BIBLIOGRAPHY OF URBAN CLIMATE

2000-2004

Prepared by

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## Classification system

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### Summary of paper classification

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The experimental work of this paper has been conducted over a period of one year, starting in January 1997, for measurement of air pollutants and meteorological parameters in the urban atmosphere of the Khaldiya residential area in Kuwait. The measurements were carried out simultaneously every 5 minutes by using the Kuwait University mobile air pollution monitoring laboratory (Chemical Engineering Department). The main emphasis of the paper has been placed on the problem of ozone for those days that are characterized by events of photochemical smog. The first objective of this paper deals specifically with the use of the Integrated Empirical Rate (IER) photochemical kinetic mechanism that has been developed at the Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia as a screening tool for photochemical smog assessment. The IER has been used to determine whether the local photochemistry of ozone events is light-limited (VOC-limited) or NOchi-limited. Such information is necessary in developing an effective emission control plan and enables the decision as to whether NO, or NMHC emission needs to be controlled. On the other hand, the available models to predict the concentrations of ozone are complex and require a number of input data that are not easily acquired by environmental protection agencies or local industries. Thus, the second objective concerns the short-term forecasting of ozone concentration based on a neural network method. Classification: 0.


This paper presents a statistical model that is able to predict carbon monoxide (CO) concentrations as a function of meteorological conditions and various air quality parameters. The experimental work was conducted in an urban atmosphere, where the emissions from cars are prevalent. A mobile air pollution monitoring laboratory was used to collect data, which were divided into two groups: a development group and a testing group. Only the development dataset was used for developing the model. The model was determined by using a stepwise multiple regression modelling procedure. Thirteen independent variables were selected as inputs: non-methane hydrocarbon (NMHC), methane (CH4), suspended dust, carbon dioxide (CO2), nitrogen oxide (NO), nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O-3), wind speed, wind direction, temperature, relative humidity and solar energy. It was found that NO has the most effect on the predicted CO concentration. The contribution of NO to the CO concentration variations was 91.3%. Adding in the terms for NO2, NMHC and CH4 improved the model by only a further 2.3%. The derived model was shown to be statistically significant, and model predictions and experimental observations were shown to be consistent. Classification: 0.

An integrated method for the prediction of the spatial pollution distribution within a street canyon directly from a microscopic traffic simulation model is outlined. The traffic simulation package Paramics is used to model the flow of vehicles in realistic traffic conditions on a real road network. This produces details of the amount of pollutant produced by each vehicle at any given time. The authors calculate the dispersion of the pollutant using a particle tracking diffusion method which is superimposed on a known velocity and turbulence field. This paper shows how these individual components may be integrated to provide a practical street canyon pollution model. The resulting street canyon pollution model provides isoconcentrations of pollutant within the road topography. *Classification: 5,8.*


*Classification: 3,2*

Agrawal, M., Singh, B., Rajput, M., Marshall, F. and Bell, J. N. B. (2003) 'Effect of air pollution on peri-urban agriculture: a case study Urban air pollution has a negative impact on peri-urban agriculture', *Environmental Pollution*, 126, 323-330

*Classification: 5.*


The exhaust dispersion in the close vicinity of urban roadways and intersections takes place under the joint influence of natural and vehicle-induced turbulence. The physical simulation studies of vehicular exhaust using wind tunnels have shown high potential to understand complex dispersion mechanisms. One of the vital components of simulation in the environmental wind tunnel (EWT) is the design of model vehicle movement system (MVMS). An efficient design of MVMS is a foremost requirement for carrying out exhaust dispersion studies in the EWT, otherwise it may adversely affect the atmospheric boundary layer. Therefore, an attempt has been made to critically review the previously used MVMS in exhaust dispersion studies. Further, sophisticated MVMS with real traffic situation for urban streets at various configurations has been designed and developed. The MVMS for urban streets and intersection has been successfully operated for variable traffic volume and speed as seen in real life situation. In addition, multi-lane traffic for two-way urban roads has also been successfully operated. The dispersion results revealed that the traffic induced turbulence at low wind condition causes considerable amount of pollutant
Al Jiboori, M. H., Xu, Y. M. and Qian, Y. F. (2002) 'Local similarity relationships in the urban boundary layer', Boundary-Layer Meteorology, 102, 63-82

To investigate turbulent structures in an urban boundary layer (UBL) with many tall buildings, a number of non-dimensional variable groups based on turbulent observations from a 325-m meteorological tower in the urban area of Beijing, China, are analyzed in the framework of local similarity. The extension of surface-layer similarity to local similarity in the stable and unstable boundary layer is also discussed. According to local similarity, dimensionless quantities of variables: e.g., velocity and temperature standard deviations $\sigma_i / u^*(1)$ ($i=u,v,w$) and $\sigma_T / T^*$, correlation coefficients of $uw$ and $wT$ covariance, gradients of wind and temperature $\Phi(m)$ and $\Phi(h)$, and dissipation rates of turbulent kinetic energy (TKE) and temperature variance $\Phi(\epsilon)$ and $\Phi(N)$ can be represented as a function only of a local stability parameter $z/\Lambda$, where $\Lambda$ is the local Obukhov length and $z$ is the height above ground. The average dissipation rates of TKE and temperature variance are computed by using the $u$ spectrum, and the $uw$ and $wT$ cospectra in the inertial subrange. The functions above were found to be in a good agreement with observational behaviour of turbulence under unstable conditions, but there were obvious differences in the stable air. Classification: 8.


Measurements are reported of particle number concentration at two urban sites within Birmingham, UK. The measurements were made with a condensation particle counter (TSI Model 3022A) and an ultrafine particle counter (TSI Model 3025) operated in tandem. Other colocated measurements included particle surface area by epiphanimeter, sulfur dioxide, oxides of nitrogen and ozone, solar radiation or $J(O)(1)(D)$, and in some campaigns, particle number size distribution by Scanning Mobility Particle Sizer. Events were identified when substantial excursions in particle number count were accompanied by a divergence between the two particle counters indicating a large number of particles in the 3-7 nm diameter range. Criteria have been developed to distinguish between particles within this size range arising from homogeneous nucleation within the atmosphere and from emissions from point sources. Out of a total of 232 days sampling distributed throughout the year, events on only 8 days could be attributed fairly unequivocally to homogeneous nucleation processes, with a further 4 days possibly attributable. Nucleation events occur in winter as well as summer months, but depend, among other things, upon a low particle surface area. Modeling of aerosol dynamical processes for 20 June 1999, indicates that the observations can be explained by a nucleation rate of $6 \times 10^6 \text{ cm}^{-3} \text{s}^{-1}$ at a condensable vapor concentration (as H2SO4) of $6.5 \times 10^7 \text{ cm}^{-3}$. It is inferred that both the nucleation and particle growth processes involve condensable molecules other than, or in addition to, sulfuric acid. Classification: 5.

The performance of an aerosol module of the three-dimensional Eulerian model CAMx (Comprehensive Air Quality Model with Extensions) was evaluated in a domain covering the Po Basin in northern Italy. Concentrations of secondary aerosol species such as particulate NO3-, NH4+, SO42-, and SOC (secondary organic carbon) were calculated for the particle size below 2.5 μm and compared with the data available from a field experiment, which took place in May - June 1998. Model results for the inorganic aerosols were comparable to the measurements at an urban and a rural station. Sensitivity studies with reduced anthropogenic NOx and volatile organic carbon (VOC) emissions showed that SOC behaves in the same way as ozone, i.e., decreases with reduced VOC emissions and increases with reduced NOx emissions in the plume where ozone production is predicted to be VOC sensitive. Sensitivity of secondary aerosol formation to NH3 and NOx emissions was studied by reducing these emissions. Varying NH3 emissions led to an almost linear change in secondary aerosol mass at sites with low NH3. At ammonia-rich sites, on the other hand, availability of nitrate became important for the further formation of secondary aerosols. Monoterpene emissions were predicted to contribute about 25% of the secondary organic aerosols produced in the northern part of the model domain, which is mostly a forested area. Classification: 5.


The hygroscopic nature of atmospheric aerosol has generally been associated with its inorganic fraction. In this study, a group contribution method is used to predict the water absorption of secondary organic aerosol (SOA). Compared against growth measurements of mixed inorganic-organic particles, this method appears to provide a first-order approximation in predicting SOA water absorption. The growth of common SOA species is predicted to be significantly less than common atmospheric inorganic salts such as (NH4)(2)SO4 and NaCl. Using this group contribution method as a tool in predicting SOA water absorption, an integrated modeling approach is developed combining available SOA and inorganic aerosol models to predict overall aerosol behavior. The effect of SOA on water absorption and nitrate partitioning between the gas and aerosol phases is determined. On average, it appears that SOA accounts for approximately 7% of total aerosol water and increases aerosol nitrate concentrations by approximately 10%. At high relative humidity (greater than or equal to 85%) and low SOA mass fractions (<20% of total PM2.5), the role of SOA in nitrate partitioning and its contribution to total aerosol water is negligible. However, the water absorption of SOA appears to be less sensitive to changes in relative humidity than that of inorganic species, and thus at low relative humidity (similar to 50%) and high SOA mass fraction concentrations (similar to 30% of total PM2.5), SOA is predicted to account for approximately 20% of total aerosol water and a 50%
increase in aerosol nitrate concentrations. These findings could improve the results of modeling studies where aerosol nitrate has often been underpredicted. Classification: 0.


An urban canyon energy budget simulation model is described. The model is simple and computationally inexpensive enough to permit characterization of the spatial and temporal variability of canyon energy exchanges by running multiple cases. It is two-dimensional and dry and avoids the necessity for computational fluid dynamical calculations by using parameterizations for the down-canyon wind profile and cross-canyon vortex flow and by employing an exchange coefficient formulation for sensible heat loss from the walls. These are combined with radiation calculations using the procedure of Arnfield (1976, 1982) and substrate heat fluxes computed using the Fourier heat conduction equation and wall and floor thermal property information. The model is validated against the measured canyon energy budget data of Nunez and Oke (1977) and reproduces these data quite well, with Willmott indices of agreement in the range 0.91 to 1.00 and root-mean-square errors of 14 to 46 W m\(^{-2}\) for individual facets and for the total canyon system. The poorest correspondence was for the substrate heat flux, the maxima for which were overestimated, suggesting use of excessively large facet thermal properties. These inputs were adjusted based on the measurement-simulation discrepancies, leading to further improvement in model performance. The adjusted thermal properties are consistent both with published data and with the available information on the morphological characteristics of the canyon. Classification: 3.


Classification: 8,7.


Progress in urban climatology over the two decades since the first publication of the International Journal of Climatology is reviewed. It is emphasized that urban climatology during this period has benefited from conceptual advances made in microclimatology and boundary-layer climatology in general. The role of scale, heterogeneity, dynamic source areas for turbulent fluxes and the complexity introduced by the roughness sublayer over the tall, rigid roughness elements of cities is described. The diversity of urban heat islands, depending on the medium sensed and the sensing technique, is explained. The review focuses on two areas within urban climatology. First, it assesses advances in the study of selected urban climatic processes relating to urban atmospheric turbulence (including surface roughness) and exchange processes for energy and water, at scales of consideration ranging from...
individual facets of the urban environment, through streets and city blocks to
neighbourhoods. Second, it explores the literature on the urban temperature field. The
state of knowledge about urban heat islands around 1980 is described and work since
then is assessed in terms of similarities to and contrasts with that situation. Finally, the
main advances are summarized and recommendations for urban climate work in the
future are made. Copyright (C) 2003 Royal Meteorological Society. Classification: 1.

Arnold, S. J., ApSimon, H., Barlow, J., Belcher, S., Bell, M., Boddy, J. W.,
Britten, R., Cheng, H., Clark, R., Colville, R. N., S. Dimitroulopoulou,
A. Dobre, B. Greally, S. Kaur, A. Knights, T. Lawton, A. Makepeace,
D. Martin, M. Neophytou, Neville, S., M. Nieuwenhuijsen, G. Nickless,
C. Price, A. Robins, D. Shallcross, P. Simmonds, R. J. Smalley, J. Tate,
Air Pollution Project', Science of the Total Environment, 332, 139-153

numerical study of atmospheric pollutant dispersion in different two-
dimensional street canyon configurations', Atmospheric Environment, 37,
4037-4049

The scope of this paper is to study numerically the dispersion of atmospheric
pollutants within different street canyon geometrical configurations and building
height scenarios. The microscale model MIMO, designed to take into account
pollution dispersion in the vicinity of buildings, is validated against a two-
dimensional wind-tunnel experiment for a square (W/H = 1) and a deep canyon (W/H
= 1/2) configuration. It was found that the model performance is satisfactory. Having
established this, the study involved the alteration of the building heights bounding the
canyon for both square and deep configurations. Furthermore, the effects of different
aspect ratios on the pollution dispersion characteristics are investigated. It is
demonstrated that, under certain conditions, pollutants disperse more easily, while
under others pollutant levels increase, with implications for pedestrian exposure.
Furthermore, interaction of air in and above the canyons is investigated under
different street geometries. It is found that both street geometry and building height
influence the interaction between air inside and above the canyons. (C) 2003 Elsevier
Ltd. All rights reserved. Classification: 8, 5.

Boundary Layer Meteorology, 109, 285-310

A three-dimensional, non-hydrostatic, high-resolution numerical model was used to
analyse urban heat-island (UHI) intensity in an idealised but realistic configuration.
The urban area was 20 km square and lay on flat land at about latitude 50 degrees N in
a maritime climate. In the model the urban area was represented by anomalies of
albedo, anthropogenic heat flux, emissivity, roughness length, sky-view factor (SVF),
surface resistance to evaporation (SRE) and thermal inertia. A control simulation
included all these factors and the resultant UHI structure, energetics and intensity were validated against observations. The results also compared favourably with earlier simulations.

A series of experiments was conducted in which successively one of the anomalies that represented the urban area was omitted from the control simulation so as to provide the basis for an assessment of its effect. In daytime the individual effects due to albedo, anthropogenic heat, emissivity, SVF and thermal inertia ranged from 0.2 to 0.8 degreesC. In common with albedo, anthropogenic heat, emissivity and SVF, the SRE aided the formation of a UHI; it was also the most important factor in increasing its intensity. The roughness length had the opposite effect. At night emissivity, roughness length, SVF and SRE had effects ranging from 0.3 to 0.75 degreesC, but the largest effect (2 degreesC) was due to the anthropogenic heat. These results showed a difference in the causes of daytime and nighttime UHIs. In daytime the roughness length and SRE were the most important factors affecting UHI intensity; at night the anthropogenic heat was the most important. The simulations suggested that the size of the urban area had a minimal effect on UHI intensity. Classification: 4.


Mixing ratios of acetic (CH₃COOH), formic (HCOOH), pyruvic (CH₃COCOOH), and oxalic ((COOH)(2)) acids were measured both in gas and particulate phase in the marine boundary layer, over the Atlantic Ocean from 63 degrees N to 39 degrees S on board of the RN Polarstern in October/November 1996. The average mixing ratios for gas phase CH₃COOH, HCOOH, CH₃COCOOH, and (COOH)(2) were 291.2 +/- 151.9, 448.7 +/- 182.1, 1.1 +/- 1.0, and 6.1 +/- 5.4 parts per trillion by volume (pptv), respectively. The partitioning of these acids in the aerosol phase and the size distribution of their particulate form was also investigated. In the fine mode the mean mixing ratios for acetate, formate, pyruvate, and oxalate were 69.7 +/- 47.5, 32.5 +/- 39.4, 1.0 +/- 1.0, and 5.1 +/- 3.7 pptv, respectively. Elevated levels of all organic acids were encountered in the southern hemisphere (springtime) compared to the northern hemisphere (autumn), indicating a possible seasonal variation in their source strength and/or enhanced photochemical production. The observed distributions of formic and acetic acids have been compared to the results of a global chemistry/transport three-dimensional model. The model results show that acetic acid has mainly secondary photochemical sources (about 120 Tg CH₃COOH/yr). On the opposite, the known chemical sources of HCOOH are quite weak (20 Tg HCOOH/yr) and insufficient to simulate the HCOOH levels observed in the marine atmosphere. A local marine source of HCOOH of about 50 Tg/yr on a global scale is required to reasonably simulate the observations in the marine atmosphere. Classification: 0.

Two semicontinuous elemental and organic carbon analyzers along with daily integrated samplers, which were used for laboratory elemental and organic carbon analysis, were operated to measure PM2.5 organic carbon (OC) and elemental carbon (EC) for the entire year of 2002 at the St. Louis Midwest Supersite. The annual-average denuded OC and EC concentrations were 3.88 and 0.7 μg/m(3), respectively. A comparison of the 24-hr average denuded and undenuded OC measurements showed a positive bias for the undenuded OC measurement that was best represented by a positive intercept of 0.34 +/- 0.1 μg/m(3) and a slope of 1.06 +/- 0.02, with an R-2 of 0.91. The full year of daily EC and OC measurements was used to demonstrate that a one-in-six-day sampling strategy at this site accurately represents the annual average concentrations. Although fine particle OC concentrations did not correlate with day of the week, EC concentrations showed a significant weekly pattern, with the highest concentration during the middle of the workweek and the lowest concentration on Sundays. Hourly EC and OC measurements yielded average diurnal patterns for the EC to OC ratio that peaked during morning rush hour traffic on weekdays but not on weekends. Classification: 5.


Classification: 1.


Pollutant transport from urban street canyons is numerically investigated using a two-dimensional flow and dispersion model. The ambient wind blows perpendicular to the street and passive pollutants are released at the street level. Results from the control experiment with a street aspect ratio of 1 show that at the roof level of the street canyon, the vertical turbulent flux of pollutants is upward everywhere and the vertical flux of pollutants by mean flow is upward or downward. The horizontally integrated vertical flux of pollutants by mean flow at the roof level of the street canyon is downward and its magnitude is much smaller than that by turbulent process. These results indicate that pollutants escape from the street canyon mainly by turbulent process and that the net effect of mean flow is to make some escaped pollutants reenter the street canyon. Further experiments with different inflow turbulence intensities, inflow wind speeds, and street aspect ratio confirm the findings from the control experiment. In the case of two isolated buildings, the horizontally integrated vertical flux of pollutants by mean flow is upward due to flow separation but the other main results are the same as those from the control experiment. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 8,5.

A three-dimensional computational fluid dynamics (CFD) model is developed to simulate urban flow and dispersion, to understand fluid dynamical processes therein, and to provide practical solutions to some emerging problems of urban air pollution. The governing equations are the Reynolds-averaged equations of momentum, mass continuity, heat, and other scalar (here, passive pollutant) under the Boussinesq approximation. The Reynolds stresses and turbulent fluxes are parameterized using the eddy diffusivity approach. The turbulent diffusivities of momentum, heat, and pollutant concentration are calculated using the prognostic equations of turbulent kinetic energy and its dissipation rate. The set of governing equations is solved numerically on a staggered, nonuniform grid system using a finite-volume method with the semi-implicit method for pressure-linked equation (SIMPLE) algorithm. The CFD model is tested for three different building configurations: infinitely long canyon, long canyon of finite length, and orthogonally intersecting canyons. In each case, the CFD model is shown to simulate urban street-canyon flow and pollutant dispersion well.


A circulating water channel is constructed to examine urban street-canyon flow. In the cases of an even-notch street canyon in which model buildings on both sides of the street have equal heights, one vortex is observed in model canyons with aspect ratios of 1 and 1.5, and two counterrotating vortices are observed in canyons with aspect ratios of 2, 2.4, and 3. In all of the even-notch cases, the center of the vortex (or the upper vortex) is located slightly downstream of the canyon center, and the downward motion downstream is stronger than the upward motion upstream. The magnitudes of the maximum updraft and downdraft are almost independent of the aspect ratio. In the case of a stepup notch, one vortex is observed in the canyon. In the case of a stepdown notch, two counterrotating vortices are observed. The upper vortex resembles to some extent an isolated roughness flow, and the lower vortex is characterized by a skimming flow. It is shown that the results of the water-channel experiments are generally in good agreement with those simulated using a numerical model with a turbulent kinetic energy-dissipation (k-epsilon) turbulence closure scheme, although there is a noticeable difference in the relative strengths of the upper and lower vortices in the two-vortex regime. This study demonstrates that the circulating water channel is useful for the study of street-canyon flow.


This work presents the results of one-year monitoring study of Volatile Hydrocarbons, VHCs, in the atmosphere of Athens. It is the first systematic attempt to determine the VHC levels in the Athens' atmosphere with the very well known photochemical pollution problems. The purpose of this work was to create a database concerning VHCs in order to evaluate the photochemical pollution in this area (ozone creation, case studies and meteorology). Totally, 308 samples were collected at three different
sites used in the state-monitoring programme involving the criteria pollutants. Air samples were collected on Tenax TA tubes and analysed by thermal desorption and dual column GC dual FID. Fifteen selected compounds were studied; 6 alkanes and 9 benzenoid compounds. The measured values of individual alkanes ranged from 0.39 mug m(-3) to 33 mug m(-3), and those of aromatics from 0.20 mug m(-3) to 616 mug m(-3). The sum of all 15 VHC concentrations ranged between 16 and 1697 mug m(-3). The time and spatial variations in the concentration of these compounds were assessed. Volatile hydrocarbons exhibited a clear seasonal and time cycle, showing higher concentrations during winter and early morning hours. Study of the spatial variations of VHC levels showed higher concentrations at the center of the city. The variation of toluene/benzene ratio and the correlation between VHCs, criteria pollutants (CO, NOx and O-3) and meteorological parameters were also assessed. It was demonstrated that a trip-line of the VHCs concentration at the city center doubles the ozone concentration at peripheral areas under favourable meteorological conditions. Classification: 5.


This paper considers the flow velocities and the dispersion of pollutants in the wake of a number of different types of ground vehicles. It does this mainly through a collation of the results of a number of experimental, numerical and analytical investigations carried out by the author and his co-workers over the last few years, and a comparison of these results with the work of other investigators. It is shown that the wakes of ground vehicles may be conveniently taken to consist of two regions: a near wake and a far wake. The near wake is characterised by large scale recirculation and longitudinal vortex structures, with unsteady fluctuations caused by a variety of effects, including instability of the separated shear layer and wake pumping. In the far wake there are no discernible flow structures with a steady decay of the velocity field, with the major component of wake unsteadiness being at large scales. The effect of cross-winds is to translate and diffuse the wake, with the balance between the two effects changing depending upon the nature of the surrounding topography. Only a relatively few measurements have been made of dispersion within vehicle wakes, other than in the rather complex case of vehicles in street canyons. However, there are a number of analytical solutions of wake dispersion that have, to some extent, been validated by comparison with full-scale experiments. On the basis of these investigations, it is suggested that the lower frequency fluctuations in vehicle wakes may have an effect on the dose of pollutants received by pedestrians at the roadside, and more work is suggested to quantify this further. (C) 2001 Academic Press. Classification: 5,8.


A wind tunnel study of pollution dispersion in the wake of a moving vehicle in a cross-wind has been performed in which a 1/50th scale lorry was fired across an environmental wind tunnel with a simulated boundary layer. A flame ionization
detector was positioned at various distances downwind of the model to measure the propane which was emitted by the lorry. Individual time series of propane concentration and ensemble averages thereof provided extensive information about the nature of wake-wind interaction and its effects on the dispersion process. Results from both a rural roadway and an urban street canyon are presented. The results were used to assess the validity of a numerical model, PUFFER (Hargreaves and Baker, J. Wind Eng. Ind. Aerodyn. 69-71 (1997) 927). It was found that the model performed best when employing an auto-regressive moving average (ARMA)-generated wind time series as input. Ensemble averages of several model runs, each started with a differently seeded ARMA model, showed encouraging agreement with the experimental ensemble averages. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 5,8.


Classification: 1,2.


Phoenix, Arizona has both a strong urban heat island and a large near-surface atmospheric CO2 "dome" during periods of atmospheric stability. In this investigation, we use a detailed one-dimensional infrared radiation simulation model to determine the thermal impact of the elevated CO2 levels in the urban environment. We find that the increased CO2 concentrations below the inversion layer contribute only slightly to the observed heat island, which suggests that other factors, such as absorption of solar energy by urban surface materials and lower soil moisture levels, are largely responsible for the observed increase in urban temperatures. Classification: 3,1,5.


Flow over urban surfaces depends on surface morphology and interaction with the boundary layer above. However, the effect of the flow on scalar fluxes is hard to quantify. The naphthalene sublimation technique was used to quantify scalar vertical fluxes out of a street canyon under neutral conditions. For an array of eight canyons with aspect ratio H/W=0.75 (here, H is building height and W is the street width), increased flux was observed in the first two or three canyons for moderate and low roughness upstream. This is consistent with predictions of the length scale for initial adjustment of flow to an urban canopy. The flux was constant after the initial adjustment region and thus dependent only on local geometry. For a street canyon in
the ‘equilibrium’ part of the array, each facet of the street canyon was coated with naphthalene to simulate scalar release from street, walls and roof, to evaluate the effect of street canyon geometry on fluxes for H/W=0.25, 0.6, 1 and 2. Fluxes from the roof and downstream wall were considerably larger than fluxes from the street and upstream wall, and only the flux from the downstream wall exhibited a simple decrease with H/W. For each H/W there was a monotonic decrease between downstream wall, street and upstream wall transfer. This suggests that flow decelerates around the recirculation region in the lee of the upstream building, i.e. a recirculating jet rather than a symmetrical vortex. The addition of a second source within the street canyon resulted in reduced fluxes from each facet for H/W>0.25, due to increased concentration of naphthalene in the canyon air. Classification: 3,8.


Transport of pollution and heat out of streets into the boundary layer above is not currently understood and so fluxes cannot be quantified. Scalar concentration within the street is determined by the flux out of it and so quantifying fluxes for turbulent flow over a rough urban surface is essential. We have developed a naphthalene sublimation technique to measure transfer from a two-dimensional street canyon in a wind tunnel for the case of flow perpendicular to the street. The street was coated with naphthalene, which sublimes at room temperature, so that the vapour represented the scalar source. The transfer velocity w(T) relates the flux out of the canyon to the concentration within it and is shown to be linearly related to windspeed above the street. The dimensionless transfer coefficient w(T)/U-delta represents the ventilation efficiency of the canyon (here, w(T) is a transfer velocity, U-delta is the wind speed at the boundary-layer top). Observed values are between 1.5 and 2.7 x10(-3) and, for the case where H/W-->0 (ratio of building height to street width), values are in the same range as estimates of transfer from a flat plate, giving confidence that the technique yields accurate values for street canyon scalar transfer. w(T)/U-delta varies with aspect ratio (H/W), reaching a maximum in the wake interference regime (0.3 < H/W < 0.65). However, when upstream roughness is increased, the maximum in w(T)/U-delta reduces, suggesting that street ventilation is less sensitive to H/W when the flow is in equilibrium with the urban surface. The results suggest that using naphthalene sublimation with wind-tunnel models of urban surfaces can provide a direct measure of area-averaged scalar fluxes. Classification: 3,8.


Three solid adsorbents (Carbotrap, Carbotrap C, and Carbosieve III) were evaluated for sampling trace non-methane hydrocarbons in urban atmospheres. The sampled atmosphere was pumped through a multisorbent tube containing the three sorbents
separated by a small amount of silanized glass wool. The trapped compounds were recovered by thermal desorption and analysed by combining cryogenic enrichment with gas chromatography and mass spectrometry. Adsorption/thermal desorption and breakthrough experiments were performed to test their ability to quantitatively trap the light hydrocarbons. The technique was suitable for determination of low ppbv concentrations of these compounds. Ambient atmospheric sampling was conducted in Vitoria-Gasteiz (Basque Country, Spain), and the measurements cover a period of one year (2001-2002). Fifteen C-2-C-6 hydrocarbons are identified and quantified, and seasonal trends are discussed. Classification: 0.


An analysis of a pollution episode in an urban atmosphere, using a complex model system is presented. The nested atmosphere-chemistry model system simulates the atmospheric conditions during a one week measurement campaign, called FLUMOB, in July 1994 in Berlin-Brandenburg, Germany. The analysis shows that naturally emitted hydrocarbons played the dominant role in the ozone formation in the investigated area. The composition of non-methane volatile organic compounds was made up to 70-80% by biogenically emitted hydrocarbons. During the analysed case, ozone formation was sensitive to hydrocarbon concentrations so that the ozone production was limited by the availability of hydrocarbons and thus especially by the amount which was biogenically emitted. Furthermore, it is shown that the FLU-MOB episode was influenced by elevated concentrations of ozone in the free troposphere, In contrast to previous analyses, the importance of ozone produced outside of Europe is emphasized. In spite of the stagnant high pressure situation which occurred during the FLUMOB episode Germany was significantly influenced by long-range transport of ozone. This transport also influenced near surface ozone concentrations. Classification: 5.


Cloud condensation nuclei (CCN) concentrations in Mexico City have a diurnal cycle that is similar to those of condensation nuclei (CN) and PM2.5 but CCN, on average, lags the changes in CN and PM2.5 by almost an hour. The nature of these patterns is related to the onset of emissions from vehicular traffic in the morning followed by the photochemical production of secondary organics that condense on the primary particles. The rates at which particles grow and the detection thresholds of the instruments that measure them impose the apparent lag in CCN trends. A size-resolved aerosol model simulates the observed trend when instrument thresholds and boundary layer growth are taken into account. The measurements made in the year 2000 show no discernible decrease in maximum daily CCN concentrations when compared to similar measurements made in 1984, despite the efforts of local authorities to decrease pollution levels in Mexico City. Classification: 5.

Classification: 5.


Samples of fine and coarse fractions of airborne particulate matter (PM) were collected in a semi-residential (AECD) area from June 2001 to June 2002 of Dhaka and in an urban area of Rajshahi, a city in northwestern region of Bangladesh from August 2001 to May 2002. The samples were collected using a ‘Gent’ stacked filter sampler in two fractions of <2.5 m fine and 2.5–10 m coarse sizes. The samples were analyzed for elemental concentrations by PIXE. The data sets were then analyzed by positive matrix factorization technique to identify the possible sources of atmospheric aerosols in these areas. The best solutions were found to be six and seven factors for elemental compositions for coarse and fine PM fractions in semi-residential Dhaka and five factors for elemental compositions of each of the coarse and fine PM respectively in the urban area of Rajshahi. The sources are soil dust, road dust, cement, sea salt, motor vehicles and biomass burning. The PMF results show that a large fraction of about more than 50% of the PM2.5–10 mass at both sites comes from soil dust and road dust. The motor vehicle including two strokes contributes about 48% of the PM2.5 mass in case of semi-residential area Dhaka. On the other hand, the biomass-burning factor contributes about 50% of the PM2.5 mass in Rajshahi. Classification: 5.


During recent years, numerous studies have examined the Buenos Aires urban climate, but the relationship between large-scale weather conditions and the Buenos Aires urban heat island (UHI) intensity has not been studied. The goal of this paper is to apply an objective synoptic climato-logical method to identify homogeneous air masses or weather types affecting Buenos Aires during winter, and to relate the results to the UHI intensity. A K-means clustering method was used to define six different air masses considering the 03:00, 09:00, 15:00 and 21:00 LT surface observations of dry bulb temperature, dew point, cloud cover, atmospheric pressure and wind direction and velocity at Ezeiza, the most rural meteorological station of the Buenos Aires metropolitan area (Fig. 1). Results show that the mean UHI intensity is at its maximum (2.8degreesC) a few hours before sunrise when conditions are dominated by cold air masses associated with cold-core anticyclones, weak winds and low cloud cover. Inverse heat islands are found during the afternoon for all air masses indicating that surface processes are not dominant at that time. The relatively infrequent and
warmest air mass is the only one that presents a mean negative urban-rural temperature difference (-0.1 degreesC) during the afternoon with the smallest diurnal cycle of the UHI intensity probably due to the prevailing high humidity and cloudy sky conditions. The paper provides an insight into the Buenos Aires urban-rural temperature difference under a variety of winter weather types and results could be useful to improve local daily temperature forecasts for the metropolitan area of Buenos Aires on the basis of the routine forecasts of weather types. Classification: 1,4.


For many practical applications, as e.g. in support of air pollution management, numerical models based on solution of the basic flow and dispersion equations are still too complex. Alternative are models that are basically parameterised semi-empirical models making use of a priori assumptions about the flow and dispersion conditions. However, these models must, be thoroughly tested and their performance and limitations carefully documented. The Danish Operational Street Pollution Model (OSPM) belongs to this category of parameterised models. In the OSPM, concentrations of exhaust gases are calculated using a combination of a plume model for the direct contribution and a box model for the recirculating part of the pollutants in the street. Parameterisation of flow and dispersion conditions in street canyons was deduced from extensive analysis of experimental data and model tests. Results of these tests were used to further improve the model performance, especially with regard to different street configurations and a variety of meteorological conditions. Classification: 5,8.


Mass size distributions of atmospheric aerosols have been sampled in the region of Vienna, a typical city in central Europe, at an urban and a rural site. The aerosol was collected simultaneously by cascade impactors. Two experiments which had a duration of 4 weeks each, were performed in August 1999 and in January/February 2000. Daily sampling periods were from 8:00 to 20:00, and from 20:00 to 8:00. An evaluation of the mass size distributions is represented in this paper. Emphasis is on the relationships of different aerosol components in a local and a regional context. The main results are as follows. The main components of the atmospheric aerosol are a fine aerosol, the accumulation aerosol, and a coarse aerosol. Specific coarse modes with modal diameters of 4.7 m average and geometric standard deviations of about 3 occur at the urban and at the rural site, some times surprisingly strong. The fine and the coarse modes are very likely related to motor-car traffic. Usually the PM2.5 and PM10 aerosols are regionally strongly correlated. Occasionally, this correlation is effectively disturbed by local and/or regional emissions. Time series of correlation coefficients reveal an episodic character of the atmospheric aerosol. Periods of strong
inter-site correlations of PM2.5 and PM10 indicate the dominance and the co-
variation of the accumulation aerosols or the dominance and the co-variation of the
coarse modes. Classification: 5.


Classification: 5.


Polycyclic aromatic hydrocarbons (PAHs) are becoming a major component of atmospheric toxic pollutants (ATPs) in Guangzhou city, China. Studies showed that ATPs may have adverse health effect in urban area. An investigation on particulate- and vapor-phase distribution of n-alkanes and PAHs in urban atmosphere has been conducted. In LiWan district, 24h sampling for three consecutive days was performed in April and July 2001 at ground level. For comparison, samples were also collected on a nine-story building, ca. 25 m above ground level. The ambient concentrations of Sigman-alkanes and SigmaPAHs, compositional variations including molecular diagnostic ratios, natural biogenic and investigated. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.


Classification: 3.


It is well recognized that automobile catalytic converters are the main source of Pd, Pt and Rh (also called platinum-group elements (PGEs)) in an urban atmosphere. Over recent years, urinary biomonitoring of PGEs has gained considerable importance in assessing the individual human exposure to these elements. This paper reports the concentration ranges of PGEs in the urine of 257 Italian subjects, aged between 23 and 88 years. Subjects were selected on the basis of standardized criteria in two different Italian cities, so as to represent a small urban area surrounded by an essentially rural environment and characterized by low automobile-traffic density
(Foligno) and a large urban area with almost constant high-traffic conditions (Rome). The determination of PGEs was performed by sector field inductively coupled plasma-mass spectrometry (SF-ICP-MS) after 1:4 (v/v) dilution of the samples. The 5th and 95th percentiles for PGEs in urine of subjects living in Foligno were the following (in ng l(-1)): I'd 1.99-17.2, Pt 0.24-3.08 and Rh 0.53-14.8. The 5th and 95th percentiles in the urine of subjects from the area of Rome were (in ng l(-1)): Pd 0.71-17.0, Pt 0.49-8.13 and Rh 4.10-38.6. Platinum and Rh median concentration values showed large and significant differences (P < 0.0001) between the two urban settings considered (0.52 and 3.50 ng l(-1) for Pt and Rh in Foligno, respectively, and 1.70 and 12.85 ng l(-1) for Pt and Rh in Rome, respectively). On the other hand, no striking differences were found in the Pd concentration (median value of 6.02 ng l(-1) in Foligno versus 7.79 ng l(-1) in Rome). The sex variable correlates only with Pd concentration (P = 0.05), pointing out that in males concentrations are higher than in females. (C) 2004 Elsevier B.V. All rights reserved. Classification: 0.


Platinum and Rh content in the atmosphere of Rome as released by car catalytic converters was monitored from 1998 to 2000 in six urban sites with different traffic intensities and in one rural area. Samples collected with medium-volume PM10 samplers were analyzed by Sector Field Inductively Coupled Plasma Mass Spectrometry (SF-ICP-MS). The Pt content varied from 2.4 to 60.1 pg m(-3) (mean value 17.8 pg m(-3)) at the urban locations whilst that of Rh spanned the range 0.8-9.4 pg m(-3) (average value 4.0 pg m(-3)). The rural area showed metal levels mostly below the limits of detection, pointing to automobile traffic as the main source of those elements in the urban atmosphere. The highest mean concentrations of Pt and Rh, i.e. 22.2 and 5.0 pg m(-3), were detected along the ring road where the traffic density is high (> 100,000 vehicles per day) and the driving speed between 100 and 120 km h(-1). The lowest Pt and Rh mean concentrations, i.e. 11.4 and 3.4 pg m(-3), were measured downtown, where traffic density is lower (20,000 vehicles per day) and the driving speed is limited (50 km h(-1)). Significant concentrations of Pt and Rh were found in the vicinity of traffic signals, indicating that the "stop-and-go" conditions might also affect their release. The measured Pt/Rh ratio spanned the range 3.3-5.9 in accordance with that present in the more commonly used gasoline car catalytic converters. Seasonal variations between wintertime (with Pt and Rh mean concentrations of 23.8 and 5.1 pg m(-3), respectively) and summertime (with Pt and Rh mean concentrations of 14.1 and 3.3 pg m(-3), respectively) were also observed. Classification: 5.


Information on weathering steel behaviour and its rust products characteristics after decades of atmospheric exposure are scarce. On the other side, generally accepted laboratory tests for the assessment of its corrosion resistance have not been developed
yet. Consequently, Simulating corrosion in the laboratory during long periods of time are attractive for the interesting and complete information obtainable from them. In the present work, AISI-SAE 1008 and ASTM-588 B steel samples have been exposed for two years to a immersion-emersion CEBELCOR type test in the laboratory, simulating a moderate urban atmosphere. Two groups of six samples each were tested. After the first year, three samples of each batch were retired for analysis and the rest was kept until they reached two years of exposure. The half cell electrode potentials were measured daily. The rust was characterized by metallographic techniques, Mossbauer spectroscopy (MS), Fourier transform infrared spectroscopy (FTIR), and X-ray diffraction (XRD). Comparison was done with field exposure experiments reported in the literature, and conclusions on the behaviour of tested samples were drawn looking for differences and similarities with samples and structures tinder actual atmospheric conditions. Classification: 0.


Continuous hourly air quality data involving 37 C-2-C-9 non-methane hydrocarbons (NMHC) over 4 years are reported for the first time in Lille metropol, northern France, at two urban roadside and background sites. The data have been analysed in two complementary steps: univariate statistics which define the spatial and temporal characteristics of NMHC by constructing the seasonal and daily concentration profiles, and multivariate statistics based on principal component analysis (PCA). A number of important sources have been clearly identified depending on the season: (1) motor vehicle exhaust, which dominates the NMHC distribution and particularly in winter, even for isoprene; (2) wintertime stationary combustion and activities related to fossil fuel consumption in general, such as natural gas leakage of ethane and propane; (3) summertime evaporative emissions from fuel and solvent; and (4) summertime biogenic emissions through isoprene behaviour and their dependence on temperature. (C) 2002 Elsevier Science B.V. All rights reserved. Classification: 5.


The study of the urban heat island has been carried out through two new enhanced versions of the UCLM (Urban Canopy Layer Model) model, Landsat/Thematic Mapper data sets and meteorological data collected over a square area 30 km of side including Milan and its hinterland. The urban climate can be described in different summer and winter radiative settings. The input data are divided into two classes: 1) parameters related to urban and rural local properties (albedo and emissivity, vegetation index NDVI, surface roughness length, land cover...); 2) meteorological data related to the general synoptic conditions. The bulk system of the model is made up of four independent equations expressed in terms of four unknowns, i.e., the temperature values at ground level, canopy level and reference level (100 m) and relative humidity within the urban structure. The study area is divided by a regular square mesh of variable dimension (from 30 m to 1500 m); both the input and output
data are average cell values. UCLM30 and UCLM60 calculate the temperature excess as well as the turbulent heat exchanges and the heat storage in the urban canopy as a function of the radiative and dynamic forcing. As can be observed in reality, the model shows that in summer the highest urban heating occurs in early morning and after sunset and that, in extreme conditions, the temperature can be up to 8 degreesC warmer in town than in the nearby rural lands. Classification: 3.1.


This study examines the spatial and quantitative influence of urban factors on the surface air temperature field of the medium-sized of Szeged, Hungary, using mobile measurements under different weather conditions in the periods of March 1999-February 2000 and April-October 2002. Efforts have been concentrated on the development of the urban heat island (UHI) in its peak development during the diurnal cycle. Tasks included: (1) determination of spatial distribution of mean maximum UHI intensity and some urban surface parameters (built-up and water surface ratios, sky view factor, building height) using the standard Kriging procedure, as well as (2) development of a statistical model in the so-called heating and non-heating seasons using the above mentioned parameters and their areal extensions. In both seasons the spatial distribution of the mean maximum UHI intensity, fields had a concentric shape with some local irregularities. The intensity reaches more than 2.1 degreesC (heating season) and 3.1 degreesC (non-heating season) in the centre of the city. For both seasons statistical model equations were determined by means of stepwise multiple linear regression analysis. As the measured and calculated mean maximum UHI intensity patterns show, there is a clear connection between the spatial distribution of the urban thermal excess and the examined land-use parameters, so these parameters play an important role in the evolution of the strong UHI intensity field. From the above mentioned parameters the sky-view factor and the building height were the most determining factors which are in line with the urban surface energy balance. Therefore in the future, using our model it will be possible to predict mean maximum UHI intensity in other cities, which have landuse features similar to Szeged. Classification: 4.


