5.*

Simcik, M. F., Eisenreich, S. J. and Lioy, P. J. (1999) 'Source apportionment and source/sink relationships of PAHs in the coastal atmosphere of Chicago and Lake Michigan', *Atmospheric Environment,* **33, 5071-5079**

Multivariate statistical techniques were used to investigate source apportionment and source/sink relationships for polycyclic aromatic hydrocarbons (PAHs) in the urban and adjacent coastal atmosphere of Chicago/Lake Michigan in 1994- 1995, The PAH signatures for the atmospheric particle phase, surface water particle phase and sediments indicate that atmospheric deposition is the major source of PAHs to the sediments and water column particulate phase of Lake Michigan. Th PAH signature for the atmospheric gas phase and water dissolved phase indicate an intimate linkage between the lake and its overlying atmosphere. A modified factor analysis- multiple regression model was successfully applied to the source apportionment of atmospheric PAHs (gas + particle). Coal combustion accounted for 48 +/- 5% of the Sigma PAH concentration in both the urban and adjacent coastal atmosphere, natural gas combustion accounted for 26 +/- 2%, coke ovens accounted for 14 + 3%, and vehicle emissions (gas + diesel) accounted for 9 +/- 4%. Each is an identified source category for the region. These results are consistent with the mix of fossil fuel combustion sources and ratios of indicator PAHs. (C) 1999 Published by Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Sini, J. F., Anquetin, S. and Mestayer, P. G. (1996) 'Pollutant dispersion and thermal effects in urban street canyons', *Atmospheric Environment,* **30, 2659-2677**

A numerical model has been built to simulate the small-scale atmospheric flows within the urban canopy, based on the lower atmosphere classical assumptions and the "standard k-epsilon" two-equation turbulence model. This model is used here to study the flows and vertical exchanges of pollutants within the street and at the interface with the atmospheric layer above the roofs, in the asymptotic case of infinitely long street canyons. A thorough study of the influence of the street geometrical aspect ratio leads to a refinement of the flow separation in three regimes, popularized by Oke (1988, Energy Bldg 11, 103-113), taking into account not only the influence of the buildings on the flow of the surface layer just above the roofs but also the structure of the recirculating flow within the street. The time evolution of pollutant concentration within the street canyon and al the pedestrian level is analysed as a function of the geometry and pollutant doses are presented. The number and arrangement of vortex structures within the street canyon largely influence the vertical exchange rates. A preliminary study shows that the differential heating of street surfaces can largely influence the flow's capability to transport and exchange pollutants. In fact, differential heating can even shift the in-street flow structure from one regime to another, e.g., from a one-vortex flow to a flow with several contra-rotative vortices. (C) 1996 Elsevier Science Ltd. *Classification: 3,5.*

Smith, D. F., McIver, C. D. and Kleindienst, T. E. (1998) 'Primary product distribution from the reaction of hydroxyl radicals with toluene at ppb NOX mixing ratios', *Journal of Atmospheric Chemistry,* **30, 209-228**

A study has been conducted to examine the OH-initiated degradation products of toluene in the presence of sub part- per-million levels of NOx. The experiments were conducted in a dynamic reactor to minimize the conversion of the aromatic compounds while allowing a sufficient mass of products to be collected for analysis. The major primary products detected in the toluene system (with molar yields) include glyoxal (0.238), methylglyoxal (0.167), o-cresol (0.120), benzaldehyde (0.06), 4-oxo-2-pentenal (0.03), and p-cresol (0.03). Six other reaction products, most being ring cleavage products, were measured at yields below 3%. Corrections for secondary OH reactions with the products were made where necessary. The formation of the cresol isomers was found to be invariant to the NO2 concentrations which indicates that under atmospheric conditions the initial hydroxycyclohexadienyl radical reaction with NO2 is a minor process and that most of the reaction occurs with O-2. The product yields found in this study are expected to be representative of those that occur in the urban atmosphere at ambient NO2 concentrations. *Classification: 0.*

Smith, D. J. T. and Harrison, R. M. (1996) 'Concentrations, trends and vehicle source profile of polynuclear aromatic hydrocarbons in the UK atmosphere', *Atmospheric Environment,* **30, 2513-2525**

Intensive seasonal sampling campaigns were undertaken at an urban site in the West Midlands conurbation and simultaneously at a nearby rural location with hi-vol and medium volume samplers modified in order to collect particulate and vapour phase polycyclic aromatic hydrocarbons (PAHs) by means of filters and polyurethane foam

plugs (PUFs). Eighteen PAH species were determined by means of Soxhlet extraction followed by clean-up and reversed-phase HPLC with in-series W-visible and fluorescence detectors. PAH at the urban site were found to be present in greater concentrations than at the rural site by a factor of approximately four, and concentrations in the winter campaign exceeded those in the summer by a factor of five. Gas-particle partitioning characteristics of the various PAH in air were investigated and found consistent with Yamasaki's equation. Present data suggest that PAH concentrations have decreased in the U.K., probably quite dramatically, over the past 15 years. A sampling study carried out in the Queensway road tunnel in central Birmingham, revealed concentrations of PAHs and total suspended particulates (TSP) approximately one order of magnitude greater than levels found in ambient air samples from the urban location during winter. Copyright (C) 1996 Elsevier Science Ltd. *Classification: 5*.