Under low latitude conditions, minimization of solar radiation within the urban environment may often be a desirable criterion in urban design. The dominance of the direct component of the global solar irradiance under clear high sun conditions requires that the street solar access must be small. It is well known that the size and proportion of open spaces has a great influence on the urban microclimate This paper is directed towards finding the interaction between urban canyon geometry and incident solar radiation. The effect of building height and street width on the shading of the street surfaces and ground for different orientations have been examined and evaluated. It is aimed to explore the extent to which these parameters affect the
temperature in the street. This work is based on air and surface temperature measurements taken in different urban street canyons in EL-Oued City (hot and and climate), Algeria. In general, the results show that there are less air temperature variations compared to the surface temperature which really depends on the street geometry and sky view factor. In other words, there is a big correlation between the street geometry, sky view factor and surface temperatures. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 2,3.


Under low latitude conditions, minimisation of solar irradiance within the urban environment may often be an important criterion in urban design. This can be achieved when the obstruction angle is large (high H/W ratio, H = height, W = width). Solar access to streets can always be decreased by increasing H/W to larger values. It is shown in this paper that the street canyon orientation (and not only the H/W ratio) has a considerable effect on solar shading and urban microclimate. The paper demonstrates through a series of shading simulation and temperature measurements that a number of useful relationships can be developed between the geometry and the microclimate of urban street canyons. These relationships are potentially helpful to assist in the formulation of urban design guidelines governing street dimensions and orientations for use by urban designers. (C) 2003 Published by Elsevier Ltd. Classification: 2,3.


A 1-D road surface energy balance model was modified to account for the geographical variables of latitude, optical depth, sky-view factor, slope and slope orientation for the West Midlands (UK). The physical variables of albedo, emissivity and surface roughness are also included. Using a satellite land cover classification, aided by a field analysis of urban canyon characteristics, it was possible to estimate the spatial variation of surface variables across the West Midlands. Spatial analysis of the topography was achieved using a Geographical Information System (GIS) database which calculated values at 1 km(2) resolution for the geographical variables. This enabled a spatial and temporal analysis of road surface temperatures (retrospectively) across the West Midlands. Sensitivity analysis shows that the geographical variables which have the most significant influence on the model are slope angle and sky-view factor. Validation of the model (West Midlands grid model, WMG) against actual road surface temperature for 15 road weather sensors distributed around the West Midlands, for February 2000, gave R-2 values as high as 0.84; however regression indicated that for 79 nights in the period December 1999 to February 2000 the model overestimated the minimum road surface temperature with a bias of 0.65degreesC (RMSE 2.07degreesC), as opposed to the Met Office model (MOM), which underestimated with a bias of -2.03degreesC (RMSE 3.09degreesC). Time slices of the model output, covering an area of 2400 km(2), show the
development of a surface urban heat island in the West Midlands. The intensity of the modelled heat island is sensitive to the values used for the sky-view factor in the rural areas surrounding the urban conurbation. Winter solstice heat island intensity for calm clear nights in the West Midlands is calculated to be 4.7 degrees C. The structure of the heat island suggests that current Open Road weather forecast zones are not applicable in simulated clear calm conditions because of the wide range of road surface temperatures caused by the degree of urbanisation. Classification: 1,3.


Periodogram analysis has been used as an interpretative tool of long period measurements of benzene concentration in urban atmosphere. By removing the request of evenly sampled data, the periodogram allows to extend spectral analysis to this kind of data, which usually suffer the "missing data" problem due to instrument vacancies. In this way it is possible to identify the periodic behaviour of data concentration and then reproduce it by means of harmonic functions even for very incomplete experimental information allowing a good evaluation of some important statistical properties of data. Classification: 5.

Brandt, J., Christensen, J. H., Frohn, L. M. and Berkowicz, R. (2003) 'Air pollution forecasting from regional to urban street scale - implementation and validation for two cities in Denmark', Physics and Chemistry of the Earth, 28, 335-344

An operational air pollution forecast model system, THOR, has been developed. The system is used for 3-days forecasting, monitoring and traffic and/or emission reduction scenarios. The model system includes several models capable of calculating air pollution concentrations at different spatial scales, ranging from European scale over urban background scale down to urban street scale. When coupling models covering such different scales, it is possible to include contributions both from local, near-local and non-local emission sources in order to describe the air quality at a specific location-e.g. in a street canyon. The different air pollution models are driven by a numerical weather forecast model. Operational three days air pollution forecasts are produced four times every day. The system can, in principle, be applied for any city in Europe. Currently the regional model has been implemented for the whole of Europe and the urban models for two major cities in Denmark; Copenhagen and Aalborg. The individual models in the system will be shortly described and typical model results will be shown. The model system has been operational since August 1998 and is continuously being validated against measurements from the Danish urban monitoring network. Results from the evaluation of the system performance for the city of Aalborg and comparisons with results for the city of Copenhagen will be presented. The results show that the street pollution model has quite similar performance for the two cities. However, a difference is seen in the performance of the urban background model for the two cities, which is probably due to the difference in the spatial resolution of the urban emission data. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5,8.
Bravo, H. A. and Torres, R. J. (2000) 'The usefulness of air quality monitoring and air quality impact studies before the introduction of reformulated gasolines in developing countries. Mexico City, a real case study', *Atmospheric Environment, 34*, 499-506

Urban air pollution is a major environmental problem in several developing countries in the world. This phenomenon seems to be related to the growth of both the urban population in large cities and the number of old and poorly maintained car fleets. The expected rise of population in the next century in countries which suffer from lack of capital for air pollution control, means that there is a great potential for the worsening of the air quality. The worldwide promoted policy to phase out lead in gasolines has not proved to be an adequate option in improving the environmental quality. Mexico City Metropolitan Area (MCMA) represents a case in which the introduction of reformulated gasolines in an old car fleet has given as a result the reduction of the airborne lead levels but has worsened the ozone concentration of its urban atmosphere. This paper critically analyzes the chronological evolution of the ozone air pollution problem in MCMA after the successive occurrence of several changes in the formulation of low leaded and unleaded gasolines. It also presents evidences of the usefulness potential of air quality monitoring activities and air quality impact studies on the definition of realistic fuel reformulation policies of developing countries. (C) 1999 Elsevier Science Ltd. All rights reserved. *Classification: 5.*


Two Long-Term Ecological Research (LTER) sites now include urban areas (Baltimore, Maryland and Phoenix, Arizona). A goal of LTER in these cities is to blend physical and social science investigations to better understand urban ecological change. Research monitoring programs are underway to investigate the effects of urbanization on ecosystems. Climate changes in these urban areas reflect the expanding population and associated land surface modifications. Long-term urban climate effects are detectable from an analysis of the GHCN (Global Historical Climate Network) database and a comparison of urban versus rural temperature changes with decadal population data. The relation of the urban versus rural minimum temperatures (Delta Tmin(u-r)) to population changes is pronounced and non-linear over time for both cities. The Delta Tmax(u-r) data show no well-defined temporal trends. *Classification: 3,1.*


Increasing urbanization and concern about sustainability and quality of life issues have produced considerable interest in flow and dispersion in urban areas. We address this subject at four scales: regional, city neighborhood, and street. The flow is one over and through a complex array of structures. Most of the local fluid mechanical processes are understood; how these combine and what is the most appropriate
framework to study and quantify the result is less clear. Extensive and structured experimental databases have been compiled recently in several laboratories. A number of major field experiments in urban areas have been completed very recently and more are planned. These have aided understanding as well as model development and evaluation. Classification: 8.


Classification: 2.

**Ca, V. T., Ashie, Y. and Asaeda, T. (2002) 'A k-epsilon turbulence closure model for the atmospheric boundary layer including urban canopy', Boundary-Layer Meteorology, 102, 459-490**

A numerical model for the computation of the wind field, air temperature and humidity in the atmospheric boundary layer (ABL) including the urban canopy was developed for urban climate simulation. The governing equations of the model are derived by applying ensemble and spatial averages to the Navier-Stokes equation, continuity equation and equations for heat and water vapour transfer in the air. With the spatial averaging procedure, effects of buildings and other urban structures in the urban canopy can be accounted for by introducing an effective volume function, defined as the ratio between the volume of air in a computational mesh over the total volume of the mesh. The improved k - epsilon model accounts for the anisotropy of the turbulence field under density stratification. In the improved k - epsilon model, the transport of momentum and heat in the vertical direction under density stratification is evaluated based on the assumption of a near-equilibrium shear flow where transport effects on the stresses and heat fluxes are negligible. The heating processes at surfaces of buildings and ground are also modelled. The comparison of the computational results obtained with the present model and existing observational data and numerical models shows that the present model is capable of predicting the structure of turbulence in the urban canopy layer under density stratification. Numerical experiments with the new model show that the flow behaviour of the air in the urban canopy layer is strongly affected by the existence of buildings and density stratification. Classification: 8.


This large-eddy simulation study investigates the effects of an idealised surface inhomogeneity of sensible heat flux on dispersion of a passive plume emitted from elevated sources into an urban convective boundary layer (UCBL). The results show that when Deardorff's translation is made to introduce a wind with its direction aligned with the centreline of park blocks, dispersion of such a passive plume is strongly affected by turbulent structure associated with the patchy pattern of surface heat flux. In comparison with a case with a homogeneous surface, when the point
source is located above the central line across the park areas, the mean plume height $Z(c)$ is lower, the vertical dispersal parameter $S_z$ is smaller, the surface concentration $C_0$ is generally higher, and pollutant is less dispersed in the vertical direction. When the point source is aligned with the built-up area, however, the opposite situation occurs. The difference in surface concentration at a same downwind distance can be as large as 100% among the cases over a homogeneous surface, the location above built-up surface and the location above park surface in the idealised urban area. The extent to which the patchy pattern of surface heat flux influences the plume dispersion depends on two parameters: $d/Z(i)$ and $b/p$, where $d$ is the distance between the centres of two adjacent parks, $b$ is the width of built-up area, $p$ is the size of park, and $Z(i)$ is the UCBL height. This study suggests that dispersion of a passive plume in a UCBL has different behaviour from that for a homogeneous surface in the previous studies. Estimate of pollutant concentration by the existing methods or models that are based on observations over a homogeneous surface cannot distinguish such differences revealed by the results in this paper. (C) 1999 Elsevier Science Ltd. All rights reserved. Classification: 5,8.


The effects of surface inhomogeneity of sensible heat flux on fumigation have been investigated by large-eddy simulation (LES) in the present study. The surface inhomogeneity consists of regularly aligned squares of park area surrounded by built-up area, the two types of surface having different values of sensible heat flux. The dynamics of such a CBL, named the urban CBL (UCBL), and the effects on dispersion of plumes initially placed inside the UCBL have been examined by Cai (Q. J. Royal Meteor. Soc. 125 (1999) 1427) and Cai (Atmos. Env. 34 (2000) 61) respectively. The present study delivers the following major findings. (i) The results of mean plume height and ground-level concentration (GLC) over the two landuse types for a fumigation case are opposite to those for an "in-UCBL" dispersion case studied in Cai (Atmos. Env. 34 (2000) 61). In other words, for a fumigation case mean plume height is lower and GLC is higher over the built-up area (in comparison with those over the park area), whereas for an "in-UCBL" dispersion case mean plume height is higher and GLC is lower over the built-up area. (ii) In general, the two quantities have larger fluctuations over the built-up area than those over the park area. The above characteristics in (i) and (ii) are the consequence of stronger turbulence over the built-up area than that over the park area. (iii) The length scale of surface patchy pattern, $d$, is the most effective surface parameter that affects the contrast of several variables (mean plume height, GLC, and dispersal parameters) between the two landuse types. (iv) For the same $d$, the case with a larger value of skewness of surface pattern has a larger contrast of these variables between two landuse types during the early phase of fumigation. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 5.

experiments and a Reynolds-averaged Navier-Stokes approach', *Journal of Applied Meteorology*, 43, 696-710

An experiment investigating flow around a single complex building was performed in 2000. Sonic anemometers were placed around the building, and two-dimensional wind velocities were recorded. An energy-budget and wind-measuring station was located upstream to provide stability and inflow conditions. In general, the sonic anemometers were located in a horizontal plane around the building at a height of 2.6 m above the ground. However, at the upwind wind station, two levels of the wind were measured. The resulting database can be sampled to produce mean wind fields associated with specific wind directions such as 210°, 225°, and 240°. The data are available generally and should be useful for testing computational fluid dynamical models for flow around a building. An in-house Reynolds-averaged Navier–Stokes approach was used to compare with the mean wind fields for the predominant wind directions. The numerical model assumed neutral flow and included effects from a complex array of trees in the vicinity of the building. Two kinds of comparisons are presented: 1) direct experimental versus modeled vector comparisons and 2) a numerical metric approach that focuses on wind magnitude and direction errors. The numerical evaluation generally corroborates the vector-to-vector inspection, showing reasonable agreement for the mean wind fields around the building. However, regions with special challenges for the model were identified. In particular, recirculation regions were especially difficult for the model to capture correctly. In the 240° case, there is a tendency for the model to exaggerate the turning effect in the wind caused by the effect of the building. Two different kinds of simulations were performed: 1) predictive calculations with a reasonable but not high-fidelity representation of the building's architectural complexity and 2) postexperiment calculations in which a large number of architectural features were well represented. Although qualitative evidence from inspection of the angles of the vectors in key areas such as around the southeast corner of the building indicated an improvement from the higher-fidelity representation of the building, the general numerical evaluation indicated little difference in the quality of the two solutions. *Classification: 8.*


The 3-hourly standard meteorological data measured at Rome for the period 1951-1996 were analysed in order to gather information about the impact of climate on monument decay. The freezing-thawing and condensation-evaporation cycles in micropores were computed for each month. The occurrence of the freezing-thawing cycles was determined by means of a cross comparison between the temperature observations and the model calculations for the lowering of the freezing point due to the curvature effect of the ice surface into pores. The occurrence of the condensation-evaporation cycles was determined by means of a cross comparison between relative humidity observations and the lowering of the critical relative humidity for condensation into micropores due to the curvature of the water meniscus. The effect of sea spray on the lowering of the freezing point was calculated to evaluate the number of the freezing-thawing cycles on the surface or in the macropores contaminated by NaCl. Wind roses as well as the drizzle, rain, shower, hail, snow and fog roses were drawn in order to determine which vertical-surface orientations
undergo wetting or washing out by meteoric water. Finally, the relevance of each of these meteorological variables was evaluated, evidencing the peculiarities of the region, which is influenced by both the Mediterranean climate and the cyclonic systems coming from the Atlantic Ocean. *Classification: 1.*

**Carslaw, D. C. and Beevers, S. D. (2004) 'Investigating the potential importance of primary NO2 emissions in a street canyon', *Atmospheric Environment, 38*, 3585-3594**

Monitoring data from a busy street canyon location in central London and a background site have been used to estimate the potential importance of primary NO2 emissions from road vehicles travelling along the street canyon. By considering the difference in the total 'oxidant', OX (NO2 + O3) between the two sites insight has been gained into the potential magnitude of primary NO2 emissions from road vehicles. It is shown that the day of the week and hour of the day variation in OX closely matches some attributes of the variation in road traffic flows and vehicle composition. In particular, the variation in OX compares well the variation in estimated NOx emissions from diesel vehicles by hour of the day and day of the week. A multiple regression is used to estimate the fraction of NO2 in petrol and diesel exhausts that is directly emitted. These results suggest that petrol and diesel vehicles in the street canyon emit 0.6 +/- 0.2 and 12.7 +/- 0.1 vol % NO2, respectively. Primary emissions of this magnitude appear to explain much of the variation observed from the measurements. These results have implications for modelling studies in terms of source apportionment and how NO2 concentrations respond to NOx control. It is recommended that detailed primary NO2 emissions inventories are developed and used by dispersion modellers for concentration predictions and comparisons with UK national and international limits for NO2. (C) 2004 Elsevier Ltd. All rights reserved. *Classification: 5.*

**Carvalho, A., Pio, C. and Santos, C. (2003) 'Water-soluble hydroxylated organic compounds in German and Finnish aerosols', *Atmospheric Environment, 37*, 1775-1783**

Total suspended particulate matter was collected in a German anthropogenically influenced agricultural area and in a Finnish forest. The occurrence of water-soluble compounds leftover by a traditional dichloromethane (DCM)-extraction technique was investigated using an additional water-extraction and analyzing the corresponding trimethylsilyl derivatives by GC-MS. The organic carbon content of the samples and extracts was also measured. The additional extraction with water recovered more than 20% of total organic carbon, which is comparable to the 31% extracted with DCM. The fraction of water-extractable organic carbon that eluted was <10%, but the employed GC-MS approach proved to be useful in the identification and quantification of polar water-soluble organics containing hydroxyl groups. Concentrations and size distributions of polyhydroxymono- and dicarboxylic acids, polyols, and sugars were obtained. The German meadow presented the highest levels of sugars and acidic compounds, whilst polyols were the most abundant class in the Finnish forest. The major compounds of these classes were malic acid, mannitol, arabitol, glucose and sucrose. Levoglucosan was also detected in the water-extract.
Acidic compounds occurred mainly in fine particles. Polyols and most sugars presented size distributions with variable fine or coarse maximum. Possible primary and secondary sources of polyhydroxylated compounds are discussed. (C) 2003 Elsevier Science Ltd. All rights reserved. *Classification: 0.*


The diurnal evolution of the urban boundary layer over the central area of Rome was observed by the simultaneous and co-located operation of a Doppler sodar, a microwave radiometer and a dual polarization lidar. The Doppler sodar was configured to provide a wind profile up to about 800 m, and a time-height picture of the thermal structure of the urban boundary layer. A microwave radiometer provided a temperature profile up to 600 m with a height resolution of 50 m. The lidar provided profiles of the aerosol backscattering up to about 7-10 km with 30 m height resolution. The experiment was conducted for several days in the year 1998 during day and night with clear sky and low wind. The aerosol profiles in the urban troposphere appear linked to stability conditions in the lower layers and strong pollution. The presence of aerosols, typically in the afternoon hours at heights up to 2-3 km, can be related to a relatively high mixed layer. Such layer is caused by free convection as indicated by the Richardson number, estimated by the temperature and wind data. Some typical case studies are discussed. (C) 2001 Elsevier Science Ltd. All rights reserved. *Classification: 5,8.*


In this article, we investigate experimentally and analytically the dispersion mechanisms of a passive tracer in a two-dimensional model of a street canyon. The principal concern is the concentration transfer between the street and the external flow. In contrast to previous studies, the mass fluxes are not only inferred from mean concentration measurements but also directly measured thanks to a Particle Tracking Velocimetry technique. Visualizations of the evolution of the concentration field show the role of the shear layer at the top of the street canyon. Analytical transfer and dispersion models are derived, demonstrating the importance of external turbulence properties on the transfer. Those models are in excellent agreement with the measurements. The results presented in this article strongly suggest that the transfer in a street canyon does depend on the structure of the incoming turbulence, i.e. on the local stability conditions and on the upwind buildings. (C) 2003 Elsevier Science Ltd. All rights reserved. *Classification: 8,5.*

Inhalable particulate matter (PM10) measurements were performed in six different sites in the city of Chillan, Chile, during September 2001 to September 2002. Chemical composition of PM10 was performed to samples of 47 mm diameter Teflon membranes within the city of Chillan. The spatial and temporal variability of the chemical composition of PM10 was evaluated taking into account additional data from meteorology and further air pollutants. The chemical analyses of PM10 showed that carbonaceous substances and crustal material were the most abundant components of PM10 during the winter and summer, respectively. The concentrations of PM10 were higher during the cold season than during the warm season. This was explained mainly due to the massive use of wood as fuel for residential heating within the city of Chillan, producing a dense smoke cloud in those days of atmospheric stability. The PM10 concentrations were higher in the downtown area of the city of Chillan, where also the chemical composition was more variable due to urban traffic and other anthropogenic sources. Classification: 5.


Inhalable particulate matter (PM10) concentrations were measured over 24-h intervals at six different urban sites in the city of Chillan from September 2001 to April 2003. Sampling locations were selected to represent central city, commercial, residential, and industrial portions of the city. Chemical composition of PM10 was performed to samples of 47 mm diameter Teflon membranes within the city of Chillan. The spatial and temporal variability of the chemical composition of PM10 was evaluated taking into account additional data from meteorology and further air pollutants. The majority of PM mass was comprised of carbon, nitrate, sulfate, ammonium, and crustal components but in different proportion on different days and at different sites. The chemical analyses showed that carbonaceous substances and crustal material were the most abundant component of PM10 during the winter and summer, respectively. The concentrations of PM10 were higher during the cold season than during the warm season. The PM10 concentrations were higher in the downtown area of the city of Chillan, where also the chemical composition was more variable due to urban traffic and other anthropogenic sources. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 5.


Using laboratory experimental data taken from a temperature-controlled water tank, the basic features of the circulation associated with an inland urban heat island (UHI) of diameter D and surface heating rate H0 and its interaction with a sea-breeze current were investigated. When the environment was stably stratified with a buoyancy frequency N (nocturnal UHIs) and the sea breeze was absent, the UHI circulation was
mainly governed by the Froude number \([Fr = U/(ND)]\), in agreement with theoretical predictions found in literature (\(U\) was the horizontal velocity scale of the flow based on \(H_0\) and \(D\)). Furthermore, the results were in agreement with other laboratory studies and with nighttime field observations conducted in large cities. It was found that \(U\), when calculated with \(H_0 + HL\) (where \(HL\) was the surface heat flux associated with the land temperature growth occurring after sunrise), could also be employed as the velocity scale for UHI circulations that develop in statically unstable environments (daytime UHIs). Analysis of the interaction between an inland daytime UHI and a sea-breeze flow with maximum velocity \(UB\) showed that the resulting circulation was strongly dependent on the ratio \(UB/U\) and that substantial differences from cases in which urban complexes are located along the shore were present. Comparison with numerical experiments also supports these results. Classification: 4,8.


The flow field and pollutant dispersion characteristics in a three-dimensional urban street canyon are investigated for various building array geometries. The street canyon in consideration is located in a multi-canopy building array that is similar to realistic estate situations. The pollutant dispersion characteristics are studied for various canopy aspect ratios, namely: the canyon height to width ratio, canyon length to height ratio, canyon breadth ratio and crossroad locations are studied. A three-dimensional field-size canyon has been analysed through numerical simulations using \(k\)- epsilon turbulence model. As expected, the wind flow and mode of pollutant dispersion is strongly dependent on the various flow geometric configurations and that the results can be different from that of a single canyon system. For example, it is found that the pollutant retention value is minimum when the canyon height-to-width ratio is approximately 0.8, or that the building height ratio is 0.5. Various rules of thumbs on urban canyon geometry have been established for good pollutant dispersion. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5,8.


This paper is concerned with the motion of air within the urban street canyon and is directed towards a deeper understanding of pollutant dispersion with respect to various simple canyon geometries and source positions. Taking into account the present days typical urban configurations, three principal flow regimes "isolated roughness flow", "skimming flow" and "wake interference flow" (Boundary Layer Climates, 2nd edition, Methuen, London) and their corresponding pollutant dispersion characteristics are studied for various canopies aspect ratios, namely relative height \((h(2)/h(1))\), canyon height to width ratio \((h/w)\) and canyon length to height ratio \((l/h)\). A field- size canyon has been analyzed through numerical simulations using the standard \(k\)-epsilon turbulence closure model. It is found that the pollutant transport and diffusion is strongly dependent upon the type of flow regime inside the canyon.
and exchange between canyon and the above roof air. Some rules of thumbs have been established to get urban canyon geometries for efficient dispersion of pollutants. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 8,2,5.


Classification: 5.


Field data are used to evaluate the Vertical distribution of suspended particulates at different height levels in an urban area of Hong Kong. Four buildings in different street configurations and street environments were selected. According to the street configuration, they are classified into two groups: street canyon and open street. In street canyon, TSP and PM10 concentration varies with height exponentially. However, the rate of TSP, PM10 and PM2.5 decrease with distance from the ground floor is in decreasing order of TSP, PM10 and PM2.5. The particulate matter dispersion in street canyon is affected by the prevailing wind direction and the street configuration in particular the height-to-width ratio. In open streets, the vertical concentration depends on the vertical mixing, local dilution and other external factors such as sea breeze, as well as the proximity of trunk road and construction activity. Fine particulates contribute a major part of suspended particulates in Hong Kong and the impact can penetrate to the tenth floor and above. The PM2.5 level is high in Hong Kong and above 80% of the PM2.5 recorded in this field study exceeded the EPA NAAQS standards, (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 5,8.


A two-dimensional numerical model based on Reynolds-averaged Navier-Stokes equations coupled with a series of standard, Renormalization Group (RNG) and realizable kappa-epsilon turbulence models was developed to simulate the fluid-flow development and pollutant dispersion within an isolated street canyon using the FLUENT code. In the present study, the validation of the numerical model was evaluated using an extensive experimental database obtained from the atmospheric boundary layer wind tunnel at the Meteorological Institute of Hamburg University, Germany (J. Wind Eng. Ind. Aerodyn. 62 (1996) 37). Among the studied turbulence models, the RNG kappa-epsilon turbulence model was found to be the most optimum turbulence model coupled with the two-dimensional street canyon model developed in the present study. Both the calculated and measured dimensionless pollutant
concentrations have been shown to be less dependent on the variation of wind speed and source strength conditions for the studied street canyon aspect ratio of the B/H = 1 case. However, the street canyon configuration has significant influence on the pollutant dispersion. The wider street and lower height of the buildings are favorable to pollutant dilution within the street canyon. The fluid-flow development has demonstrated that the rotative vortex or vortices generated within the urban street canyon can transport the pollutants from a line source to the wall surfaces of the buildings. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5,8.


To develop reliable computer models for the bluff body flow and transport of pollutants or chemical and biological (CB) agents in urban environments requires accurate measurements of the basic flow fields for carefully controlled, well-known conditions. Fluid modeling in an industrial wind tunnel provides an opportunity to produce accurate simulations of the bluff body flow and transport of urban pollution or of CB agents associated with urban terrorism incidents. A basic building shape, the Wind Engineering Research Field Laboratory building (WERFL) at Texas Tech University, is used for this study. The urban street canyon was represented by a 1:50 scale WERFL model that was surrounded by models of similar dimensions. These buildings were arranged in various symmetric configurations with different separation distances and different numbers of surrounding building. A series of measurements is made over a generic urban street canyon arrangement using flow visualization, anemometry, pressure transducer and gas chromatography. The experimental data include visualization, velocity and turbulence intensity profiles, surface pressure on the building and dispersion of releasing gas. Results are compared to three-dimensional numerical models of the same configuration using the commercial code, FLUENT 5.3. The effects of grid resolution, boundary conditions, source placement and selection of turbulence model (kappa-epsilon, RNG kappa-epsilon, Reynolds stress, etc.) are examined in a series of sensitivity calculations. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 8.


The goal of this paper is to present bluff body flow and transport from steady point sources of pollutants, or chemical and biological agents in an idealized urban environment. This paper includes ventilation behavior in different street canyon configurations. To evaluate dispersion in a model urban street canyon, a series of tests with various street canyon aspect ratios (B/H) are presented. Both open-country roughness and urban roughness cases are considered. The flow and dispersion of gases emitted by a point source located between two buildings inside an urban street canyon were determined by the prognostic model FLUENT using four different RANS turbulent closure approximations and in the model fire dynamics simulator using a large eddy simulation methodology. Calculations are compared against fluid
modeling in the Industrial Meteorological Wind Tunnel at Colorado State University. A basic building shape, the Wind Engineering Research Field Laboratory building (WERFL) at Texas Tech University, was used for this study. The urban street canyon was represented by a 1:50 scale WERFL model surrounded by models of similar dimensions. These buildings were arranged in various symmetric configurations with different separation distances and different numbers of up- or downwind buildings. Measurements and calculations reveal the dispersion of gases within the urban environment are essentially unsteady, and they are not always well predicted by the use of steady-state prediction methodologies. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 5,8.


Very large roof suctions on low-rise buildings occur for isolated buildings during both fullscale experiments and wind tunnel tests performed by many investigators. This paper investigates the sensitivity of these high suctions to the presence of multiple surrounding building configurations. This study uses the Wind Engineering Research Field Laboratory (WERFL) building studied during the CSU/TTU Cooperative Program in Wind Engineering as a basic building shape. A model of the WERFL structure was constructed to a 1:50 scale and instrumented with multiple pressure ports. Pressure taps on the 1:50 scale building model were connected to two 48-channel PSI transducer units. A large number of "dummy" models of similar dimensions were constructed to represent surrounding buildings. These model buildings were arranged in various symmetric configurations with different separation distances, and placed in the Industrial Wind Tunnel of the Wind Engineering and Fluids Laboratory, Colorado State University. Measurements include mean, RMS and peak pressures, street canyon velocity profiles and laser-sheet flow visualizations. Shelter effects produced by the surrounding buildings on the central instrumented building were found to be significant, such that flow patterns are displaced and mean and peak induced loads are significantly different from the isolated building base case. The surface pressures of master WERFL model inside the urban street canyons were determined by the prognostic model FLUENT using the four differences closure approximation and FDS, large eddy simulations methodology. Calculations are compared against fluid modeling from wind-tunnel test. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 8.


Classification: 5.

A new national database for freezing-rain occurrences during the 1945–2000 period provided an opportunity for a study of the potential urban effects on freezing-rain events. Numerous past studies of snowfall events in urban areas have defined decreases of 10%–35% related to the urban heat island. The heat island, which acts to elevate near-surface temperatures, could also keep some freezing-rain situations from occurring in the city. The study involved four cities in the Midwest and Northeast for which the average annual number of days with freezing rain are three or more, for which data from in-city stations existed, and for which data for several surrounding rural stations existed. The two largest qualifying cities, New York City, New York, and Chicago, Illinois, had sizable reductions in average and maximum annual freezing-rain-day frequencies, ranging from 16% to 43% less than values of surrounding rural stations, and their freezing-rain “seasons” were 1–2 months shorter than those in surrounding rural areas. The ocean/lake influences at both cities, along with the heat island, also helped to reduce the local incidence of freezing-rain events. Two qualifying smaller urban areas, Washington, District of Columbia, and St. Louis, Missouri, had reductions in freezing-rain-day occurrences but had no shifts in the length of their freezing-rain seasons. Results suggest that freezing-rain occurrences in large cities are decreased between 10% and 30% by the heat island, which acts to keep rain from freezing to urban surfaces. Classification: 4,6.


Previously, the acquisition of sky-view factor data for climate studies has been time consuming and dependent on postprocessing. However, advances in technology now mean that techniques using fish-eye imagery can be algorithmically processed in real time to provide an instant calculation of the sky-view factor. Although data collection is often limited due to the need to survey under homogenous overcast skies, vast datasets can now be rapidly assembled for the training of proxy "all weather" techniques. An artificial neural network is used to estimate the sky-view factor using raw global positioning system (GPS) data and is shown to explain over 69% of the variation of the sky-view factor in urban areas. Classification: 3.


Measurements of particle number size distribution in the range 11-452 nm have been made on the side of the busy Marylebone Road in central London over a period from April 1998 to August 2001. The data have been analysed to demonstrate the influences of meteorological factors upon different size fractions and upon the overall size distribution. The relationship to traffic volumes indicates that the accumulation mode particles are associated with emissions from heavy-duty traffic (mainly diesel vehicles) whilst particles in the range 30-60 nm show a stronger association with light-duty traffic. Both of these size fractions show the anticipated dilution effect with increasing wind speed. Particles in the 11-30 nm range behave anomalously showing no clear relationships to traffic volumes and a lesser effect of dilution by increasing
wind speed than for the larger particles. Particles in this fraction tend to peak in the early morning showing an inverse association with air temperature. It is concluded that this size range contains freshly nucleated particles formed as the exhaust gases are diluted with ambient air. (C) 2003 Elsevier Ltd. All rights reserved.


In the atmosphere, exchanges between the gas and particle phases has a profound influence on the removal processes and residence times of semi-volatile compounds. This study describes analytical procedures for the reliable quantitation of both gas and particle phase azaarenes (two-, three- and four-rings). Samples of particulate material were collected on the glass fiber filters and gas phase material on polyurethane foam plugs. Azaarene compounds were isolated utilizing an acid/base partition method. Isolated azaarenes compounds were then characterized and quantified using gas chromatography with mass spectrometry (GC/MS). The analytical method described in this paper is the first procedure for the simultaneous determination of gas and particle phase azaarenes and allows 47 azaarene compounds to be reliably quantified despite the complexity of urban aerosols. (C) 2003 Elsevier B.V. All rights reserved.


Twenty-five volatile organic compounds (VOCs) up to C-10 were measured using Carbotrap multibed thermal adsorption tubes during the morning and afternoon rush hours on four different days in all three traffic tunnels in Kaohsiung, Taiwan. A gas chromatograph (GC) equipped with a flame-ionization detector (FID) was then used to analyze the VOCs. The analytical results show that VOC concentrations increase with traffic flow rate, and emission profiles in the three tunnels are mostly in the range C-2-C-6. In addition to the traffic conditions and vehicle type, the pattern of emissions in each tunnel was also influenced by other factors, such as vehicle age, nearby pollution sources, and the spatial or temporal variation of VOCs in the urban atmosphere. The ozone formation potential (OFP) in each tunnel was assessed based on the maximum incremental reactivities of the organic species, demonstrating that OFP increases with traffic flow rate. Vehicle distribution influences the contributions of organic group to OFP in a tunnel. Meanwhile, when ranked in descending order of contribution to OFP in all tunnels, the organic groups followed the sequence olefins, aromatics, and paraffins. Classification: 5.


Classification: 3,8.


Results from an experimental network of seven energy balance stations in and around a European city are presented. The network of micrometeorological stations was part of the Basel Urban Boundary Layer Experiment (BUBBLE) carried out in the city of Basel, Switzerland. Three urban sites provided turbulent flux densities and radiation data over dense urban surfaces. Together with a suburban site and three rural reference sites, this network allowed the simultaneous comparison of urban, suburban, and rural energy balance partitioning during one month of summertime measurements. The partitioning is analysed together with long-term data to evaluate the magnitude of the urban flux density modification, and to document characteristic values in their diurnal and yearly course. Simple empirical relations between flux densities and surface characteristics are presented. The energy balance partitioning is addressed separately for daytime and nocturnal situations. All four components of the surface radiation budget are analysed. Moreover, the vertical flux density divergences within the urban canopy layer are discussed. Copyright © 2004 Royal Meteorological Society. Classification: 3.


In this study, Terra/Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) imagery was analyzed together with in situ spatial data to examine the potential of high spatial resolution multispectral remote sensing to support the definition of energy exchanges in urban environment. The spatial distributions of physical parameters with relation to the urban energy budget were determined, and finally, taking into account the effects of different types of built-up areas and different land uses, the spatial distribution of all-wave surface net radiation balance for the center of the metropolitan city of Athens was estimated within about +/-44.5 Wm(-2). The atmospheric downward longwave flux was estimated with the use of radiosonde measurements. The Santa Barbara DISORT atmospheric radiative transfer model was used for the simulation of the radiative transfer in the atmosphere.
The results indicate that ASTER multispectral imagery enables a better understanding of energy aspects and their causes and effects, providing an important addition to conventional methods of monitoring the urban environment. *Classification: 3.*


Detection of plumes produced by industrial accidents using NOAA/AVHRR thermal imagery may be substantially supported in urban areas by the presence of the heat island phenomenon. In this study, an attempt is made to classify the urban web on the basis of the heat island and its impact on the brightness temperatures. Application of the classification scheme on a night-time thermal infrared NOAA-14 image depicting the urban web of Athens demonstrates the potential of this classification for the detection of a plume caused by a fire in a warehouse. Detection of the plume in this case is favoured by the urban heat island phenomenon due to which the urban surface has higher temperature compared to the adjacent environment and the plume above. As a result, distinction of the pixels corresponding to the plume is more effective. *Classification: 3,5.*


*Classification: 5.*


Samples of fine and coarse fractions of airborne particulate matter were collected in an urban residential area of metropolitan Bangkok from June 1995 to May 1996 and in a suburban residential area in Pathumthani, Bangkok's boundary province, from September 1993 to August 1994. The samples were analyzed for elemental concentrations by instrumental neutron activation analysis. The data sets were then analyzed by positive matrix factorization followed by rotation to identify the possible sources of atmospheric aerosols in both areas. The best solutions were found to be six factors for elemental compositions of each of the fine and coarse particulate matter fractions at the urban site and five factors each for both fine and coarse fractions at the suburban location. Soil was the major source of airborne particulate matter identified for all data sets. The motor vehicle factor showed much higher concentration for Br in urban than in suburban area. A motorcycle factor with high concentrations of Zn and Mn were found at the urban site. The factor containing highest concentrations of Na and Cl was attributed to sea-salt and was clearly seen in the urban atmosphere. The site was located 35 km to the north from the Gulf of Thailand and was influenced by wind from the south and southwest for most of the year. Charcoal/wood burning and incineration factors were likely to be the local sources. A factor with high concentration of Ca was attributed to a construction near the urban residential site and
from two plaster manufacturing factories close to the suburban residential site. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 5.


Physical simulation was used to study pollution dispersion in a street canyon. The street canyon model was designed to study the effect of measuring flow and concentration fields. A method of CO2-laser photoacoustic spectrometry was applied for detection of trace concentration of gas pollution. The advantage of this method is its high sensitivity and broad dynamic range, permitting monitoring of concentrations from trace to saturation values. Application of this method enabled us to propose a simple model based on line permeation pollutant source, developed on the principle of concentration standards, to ensure high precision and homogeneity of the concentration flow. Spatial measurement of the concentration distribution inside the street canyon was performed on the model with reference velocity of 1.5 m/s. Classification: 8,5.


Numerical simulations compared with field measurements are used to explain the effect of sea breezes on photochemical smog episodes in Athens during the Mediterranean Campaign of Photochemical Tracers on 12-14 September 1994. The numerical simulations, performed using a nonhydrostatic vorticity mesoscale model coupled to the Lurmann-Carter-Coyner photochemical module, are compared with ground-based lidar and aircraft measurements. The current analysis shows that the three selected days include the two main summertime flow patterns characteristic of the Athens peninsula, each of which lead to significantly different pollution amounts. On 12 and 13 September, a strong, northerly synoptic wind reduces the inland penetration of the sea breeze so that ozone concentrations within the greater Athens area remained low. In contrast, the weaker synoptic forcing on 14 September allowed the development of sea breezes over the whole peninsula and high ozone concentrations were found north and east of the city. An analysis based on pollution amounts and wind patterns is carried out to divide the peninsula into regions, each of which corresponds to a specific pollutant behavior. Classification: 5.

Clark-Thorne, S. T. and Yapp, C. J. (2003) 'Stable carbon isotope constraints on mixing and mass balance of CO2 in an urban atmosphere: Dallas metropolitan area, Texas, USA', *Applied Geochemistry*, 18, 75-95

The concentrations and 8(13)C values of atmospheric CO2 were measured in similar to 150 air samples collected at 8 sites in the Dallas metropolitan area over the period August 1998 to December 1999. Measured concentrations (C) of atmospheric CO2
ranged from 369 to 475 ppm, while the 8(13)C values ranged from -12.0 to -8.1 parts per thousand. These values contrast with a "global" concentration at the time of this study of approximately 367 ppm and a corresponding delta(13)C value of about -8.0 parts per thousand. delta(13)C was linearly correlated with I/C for samples collected at heights of similar to 2 m at 3 sites adjacent to streets with significant automobile traffic. Extrapolation of this two-component mixing line to I/C = 0 yielded a delta(13)C value of about -27 parts per thousand for the CO2 input-i.e., the same as that of gasoline. A simple box model, incorporating photosynthesis, respiration, and anthropogenic addition of CO2, indicates that differences between downwind and upwind concentration-weighted 8(13)C values (delta[C*delta(13)C]) of atmospheric CO2 may be linearly correlated with downwind and upwind differences in concentration (C*(d) - C*(u)), where C* is reported as mol/m(3). The model predicts that measurable effects of photosynthetic withdrawal of atmospheric CO2 are manifested by data arrays with slopes more positive than about -16. This effect of photosynthesis is evident in a linear array of "warm weather", Dallas atmospheric CO2 data (slope of -12.7 parts per thousand). Collectively, the data for all 8 sites exhibited considerable scatter about binary mixing lines that depict the addition of CO2 from combustion of natural gas and gasoline. However, when model slopes (m) were calculated for binary mixing between a "background" atmospheric CO2 and each individual sample, it was found that, in general, m increases with decreasing temperature. The effects of photosynthesis and respiration complicate this relationship, but the overall pattern suggests that, as temperature decreases, the proportion of anthropogenic CO2 derived from combustion of natural gas increases. This increase appears to reflect increased use of natural gas for home heating, etc., in cooler weather. Therefore, seasonally changing patterns of fossil fuel use are detectable in the atmospheric CO2 of this urban environment. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.


Over the last decade, simple models of the convective boundary layer (CBL) have been suggested as an approach to inferring regionally averaged land-air exchanges of heat, water and trace gases, because the properties of the CBL respond to an average of the underlying small-scale heterogeneity. This paper explores the use of an integral CBL method to infer regionally averaged fluxes in a landscape that has at least three major sources of heterogeneity - irrigated and non-irrigated rural land use and a large urban area (Sacramento region, California). The first part of the paper assesses the validity of the simple slab model of the CBL - this is integrated forwards in time using local-scale measured heat and water vapour fluxes, to predict mixed-layer depth, temperature and humidity. Of the four different CBL growth schemes used, the Tennekes and Driedonks model is found to give the best performance. Evaluation of the model performance with different weightings of heat and water vapour fluxes based on the land use characteristics in the region suggest that the source area for the boundary-layer sonde measurements is larger than physically-based estimates would suggest. Finally, measured time series of potential temperature are used to infer regionally averaged sensible heat fluxes using an integral CBL (ICBL) method. These ICBL fluxes are compared with those measured at the local scale over the three land
use types that comprise the region of interest. They are found to be closest to the heat fluxes calculated by appropriately weighting the measured heat fluxes in the source area calculated for the ICBL. We conclude that the integral CBL budget method provides adequate estimates of regionally-averaged surface heat fluxes in a landscape that is characterised by surface types with distinctly different surface energy budgets. 