Smith, D. J. T., Harrison, R. M., Luhana, L., Pio, C. A., Castro, L. M., Tariq, M. N., Hayat, S. and Quraishi, T. (1996) 'Concentrations of particulate airborne polycyclic aromatic hydrocarbons and metals collected in Lahore, Pakistan', *Atmospheric Environment,* **30, 4031-4040**

Hi-vol air sampling equipment was run at three sites (representative of "city", "industrial" and "rural" sampling locations) in Lahore, Pakistan, for over a year. The extraction and quantitative analyses of all Lahore air samples was completed for a suite of metals, various anions, ammonium, elemental and organic carbon, as well as particle-associated polycyclic aromatic hydrocarbons (PAHs). A comparison of Lahore yearly mean pollutant concentrations with those obtained in Birmingham, U.K., shows that airborne metal levels in the Pakistani city are greater by at least one order of magnitude. The concentrations in Lahore obtained from this study are broadly in line with similar studies in Karachi as well as Calcutta and Bombay. Concentrations of particle-associated PAH are also around one order of magnitude higher than in U.K, samples, and, given the difference in ambient temperature, vapour-to-particle ratios of PAH are expected to be far higher in the hotter climate of Lahore. Minerals identified by X-ray diffraction (XRD) in the Lahore air samples were broadly in line with those determined at locations in other parts of the world. Copyright (C) 1996 Elsevier Science Ltd. *Classification: 5*.

Souza, S. R. and Carvalho, L. R. F. (1997) 'Carboxylic acids measurements in urban air of Sao Paulo City. An analytical and environmental approach', *Quimica Nova,* **20, 245-251**

In this work, analytical strategies are evaluated in order to measure accurately the ambient levels of atmospheric organic acids. Environmental considerations about the determination of low molecular weight mono- and di-carboxylic acids from urban areas of Sao Paulo are described. *Classification: 5*.

Souza, S. R., Vasconcellos, P. C. and Carvalho, L. R. F. (1999) 'Low molecular weight carboxylic acids in an urban atmosphere: Winter measurements in Sao Paulo City, Brazil', *Atmospheric Environment,* **33, 2563-2574**

Atmospheric gas and particle-phase carboxylic acids were measured during July 1996, Winter, in an urban area of Sao Paulo, a highly polluted Latin American city. Ion chromatography and capillary electrophoresis techniques were used to determine the species. As oxalic (36.2 +/- 21.4%), pyruvic (15.0 +/- 7.9%), beta-hydroxy-butyric (9.15 +/- 9.00%) and glycolic (3.55 +/- 2.26%) acids were determined in aerosol particles, formic and acetic acids were determined both in the gaseous (4.36 +/- 2.70 and 3.66 +/- 2.63 ppbv, respectively) and particulate phases (17.8 +/- 12.4 and 18.2 +/- 9.8%, respectively). Approximately 98% of the total acetic and formic acids were in the gas-phase and the gas-aerosol equilibrium was influenced by high levels of relative humidity. Gaseous formic- to-acetic ratios fell in the 0.94-1.85 range. Photochemical production appeared to be a very likely source of the gaseous acetic and formic acid levels found in this investigation. Direct emissions, mainly motor exhaust of vehicles also contributed to their presence in air. The observed amounts of formic and acetic acids in the particle phase were comparable with those observed in other urban sites. Results from aerosol particles indicated lower concentrations of the carboxylic acids at night, but their diurnal and nocturnal variation were similar. Using a correlation matrix, it was possible to suggest some sources for the carboxylic acids in the particulate phase. During daytime, vehicular emission appeared to be the primary source of acetic acid, whereas formic and pyruvic acids should be formed photochemically. Moreover, emissions from biogenic primary sources appeared to be an important contribution to atmospheric concentrations of formic and glycolic acids. Presumably, the photooxidation of pyruvic and glycolic acids gave rise to the oxalic acid. No source for acetic and pyruvic acids at nighttime was possible to suggest. However, direct vehicular and biogenic emissions might be major sources of TOC in nocturnal measurements. Oxalic acid might result from vehicular emission, glycolic acid from biogenic emission and formic acid from both sources. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5*.

Spronken-Smith, R. A. and Oke, T. R. (1998) 'The thermal regime of urban parks in two cities with different summer climates', *International Journal of Remote Sensing,* **19, 2085-2104**

Differences between the temperature of vegetated urban parks and that of their surrounding built environment are reported. The study is based on observations of surface and air temperature in Vancouver, BC and Sacramento, CA. during summer conditions. A combination of remotely sensed surface temperature and air temperature from fixed station and mobile (car and bicycle) traverses is used to characterize the magnitude of park-induced coolness-the 'park cool island' (PCI) effect. Relatively large surface PCI are present by day and at night, although for different reasons. Air temperature effects are smaller. In Vancouver, parks are typically 1-2 degrees C, but in ideal conditions can be almost 5 degrees C cooler than their surroundings. Larger PCI are possible in Sacramento where irrigated green-space can be 5-7 degrees C cooler. Park type, especially the extent of irrigation and the presence of trees, is important in PCI development. During the day trees may play an important role in establishing a cool park effect, perhaps through a combination of shade and evaporative cooling. At night it appears that the surface geometry and moisture status of the park are important controls on surface cooling. Open parks (with higher sky view factors) that have dry soils (and hence lower thermal admittance) cool the most. Nocturnal cooling in open grass parks is often similar to that at rural sites. The influence of parks on air temperatures appears to be restricted to a distance of about one park width. *Classification: 3,1*.

Spronken-Smith, R. A. and Oke, T. R. (1999) 'Scale modelling of nocturnal cooling in urban parks', *Boundary-Layer Meteorology,* **93, 287-312**

Scale modelling is used to determine the relative contribution of heat transfer processes to the nocturnal cooling of urban parks and the characteristic temporal and spatial variation of surface temperature. Validation is achieved using a hardware model-to-numerical model-to-field observation chain of comparisons. For the calm case, modelling shows that urban-park differences of sky view factor (psi(s)) and thermal admittance (mu) are the relevant properties governing the park cool island (PCI) effect. Reduction in sky view factor by buildings and trees decreases the drain of longwave radiation from the surface to the sky. Thus park areas near the perimeter where there may be a line of buildings or trees, or even sites within a park containing tree clumps or individual trees, generally cool less than open areas. The edge effect applies within distances of about 2.2 to 3.5 times the height of the border obstruction, i.e., to have any part of the park cooling at the maximum rate a square park must be at least twice these dimensions in width. Although the central areas of parks larger than this will experience greater cooling they will accumulate a larger volume of cold air that may make it possible for them to initiate a thermal circulation and extend the influence of the park into the surrounding city. Given real world values of psi(s) and mu it seems likely that radiation and conduction play almost equal roles in nocturnal PCI development. Evaporation is not a significant cooling mechanism in the nocturnal calm case but by day it is probably critical in establishing a PCI by sunset. It is likely that conditions that favour PCI by day (tree shade, soil wetness) retard PCI growth at night. The present work, which only deals with PCI growth, cannot predict which type of park will be coolest at night. Complete specification of nocturnal PCI magnitude requires knowledge of the PCI at sunset, and this depends on daytime energetics. *Classification: 3,7.*

Steil, P. (1998) 'Ozone and nitrogen oxide concentrations at an elevated site of the Olympic Tower in Munich', *Meteorologische Zeitschrift,* **7, 129-138**

Ozone (O-3), nitrogen monoxide (NO) and nitrogen dioxide (NO2) were monitored at the Olympic Tower in the northwest of the city of Munich between 1991 and 1995. A measuring site was erected on a platform 220 m agl. To investigate the vertical exchange of these trace gases another station was installed at the bottom of the tower. Compared to the ground station the mean ozone concentrations were always higher at 220 m, especially during nighttime. In autumn and winter only small diurnal variations of mean ozone levels were observed at this location, which were similar to results at Hohenpeissenberg, 65 km southwest of Munich. Half-hour mean values of ozone concentrations at these measuring sites in July 1995 also showed good agreement most the time. During a smog episode maximum ozone concentrations at the Olympic Tower rose about 30 mu g/m(3) per day. Measurements in summer have shown that after sunrise ozone from above the nocturnal urban boundary layer is mixed to the ground and contributes significantly to the level registered there before noon. Concentrations of O-x (= NO2 + O- 3) at 220 m above ground did not change much then, because O-3 mainly converted NO to NO2. A statistical model to forecast maximum ozone concentrations for the city of Munich was derived from the results of these measurements. *Classification: 5.*

Stettler, M. and vonHoyningenHuene, W. (1996) 'On the relation between haze layer and air mass aerosol at an urban location - Case studies', *Atmospheric Research,* **40, 1-18**

Aerosol extinction spectra of the lowest part of the urban boundary layer at Leipzig measured by means of sunphotometers in the wavelength range between 0.36 mu m and 1.05 mu m are presented. The temporal behaviour of these spectra is compared with that of relevant atmospheric turbidity parameters. Special attention is paid to the analysis of atmospheric aerosol optical thickness spectra. It is shown that, concerning aerosol properties, the ageing of an air mass caused by urban activities is identical with an increase of aerosol optical thickness, especially in the short wavelength-range. This fact could be attributed to the convective rise of, primarily, small aerosol particles (r < 0.3 mu m) being emitted by anthropogenic sources near the ground: This process also seems to be responsible for a vertical aerosol stratification within the haze layer. It was found that in the case of turbulent mixing the optical state of the ground layer is mainly determined by accumulation and coarse mode particles, whereas the upper layers contain a large amount of fine particles. *Classification: 5.*

Suzuki, Y. (1997) 'Automated analysis of low-molecular weight organic acids in ambient air by a microporous tube diffusion scrubber system coupled to ion chromatography', *Analytica Chimica Acta,* **353, 227-237**

A method for the automatic analysis of low-molecular weight organic acids (C-<5) in the atmosphere was developed using a microporous tube coupled to an ion chromatograph. A 220 cm long microporous polytetrafluoroethylene (PTFE) tube provided high collection efficiencies of alkanoic acids (formic acid: 97%, acetic acid: 94%, propionic acid: 92%) and alkenoic acids (vinylacetic acid: 98% and methacrylic acid: 96%). a 20 min cycle analysis could be continuously repeated. The coefficient of variation for repeated measurements was less than 5% for concentrations higher than 1 ppbv and 5-10% for concentrations lower than 1 ppbv. The detection limits of formic acid, acetic acid and propionic acid were 0.20, 0.29 and 0.32 ppbv, respectively. The concentration in gas samples was calculated using a good linear gas-solution curve (calibration curve). Formic acid, acetic acid and propionic acid in the urban atmosphere were determined in the concentration range of 1.5- 5.5, 1.0-2.8 and <0.32-1.25 ppbv, respectively. (C) 1997 Elsevier Science B.V. *Classification: 0.*

Suzuki, Y., Ueki, K., Imai, S., Hayashi, K. and Yamaji, A. (1997) 'A field study of the incorporation of atmospheric ion species into raindrops', *Atmospheric Environment,* **31, 1369-1379**

Urban atmospheric ion species are incorporated into raindrops near the ground. Rain was collected from July 1993 through June 1994 at the midtown in Kobe City and al the top of Mt. Maya which is located adjacent to the town at an altitude of 700 m. The incorporated H+ was about one-half of the total deposited amount of H+ at the midtown. The ratios of the incorporated ions other than H+ to the total deposited amount of ions at the midtown ranged from 0.09 to 0.31. Therefore, the majority of ions deposited at the midtown was supplied from clouds. Sodium ion (Na+), Ca2+ and Mg2+ in, suspended particulate

matter (SPM) were more abundant during the rain period than the non-rain period. When the SPM concentration was high, the pH of raindrops was lowered by acidic components such as SO, which had increased in the atmosphere. Generation of H+ ion in raindrops near the ground could be due to the incorporation of SO, supplied from diesel exhaust gas. (C) 1997 Published by Elsevier Science Ltd. *Classification: 6,5.*

Taha, H. (1997) 'Urban climates and heat islands: Albedo, evapotranspiration, and anthropogenic heat', *Energy and Buildings,* **25, 99-103**

As an introduction to this special issue on urban heat islands and cool communities, this paper reviews some of the characteristics of urban climates and the causes and effects of urban heat islands. In particular, the impacts of surface albedo, evapotranspiration, and anthropogenic heating on the near-surface climate are discussed. Numerical simulations and field measurements indicate that increasing albedo and vegetation cover can be effective in reducing the surface and air temperatures near the ground. *Classification: 1,3,7.*