Classification: 3.


An urban canopy model is developed for spatially averaged mean winds within and above urban areas. The urban roughness elements are represented as a canopy-element drag carefully formulated in terms of morphological parameters of the building arrays and a mean sectional drag coefficient for a single building. Turbulent stresses are represented using a mixing-length model, with a mixing length that depends upon the density of the canopy and distance from the ground, which captures processes known to occur in canopies. The urban canopy model is sufficiently simple that it can be implemented in numerical weather-prediction models. The urban canopy model compares well with wind tunnel measurements of the mean wind profile through a homogeneous canopy of cubical roughness elements and with measurements of the effective roughness length of cubical roughness elements. These comparisons give confidence that the basic approach of a canopy model can be extended from fine-scale vegetation canopies to the canopies of large-scale roughness elements that characterize urban areas. The urban canopy model is also used to investigate the adjustment to inhomogeneous canopies. The canonical case of adjustment of a rural boundary layer to a uniform urban canopy shows that the winds within the urban canopy adjust after a distance \( x(0) = 3L(c) \ln K \), where \( L(c) \) is the canopy drag length-scale, which characterizes the canopy-element drag, and \( \ln K \) depends weakly on canopy parameters and varies between about 0.5 and 2. Thus the density and shape of buildings within a radius \( x(0) \) only determine the local canopy winds. In this sense \( x(0) \) gives a dynamical definition of the size of a neighbourhood. The urban canopy model compares well with observations of the deceleration of the wind associated with adjustment of a rural boundary layer to a canopy of cubical roughness elements, but only when the sectional drag coefficient is taken to be somewhat larger than expected. We attribute this discrepancy to displacement of streamlines around the large-scale urban roughness elements, which yields a stress that decelerates the wind. A challenge for future research is to incorporate this additional 'dispersive stress' into the urban canopy model. Classification: 8.


Atmospheric dispersion modelling was used to assess exposure of road users to PM2.5 in London. The measured exposure along one of the routes was similar to the modelled concentration at the most polluted points on that route. The model indicated that the nearest road is the dominant source of PM2.5 at these points, while imported
transboundary secondary PM2.5 is more dominant along the rest of the route. Control of exposure is therefore easier to achieve by local air quality management measures than control of air quality monitored at fixed locations. This provides an incentive to develop model capability for exposure assessment. To achieve this, the high spatial resolution of the model output in street canyons was shown to be important. The model's systematic underprediction of measured exposure was attributable to very short-range transient variability in PM2.5 concentration associated with traffic queuing, signal control, and plumes from individual vehicles, consistent with observations of the elemental carbon fraction of the PM2.5 samples. This therefore needs to be studied further. (C) 2003 Elsevier Science Ltd. All rights reserved.


Classification: 2,5.


Classification: 3.


The Australian Air Quality Forecasting System (AAQFS) is the culmination of a 3-yr project to develop a numerical primitive equation system for generating high-resolution (1-5 km) short-term (24-36 h) forecasts for the Australian coastal cities of Melbourne and Sydney. Forecasts are generated 2 times per day for a range of primary and secondary air pollutants, including ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, and particles that are less than 10 mum in diameter (PM10). A preliminary assessment of system performance has been undertaken using forecasts generated over a 3-month demonstration period. For the priority pollutant ozone it was found that AAQFS achieved a coefficient of determination of 0.65 and 0.57 for forecasts of peak daily 1-h concentration in Melbourne and Sydney, respectively. The probability of detection and false-alarm rate were 0.71 and 0.55, respectively, for a 60-ppb forecast threshold in Melbourne. A similar level of skill was achieved for Sydney. System performance is also promising for the primary gaseous pollutants. Further development is required before the system can be used to forecast PM10 confidently, with a systematic overprediction of 24-h PM10 concentration occurring during the winter months. Classification: 5.

The aim of the present work is to develop a simple model in order to calculate the vertical pollutant distribution inside a street canyon at low wind speed. It is aimed at providing a relationship between traffic emission and the pollutant in excess. It is assumed that street ventilation is controlled by the vertical turbulent diffusion. The diffusion coefficient $K_z$ must be known. In the present study, the correlation between calculated and experimental values will be shown, which makes it possible to estimate this parameter. *Classification*: 8.

Coppalle, A., Delmas, V. and Bobbia, M. (2001) 'Variability of NOx and NO2 concentrations observed at pedestrian level in the city centre of a medium sized urban area', *Atmospheric Environment*, 35, 5361-5369

NOx and NO2 concentrations were measured at different locations in a city centre of an urban zone (Population 450000) in order to study the variation of the outdoor exposure at pedestrian level. These measurements were carried out to understand the influence of traffic emissions at each measured site. The observations were done during four weeks in winter, including several days with high pollution levels. The results at different locations have been used to analyse criteria recommended for locating observation sites in a monitoring network. No large differences in background pollution averaged over several weeks have been found throughout the city centre, even during pollution peaks. Measurements were also carried out inside one street canyon. The contribution of the street traffic to the NO=NOx-N02 concentrations observed at side-walk has been found important, i.e., several times the background level. On the other hand, the majority of observed NO2 pollution is due to the contribution of background pollution within the street. The pollutant excess at pedestrian level is strongly correlated to the street traffic emission and to the atmospheric turbulence observed at roof level. Application of a box model to the street data demonstrates that such models can be useful to estimate the pollutant accumulation within the street. (C) 2001 Elsevier Science Ltd. All rights reserved. *Classification*: 5.


A survey on the concentration of particulate matter in the urban atmosphere was carried out in the city of Sao Carlos, Brazil. Five sites were selected for data collection: one in the city centre (high concentration of people and automotive vehicles), three in industrial areas, and one at the interface with the countryside. The particle size distribution and mass concentration, temperature, humidity and wind velocity were measured at each site. In the city centre, the concentration of the particles smaller than 10 mum (PM10) was also measured. The particle size distribution was obtained with a laser scattering particle counter. The total and PM10
concentrations were obtained with high volume samplers. The tests were performed for 75 consecutive weeks. The results show that the particle concentration is sensitive to seasonal conditions. During autumn and winter, which is the drier and windy period of the year, larger particles were dispersed, leading to higher concentrations, both total and PM10. The relative humidity varied with the schedule of sampling and with the season: the autumn and winter weeks were much drier than the other periods. Higher rainfall levels coincided with lower particle concentrations. All these results are statistically significant. Classification: 5.


Polycyclic aromatic hydrocarbons (PAHs), mutagenic compounds predominantly derived from combustion, have been used as markers of combustion sources to the atmosphere. Marine aerosol collected aboard the NOAA R/V Ronald Brown during the Aerosols99 and the Indian Ocean Experiment (INDOEX) projects was analyzed for PAHs to assess the continental impact of combustion-derived particulate matter on the Atlantic and Indian Ocean atmospheres. PAH concentrations in the Atlantic and southern Indian Ocean atmospheres were consistent and low, ranging from <0.45 pg/m(3) for coronene to 30 pg/m(3) for 9,10- dimethylanthracene. PAH concentrations increased ten fold as the ship crossed the Intertropical Convergence Zone (ITCZ) into the northern Indian Ocean, indicating an increased anthropogenic influence. PAH concentrations over the northern Indian Ocean atmosphere were approximately an order of magnitude greater than those in the northern Atlantic Ocean atmosphere. PAH composition profiles over the northern Indian Ocean were specific to wind regimes and influenced by a combination of biomass and fossil fuel combustion. This was supported by significant correlations between select PAHs and organic carbon (OC), elemental carbon (EC), SO4-2 and K+ for particular wind regimes. Indeno[1,2,3-cd]pyrene/EC ratios used as a combustion source marker suggest that fossil fuel combustion, rather than biomass burning, is the predominant source of PAHs to the Northern Hemisphere Indian Ocean atmosphere. Interestingly, fossil fuel consumption in the Indian sub-continent is a fraction of that in Europe and the United States but the soot and PAH levels in the adjacent Northern Indian Ocean atmosphere are significantly greater than those in the Northern Atlantic atmosphere. Classification: 0.


In this paper, the "Experience sur Site pour COntraindre les Modeles de Pollution atmospherique et de Transport d'Emissions" (ESCOMPTE) program is presented. The ESCOMPTE program is used to produce a relevant set of data for testing and evaluating regional pollution models. It includes high-resolution (in space and time)
atmospheric emission inventories and field experiments, and covers an area of 120 X 120 km, centered over the Marseilles-Berre area in the southeast of France during Summer 2001. This region presents a high occurrence of photochemical pollution events, which result from numerous industrial and urban sources of primary pollutants. From the dynamical characteristics of the area, sea-breeze circulation and channeling effects due to terrain features highly influence the location of the pollutant plumes. ESCOMPTE will provide a highly documented framework for dynamics and chemistry studies. Campaign strategies and experimental set up are described. During the planning phase, existing modeling results helped defining the experimental design. The campaign involved surface measurement networks, remote sensing, ship-borne, balloon-borne, and airplane measurements. Mean standard meteorological parameters and turbulent fluxes, ozone, ozone precursors, photochemically active trace gases, and aerosols were measured. Five intensive observation periods (IOPs) were documented using a wide spectrum of instruments, involving aircraft (7) (one of them equipped with a Doppler lidar, the others for in situ meteorological and chemical measurements), constant volume balloons (33), ozone lidars (5), wind profilers (15 sodars and radars), Doppler scanning lidar (1), radiosonde systems (at 4 locations), instrumented ships (2). In addition to the air quality networks from environmental agencies, 15 supplementary ground stations equipped for chemistry and/or meteorology and/or surface flux measurements, were operational. All instruments were calibrated and compared during a Quality Control/Quality Assurance (QC/QA) week, at the very beginning of the campaign. Fifteen days were intensively documented during five IOPs, referenced as 1, 2a, 2b, 3, and 4. High pollution levels were encountered during sea-breeze conditions observed during IOPs 2b and 3, whereas IOPs 2a and 4 corresponded to moderate wind, and channeled plume regimes. In addition, hourly emissions inventories for all IOPs were established to complete data sets and to finalize the ESCOMPTE database (EDB). Two other projects were associated to ESCOMPTE: urban boundary layer (UBL) and tropospheric water vapor content by GPS tomography (GPS/H2O). They took advantage of the scientific environment provided by ESCOMPTE. (C) 2004 Elsevier B.V. All rights reserved.

**Crutzen, P. J. (2004) 'New Directions: The growing urban heat and pollution "island" effect - impact on chemistry and climate', Atmospheric Environment, 38, 3539-3540**

Classification: 4,1.


Passive samplers have been widely used for over 30 years in the measurement of personal exposure to vapours and gases in the workplace. These samplers have just recently been applied in the monitoring of ambient air, which presents concentrations that are normally much smaller than those found in occupational environments. The locally constructed passive sampler was based on gas molecular diffusion through static air layer. The design used minimizes particle interference and turbulent...
diffusion. After exposure, the SO2 trapped in impregnated filters with Na2CO3 was extracted by means of an ultrasonic bath, for 15 min, using 1.0×10-2 mol L-1 H2O2. It was determined as SO4-2 by ion chromatography. The performance of the passive sampler was evaluated at different exposure periods, being applied in industrial and urban areas. Method precision as relative standard deviation for three simultaneously applied passive samplers was within 10%. Passive sampling, when compared to active monitoring methods under real conditions, used in urban and industrial areas, showed an overall accuracy of 15%. A statistical comparison with an active method was performed to demonstrate the validity of the passive method. Sampler capacity varied between 98 and 421 µg SO2 m-3 for exposure periods of one month and one week, respectively, which allows its use in highly polluted areas. Classification: 5.


The Global Positioning System (GPS) has been widely used in land vehicle navigation applications. However, the positioning systems based on GPS alone face great problems in the so-called urban canyon environments, where the GPS signals are often blocked by highrise buildings and there are not enough available satellite signals to estimate the positioning information of a fix. To solve the problem, a constrained method is presented by approximately modeling the path of the vehicle in the urban canyon environments as pieces of lines. By adding this constraint, the minimum number of available satellites reduces to two, which is satisfied in many urban canyon environments. Then, different approaches using the constrained method are systematically developed. In addition, a state-augmentation method is proposed to simultaneously estimate the positions of the GPS receiver and the parameters of the line. Furthermore, the interacting multiple model method is used to determine the correct path which the vehicle follows after passing an intersection of roads. Simulation results show that this approach can solve the urban canyon problems successfully. Classification: 5.


The turbulent flow inside an idealized urban street canyon with an aspect ratio of one is studied by means of large-eddy simulation. The Regional Atmospheric Modelling System is configured to simulate the turbulent flow in a neutrally stratified atmosphere with the initial wind perpendicular to the street canyon axis. The mean velocity components, resolved-scale turbulent kinetic energy (RS-TKE), the skewness and kurtosis of the resolved-scale velocity components (u along the canyon and w vertically) are compared with wind-tunnel measurements. The comparison indicates that a reasonable agreement is achieved. The simulation slightly underestimates the intensity of the primary eddy. It is found that distribution of the RS-TKE is very asymmetric: high in the vicinity of the downstream wall, and uniformly low in the vicinity of the upstream wall. The analyses of skewness and kurtosis indicate that there is a layer just below the rooftop in the canyon where
ejection events dominate. Quadrant analysis of resolved-scale velocity fluctuations, $u'$ and $w'$, under the rooftop at the centre of the canyon reveals that the exchange of momentum across the canyon top is contributed unevenly by different events. Weak ejection events dominate the frequency of occurrences, but fewer strong sweep events contribute the majority of the total momentum transfer. The features of momentum transfer are further investigated by analysing the spatial-temporal variations of $u'$,$w'$, and $u'w'$ at the roof level. It is found that the variation of these variables is highly intermittent and is associated with multi-scale turbulent events. The period of eddies containing high RS-TKE is attributed to the Kelvin-Helmhotz instabilities. These results improve our understanding of the turbulent structure in street canyon flow.

Classification: 8.


Classification: 5.


This review surveys analysis of airborne and vehicle emitted low-molecular-weight carboxylic acids. Attention is paid to providing a comprehensive coverage of collection techniques, sample handling, storage, extraction methods followed by a discussion of recent developments in carboxylic acid analysis using chromatographic (gas and ion chromatography) and electrophoretic (capillary electrophoresis) techniques. The occurrence and sources of carboxylic acids in the ambient air are also summarized. Classification: 0.

Davies, F., Collier, C. G., Pearson, G. N. and Bozier, K. E. (2004) 'Doppler lidar measurements of turbulent structure function over an urban area', *Journal of Atmospheric and Oceanic Technology*, 21, 753-761

Analysis of radial wind velocity data from the Salford pulsed Doppler infrared lidar is used to calculate turbulent spectral statistics over the city of Salford in the United Kingdom. The results presented here, first, outline the error estimation procedure used to correct the radial wind velocity measurements from the Salford lidar system; second, they correct the data for the spatial averaging effects of the Salford lidar pulse; and finally, they use the corrected data to calculate turbulent spectral statistics. Using lidar data collected from the Salford Urban Meteorological Experiment (SALFEX), carried out in May 2002, kinetic energy dissipation rates, radial velocity variance, and integral length scales are calculated for the boundary layer above an urban canopy. The estimates of the kinetic energy dissipation rate from this method are compared to calculations using more traditional spectral methods. The estimates of the kinetic energy dissipation rate for the two methods are correlated and both
show an increase in dissipation rate through the day. The procedure followed for the correction of the spatial averaging effects of the lidar pulse shape actually uses the Salford lidar pulse shape profile. Classification: 8.


Human mortality in US cities is highest on extremely hot, humid summer days, but in general, winter-mortality rates are significantly higher than summer rates. The observed winter-dominant warming pattern, which has been linked to increasing greenhouse-gas concentrations, has led some researchers to propose future mortality decreases, while others contend that increasing heat-related mortality in summer will more than offset any winter-mortality reductions. Because winter mortality is only weakly linked to daily weather, we examine the seasonality of mortality using monthly data for 28 major US cities from 1964 to 1998. Daily all-causes mortality counts are age-standardized, aggregated monthly, and related to mean monthly 07:00 h local standard time (LST) air temperature in each city. The climate-mortality seasonality patterns are examined for spatial and temporal (decadal-scale) variability, and the impact of climate change on mortality rates is investigated after an approximation of the inherent technology/adaptation trend is removed from the monthly time series. Mortality seasonality varies little between most US cities with comparable climates. By the 1990s, monthly mortality anomalies were similar between all cities regardless of climate, suggesting there is no net mortality benefit to be derived from a location's climate. After removing the impact of long-term declining mortality rates, some statistically significant monthly climate-mortality relationships remain in most cities, with generally positive temperature-mortality relationships in summer and negative relationships in winter. Future mortality could be reduced with a winter-dominant warming but increase with pronounced summer warming. In each case, however, net future climate-related mortality rates are very low relative to the baseline death rate, indicating that climate change will have little impact in defining future mortality patterns in US cities. Classification: 1,7.


In the last three decades carbonyl compounds, aldehydes and ketones, have received a great deal of attention due to their strong influence on photochemical smog formation and their recognized adverse human health effects. Carbonyl compounds are directly emitted into the atmosphere by combustion sources and also produced from photochemical oxidation of hydrocarbons and other organic compounds. In this paper it is presented a general overview about the carbonyl compounds sources, reactivity, concentration levels and toxicological effects. Classification: 0.


An operational multisource, multireceptor Gaussian dispersion model, the Danish regulatory model Operationelle Meteorologiske Luftkvalitetsmodeller (OML) has been modified for applications in urban environments. A so-called roughness sublayer has been introduced into the model to represent the turbulence characteristics of the lowest part of the surface layer over rough surfaces like cities. The meteorological preprocessor was enhanced to take into account an urban energy budget. The performance of the resulting OML-Urban has been validated for nitrogen oxides and sulfur dioxide for Zurich for 1990. For that year, a detailed emission inventory as well as continuous hourly measurements at four stations are available. The 24 air pollution monitoring stations used for validation have been divided into different groups, depending on local influences from nearby roads. In comparison with results from the standard OML using an urban roughness length, the urban modification (roughness sublayer and changes in the meteorological preprocessor) results in a 25%-35% increase of the annual mean surface concentration. OML-Urban shows a good reproduction of the probability density function of observed hourly concentrations, and the simulated yearly averaged concentrations show a good correspondence to observations. *Classification: 5.*


The Lattice Boltzmann (LB) method is a novel fluid modelling technique developed from cellular automata. Instead of numerically solving the continuum Navier-Stokes equations, it simulates the interactions of mesoscopic particle populations p(alpha) using discrete speeds and positions to obtain the macroscopic velocity, density and temperature fields. Localised at neighbouring grid nodes, the method handles complex geometries and multiple fluids more easily than traditional continuum CFD methods. Rothman and Zaleski (Lattice-Gas Cellular Automata: Simple Models of Complex Hydrodynamics (1997) Cambridge University Press, Cambridge) discuss LB method theory and development in more detail. To demonstrate the power of the technique, a 2D LB model is first used to perform urban canyon configuration studies at Reynolds number Re = 100 for Height to Width (H/M) ratios from 0.125 to 2. Then, thermal lid driven cavity simulations for Re = 100 and Rayleigh number Ra = 2000 are performed for different locations of a relatively hot wall. The simulated flow fields appear qualitatively consistent with physical flows observed in wind tunnel and field studies, and indicate that LB methods generate results comparable to traditional CFD methods for the selected flow situations. (C) 2002 Elsevier Science Ltd. All rights reserved. *Classification: 8.*

Polycyclic aromatic hydrocarbons (PAHs) were measured in airborne particles (PM [0] collected in an urban site of Sao Paulo City, Brazil. Samples were Soxhlet extracted sequentially with dichloromethane and acetone, followed by solid phase fractionation. Increasing polar fractions (A-K) of dichloromethane and acetone extracts were obtained. Fractionated extracts were analyzed by gas chromatography/mass spectrometry and Salmonella microsuspension bioassy. Sixteen PAH compounds were quantified in dichloromethane B and C fractions, nevertheless the D and E fractions presented higher mutagenic activities. Concentrations of the individual PAHs ranged from 0.8 ng m(-3) (perylene) to 12.8 ng m(-3) (benzofluranthene), reaching a total concentration of 95.5ng m(-3). BaP/BgP and Pyr/BaP ratios indicated the presence of vehicular emissions and BghiP/Ind and Chr/BeP ratios suggested a contribution of wood combustion emissions. Further investigation is still necessary for a better understanding of the PAH sources in the urban atmosphere of Sao Paulo City. (C) 2002 Elsevier Science Ltd. All rights reserved. *Classification*: 0.


Aerosol samples were collected in the Sao Paulo Metropolitan Area, Brazil, during two periods (winter and summer) for fine and coarse particles; they were analysed by gravimetry, scanning electron microscopy, particle induced X-ray emission (PIXE) and electron probe X-ray micro analysis (EPXMA) in order to investigate the mass concentration, morphology and physico-chemical properties of the particles. The gravimetry and PINE results confirmed that the aerosol concentration is higher in winter than in summer, as expected from the climatological conditions (dry winter and humid summer). Hierarchical cluster analysis of the EPXMA results showed the presence of metal compounds, silicon-rich particles, sulphates, carbonates, chlorides, organics and biogenic particles. (C) 2002 Elsevier Science Ltd. All rights reserved. *Classification*: 5.


A general overview about the ambient levels of low molecular weight carboxylic acids and their possible emission sources, as well as the implication of them in the atmosphere is presented. Carboxylic acids are considered to be one of the dominant classes of organic compounds found in the atmosphere in an variety of phases, such as in rainwater, snow and ice, on aerosol particles and gas phase. They may be originated: from biogenic and anthropogenic direct emission and by photochemical reaction in situ. Emission sources and formation mechanisms of organic acids in the atmosphere are discussed. *Classification*: 0.

On the basis of measured field data, the paper evaluates the procedure to predict the wind velocity in the urban boundary layer in a town using available airport data. In particular, the accuracy of the prediction of velocity and wind direction and their statistical deviations are dealt with and design ramifications are discussed. (C) 2002 Elsevier Science Ltd. All rights reserved. *Classification: 2,8.*


Variations in the extreme percentiles of empirical hourly PM2.5 concentration distributions from a unique high-density network of 20 stations within New York City are statistically analyzed. Significant diurnal, seasonal and day-of-week variations are noted, with the highest concentrations typically found between 7:00 and 9:00 a.m., during summer, and on weekdays. The lowest concentrations are generally found during early morning hours (4:00–6:00 a.m.), in winter and on weekends. The amplitudes of these seasonal and diurnal cycles vary with percentile, with less pronounced cycles for the lowest and in some cases highest percentiles. The diurnal and day-of-week patterns suggest that although anthropogenic factors may be primarily responsible for the observed diurnal cycle, meteorological conditions also have some influence.

There is little spatial variation in concentration across the city. Highly significant between-station correlations are obtained for all seasons. However, lower correlation is found in winter. Meteorologically, the highest PM2.5 concentrations occur with moderate southwesterly winds and high temperatures and humidity during summer. These conditions are related to the westward expansion of the Bermuda high-pressure system. Calm winds are conducive to the highest winter particulate concentrations. Relatively strong northerly winds are typically associated with the lowest PM2.5 concentrations. It appears that regional-scale processes dominate day-to-day changes in particulate concentrations across the city. *Classification: 5.*


Over 4300 monitoring sites operate in North America as part of three nation air quality monitoring networks (the Canadian - National Air Pollution Surveillance (NAPS) network; the United States - State and Local Air Monitoring Stations (SLAMS) and National Air Monitoring Stations (NAMS), and the Mexican - Metropolitan Networks of Mexico). These three networks as well as the recently implemented US Photochemical Assessment Monitoring Stations (PAMS) are reviewed in terms of their design objectives, siting criteria, quality assurance, and data
analysis requirements. The principal objective of this paper is to review the current state of national air quality monitoring networks in North America and to assess the effectiveness and adequacy of these networks in addressing the critical needs of the various user communities they were designed to serve. The review specifically focuses on the network contributions to the measurement of ozone, particulate matter (PM10 and PM2.5) and their associate precursor compounds. Network data and analysis needs for the air quality management/regulatory and science communities are compared and contrasted with several illustrative examples of data analysis applications supportive of the needs of the user communities provided. Specific performance issues regarding PAMS instrumentation and/or measurements methods, quality assurance and data analysis and distribution are reviewed and recommendations made with regard to improvements for consideration in future upgrades of national networks. (C) 2000 Elsevier Science Ltd. All rights reserved.

Classification: 5.


Classification: 5.


Classification: 7.


Simultaneous measurement of velocity and concentration provides a tool for studying the turbulent diffusion. This quantity until now was mainly modeled and not measured and it plays an essential role in turbulent diffusion of pollutant. We present a new technique to measure the turbulent mass flux vector, (u'c') over bar, based on the same PIV/PTV images, employed for both instantaneous velocity and concentration measurements. Then we applied the new technique to check the correctness of the model widely used for the turbulent mass flux in RANS simulations, in a street canyon type flow. We found places where the turbulent diffusion is opposite to the gradient in mean concentration. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 8.

This paper analyzes the implications of anthropogenic heat discharges into the urban thermal environment of Tokyo. Heat discharges by the representative office, commercial and residential buildings were simulated with the help of the DOE-2 building energy simulation model. The approach used in this paper also takes into account the heat storage within building structures. The geographical information system based technique was used to estimate the heat discharge distribution all over Tokyo. The mesoscale analyses of the urban climate were carried out with a model that was based on the Colorado State University Mesoscale Model. The improvements in the urban thermal environment via the various measures were analyzed for two types of scenarios, namely, scenarios related to the management of heat discharge sources and urban surface modifications. The maximum improvement in average temperature for daytime was found to be 0.47 degrees C (at noon) as a result of greening the areas around the buildings of Tokyo. Similarly, the maximum improvement in average temperature for the evening was found to be 0.11 degrees C by discharging all heat to the ground. (C) 2002 Elsevier Science B.V. All rights reserved. *Classification*: 2,3.


The modelling of pollutant dispersion at the street scale in an urban environment requires the knowledge of turbulence generated by the traffic motion in streets. In this paper, a theoretical framework to estimate mechanical turbulence induced by traffic in street canyons at low wind speed conditions is established. The standard deviation of the velocity fluctuations is adopted as a measure of traffic-produced turbulence (TPT). Based on the balance between turbulent kinetic energy production and dissipation, three different parameterisations for TPT suitable for different traffic flow conditions are derived and discussed. These formulae rely on the calculations of constants that need to be estimated on the basis of experimental data. One such estimate has been made with the help of a wind tunnel data set corresponding to intermediate traffic densities, which is the most common regime, with interacting vehicle wakes. *Classification*: 8,5.

Diao, G. W. and Chu, L. T. (2001) 'A kinetic study of the reaction of NO2 with HI over the temperature range 278 to 333 K', *Physical Chemistry Chemical Physics, 3*, 1622-1630

The rate constant, k, for the reaction, NO2+HI --&gt; products, has been measured directly for the first time. The rate was found to be -d[NO2]/dt=k[NO2][HI] with k=(6.9 +/-1.1)x10(-19) cm(3) molecule(-1) s(-1) at 303 K. The measurements were made under pseudo-first-order conditions with HI in excess over NO2. NO2 loss rate was monitored by FTIR in a static glass reactor. NO, H2O and I-2 were observed as
products and HNO2 as an intermediate. The study showed that the reaction was influenced by the conditions of the wall which had a surface loss rate constant k(w)=0.13 s(-1). This indicates that the measured k is an upper limit. Within a limited pressure range, the rate was independent of the total pressure in the system. From measurements made over the temperature range 278-333 K, we obtained the following expression for k=(3.6 +/-0.2)x10(-14)x exp[-(2.7 +/-0.7)x10(4)/RT] cm(3) molecule(-1) s(-1) valid between 293 and 333 K. A reaction scheme is proposed involving NO2+HI -->HNO2+I as the initiation step based on the kinetic and product studies, followed by a heterogeneous reaction between HNO2 and HI. A comparison of the reactions between NO2 with HX is made. This reaction is unlikely to play a major role in the removal of HI and as a source for HNO2 in the atmosphere because of its slow rate. Classification: 0.


Because of rapid growth and urbanization of Atlanta, Georgia, over the past few decades, the city has developed a pronounced urban heat island (UHI) that has been shown to enhance and possibly to initiate thunderstorms. This study attempts to find patterns and causes of Atlanta's induced precipitation that might not have been initiated otherwise. Land use maps, radar reflectivity, surface meteorological data, upper-air soundings, and airmass classification (spatial synoptic classification) types are all used to determine when, where, and why precipitation is initiated by Atlanta. Findings illustrate significant spatial and temporal patterns based on a 5-yr climatological description of events. July had the most events, with a diurnal peak just after local midnight. Low-level moisture, rather than UHI intensity, appears to be the most important factor for UHI-induced precipitation. However, UHI intensity also plays an important role. Events tended to occur under atmospheric conditions that were more unstable than those on rain-free days but not unstable enough to produce widespread convection. Classification: 4.


A field experiment was carried out in Phoenix during June 2001 to examine the role of vertical mixing on the O-3 chemistry of the boundary layer during the morning transition from stable to unstable atmospheric conditions. Surface instruments, instruments located on two floors of a 39 story building in downtown Phoenix, and an instrumented airplane were used to characterize the evolving chemistry in the lowest 650 m of the atmosphere. Remote sensing and in situ platforms were used to obtain detailed profiles of winds and temperatures during the early morning hours and for several hours after sunrise. The analysis presented in this paper focuses on vertical profiles of CO, O-3, and NO/NOy measured on the building and their relationship to the morning boundary layer evolution over Phoenix. Some features of these profiles were found that are consistent with a simple conceptual picture of nighttime trapping.
of pollutants in a stable surface layer and a subsequent release the following morning. On some days, however, evidence of significant vertical mixing was found during the early morning hours well before the times expected for the development of convective mixing after sunrise. Possible causes include advection, street canyon turbulence, and large-scale convergence, but a satisfactory explanation for the observed evolution of the chemical profiles has not yet been found. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5,8.


A sampling site at Herceg-Nov (Montenegro) is included in the network for the monitoring of airborne pollutants along the Mediterranean coast. The 24-h concentrations of total suspended particles (TSP) were measured by a standardized gravimetric method in a 1-in-6 day schedule program. The available data set from the period 1995-2000 was chosen for statistical analysis. The 3-parameter Weibull probability model successfully described the distributions of TSP concentrations as the total population and the part of them transported from the continental side. However, in the concentration set from the southern segment, outliers were found indicating the appearance of the highest concentrations from the open Adriatic Sea. The collected particles mostly constituted of PM10 and the ratio PM10/TSP reached value of 0.9. An analysis of the filter samples by scanning electron microscopy (SEM) confirmed the presence of marine aerosol, crustal and amorphous material. The Fe content of >2% in the TSP samples was accepted for the identification of genuine Saharan dust transport. The frequency of these events of 7% a year contributed to an increase of the annual TSP concentrations of 10%-15%. The amorphous material was found in the sample of 31 May/1 June 1999 after the bombing of Cape Arza on the Lustica Peninsula, which is situated 5 km away from the sampling site. The attack occurred on 30 May and depleted uranium ammunition was used. The U-238 radioactivity was at the background level, but the pulvorous material found in that sample most likely originated from dust and soil transported from Cape Arza to Herceg-Nov on 31 May as the backward trajectory analysis by the Eta model showed. Resuspension was the dominant process affecting the TSP concentration, but this episode did not reflect significantly on the annual TSP levels, as is the case with the Saharan dust storms. The methodology applied in this work allowed a fugitive source of PM from destroyed objects and bombed terrain to be discovered. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 5.


Multiple satellite sensors are used to analyze physical processes that determine energy fluxes and their interaction at the urban surface. The study is based on summertime microclimate analyses of the Los Angeles and Paris metropolises. The method consists of deriving some parameters governing the surface heat fluxes, constructing statistics of thermal infrared images, and using a GIS to combine them with a
landcover classification from SPOT-HRV multispectral images, and with data from intensive in-situ experiments. The average images reveal spatial and temporal variations of land surface temperature (LST), and distinct microclimatic patterns. The combined interpretation of the statistics images and of the landcover classification shows: (i) the effect of surface physical properties, especially in downtown business and industrial districts that display heat-islands larger than 7 degrees C; (ii) the temperating influence of water; (iii) the negative correlation between afternoon land surface temperature and normalized vegetation index, which confirms the cooling effect of urban parks; (iv) the correlation between variations of surface temperature and ozone concentration at diurnal and longer time scales. (C) 2003 Elsevier Science B.V. All rights reserved. Classification: 3.


Accurate simulation of air quality at neighbourhood scales (on order of 1-km horizontal grid spacing) requires detailed meteorological fields inside the roughness sub-layer (RSL). Since the assumptions of the roughness approach, used by most of the mesoscale models, are unsatisfactory at this scale, a detailed urban and rural canopy parameterisation, called DA-SM2-U, is developed inside the Penn State/NCAR Mesoscale Model (MM5) to simulate the meteorological fields within and above the urban and rural canopies. DA-SM2-U uses the drag-force approach to represent the dynamic and turbulent effects of the buildings and vegetation, and a modified version of the soil model SM2-U, called SM2-U(3D), to represent the thermodynamic effects of the canopy elements. The turbulence length scale is also modified inside the canopies. SM2-U(3D) assesses the sensible and latent heat fluxes from rural and urban surfaces in each of the computational layers inside the canopies by considering the shadowing effect, the radiative trapping by the street canyons, and the storage heat flux by the artificial surfaces. DA-SM2-U is tested during one simulated day above the city of Philadelphia, U. S. A. It is shown that DA-SM2-U is capable of simulating the important features observed in the urban and rural RSL, as seen in the vertical profiles of the shear stress, turbulent kinetic energy budget components, eddy diffusivity, potential air temperature, and specific humidity. Within the canopies, DA-SM2-U simulates the decrease of the wind speed inside the dense canopies, the skirting of the flow around the canopy blocks, warmer air inside the vegetation canopy than above open areas during the night and conversely during the day, and constantly warmer air inside the urban canopy. The comparison with measurements shows that the surface air temperature above rural and urban areas is better simulated by DA-SM2-U than by the 'standard version' of MM5. Classification: 8.


Classification: 1,2.

From July 1997 to June 1998 aerosol particle samples (diameter 0.1–25 µm) were collected at Kleiner Feldberg (Taunus mountains, Germany), a rural location that is temporarily influenced by the nearby urban Rhein-Main area and/or by long-range transport from East Germany and Eastern Europe. The atmospheric concentrations of the elements sodium to lead (11Z83) were determined by total reflection X-ray fluorescence analysis. Size, morphology and chemical composition of more than 27,000 individual aerosol particles were determined by high-resolution scanning electron microscopy and energy-dispersive X-ray microanalysis. Based on morphology and chemical composition the particles were classified in the particle groups: ammonium sulfates, calcium sulfates, sea salt, aluminosilicates, silica, metal oxides/hydroxides, soot, biological particles, carbon/sulfate mixed particles, and remaining carbon-rich particles (Crest). Polluted air masses at Kleiner Feldberg are characterized by high number concentrations of soot (up to 80% in the size range from 0.1 to 0.2 µm), metal oxides and sulfates. Anthropogenic and natural sources of aluminosilicates, silica and metal oxides/hydroxides are easily distinguished by their morphology. From the size resolved relative abundance of the different particle groups the total and the size resolved complex refractive index (CRI) of the dry particulate matter () was calculated for the different sampling days. Urban influenced air masses are characterized by high real parts (1.60–1.73) and imaginary parts (0.034–0.086) of the total CRI, rural air masses by lower real (1.54–1.61) and imaginary parts (0.001–0.021). The high real parts of the CRI of polluted air masses are predominantly caused by the high abundance of metal oxide/hydroxide particles, the high imaginary parts by high abundances of soot. *Classification: 5.*


The numerical model MIMO is a three-dimensional model for simulating microscale wind flow and dispersion of pollutants in built-up areas. It solves the Reynolds averaged conservation equations for mass, momentum and energy. Additional transport equations for humidity, liquid water content and passive pollutants can be solved. The Reynolds stresses and turbulent fluxes of scalar quantities can be calculated by several linear and nonlinear turbulence models. A staggered grid arrangement is used and coordinate transformation is applied to allow nonequidistant meshsize in all three dimensions in order to achieve a high resolution near the ground and near obstacles. The model was validated for a variety of test cases and it was applied successfully to air pollution problems. (C) 2000 Elsevier Science Ltd. All rights reserved. *Classification: 8.*

It is well known that the commonly used k-epsilon turbulence models yield inaccurate predictions for complex flow fields. One reason for this inaccuracy is the misrepresentation of Reynolds stress differences. Nonlinear turbulence models are capable to overcome this weakness while being not considerably more complex. However no comprehensive studies are known which analyze the performance of nonlinear turbulence models for three-dimensional flows around building-shaped structures. In the present study the predictions of the flow around a surface-mounted cube using three nonlinear two-equation turbulence models are discussed. The results are compared with predictions of the standard k-epsilon turbulence model and wind tunnel measurements. It is shown that the use of nonlinear turbulence models an be beneficial in predicting wind flows around buildings. *Classification: 5,8.*


A decision support system has been developed to support local authorities in air quality management for big Turkish cities. The system is based on CALPUFF dispersion model, digital maps and related databases to estimate the emissions and spatial distribution of air pollutants. It applies a geographical information system. The system estimates ambient air pollution levels at high temporal and spatial resolutions. The system enables mapping of emissions and air quality levels. Mapping and scenario results can be compared with air quality limits. Impact assessment of air pollution abatement measures can also be carried out. *Classification: 5.*


It is a well established fact that the urban landscape creates a climate which influences, for example, human comfort, air quality and energy consumption. However, in spite of this knowledge, it has been recognised that climate issues often have low impact on the urban planning process in practice. The reason for this lack of influence is an important question for which answers must be sought among climatologists, planners and the planning process. The main objective with the present study was to investigate if, how and when knowledge about the climate is used in the urban planning process. The research strategy was developed in an interdisciplinary research group involving climatologists and planners. Case studies involving different interview techniques and historical data were carried out by different actors involved in urban planning at the municipality level in three cities in Sweden. The study showed that urban planners were interested in climatic aspects but the use of climatic information was unsystematic and the results confirmed that climatology has a low impact on the planning process. The low impact is a result of several constraints which could be related to five explanatory variables i.e. conceptual and knowledge based, technical, policy, organisational and the market. The discussion part of the
paper presents some key conclusions which address these constraints. It is important that urban climatologists meet the planners demand-driven needs by providing them with good arguments, suitable methods and tools. Urban climatologists are also encouraged to improve the awareness of the importance of urban climate not only among planners but also among decision-makers and the public. However, as planning is a political activity which not always is based on or even related to scientific knowledge, some of the identified constraints could only be counteracted through improved institutional capacity in the social context of planning. (C) 2000 Elsevier Science B.V. All rights reserved. Classification: 2,1.


Snow samples from six sites located in and around urban areas in Sivas city, Turkey, were collected in the winter of 2000. After ultrasonic leaching of the melted snow solutions, they were analysed for heavy metals (Mn, Zn, Pb, Cu, Ni and Cd) by atomic absorption spectrometry (AAS). The results of the analyses were used to determine major sources and magnitude of heavy metal pollution. Besides, it was compared with the heavy metal concentrations in the urban snow with those of background areas to see whether they could be used as an effective indicator of urban atmosphere pollution. High concentrations of heavy metals were detected in snow samples collected in close proximity to emission sources such as motor-vehicle emissions, combustion of coal and fuel-oil, industrial area. The heavy metal levels in urban snow were several times higher than the background levels. After heavy metal pollution factors of each site were determined, their possible pollutant sources were detected. Our findings show that, data on the heavy metal concentrations in snow are a reliable guide to the degree of air pollution, and can be used as a simple and effective indicator of urban atmosphere pollution. The precision of method varied between 1.22 and 5.62% (n = 54) as average relative standard deviation % (RSD %) depended on the analyte and nature of the sample. Classification: 5.


Classification: 5.


A comparison of the determination of boundary-layer structures by a SODAR, by a RASS, and by a ceilometer is presented. One important structure is the mixing-layer height (MLH). The comparison is focused on 3 days with an evolution of a convective boundary layer over a larger city in Germany. The three instruments give information
that partly agree and partly complement each other. By this, a picture of the diurnal evolution of the vertical structure of this urban boundary layer is presented. The ceilometer gives information on the aerosol content of the air and the RASS provides a direct measurement of the vertical temperature distribution in the boundary layer. The RASS and the ceilometer add information on the moisture structure of the boundary layer that is not detected by the SODAR. On the other hand this comparison validates known techniques by which the MLH is derived from SODAR data. Especially the temperature information from the RASS agrees well with lifted inversions derived from the analysis of the SODAR data. The ceilometer, being the smallest instrument, has a potential to be used in future MLH studies. 

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Classification: 4,7.