Takagi, M., Gyokusen, K. and Saito, A. (1998) 'Increase in the CO2 exchange rate of leaves of Ilex rotunda with elevated atmospheric CO2 concentration in an urban canyon', *International Journal of Biometeorology,* **42, 16-21**

It was found that the atmospheric carbon dioxide (CO2) concentration in an urban canyon in Fukuoka city, Japan during August 1997 was about 30 mu mol mol(-1) higher than that in the suburbs. When fully exposed to sunlight, in situ the rate of photosynthesis in single leaves of Ilex rotunda planted in the urban canyon was higher when the atmospheric CO2 concentration was elevated. A biochemically based model was able to predict the in situ rate of photosynthesis well. The model also predicted an increase in the daily CO2 exchange rate for leaves in the urban canyon with an increase in atmospheric CO2 concentration. However, in situ such an increase in the daily CO2 exchange rate may be offset by diminished sunlight, a higher air temperature and a lower relative humidity. Thus, the daily CO2 exchange rate predicted using the model based soleley on the environmental conditions prevailing in the urban canyon was lower than that predicted based only on environmental factors found in the suburbs. *Classification: 7,5.*

Tomiyasu, B., Arai, N., Koyama, H., Liu, G. L., Owari, M. and Nihei, Y. (1996) 'Source apportionment of individual airborne particle in underground center by using electron probe microanalyzer', *Nippon Kagaku Kaishi,* **500-507**

The airborne suspended particulate matter (SPM) in urban artificial space consists of many kinds of particles emitted from different sources. The air in these spaces seems to be polluted by SPM particles emitted from sources in these spaces and apart from these spaces. Specifying the emission source of SPM particle is an important subject for environmental hygiene. The composition of each SPM particle is directly related to its origin. The conventional source apportionment methods are based on the bulk chemical analysis. Bulk chemical analysis, however, cannot offer direct information about sources, because only an average composition of collected SPM particles is obtained from such analysis. In this study, we developed a novel approach to the source apportionment of

SPM particles by the combination of the sampling by the personal air sampler, the measurement of SPM weight concentration by the Piezo-balance mass monitor, the individual analysis by electron probe microanalyzer and a kind of multivariant cluster analysis, median cluster analysis, using composition of each particle. This method was applied to SPM particles collected at underground center, underground parking and the traffic route near the ventilation in these artificial spaces in Kyushu area. Three SPM samples were collected at different time on a day: morning, daytime and night. From the results, it was clear that (i) the air in these artificial spaces were polluted from the SPM particles emitted from these spaces and pollutants in outside atmosphere, (ii) the ventilating system in these artificial spaces had a large effect on the composition of SPM particles in the air in these spaces, (iii) the structure of artificial space and design of ventilating system are very important factors for the control of air pollution in artificial spaces. We concluded that the developed method is powerful for the source apportionment of airborne SPM particles of polluted urban atmosphere. *Classification: 5,2.*

Toriumi, R., Tai, H., Kuze, H. and Takeuchi, N. (1999) 'Tunable, UV solid-state lidar for measurement of nitric oxide distribution', *Japanese Journal of Applied Physics Part 1-Regular Papers Short Notes & Review Papers,* **38, 6372-6378**

A solid-state differential absorption lidar (DIAL) system was developed for nitric oxide monitoring. The ultraviolet (UV) light was generated through second-harmonic generation, subsequent to the sum-frequency mixing of the pulses from a Ti:sapphire laser, pumped by a frequency-doubled Nd:YAG laser, and from the fundamental of another Nd:YAG laser. The output pulse energy achieved in this way was 4 mJ at 226.8 nm with 2 pm linewidth. This DIAL system made it possible to measure the spatial distribution of nitric oxide emitted from a diesel engine installed at a distance of 130m from the lidar for demonstration of stack plume, with the detection accuracy of 0.065 ppm with a range resolution of 10 m. We also measured the background nitric oxide of the order of 10 ppb in the urban atmosphere. *Classification: 5.*

Toyoda, S., Tominaga, T. and Makide, Y. (1998) 'Cryogen-free automated gas chromatograph system for monitoring of halocarbons in the atmosphere at background concentration levels', *Analytical Sciences,* **14, 917-923**

An automated gas chromatograph/electron capture detector (GC/ECD) system is developed for the monitoring of major seven halocarbons in the atmosphere (CCl_2F_2: CFC-12, CCl_3F: CFC-11, CCl_2FCClF_2: CFC-113, CH_3CCl_3, CCl_4, $CHCl=CCl_2$, and $CCl_2=CCl_2$) at the tropospheric background concentration levels. By using two columns in series for each of two groups divided by the volatility of the compounds, the system requires neither cryogen for preconcentration nor any physical/chemical dryer for water removing. A sample amount of ca. 18 ml STP is sufficient to detect these species, and analysis of sub-ambient atmospheric-pressure sample in a canister is also possible. Monitoring of these halocarbon concentrations was carried out at 90-min intervals in the urban area. *Classification: 0.*

Trier, A. (1997) 'Submicron particles in an urban atmosphere: A study of optical size distributions .1', *Atmospheric Environment,* 31, 909-914

Atmospheric particle size distributions and number concentrations in the 0.065-0.900 mu m diameter range have been observed at a site in the city of Santiago de Chile from June 1992 to December 1994 by means of an active light-scattering spectrometer; such information was not previously available. Observed concentrations ranged from 2000 to 16,000 per cm(3).:Geometric mean diameters (GMD) for the distributions ranged from 0.100 to 0.160 mu m, while geometric standard deviations (GSD) ranged from 1.34 to 1.65 and volume-weighted mean diameters (VWD) ranged from 0.18 to 0.42 mu m. Scatter plots and time-ordered sequences for these parameters are shown as well as Spearman rank-difference correlations. Examples of the particle-number concentration distributions and of daily concentration trends are displayed and discussed. Copyright (C) 1996 Elsevier Science Ltd. *Classification: 8,6.*