Advances in satellite sensors have provided new datasets for monitoring air quality at urban and regional scales. Qualitative true color images and quantitative aerosol optical depth data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor on the Terra satellite were compared with ground-based particulate matter data from US Environmental Protection Agency (EPA) monitoring networks covering the period from 1 April to 30 September, 2002. Using both imagery and statistical analysis, satellite data enabled the determination of the regional sources of air pollution events, the general type of pollutant (smoke, haze, dust), the intensity of the events, and their motion. Very high and very low aerosol optical depths were found to be eliminated by the algorithm used to calculate the MODIS aerosol optical depth data. Correlations of MODIS aerosol optical depth with ground-based particulate matter were better in the eastern and Midwest portion of the United States (east of 100°W). Data were patchy and had poorer correlations in the western US, although the correlation was dependent on location. This variability is likely due to a combination of the differences between ground-based and column average datasets, regression artifacts, variability of terrain, and MODIS cloud mask and aerosol optical depth algorithms. Preliminary analysis of the algorithms indicated that aerosol optical depth measurements calculated from the sulfate-rich aerosol model may be more useful in predicting ground-based particulate matter levels, but further analysis would be required to verify the effect of the model on correlations. Overall, the use of satellite sensor data such as from MODIS has significant potential to enhance air quality monitoring over synoptic and regional scales. Classification: 5.

The concentrations of gas-phase and particle-bound polycyclic aromatic hydrocarbons (PAHs) were measured simultaneously at an industrial area (Taichung Industrial Park) and a suburban area (Tunghai University Campus) in Taichung, Taiwan. Twenty-four hours samplings for two consecutive days were performed between August and December 2002 at both sampling sites. Ambient air particle-bound PAHs were collected on quartz filters and gas-phase PAHs were collected on glass cartridges using a PUF Sampler, respectively. Both types of samples were extracted with a DCM/n-hexane mixture (50/50, v/v) for 24 h, then the extracts were subjected to gas chromatography-mass spectrometric (GC-MS) analysis. Total PAHs concentrations at the Taichung Industrial Park (TIP) sampling site and the Tunghai University Campus (THUC) sampling site were found to be 1232.3 +/- 963.6 and 609.8 +/- 356.3 ng/m(3), respectively. Stationary combustion processes were mainly responsible for PAHs sources at the TIP sampling site, while traffic vehicle exhaust was the largest contributor for PAHs sources at the THUC sampling site. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 5.


Considering the urban characteristics, a customized multi-scale numerical modeling system is established to simulate the urban meteorological environment. The system mainly involves three spatial scales: the urban scale, urban sub-domain scale, and single to few buildings scale. In it, different underlying surface types are employed, the building drag factor is used to replace its roughness in the influence on the urban wind field, the effects of building distribution, azimuth and screening of shortwave radiation are added, and the influence of anthropogenic heating is also taken into account. All the numerical tests indicate that the simulated results are reasonably in agreement with the observational data, so the system can be used to simulate the urban meteorological environment. Making use of it, the characteristics of the meteorological environment from the urban to urban sub-domain scales, even the among-buildings scale, can be recognized. As long as the urban planning scheme is given, the corresponding simulated results can be obtained so as to meet the need of optimizing urban planning. Classification: 2.


Classification: 5.

Classification: 4.


The results of numerical simulations of tracer dispersion in an urban stable boundary layer are presented. Both Gaussian approximation and fourth order closure are considered and a Gram-Charlier probability density function is used in our Lagrangian stochastic model. Different parameterizations for the boundary-layer height and different values of kurtosis are tested. The model is based on the generalized Langevin equation, whose coefficients are solution of the Fokker-Planck equation and plume rise is taken into account. The model accuracy is assessed by means of a model evaluation based on the predicted and observed crosswind integrated concentrations, maximum on the arc and standard deviation of the crosswind concentration distribution on the arc. Classification: 5,8.


Recent studies that have found increased health effects of atmospheric ultrafine particulate matter (PM) have refocused attention on particle number rather than particle mass concentrations as a relevant measurement of PM pollution. As part of the Southern California Supersite program, ambient particle characteristics were measured over 13 months at three different sites in the eastern portion of the Los Angeles Basin: Riverside, Rubidoux, and Claremont, CA. The sites represent receptor locations that are influenced by local particle sources as well as advection from the more intense particle sources upwind closer to Downtown Los Angeles. An SMPS/APS tandem system was employed to collect continuous particle size distributions, from which particle number and mass concentrations were calculated. An aethalometer provided continuous particulate elemental carbon (EC) concentrations. Results show no meaningful correlation between particle number and mass, indicating that fine particle standards may not be effective in controlling ultrafine concentrations. Diurnal patterns show a morning traffic peak indicated by increases in particle mass, number, and EC. Afternoon periods in the warmer months are characterized by high number counts while mass and EC remain low, suggesting the formation of new particles by photochemistry. Particle mode diameters range from 30 nm up to above 100 nm, a result not seen in most other studies of particle size distributions in other urban or rural areas where mode diameters are generally less than 50 nm. Evidence is presented that the observed ultrafine particle concentrations...
and size distributions are influenced by long-range advection and photochemical processes as well as vehicular emissions, which have been previously assumed to dominate day-to-day ultrafine particle levels. Classification: 5.


With the help of meteorologists, atmospheric laser communication within cities is becoming more reliable and more widely used. Classification: 2.


The requirements of the framework Directive on air quality assessment and management introduce real practical problems for the meteorological community. Some of the meteorological variables needed in urban air pollution assessments are not routinely measured and in normal circumstances the number of meteorological stations in urban areas is limited to a few sites, often just at airports. The European wide project COST 715 on 'Meteorology applied to urban air pollution problems' has been set LIP to review these problems. This paper describes the limitations of current methods. It recognizes that the urban boundary layer is a non-equilibrium situation where standard theories applied to rural areas may not be valid. It shows that predictions of concentrations for assessments should always state the uncertainty associated with them. This uncertainty can be large because of the complexity of urban pollution situations, particularly the description of the local urban meteorology. An example is given of how, with some additional local meteorological measurements, the uncertainty can be reduced. The paper concludes by listing some of the key areas where further work is required. Information about the COST 715 project is available from the website at http://www.dmu.dk/atmosphericenvironment/cost715.htm. Classification: 5,8.


The horizontal and vertical distributions of volatile organic compounds (VOCs) and ozone (O₃) concentrations within the lower troposphere over the greater Athens area, Greece, under sea-breeze conditions were studied. Furthermore, an attempt was made to explain the dynamic and chemical mechanisms responsible for the formation of these distributions. Measurements were collected using a specially instrumented Falcon 20-E5 research aircraft, ground-based meteorological instrumentation, and a network of air quality monitoring stations within the context of the Scientific Training and Access to Aircraft for Atmospheric Research Throughout Europe (STAAARTE) 1997 experimental campaign. Relatively high ozone values (55–100 ppbv) were identified within the first 300–400 m above ground, and significantly reduced values
were found over the depth of the atmospheric boundary layer. High values of VOC concentrations [150–350 ppbCarbon (C)] were observed near the ground as well as within the first 300–400 m above ground. At higher altitudes, of 1400–1600 m, VOC concentrations remained relatively high (100–200 ppbC). It was demonstrated that the sea-breeze circulation plays a major role in the formation of the above-mentioned concentration levels and that chemical transformations explain specific characteristics. Classification: 5.


This paper presents a comparative study on the atmospheric corrosion of copper, at two sites, in Portugal, with exposures started in two different seasons (summer and winter). Particular attention is devoted to the initial stages of the corrosion process. The levels of pollutants, namely of SO2 and chlorides, in both atmospheres, have been measured, over the periods from August 1999 to July 2000 and from November 2000 until July 2001. Climatic data for both sites and both periods has been collected and analysed. Kinetics of the corrosion process (weight losses) have shown to be described by: Deltam  = kt(0.6) and Am = kit(0.4), with k equal to 3.4 (g m(-2) month (-0.6)) and 17 (g m(-2) month (-0.4)), for the one year exposures, started in summer, at the urban and maritime atmospheres, respectively. Exposures started in winter, at the urban atmosphere, have lead to kinetics described by Deltam  = kt(0.7) with k = 5.0 (g m(-2) month(-0.7)). The chemical composition and the morphology of the copper patinas, corresponding to exposures of 2 and 12 months, at the two sites, are compared as well as the morphology of the corroded surfaces. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 5.


The urban bioclimate model UBIKLIM is an application model providing an assessment on the influence of urban climate on human beings. On a calm summer's day with fair weather conditions it calculates the meteorological parameters air temperature, humidity, wind velocity and short and long wave radiation based on a digital height model and appropriate land use information. These meteorological parameters determine the heat exchange conditions of human beings and thus can be analyzed with the help of the Klima-Michel model into physiologically significant terms. The result is a bioclimate map on a scale that is appropriate for climate-related planning in an urban environment. In urban areas lying in a distinct relief, a superimposed wind regime such as a down valley wind, can modify the bioclimate considerably. Up to now it was not possible for UBIKLIM to take this situation into account. In this point UBIKLIM has been developed further, but its easily applicable character has been preserved. This has been realized, firstly by combining an orographically induced wind field with the one calculated in UBIKLIM as a function of land use esp. of urban structure, and secondly by introducing an algorithm by working out conveyance processes in the direction of the superposed wind field.
UBIKLIM fills the gap between meso and micro scale models. Results of the further developed model are shown in the example of the city of Freiburg im Breisgau which is influenced by the distinct relief at the southern edge of the Black Forest. Classification: 7,1.


In order to accumulate fundamental data on the atmospheric environments in subway, the mass concentration, particle size distribution and elemental constitution of suspended particulate matter (SPM), and the concentration and constitution of polycyclic aromatic hydrocarbon (PAH), were measured and analyzed at three subway stations with different air supply systems on the same line. The mass concentration of SPM in the subway stations showed seasonal variations, and was higher in December and October than in March and June. It was also higher at the subway stations than in the aboveground throughout the seasons. The concentrations of SPM in the size range of 0.5-5.0 mum were higher in the subway stations than aboveground, suggesting this size of SPM was generated by the operation of trains. The elements that were observed at high concentrations in the subway SPM were Fe, Ba, Cu and Ca. On the other hand, the elements of which concentrations were relatively higher in the aboveground air were Cl, Na and K. Polycyclic aromatic hydrocarbons collected at the subway stations showed similar concentrations and characteristics to those observed in the urban atmosphere. Classification: 5.


Classification: 1,3,7.


A novel relaxed eddy accumulation (REA) system for aerosol particle flux measurement has been developed and tested. The system consisted of a fast-response sonic anemometer, a flow system, and software for operating the valves and the concentration analysis system. The prototype was used during September - October 2001 at the SMEAR II station of the University of Helsinki. The REA system was operated with a varying threshold for valve switching determined by the running mean standard deviation of the vertical wind speed. Such a varying threshold made the flux proportionality coefficient beta independent of observation conditions. Using temperature as a tracer, beta was determined to be 0.392 +/- 0.002. The system was
validated by comparing the carbon dioxide fluxes estimated by REA with the ones measured by the eddy covariance technique. The system was used subsequently for flux measurements of 50-nm aerosol particles and deposition velocity estimation. Observed deposition velocities over a pine forest during the autumn season were on the average $0.43 \pm 0.06$ (standard error) cm s$^{-1}$, which is higher than the earlier model estimates for forest canopies. Deposition velocity was dependent on the turbulence level and stability. To the authors' knowledge, no direct experimental data of deposition velocities on this size range is available in the literature. Classification: 5.


An analytical method for simultaneous determination of "particle"-associated and "gaseous"-phase concentrations of polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbons (PAH) in atmospheric aerosol samples obtained by high-volume samplers using polyurethane foam adsorbent (PUF) and quartz fiber filters (QFF) has been investigated. Quality control of the analytical procedure was carried out by blank control and by evaluating limits of detection, recoveries, accuracy, and repeatability. The proposed method was subsequently used to determine PAH and PCB in the "gaseous" and "particulate" phases of the aerosols that enter the Venice Lagoon atmosphere. The highest concentrations of SigmaPCB and SigmaPAH were predominantly in the "gaseous" phase. In both "particulate" and "gaseous" phases the penta-CB congeners dominated total PCB concentrations whereas phenanthrene, fluoranthene, and pyrene dominated the SigmaPAH concentrations. Total ("gaseous" plus "particulate") PCB and PAH concentrations were higher at the site directly influenced by the industrial plants but the concentrations in marine aerosol samples were lower by a factor four only and must be taken into consideration when studying the chemical contamination of the Venice Lagoon. Classification: 0.


A deconvolution filtering model of multiple scattering in ground-based single field of view (SFOV) LIDAR returns is described. It is based on time series deconvolution techniques. The contribution of multiply scattered photons in SFOV LIDAR returns can be numerically modeled by processing LIDAR signals without additional information about aerosol properties and measurement geometry. Deconvolution results are in good agreement with those performed by Monte Carlo calculations, showing that the significance of multiply scattered photons is strongly correlated with aerosol concentration. It is found that, for ground-based LIDAR, the contribution of multiply scattered photons to LIDAR signals is typically below 5% in a clear urban atmosphere, and up to 14% in a very dirty urban atmosphere in Hong Kong during winter seasons. Classification: 5.
A method for estimating the aerodynamic roughness length and displacement height of an underlying surface from single-level sonic anemometer data is applied to an urban surface in Beijing. Both surface roughness length and displacement height are found to vary considerably with wind direction. The results show that during the selected period average values of the aerodynamic roughness length and the zero-plane displacement height were 1.6 m and 36.0 m respectively. Comparison of the present results with previous studies for this site demonstrates that the roughness length and zero-plane displacement have increased over the last eight years. These increases were associated with an increase in the height of urban buildings. Classification: 8.


Classification: 3,4.


An infrared lidar DIAL technique was used to monitor ozone concentration in Madrid urban atmosphere. Interestingly, we found an unusual increase of ozone concentration due to heavy traffic conditions accompanying the holiday rush despite the prevailing low photochemical activity. Consequently, the usual daily ozone profile shifts towards the later hours. A direct and quantitative correlation between ozone pollution and human activity such as the excess of vehicle traffic accompanying summer holiday departures from Madrid city was observed. This new type of information will be useful in the development of local models to understand the dynamics underlying urban pollution. Classification: 5.


Ultrafine particulate matter (PM) consists of particles mostly emitted by combustion sources but also formed during gas-to-particle formation processes in the atmosphere. Various studies have shown these particles to be toxic. The very small mass of these particles has posed a great challenge in determining their size-dependent chemical composition using conventional aerosol sampling technologies. Implementing 2
technologies in series has made it possible to overcome these 2 problems. The first technology is the USC Ultrafine Concentrator, which concentrates ultrafine particles (i.e., 10-180 nm) by a factor of 20-22. Ultrafine particles are subsequently size fractionated and collected on suitable substrates using the NanoMOUDI, a recently developed cascade impactor that classifies particles in 5 size ranges from 10 to 180 nm. The entire system (concentrator + NanoMOUDI) was employed in the field at 2 different locations in the Los Angeles Basin in order to collect ultrafine particles in 3 consecutive 3 h time intervals (i.e., morning, midday, and afternoon). The results indicate a distinct mode in the 32-56 nm size range that is most pronounced in the morning and decreases throughout the day at Downey, CA (a "source" site), affected primarily by vehicular PM emissions. While the mass concentrations at the source site decrease with time, the levels measured at Riverside, CA (a "receptor" site), are highest in the afternoon with a minimum at midday. In Riverside, ultrafine EC (elemental carbon) and OC (organic carbon) concentrations were highly correlated only during the morning period, whereas these correlations collapsed later in the day. These results indicate that in this area, ultrafine PM is generated by primary emissions during the morning hours, whereas secondary aerosol formation processes become more important as the day progresses. Classification: 0.


Possible mechanisms of the photochemical conversion of polycyclic aromatic and nitroaromatic hydrocarbons in the urban atmosphere under the action of sunlight were analyzed. A kinetic model of the process was proposed, which takes into account the emission of harmful substances and the deposition of these substances onto the Earth's surface. It was found that emission is a predominant process within the bounds of a city. Beyond the precincts of a city, the concentrations of these hydrocarbons decrease because of photochemical degradation. In this case, the rate of this process for compounds adsorbed by soot particles is much higher than the corresponding value for compounds that occur in the gas phase. The results of calculations were compared with measurement data. Classification: 5.


The nitrate radical (NO3) is the dominant atmospheric oxidant during the night in most environments. During the day, however, NO3 has thus far been considered insignificant. Here we present daytime measurements of NO3 by Differential Optical Absorption Spectroscopy near Houston, Texas, during the Texas Air Quality Study 2000. On 3 consecutive days in August/September 2000, NO3 reached levels from similar to 5 ppt 3 hours before sunset to 31 ppt around sunset. Daytime NO3 had a negligible effect on the photostationary state (PSS) between O-3 and NOx, with the exception of the last hour before sunset, when it significantly accelerated NO-to-NO2
conversion. On August 31, chemical reactions involving NO3 destroyed 8 (+/-4) ppb OX (= O-3 + NO2) during the day and 27 (+/-6) ppb at night. NO3 chemistry contributed 10 (+/-7)% to the total O-x loss during the daytime, and 28% (+/-18%) integrated over a 24-hour period. It therefore played an important role in the OX budget. NO3 also contributed significantly to the daytime oxidation of hydrocarbons such as monoterpenes and phenol in Houston. The observed daytime NO3 mixing ratios can be described as a function of O-3 and NOx. Above [NOx]/[O-3] ratios of 3%, daytime NO3 becomes independent of NOx and proportional to the square of O-3. Our calculations indicate that elevated (>1 ppt) NO3 levels can be present whenever ozone mixing ratios exceed typical urban smog levels of 100 ppb.


Recent field observations in urban areas have shown that trace gases, such as O-3, NO2, and NO3, develop distinct vertical concentration profiles at night. Because nocturnal chemistry can change the gas-phase and particulate composition in the urban boundary layer considerably, it is important to understand the mechanisms that lead to the change of trace gas levels with altitude. The quantification of the altitude dependence of chemical processes leading to the removal of volatile organic carbons (VOC) and NOx are crucial to assess the influence of nocturnal chemistry on ozone formation during the following day. We present a one-dimensional chemical transport model developed to study the interaction between chemistry and vertical transport in the nocturnal boundary layer. The model reproduces the general features found in field observations, such as positive O-3 and NO3 gradients. The slow upward transport of NO and VOC emitted near the ground and the simultaneously occurring chemistry, in particular the reactions of NO with O-3 and NO3, are found to control the vertical structure of the chemistry of NOx, NO3, N2O5, and VOC. In the case of NO2 and O-3, dry deposition is also significant. The model results show that vertical transport of N2O5 plays an important role, and is often the main source of NO3 radicals near the ground. Chemical steady state calculations of the concentrations of NO3 and N2O5, as they have been used in the past, are therefore not representative in cases with significant vertical fluxes of N2O5. The vertical gradient of the oxidation rate of NO2 implies that the removal of NOx occurs predominately in the upper nocturnal boundary layer (NBL). Our study shows that observations at one altitude and chemical box models are often insufficient to accurately describe the chemistry in NBL. Classification: 5,8.


Classification: 6,1,3.

Classification: 4.

Godlowska, J. (2004a) 'The particulate matter PM10 air pollution in Cracow', *Reports of Institute of Meteorology and Water Management, Warsaw*, XXVII (XLVIII), 79-89

Classification: 5.

Godlowska, J. (2004b) 'Statistical characteristics of temperature difference between 2 m and 10 m level for various atmospheric stability state, assessed with use of sodar', *Reports of Institute of Meteorology and Water Management, XXVII (XLVIII)*, 21-35

Classification: 8.


This paper describes the methodology developed by the authors to analyze the influence of "green areas" on the urban comfort of the city of Valencia, taken as the prototype of Mediterranean cities. Based on the analysis of its climatological conditions, different "comfort indices" are used to study several characteristic districts of the city of Valencia which globally define the urban behavior of this city. Some of these comfort indices have been formulated in terms of the existing green areas; the results obtained permit to know the surface of the green areas required by each district to be considered theoretically comfortable. This methodology can be very useful to urban planners in the design and distribution of green areas in cities. (C) 2004 Elsevier Ltd. All rights reserved. *Classification: 7,2.*


This work sums up the methodology used and the work plan for verifying the role played by "green zones" in comfort in the city of Valencia, taken as a prototype of the Mediterranean city. Starting from an analysis of the city's climatological situation, a study is made of the performance of several internationally well-known "comfort indices" in a number of city districts considered to be characteristic, and defining the urban situation as a whole. Some of these comfort indices were formulated by green zones and it was later possible to find out the required size of such green zones for each district, in order for these to be theoretically considered comfortable. This
methodology is considered valid as a tool for planners of big cities, in the design of green zones. (C) 2001 Elsevier Science B.V. All rights reserved. Classification: 2,7.


The monitoring data for the PM mass fractions of PM1, PM2.5, PM10 and TSP as well as the particle number concentrations at four sites in Austria (3 urban and 1 rural) and over a 1 year period are presented within this paper. The mass concentrations discussed are mostly based on TEOM measurements, but beta absorption and HiVol gravimetric sampling has been used in parallel. The data are compared with other European and world wide information available so far-for PM1 the data base still is very poor. Generally the data fit into the Central European context as far as the long-term averages and the daily and seasonal pattern and the ratios between the various fractions are concerned. Annual means of mass concentrations for PM1, PM2.5 and PM10 are in the order of 16, 20 and 28 μg m(-3) at the urban sites and a little bit lower at the rural site. In average PM1 counted for about 50-60% and PM2.5 for about 70% of PM10. The number concentrations at the urban sites are in the upper European level and show a distinct seasonal cycle. At the rural site no seasonal influence can be seen. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 5.


The optical characteristics of smoke aerosol produced by peatbog fires are measured. Variations in both the meteorological visual range and the mass concentration of submicron aerosol in the smoky atmosphere over Moscow and over the Moscow region are analyzed. The microstructure of submicron smoke aerosol in the atmospheric surface layer and in the atmospheric column is determined. The concentrations of gas pollutants in the smoky urban atmosphere arc measured. The mass concentrations of heavy metals in the smoke aerosol are also measured. Classification: 5.


Classification: 3,6.

The spectral reflectance and transmittance over the wavelength range of 250-700nm were evaluated for leaves of 20 deciduous tree species and leaf sheaths of five isogenic wax variants of Sorghum bicolor differing in visible reflectance due to cuticular waxes. Using the sorghum sheath reflectance and cuticle surface characteristics as a model, it was concluded that tree leaf reflectance above 0.06 was likely due to the presence of variously-shaped fine epicuticular wax structures on the leaf surface. Increasing the density of sub-micron wax structures corresponded to an enhanced ultraviolet (UV) reflectance over the PAR reflectance of a given leaf surface—either S. bicolor sheath or tree leaf. Amorphous globular epicuticular wax structures did not appear to scatter UV as well as wax filaments or vertical plates in varying patterns even when the dimensions of the structures were similar. Further work is needed to clarify this relationship and the influence of cellular pigments on subsurface contributions to the reflectance.

**Classification: 3,7.**


Much attention is being directed to the measurement and modeling of surface-atmosphere exchanges of CO2 for different surface types. However, as yet, few measurements have been conducted in cities, even though these environments are widely acknowledged to be major sources of anthropogenic CO2. This paper highlights some of the challenges facing micrometeorologists attempting to use eddy covariance techniques to directly monitor CO2 fluxes in urban environments, focusing on the inherent variability within and between urban areas, and the importance of scale and the appropriate height of measurements. Results from a very short-term study of CO2 fluxes, undertaken in Chicago, Illinois in the summer of 1995, are presented. Mid-afternoon minimum CO2 concentrations and negative fluxes are attributed to the strength of biospheric photosynthesis and strong mixing of local anthropogenic sources in a deep mixed layer. Poor night-time atmospheric mixing, lower mixed layer depths, biospheric respiration, and continued emissions from mobile and fixed anthropogenic sources, account for the night-time maxima in CO2 concentrations. The need for more, longer-term, continuous eddy covariance measurements is stressed. (C) 2001 Elsevier Science Ltd. All rights reserved. **Classification: 5,3.**


A linked set of simple equations specifically designed to calculate heat fluxes for the urban environment is presented. This local-scale urban meteorological parameterization scheme (LUMPS), which has similarities to the hybrid plume dispersion model (HPDM) scheme, requires only standard meteorological
observations and basic knowledge of surface cover. LUMPS is driven by net all-wave radiation. Heat storage by the urban fabric is parameterized from net all-wave radiation and surface cover information using the objective hysteresis model (OHM). The turbulent sensible and latent heat fluxes are calculated using the available energy and are partitioned using the approach of de Bruin and Holtslag, and Holtslag and van Ulden. A new scheme to define the Holtslag and van Ulden alpha and beta parameters for urban environments is presented; alpha is empirically related to the plan fraction of the surface that is vegetated or irrigated, and a new urban value of beta captures the observed delay in reversal of the sign of the sensible heat flux in the evening. LUMPS is evaluated using field observations collected in seven North American cities (Mexico City, Mexico; Miami, Florida; Tucson, Arizona; Los Angeles and Sacramento, California; Vancouver, British Columbia, Canada; and Chicago, Illinois). Performance is shown to be better than that for the standard HPDM preprocessor scheme. Most improvement derives from the inclusion of the OHM for the storage heat flux and the revised beta coefficient. The scheme is expected to have broad utility in models used to calculate air pollution dispersion and the mixing depths of urban areas or to provide surface forcing for mesoscale models of urban regions. Classification: 3.


A common parameter used to characterize the geometry of urban landforms is the sky-view factor (psi (s)). Here, two simple alternatives are presented that can be used both objectively and rapidly to estimate psi (s). The first method uses a Nikon CoolPix 950 digital camera fitted with a Nikon FC-E8 fisheye lens. The second method involves a LI-COR LAI-2000 Plant Canopy Analyzer to measure automatically diffuse non-interceptance (DIFN) light using a fisheye optical sensor. Through a series of intercomparisons for urban canyons of known geometry, the digital camera is shown to provide accurate estimates of psi (s). The LAI-2000 also performs well, although it tends to over-estimate psi (s), (for the conditions considered here, the mean absolute error is 0.04), and has a more restricted set of sky conditions under which it performs well (ideally, uniform overcast skies). For both methods, data collection and post-processing is rapid, and storage of data is straightforward. Thus, mobile data collection is possible which allows detailed information on the spatial variability of psi (s), in urban areas to be determined. An example of such an application for a small US city, Bloomington, IN, is presented. Copyright (C) 2001 Royal Meteorological Society. Classification: 3.


Eddy covariance (EC) observations above the densely built-up center of Marseille during the Experience sur site pour contraindre les modele de pollution atmospherique et de transport d'emissions (ESCOMPTE) summertime measurement
campaign extend current understanding of surface atmosphere exchanges in cities. The instrument array presented opportunities to address issues of the representativeness of local-scale fluxes in urban settings. Separate EC systems operated at two levels, and a telescoping tower allowed the pair to be exposed at two different sets of heights. The flux and turbulence observations taken at the four heights, stratified by wind conditions (mistral wind and sea breeze), are used to address the partitioning of the surface energy balance in an area with large roughness elements. The turbulent sensible heat flux dominates in the daytime, although the storage heat flux is a significant term that peaks before solar noon. The turbulent latent heat flux is small but not negligible. Carbon dioxide fluxes show that this central city district is almost always a source, but the vegetation reduces the magnitude of the fluxes in the afternoon. The atmosphere in such a heavily developed area is rarely stable. The turbulence characteristics support the empirical functions proposed by M. Roth. *Classification: 3.*


The Mediterranean Campaign of Photochemical Tracers-Transport and Chemical Evolution that took place in the greater Athens area from 20 August to 20 September 1994 has confirmed the role of sea-breeze circulation in photochemical smog episodes that had been suggested already by a number of experiments and numerical studies. The meteorological and photochemical modeling of this campaign were discussed in Part I. Part II focuses on the study of the 14 September photochemical smog event associated with a sea-breeze circulation. The objective of the study is to identify and to understand better the nonlinear processes that produce high ozone concentrations. In particular, the effect of land and sea breezes is investigated by isolating the effect of nighttime and daytime emissions on ozone concentrations. The same principle then is used to isolate the effect on ozone concentrations of the two main sources of emissions in the greater Athens area: the industrial area around Elefsis and the Athens urban area. Last, the buildup of ozone from one day to another is investigated. From this study, it comes out that ozone production in the Athens area is mainly a 1-day phenomenon. The increased values of photochemical pollutant (up to 130 ppb at ground level) reached during summertime late afternoons on mountain slopes to the north and northeast of the city are related mainly to the current-day emissions. Nevertheless, the recirculation of old pollutants can have an important effect on ozone concentrations in downtown Athens, the southern part of the peninsula, and over the sea, especially near Aigina Island. *Classification: 5,4.*


*Classification: 5.*

Most of the mesoscale models use roughness parameters to characterise the ground and to compute the surface stress. As the experimental determinations of the urban roughness parameters are rare and not very reliable, a new methodology based on microscale numerical simulations is presented here and the first results from two-dimensional simulations with different roof shapes are analysed. Firstly, it appears that the roof shape has a large influence: large difference in the Reynolds stress profile and in the roughness sub-layer thickness, enhancement of the exchanges at the roof level by buildings with attic. It also appears that the fetch necessary to obtain a constant flux layer is unrealistic compared to the real spatial homogeneity of quarters in European cities. Consequently, a new parameterisation of the urban ground-induced friction is to be developed without reference to the constant flux layer theory. *Classification: 8.*


PM2.5 and PM10 samples were collected at two sampling sites in Hong Kong in wintertime from November 2000 to March 2001 and in summertime from June to August 2001. The concentrations of 16 selected polycyclic aromatic hydrocarbons (PAHs) in aerosols were quantified. Spatial and seasonal variations of PAHs were characterized. The dominated PAHs in PM2.5 and PM10 included benzo[b]fluoranthene, pyrene, fluoranthene, indeno[1,2,3-cd]pyrene and chrysene, accounting for 50–82% of total PAHs. The sum of 16 PAHs in PM2.5 at roadside ranged from 3 to 330 ng/m³, and in PM10 between 5 and 297 ng/m³, whereas at a residential/industrial/commercial site, the total PAHs in PM2.5 was from 0.5 to 122 ng/m³, and 2–269 ng/m³ in PM10. Results indicated that most of the PAHs were in the PM2.5 fraction. Spatial variations were predominantly due to the difference of source strength. For both PM2.5 and PM10, the total PAHs at PU site was higher than that at KT site. The average concentrations of individual PAHs in aerosols at PU site were also higher than that at KT site. Higher winter PAHs concentrations and lower summer concentrations were observed at the two sites. Higher winter PAHs concentrations were mainly caused by local emission sources superimposed by highly polluted air masses from Mainland China. The lower summer PAHs concentrations were likely due to easier dispersion of air pollutants, washout effects and to a lesser extent, photo-degradation and higher percentage in the air in vapor phase. Potential sources of PAHs in aerosols were identified using the diagnostic ratios between PAHs and PCA analysis. At PU site, vehicular emissions were the main contributors of particle-associated PAHs, and stationary combustion sources may also contribute to the particulate PAHs. On the contrary, at the KT site, PAHs in aerosols were predominantly from gasoline and diesel engines. *Classification: 5.*

A comprehensive emission inventory for megacity Delhi, India, for the period 1990–2000 has been developed in support of air quality, atmospheric chemistry and climate studies. It appears that SO2 and total suspended particles (TSP) are largely emitted by thermal power plants (68% and 80%, respectively), while the transport sector contributes most to NOx, CO and non-methane volatile organic compound (NMVOC) emissions (>80%). Further, while CO2 has been largely emitted by power plants in the past (about 60% in 1990, and 48% in 2000), the contribution by the transport sector is increasing (27% in 1990 and 39% in 2000). NH3 and N2O are largely emitted from agriculture (70% and 50%, respectively), and solid waste disposal is the main source of CH4 (80%). In the past TSP abatement to improve air quality has largely focused on traffic emissions; however, our results suggest that it would be most efficient to also reduce TSP emissions by power plants. We also assessed the potential large-scale transport of the Delhi emissions based on 10-day forward trajectory calculations. The relatively strong growth of NOx emissions indicates that photochemical O3 formation in the regional environment may be increasing substantially, in particular in the dry season. During the summer, on the other hand, convective mixing of air pollutants may reduce regional but increase large-scale, i.e. hemispheric effects. Classification: 1.


Classification: 5,8,7.


Classification: 2.


A simple baseline urban dispersion model is suggested for use in simulating near-surface releases of tracer chemicals in the urban canopy layer. The model is based on the Gaussian plume or puff model, accounting for low wind speeds, nearly neutral stabilities, large turbulence intensities, and large initial mixing in urban areas. The performance characteristics of this baseline model can be easily determined and used
for comparisons with more complex models. Two urban tracer data sets are used to
demonstrate the baseline model's performance—the Salt Lake City (SLC) Urban 2000
data set, and the Los Angeles (LA) 2001 data set. The focus of the comparisons is on
the maximum concentration, Cmax, on a given monitoring arc, normalized by the
emission rate, Q. The Cmax/Q observations follow some straightforward similarity
relations, such as a decrease with downwind distance, x, raised to the power -1.5 to -
2.0, and a lack of dependence on wind speed during nighttime light wind scenarios
when wind speeds are less than about 1.5 m/s. The predictions of the simple baseline
model are shown to agree with the observations from the 30 experimental trials in
SLC and LA within a factor of about two to three. Classification: 5.

Hanna, S. R., Tehrani an, S., Carissimo, B., Macdonald, R. W. and Lohner, R.
(2002) 'Comparisons of model simulations with observations of mean flow
and turbulence within simple obstacle arrays', Atmospheric Environment,
36, 5067-5079

A three-dimensional numerical code with unstructured tetrahedral grids, the finite
element flow solver (FEFLO), was used to simulate the mean flow and the turbulence
within obstacle array configurations consisting of simple cubical elements. Model
simulations were compared with observations from a hydraulic water flume at the
University of Waterloo. FEFLO was run in large eddy simulation mode, using the
Smagorinsky closure model, to resolve the larger scales of the flow field. There were
four experiment test cases consisting of square and staggered arrays of cubical
obstacles with separations of 1.5 and 0.5 obstacle heights. The mean velocity profile
for the incoming neutral boundary layer was approximated by a power law, and the
turbulent fluctuations in the approach flow were generated using a Monte Carlo
model. The numerical simulations were able to capture, within 40% on average, the
general characteristics of the mean flow and the turbulence, such as the strong mean
wind shears and the maximum turbulence at the elevation of the obstacles and the
nearly constant mean wind and the 50% reduction in the turbulent velocity within the
obstacle canopy. As expected, the mean wind speeds were significantly decreased (by
about a factor of two or three) in the array with closer obstacle packing. It was found
that, a "street canyon" effect was more obvious for the square arrays, with higher flow
speeds in between the obstacles, than for the staggered arrays. (C) 2002 Elsevier
Science Ltd. All rights reserved. Classification: 8.

contributions to ambient concentrations of CO and NOX in the urban
area of Beijing', Journal of Environmental Science and Health Part a-
Toxic/Hazardous Substances & Environmental Engineering, 36, 215-228

An emission inventory based on GIS technology was developed in this study, and
used to estimate the spatial distribution of the stationary and mobile sources in the
urban area of Beijing. The stationary sources were divided into various types of finer
classes depending on different usage, stack height and emission factors. The mobile
sources were treated as both line sources and area sources. It was shown that total
anthropogenic CO and NOX emissions had reached 1.4 million and 233 thousand
tons, respectively, and vehicle sources emissions of CO and NOX accounted for
76.8% and 40.2%, respectively, of the total emissions in 1995. ISCST3, a Gaussian dispersion air quality model, was modified at low wind speed condition, and then used to facilitate the study of source contributions to ambient concentrations of CO and NOX in Beijing. The simulation results showed that emissions from the vehicle sources had contributed 76.5% and 68.4% of the total CO and NOX concentrations in urban atmosphere of Beijing in 1995, and were even higher in the city core (86.3% of the CO and 72.0% of the NOX). Therefore, strategies for CO and NOX pollution control will of necessity need to focus on the vehicle sources. 


Flow over urban surfaces depends on surface morphology and interaction with the boundary layer above. However, the effect of the flow on scalar fluxes is hard to quantify. The naphthalene sublimation technique was used to quantify scalar vertical fluxes out of a street canyon under neutral conditions. For an array of eight canyons with aspect ratio H/W=0.75 (here, H is building height and W is the street width), increased flux was observed in the first two or three canyons for moderate and low roughness upstream. This is consistent with predictions of the length scale for initial adjustment of flow to an urban canopy. The flux was constant after the initial adjustment region and thus dependent only on local geometry. For a street canyon in the ‘equilibrium’ part of the array, each facet of the street canyon was coated with naphthalene to simulate scalar release from street, walls and roof, to evaluate the effect of street canyon geometry on fluxes for H/W=0.25, 0.6, 1 and 2. Fluxes from the roof and downstream wall were considerably larger than fluxes from the street and upstream wall, and only the flux from the downstream wall exhibited a simple decrease with H/W. For each H/W there was a monotonic decrease between downstream wall, street and upstream wall transfer. This suggests that flow decelerates around the recirculation region in the lee of the upstream building, i.e. a recirculating jet rather than a symmetrical vortex. The addition of a second source within the street canyon resulted in reduced fluxes from each facet for H/W>0.25, due to increased concentration of naphthalene in the canyon air.


The influence of building geometry on the radiation terms of the surface energy balance is a principal reason for surface temperature differences between rural and urban areas. Methods exist to calculate the radiation balance in an urban area, but their validity across the range of urban geometries and materials has not been carefully considered. Here the exchange of diffuse radiation in an urban street canyon is investigated using a method incorporating all reflections of radiation. This exact solution is compared to two commonly used approximations that retain either no reflections, or just one reflection of radiation. The area-averaged net radiative flux density from the facets of the canyon decreases in magnitude monotonically as the canyon aspect ratio increases. The two approximate solutions possess unphysical differences from this monotonic decrease for high canyon aspect ratios or low material emissivities/ high material albedos. The errors of the two approximate
solutions are small for near blackbody materials and small canyon aspect ratios but can be an order of magnitude for intermediate material properties and deep street canyons. Urban street canyon models need to consider at least one reflection of radiation and multiple reflections are desirable for full applicability. Classification: 3.


Atmospheric electrical measurements provide proxy data from which historic smoke pollution levels can be determined. This approach is applied to infer autumnal Parisian smoke levels in the 1890s, based on atmospheric electric potential measurements made at the surface and the summit of the Eiffel Tower (48.7°N, 2.4°E). A theoretical model of the development of the autumn convective boundary layer is used to determine when local pollution effects dominated the Eiffel Tower potential measurements. The diurnal variation of the Eiffel Tower potential showed a single oscillation, but it differs from the standard oceanic air potential gradient (PG) variations during the period 09–17 UT, when the model indicates that the Eiffel Tower summit should be within the boundary layer. Outside these hours, the potential changes closely follow the clean air PG variation: this finding is used to calibrate the Eiffel Tower measurements. The surface smoke pollution concentration found during the morning maximum was 60±30 g m⁻³, substantially lower than the values previously inferred for Kew in 1863. A vertical smoke profile was also derived using a combination of the atmospheric electrical data and boundary layer meteorology theory. Midday smoke concentration decreased with height from 60 g m⁻³ at the surface to 15 g m⁻³ at the top of the Eiffel Tower. The 19th century PG measurements in both polluted and clean Parisian air present a unique resource for European air pollution and atmospheric composition studies, and early evidence of the global atmospheric electrical circuit. Classification: 3.


Twenty-four hour averaged concentrations of PM2.5 and PM10 have been measured at UK urban sites using dichotomous samplers. Four site pairs have been selected, each of which comprises a busy roadside site and a nearby urban background location. Differences between roadside and urban background concentrations are interpreted in terms of street geometry and atmospheric circulations. Markedly different patterns of behaviour are observed between the more enclosed and more open sites. At the former, the traffic increment in particle mass (difference between roadside and background sites) tends to be independent of the magnitude of concentrations. At the more open sites, there is a tendency for the traffic increment in particle mass to increase with increasing concentration. At one site, with an asymmetric building configuration across the street, the behaviour is wind-direction dependent with higher traffic increments observed when the air above the urban canopy passes first over the taller buildings before apparently creating a recirculating vortex over the roadway.
Incremental coarse to incremental fine particle ratios vary greatly between sites (0.21–0.61 on average), the values increasing with the total traffic volume at the site. Classification: 8.


Twenty-four hour samples of airborne PM10 particulate matter have been collected as coarse and fine fractions using automated dichotomous samplers at four paired roadside and urban background locations in London and Birmingham, UK. The samples have been analysed for sulphate, nitrate, chloride, organic carbon, elemental carbon, iron and calcium and the data have been used to construct a simple model of aerosol chemistry. It is assumed initially that the major components are ammonium sulphate, ammonium nitrate, sodium chloride, elemental carbon, organic carbon and mineral dusts (for which iron and calcium are tracers). This leaves a small proportion of mass unaccounted for, which we attribute to strongly bound water. Increasing the ammonium sulphate and ammonium nitrate content by 29% allows 100% of mass to be accounted for with a high percentage of variance in 24 h mass concentrations explained. Classification: 5.


Typical size distributions for airborne particles are described and the significance of the ultrafine fraction highlighted. Size distributions may be expressed in terms of either mass (volume), surface area or number, and the interpretation of each is discussed together with appropriate measurement methods. The sources of ultrafine particles in the atmosphere include both primary emissions and secondary particles formed through homogeneous nucleation processes within the atmosphere. Examples of measurements of atmospheric ultrafine particles are given, highlighting situations with high concentrations of primary ultrafine particles and also situations where gas-to-particle conversion through homogeneous nucleation gives rise to bursts of new particle production. Finally, the relationship between particle mass and number within the atmosphere at a polluted site is examined. Classification: 5.