Tripathi, B. D., Chaturvedi, S. S. and Tripathi, R. D. (1996) 'Seasonal variation in ambient air concentration of nitrate and sulfate aerosols in a tropical city, Varanasi', *Atmospheric Environment,* 30, 2773-2778

This study reports the seasonal variation in the ambient air concentration of sulfate and nitrate aerosols in the urban atmosphere of Varanasi, India, during the years 1991-1993. The city was hypothetically divided into six monitoring zones (I- VI), with five sampling points in each zone. Sulfate and nitrate concentrations (24-h average) ranged from 0.1 to 22.4 mu g m(-3) and 0.06 to 28.4 mu g m(-3), respectively. The maximum concentrations of sulfate and nitrate were observed at zones II and VI, respectively. However, the minimum concentrations of both pollutants were observed at zone I. Highest concentrations of sulfate and nitrate in the winter season followed by summer and rainy season revealed the effect of various seasons on the distribution pattern of sulfate and nitrate. Variation in NO3-/SO42- ratio indicates that ambient aerosol concentration depends on quality and quantity of primary pollutants released at the source. (C) 1996 Elsevier Science Ltd. *Classification: 5.*

Tsakiri, M., Stewart, M., Forward, T., Sandison, D. and Walker, J. (1998) 'Urban fleet monitoring with GPS and GLONASS', *Journal of Navigation,* 51, 382-393

The increasing volume of traffic in urban areas has resulted in steady growth of the mean driving time on fixed routes. Longer driving times lead to significantly higher transportation costs, particularly for vehicle fleets, where efficiency in the distribution of their transport tasks is important in staying competitive in the market. For bus fleets, the optimal control and command of the vehicles is, as well as the economic requirements, a basic function of their general mission. The Global Positioning System (GPS) allows reliable and accurate positioning of public transport vehicles except within the physical limitations imposed by built-up city 'urban canyons'. With a view to the next generation of satellite positioning systems for public transport fleet management, this paper highlights the limitations imposed on current cps systems operating in the urban canyon. The capabilities of a future positioning system operating in this type of environment are discussed. It is suggested that such a system could comprise receivers capable of

integrating the Global Positioning System (GPS) and the Russian equivalent, the Global Navigation Satellite System (GLONASS), and relatively cheap dead-reckoning sensors. *Classification: 5,2.*

Tuncel, S. G. and Ungor, S. (1996) 'Rain water chemistry in Ankara, Turkey', *Atmospheric Environment,* **30, 2721-2727**

Samples of rain water were collected in Ankara for the period between September 1989 and May 1990, by using wet-only sampler. Concentrations of major cations (H+, Na+, K+, Ca2+ and NH4+) and major anions (Cl-, NO3- and SO42-) were determined for the first time in Turkey. The rain water was not acidic owing to high concentrations of alkaline soil particles in the atmosphere. However, the concentrations of acid forming ions, such as SO42- and NO3-, were higher than the concentrations expected in a typical urban atmosphere. Most of the SO42- in rain water was in the form of CaSO4. Rain-aerosol coupling were examined by simultaneous sampling of aerosols with rain. The ions most efficiently scavenged from the atmosphere were found to be SO42- and Ca2+. (C) 1996 Elsevier Science Ltd. *Classification: 5,6.*

Ulke, A. G. and Mazzeo, N. A. (1998) 'Climatological aspects of the daytime mixing height in Buenos Aires city, Argentina', *Atmospheric Environment,* **32, 1615-1622**

An analysis of the climatic behavior of different parameters related to air quality in Buenos Aires city is presented. The principal statistical characteristics of hourly daytime mixing height distributions are studied. The cumulative frequencies of hourly daytime mixing height ranges are calculated. The frequencies of occurrence of daytime atmospheric stability conditions are obtained. An analysis of mixing heights and related atmospheric stability conditions is presented. The obtained mean mixing heights and standard deviations are smaller in winter and higher in summer. The lowest mixing heights occur in the morning with an increasing trend until the maximum at 14-15 LT and a slower decreasing rate toward sunset. The highest hourly daytime mean values derived for summer and winter, respectively, are 1170 and 592 m. The lowest are 547 and 261 m. The obtained standard deviations range from 289 to 638 m in summer and from 144 to 382 m in winter. The most commonly occurring mixing heights for a given time of the day are lower than the corresponding mean mixing heights and occur in the range 333-833 m in summer and 205-349 m in winter. There is an elevated frequency of occurrence of daytime mixing heights below 1500 m (99% in winter and 85% in summer). The more frequent daytime stability conditions are the near neutral, slightly unstable and unstable (96% in winter and 94% in summer). These stability conditions are associated with mixing heights below 1500 m. The smallest mean daytime mixing heights by stability category occur during winter, while the largest are obtained in summer, ranging, respectively, between 330 and 486 m and 716 and 1037 m. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 1,5,8.*

Upmanis, H., Eliasson, I. and Lindqvist, S. (1998) 'The influence of green areas on nocturnal temperatures in a high latitude city (Goteborg, Sweden)', *International Journal of Climatology,* **18, 681-700**

The air temperature pattern in three urban parks and their surrounding built-up areas was studied over a one and a half year period in Goteborg, Sweden. The measurements were made at mobile and permanent stations on nights with clear skies and light winds. The maximum temperature difference found between a park and a built-up area was 5.9 degrees C (summer), and the extension of the cool park climate into the built-up area was over 1100 m from the park border. Both the extension and the magnitude of the temperature difference depended on the size of the park and the distance from the park border. The green area cooled at a faster rate than the built-up area, although there were large variations within each area. At the rural station, located at an open site, the cooling was less than at the open part of the green area. Differences in sky obstruction between the sites explained some of the variations in cooling and temperature. However, the relationship between the urban-park temperature difference and sky view factor was not statistically significant. (C) 1998 Royal Meteorological Society. *Classification: 3,7.*

Vakeva, M., Hameri, K., Kulmala, M., Lahdes, R., Ruuskanen, J. and Laitinen, T. (1999) 'Street level versus rooftop concentrations of submicron aerosol particles and gaseous pollutants in an urban street canyon', *Atmospheric Environment,* **33, 1385-1397**

Gaseous air pollutants and aerosol particle concentrations were monitored in an urban street canyon for two weeks. The measurements were performed simultaneously at two different heights: at street level (gases 3 m, aerosol particles 1.5 m) and at a rooftop 25 m above the ground. The main objective of the study was to investigate the vertical changes in concentrations of pollutants and the factors leading to the formation of the differences. The physical parameters controlling the concentration gradients (e.g. the flow and micrometeorology) were not directly measured and the conclusions of the study rely mostly on the high time resolution concentration measurements. It was concluded that dilution and dispersion decreases the concentrations of pollutants emitted at street level by a factor of roughly 5 between the two sampling heights. However, for some compounds the chemical reactions were seen to be of more importance when the vertical gradient is formed. In order to determine the processes leading to gradients in aerosol particle concentrations the photochemical formation of submicrometer aerosol particles was investigated using a theoretical expression based on the measured data. It was clearly seen that most of the particles originate from traffic in the vicinity of the measurement site. Also a few events were detected which might have been due to local gas-to-particle conversion. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 8,5.*

Varshney, C. K. and Padhy, P. K. (1998) 'Total volatile organic compounds in the urban environment of Delhi', *Journal of the Air & Waste Management Association,* **48, 448-453**

Total volatile organic compounds (TVOCs) in the urban ambient environment of Delhi were monitored from November 1994 to June 1995 at 13 sites using an inexpensive and a manual-labor- intensive sample collection procedure in want of sophisticated equipment. The results of the study show appreciable levels of TVOCs in the ambient environment of Delhi. The amount of TVOCs in the ambient environment was found to vary between 3 and 42 ppmv and exhibited wide temporal and seasonal variations. On a diurnal cycle,

TVOC levels mostly peaked at 9:00 a.m., which coincided with the peak traffic hour. TVOC buildup in the urban atmosphere has serious implications for air quality through the formation of highly toxic oxidants. The results of this preliminary study make out a strong case for a regular monitoring of TVOCs in the urban environment of Delhi. *Classification: 5.*

Vasconcelos, M. and Tavares, H. M. F. (1998) 'Atmospheric metal pollution (Cr, Cu, Fe, Mn, Ni, Pb and Zn) in Oporto city derived from results for low-volume aerosol samplers and for the moss Sphagnum auriculatum bioindicator', *Science of the Total Environment,* **212, 11-20**

A low-volume aerosol sampler with filters and bags of Sphagnum auriculatum were exposed, in parallel, to the atmosphere of Oporto city for approx. 2 months in 1994, during a dry weather period. The levels of Cr, Cu, Fe, Mn, Ni, Pb and Zn in the moss (weekly samples) and in the filters (daily samples) were determined by atomic absorption spectrophotometry and the results were compared. For all the heavy metals, the rate of metal uptake by moss was significantly correlated with the metal concentration in atmospheric aerosols. The results indicated that moss bags of S. auriculatum can provide a quantitative estimation of the concentration of different heavy metals in urban atmospheres, when specific calibration by mechanic monitoring, at the same sampling point, is performed during a first stage of biomonitoring. The mean aerosol metal concentrations found in the Oporto atmosphere were similar to those observed in other urban atmospheres in different countries. The relative order of the mean metal concentrations was Fe (1.8 mu g/m(3))> Zn > Pb > Cu > Cr > Mn > Ni (20 ng/m(3)). The aerosol Pb levels were monitored at different sampling points over various periods of time between 1991 and 1997. The mean Pb levels were less than or equal to 0.5 mu g/m(3) and approximately constant at each sample point up to January 1996. After that date it decreased by approx. 50%, in consequence of the reduction of the Pb concentration in leaded gasoline. (C) 1998 Elsevier Science B.V. *Classification: 5,7.*

Vasileva, S. V. and Makhova, E. V. (1996) 'Genetic activity of ultralow doses of antitumor antibiotics and 2-nitrofluorene: Ecological aspects of the problem', *Izvestiya Akademii Nauk Seriya Biologicheskaya,* **676-680**

The genetic (mutagenic) activity of ultralow doses (below 1 x 10(-12) M) of the antitumor antibiotics, anthracyclines and bleomycin, as well as the typical pollutant and component of the urban atmosphere 2-nitrofluorene, was studied on the model of Salmonella typhimurium LT2 TA98 hisD3052. It was shown for the first time that carminomycin and 2-nitrofluorene at 1 x 10(-17) and 1 x 10(-22) M induced a two- to threefold increase in the number of revertants-prototrophs over the spontaneous background. The areas of increase (1 x 10(-15) M) and decrease (1 x 10(-19) and 1 x 10(-21) M) in the number of mutants, as compared with the spontaneous background, were found in the curve of dose dependence of the number of mutants in the presence of bleomycin. The results obtained were discussed in terms of their ecological importance. *Classification: 0.*

Voisin, C. (1997) 'Health effects of outdoor air pollution on susceptible populations. Necessity for a protection policy', *Bulletin De L Academie Nationale De Medecine,* **181, 499-523**