Harrison, R. M. and Yin, J. X. (2000) 'Particulate matter in the atmosphere: which particle properties are important for its effects on health?' *Science of the Total Environment*, 249, 85-101

Whilst epidemiological studies have consistently demonstrated adverse effects of particulate matter exposure on human health, the mechanism of effect is currently unclear. One of the major issues is whether the toxicity of the particles resides in some particular fraction of the particles as defined by chemical composition or size.
This article reviews selected data on the major and minor component composition of PM2.5 and PM10 particulate matter showing quite major geographic variations in composition which are not reflected in the exposure-response coefficients determined from the epidemiology which show remarkably little spatial variation. The issue of particle size is more difficult to address due to the scarcity of data. Overall, the data presented provides little support for the idea that any single major or trace component of the particulate matter is responsible for the adverse effects. The issue of particle size is currently unclear and more research is warranted. (C) 2000 Elsevier Science B.V. All rights reserved. Classification: 5.


An analysis is presented of continuous simultaneous measurement data for PM10 and PM2.5 using TEOM instruments from five sites in the United Kingdom. The results are analysed specifically in relation to the sources and processes influencing the coarse particle fraction (2.5-10 µm). The data show a generally strong correlation between fine and coarse particle concentrations at all sites, with a generally higher proportion of coarse particles in the dryer months of the year. The one rural site shows a notably lower proportion of coarse particles than the urban and suburban sites. Whilst it is possible to disaggregate the coarse particle concentrations into a component which is diluted by increasing windspeed and a component which increases with windspeed and is hence possibly attributable to wind-induced resuspension processes, the latter is only a minor proportion of the total coarse particle concentration. There are appreciable weekday-to-weekend and day-to-night differences between coarse particle concentrations which are most marked at the urban sites indicative of anthropogenic activities being a source of coarse particles. The dearest indication of the likely predominant source of coarse particles arises from an analysis of a data set derived from an urban street canyon site after subtraction of measurements from a nearby urban background location. The data indicate strong relationships of both fine and coarse incremental particle concentrations in the street canyon with incremental NOx. If incremental fine particles and coarse particles are attributed to exhaust emissions and vehicle-induced resuspension, respectively, then it may be concluded that vehicle-induced resuspension provides a source strength approximately equal to that of exhaust emissions. An analysis of the coarse particle concentration data suggest that episodes of elevated coarse particle concentrations alone very rarely lead to exceedence of the UK air quality standard for PM10 of 50 µg m(-3) measured as a 24-h running mean. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 5.


The effect of rural variability in calculating the urban heat island effect for Phoenix, Arizona, was examined. A dense network of temperature and humidity sensors was
deployed across different land uses on an agricultural farm southeast of Phoenix for a 10-day period in April 2002. Temperature data from these sensors were compared with data from Sky Harbor Airport in Phoenix (an urban station) to assess the urban heat island effect using different rural baselines. The smallest and largest temperature differences between locations on the farm at a given time were 0.8° and 5.4°C, respectively. A t test revealed significant temperature differences between stations on the farm over the entire study period. Depending on the choice of rural baselines, the average and maximum urban heat island effects ranged from 9.4° to 12.9°C and from 10.7° to 14.6°C, respectively. Comparison of land cover types of the agricultural farm and land cover percentages in the Phoenix urban fringe was performed with satellite imagery. Classification of the entire urban fringe by using satellite imagery allowed for the local farm data to be scaled to a regional level. Classification: 3,4,1,7.


Time-resolved chemical ionization mass spectrometry (CIMS) has been used to investigate the variations of the mixing ratios of benzene, toluene and the C-2-benzenes (xylenes and ethyl benzene) in automotive exhaust during transient engine operation. A significant increase of the benzene/toluene ratios from 0.35 to 1.31 (median) was found upon introduction of a catalytic converter system. A preliminary emission model was developed from these test stand measurements to simulate benzene/toluene ratios of passenger car fleets with variable proportions of three-way catalyst vehicles. Although only the emissions of gasoline-driven passenger cars have been considered so far, the predicted increase of the benzene/toluene ratios during the introduction period of the three-way catalyst from 1980 to 2000 is in good agreement with the observed increase of the atmospheric benzene/toluene ratio measured at a suburban monitoring site (Dubendorf, Switzerland) which is strongly influenced by road traffic emissions. At this site, the atmospheric concentrations of benzene and alkyl benzenes have been detected at hourly intervals since 1993. A steady decrease of the yearly mean from 3.54 to 2.00 ppb for toluene and from 2.87 to 1.33 ppb for the sum of C-2-benzenes was found from 1994 to 1998, respectively, when the proportion of three-way catalyst passenger cars increased from 60 to 82%. Nevertheless, the mean benzene concentration was only affected to a small degree (from 1.10 to 0.97 ppb) within the same period of time. Thus, the observed increase of the atmospheric benzene/toluene-mixing ratios from 0.32 to 0.58 (mean) is in good agreement with the predicted values from the presented emission model. Reduced catalyst conversion efficiency for benzene with respect to alkylated benzenes can explain most of the observed increase of the benzene/toluene and benzene/C-2- benzenes mixing ratios. In addition, benzene emissions e.g. from the class of light duty vehicles, which are operated more frequently at sub-optimal combustion conditions, may also contribute to the unexpectedly stable atmospheric benzene concentration at the investigated suburban monitoring site. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 0.
Many of the potential effects of ultraviolet radiation (UVR)-damage to materials, altered herbivory of insects and activity of microbes, modified growth of vegetation, and adverse or beneficial effects on human health-are modified by the presence of trees that influence UVR exposure to various degrees. Though tree effects on total solar irradiance have been investigated often by measurements and modeling, tree influences on UVR, particularly in the ultraviolet B (UVB, 320-280nm), differ substantially from tree influences on the rest of the solar spectrum, and thus the ratio of UVB to photosynthetically active radiation (PAR) is altered. Trees greatly reduce both UVB and PAR irradiance in their shade when they obscure both the sun and sky. Beneath dense forest canopies, relative irradiance (I_r=irradiance_beneath_trees/above-canopy_irradiance) for both UVB and PAR radiation may be 0.01-0.02. In the shade of a single tree, I_r on the horizontal in the PAR and total shortwave (SW) was about 0.1, whereas in the UVB and ultraviolet A (UVA, 320-400nm), I_r was about 0.4. Conversely, where direct beam radiation came through gaps between crowns in a group of deciduous trees in winter, PAR I_r values averaged 0.95 and UVB I_r averaged only 0.41. In comparisons of minimum values of I_r on horizontal and the south-facing vertical surfaces in tree shade for UVB, UVA, SW, and PAR, where UVB I_r on the horizontal ranged from 0.22 to 0.62, depending on solar zenith angle, UVB I_r on the vertical ranged from 0.05 to 0.27. UVB I_r consistently exceeded UVA I_r on both the horizontal and vertical surfaces. PAR and SW I_r differed little between horizontal and vertical surfaces in tree shade. Modeled average I_r on the horizontal below a regular grid of ellipsoidal tree crowns was given by I_p=1-m-(0.711/5.05)sin(m), where m is fraction of area covered by tree crowns and is solar zenith angle. The tree influences will vary with pollutants in the boundary layer, which affect scattering of UVR.

Classification: 3,7.

An improved dispersion model, UCD 2001, designed to estimate pollutant concentrations near roadways was developed and its performance evaluated. The UCD 2001 model internally represents a highway link as a three-dimensional array of point sources that simulates a roadway mixing zone which extends 2.5 m above a highway link. Dispersion from each point source is estimated with the Huang dispersion solution. The Huang equation is a simplified solution to the semi-empirical advection diffusion equation; its derivation permits vertical profiles of wind speed and eddy diffusivity in the boundary layer to be approximated by power law functions. The UCD 2001 model was calibrated with one-half of the General Motors (GM) SF6 tracer study data base and resulted in a selection of eddy diffusivity parameters that did not vary with ambient meteorology. This parameterization is consistent with several independent studies which indicate that the atmosphere is well-mixed and neutrally stratified immediately downwind of a roadway with significant vehicular activity.
UCD 2001 model performance was evaluated and compared to the CALINE3 and CALINE4 dispersion models using the GM database. UCD 2001 adequately simulates near parallel, low wind speed (less than 0.5 m/s) meteorological scenarios, whereas the CALINE models significantly overpredict most receptor concentrations for these conditions. The UCD 2001 model results in approximately 80–90 percent reduction in squared residual error when compared to the CALINE3 and CALINE4 models. In addition, the UCD 2001 model exhibits better agreement in simulating the top forty observed concentrations than either CALINE model. Lastly, the UCD 2001 model requires less user input and modeler expertise than most roadway dispersion models, and should result in more consistent and robust pollutant field estimations. 

Classification: 5.


This paper presents some results from a numerical model of the wind and thermal climates, and the energy budgets, of city canyons. The model is capable of simulating spatial patterns of canyon energy budget components subsurface and air temperature, and the components of the wind, as these are 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. Some model results are presented to illustrate the effects of changing canyon geometries on the model output. Geometries considered important in the literature are the ratio of the height of buildings to the width of the canyon and the ratio of the length of the canyon to height of the buildings. The variables considered here are building height, canyon width and canyon length. The effects of changing canyon geometry are demonstrated by changing the canyon length whilst keeping the other two variables constant; using a different width canyon whilst keeping the other two variables constant; and, using a different building height whilst keeping the other two variables constant. (C) 2002 IMACS. Published by Elsevier Science B.V. All rights reserved. Classification: 3,1.


The performance of the Australian Air Quality Forecasting System (AAQFS) is examined by means of a case study of a 7-day photochemical smog event in the Sydney region. This was the worst smog event for the 2000/01 oxidant season, and, because of its prolonged nature, it provided the opportunity to demonstrate the ability of AAQFS to forecast situations involving recirculation of precursors and remnant ozone, fumigation, and complex meteorological dynamics. The forecasting system was able to successfully predict high values of ozone, although at times the peak concentrations for the inland stations were underestimated. The dynamics for the Sydney region require a sensitive balance between the synoptic and mesoscale flows. Often high concentrations of ozone were advected inland by the sea breeze. On two
occasions the system forecast a synoptic flow that was too strong, which blocked the inland advancement of the sea breeze. The peak ozone forecasts were underpredicted at the inland stations on those occasions. An examination of possible factors causing forecast errors has indicated that the AAQFS is more sensitive to errors in the meteorological conditions, rather than in the emissions or chemical mechanism in the Sydney region. Classification: 5.


The village of Barrow, Alaska, is the northernmost settlement in the USA and the largest native community in the Arctic. The population has grown from about 300 residents in 1900 to more than 4600 in 2000. In recent decades, a general increase of mean annual and mean winter air temperature has been recorded near the centre of the village, and a concurrent trend of progressively earlier snowmelt in the village has been documented. Satellite observations and data from a nearby climate observatory indicate a corresponding but much weaker snowmelt trend in the surrounding regions of relatively undisturbed tundra. Because the region is underlain by ice-rich permafrost, there is concern that early snowmelt will increase the thickness of the thawed layer in summer and threaten the structural stability of roads, buildings, and pipelines. Here, we demonstrate the existence of a strong urban heat island (UHI) during winter. Data loggers (54) were installed in the similar to 150 km(2) Study area to monitor hourly air and soil temperature, and daily spatial averages were calculated using the six or seven warmest and coldest sites. During winter (December 2001-March 2002), the urban area averaged 2.2 degrees C warmer than the hinterland. The strength of the UHI increased as the wind velocity decreased, reaching an average value of 3.2 degrees C under calm (<2 m s(-1)) conditions and maximum single-day magnitude of 6 degrees C. UHI magnitude generally increased with decreasing air temperature in winter, reflecting the input of anthropogenic heat to maintain interior building temperatures. On a daily basis, the UHI reached its peak intensity in the late evening and early morning. There was a strong positive relation between monthly UHI magnitude and natural gas production/use. Integrated over the period September-May, there was a 9% reduction in accumulated freezing degree days in the urban area. The evidence suggests that urbanization has contributed to early snowmelt in the village. Copyright (C) 2003 Royal Meteorological Society. Classification: 4,1.


Classification: 8,7.


During March-April 2001 the University of Wisconsin Nonhydrostatic Modeling System (UWNMS) was used to provide flight planning and estimation of ozone flux into the troposphere over East Asia in support of the Transport and Chemical Evolution over the Pacific (TRACE-P) mission. On 24 March a convective complex developed in eastern China and propagated eastward over the Pacific south of Japan. Aircraft and satellite observations, together with the UWNMS simulations, captured this convective event, which first entrained urban boundary layer air over Asia and then marine boundary layer air over the Pacific. The convective updraft split the subtropical westerly jet, deformed the tropopause upward, radiated gravity waves into the stratosphere, and induced a ring of stratospheric ozone to descend around its periphery into the middle troposphere. The DC-8 observations and UWNMS show a vault of moderate ozone (similar to 65 ppbv) in the 8-12 km layer within the convection, with high stratospheric values (similar to 100 ppbv) subsiding around the periphery into the troposphere near 6.5 km. A new two-scale method for diagnosing cross-tropopause ozone flux is compared with an annular volume estimate. During this 24 hour convective event, similar to 0.8 Tg ozone entered the troposphere from the stratosphere, comparable in magnitude to ozone fluxes in midlatitude cyclones. Classification: 0.


The sky view factor (SVF) is used in forest, road and urban climatology to characterise radiative properties. We now propose a method suitable for forest canopies using the raster based and commercially available software IDRISI. It uses quadratic pixels in rows and columns in a scanned equiangular fish-eye image. A threshold value is chosen to divide the image into sky and non-sky areas. The resulting image is then multiplied with a sky view weight image, where the weights of the pixels depend on the angular distance from zenith. The sum of pixel products gives the SVF Quality analysis of the method is also performed. The choice of threshold value gives some uncertainties due to leaves reflecting sunlight. This error will be reduced by observing details (branches etc.) in the image and by choosing an overcast day for capturing the image. The precision range for SVF calculations will be better than 0.1. Classification: 3.


The dependence on emissions of urban photochemistry is studied under meteorological conditions favouring pollution episodes. We use a simple chemistry-transport model, yet realistic with respect to the main chemical and physical processes and considering the diurnal cycle of forcing parameters. For a range of NOx emissions, the diurnal equilibria of the system are searched for. It is shown that, if the
photochemistry over a large city mostly exhibits a negative sensitivity to NOx emissions, there are meteorological situations under which it becomes (positively) NOx sensitive, the dispersion time scale being a key parameter. We show that, under specific conditions, the urban atmosphere might reach two very different diurnal equilibria. We demonstrate that the sensitivity to NOx emissions evolves with time: under specific conditions, the urban atmosphere becomes NOx sensitive within two days. Classification: 5.


Classification: 8.


In order to predict the air quality impact by vehicle emissions within an urban street canyon, a two-dimensional air quality numerical model was developed based on atmospheric convection diffusion equations and a k-epsilon turbulent model. The numerical model has been evaluated using the database from a set of street canyon air tracer experiments carried out near the crossing of Aoyama ichome, Minato-ku, Tokyo in December 1980, by the Japan Environmental Management Association of Industry (JEMAI). Twenty-four cases have been studied for the sensitivity analysis, including more practical cases when the inflow wind has an inclination with the horizontal road and the two buildings have different heights. As a result, it has been shown that the concentration distributions of pollutants emitted from the street are governed by both the inflow wind and the street canyon geometry. A stable vortex was formed within the street canyon, which agrees with other researchers. Pollutant concentrations were predicted to have higher values on the leeward side compared to the windward side. It was concluded that the released pollutants from street canyon become more diluted in the following cases: a lower height of the street canyon, a faster wind speed, a higher height of the leeward building than the windward building and an inflow wind direction towards the street. It is also suggested that the numerical model is useful for predicting the air quality within a typical urban street canyon. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 8.


Aerosol number size distributions have been measured since 5 May 1997 in Helsinki, Finland. The presented aerosol data represents size distributions within the particle diameter size range 8-400 nm during the period from May 1997 to March 2003. The daily, monthly and annual patterns of the aerosol particle number concentrations were investigated. The temporal variation of the particle number concentration showed
close correlations with traffic activities. The highest total number concentrations were observed during workdays; especially on Fridays, and the lowest concentrations occurred during weekends; especially Sundays. Seasonally, the highest total number concentrations were observed during winter and spring and lower concentrations were observed during June and July. More than 80% of the number size distributions had three modes: nucleation mode (D-p < 30 nm), Aitken mode (20-100 nm) and accumulation mode (D-p > 90 nm). Less than 20% of the number size distributions had either two modes or consisted of more than three modes. Two different measurement sites were used; in the first (Siltavuori, 5.5.1997-5.3.2001), the arithmetic means of the particle number concentrations were 7000 cm(-3), 6500 cm(-3), and 1000 cm(-3) respectively for nucleation, Aitken, and accumulation modes. In the second site (Kumpula, 6.3.2001-28.2.2003) they were 5500 cm(-3), 4000 cm(-3), and 1000 cm(-3). The total number concentration in nucleation and Aitken modes were usually significantly higher during workdays than during weekends. The temporal variations in the accumulation mode were less pronounced. The lower concentrations at Kumpula were mainly due to building construction and also the slight overall decreasing trend during these years. During the site changing a period of simultaneous measurements over two weeks were performed showing nice correlation at both sites. 


Classification: 1,3.


The frequency distribution of low-level clouds was estimated around the Tokyo metropolitan area on summer days without regional-scale cloud cover using NOAA satellite images from 1200 to 1500 LST during an 11-year period. The urban area is determined by the NDVI obtained by the same satellite. The low-level cloud frequency is higher over this large urban area than over rural areas in the early afternoon, especially over the radially extending urban areas along major highways or railways from the metropolis. We can conclude that the frequency of the low-level clouds is enhanced over the urban area, since the cloud frequency is negatively well correlated with the NDVI and their peaks fit well within a shift of about 2 km. The frequency of low-level clouds, however, is quite low in the coastal zone, even in the urban area, because of sea breezes. Classification: 4.


The oxidation of nitric oxide (NO) to nitrogen dioxide (NO2), the initial step in formation of nitric acid, was analyzed based on atmospheric observations in urban
central Osaka, Japan, focusing the relation with the behavior of photoreactive hydrocarbon (HC) species. Simultaneous observation at two vehicle exhaust monitoring stations, one has higher oxidation ratio of NO (NO2/NOx) and the other has lower NO2/NOx, in November 1998 and May 1999, had been held and investigated in current report. By using concentration ratios of reactive HCs to acetylene, obvious relation between NO2/NOx and HCs reaction was implied. In November observations, decline of aromatics to acetylene ratios with increasing NO2/NOx were observed at one station, while not appeared at the other station. Opposite tendencies were observed at the two sampling stations from November to May, implying complicated regional characteristics of photochemistries.


This study provides information on the long-term evolutions of the atmospheric methane (CH4) concentrations in Nagoya City, Japan, which were analyzed by using the continuous monitoring data observed at the eight observatory stations for 1983-1997. The 15-year records of the atmospheric CH4 concentrations were examined by means of a time-series analysis using a fast Fourier transform with a low-pass filter to elucidate the seasonal cycles and the long-term trends. The annual averages of the CH4 concentrations in Nagoya were 1.85 ppmv (parts per million by volume), 1.91 ppmv, and 1.90 ppmv in 1988, 1995 and 1997, respectively. Moreover, the annual average growth rate showed a drastic decrease from 17 ppbv (parts per billion by volume) year(-1) in 1992 to 2 ppbv year(-1) in 1993, and further down to -7 ppbv year(-1) in 1997. Comparison of the atmospheric CH4, records in Nagoya with those in global air of the northern hemisphere observed at Mauna Loa observatory in Hawaii, USA, allows us to estimate the excess concentration of CH4, in the urban atmosphere of Nagoya, which was 0.17 ppmv in 1988 and 0.15 ppmv in 1997. On a local scale, the atmospheric CH4 concentrations in the northern part of Nagoya City increased until 1992 and then gradually decreased from 1993 to 1997, although those in the south-western urban areas constantly for 1988-1997. The variation of the long-term trends of the increased at the averaged growth rate of 13 ppbv year(-1) concentrations in Nagoya may be ascribed to the emission changes from the CH4 sources due to the human activities such as waste dumping and landfills. (C) 2000 Elsevier Science B.V. All rights reserved. Classification: 5.


Anthropogenic emissions of methane (CH4) from major sources such as landfills, automobiles, and rice paddy fields in the Nagoya metropolitan area were estimated using several emission process parameters such as emission factors and activity data for the decade from 1988 to 1997. The sum of CH4 amounts emitted from these three
major sources was calculated to be 4.93 Gg of CH4 in 1988 and 5.19 Gg of CH4 in 1997. Methane emissions from the 12 landfill sites located around the Nagoya metropolitan area gradually increased until 1996 and then decreased in 1997, while those from automobiles and rice paddy fields continuously declined for the same decade. The total amount of CH4 emitted from the 12 landfills was much larger than those from other two sources. In 1993, for example, the amount was estimated as 3.26 Gg of CH4, 58% of which was generated from the largest landfill site. The excess CH4 concentration in the urban atmosphere, which was estimated from the difference between the CH4 concentration at the urban site and the background CH4 concentration at the Mauna Loa observatory, Hawaii, USA, showed the long-term trends similar to the CH4 emission from the largest landfill site. As a result, we conclude that the CH4 emission from the largest landfill dominantly impacted on the excess CH4 concentration due to the major sources in the Nagoya metropolitan area.

Classification: 5.


Results obtained using SPCTRAL2 parametric model for the polluted urban atmosphere of Athens, Greece, were analysed and compared with ground level experimental spectral solar irradiance measurements and spectrally integrated solar irradiances in two discrete narrow bands, ultraviolet and visible. For the aerosol characterization, the aerosol optical depth evaluated at 500 nm was used as the basic input parameter. The algorithm used seems to reproduce the experimental solar spectral irradiances adequately depending on the aerosol model used. The results obtained have been explained through mean bias and root mean square statistical deviations and the resultant influence of the aerosol volume spectra. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 3.


The relationship between the two radiant fluxes is studied from almost a 3-year data archive of hourly photosynthetically active photon flux (QP) and global solar irradiance (RS) performed at Athalassa, Cyprus. These data are used to determine temporal variability of the ratio (QP/RS) and its dependence on sky conditions. The seasonal variation of the ratio obtained from daily data ranges from 1.942 E MJ-1 (summer) to 1.892 E MJ-1 (winter) with an annual mean value of 1.919 E MJ-1. The ratio increased from 1.865 to 2.01 E MJ-1 (daily values) or from 1.878 to 2.197 E J-1 (hourly values), as sky conditions changed from clear to overcast. Effective atmospheric parameters such as sky clearness, brightness and path length were found to cause substantial changes to the PAR fraction. Classification: 3.

Size resolved emission factors for submicrometer particles related to trace gases have been obtained from measurement data at a suburban roadside, with a traffic intensity of 18,000 vehicles per day. Number of particles with diameter 10-368 nm, trace gases (NO, NOx, O-3 and SO2) traffic and meteorology parameters were measured outside of Goteborg, Sweden. Size distributions of small particles at the site are presented and their relation to meteorological and traffic related variables was evaluated. Wind speed correlated negatively with 10-368 nm particles and temperature correlated negatively with the smaller particles (10-60 nm). Nitric oxide was shown to be a better tracer for traffic related ultrafine particles, than traffic intensity itself. The calculated emission factor, with errors at 95% confidence level, for particles in the range 10-368 nm is presented in relation to nitrogen oxides. The emission factors were 268 +/- 60 and 176 +/- 37 particles cm(-3) per ppb NO and NOx, respectively. The particle emission factors for 10-100, 10-50, 50-170 and 170-368 nm were 260 +/- 70, 228 +/- 52, 41 +/- 11 and <1 particle cm(-3) per ppb NO, respectively. The size distribution of the emissions is given by number of particles normalised by the width of the size bin, i.e. in units of dNd log Dp(-1) ppb(-1). The maximum normalised emission factor was 450 cm(-3) per ppb NO for 20 nm particles. The shape of the size distribution of emissions revealed one sharp peak at 20 nm, with a small shoulder at 70 nm. (C) 2004 Elsevier Ltd. All rights reserved. *Classification: 5.*


Numerical simulations of thermal field variation due to land use changes, such as the reduction of the lacustrine system and the growth of the urban area, in the Basin of Mexico are presented. It is shown that the historically recorded warming in the basin could be attributed, not only to the growth of the urban area, but more importantly to the drastic reduction in the lacustrine system that existed in the basin. *Classification: 8, 7.*


A two-dimensional, steady, k-epsilon turbulence model was used to investigate the high Reynolds number skimming flow field of an urban street canyon. We describe the critical canyon width- to-height ratios that distinguish a cascade of vortex patterns that form in an urban street canyon. Details of the flow field are reported that includes
the structure of the mean flow field, turbulent kinetic energy, turbulent length scale, turbulent eddy viscosity, and Reynolds stress for three typical different aspect ratios, W/H, of a street canyon. The consequences of vortex layering on vertical transport are explored. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 8.


A 3-D Eulerian-Lagrangian approach to moving vehicles is presented that takes into account the traffic-induced flow rate and turbulence. The method is applied to pollutant dispersion in an individual street canyon and a system of two street canyons forming a perpendicular intersection. The approach is based on computational fluid dynamics (CFD) calculations using a Eulerian approach for continuous phase and a Lagrangian approach for moving vehicles. The wind speed was assigned values of 4, 7 and 12 m/s. One-way and two-way traffic with different traffic rates per lane is considered. In the case of the intersection, a longitudinal wind direction was assumed. Predictions show differences in the pollutant dispersion in the case of one-way and two-way traffic. Classification: 8,5.


A 3-D Eulerian-Lagrangian approach to moving vehicles is presented that takes into account the traffic induced flow rate and turbulence. The method is applied to pollutants dispersion in a street canyon. The approach is based on CFD calculations using Eulerian approach to the continuous phase and Lagrangian approach to the discrete phase of moving objects vehicles. A commercial CFD code StarCD was used into which the Lagrangian model was integrated. As an example a street canyon is taken into consideration. It has the length of 50 m and the aspect ratio of 1.27. The speed of wind was assigned values of 4, 7 and 12 m/s at the altitude of 300 m. The total height of the domain is 115 m. In the study different traffic situations are considered, namely one-way and two-way traffic with different traffic rates per lane. The predictions show that different traffic situations affect pollutants dispersion in the street canyon and that there are also differences in the pollutants dispersion in case of one- and two-way traffic. Classification: 8,5.


Over land surfaces a quarter of the total airborne particulate may be made up of biological material in the form of pollen, fungal spores, bacteria, viruses, or fragments of plant and animal matter. Meteorological variables affect the initial release of this material and its dispersal once airborne. Temperature and water availability will affect
the size of the source and will control the release of some actively released fungal spores. Inertly released material will become airborne when the drying of the surface reduces bonding forces, and when the material is disrupted by sufficiently strong air movement or by mechanical disturbance. The wind speed necessary to disrupt material is noted to be less on a plant surface than on the ground surface. Measurements of the concentrations of airborne material near dominant sources are reviewed for both area sources, and for point sources such as sewage and waste treatment works, agricultural practices, and diseased animals. The concentration of airborne material remote from sources is considered along with the effects of on and off shore winds and some examples of long distance transport of material. The vertical concentration of bacteria is noted to decline less rapidly than that of fungal spores. The short-term variation of pollen, fungal spore, and bacterial concentrations are also considered. (C) 2003 Elsevier B.V. All rights reserved. Classification: 0.


The influence of vegetation on the urban climate was studied in the subtropical city Gaborone, the rapidly expanding capital of Botswana with approximately 200000 inhabitants. Temperature records from an urban and a rural station were analysed for the period 1985-96. In an attempt to explain possible seasonal change in vegetation, NOAA satellite normalized difference vegetation index imagery was analysed. The present urban influence was investigated with temperature loggers at selected urban and rural sites. In addition, mobile measurements revealed spatial patterns in temperature and humidity for different land uses. Seasonal patterns of urban-rural differences in minimum temperatures emerge during the period 1994-96, especially during the winter when the heat island effect is largest. It is shown that differences in urban and rural vegetation over the year partly explain this variation. Mobile measurements reveal a weak nocturnal heat island of 2-3 degreesC during clear and calm nights. There are intra-urban temperature differences that are in the same range as the urban-rural relationship due to the role of vegetation. Evapotranspiration lowers the temperature, which was detected by high humidity in areas of lush vegetation. This becomes apparent at midday, when densely vegetated areas were up to 2 degreesC cooler than rural sites. An oasis effect, therefore, only exists on a highly local basis. In contrast, parts of the city with sparse vegetation are warmer than the countryside. There is an apparent opposed effect of rural and urban vegetation, whereby the former is hindering the temperature from falling and the latter is cooling the environment through evapotranspiration. This can be explained by the overwhelming amounts of imported water in the city promoting evaporative cooling. Copyright (C) 2004 Royal Meteorological Society. Classification: 7,3,2.


Relationships between sources and levels of particulate matter and climatic parameters (urban heat island intensity, wind speed, temperature and relative
humidity) were investigated in the coastal city of Dar es Salaam, Tanzania's largest city. Measurements were made during the wet and dry seasons of 2001 at an urban and a rural site. Five elements were used to represent different sources: K in fine particles (biomass), Zn in fine particles (industry), Cl in coarse particles (sea spray), Ti in coarse particles (soil) and Pb in fine particles (traffic). The concentrations of these elements varied considerably between the urban and rural site during both the wet and dry season, with the urban site in the dry season having the highest concentrations. Diurnal differences are also apparent, although not as straightforward. In an attempt to explain these differences, correlations between all elements and the climatic parameters were investigated. The results show that the nocturnal urban heat island intensity was positively correlated and wind speed negatively correlated with particulate levels, presumably due to the increased atmospheric stability. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 5.


Classification: 8,7.


To conceptualize strategies for regional environmental management in the Trier region, extensive urban meteorological measurements were undertaken. Weather stations from the German Weather Service and the state Pollution Monitoring Network were used as well as a number of our automatic meteorological stations and a mobile platform (instrumented van). The bioclimatic conditions in the city of Trier are affected by the valley of the Moselle River. Both the wind field and the thermal stratification in the urban boundary layer showed local characteristics especially marked in the diurnal variation and monthly mean concentrations of the air pollutants nitrogen and sulfurdioxide (NOx, SO2), ozone (O-3) and particle matter (PM10). Catabatic flows from the side valleys partially reduce the urban heat island and increase the ozone concentration in the city in the evening during calm weather conditions. The impact-based air-quality index is mostly determined by a high PM10 concentration. Strategies to reduce air pollutions in the Trier region are discussed. Classification: 1,5.


Classification: 8.
Because of their continual production increase, wastes and the associated composting have become a problem of great interest. The aim of this work was to identify and quantify some of the main volatile organic compounds (VOCs) emitted by a composting factory during a summer period. Nonane ethyl acetate, tetrachloroethene and aromatic compound concentrations are quite similar as in the urban atmosphere. It can be noticed that heptane, decane and trichloroethene levels are 2 to 4 times higher than the city concentrations. Moreover, limonene concentrations are very high (average of 25 ng/l). Potential sources of these VOCs are the degradation of paints, adhesives, solvents, markers, food, detergents, fresheners, mothballs, etc. Moreover, limonene can result from chemical formula, which are used to mask the odours.

**Classification: 0.**

This work studies the variability of the Linke (TL) and Unsworth-Monteith (TU) turbidity parameters in the urban atmosphere of Athens. Beam irradiance observations performed at the Actinometric Station of the National Observatory of Athens are used in the period 1975-1995. This study examines (i) the inter-annual variation of T-L and T-U, (ii) their mean seasonal variability, (iii) their monthly average variation and (iv) their mean daily variation. Also, for various air-mass origins, the mean seasonal variations of T-L and T-U are given. The frequency of occurrence of the parameters in various ranges is also shown. An innovative interpretation of the impact of the Saharan dust on the radiative properties in the atmosphere of Athens is attempted.

**Classification: 5,3.**

Large-eddy simulations have been performed for fully developed turbulent flow within and above explicitly resolved simple cube arrays. The results from our model, hereafter LES-CITY, are shown to agree with laboratory experiments. We investigated the systematic influence of cube density on turbulent flow characteristics by performing numerical experiments for cube areal densities from 0 to 44%. The
following results were obtained: (1) The dispersive momentum flux was quite large within the canopy layer due to a mean stream re-circulation, whereas it was smaller above the canopy. The spatial variation of temporally averaged momentum in the roughness sub-layer was 20% or less of the total kinematic surface drag. (2) The temporally and spatially-averaged flow structure confirmed the existence of conventionally described canyon flow regimes; isolated, interfacial, and wake. However, the intermittency of the canyon flow for all cube densities was quite large and the stream patterns were never persistent. (3) Turbulent organized structures (TOS) similar to those observed in turbulent surface-layer flows were simulated, which are characterized by longitudinally-elongated low speed streaks and the corresponding shorter streamwise vortices. The streaks in sparse and dense canopy flows were likely to be aligned to the street line and to the roof lines, respectively. Such heterogeneity of TOS partially accounts for the large spatial variation of momentum flux. (4) In contrast to the mixing layer analogy of vegetation flows, the TOS and the resulting turbulent statistics of urban flow above the canopy resembled those in surface layers. The recirculation within the canopy significantly influenced the turbulent statistical properties. Classification: 8.


Field observations of area-averaged turbulence characteristics were conducted in a densely built-up residential neighbourhood in Tokyo, Japan. In addition to eddy-correlation (EC) sensors a scintillometer was used for the first time in a city. Significant results include: (1) Scintillometer-derived sensible heat fluxes, Q(H), obtained at a height 3.5 times the building height agree well with those using the EC technique; (2) source areas for the scintillometer fluxes are larger than for the EC sensors, so that at low heights over inhomogeneous terrain scintillometry offers advantages; (3) new similarity relationships for dissipation rates are proposed for urban areas; (4) a new technique that uses simultaneous scintillation measurements at two heights to directly estimate area-averaged zero-plane displacement height, z(d), is proposed. z(d) estimated in this way depends slightly on atmospheric stability (lower z(d) under more unstable conditions). Classification: 8.


Epidemiologic studies have associated cardiovascular morbidity and mortality with ambient particulate air pollution. Particles smaller than 100 nm in diameter (ultrafine particles) are present in the urban atmosphere in very high numbers yet at very low mass concentration. Organs beyond the lungs are considered as targets for inhaled ultrafine particles, whereby the route of particle translocation deeper into the lungs is unclear. Five rats were exposed to aerosols of ultrafine titanium dioxide particles of a count median diameter of 22 nm (geometric standard deviation, GSD 1.7) for 1 hour.
The lungs were fixed by intravascular perfusion of fixatives immediately thereafter. TiO2 particles in probes of the aerosol as well as in systematic tissue samples were analyzed with a LEO 912 transmission electron microscope equipped with an energy filter for elemental microanalysis. The characteristic energy loss spectra were obtained by fast spectrum acquisition. Aerosol particles as well as those in the lung tissue were unambiguously identified by electron energy loss spectroscopy. Particles were mainly found as small clusters with a rounded shape. Seven percent of the particles in the lung tissue had a needle-like shape. The size distribution of the cluster profiles in the tissue had a count median diameter of 29 nm (GSD 1.7), which indicates no severe clustering or reshaping of the originally inhaled particles. Electron energy loss spectroscopy and related analytical methods were found to be suitable to identify and localize ultrafine titanium dioxide particles within chemically fixed and resin-embedded lung tissue. (C) 2004 Wiley-Liss, Inc. Classification: 0.


A semi-empirical approach by applying existing techniques to model benzene concentrations in a street canyon is presented here. The dominant input parameters of the model are traffic density and the type of vehicle distribution, which are necessary to calculate with preciseness the road's emission rate. The dispersion aspect of the model is a semi-empirical relationship based on the road emission rate, wind speed and direction, and also the geometrical characteristics of the road. The model produces very good results (RMSE 10.45 and 10.11 µg m⁻³; RRMSE 1.56 and 1.54, for spring and autumn, respectively) given its simplicity and the limited amount of data available with which to optimize the model. Classification: 5.


Classification: 8.


Vehicle-induced turbulence can be an important factor of pollutant dispersion in urban areas, especially under conditions of low wind speeds which are typical for street canyons. An experimental concept (Plate, 1982) for modelling the effects of vehicle-induced turbulence was applied in the present study. The movement of vehicles was simulated in a boundary-layer wind-tunnel by small metal plates mounted on two belts moving along a modelled street canyon. The scaling factor was based on the ratio of turbulence production by cars to that by wind flow. The traffic was represented by the velocity, density, frontal area and drag coefficients of the vehicles. The velocity and traffic density were varied, and the influence of the
vehicle-induced turbulence on concentration patterns at the canyon walls was studied. It was found that concentration decreases with an increasing ratio of vehicle to wind-velocity and with an increase of traffic density. A dimensionless combination of vehicle to wind-velocity ratio and density factor was proved to be a universal parameter describing the dependence of the concentration on vehicle-induced turbulence. The wind-tunnel measurements were compared with predictions by the numerical Operational Street Pollution Model (OSPM; Hertel and Berkowicz, 1989a). Differences between the wind-tunnel and numerical results regarding effects of vehicle-induced turbulence are discussed. The comparison revealed general agreement between wind-tunnel and numerical data. Turbulence and concentration measurements in a street canyon in Copenhagen have been additionally employed for analysis of the model results. Classification: 8,5.


The paper addresses the problem of the parameterisation of traffic induced turbulent motion in urban dispersion models. Results from a variety of full-scale and wind-tunnel studies are analysed and interpreted within a modelling framework based on scaling considerations. The combined effects of traffic and wind induced dispersive motions are quantified for different traffic situations (variable traffic densities, vehicle velocities and vehicle types) and incorporated into the developed parameterisations. A new dispersive velocity scale is formulated and recommendations regarding its application in urban dispersion models are given. The necessity of accounting for traffic induced air motions in predictions of street-canyon pollution levels is demonstrated. Further research is needed to verify the empirical constants in the proposed parameterisations and to generalize the developed approach for a broader range of urban building configurations, meteorological conditions, and traffic situations. Classification: 5,8.


High concentrations of car-exhaust gases in urban street canyons are typically associated with low wind velocities or situations when the wind blows perpendicular to the canyon axis. The latter flow configuration has been studied in a wind tunnel model of a street canyon. The mean flow and turbulence structure have both been investigated and comparisons have been carried out with results of full-scale flow measurements in urban street canyons. A qualitative similarity has been found between the results of atmospheric measurements and flow characteristics in the modelled street canyon. Data from all employed sources give evidence of a flow acceleration (in some cases, rather sharp) above roof level. Additionally, the effects of traffic on the organised and turbulent components of airflow in the canyon have been quantified. The experimental data show significant differences in flow and turbulence...
patterns corresponding to the model cases of one-way and two-way traffic. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 8.


In urban conditions, car exhaust gases are often emitted inside poorly ventilated street canyons. One may suppose however that moving cars can themselves produce a certain ventilation effect in addition to natural air motions. Such ventilation mechanism is not sufficiently studied so far. A similarity criterion relating the vehicle- and wind-induced components of turbulent motion in an urban street canyon was proposed in 1982 by E. J. Plate for wind tunnel modelling purposes. The present study aims at further evaluation of the criterion and its applicability for a variety of wind and traffic conditions. This is accomplished by joint analyses of data from numerical simulations and wind tunnel measurements. Classification: 5.


In this study, a detailed model of an urban landscape has been re-constructed in the wind tunnel and the flow structure inside and above the urban canopy has been investigated. Vertical profiles of all three velocity components have been measured with a Laser-Doppler velocimeter, and an extensive analysis of the measured mean flow and turbulence profiles carried out. With respect to the flow structure inside the canopy, two types of velocity profiles can be distinguished. Within street canyons, the mean wind velocities are almost zero or negative below roof level, while close to intersections or open squares, significantly higher mean velocities are observed. In the latter case, the turbulent velocities inside the canopy also tend to be higher than at street-canyon locations. For both types, turbulence kinetic energy and shear stress profiles show pronounced maxima in the flow region immediately above roof level. Based on the experimental data, a shear-stress parameterization is proposed, in which the velocity scale, $u(s)$, and length scale, $z(s)$, are based on the level and magnitude of the shear stress peak value. In order to account for a flow region inside the canopy with negligible momentum transport, a shear stress displacement height, $d(s)$, is introduced. The proposed scaling and parameterization perform well for the measured profiles and shear-stress data published in the literature. The length scales derived from the shear-stress parameterization also allow determination of appropriate scales for the mean wind profile. The roughness length, $z(0)$, and displacement height, $d(0)$, can both be described as fractions of the distance, $z(s)-d(s)$, between the level of the shear-stress peak and the shear-stress displacement height. This result can be interpreted in such a way that the flow only feels the zone of depth $z(s)-d(s)$ as the roughness layer. With respect to the lower part of the canopy ($z<d(s)$) the flow behaves as a skimming flow. Correlations between the length scales $z(s)$ and $d(s)$ and morphometric parameters are discussed. The mean wind profiles above the urban structure follow a logarithmic wind law. A combination of morphometric estimation
methods for $d(0)$ and $z(0)$ with wind velocity measurements at a reference height, which allow calculation of the shear-stress velocity, $u^*(\cdot)$, appears to be the most reliable and easiest procedure to determine mean wind profile parameters. Inside the roughness sublayer, a local scaling approach results in good agreement between measured and predicted mean wind profiles. Classification: 8.

Kawamura, K., Steinberg, S. and Kaplan, I. R. (2000) 'Homologous series of C-1-C-10 monocarboxylic acids and C-1-C-6 carbonyls in Los Angeles air and motor vehicle exhausts', Atmospheric Environment, 34, 4175-4191

Molecular distributions of monocarboxylic acids (C-1-C-10) and aldehydes (C-1-C-6) have been studied in the atmosphere of Los Angeles, as well as in motor exhaust and city dust samples. Acetic and formic acids followed by propionic acid were found to be the dominant organic acid in the gaseous phase. Formaldehyde and acetaldehyde are two dominant carbonyls, followed by propionaldehyde and glyoxal. The concentrations of organic acids and aldehydes in Los Angeles air during autumn 1984 was 0.52-5.2 and 0.94-5.8 ppb, respectively. In contrast, concentrations of the organic acids and aldehydes in motor exhaust collected under running modes were 140-410 and 340-2500 ppb, respectively. This suggests that internal combustion engines are important primary sources of both volatile organic acids and aldehydes in the urban atmosphere. By contrast, diurnal, variations in concentrations of organic acids were observed during clear hot days (maximum temperature: up to 40 degrees C), whereas such trends were largely absent during low overcast days. A positive correlation ($r = 0.8$) was observed between the acid concentrations and maximum ambient temperatures, suggesting that secondary photochemical production of organic acids is much more important in Los Angeles than primary emissions from automobiles during daytime under strong solar radiation. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 5.


The concentrations of a number of heavy metals in the air in three Danish cities have been measured by means of PIXE for more than two decades. The well-known capability of PIXE for fast and efficient analysis of aerosol samples has been employed for analysis of daily samples from several sites during the whole period. The main sources are traffic, domestic heating and long-range transport. Source apportionment and trends for single metals are assessed by means of simple statistical methods. The most striking change has occurred for the Pb concentration, which is reduced by almost a factor of 100 following the reduction of the Pb content in petrol. The main source of Cu, Cr and Zn is the traffic. The concentrations of these elements have been slightly increasing. The concentrations for most of the other heavy metals, which originate mainly from sources outside the cities, have been decreasing. (C) 2002 Elsevier Science B.V. All rights reserved. Classification: 5.

Total suspended particulate matter (TSP) was collected and analysed at two sites in central and north London during 1995/6 for particulate-associated total organic carbon (TOC), particulate elemental carbon (PEC), 16 polycyclic aromatic hydrocarbons (PAHs) and 23 n-alkanes. The analysis revealed slightly higher concentrations of all of these substances at the central London location and generally low correlations between variables. Overall, PEC was measured as 1-13% of TSP, whilst TOC was measured as 7-45% of TSP. Seasonal differences in concentrations were identified at both sites, with higher concentrations of combustion related compounds occurring in winter and autumn. The dominant PAH compounds were found to be the higher molecular weight compounds, namely BghiP, BaA and Chrys. n-alkane compound distributions between C-10 and C-34 showed that the highest concentrations of compounds were between C-21 and C-29. Three methods were used to identify specific sources of particulate-associated organic compounds. Ratios of PAHs indicated a dominant petroleum source at both sites, with a higher diesel component at the central London site. Carbon preference index (CPI) values of 1.03 and 1.28 for the central and north London sites, respectively, indicated a stronger anthropogenic (vehicular) influence at the central London location. Using principal component analysis (PCA), key principal components (PCs) were extracted from each data set. These PCs collectively accounted for 76.4 and 78.1% of the total variations within the north and central London data sets, respectively, although differentiation of sources proved difficult because the organic compounds monitored may not be statistically independent. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 5.


For microscale numerical modelling of street canyon air pollution, the traffic-related component of the total ambient pollutant concentration is often assumed to be inversely dependent on the wind-speed at roof tops for idealized conditions of neutral stratification, no solar radiation, and no traffic-induced turbulence. Detailed data analyses of two comprehensive datasets from Gottinger Strasse (Hannover) and Jagtvej (Copenhagen), including concentration and wind-field measurements in the street and above the roof tops are presented to test these idealized assumptions, and to improve numerical modelling for a wider range of conditions. The experimental results show systematical deviation from the idealized inverse wind-speed law, when roof top wind-speeds were less than 10 m/s. It was found that turbulence associated with traffic is a parameter, which is increasingly important for lower wind-speeds. Classification: 8.

Simultaneous measurements of particle size distribution (size/range 10-700 nm) inside an urban street canyon and a nearby urban background location in Copenhagen in May-November 2001 were used to separate the traffic source contribution in the street canyon from the background levels. The background concentrations are highly variable due to changing contributions from long-range transport and local sources showing a diurnal pattern with a shift to smaller particle sizes during midday hours. The average ratio background/street concentration is 0.26 for NOx and 0.35, 0.42, 0.60, 0.64, respectively, for CO, total particle number (ToN), surface and volume. The particle size distribution of the traffic source shows during daytime and evening hours (6-24) a maximum at particle sizes of 20-30 nm independent of the changing heavy-duty vehicle share during the same time interval. The particle number concentration highly correlated (R > 0.83) with NOx through a wide range of particle sizes. The method of inverse modelling was applied to estimate average fleet emission factors typical of urban conditions in Denmark. Emission factors per average vehicle were estimated as \((2.8 +/- 0.5) \times 10^{14}\) particles/km, \((1.3 +/- 0.2)\) g NOx/(veh km) and \((11 +/- 2)\) g CO/(veh km). We observe two types of 'nanoparticle events' (a) in background, probably due to photochemistry and (b) in the night hours when traffic is dominated by diesel taxis. During night hours (0-5), the maximum in the emitted particle size distribution, is shifted to smaller sizes of about 15-18 nm. This shift to smaller particle sizes is related to an increase in the average NOx and ToN emission per vehicle by a factor of 2-3 and a reduced CO emission also by a factor of 2-3. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5,8.
Aerosol mass to its volume is an "effective" density, a ratio of the bulk aerosol density to the shape factor. As a result of the comparison with the TEOM the ambient aerosol in the Pittsburgh area was found to have an effective density of 1.5 +/- 0.3 g cm(-3). Given that the aerosol during the study was found to always contain water, the particles are expected to be spherical and thus the shape factor may be assumed to be 1. This assumption has been supported by a comparison with the MOUDI, using the aerosol density of 1.5 g/cm(3). It should be noted that the estimated aerosol density and the shape factor are applicable to this study only and may be different in other locations. Classification: 0.


Classification: 7.


Urban street-canyon flows in the presence of street-bottom heating are investigated using a two-dimensional numerical model with a k-epsilon turbulence closure scheme. The street aspect ratio (H/D, where H and D are the building height and the width between two buildings, respectively) varies from 0.6 to 3.6 (in 0.2 interval) and the initial potential temperature difference between the street-canyon bottom and the air (Delta Theta) ranges from 0 to 16 K (in 2 K interval). Five flow regimes are identified. Regime I is observed when the aspect ratio is very small but the bottom heating is very strong (HID = 0.6 and Delta Theta greater than or equal to 10 K). In regime I, as the heating intensity increases, the thermally induced vortex expands but the mechanically induced vortex contracts. Regime II is mainly observed when the aspect ratio is relatively small or the bottom heating is weak. In regime II, the vortex intensity increases with increasing heating intensity. Regime III is observed when the bottom heating is relatively significant (Delta Theta greater than or equal to 4 K) and the aspect ratio lies in the range of 1.2-2. This regime differs from regime II in that the vortex induced by temperature gradient on the upwind side of the upper layer has meaningful intensity and size and the maximum horizontal velocity decreases with increasing heating intensity. When the bottom heating is relatively significant, regime IV is most commonly observed. This consists of two corotating vortices in the vertical within combined streamlines. Regime V exhibits two counterrotating vortices induced on both sides of the maximum temperature axis in the lower layer. The upper vortex is little influenced by the bottom heating. The numerical model result is shown to be reasonably in good agreement with the wind-tunnel data. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 3,8.

The effects of inflow turbulence intensity on flow and pollutant dispersion in an urban street canyon with a street aspect ratio of 1 are examined using a two-dimensional numerical model. As the inflow turbulence intensity increases, turbulent kinetic energy and turbulent diffusivity in the street canyon increases. Also, the mean horizontal velocity near the roof level increases and the street-canyon vortex strengthens. The analyses of the time series and residue ratio of pollutant concentration show that the inflow turbulence intensity significantly affects pollutant concentration in the street canyon. As the inflow turbulence intensity increases, the pollutant concentration in the street canyon becomes low and hence more pollutants escape from the street canyon. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 8,5.

Kim, J. J. and Baik, J. J. (2004a) 'A numerical study of the effects of ambient wind direction on flow and dispersion in urban street canyons using the RNG k-epsilon turbulence model', *Atmospheric Environment*, 38, 3039-3048

A three-dimensional computational fluid dynamics model with the renormalization group k-epsilon turbulence scheme is developed. The model developed is used to investigate the effects of ambient wind direction on flow and dispersion around a group of buildings. According to the ambient wind direction, three flow patterns are identified in a view of the characteristics of the mean flow circulation generated in street canyons. In the first flow pattern, a portal vortex generated behind the east wall of the upwind building is symmetric about the center of the street canyon. In the second flow pattern, a portal vortex is also generated behind the east wall of the upwind building, but its horizontal axis is not perpendicular to the ambient wind direction. In the third flow pattern, the footprints of a portal vortex are located behind both the east and north walls of the upwind building. When the incident wind angle is 45 degrees, flow is diagonally symmetric behind the upwind building. As the incident wind angle increases, pollutant escape from the street canyons decreases. Except for the case where the ambient wind direction is perpendicular to the buildings, pollutants are trapped in the portal vortex, thus exhibiting high concentration there. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 8.


A two-dimensional numerical model with a k-epsilon turbulence closure scheme and a nonuniform grid system is used to examine the effects of a single hill and/or two buildings on the flow and pollutant dispersion. In a single-hill configuration, the hill slope is an important factor determining the existence of a recirculation zone behind the hill. As the hill slope increases, the recirculation zone becomes wide. In the presence of a single street canyon formed by two isolated buildings, the ambient wind blows not parallel to the roof-level but passes above the canyon with a small curvature. This results in more momentum transfer into the street canyon by the ambient wind than that in a slot-flow case. When there exist both a single hill and two buildings, the vertical velocity at the top height of the canyon becomes negligible as
the height of the downwind street canyon approaches to that of the upwind hill. A flow reattachment promoted by the upwind hill acts to restrict the vertical extent of vortex below the roof-level and to enlarge the size of recirculation zone behind the downwind building. The obstacle effects on pollutant plume dispersion are examined by analyzing the vertical standard deviation and average height of plume. The upward motion induced by flow impingement influences plume height in front of the obstacles, while behind them the downward motion related to flow reattachment to the ground largely affects the vertical spread and average height of plume. In the presence of both a single hill and two buildings, an accelerated reattachment at the top height of the canyon by the upwind hill plays an important role in the vertical spread and average height of plume. 


Optical properties of atmospheric extinction, scattering, and absorption coefficients were measured continuously with a transmissometer, an integrating nephelometer, and an aethalometer, respectively. Three Asian dust storm events had been observed at Kwangju on 22 March, 11-13 April, and 25-26 April 2001. The physicochemical and optical properties of Asian dust aerosols were analyzed for those three cases and compared with those observed under clean, marine, and hazy urban atmospheric conditions. Their chemical composition varied depending on the source region and the transport path of the air mass. The first Asian dust storm particles, which originated from the northwestern Chinese desert regions, showed typical dust aerosol characteristics of high loading of mineral dust. The second one, which originated initially from the northwestern Chinese desert regions, had been impacted by long-range-transported air pollutants, resulting in increased concentrations of sulfate and organic carbon particles. The third one, which originated from the northeastern Chinese sandy areas, had traveled south to Kwangju, resulting in increased elemental carbon and organic carbon concentrations. Aerosol chemical and optical properties under clean continental, southeastern marine, and stagnant local pollution conditions were also analyzed. The mass scattering coefficient and single-scattering albedo in the fine and coarse modes were determined for three Asian dust event days. The concentration of black carbon (BC) aerosol in the fine and coarse modes was measured with an aethalometer by alternately switching between a particulate-matter-smaller-than-2.5-mum (PM2.5) and a PM10 inlet to it. It was found that BC mass concentration in the coarse mode measured by an aethalometer (BCac) increased because of agglomerated black carbon particles and high loading of dust particles. Single-scattering albedo omega increased to 0.93, 0.90, and 0.84 for the three Asian dust events, respectively, while it was 0.85 for mean omega during other times. 

For continuous monitoring of atmospheric visibility in the city of Kwangju, Korea, a transmissometer system consisting of a transmitter and a receiver was installed at a distance of 1.91 km across the downtown Kwangju, Korea. At the transmitter site a nephelometer and an aethalometer were also installed to measure the scattering and absorption coefficients of the atmosphere, respectively. Unusually high number of Yellow Sand events had occurred in the Northeast Asia during the spring of 2000. Visibility in Kwangju under such conditions was greatly impaired over large area for a few days. In order to investigate the effects of Yellow Sand on visibility impairment, chemical and elemental analyses of aerosol samples were performed along with the optical measurement of visibility. Hourly averaged visual range decreased from 61.7 to 1.9 km when hourly averaged concentration of PM10 varied from 32.9 to 601.8 mg/m(3) during Yellow Sand periods. Fine particulate (< 2.5 mum) concentrations were relatively lower than coarse particulate matters. Results of the data analyses show that mineral dusts originated from continental sources were simultaneously transported along with anthropogenic sulfate aerosols and marine aerosols. Total light extinction coefficient, b(\text{ext}), proposed by the IMPROVE network showed poor correlation with b(\text{ext}) measured by transmissometer. Coarse mass scattering efficiency was classified into three categories; E-NHSOc, E-mineral, and Esea-salt, which were determined as ammonium sulfate combined with nss-sulfate of 1.0, sea-salt of 0.4, and mineral of 0.77 m(2)/g, respectively. Mass fraction of NHSOc, sea-salt, and mineral dust was 0.20, 0.14, and 0.66, respectively. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 5.


Classification: 3,1.

Kim, Y. J., Kim, K. W. and Oh, S. J. (2001c) 'Seasonal characteristics of haze observed by continuous visibility monitoring in the urban atmosphere of Kwangju, Korea', Environmental Monitoring and Assessment, 70, 35-46

Continuous visibility monitoring has been carried out in Kwangju, Korea since May 1999. The total light extinction coefficient b(\text{ext}) measured by a transmissometer and reveals seasonal trends in urban visual air quality, especially under hazy conditions with a visual range of less than 15 km. Seasonal atmospheric visibility under low relative humidity during the winter was observed to be better than during any other seasons. Summertime visibility was severely degraded due to highly increased light scattering by hygroscopic particles under high humidity atmospheric conditions. Visibility during spring and fall was also moderate. However, yellow sand in spring caused the lowest visibility conditions over the measurement area for a few days. With continuous monitoring using the transmissometer, the daily average seasonal visual range was measured to be 13.1, 9.2, 11.0, and 13.9 km in spring, summer, fall and winter, respectively. Under the atmospheric humidity condition less than 60%, visual range was observed to be 16.1, 13.9, 15.1, and 16.6 km in spring, summer, fall, and winter, respectively. The mean light extinction budget by sulfate and nitrate aerosols was determined to be the highest value of 63.71% during the summer and the
The reactions between nitrogen dioxide (NO2) and conjugated dienes in the urban atmosphere may contribute to elevated atmospheric NO2 concentrations in winter pollution episodes. In response to a need for kinetic data for these reactions, a simple method for predicting rate constants for the reaction between nitrogen dioxide (NO2) and alkyl-substituted alkenes (monoalkenes and conjugated dienes) has been developed. A structure activity relationship (SAR) based on the structure of the alkenes is shown to be useful in providing an initial estimate of an unknown rate constant for such reactions. The SAR is formulated using rate constants predicted by a correlation between the logarithm of an experimentally determined rate constant and the calculated energy of the highest occupied molecular orbital (HOMO) of the alkenes under consideration. The success of the approach is judged by the probability that the rate constant predicted by the SAR lies within a factor of two of the measured value for those monoalkenes and dienes for which experimental data exist. These probabilities were 82% for the dienes, but only 43% for the monoalkenes. However, rate constants for 94% of the dienes and 86% of the monoalkenes were predicted within a factor of three. For the dienes, at least, the SAR thus provides a good chance of providing a first estimate of the rate constant for cases where experiments have not yet been performed.


Simultaneous nighttime HONO, NO, NO2 and particle surface area density gradients in the altitude range 10-190m were measured for the first time on the meteorological tower at the Forschungszentrum Karlsruhe/Germany using a new, very sensitive HONO instrument, a commercial NO, monitor and a SMPS system. For all gradient measurements during the campaign it was observed that the [HONO]/[NO2] ratio decreased with increasing altitude below 100 m. In contrast, the particle surface area density was found to be more or less constant. Accordingly, no correlation between the [HONO]/[NO2] ratio and the particle surface area density was observed showing that HONO formation was dominated by processes on ground surfaces and that significant HONO formation on particle surfaces could be excluded for the measurement site. Besides the nighttime gradient measurements, high daytime HONO concentrations were observed at constant altitude, which point to a significant and yet unknown daytime source of HONO. In addition, a HONO/NOx ratio from direct emissions of 0.8% was estimated from the field campaign. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5.

The photochemical equations describing O$_3$ formation in the lower troposphere contain 2 major sink terms for free radicals; combination reactions and reactions with NOx. Knowing the fraction of radicals removed by reactions with NOx, termed L-N/Q, allows one to predict the sensitivity of O$_3$ production to NO and VOCs. We derive an analytic formula that gives L-N/Q in terms of readily measured O$_3$ precursors and test this formula using constrained steady state calculations based on field observations gathered in Phoenix, Arizona. The formula quantifies well-known results regarding the effects of dilution, oxidation, and the production of oxidants on the transition from VOC to NOx sensitive behavior as an air parcel is advected away from an urban source. 


A study of the formation of stable stratification after sunset is presented. The dynamics of atmospheric parameters (e.g., the wind velocity and temperature profiles, height of various layers, etc.) associated with the interaction processes of mountain-valley circulation and urban heat island is followed. The observations are carried out using lidars (aerosol and Raman), kytoon (tethered balloon) and pilot balloons over the city of Sofia (42 degrees 39' N, 23 degrees 23' E, 591 m above MSL) and cover heights from 70 to 900 m. The presence of neighboring mountains and the urban heat island effect lead to the formation of three temperature inversions (ground, elevated and capping) and specific vertical profiles of the wind velocity. The formation mechanism is considered of two-layer aerosol structure in the atmosphere over the urban area and its dynamics observed by the lidar after sunset. The results obtained are compared with a model developed on the basis of common models: one describing nocturnal boundary layer development within a mountain valley and the other dealing with stable stratification formation in the case of urban area situated on plain terrain. (C) 2000 Elsevier Science Ltd. All rights reserved.


A commercial automated gas chromatograph with preconcentration on solid adsorbents (AirmoVoc HC1010) was coupled with a mass spectrometer in parallel with the flame ionization detection (FID) system and characterized for its suitability for quasi continuous measurements of atmospheric hydrocarbons (HCs) with a time resolution of 20 min. Of the 50 identified HCs in the range C-5-C-10, 15 elute in isolated peaks and 20 in groups of two or more HCs. The remaining 15 HCs suffer
from coelution by oxygenated and halogenated compounds. Procedures to minimize and quantify the blanks and the memory from the adsorbents are described. Calibration was based on a custom-made diffusion source. The accuracy of this calibration (+/-10%, 2 sigma) was verified by analysis of a certified 70-component standard (average deviation: -4.3+/-2%). During a field experiment in Summer 1998, the HC1010 system was compared with a custom-made GC system with cryogenic preconcentration and much better separation properties but lower time resolution. In ambient air, good agreement (2 sigma deviation <14% or 10 ppt) was found for HCs and groups of HCs that are free from coelution with oxygenated compounds, whereas large discrepancies (in some cases more than a factor of three) were found for those HCs that coelute with oxygenated compounds, as identified by MS. Analysis of the mass spectra from those peaks via specific target ions showed much better agreement with the FID system of the reference GC within 25%. (C) 2000 Elsevier Science B.V. All rights reserved. Classification: 0.


Classification: 5.


In Christchurch and other Canterbury towns on the east coast of New Zealand's South Island, poor dispersion conditions and high emissions of particulate matter and carbon monoxide regularly lead to the build-up of smog during anticyclonic weather conditions in wintertime. This study analyses surface wind fields during smog nights using data collected during the Christchurch Air Pollution Study 2000 (CAPS2000). Westerly land breezes and drainage winds from the foothills of the Southern Alps and the Canterbury Plains are evident in all coastal Canterbury towns, but local terrain features often complicate the wind fields. This holds particularly for Christchurch, where Banks Peninsula causes flow splitting of both the drainage winds on the Canterbury Plains and any superimposed larger scale winds. Furthermore, stagnation of airflow over Christchurch is often caused by the convergence of localized southeasterly drainage winds down the western part of the Banks Peninsula (Port Hills) with the regional-scale northwesterly drainage winds from the Canterbury Plains. Results illustrate the interaction of cold air drainage over Christchurch, although the unusually high frequency of synoptic-scale easterly winds during the study period appeared to reduce the effects of both these sources of cold air drainage on air pollution concentrations. The effects of topographically induced flow splitting and non-stationary drainage wind convergence on urban air pollution dispersion identified here have not previously been studied in detail internationally and should receive greater attention in the future. Copyright © 2004 Royal Meteorological Society. Classification: 8.
In this paper the fifth-generation Pennsylvania State University–National Center for Atmospheric Research Mesoscale Model (MM5) forecast skill over an area of complex terrain is evaluated. Namely, the model is verified over a period of 1 yr (2002) over the greater area of Athens, Greece, for its near-surface temperature and wind forecasts, at 8- and 2-km grid spacing, but also over a 15-day period for the summer thunderstorm activity forecasts. For the near-surface temperature a cold bias is evident. The model is, in general, unable to reproduce the summer heat waves observed in the area. The increase of the grid resolution, from 8 to 2 km, results in an improvement of the forecast skill. Postprocessing of the forecasts by applying a Kalman-filtering correction method was very effective for both the 8- and the 2-km forecasts. For the forecast skill of wind, the analysis showed that there is not any net increase of the errors with increasing forecast time for the 48-h forecast period, the mean absolute errors, in general, present the lowest values at noontime, and the increase in resolution, from 8 to 2 km, results in a slight decrease of these errors. The analysis of the model skill to accurately forecast summertime precipitation showed that the 2-km simulations, without activation of the convective parameterization scheme, were unable to reproduce the observed thunderstorm activity. Sensitivity tests for the same period with simulations in which the convective parameterization was not activated for both the 8- and the 2-km simulations were still inaccurate, while activation of the convective parameterization scheme at all grids (even at 2 km) considerably increased the precipitation forecast skill. Classification: 8.


Benzene, toluene, sulphur dioxide, ozone and nitrogen dioxide were measured at a mean level of 13.5 m above ground in a narrow, four-lane street canyon (height 30 m, width 20 m) in Thessaloniki, Greece during the period January July 1997 by means of a commercial differential optical absorption spectrometer (OPSIS DOAS). Primary pollutant levels were found to be 2.5-4.4 times higher during the cold part of the year than during the warm part of the year, the winter/summer ratio increasing with the reaction rate constant with OH for each of the measured species. Ozone, on the other hand, exhibited a winter/summer ratio of 0.36. NO2 originates from both primary and secondary sources; its winter/summer concentration ratio of 1.4 lies, therefore, between those of primary pollutants and ozone. Pollution levels were influenced considerably by wind speed, while for the street canyon under study wind direction did not influence pollutant levels considerably. While primary pollution was found to decrease with increasing wind speed, ozone increased. Benzene mean levels during the study period were around 6 ppb and hence much higher than the EU annual limit value of 5 mug m(-3) (1.44 ppb at STP). Toluene mean levels were around 14 ppb and hence also several times above the WHO recommendation of 2 ppb for 24 h. The apportionment of traffic emissions in four time zones used in most inventories in
urban airshed models was tested using benzene and toluene measurements at low (< 1 m s\(^{-1}\)) wind speeds. The agreement between model emissions and calculated emissions apportionment into the four time zones was good, except for Zone D (23:00- 1:59), where model inventory emissions were somewhat too low. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.


Regular observations of atmospheric mixing-ratios of carbon dioxide and methane in the urban atmosphere, combined with analyses of their carbon-isotope composition (\(\delta^{13}C\), \(\delta^{14}C\)), provide a powerful tool for assessing both the source strength and source partitioning of those gases, as well as their changes with respect to time. Intense surface fluxes of CO\(_2\) and CH\(_4\), associated with anthropogenic activities result in elevated levels of these gases in the local atmosphere as well as in modifications of their carbon-isotope compositions. Regular measurements of concentration and carbon-isotope composition of atmospheric CO\(_2\), carried out in Krakow over the past two decades, were extended to the period 1995-2000 and also to atmospheric mixing-ratios of CH\(_4\) and its carbon-isotope composition. Radiocarbon concentrations (\(\delta^{14}C\)) in atmospheric CO\(_2\) recorded at Krakow are systematically lower than the regional background levels. This effect stems from the addition of C-14-free CO\(_2\) into the local atmosphere, originating from the burning of fossil fuels. The fossil-fuel component in the local budget of atmospheric carbon calculated using a three-component mixing model decreased from ca. 27.5 ppm in 1989 to ca. 10 ppm in 1994. The seasonal fluctuations of this component (winter-summer) are of similar magnitude. A gradually decreasing difference between the (CO\(_2\))-C-14 content in the local atmosphere and the regional background observed after 1991 is attributed to the reduced consumption of C-14- free fuels, mostly coal, in southern Poland and the Krakow municipal area. The linear regression of \(\delta^{13}C\) values of methane plotted versus reciprocal concentration, performed for the data available for Krakow sampling site, yields the average \(\delta^{13}C\) signature of the local source of methane as being equal to -54.2 parts per thousand. This value agrees very well with the measured isotope signature of natural gas being used in Krakow (-54.4 +/-0.6 parts per thousand) and points to leakages in the distribution network of this gas as the main anthropogenic source of CH\(_4\) in the local atmosphere. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5.


In 1997, a measuring campaign was conducted in a street canyon (Runeberg Street) in Helsinki. Hourly street level measurements and on-site electronic traffic counts were conducted throughout the whole of 1997; roof level measurements were conducted for approximately two months during the so-called intensive measuring campaign, from 3
March to 30 April 1997. Hourly mean concentrations of NOx, NO2, O-3 and CO were measured at street and roof levels; the relevant hourly meteorological parameters were measured at roof level. We present here an evaluation of the Operational Street Pollution Model (OSPM) street canyon dispersion model against the data measured during the whole of 1997. As the roof level concentrations and meteorological measurements were not available for the whole year, we utilised computed or meteorologically pre-processed values. The use of modelled urban background concentrations and meteorological values (instead of on-site roof level measurements) did not lessen the agreement between modelled and measured average concentration values at street level. The agreement between the temporal variations of predictions and measured data was also fairly good; for instance, the corresponding index of agreement values for NOx, NO2 and CO were 0.89, 0.81 and 0.87, respectively. However, as expected, the agreement in the temporal variations was somewhat better using actual measured on-site data during the intensive measuring campaign, than when using modelled urban background concentrations and meteorological values. This study demonstrates that it is possible to utilise the street canyon dispersion model OSPM with reasonable accuracy using modelled urban background and preprocessed meteorological values as model input. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5.


In 1997, a measuring campaign was conducted in a street canyon (Runeberg St.) in Helsinki. Hourly mean concentrations of CO, NOx, NO2 and O-3 were measured at street and roof levels, the latter in order to determine the urban background concentrations. The relevant hourly meteorological parameters were measured at roof level; these included wind speed and direction, temperature and solar radiation. Hourly street level measurements and on-site electronic traffic counts were conducted throughout the whole of 1997; roof level measurements were conducted for approximately two months, from 3 March to 30 April in 1997. CO and NOx emissions from traffic were computed using measured hourly traffic volumes and evaluated emission factors. The Operational Street Pollution Model (OSPM) was used to calculate the street concentrations and the results were compared with the measurements. The overall agreement between measured and predicted concentrations was good for CO and NOx (fractional bias were - 4.2 and + 4.5%, respectively), but the model overpredicted the measured NO2 concentrations (fractional bias was + 22%). The agreement between the measured and predicted Values was also analysed in terms of its dependence on wind speed and direction; the latter analysis was performed separately for two categories of wind velocity. The model qualitatively reproduces the observed behaviour very well. The database, which contains all measured and predicted data, is available for further testing of other street canyon dispersion models. The dataset contains a larger proportion of low wind speed cases, compared with other available street canyon measurement datasets. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 8.5.
A measuring campaign was conducted in the street canyon 'Runeberg street' in Helsinki in 1997. Hourly concentrations of carbon monoxide (CO), nitrogen oxides (NOx), nitrogen dioxide (NO2) and ozone (O3) were measured at the street and roof levels, and the relevant hourly meteorological parameters were measured at the roof level. The hourly street level measurements and on-site electronic traffic counts were conducted during the whole year 1997, and roof level measurements were conducted during approximately two months, from 3 March to 30 April in 1997. The Operational Street Pollution Model (OSPM) was used to calculate the street concentrations and the results were compared with the measurements. The overall agreement between measured and predicted concentrations was good for CO and NOx, but the model slightly overestimated the measured concentrations of NO2. The database, which contains all measured and predicted data, is available for a further testing of other street canyon dispersion models. 


We developed a simple, single-layer urban canopy model, and compared it to both multi-layer and slab models. Our single-layer model has the following features: (a) It is a column model of energy and momentum exchange between an urban surface and the atmosphere, (b) it includes the influence of street canyons, which are parameterized to represent the urban geometry, (c) it includes shadowing from buildings and reflection of radiation, and (d) it estimates both the surface temperatures of, and heat fluxes from, three surface types: roof, wall, and road. In the simulation of the single-layer model, the roof was hottest during the daytime, but coolest from midnight to early morning. This is consistent with output from the multi-layer model and field observations at a residential area on a clear, summer day. The diurnal variation of the energy budget from the single-layer model agrees well with that from the multi-layer model. Our single-layer model's performance is nearly that of a multi-layer model for studying mesoscale heat islands. Nevertheless, it is simply parameterized, and thus easily included in larger-scale atmospheric models. The slab model has the largest nighttime cooling rate of the three models. To overcome this, it needs more adjustments than for the canopy models. 


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Classification: 1.


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Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous pollutants in urban atmospheres. Several PAHs are known carcinogens or are the precursors to carcinogenic daughter compounds. Understanding the contributions of the various emission sources is critical to appropriately managing PAH levels in the environment. The sources of PAHs to ambient air in Baltimore, MD, were determined by using three source apportionment methods, principal component analysis with multiple linear regression, UNMIX, and positive matrix factorization. Determining the source apportionment through multiple techniques mitigates weaknesses in individual methods and strengthens the overlapping conclusions. Overall source contributions compare well among methods. Vehicles, both diesel and gasoline, contribute on average 16-26%, coal 28-36%, oil 15-23%, and wood/other having the greatest disparity of 23-35% of the total (gas- plus particle-phase) PAHs. Seasonal trends were found for both coal and oil. Coal was the dominate PAH source during the summer while oil dominated during the winter. Positive matrix factorization was the only method to segregate diesel from gasoline sources. These methods indicate the number and relative strength of PAH sources to the ambient urban atmosphere. As with all source apportionment techniques, these methods require the user to objectively interpret the resulting source profiles. Classification: 5.


We investigate the re-entrainment of pollutants around a low-rise industrial building under opposing cross winds through experimental means in a wind tunnel. Two scaled models of an industrial building for electrowinning metal extraction were tested. The first model was a two-dimensional simplified segment of the building with a scale ratio of 1:40, while the second was a 1:100 three-dimensional model of the full building. Particle image velocimetry was adopted to provide the planar velocity measurements that illustrated the flow distribution around the building. Flame ionization detection with propane tracer gas was used to measure the concentration
distribution. The results of the 2D model show that the exhaust plume interacted with the opposing wind in two different stages, namely ground attachment and bent-over. The ground attachment stage occurred under low wind speeds, whereby the exhaust plume exhibited Coanda attachment with the ground surface before being lifted off by the cross wind and circulated to the leeward wake cavity. Upon further increase in the wind speed, the bent-over stage occurred with the exhaust plume being detached from the ground and deflected upward over the roof, before entrained by the wake. The re-entrainment ratio decreased with the increase in wind speed within the range of wind speeds tested, indicating that the range did not include the critical wind speed. Results from the 3D model painted a somewhat different picture and pointed to the significance of the end conditions. The maximum re-entrainment always occurred near the two ends of the building, where the pollutants mostly flowed around the ends rather than over the roof. The re-entrainment ratio was consistently higher at the two ends compared to the central sections. Finally, a building re-entrainment index, (KR), is proposed to characterize the re-entrainment performance of a specific building geometry. Classification: 8.


Currently an urban climate analysis is performed in the basin of Ljubljana (capital of Slovenia), and the results will be used for the revision of the zoning plan. The observations reflect a high frequency of inversion layers, whereby in the surroundings of the city the frequency is higher than in the city centre. In addition low wind speeds are also quite frequent, especially in wintertime, which results in bad dispersion conditions for pollutants in that region. A further objective of that study is the description of a particular local wind system, with a flow directed towards the city centre during the night. The corresponding backward flow at higher levels above the city (approx. 130 m) was observed by means of a SODAR device. In the city planning map suggestions were made concerning areas for living and small business, taking into account the findings of the climatological analysis. Here, the first important results are discussed. The analysis will be finished by 2001, and it is planned to publish the final results. Classification: 1.


The assessment of volatile organic compounds (VOCs) has become a major issue of air quality network monitoring in Hong Kong. This study is aimed to identify, quantify and characterize volatile organic compounds (VOCs) in different urban areas in Hong Kong. The spatial distribution, temporal variation as well as correlations of VOCs at five roadside sampling sites were discussed. Twelve VOCs were routinely detected in urban areas (Mong Kok, Kwai Chung, Yuen Long and Causeway Bay). The concentrations of VOCs ranged from undetectable to 1396 mg/m(3). Among all of the VOC species, toluene has the highest concentration. Benzene, toluene, ethylbenzene and xylenes (BTEX) were the major constituents (more than 60% in composition of total VOC detected), mainly contributed from mobile sources. Similar
to other Asian cities, the VOC levels measured in urban areas in Hong Kong were affected by automobile exhaust and industrial emissions. High toluene to benzene ratios (average T/B ratio = 5) was also found in Hong Kong as in other Asian cities. In general, VOC concentrations in the winter were higher than those measured in the summer (winter to summer ratio > 1). As toluene and benzene were the major pollutants from vehicle exhausts, there is a necessity to tighten automobile emission standards in Hong Kong. (C) 2002 Published by Elsevier Science Ltd.


Polycyclic aromatic hydrocarbons (PAHs) and carbonyls compounds are becoming a major component of atmospheric toxic air pollutants (TAPs) in Hong Kong. Many studies in Hong Kong show that traffic emission is one of the most significant contributors in urban area of Hong Kong. A twelve months monitoring program for PAHs and carbonyl compounds started on 10 April 1999 including a two weeks intensive sampling in winter had been performed at a roadside urban station at Hong Kong Polytechnic University in order to determine the monthly and seasonal variations of PAHs and carbonyl concentrations. The objective of this study is to characterize the roadside concentrations of selected TAPs (PAHs and carbonyl compounds) and to compare with the long-term compliance monitoring data acquired by Hong Kong Environmental Protection Department (EPD). Monthly variations, seasonal variations and winter/summer ratios at the monitoring station are discussed. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 5.


The evolution of ozone (O3) in the nocturnal and morning- transitional planetary boundary layer (PBL) of the Phoenix valley was measured as a part of the 'Phoenix Sunrise Experiment 2001' of the U.S. Department of Energy conducted in June 2001. The goal of the field program was to study the transport, distribution and storage of ozone and its precursors in the urban boundary layer over a diurnal cycle. The ground level O-3 as well as mean meteorological variables and turbulence were measured over the entire period, and vertical profiling (using a tethered balloon) was made during the morning transition period. Approximately half of the observational days showed the usual diurnal cycle of high O-3 during the day and low O-3 at night, with nitrogen oxides (NOx = NO2 + NO) showing an out of phase relationship with O-3. The rest of the days were signified by an anomalous increase of O-3 in the late evening (similar to 2200 LST), concomitant with a sudden drop of temperature, an enhancement of wind speed and Reynolds stresses, a positive heat flux and a change of wind direction. NOx measurements indicated the simultaneous arrival of an 'aged' air mass, which was corroborated by the wind predictions of a mesoscale numerical
model. In all, the results indicate that the recirculation of O-3 rich air masses is responsible for the said high-O-3 events. Such air masses are produced during the transport of O-3 precursors by the upslope flow toward mountainous suburbs during the day, and they return back to the city at night via downslope winds (i.e. mountain breeze). The corresponding flow patterns, and hence the high-O-3 events, are determined by back-ground meteorological conditions. The vertical profiling of O-3 and flow variables during the morning transition points to a myriad of transport, mixing and chemical processes that determine the fate of tropospheric O-3. How well such processes are incorporated and resolved in predictive O-3 models should determine the accuracy of their predictions. Classification: 5,8.


In this study, polycyclic aromatic hydrocarbon (PAH) emissions from two batch-type medical waste incinerators (MWIs), one with a mechanical grate and the other with a fixed grate, both operated by a medical center, were assessed. Both MWIs shared the same air-pollution control devices (APCDs), with an electrostatic precipitator and a wet scrubber installed in series. Results show that when APCDs were used, total PAHs and total benzo[a]pyrene equivalent (total BaPeq) emission concentrations of both MWIs were reduced from 2220 to 1870 mug/m(3) and 50 to 12.4 mug/m(3), respectively. We used the Industrial Source Complex Short Term model (ISCST) to estimate the ground-level concentrations of the residential area and the traffic intersection located at the downwind side of the two MWIs. For the traffic intersection, we found both total PAHs and total BaPeq transported from MWIs to both studied areas were not significant. For the residential area, similar results were found when APCDs were used in MWIs. When APCDs were not included, we found that total PAHs transported from MWIs accounted for <12%, but total BaPeq accounted for >90%, of the on-site measured concentrations. These results suggest that the use of proper APCDs during incineration would significantly reduce the carcinogenic potencies associated with PAH emissions from MWIs to the residential area. Classification: 5.


Emissions from fossil fuel combustion pose a serious threat to public health and impose the need for an improved monitoring of polycyclic aromatic hydrocarbons (PAH), a major class of persistent organic pollutants. For this purpose, utilization of evergreen conifers offers significant biomonitoring potential. In part I of this series we inspected the load of combustion derived magnetic particles in pine needles from 43 locations of the Cologne Conurbation, Germany; we here report the corresponding PAH concentrations and distribution patterns. Concentrations (dry weight) of summed 3–6-ring PAH range between 51 and 410 ng g-1 with a median of 123.8 ng g-1; thus
being in agreement with other urban studies. Phenanthrene was the dominating PAH with median concentrations of 47 ng g⁻¹ followed by fluoroanthene and pyrene at 22 and 13 ng g⁻¹, respectively. The major proportion of PAH was attributed to traffic sources, with minor contribution from power plant, domestic heating, industrial, and vegetation burn emissions. Significant differences between major and minor roads were not observed indicating a thorough mixing of PAH-loaded air masses in the Cologne Conurbation. Needles in inner city parks gave much higher PAH concentrations than those in suburban green areas. Although distribution patterns of PAH were variable a PAH source reconciliation based on isomer compositions is difficult, due to thorough mixing of air masses and associated loss of source specificity. Ambient air monitoring in urban areas based on persistent organic pollutant load of vegetation is a feasible and cost effective way of controlling environmental quality. Classification: 7.


Air quality is one of the major environmental concerns in cities as it has a direct impact on human health. One of the biggest sources of air pollution is urban traffic. To predict air quality in urban areas, significant effort and considerable funding has been, and is being, spent in developing numerical models for urban dispersion and in obtaining experimental datasets. So far, less effort has been expended on providing formalized procedures and reference data suitable for model validation. At the Meteorological Institute of the University of Hamburg a project has been started to compile a database of wind-tunnel measurements, which can be used for validation of microscale dispersion models. Laser Doppler Anemometer measurements were made on several configurations of the building arrangements. Mean velocity as well as the intensity of turbulence and the Reynolds stress were obtained. Classification: 8,5.