The shout term vulnerability of sections of the population to the harmful effects of chemical pollutants in the urban atmosphere represents an important unresolved problem of public health. These groups include young children, the elderly, asthmatic patients, and patients with chronic bronchitis and cardio-respiratory insufficiency. A recently ratified French law on air and rational energy use is aimed at resolving this problem in the context of recognizing that everybody has a right to breathe air which is not damaging to their health. In order to achieve this objective and direct the measures to be taken to reduce the emission of polluants relating to industrial activity, to heating and to road traffic, the law provides for an extension to the chain of automatic registering stations which enable the recording of atmospheric data in large urban centers. It also defines the limits of substances allowed in the air over given periods and revises the critical levels of particulate and gaseous polluants allowed according to current experimental and epidemiological data Thresholds for informing and for alerting the population will also be defined with eventually restrictive measures for industry and for car traffic envisaged. These provisions are a major step for the protection of susceptible populations and should be enhanced in the near future by extension to cover other potentially noxious substances. This requires continued study on the short and long term effects of atmospheric pollution on peoples' health. *Classification: 7,5.*

Volkamer, R., Etzkorn, T., Geyer, A. and Platt, U. (1998) 'Correction of the oxygen interference with UV spectroscopic (DOAS) measurements of monocyclic aromatic hydrocarbons in the atmosphere', *Atmospheric Environment,* **32, 3731-3747**

The measurement of monocyclic aromatic hydrocarbons by Differential Optical Absorption Spectroscopy (DOAS) and Differential Absorption LIDAR (DIAL) in the atmosphere suffers from interference by the three forbidden Herzberg band systems of O_2 and a fourth band system due to the dimers O_2-O_2 and O_2-N_2 at wavelengths below 287 nm. Due to the lack of reference spectra in digital form, until now the oxygen absorptions were difficult to eliminate from atmospheric absorption spectra. In this work, reference spectra of the Herzberg bands of oxygen are presented, that allow to eliminate this oxygen interference for practical purposes. Two sets of oxygen reference spectra were recorded between 240 and 290 nm with spectral resolutions of 0.15 nm (FWHM) and 0.05 nm. Spectra were taken at 240 and 720 m absorption path lengths in several mixtures of oxygen and nitrogen from 10% O_2/90% N_2 to 100% pure O_2 at atmospheric pressure (O_2 column densities from 6 x 10(22) to 1.8 x 10(24) molecules cm(-2)). At the resolution of the measurements, the rotational structure of the Herzberg I band Q-branches is not resolved. Therefore, saturation effects of individual transitions of the Herzberg I bands can cause the observed band shape to vary with the column density of oxygen. This apparent deviation from Lambert Beer's law can lead to problems with the oxygen correction of atmospheric DOAS measurements. In the practical application of the oxygen reference spectra, additional problems arise, because the ratio of molecular absorption in the Herzberg bands and dimer absorption changes when the partial pressure of oxygen is varied. Even though this effect is reduced due to the presence of N_2 it needs to be accounted for, if the spectra are applied to atmospheric measurements. Solutions to

these problems are discussed and demonstrated together with methods to optimize DOAS measurements of aromatic hydrocarbons. As sample application the oxygen reference spectra were used to correct DOAS measurements of monocyclic aromatic hydrocarbons carried out in the urban air of Heidelberg. Simultaneous time series of mixing ratios are presented for benzene, toluene, p- xylene, m-xylene and phenol. Mean concentrations were found to be 1.8, 2.5, 0.8, 1.2 ppb and 77 ppt, respectively. The spectra are available in digital form from the authors upon e-mail request. (C) 1998 Elsevier Science Ltd. All rights reserved. *Classification: 0.*

Voogt, J. A. and Oke, T. R. (1997) 'Complete urban surface temperatures', *Journal of Applied Meteorology,* **36, 1117-1132**

An observation program using ground and airborne thermal infrared radiometers is used to estimate the surface temperature of urban areas, taking into account the total active surface area. The authors call this the complete urban surface temperature. This temperature is not restricted by the viewing biases inherent in remote sensors used to estimate surface temperature over rough surfaces such as cities, Two methods to estimate the complete surface temperature are presented. Results for three different land-use areas in the city of Vancouver, British Columbia, Canada, show significant differences exist between the complete, nadir, and off-nadir airborne estimates of urban surface temperature during daytime. For the sites and times studied, the complete surface temperature is shown to agree with airborne off-nadir estimates of the apparent surface temperature of the most shaded walls. Some implications of using the complete surface temperature to estimate screen level air temperature and to calculate surface sensible heat flux are given. *Classification: 1,3.*

Voogt, J. A. and Oke, T. R. (1998a) 'Effects of urban surface geometry on remotely-sensed surface temperature', *International Journal of Remote Sensing,* **19, 895-920**

Direct observations of urban surface temperature in daytime are made using a thermal scanner mounted in a helicopter over three land-use areas in Vancouver, B.C. The results reveal strong directional variations in the observed apparent surface temperature. The variations arise due to the differential patterns of irradiated and shaded surfaces within the sensor field of view created by the three-dimensional urban surface structure and the position of the Sun. The directional variations may be considered to be a form of effective anisotropy due to the large scale roughness of the urban surface. Variations in excess of 9 degrees C were measured over a downtown area. Urban residential and light industrial land- use areas also exhibited strong effective anisotropy. The directional temperature variations are of similar magnitude to atmospheric corrections applied to thermal imagery. This implies that effective anisotropy should receive serious consideration in the interpretation of thermal imagery obtained over urban areas. The scale dependence of the effective anisotropy is discussed. *Classification: 3.*

Voogt, J. A. and Oke, T. R. (1998b) 'Radiometric temperatures of urban canyon walls obtained from vehicle traverses', *Theoretical and Applied Climatology,* **60, 199-217**

Building walls form an important component of the total surface area in cities, but are not generally considered in most attempts to measure urban surface temperatures. A procedure which allows sampling of the spatial and temporal variation of wall surface temperatures in urban areas is presented. Radiometric surface temperatures are monitored using an array of infrared thermometers mounted on a moving vehicle. It is necessary to remove observations which view sky, or mixed sky and building scenes. Distribution truncation and distribution modelling are investigated as methods to remove the unwanted observations. Use of the traverse method in several urban areas reveals strong temporal variations in wall temperatures due to solar loading. Significant spatial variations in temperatures suggest caution be used in the extrapolation of data from single canyon studies to larger scales. Times of strong surface temperature contrast between different walls are linked to canyon and solar geometry. In the light industrial and residential observation areas, north-south streets show mid- morning and late afternoon peaks of approximately equal magnitude in the difference between wall surface temperatures. East-west streets show a single peak in the hour following solar noon. The downtown study area, with streets oriented northeast-southwest and northwest-southeast, shows a double wave pattern with one peak dominant. These patterns are of interest because they can lead to large biases in remotely- observed surface temperature with view direction. *Classification: 3*.