The Town Energy Balance (TEB) model, which parameterizes the local-scale energy and water exchanges between urban surfaces and the atmosphere by treating the urban area as a series of urban canyons, coupled to the Interactions between Soil, Biosphere, and Atmosphere (ISBA) scheme, was run in offline mode for Marseille, France. TEB's performance is evaluated with observations of surface temperatures and surface energy balance fluxes collected during the field experiments to constrain models of atmospheric pollution and transport of emissions (ESCOMPT):urban boundary layer (UBL) campaign. Particular attention was directed to the influence of different surface databases, used for input parameters, on model predictions. Comparison of simulated canyon temperatures with observations resulted in improvements to TEB parameterizations by increasing the ventilation. Evaluation of the model with wall, road, and roof surface temperatures gave good results. The model succeeds in simulating a sensible heat flux larger than heat storage, as observed. A sensitivity
comparison using generic dense city parameters, derived from the Coordination of Information on the Environment (CORINE) land cover database, and those from a surface database developed specifically for the Marseille city center shows the importance of correctly documenting the urban surface. Overall, the TEB scheme is shown to be fairly robust, consistent with results from previous studies. *Classification: 3.*


Numerical simulations for an anticyclonic summer episode in the Paris area have been performed at the meso-gamma scale for a 48-hour period, and compared to observations from a dense operational observational network. The meteorological stations have been classified, according to the extent of urbanization of their surroundings, into four classes (central Paris, urban, suburban, and rural). The atmospheric model, coupled with an urban surface scheme, correctly reproduces the temperature (within 1 K from the observations) and humidity. The intense urban heat island during the night is also well represented. Following the validation, the model is used to quantify atmospheric effects of Paris on the boundary layer, through a comparison with a purely rural simulation. At night, the model simulates a neutral or even slightly unstable boundary layer to a depth of 200 m over the city. In contrast, a very stable layer formed in the countryside. During the day, the boundary layer was more turbulent and 500 m deeper over Paris; vertical velocities of up to 1 m s\(^{-1}\) were created over the city. This leads to an urban breeze with convergence at low levels (with winds around 5 to 7 m s\(^{-1}\)), and divergence at the boundary-layer top (with similar wind speeds). The horizontal extent of the breeze reaches for more than 50 km from the city centre, and could have an important impact on pollutant diffusion in the area for calm days. Finally, three other spring cases are presented briefly. These show that an urban breeze develops if the synoptic wind is weak enough or disorganized; an urban plume develops otherwise. *Classification: 8.*


Several classes of organic compounds were analyzed in aqueous aerosols collected in June, November, and December 1996 from above the sewage aeration tanks of a treatment plant (Prato, Italy). Particle size distribution of organic compounds and their enrichment ratio (E-r) with respect to the magnesium ion were determined to infer the extent to which various species were aerosolized. Organic components were found to be predominantly enriched in fine and large particles of the aerosol and their transfer may be attributed to the 1) adsorption of surfactant organic matter at the air/water interface (such phenomenon is particularly evident for the fine and ultra-fine fractions) and 2) flotation of colloidal matter from wastewater to the largest particles with consequent transport of the adsorbed organic compounds. In addition, the interaction of surfactants with hydrophobic compounds explained the enrichment of the latter in the finest fractions. *Classification: 5.*

*Classification: 8.*


Volatile organic compounds play a central role in the processes that generate both urban photochemical smog and tropospheric ozone (1,2). For successful and accurate prediction of these pollution episodes, identification of the dominant reactive species within the volatile organic carbon pool is needed (3). At present, lack of resolution inherent in single-column chromatographic analysis (4) limits such a detailed chemical characterization of the complex urban atmosphere. Here we present an improved method of peak deconvolution from double-column (orthogonal) gas chromatography (5,6). This has enabled us to isolate and classify more than 500 chemical species of volatile organic compounds in urban air, including over 100 multi-substituted monoaromatic and volatile oxygenated hydrocarbons. We suggest that previous assessments of reactive carbon species may therefore have underestimated the contribution made by volatile organic compounds to urban pollution, particularly for compounds with more than six carbon atoms. Incorporating these species in predictive models should greatly improve our understanding of photochemical ozone yields and the formation of harmful secondary organic aerosols (7,8). *Classification: 5.*

Li, C., Lau, A. K.-H. and Mao, J. (2004a) 'Validation of MODIS AOD products with 1-km resolution and their application in the study of urban air pollution in Hong Kong', *Proceedings - SPIE The International Society for Optical Engineering*, 5547, 122-133

*Classification: 5.*


Characteristics of PM1/PM2.5/PM10 were evaluated in the ambient general (Chung-Shan) and traffic (Da-Tung) monitoring stations in the Taipei area. It was observed that average concentrations of PM1, PM2.5, and PM10 were 14.0, 24.4, and 48.1 mg/m(3) in the Chung-Shan station, respectively. In the Da-Tung station, the mean levels of PM1, PM2.5, and PM10 were 37.6, 42.8, and 61.5 mg/m(3), respectively. In addition, it was found that PM1/PM2.5 mass ratios could be as high as 0.90 in the traffic station. Regarding carbon profiles, it was observed that mass fractions of total
carbon in PM1, PM2.5, and PM10 were 0.58, 0.49, and 0.35 in the Chung-Shan station and 0.74, 0.66, and 0.53 in the Da-Tung station, respectively. It was clearly indicated that fine particles related to combustion sources play an important role in urban atmosphere. Further investigation is needed to evaluate chemical compositions and health effects of PM1. Classification: 5.


Fifteen polycyclic aromatic hydrocarbons (PAHs) were measured simultaneously in the indoor and outdoor air of 14 homes in the Taipei urban area in both summer and winter seasons. It was indicated that indoor and outdoor geometric mean PAH concentrations were 267 and 209 ng m(-3), respectively. In addition, it was observed that indoor PAH concentrations generally exceeded the corresponding outdoor PAH concentrations. Moreover, the median value of indoor/outdoor PAH ratios was observed to be 1.23 which might demonstrate that there was no presence of significant indoor PAH sources in this subtropical region. Concerning PAH seasonal variations, the observed lower winter/summer ratios might be related to the absence of domestic heating in residential environments. With regard to PAH compositions, the most abundant PAH found indoors was naphthalene. Fluorene and phenanthrene were the second and third highest concentrations found indoors and outdoors. In incensed homes, PAHs could be contributed mainly to incense burning as well as background sources might be the largest contributor to PAHs in non-incensed homes. (C) 1999 Elsevier Science Ltd. All rights reserved. Classification: 0.


Traffic has long been recognized as the major contributor to polycyclic aromatic hydrocarbon (PAH) concentrations. However, this does not consider the contribution of cooking sources of PAHs. This study set out, first, to assess the characteristics of PAHs and their corresponding benzo[a]pyrene equivalent (B[a]P-eq) emissions from cooking sources to the urban atmosphere. To illustrate the importance of cooking sources, PAH emissions from traffic sources were then calculated and compared. The entire study was conducted on a city located in southern Taiwan. PAH samples were collected from the exhaust stacks of four types of restaurant: Chinese, Western, fast food, and Japanese. For total PAHs, results show that the fractions of gaseous PAHs (range, 75.9-89.9%) were consistently higher than the fractions of particulate PAHs (range, 10.1-24.1%) in emissions from the four types of restaurant. But for total B[a]P-eq, we found that the contributions of gaseous PAHs (range, 15.7-21.9%) were consistently lower than the contributions of particulate PAHs (range, 78.1-84.3%). For emission rates of both total PAHs and total B[a]P-eq, a consistent trend was found for the four types of restaurant: Chinese (2,038 and 154 kg/year, respectively) > Western (258 and 20.4 kg/year, respectively) > fast food (31.4 and 0.104 kg/year, respectively) > Japanese (5.11 and 0.014 kg/year, respectively). By directly adapting
the emission data obtained from Chinese restaurants, we found that emission rates on total PAHs and total B[a]P-eq for home kitchen sources were 6,639 and 501 kg/year, respectively. By combining both restaurant sources and home kitchen sources, this study yielded emission rates of total PAHs and total B[a]P-eq from cooking sources of the studied city of 8,973 and 675 kg/year, respectively. Compared with PAH emissions from traffic sources in the same city, we found that although the emission rates of total PAHs for cooking sources were significantly less than those for traffic sources (13,500 kg/year), the emission rates of total B[a]P-eq for cooking sources were much higher than those for traffic sources (61.4 kg/year). The above results dearly indicate that although cooking sources are less important than traffic sources in contributing to total PAH emissions, PAH emissions from cooking sources might cause much more serious problems than traffic sources, from the perspective of carcinogenic potency. Classification: 5.

Li, Q., Zhang, H., Liu, X. and Huang, J. (2004b) 'Urban heat island effect on annual mean temperature during the last 50 years in China', Theoretical and Applied Climatology, 79, 165-174

Classification: 3,1.


Fine particle composition data from samples collected at Queens College during July 2001 were studied using positive matrix factorization (PMF). The sampling systems are an integrated filter sampler with a 6-h sampling time interval, an aerosol mass spectrometer (AMS) with a 10-min sampling time interval and a particle-into-liquid sampler with ion chromatography (PILS-IC) with 15-min sampling time interval. The data from the AMS and the PILS-IC were aggregated to 6-h average values for the PMF calculation. Sulfate, ammonium, and nitrate data were compared among the different instruments. The PMF method uses the estimated errors in the data to provide optimal point-by-point weighting and permits efficient treatment of missing and below detection limit values. Six source categories were resolved from the data. They are: secondary sulfate with high concentration SO42-; secondary nitrate with the presence of high concentration NO3-; motor vehicle emissions with high concentration of OC and Zn; road dust represented by Al, Ca, Fe, and K; sea salt with high concentration of Cl and Na; and oil combustion marked by the presence of Ni and V. Classification: 5.


A study of the neutrally-stratified flow within and over an array of three-dimensional buildings (cubes) was undertaken using simple Reynolds-averaged Navier-Stokes
RANS) flow models. These models consist of a general solution of the ensemble-averaged, steady-state, three-dimensional Navier-Stokes equations, where the k-epsilon turbulence model (k is turbulence kinetic energy and epsilon is viscous dissipation rate) has been used to close the system of equations. Two turbulence closure models were tested, namely, the standard and Kato-Launder k-epsilon models. The latter model is a modified k-epsilon model designed specifically to overcome the stagnation point anomaly in flows past a bluff body where the standard k-epsilon model overpredicts the production of turbulence kinetic energy near the stagnation point. Results of a detailed comparison between a wind-tunnel experiment and the RANS flow model predictions are presented. More specifically, vertical profiles of the predicted mean streamwise velocity, mean vertical velocity, and turbulence kinetic energy at a number of streamwise locations that extend from the impingement zone upstream of the array, through the array interior, to the exit region downstream of the array are presented and compared to those measured in the wind-tunnel experiment. Generally, the numerical predictions show good agreement for the mean flow velocities. The turbulence kinetic energy was underestimated by the two different closure models. After validation, the results of the high-resolution RANS flow model predictions were used to diagnose the dispersive stress, within and above the building array. The importance of dispersive stresses, which arise from point-to-point variations in the mean flow field, relative to the spatially-averaged Reynolds stresses are assessed for the building array. Classification: 8.


We have investigated the thermodynamics and kinetics of ammonium nitrate/water and mixed ammonium nitrate/succinic acid/water microparticles. The water activity of ammonium nitrate microparticles is determined as a function of composition down to 12% relative humidity by accounting for the rapid evaporation of ammonia and nitric acid. Both the observed deliquescence and water activities for ammonium nitrate/water microparticles are found to be in good agreement with predicted values. Supermicron ammonium nitrate particles generated from high-purity methanol are found not to effloresce, but form an anhydrous liquid state observed only in particle form. We also present data on the hydrosopicity and phase transitions of internally mixed ammonium nitrate/succinic acid particles. A pronounced reduction in the particle growth factor at deliquescence is reported, indicating that the succinic acid does not take up a significant amount of water. Additionally, the deliquescence relative humidity is found to decrease slightly as the mass percent of succinic acid is increased from 12.5 to 50%. Solid succinic acid in ammonium nitrate drops acts to catalyze efflorescence of ammonium nitrate at high relative humidity. However, when the relative humidity is increased sufficiently to completely dissolve the succinic acid, no efflorescence is observed. The resulting data are analyzed using classical nucleation theory to derive the free energy barrier to nucleation, the critical supersaturation, the size of the critical nucleus, and the contact parameter between ammonium nitrate crystal and the solid succinic acid. Classification: 0.

In spring 1997 at the Sonnblick Observatory, located at 3106 m elevation in the Austrian Alps, interstitial aerosol and cloud water samples were simultaneously collected in supercooled convective clouds. These samples were analyzed for their polar organic composition using a newly developed analytical method that allows the simultaneous determination of dicarboxylic acids, monocarboxylic acids, and other polar organic constituents. Using the obtained data set, in-cloud scavenging efficiencies (epsilon) for individual polar organic compounds were calculated. For the different organic substances, scavenging efficiencies ranged from 0.16 to 0.98, compared with sulfate, which exhibited an average scavenging efficiency of 0.94. For dicarboxylic acids, scavenging efficiencies (average of about 0.8) were of the same order as for sulfate. Distinctly lower values (average of about 0.6) were achieved for polar aromatic compounds like phthalic acid or diisobutylphenol. The lowest scavenging efficiencies (average about 0.4) were found for alcohols and monocarboxylic acids. Thus we found in the Sonnblick cloud experiment that more polar organic aerosol constituents are more efficiently scavenged into cloud droplets than less polar compounds. In addition, the scavenging efficiencies exhibited a dependence on the solubilities of the examined compounds. For highly water soluble compounds (1-1000 g L-1) a decrease of the water solubility for an individual compound leads to a decrease in the scavenging efficiency for this compound. For "poorly soluble" substances with water solubilities below 1 g L-1, a near-constant value for the scavenging efficiency was found, indicating that their scavenging behavior is then dominated by the scavenging of the bulk noncarbonate carbon independent of the physical and chemical properties of the individual substances. *Classification: 0.*


Concentrations of ambient particulate matter mass were measured in terms of PM1 and PM1–10 for 8 months between 2000 and 2001, at a sampling site in the urban area of the city Kaohsiung, Taiwan. The data from 20 samples were closely studied for any seasonal phenomena that affected air pollution patterns. The PM1 and PM1–10 concentration variations differed in the examined patterns. This seemed to indicate that the ambient coarse (PM1–10) and submicron (PM1) particles were being contributed by different sources. On average for the 8-month samples, 52±20% of the PM10 was made up of PM1. The PM1-to-PM10 ratio was observed to vary between summer and winter, it being higher in the summer (approximately 62% in summer and 48% in winter). The correlation (r2) between the PM1/PM10 ratio and the parameters showed that there was no significant correlation between the PM1/PM10 ratio, PM concentrations, and the average and maximum wind speeds. Both emission activities and meteorological conditions are important when considering airborne pollutant concentrations. Based on the evaluation of the data obtained in this study, the contribution to the concentration level of the PM and the ratio at the sampling site could have depended upon meteorological parameters and also the formation of PM,
i.e. the formation of secondary aerosols. Results from recent studies (J. Air Waste Manage. Assoc. 51 (2001) 489; Atmos. Environ. 36 (2002) 1911) at this same study site supported that combustion sources and secondary aerosols played significant roles in the formation of ambient submicron (PM1) aerosol particles in the urban area.

Classification: 5.


This study uses large-eddy simulation (LES) to illustrate the flow and turbulence structure and to investigate the mechanism of passive scalar transport in a street canyon. Calculations for a modeled street canyon with building-height-to-street-width ratio of unity at Reynolds number equal to 12 000 are conducted. When the approaching wind is perpendicular to the street axis, the calculation produces a primary vortex in the street canyon, similar to previous studies. An evaluation of the LES results with wind-tunnel measurements reveals good agreement for both mean and turbulence parameters of the flow and scalar fields. The computed primary vortex is confined to the street canyon and is isolated from the free stream flow such that the removal of a scalar emitted at the street level is accomplished by turbulent diffusion at the roof level. It is determined from the calculations that very little scalar is removed from the street canyon, and 97% of the scalar is retained. The scalar mixing at the roof level occurs primarily on the leeward side of the street canyon. In addition to the primary vortex, three secondary vortices are located in the corners of the street canyon at which scalar mixing is enhanced. An examination of additional simulations shows how the location of the scalar source affects the distribution of the scalar.

Classification: 8.


This study employs a large-eddy simulation technique to investigate the flow, turbulence structure, and pollutant transport in street canyons of building-height-to-street-width (aspect) ratios of 0.5, 1.0, and 2.0 at a Reynolds number of 12 000 and a Schmidt number of 0.72. When the approaching wind is perpendicular to the street axis, a single primary recirculation is calculated for the street canyons of aspect ratios 0.5 and 1.0, and two vertically aligned, counterrotating primary recirculations are found for the street canyon of aspect ratio 2.0. Two to three secondary recirculations are also calculated at the corners of the street canyons. A ground-level passive pollutant line source is used to simulate vehicular emission. The turbulence intensities, pollutant concentration variance, and pollutant fluxes are analyzed to show that the pollutant removal by turbulent transport occurs at the leeward roof level for all aspect ratios. Whereas the ground-level pollutant concentration is greatest at the leeward corner of the street canyons of aspect ratios 0.5 and 1.0, the ground-level pollutant concentration in a street canyon of aspect ratio 2.0 occurs at the windward corner and is greater than the peak concentrations of the other two cases. Because of
the smaller ground-level wind speed and the domination of turbulent pollutant transport between the vertically aligned recirculations, the ground-level air quality is poor in street canyons of large aspect ratios. The retention of pollutant in the street canyons is calculated to be 95%, 97%, and 99% for aspect ratios of 0.5, 1.0, and 2.0, respectively. Classification: 8.


Water tank experiments are carried out to investigate the convection flow induced by bottom heating and the effects of the ambient wind on the flow in non-symmetrical urban street canyons based on the PIV (Particle Image Visualization) technique. Fluid experiments show that with calm ambient wind, the flows in the street canyon are completely driven by thermal force, and the convection can reach the upper atmosphere of the street canyon. Horizontal and vertical motions also appear above the roofs of the buildings. These are the conditions which favor the exchange of momentum and air mass between the street canyon and its environment. More than two vortices are induced by the convection, and the complex circulation pattern will vary with time in a wider street canyon. However, in a narrow street canyon, just one vortex appears. With a light ambient wind, the bottom heating and the associated convection result in just one main vortex. As the ambient wind speed increases, the vortex becomes more organized and its center shifts closer to the leeward building. Classification: 8.


Numerical simulations are carried out for the disturbed flow caused by three six-story buildings and a twenty-story tall tower respectively, as well as the distribution of automobile exhaust gas from a nearby road, based on the Peking University Model of Atmospheric Environment. The results show that the ventilation is better around the tall tower than around the three six-story residential buildings for the same number of households in the same urban region. Classification: 8.


Concentrations and fluxes of fine particles were measured for 2 weeks in a city centre street canyon with busy traffic. Two optical particle counters (PMS ASASP-X) were operated with ultrasonic anemometers as eddy covariance systems. One system was located at 3.5 m height between the road and pavement while the other was periodically cycled through heights of 5, 10, 15 and 18 m on a hydraulic lift. At street level, number concentrations in the range $0.1 < D-p < 0.5$ mum followed a diurnal cycle similar to that observed in other studies in the urban background, with a peak
coinciding with the morning peak in traffic flow. Daytime concentrations were moderated by inverse relationships with wind speed within the canyon, as well as an independent inverse relationship with wind speed measured at a roof-top site 750 m from the canyon. The vertical turbulent flux also followed a diurnal cycle similar to that previously observed above an urban canopy, with the greatest flux occurring in the middle of the day. A negative vertical gradient in flux was typically found within the canyon. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 5,8.


The Air Quality Management community is increasingly turning its attention to urban 'hot-spots' where localised high concentrations of pollutants can arise. One such location is the urban street canyon where dispersion is poorly understood or described by regulatory models because of the complexity of the airflow, turbulence and local influences. Similarly, simple metrics such as PM10 fail to describe the range of sizes, composition, sources and behaviours encompassed by the term 'particle'. A 2-week experimental case study to measure size-segregated aerosol in the size range 4.6nm-10μm at a fine time scale (10 min resolution) was undertaken in a typical street canyon in Manchester. The wind direction incident to the canyon, and hence the vortex flow within the canyon, was found to have a large influence on the number concentrations, with values typically 2-10 times greater in perpendicular flow than the estimated inner-urban background. Concentrations were also inversely related to wind speed and directly related to traffic flow. Coarse mode mass concentrations were generally found to follow urban background PM10 concentrations except with a 0-5 μg m(-3) enhancement related to traffic-induced re-suspension within the canyon. A small pollution episode consisting of coarse material re-suspended by high winds was extended in time within the canyon. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5,8.


Ultrasonic anemometers have been used to make measurements of airflow and turbulence in two urban street canyons in Greater Manchester, UK. This paper concentrates mostly on results from one-asymmetrical city centre canyon with complex building geometry, building heights up to 28 m and busy traffic. Data was recorded for a total of five working weeks in four separate periods in 2001 at one roadside location at a range of heights from 2 to 18 m. This data was supplemented by a series of mobile measurements at 2-4 m height at 18 different roadside locations within the same canyon. Although some features of a vortex-flow, as assumed in some (but by no means all) numerical models, was observed, other important flow features were found which, although canyon-specific, nevertheless indicate the ways in which flow in all real canyons may differ from the assumptions implicit in some models. Of particular importance were lateral channelled flow and sheltering in
perpendicular flow. Profiles of turbulence are presented along with a simple model relating turbulence to wind speed and traffic flow rate. A strong influence of traffic on vertical turbulence production was found in a layer no deeper than 3 m. This influence was absent in measurements in a traffic-free suburban canyon. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 8.


Classification: 8,5.


A field experiment was conducted to study the mean and turbulent characteristics of air Row within, and above, a street under neutral stratification Profiles of the mean wind and turbulent statistics were obtained and compared with flow over smoother terrain. Our results modify the conventional picture of a persistent re-circulation within the street with small-scale turbulent fluctuations about this mean (Oke, 1987). Instead, the mean re-circulation within the street was found to be much weaker than the unsteady turbulent fluctuations. Hence, the mean Row is merely a residual of an unsteady turbulent re- circulation. The re-circulation in the street is coupled to the wind aloft through a shear layer that develops at the roof-level. The shear layer is unstable, through Kelvin-Helmholtz instability, which leads to intermittency in the re-circulation in the street, and thence to ventilation of the air in the street. This finding is likely to be important for dispersion in urban areas. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 8.


An intensive measurement of particulate matter and gaseous materials was made to assess the characteristics of wintertime atmospheric pollutants in an urban area of Kansai, Japan. Sampling was performed by a combination of filter pack sampler and low-pressure Andersen impactor (LPAI). Particle-induced X-ray Emission (PIXE) and Thermal/Optical Reflectance (TOR®) methods were employed in analyzing element and carbon, respectively. The concentrations of SO2, NOx, and PM2.5 monitored during our intensive measurement show a strong time serial variation. PM2.5 levels are higher in the daytime with an average level of 21.3 g m-3. Most of the peaks for NOx were regularly found in the morning throughout the campaign duration. The number concentration of particles larger than 0.3 m appears dominated by the ultrafine particles ranged between 0.3 and 0.5 m. The size distribution of elemental concentration as a function of water solubility was investigated. Organic carbon (OC) concentration shows the strong size distribution with the main peak formed in a range of 0.29–0.67 m, while elemental carbon (EC) is principally
enriched in a range of 0.12–0.29 m ultra fine fraction. TC (OC+EC) fraction accounts for 42.5% and 26.2% of the mass concentration in fine particle fraction (<1.17 m) and coarse particle fraction (>1.17 m), respectively. The simulated backward aerosol dispersion with the surface wind roses for three events of high PM2.5 mass concentration indicates that aerosol dispersions might be originated from the emission sources of Osaka and Shiga. Also the possibility of long-range transportation of fine particulate matter from the domestic areas of Japan, Taiwan, and Pacific Ocean was still raised. The result of factor analysis indicates that automobile exhaust, fossil fuel combustion, refuse incineration, iron industry, and soil originated particles contribute the major portion of PM2.5 in our sampling area. Classification: 5.


During the Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia), samples of carbonaceous aerosols were collected on board the Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS) De Havilland DHC-6 Twin Otter aircraft. The samples were analyzed to determine their total carbon (TC) and water-soluble organic compound (WSOC) contents as well as to identify the individual compounds comprising the WSOC fraction of the aerosol. The TC concentrations varied from 3.5 to 14.3 mug C m(-3); the highest TC levels were observed for samples collected in pollution layers that originated over mainland China. WSOC concentrations ranged from 0.54 to 7.2 mug C m(-3), with the WSOC fraction contributing from 10 to 50% of the carbon mass. About 50% of the carbonaceous aerosol mass in pollution layers could be attributed to WSOC. For samples collected in dust layers the WSOC fraction of TC was much lower than that observed in pollution layers. The sum of all the detected organic ions accounted for 6.9 - 19% of the WSOC. In the six samples collected by the Twin Otter during ACE-Asia, of the organic ions identified in the WSOC fraction, oxalate had the highest concentration. Samples collected from pollution layers exhibited a slightly higher ratio of formate to oxalate as compared to the other samples. Two samples had a relatively high ratio of lactate to oxalate, which might be a signature of some currently unidentified source of carbonaceous aerosol. The sum of the masses of sulfate and nitrate ions exceeded the sum of the masses of the identified organic ions by a factor of 9 to 17. The chemical levoglucosan, a tracer for biomass burning, comprised from 0.1 to 0.4% of TC mass. Comparing this ratio to the ratio measured directly in wood-burning studies it was determined that biomass burning may have represented from approximate to2 to 10% of the carbonaceous aerosol collected during ACE-Asia. Classification: 0.


Classification: 5.

*Classification: 5.*


In the U.K., local authorities have new duties to review and assess air quality. Dispersion models are important tools in this process. The performance of a street canyon model, AEOLIUS, in calculating carbon monoxide (CO) concentrations in urban areas is discussed. A field experiment was conducted in a busy street canyon in Leek, Staffordshire. Wind speed and direction were measured at three heights adjacent to the street. The canyon's CO concentrations and traffic counts were recorded. Predicted concentrations of CO, calculated using AEOLIUS, were compared with the observed values. The concept of a 'roof-top' wind is discussed, as are the consequences of using wind measurements from outside the town. Choice of wind measurement location and height of the anemometer above the canyon had a pronounced effect on calculating the 'roof-top' wind. Two methods of deriving a street level wind speed from a 'roof-top' wind speed gave results that differ by up to a factor of two. AEOLIUS had variable skill at predicting CO concentrations depending on the 'roof-top' wind direction: possible reasons for this variability are explored. A sensitivity study of the model showed that vehicle emissions have the greatest impact on predicted concentrations. Implications for local air quality management are discussed. *Classification: 5,8.*


An increasing number of single-particle measurements show that organic and inorganic constituents of the atmospheric aerosol are internally mixed within the particles. Therefore, the phases of the aerosol will be influenced by both mixing of the organic substances with each other and mixing between organic and inorganic constituents. In this work, the mixing properties of the organic aerosol fractions have been investigated theoretically and experimentally with respect to melting and deliquescence. We show that a liquid (or an amorphous solid) is the thermodynamically stable phase—even in the absence of water as a solvent—provided that a sufficiently high number of miscible components are present. Furthermore, we show experimentally that the deliquescence relative humidity of aqueous solutions of dicarboxylic acids decreases with an increasing number of components present in the solution. A five-component mixture consisting of malic, malonic, maleic, glutaric, and methylsuccinic acids deliquesces at a relative humidity (RH) as low as 45.4% RH, while the pure dicarboxylic acids exhibit deliquescence points between 72 and 96% RH. A further reduction of the deliquescence relative humidity is observed when
an inorganic salt is added to the dicarboxylic acid five-component mixture. For NaCl, deliquescence of the eutonic composition occurred at 41.3%, for ammonium sulfate at 36.4%, and for ammonium nitrate even at 27.1% RH. Interactions between the solutes lead to either higher or lower solubilities in the multicomponent mixture as compared to the respective single-component aqueous solutions. In the mixed dicarboxylic acids/inorganic salt solutions, the solubilities of ammonium nitrate and sulfate are increased by similar to 40%, the one of sodium chloride is decreased by a similar amount. In summary, these mixing properties suggest that small fractions of organic species prevent tropospheric aerosols from becoming fully solid, and the organic fraction may even stay fully liquid irrespective of tropospheric humidity. 


Nitratated polynuclear aromatic hydrocarbons (NPAH) with a molecular mass of 247 Daltons were found in soot collected in downtown Athens during a campaign performed in 1996. In particular, 2-nitrofluoranthene (2-NFa) and 2-nitropyrene (2-NPy), which are mainly related to photo-induced chemical processes occurring in the atmosphere, were more abundant than 1-nitropyrene (1-NPy) usually associated to motor vehicle exhaust. (C) 1999 Elsevier Science Ltd. All rights reserved.


A mesoscale model with a detailed urban surface exchange parameterization is used to study urban influences on boundary layer structure. The parameterization takes into account thermal and mechanical factors, and it is able to reproduce the most important observed urban boundary layer features. A series of simulations is carried out on a 2D idealized domain to analyze the urban boundary layer sensitivity to wind speed, urban morphology, and rural soil moisture. The results show that, during the night, wind speed is correlated with inversion height, inversion depth, and inversion strength and that mean building height and street-canyon height-to-width ratio are correlated with inversion height but are anticorrelated with inversion depth and inversion strength. A reduction in rural soil moisture reduces inversion height and increases inversion strength. During daytime, differences between urban and rural boundary layers are strongly linked with wind speed and rural soil moisture. A factor analysis technique is used to evaluate the relative importance of thermal and mechanical urban factors in terms of their effects on boundary layer structure. The results show that, during the night, thermal factors are more important in the lower part of the urban boundary layer and mechanical factors are dominant in the upper part. Interactions between thermal and mechanical factors act to increase nocturnal boundary layer height. During the day, thermal factors play the most important role in modulating the PBL height evolution above the city. Interactions between thermal and mechanical factors act to reduce the daytime boundary layer height. Mechanical factors become
important in the evening, when the turbulent kinetic energy produced by interactions between the airflow and buildings causes a delay in the decrease of PBL height. 

Classification: 4,8.


The urban impact on the sea breeze is studied by means of a mesoscale model with a detailed urban parameterisation. Four simulations are carried out on an idealised two-dimensional flat domain. In the base case, half of the domain is characterised by sea and the other half by rural land. In the urban case, an urban area 10 km wide is added near the shoreline. Simulations are performed for a moist rural soil (weak sea breeze) and for a dry rural soil (strong sea breeze). Results are analysed in order to evaluate the impact of the city on the wind, temperature and turbulent kinetic energy fields. The dispersion of a passive tracer emitted near the coastline is, also, used in the comparison. Results show that the city accelerates the sea-breeze formation in the morning (combinations of urban circulation and sea breeze), but it slows the sea-breeze front penetration. Moreover, the presence of the city enhances the recirculation processes and strongly modifies the pollutant dispersion. These effects are enhanced for a moist rural soil. Classification: 8.


A scheme to represent the impact of urban buildings on airflow in mesoscale atmospheric models is presented. In the scheme, the buildings are not explicitly resolved, but their effects on the grid-averaged variables are parameterised. An urban quarter is characterised by a horizontal building size, a street canyon width and a building density as a function of height. The module computes the impact of the horizontal (roof and canyon floor) and vertical (walls) surfaces on the wind speed, temperature and turbulent kinetic energy. The computation of the shortwave and longwave radiation, needed to compute the temperature of the urban surfaces, takes into account the shadowing and radiation trapping effects induced by the urban canyons. The computation of the turbulent length scales in the TKE equation is also modified to take into account the presence of the buildings. The parameterisation is introduced into a mesoscale model and tested in a bidimensional case of a city over flat terrain. The new parameterisation is shown to be able to reproduce the most important features observed in urban areas better than the traditional approach which is based only on the modification of the roughness length, thereby retaining the Monin-Obukhov similarity theory. The new surface exchange parameterisation is furthermore shown to have a strong impact on the dispersion characteristics of air pollutants in urban areas. Classification: 8.

Most of the standard mesoscale models represent the dynamic and thermodynamic surface exchanges in urban areas with the same technique used for rural areas (based on Monin-Obukhov similarity theory and a surface energy budget). However it has been shown that this technique is not able to fully capture the structure of the turbulent layer above a city. Aim of this study is to evaluate the importance for meteorological and air quality simulations, of properly capture the dynamic and thermodynamic surface exchanges in urban areas. Two sets of simulations were performed over the city of Athens (Greece): a first using a mesoscale model with a detailed urban surface exchange parameterisation (able to reproduce the surface exchanges better than the traditional method), and a second with the traditional approach. Meteorological outputs are passed to a Eulerian photochemical model (the photochemical model is run offline). Comparison with measurements shows better agreement for the simulation with the detailed parameterisation. The differences between the simulations concern, mainly, wind speed (maximum difference of 0.5-1 m s(-1)), night-time temperatures (2-3 degreesC), turbulence intensity (2 m(2) s(-2)) and heat fluxes (0.15 K m s(-1)) over the urban area, urban nocturnal land breeze intensity, timing and extension of sea breeze. These differences modify the Pollutant distribution (e.g. for ozone maximum differences are of the order of 30 ppb). Differences between the simulations are also found in AOT60 values (inside and outside the city) and in O-3 chemical regimes. (C) 2003 Elsevier Ltd. All rights reserved.


Classification: 5.


The PM2.5 concentration and its elemental composition were measured in the Cincinnati metropolitan area, which is characterized by intense highway traffic. The spatial and temporal variations were investigated for various chemical elements that contributed to the PM2.5 fraction during a 1-year-long measurement campaign (December 2001–November 2002). The ambient aerosol monitoring was performed in 11 locations around the city during nine measurement cycles. During each cycle, four Harvard-type impactors were operating in parallel in specific locations to explore various factors affecting the PM2.5 elemental concentrations. The sampling was performed during business days, thus assuring traffic uniformity. The 24-h PM2.5 samples were collected on Teflon and quartz filters. Teflon filters were analyzed by
X-ray fluorescence (XRF) analysis while quartz filters were analyzed by thermal-optical transmittance (TOT) analysis. In addition to PM2.5 measurements, particle size-selective sampling was performed in two cycles using micro-orifice uniform deposit impactor; the collected fractionated deposits were analyzed by XRF. It was found that PM2.5 concentration ranged from 6.70 to 48.3 \( \text{g m}^{-3} \) and had low spatial variation (median coefficient of variation, CV=11.3%). The elemental concentrations demonstrated high spatial variation, with the median CV ranged from 38.2% for Fe to 68.7% for Ni. For traffic-related trace metals, the highest concentration was detected in the city center site, which was close to a major highway. The particle size selective measurement revealed that mass concentration of the trace metals, such as Zn, Pb, Ni, as well as that of sulfur reach their peak values in the particle size range of 0.32–1.0 \( \mu \text{m} \). Meteorological parameters and traffic intensity were not found to have a significant influence on the PM2.5 elemental concentrations. *Classification: 5.*


An urban surface scheme for atmospheric mesoscale models is presented. A generalization of local canyon geometry is defined instead of the usual bare soil formulation currently used to represent cities in atmospheric models. This allows refinement of the radiative budgets as well as momentum, turbulent heat and ground fluxes. The scheme is aimed to be as general as possible, in order to represent any city in the world, for any time or weather condition (heat island cooling by night, urban wake, water evaporation after rainfall and snow effects). Two main parts of the scheme are validated against published data. Firstly, it is shown that the evolution of the model-predicted fluxes during a night with calm winds is satisfactory, considering both the longwave budget and the surface temperatures. Secondly, the original shortwave scheme is tested off-line and compared to the effective albedo of a canyon scale model. These two validations show that the radiative energy input to the urban surface model is realistic. Sensitivity tests of the model are performed for one-year simulation periods, for both oceanic and continental climates. The scheme has the ability to retrieve, without ad hoc assumptions, the diurnal hysteresis between the turbulent heat flux and ground heat flux. It reproduces the damping of the daytime turbulent heat flux by the heat storage flux observed in city centres. The latent heat flux is negligible on average, but can be large when short time scales are considered (especially after rainfall). It also suggests that in densely built areas, domestic heating can overwhelm the net radiation, and supply a continuous turbulent heat flux towards the atmosphere. This becomes very important in winter for continental climates. Finally, a comparison with a vegetation scheme shows that the suburban environment can be represented with a bare soil formulation for large temporal or spatial averages (typical of global climatic studies), but that a surface scheme dedicated to the urban surface is necessary when smaller scales are considered: town meteorological forecasts, mesoscale or local studies. *Classification: 8,3.*

The Town Energy Balance (TEB) model of Masson simulates turbulent fluxes for urban areas. It is forced with atmospheric data and radiation recorded above roof level and incorporates detailed representations of the urban surface (canyon geometry) to simulate energy balances for walls, roads, and roofs. Here the authors evaluate TEB using directly measured surface temperatures and local-scale energy balance and radiation fluxes for two "simple" urban sites: a downtown area within the historic core of Mexico City, Mexico (stone buildings five to six stories in height), and a light industrial site in Vancouver, British Columbia, Canada (flat-roofed, single-story warehouses). At both sites, vegetation cover is less than 5%, which permits direct evaluation of TEB in the absence of a coupled vegetation scheme. Following small modifications to TEB, notably to the aerodynamic resistance formulations, the model is shown to perform well overall. In Mexico City, with deep urban canyons and stone walls, almost two-thirds of the net radiation is partitioned into storage heat flux during the day, and this maintains large heat releases and an upward turbulent sensible heat flux at night. TEB simulates all of these features well. At both sites TEB correctly simulates the net radiation, surface temperatures, and the partitioning between the turbulent and storage heat fluxes. The composite wall temperature simulated by TEB is close to the average of the four measured wall temperatures. A sensitivity analysis of model parameters shows TEB is fairly robust; for the conditions considered here, TEB is most sensitive to roof characteristics and incoming solar radiation. Classification: 3,8.


The objective of this study was to compare two real-time condensation particle counters for measurement of number concentrations of ultrafine particles (UFPs). The comparison is based on the data from side-by-side measurements conducted in several locations, both indoors and outdoors. CPC 3007 and P- Trak(TM) 8525 manufactured by TSI (instruments A and B, respectively) were used simultaneously. They measure particles in sizes from 0.01 to greater than 1 mum and 0.02 to greater than 1 mum, respectively. The results reveal a good correlation between the two instruments. The ratios of measured aerosol concentrations varied from 0.81 to 1.17, which implies that in all data sets the difference between the two instruments was less than +/-20%. About 63% of the results were in the range of +/-10%, and about 44% showed differences less than +/-5%. The maximum particle concentration detected by instrument A was approximately 105,000 particles cm(-3) and the minimum was about 230 particles cm(-3) . Because of the lower particle size threshold for instrument A, it was expected that this instrument should never show concentrations lower than those detected by instrument B. This was the case in most of the measurement series. The results revealed that the concentration of UFPs changes rapidly, especially in the presence of a local UFP source. A sampling interval of 1 min is sufficient to provide substantial information about the change in concentration level. Classification: 5.

Endeavors to reduce greenhouse gases have been made in all of the world. Nitrous oxide, N2O has not widely been recognized for a greenhouse gas. Some investigations to search the emission sources of N2O and to establish the decomposition method of N2O have just been started. We have continuously monitored atmospheric concentration of N2O at our center of Nagoya University. By the timing correlation analysis of the monitoring data of N2O and those of other greenhouse gases, we tried to find their correlations and identify the emission sources of N2O. In this paper, the results of our study on auto correlations and cross correlations of N2O with other greenhouse gases, CO2 and CH4, and climate parameters are reported. As a result, it becomes clear that though N2O concentration changes slowly and an amplitude of the change is very small in comparison with CH4 and CO2, all of them shows the same periodicity at 1 day. Moreover, an increase in N2O concentration of summer and a dependence of N2O concentration on wind direction were found. Classification: 5.


Classification: 1.

Mayer, H., Matzarakis, A. and Iziomon, M. G. (2003a) 'Spatio-temporal variability of moisture conditions within the Urban Canopy Layer', *Theoretical and Applied Climatology, 76*, 165-179

Re-analysed data from an urban climate research project in Munich, Germany, were used to investigate the spatiotemporal variability of moisture conditions (expressed here in vapour pressure VP) within the Urban Canopy Layer UCL. The results, which apply to three main sites and additional subsidiary ones, cover both summer and winter months. The summer month variation of VP is characterised by higher monthly mean values of VP for all three sites, howbeit with considerable inter-site differences. The temporal variability of mean VP values at diurnal time scales is also examined. With respect to the UCL, they reveal different amplitudes and times of occurrence of their extreme values. In addition, results of car traverses performed during clear sky conditions in downtown Munich show a remarkable small-scale spatio-temporal variability of VP. In relation to a sealed downtown site within a courtyard in Munich, a time-dependent urban moisture excess (UME) was formed. A positive correlation between UME and the urban heat island (UHI) could be verified in general. However, it was slightly negative with a very low coefficient of determination in the summer month when the maximum UME preceded the maximum UHI up to 5 hrs. As example for the effects of air moisture on the urban climate within the UCL, the role of VP on a thermal index (physiologically equivalent temperature PET) was investigated. Based on one-year data from another urban climate project in Munich, a positive correlation between PET and VP was found, although the coefficient of determination was somewhat low. However, during a human-biometeorological case study on a typical summer day in the northern downtown of Freiburg, a medium-sized city in southwest Germany, PET and VP showed a negative correlation.
(possibly because the specific temporal course of VP at the measuring points was mainly influenced by thermally induced turbulence). Classification: 8,6.

Mayer, H., Matzarakis, A. and Kalberlah, F. (2003b) 'Human-biometeorological assessment of the air pollution component of the urban climate by the index DAQx', EURASAP Newsletter, 50, 18-25

Classification: 7.


Classification: 5.


Classification: 1.


An analytical model has been developed to calculate pollutant concentrations in a street. The concentration in the street is determined from a flux balance between the horizontal convective flux, the diffusive vertical flux and a continuous road transport emission source. The Prandtl-Taylor hypothesis is used to describe vertical turbulent mass transport. The model includes wind direction dependency, but does not necessarily assume recirculation of the flow in the street canyon. The model was applied for ten streets in the City of Antwerp, Belgium and for the Podbielskistrasse in Hannover, Germany. Benzene concentrations obtained in the streets of Antwerp show a reasonable agreement with measured concentrations, provided that observed vehicle numbers are used and that the correct background concentrations and meteorological conditions are taken into account by the model. Classification: 5.


A numerical simulation of the traffic pollutant transport diffusion within one busy street of Nantes city centre has been realized for a real-time duration of 24 hours, with a time step of 20 ms, in low wind, sunny conditions. It has been generated with the urban canopy model CHENSI, which includes sub-models of thermal buoyancy, traffic emission rates, car induced turbulence. A number of frames of the simulation film are selected to illustrate the mechanism and the influence of the coupling
between dynamic and thermal convections upon the flow regimes, the street ventilation, the distribution of the pollutant concentrations and the pollutant residence times. Classification: 8.