Wallinder, I. O. and Leygraf, C. (1997) 'A study of copper runoff in an urban atmosphere', *Corrosion Science,* **39, 2039-2052**

Initiated by the concern in several countries regarding the release of copper from, e.g., roofs, facings and other outdoor constructions, the present study aims to compare runoff rates with corrosion rates during exposure of copper in an urban atmosphere. The copper runoff rate turns out to be relatively stable during the 2 year period studied, with an average rate per year of around 135 mu g Cu cm(-2). This stable runoff rate is associated with the formation and dissolution properties of cuprite (Cu_2O), which is the dominating copper patina phase throughout the 2 year period. The copper corrosion rate, on the other hand, is highly time-dependent. It exhibits an initially high value and decreases with exposure time. As a consequence, the ratio between copper runoff and copper mass loss is very low in the beginning, around 7% after 1 month, and increases with time to reach around 22% after 2 years. With prolonged exposure this ratio eventually reaches 100%, corresponding to a copper patina thickness that does not change any further with time. (C) 1997 Elsevier Science Ltd. *Classification: 6,5*.

Yadav, A. K., Raman, S. and Sharan, M. (1996) 'Surface layer turbulence spectra and dissipation rates during low winds in tropics', *Boundary-Layer Meteorology,* **79, 205-223**

Spectral characteristics of surface layer turbulence in an urban atmosphere are investigated. The observations used for this purpose represent low wind conditions in the tropics. The normalized power spectral shapes exhibit the usual characteristics in the inertial subrange and obey Monin- Obukhov scaling. However, the low-frequency behaviours do not conform to the previous observed relations. For horizontal components, large energy is contained in the low frequencies in contrast to the vertical component

where roll-off to zero frequency is faster. The turbulent kinetic energy dissipation rate estimated from the spectra using Kolmogorov's inertial subrange law is found to be isotropic unlike the velocity variances. The expressions for the dimensionless dissipation rate do not seem to work well in low winds in an urban atmosphere. For the data considered, the dissipation rate exhibits a power law relationship with the mean windspeed and the friction velocity. *Classification: 8.*

Yerrapragada, S. S., Chirra, S. R., Jaynes, J. H., Li, S., Bandyopadhyay, J. K. and Gauri, K. L. (1996) 'Weathering rates of marble in laboratory and outdoor conditions', *Journal of Environmental Engineering-Asce,* **122, 856-863**

In the modern urban atmosphere SO_2 and NO_2 attack calcite ($CaCO_3$) in marble exposed at rain-sheltered surfaces creating largely gypsum ($CaSO_4 . 2H(2)O$) crusts that eventually exfoliate. In combination with CO_2 these gases erode the marble at unsheltered surfaces. We report the development of mathematical models to predict the rate of growth of crust and the rate of surface recession. To determine the rate of growth of crust the kinetic rate constant, diffusion rate, and the order of reaction were determined by the application of the shrinking-core model applied to data generated in laboratory experiments. Based on these parameters and average ambient levels of 10 parts per billion (ppb) SO_2 and 25 ppb NO_2 in Louisville, Ky., the rate of crust formation for this metro area was calculated to be 1.8 mu m in the first year. However, the rate of recession was modeled from data obtained by exposing marble slabs to rainfalls. A surface recession of 15 mu m/yr was calculated. The models predicted well the rate of growth of crust observed at several sites in Louisville and the predicted surface recession compared well with values reported in the literature. *Classification: 5,2.*

Yu, J. Z. and Jeffries, H. E. (1997) 'Atmospheric photooxidation of alkylbenzenes .2. Evidence of formation of epoxide intermediates', *Atmospheric Environment,* **31, 2281-2287**

Photooxidation experiments of six alkylbenzene compounds were conducted under simulated atmospheric conditions. Carbonyl products with their molecular weights matching a series of epoxide carbonyls were observed. This observation supports the supposition formation of epoxide intermediates as suggested by Bartolotti and Edney's theoretical calculations. These epoxide intermediates are also consistent with recently observed prompt HO_2 formation upon hydroxyl radical attack on the ring. An alternative origin of the observed epoxides might be from a second OH attack upon the epoxide/oxepin intermediate proposed by Barnes et al. (1996, Air & Waste Management Association 89th Annual Meeting and Exhibition, Nashville). Because of the potential toxicity and mutagenicity of the epoxide products, the atmospheric chemistry of these epoxide compounds should be studied in greater detail with indoor and outdoor chamber and in field experiments to assess their role in the urban atmosphere. (C) 1997 Published by Elsevier Science Ltd. *Classification: 0.*

Zappia, G., Sabbioni, C., Riontino, C., Gobbi, G. and Favoni, O. (1998) 'Exposure tests of building materials in urban atmosphere', *Science of the Total Environment,* **224, 235-244**

Samples of stones and mortars (air setting and hydraulic) characteristic of ancient masonry and modern conservation works were exposed in Milan and Ancona for a period of 6, 12 and 24 months. After exposure, the samples were analysed. As previously observed on carbonate rocks, the data obtained highlight that sulphation also occurs on mortars (which are more reactive than stones), producing an intermediate product, i.e. calcium sulphite. Sulphate and sulphite, alongside nitrate and nitrite, typical of urban atmospheric deposition, were found in greater amounts in the samples exposed in Milan, while chloride, a typical sea-site tracer, was found higher in Ancona. (C) 1998 Elsevier Science B.V. All rights reserved. *Classification: 5,2*.