Miao, S. G. and Jiang, W. M. (2004) 'Large eddy simulation and study of the urban boundary layer', *Advances in Atmospheric Sciences*, 21, 650-661

Based on a pseudo-spectral large eddy simulation (LES) model, an LES model with an anisotropy turbulent kinetic energy (TKE) closure model and an explicit multi-stage third-order Runge-Kutta scheme is established. The modeling and analysis show that the LES model can simulate the planetary boundary layer (PBL) with a uniform underlying surface under various stratifications very well. Then, similar to the description of a forest canopy, the drag term on momentum and the production term of TKE by subgrid city buildings are introduced into the LES equations to account for the area-averaged effect of the subgrid urban canopy elements and to simulate the meteorological fields of the urban boundary layer (UBL). Numerical experiments and comparison analysis show that: (1) the result from the LES of the UBL with a proposed formula for the drag coefficient is consistent and comparable with that from wind tunnel experiments and an urban subdomain scale model; (2) due to the effect of urban buildings, the wind velocity near the canopy is decreased, turbulence is intensified, TKE, variance, and momentum flux are increased, the momentum and heat flux at the top of the PBL are increased, and the development of the PBL is quickened; (3) the height of the roughness sublayer (RS) of the actual city buildings is the maximum building height (1.5-3 times the mean building height), and a constant flux layer (CFL) exists in the lower part of the UBL. Classification: 8.


Volatile organic compounds (VOCs) have been determined to be human risk factors in urban environments, as well as primary contributors to the formation of photochemical oxidants. Ambient air quality measurements of 54 VOCs including hydrocarbons, halogenated hydrocarbons and carbonyls were conducted in or near 13 urban locations in the United States during September 1996 to August 1997. Air samples were collected and analyzed in accordance with US Environmental Protection Agency-approved methods. The target compounds most commonly found were benzene, toluene, xylene and ethylbenzene. These aromatic compounds were highly correlated and proportionally related in a manner suggesting that the primary contributors were mobile sources in all the urban locations studied. Concentrations of total hydrocarbons ranged between 1.39 and 11.93 parts per billion, by volume (ppbv). Ambient air levels of halogenated hydrocarbons appeared to exhibit unique spatial variations, and no single factor seemed to explain trends for this group of compounds. The highest halogenated hydrocarbon concentrations ranged from 0.24 ppbv for methylene chloride to 1.22 ppbv for chloromethane. At participating urban locations for the year of data considered, levels of carbonyls were higher than the level of the other organic compound groups, suggesting that emissions from motor vehicles and photochemical reactions strongly influence ambient air concentrations of
carbonyls. Of the most prevalent carbonyls, formaldehyde and acetaldehyde were the dominant compounds, ranging from 1.5–7.4 ppbv for formaldehyde, to 0.8–2.7 ppbv for acetaldehyde. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.


A model for the urban canyon is formulated for meteorological conditions of weak winds at night time. Thermal radiation, conductivity and convection are simulated by means of the Monte Carlo method. These are the main physical processes of energy transfer that give rise to the characteristic temperature distribution in these systems. The model has been satisfactory tested under ideal conditions for which analytical solutions exist. The predictions of the model under more realistic conditions accurately reproduce the observational results. A strong temperature gradient across streets, with the canyon corners up to 4 degrees C warmer than the canyon centre, is found for the deepest canyons. This theoretical prediction has been successfully verified with measurements taken in a number of streets of the city of Granada in Spain. Classification: 3,8.


Classification: 7.


Classification: 7.


Based on 1 yr of field measurements, the diurnal, seasonal, and annual fluxes of energy and carbon dioxide (CO2) at a residential area of Tokyo, Japan, are described. The major findings are as follows. 1) The storage heat flux G in the daytime had little seasonal variation, irrespective of significant seasonal change of net all-wave radiation Rn. 2) The latent heat flux in the summer daytime was large despite the small areal fraction of natural coverage (trees and bare soil). The estimated local latent heat flux per unit natural coverage was 2 times the available energy (Rn - G), which indicates that the “oasis effect” was significant. 3) The CO2 flux was always upward throughout the year and the magnitude was larger in winter, mainly because of an increase of fossil fuel consumption. The annual total CO2 flux was 6 times the downward CO2 flux at a typical temperate deciduous forest. Classification: 3.

The facades of the Bank of Greece historic building, mainly consisted of porous stone, gray marble and white pentelic marble, are subjected to an intensive air pollution attack in the center of Athens. A diagnostic study was carried out prior to the cleaning procedures for the weathering evaluation. Weathering appears mainly as black depositions, salt crusts, and oily depositions, due to the heavily polluted urban atmosphere from the nearby traffic. Previous improper cleaning treatment by water spray under high pressure caused detachment of grains and fissuring which were recognized as mechanical abrasion of the surfaces. In this study, a pilot investigation is performed with the intention of evaluating the most appropriate cleaning treatment. Therefore, several cleaning procedures were performed in the laboratory and in situ for the evaluation of methods and products applied on the facades. Both chemical and physical cleaning procedures were applied and they were chosen for their selective action: only water and sepiolite for solvent action, ammonium bicarbonate for exchange action, EDTA for the chemical chelating action and microblasting for physical action were used. In situ non-destructive evaluation was performed by Fiber Optics Microscopy in order to assess the counteractions of each cleaning method to the original surfaces. Digital Image Processing was also used to account for the efficiency of each cleaning method. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.


Air quality in cities is the result of a complex interaction between natural and anthropogenic environmental conditions. Delhi, as well as many other cities in India, is facing problems concerning air pollution. The increase in industrialization and the vehicle fleet, poor control on emissions and little use of catalytic converters, produce a great amount of particulate and toxic gases. Data on air pollutants and meteorological variables were collected in the metropolitan cities Delhi, Kolkata, Mumbai and Chennai for the period July-August, 2001. Data were treated with the bivariate regression model to explore the influence of the meteorological variables on air pollutant concentrations, and were also used to compute an Air Quality-Index, using the weighted arithmetic mean method. The proposed index seems to be applicable in the assessment of overall air quality with respect to air pollutants. Classification: 5.

The impact of oxides of nitrogen (NOx) emissions from motor vehicles to the air quality in city-state Singapore is analyzed using AIRVIRO, a regional scale dispersion model developed by the Swedish Meteorological and Hydrological institute. In a predominantly urban location like Singapore, it is difficult to separate out the contribution of pollutants from mobile and point sources at different locations. In this work, a new approach is used by first modeling only the impact of point and area sources and then overlaying the traffic impact on air quality at different locations. Monthly scenario simulations are run with point, area and traffic sources of emissions for the Gaussian model validation. Street Canyon modeling is used for street segments surrounded by buildings on either side. A simplified photochemical model, which takes into account NOx undergoing chemical transformations in the urban atmosphere, is used to account for variations in NOx and ozone levels with respect to traffic data. The diurnal variation of NOx concentration levels is studied as a function of ozone levels at site, hourly traffic counts and meteorological parameters. The impact on ambient air quality within the breathing zone of the public from mobile sources, is found to be about 40% at urban stations although overall emissions from mobile sources is only 24%. The proposed approach appears to predict the variations in NOx as a function of traffic and meteorological conditions. (C) 2000 Elsevier Science B.V. All rights reserved. Classification: 5.

Murena, F. (2004) 'Measuring air quality over large urban areas: development and application of an air pollution index at the urban area of Naples', *Atmospheric Environment*, 38, 6195-6202

A daily air pollution index (PI) has been developed and implemented at the urban area of Naples (Italy). Data gathered from nine monitoring stations during 2001–2002 have been analysed and a PI has been developed and applied. The index aims at measuring the status of air pollution with respect to its effect on human health. It can be seen as a modified version of air quality index of Environmental Protection Agency taking into consideration the limit values ruling in Europe. A procedure to evaluate the PI at each monitoring site and on the overall urban area is reported. Additive effects of air pollutants have also been considered and the PI re-evaluated. Classification: 5.


The results of an about 2-week monitoring campaign of benzene concentration in a deep street canyon in the city of Naples are reported. Passive samplers were located at different heights on the road level (3-14-27 m). The geometry of the canyon is: width W = 5.8 m and height H = 33 m (Aspect Ratio, AR = H/W = 5.7). Monitoring was carried out in two 6-day campaigns: 10-16 December 2002 and 14-20 January 2003. Traffic levels in the same street were measured to obtain typical daily curves of average vehicle flow vs. time. Sampling time was fixed in 2 days and 6 days. Therefore, 2-day and 6-day average benzene concentrations were measured. The results show that benzene is present at high concentration level in the street canyon. Two-day average concentration up to 23.8 µg m(-3) was detected. In all the samples the benzene concentration at 3 m on the road level was higher than the
threshold limit value of 10 mug m(-3). The vertical concentration profiles of benzene were fitted assuming a first-order exponential decay. Values of the decay coefficient vary in the range 8 x 10(-2)-1.6 x 10(-1) m(-1). (C) 2003 Elsevier Ltd. All rights reserved. Classification: 5.


Examination of the Doppler SODAR data from Sao Paulo, Brazil, has given valuable information on the coupling between planetary boundary layer (PBL) and the free atmosphere above, which is reported here. In this communication a case study, on the dynamics of the urban boundary layer over the Metropolitan Area of Sao Paulo (MASP), Brazil, is examined for July 27, 1999 when a multiple gravity wave (GW), a low-level jet (LLJ) and a cold front (CF) all occurred in one single day in succession, making use of data from Doppler SODAR, surface meteorological instruments, satellite imageries and model derived values. The experimental findings are compared to provide validations of ground truth with the model-derived profiles based on the mesoscale analysis of Regional Atmospheric Modelling System (RAMS). It is seen that the multiple GW, the LLJ and the CF have different types of nonlinear coupling between the PBL and the free atmosphere. However, there is convincing matching between Doppler SODAR derived features, those of mesoscale analysis from RAMS and satellite view of cloud dynamics. The study provided valuable information on (i) the very nature of these events, (ii) the nonlinear hydrodynamical coupling between the PBL and the free atmosphere above, during such events, and (iii) the possible mechanism of CF influencing the formation of GW and LLJ. Classification: 8.


Particle number distributions were measured simultaneously upwind and downwind of a suburban-agricultural freeway to determine relationships with traffic and meteorological parameters. Average traffic volumes were 6330 vehicles/hr with 10% heavy-duty vehicles, and volumes were higher in July than November. Most downwind particle number distributions were bimodal, with a primary mode at similar to10-25 nm, indicating that newly formed particles were sampled. Total downwind 6-237 nm particle number concentrations (N-tot) ranged from 9.3 x 10(3) to 2.5 x 10(5) cm(-3), with higher daily average concentrations in November compared with July. N-tot correlated with wind speed, temperature, and relative humidity. Upwind photochemically initiated nucleation likely led to elevated background nanoparticle concentrations in July, as evidenced by increasing upwind distribution modal diameter with increasing temperature and a strong correlation between upwind N-tot and solar radiation. Also in summer, N-tot showed stronger correlation with heavy-duty vehicle volumes than wind speed, temperature, and relative humidity. These results indicate the importance of measuring background particle size distributions
simultaneously with roadside distributions. There may be a minimum vehicle volume from which useful real-world vehicle particle number distributions can be measured at roadside, even when collecting samples within 10 m of the traveled lanes. Classification: 5.


Individual aerosol particles were collected on three days with different meteorological conditions in June 2000 in the urban atmosphere of Tsukuba, Japan. The samples collected with an electrostatic aerosol sampler (EAS) were examined by electron microscopy. The mixing properties of submicrometer aerosol particles of 0.02-0.2 mum radius were studied using the dialysis (extraction) of water-soluble material. Atmospheric aerosol particles were classified into four types with respect to the mixtures of water-soluble and water-insoluble material. The proportions of particles with water-soluble material (hygroscopic particles) ranged from 20% to 80% in the whole radius range and tended to increase with increasing radius. Moreover, by the morphological appearance, soot-containing particles were classified into two types, i.e., externally mixed soot-particles and internally mixed soot-particles. The number fractions of internally mixed soot-particles increased with increasing radius. It is found that the volume fraction of water-soluble material (epsilon) for the internally mixed soot-particles increased with increasing radius. In a "polluted" case, the sample showed a dominant number fraction (75%) of internally mixed soot-particles in the larger radius range of 0.1-0.21 mum. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 5.

Nasrallah, H. A., Balling, R. C., Madi, S. M. and Al-Ansari, L. (2003) 'Temporal variations in atmospheric CO2 concentrations in Kuwait City, Kuwait with comparisons to Phoenix, Arizona, USA', *Environmental Pollution, 121*, 301-305

Hourly atmospheric carbon dioxide (CO2) concentration measurements are available from 1996 to present for a suburban site within the growing metropolitan area of Kuwait City. Analyses of this record reveal (a) an annual cycle with highest values in February and lowest values in September reflecting the growth and decay of vegetation in the Northern Hemisphere as well as fluctuations in motor traffic, (b) a weekly cycle with highest values during the weekdays and lowest values during weekends, and (c) a diurnal cycle with highest values after sunset when the local atmosphere becomes more stable following vehicular emission of CO2 throughout the day and lowest values in late afternoon following several hours of relatively unstable conditions. During the daytime, CO2 concentrations are related to wind direction, with westerly winds (coming from the desert) promoting lowest CO2 Concentrations. At night, lowest CO2 levels are associated with higher wind speeds and winds from the north. The findings from the Kuwait City area, particularly when contrasted with the situation in Phoenix, further our understanding of the dynamics of CO2 levels in urban environments. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.

Classification: 5.


A selection of turbulence data corresponding to 185 days of field measurements has been analysed. The non-ideal building geometry influenced the circulation patterns in the street canyon and the largest average vertical velocities were observed in the wake of an unbroken line of buildings. The standard deviation of vertical velocity fluctuations normalised by the ambient wind speed was relatively insensitive to ambient wind direction and sensor position, and it was usually larger than the corresponding 1-hour average velocity. Cross-correlations of spatially separated velocity measurements were small, and this suggests that most of the velocity fluctuations were fairly local and not caused by unsteady street vortices. The observed velocities scaled with the ambient wind speed except under low-wind conditions. Classification: 8,1.


Modeling the effects of increased urban tree cover on ozone concentrations (July 13-15, 1995) from Washington, DC, to central Massachusetts reveals that urban trees generally reduce ozone concentrations in cities, but tend to increase average ozone concentrations in the overall modeling domain. During the daytime, average ozone reductions in urban areas (1 ppb) were greater than the average ozone increase (0.26 ppb) for the model domain. Interactions of the effects of trees on meteorology, dry deposition, volatile organic compound (VOC) emissions, and anthropogenic emissions demonstrate that trees can cause changes in dry deposition and meteorology, particularly air temperatures, wind fields, and boundary layer heights, which, in turn, affect ozone concentrations. Changes in urban tree species composition had no detectable effect on ozone concentrations. Increasing urban tree cover from 20 to 40% led to an average decrease in hourly ozone concentrations in urban areas during daylight hours of 1 ppb (2.4%) with a peak decrease of 2.4 ppb (4.1%). However, nighttime (20:00-1:00 EST) ozone concentrations increased due to reduced wind speeds and loss of NOx scavenging of ozone from increased deposition of NOx. Overall, 8-hour average ozone concentration in urban areas dropped by 0.5 ppb (1%) throughout the day. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 7,5.
Ultrafine particles (less than 100 nm in diameter) are encountered in ambient air and at the workplace. Normal background levels in the urban atmosphere for ultrafine particles are in the range 1-4 x 10(4) cm(-3); however, their mass concentration is normally not greater than 2 mug m(-3). At the workplace, ultrafine particles occur regularly in metal fumes and polymer fumes, both of which can induce acute inflammatory responses in the lung upon inhalation. Although ultrafine particles occurring at the workplace are not representative, and, therefore, are not relevant for urban atmospheric particles, their use in toxicological studies can give valuable information on principles of the toxicity of ultrafine particles. Studies in rats using ultrafine polymer fumes of polytetrafluoroethylene (PTFE) (count median diameter ca. 18 nm) showed that (i) they induced very high pulmonary toxicity and lethality in rats after 15 min of inhalation at 50 mug m(-3); (ii) ageing of PTFE fumes resulted in agglomeration to larger particles and loss of toxicity; (iii) repeated pre- exposure for very short periods protected against the toxic and lethal effects of a subsequent 15 min exposure; (iv) rapid translocation of PTFE particles occurred to epithelial, interstitial and endothelial sites. Since one characteristic of urban ultrafine particles is their carbonaceous nature, exposure of rats to laboratory-generated ultrafine carbonaceous (elemental, and organic, carbon) particles was carried out at a concentration of ca. 100 mug m(-3) for 6 h. Modulating factors of responses were prior low-dose inhalation of endotoxin in order to mimic early respiratory tract infections, old age (22- month old rats versus 10-week old rats) and ozone co-exposure. Analysis of results showed that (i) ultrafine carbon particles can induce slight inflammatory responses (ii) LPS priming and ozone co-exposure increase the responses to ultrafine carbon; (iii) the aged lung is at increased risk for ultrafine particle-induced oxidative stress. Other studies with ultrafine and fine TiO2 showed that the same mass dose of ultrafine particles has a significantly greater inflammatory potential than fine particles. The increased surface area of ultrafine particles is apparently a most important determinant for their greater biological activity. In addition, the propensity of ultrafine particles to translocate may result in systemic distribution to extrapulmonary tissues. Classification: 0.


Aerosol mass size distributions of elemental carbon (EC) and organic carbon (OC) were measured to determine the extent to which carbon speciations within ambient aerosols differ between urban and over-water atmospheres. Samples were collected during twenty-one 12-h periods in urban Chicago and over Lake Michigan during the July 1994 and January 1995 sampling intensives. Total particle bound concentrations (sum of all size fractions) of elemental and organic carbon ranged from 0.15 to 0.96 and from 0.94 to 3.04 g m(-3), respectively. On average, organic material (OM = 1.4 x OC) accounts for 18% of the total aerosol mass collected, but ranges from 10% (over-water; winter) to 39% (urban, summer). With regard to individual size fractions, organic matter ranges from 3% ( > 12 mu m over-water, winter) to 49% (0.15-0.45
mu m, urban, summer) of the particulate matter mass in the size class. Geometric mean aerodynamic equivalent diameters (GMDs) range from 0.72 to 2.4 mu m for suspended particulate matter (Sigma-PM), from 0.52 to 1.4 mu m for EC, and from 0.60 to 1.9 mu m for OC. Elemental and organic carbon GMDs are larger in the urban atmosphere than over the water during winter, while this trend is not observed in C-PM. Furthermore, geometric standard deviations are larger at the urban location in January for both EC and QC, indicating broader size distributions of both species under winter conditions due to greater quantities of EC and OC in large particles. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 5.


A simple scheme to estimate net all-wave radiation (Q(*)) is evaluated using annual datasets in three urban settings (Chicago, Illinois; Los Angeles, California; and Lodz, Poland). Results are compared with a regression model based on incoming solar radiation and with an urban canopy-layer model incorporating a canyon geometry radiation scheme that requires a larger set of meteorological and surface property inputs. This net all-wave radiation parameterization (NARP) is most sensitive to albedo and the effects of clouds on incoming longwave radiation. Although omitting the diurnal variation of albedo has little impact on overall model fit, its seasonal variability needs to be considered in some cases. For incoming longwave radiation, even clear-sky estimates show a large degree of scatter, and results degrade substantially if cloudy periods are included. NARP shows improvement over the regression approach. If observations of downwelling longwave radiation are included, NARP and the more complex canopy scheme show similar results, near or within the range of instrument error, depending of time of year. Classification: 3.


The moisture distribution near the ground surface in and around the Japanese cities of Osaka and Kyoto was investigated. From the analysis of observed data, the atmosphere over the suburban areas between coastal Osaka and inland Kyoto was drier than that over Osaka and Kyoto during the daytime hours. This feature differs from results in previous studies and from expectations based on urban and suburban surface heat budgets. To understand the drying mechanism, numerical experiments were performed, using a simplified geometrical model consisting of a straight coastline, a square urban area on the coast, a square inland urban area, and a plateau mountain surrounding the urban areas. The following main results were obtained. First, suburban drying during the daytime was mainly caused by a valley circulation that developed over the surrounding mountain area. In addition, the two heat island circulations that developed over the two urban areas also caused suburban drying. As a consequence, the coexistence of mountain and urban areas caused more notable suburban drying. Second, the amount of suburban drying was greatest when the urban
distance was 40–50 km, which is roughly equal to the actual distance between the Osaka and Kyoto urban areas. Last, temporal changes in moisture and those of suspended particulate matter, SO2, and NOx concentrations decreased before the arrival of the sea-breeze front. Thus, it is argued that moisture and pollutants were transported by the two heat island circulations that developed over Osaka and Kyoto and by the valley circulations and then were modified by the sea-breeze circulation. Classification: 8.


Individual aerosol particles were collected on 5 days with different meteorological conditions in March, April and June 1991 in the urban atmosphere of Vienna in Austria. The samples collected with an impactor were examined by electron microscopy. The mixing properties of submicrometer aerosol particles with radii between 0.1 and 1 um were studied by using the dialysis (extraction) of water-soluble material. The averaged results showed that more than 85% of particles with radii between 0.1 and 0.7 um were hygroscopic. However, more than 50% of particles with radii larger than 0.2 um were mixed particles (hygroscopic particles with water-insoluble inclusions), and they were dominant (80%) in the size range 0.5-0.7 um radius. The results also showed that the number proportion of mixed particles increased with increasing radius and the abundance increased with increasing particle loading in the atmosphere. The volume fraction of water-soluble material (epsilon) in mixed particles tended to decrease with increasing radius, implying the formation of mixed particles by heterogeneous processes such as condensation and, or surface reaction. Some results of elemental composition in individual particles analyzed with an energy-dispersive X-ray (EDX) analyzer equipped with an electron microscope are also presented in this paper. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 5.


Classification: 5.


Classification: 5.

Little attention was paid to growing air quality concerns until about a decade earlier in Istanbul. With a population of over 12 million people and some occurred episodes imposed threats to the local government, and continuous monitoring of the urban air quality was started about a decade ago. This is part of a national strategy program which includes urban air quality assessment. This paper addresses a methodology for urban air quality using fuzzy synthetic evaluation techniques. The European part of Istanbul was selected for this purpose. Air pollutants data such as sulphur dioxide (SO2), carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), and total suspended particulate matter (PM) collected at five different air quality monitoring stations located in western part of Istanbul was used in this evaluation. The results obtained were compared to those applied to EPA air quality index. It was demonstrated that fuzzy synthetic evaluation techniques are quite appropriate techniques for air quality management. A case study was presented for this purpose.

Classification: 5.


Concentrations of size fractionated particulate sodium and potassium were measured in both marine and urban air. Marine air sampling was conducted during a cruise on R/V Hakuo-maru in the northwestern North Pacific in the summer of 1998. Urban air sampling was performed in the central part of Tokyo in 1997 and 1998. The fine sodium concentration (D < 1.1 mum) in "Urban" air (180 ng m(-3)) was 3 times higher than that in "Marine" air (56 ng m(-3)). In the urban air samples, the size distributions of sodium and potassium showed bimodal peaks in the fine particle range (D < 1.1 mum) and in the coarse particle range (D > 1.1 mum). The existence of anthropogenic sodium in the fine particle range was detected in the urban air. The K/Na weight ratios in the fine particle range of the urban air (1.8-2.7) was 50-75 times higher than that in seawater (0.036). Potassium in the urban air is thought to be derived largely from anthropogenic sources. In the urban air samples, a high correlation between fine sodium and fine potassium concentrations suggests that they have the same anthropogenic source. Reevaluating the K/Na ratios in marine air to be relatively higher than that in seawater, we can estimate that several percents of anthropogenic sodium can be transported from land to remote marine air. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 0.


Polycyclic aromatic hydrocarbons (PAHs) distribution along 28 km of Warsaw main street have been surveyed in July 2000 using moss passive samplers as a simple and economic surrogate of direct air sampling. Altogether 74 samplers at 39 crossroads with traffic lights were placed on the lamp post approximate to3.5 m above ground. PAHs levels determined in samplers are in range from 828 to 3573 ng/g moss dry weight. The spatial spread of pollution within this range is statistically close to normal distribution with mean value of 2332 ng/g. Variability within and between study areas are rationalized in terms of urban environmental factors. PAHs concentrations profiles
across the town have appeared uniform. The dominant compounds are phenanthrene, fluoranthene and pyrene. Their contribution is 49-68% of total PAHs burden. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.


An urban canopy parameterization (UCP) is implemented into the fifth-generation Pennsylvania State University–National Center for Atmospheric Research Mesoscale Model (MM5) to improve meteorological fields in the urban boundary layer for finescale (1-km horizontal grid spacing) simulations. The UCP uses the drag-force approach for dynamics and a simple treatment of the urban thermodynamics to account for the effects of the urban environment. The UCP is evaluated using a real-data application for Philadelphia, Pennsylvania. The simulations show that the UCP produces profiles of wind speed, friction velocity, turbulent kinetic energy, and potential temperature that are more consistent with the observations taken in urban areas and data from idealized wind tunnel studies of urban areas than do simulations that use the roughness approach. In addition, comparisons with meteorological measurements show that the UCP simulations are superior to those that use the roughness approach. This improvement of the treatment of the urban areas in the meteorological model could have implications for simulating air chemistry processes at this scale. Classification: 8.


Volatile organic compounds (VOC), more specifically, non-methane volatile organic compounds (NMVOC) play a critical role in the atmospheric chemistry. NMVOC, through complex photochemical reactions, contribute to the formation of toxic oxidants, such as tropospheric ozone and PAN, which are injurious to health and highly phytotoxic. Certain NMVOC have been shown to be highly toxic, mutagenic and carcinogenic. NMVOC are receiving increasing attention in the west on account of their implication for human health and air quality. On the other hand, information on NMVOC in India and other developing countries is not available. As a result, appreciation of potential threat from NMVOC in relation to air quality and public health is sadly lacking among planners and policy makers. The paper deals with the estimation of total NMVOC at 13 sites in the urban environment of Delhi during November 1994 to June 1995. An inexpensive, labour intensive manual sample collection device was used and the air samples were analysed using GC-FID. The results show that the amount of NMVOC in the ambient environment of Delhi varied between 1.3 and 32.5 ppmv exhibiting wide temporal and seasonal variation. NMVOC levels mostly peaked at 0900 h, which coincide with the peak traffic hour. The implications of NMVOC build-up in the urban atmosphere are obvious for air quality. The results of this preliminary study make out a strong case for developing a regular monitoring programme for NMVOC in the urban environment of Delhi as
In June, 1997, five pairs of simultaneous 24h atmospheric aerosol samples were collected on working days using Berner low-pressure impactors at 3.5 and 20 in heights at an urban site in Helsinki, Finland. The weather was dry and sunny during the campaign. The results were compared to earlier observations made at the lower site. Average submicron masses were 11 μg/m(3) at both heights. Local vehicle exhaust emissions seemed to accumulate particulate mass especially in the 0.15-0.4 μm size range with the average mass concentration being 12% higher at street level for 0.24 μm particles. Long-range transport and sea salt were important for the 0.4-1.3 μm particles leading to slightly higher average mass concentration at the rooftop site for this size-range. Average concentrations of most components, including mass and sulphate, were higher at the rooftop site in the 0.07-0.15 μm size range suggesting that regional or long-range-transported particles and/or local high-level sources might have enhanced these concentrations at the rooftop site. Average submicron concentrations of Cu, Ba, Fe, Sb, Bi, Al and nitrate were higher at street level suggesting that local traffic and road dust were important sources for these components. Concentrations of Ca, Co, Li, Mo, Na, Ni, Pb, Rb, Se, Sr, Ti, TI, V, MSA, pyruvate, succinate, malonate, SO42-, Cl-, Na+, K+ and Ca were similar at the two heights or higher at the rooftop site pointing to long-range transport and/or local high-level sources. Comparison of size distributions and concentrations revealed several groups of correlating chemical components: (1) SO42-, HH4+ oxalate, and methane sulphonate, (2) Ti, As, K+, Cd, B, glutarate, succinate and Pb, (3) V, Ni, and, to a lesser extent, Co and Mo, (4) Ba, Cu, Fe and Sb, and (5) Zn, Rb, Pb and Mo. The suggested principal sources for the above groups are (1) long-range transport, (2) mainly long-range transport with some local contribution, (3) local oil combustion, (4) vehicle exhaust and brake wear, and (5) various local sources and long-range transport. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5.

The mesoscale meteorological model TVM, coupled to a photochemical/transport module in which different chemical mechanisms (RACM, EMEP) are implemented, has been evaluated. Field measurements and numerical results are used to determine the impact of the mesoscale flows on the photochemical smog episodes observed in the Greater Madrid Area for two selected days, characterized by the presence of a thermal low-pressure system over the Iberian Peninsula. During the 14 July 1992, the synoptic flow from the southeast favoured the transport of the precursors to the Guadarrama mountain range, where high concentrations of ozone were registered,

exceeding the population information threshold. On the 15 July 1995, the synoptic wind from the northwest interacted with the local thermally driven flows, pushing the pollutants far away from the metropolitan area with the result that high ozone concentrations were measured to the east-southeast of the city. Classification: 5.


The ambient air concentrations of 88 volatile organic compounds were determined in samples taken at 13 semi-rural to urban locations in Maine, Massachusetts, New Jersey, Pennsylvania, Ohio, Illinois, Louisiana, and California. The sampling periods ranged from 7 to 29 months, yielding a large data set with a total of 23,191 individual air concentration values, some of which were designated "ND" (not detected). For each compound at each sampling site, the air concentrations (ca, ppbV) are reported in terms of means, medians, and means of the detected values. The analytical method utilized adsorption/thermal desorption with air-sampling cartridges. The analytes included numerous halogenated alkanes, halogenated alkenes, ethers, alcohols, nitriles, esters, ketones, aromatics, a disulfide, and a furan. At some sites, the air concentrations of the gasoline-related aromatic compounds and the gasoline additive methyl tert-butyl ether were seasonally dependent, with concentrations that maximized in the winter. For each site studied here, the concentrations of some compounds were highly correlated one with another (e.g., the BTEX group (benzene, toluene, ethylbenzene, and the xylenes). Other aromatic compounds were also all generally correlated with one another, while the concentrations of other compound pairs were not correlated (e.g., benzene was not correlated with CFC-12). The concentrations found for the BTEX group were generally lower than the values that have been previously reported for urbanized and industrialized areas of other nations. Classification: 5.


The impact of microclimatic conditions in urban areas on the thermal loads of buildings has been appreciated fairly recently. The modulation of street canyons has led, inter alia, to temperature conditions that depart from the climatic data monitored at meteorological stations, affecting the heating balance of buildings, while the building operation affects the present conditions. The installation of air conditioning units leads to heat emission, which, at a microscale level, strengthens this phenomenon. The present paper outlines a computational approach to the street canyon phenomenon, with the determination of flow and temperature fields which are developed, and discusses their influence on the dynamic thermal balance of the building. (C) 2001 Elsevier Science B.V. All rights reserved. Classification: 3,2.

*Classification: 7.*


The dispersion of vehicle emission is limited by various factors existing in an urban environment, which may produce a poor air quality in an urban street canyon environment. This poor air quality has a high potential to be easily delivered into indoor air environment through building ventilation. In this study, the dispersion of vehicle emission was characterized by conducting wind tunnel tests and applying tracer gas techniques. The aspect ratio of a street canyon (i.e. the ratio of the width of a street and the average height of buildings) and the direction of external wind are the major test parameters. In addition to the simple data analysis of the results, a series of statistical analysis was also introduced to formulate the complex effects on the dispersion of vehicle emission. The updated result is presented in this article. (C) 2003 Elsevier B.V. All rights reserved. *Classification: 5.*


Simultaneous measurements of PM10 (particle mass) aerosol and gas-phase nitrous acid (HNO2) were made over a fall season at a semi-urban site, Kwangju, South Korea, to investigate the effects of agricultural waste burning on their concentrations. The PM10 aerosol and gaseous species samples were collected three times a day for 6- and 12-h durations using a three-stage filter pack during three intensive sampling campaigns, and analyzed for particulate mass, ionic species, and HNO3 concentrations. Hourly HNO2 measurements were also made using a dual channel glass-coil sampling technique and ion chromatography analysis. NO2 (g) was measured using a differential optical absorption spectroscopy (DOAS) to investigate the formation pathway of HNO2. PM10, K+, and Cl- concentrations during the agricultural wastes burning event were substantially higher than during any other sampling periods, whereas the concentrations of secondary-formed aerosols, i.e., NO3-, NH4+, and SO42-, were substantially low during the burning event, compared to those in the non-burning periods. Higher HNO2 concentrations occurred during the night and November sampling periods when PM10 mass concentrations were generally high, and lower mixing layer and more humid condition were found, rather than during the day, September, and October sampling periods. It was also found that rapid increase in HNO2 levels from 0.2 to 2.6 ppb in the afternoon on October 20 was due to direct emissions from the agricultural wastes (straw and stubble) burning practice. Increases in the HNO2/NO2 ratio after sunset, and a close relationship between HNO2/NO2 and the PM10 mass indicate that during the study period NO2 is
the precursor of HNO2 production at nighttime. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 5.


Atmospheric CO2 mixing ratios and carbon and oxygen isotope composition were measured at 18 m above the ground in Salt Lake City, Utah, United States, for a one-year period. Mixing ratios were highest in the wintertime with maximum values approaching 600 mmol mol(-1) during atmospheric inversions. Nighttime carbon and oxygen isotope ratios of source CO2 showed a seasonal pattern with isotopically depleted values in the wintertime and isotopically enriched values in the spring and summer. The effects of gasoline combustion, natural gas combustion, and biogenic respiration of plants and soils on CO2 mixing ratio were quantified with a mass balance calculation using dual carbon and oxygen isotopic tracers. The calculations showed large contributions of natural gas combustion in the winter and significant nighttime biogenic respiration in the spring and late summer/early fall. The isotope-tracer technique used shows promise for quantifying the impacts of urban processes on the isotopic composition of the atmosphere and partitioning urban CO2 sources into their component parts. Classification: 5.


A summary presentation is made of representative samples from a comprehensive experimental databank on car exhaust dispersion in urban street canyons. Physical modelling, under neutral stratification conditions, was used to provide visualisation, pollutant concentration and velocity measurements above and inside test canyons amidst surrounding urban roughness. The study extended to two different canyon aspects ratios, in combination with different roof configurations on the surrounding buildings. To serve as a reliable basis for validation and testing of urban pollution dispersion codes, special emphasis was placed in this work on data quality assurance. Classification: 5.

Pecheyran, C., Lalere, B. and Donard, O. F. X. (2000) 'Volatile metal and metalloid species (Pb, Hg, Se) in a European urban atmosphere (Bordeaux, France)', *Environmental Science & Technology*, 34, 27-32

Ambient air measurements of volatile metal and metalloid compounds were conducted in a European urban environment (Bordeaux, France). Air samples were collected with a cryogenic trap and analyzed by low-temperature gas chromatography with ICP/MS detection. Indoor and outdoor sites were studied. Tetraalkyllead compounds (Me4-nEtPb, n = 0-4) and elemental mercury were found to be the major
volatile metal species. Average concentrations of 15.5 and 2.7 ng/m(3) as metal have been reported respectively for total alkyllead species and elemental mercury in open area. These results illustrate the general phasing out of atmospheric lead initiated in the past decade. Accumulation of dimethyl selenide has been recorded in a building probably originating from human breath. Volatile metal species distribution in the different sites is discussed with regards to meteorologic al conditions and automotive traffic parameters. Occurrence of unknown volatile metal and metalloid species likely to occur in urban environment is also reported and discussed. Classification: 5.


Classification: 7.


The atmospheric concentration of gaseous ammonia has been measured during selected field campaigns from the spring of 2001 to the spring of 2002 in the urban area of Rome, at many traffic sites and at an urban background site. The concentration level at the traffic sites was in all cases about five times the background level and always much higher than the concentration in a rural near-city area. The time trend of ammonia is well correlated with the trend of a primary low-reactivity pollutant such as carbon monoxide. The concentration values of both pollutants depend on the intensity of traffic emission and on the atmospheric mixing in the boundary layer. Ammonia concentration is also dependent on the air temperature. A close link between NH3 and CO air values has been confirmed at all the measurement stations of the Air Quality Network of Rome. These results indicate that the emissions from petrol- engine vehicles equipped with catalytic converters can be an important source of ammonia in urban areas. The implications of these findings for the chemistry of the urban atmosphere need to be carefully considered. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.

Peterson, T. C. (2003) 'Assessment of Urban Versus Rural In Situ Surface Temperatures in the Contiguous United States: No Difference Found', *Journal of Climate*, 16, 2941-2959

All analyses of the impact of urban heat islands (UHIs) on in situ temperature observations suffer from inhomogeneities or biases in the data. These inhomogeneities make urban heat island analyses difficult and can lead to erroneous conclusions. To remove the biases caused by differences in elevation, latitude, time of observation, instrumentation, and nonstandard siting, a variety of adjustments were applied to the data. The resultant data were the most thoroughly homogenized and the homogeneity adjustments were the most rigorously evaluated and thoroughly documented of any large-scale UHI analysis to date. Using satellite night-lights–
derived urban/rural metadata, urban and rural temperatures from 289 stations in 40 clusters were compared using data from 1989 to 1991. Contrary to generally accepted wisdom, no statistically significant impact of urbanization could be found in annual temperatures. It is postulated that this is due to micro- and local-scale impacts dominating over the mesoscale urban heat island. Industrial sections of towns may well be significantly warmer than rural sites, but urban meteorological observations are more likely to be made within park cool islands than industrial regions. Classification: 4.


Ecological studies of terrestrial urban systems have been approached along several kinds of contrasts: ecology in as opposed to ecology of cities; biogeochemical compared to organismal perspectives, land use planning versus biological, and disciplinary versus interdisciplinary. In order to point out how urban ecological studies are poised for significant integration, we review key aspects of these disparate literatures. We emphasize an open definition of urban systems that accounts for the exchanges of material and influence between cities and surrounding landscapes. Research on ecology in urban systems highlights the nature of the physical environment, including urban climate, hydrology, and soils. Biotic research has studied flora, fauna, and vegetation, including trophic effects of wildlife and pets. Unexpected interactions among soil chemistry, leaf litter quality, and exotic invertebrates exemplify the novel kinds of interactions that can occur in urban systems. Vegetation and faunal responses suggest that the configuration of spatial heterogeneity is especially important in urban systems. This insight parallels the concern in the literature on the ecological dimensions of land use planning. The contrasting approach of ecology of cities has used a strategy of biogeochemical budgets, ecological footprints, and summaries of citywide species richness. Contemporary ecosystem approaches have begun to integrate organismal, nutrient, and energetic approaches, and to show the need for understanding the social dimensions of urban ecology. Social structure and the social allocation of natural and institutional resources are subjects that are well understood within social sciences, and that can be readily accommodated in ecosystem models of metropolitan areas. Likewise, the sophisticated understanding of spatial dimensions of social differentiation has parallels with concepts and data on patch dynamics in ecology and sets the stage for comprehensive understanding of urban ecosystems. The linkages are captured in the human ecosystem framework. Classification: 7.


Classification: 7,3,1.

Classification: 8,7.


Classification: 8.


Total suspended particulate matter was collected in a Abies boresii forest in central Greece during the period of 20 July-12 August 1997. Filters were extracted with solvents and the soluble content was separated into functional group fractions for analyses by gas chromatography/mass spectrometry. A total of 1050 different compounds could be identified in the various extracts. The lipid material consisted primarily of n-alkanes, n-alkan-2-ones, n-alkanols and n-fatty acids, with a higher concentration of molecular weights > C-20, derived from vascular plant waxes. Biomarkers for vegetation sources such as phytosterols and triterpenic compounds were also detected. Microbial components(< C-20), petroleum residues and pyrogenic aromatic hydrocarbons were present in the various aerosol extracts. Photochemical products deriving from volatile organic compounds emitted by vegetation or from anthropogenic precursors were also detected. These secondary organics include alkane derivatives, di- and carboxylic acids, nitroaromatics and many terpene photo-oxidation products. (C) 2000 Elsevier Science Ltd. All rights reserved. *Classification*: 5,7.


The Austrian city of Graz at the south-eastern edge of the Alps frequently experiences wintertime stagnations during anticyclonic flow conditions, leading to high local concentrations of primary pollutants. This paper compares instrument performance during a representative January stagnation period in 1998 in the Graz region using data obtained from a field experiment that supplemented the routine meteorological network with an array of sodars and tethersondes and a meteorological tower. Although sodars art, known to give reliable estimates of the horizontal wind in most cases, direct comparisons to other instruments for verification are still not very frequent. Therefore, the performance of the sodars to detect important modifications to the wind field over Graz will be discussed and compared to that of the tethersondes
To measure traffic pollutants with high temporal and spatial resolution under real conditions a mobile laboratory was designed and built in Helsinki Polytechnic in close co-operation with the University of Helsinki. The equipment of the van provides gas phase measurements of CO and NO, number size distribution measurements of fine and ultrafine particles by an electrical low pressure impactor, an ultrafine condensation particle counter and a scanning mobility particle sizer. Two inlet systems, one above the windshield and the other above the bumper, enable chasing of different type of vehicles. Also, meteorological and geographical parameters are recorded. This paper introduces the construction and technical details of the van, and presents data from the measurements performed during an LIPIKA campaign on the highway in Helsinki. Approximately 90% of the total particle number concentration was due to particles smaller than 50 nm on the highway in Helsinki. The peak concentrations exceeded often 200,000 particles cm(-3) and reached sometimes a value of 10(6) cm(-3). Typical size distribution of fine particles possessed bimodal structure with the modal mean diameters of 15-20 nm and similar to 150 nm. Atmospheric dispersion of traffic pollutions were measured by moving away from the highway along the wind direction. At a distance of 120-140 m from the source the concentrations were diluted to one-tenth from the values at 9 m from the source. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 5.

Plewka, A., Hofmann, D., Muller, K. and Herrmann, H. (2003) 'Determination of biogenic organic compounds in airborne particles by solvent extraction, derivatisation and mass spectrometric detection', Chromatographia, 57, S253-S259

Atmospheric oxidation of biogenic hydrocarbons such as monoterpenes is believed to be a globally significant source of aerosols. Secondary and primary biogenic hydrocarbons were determined in airborne particles. The particles were collected on quartz fibre filters in summer 2001 in a Norway spruce forest (Fichtelgebirge, Germany) at two different heights. The filters were Soxhlet extracted, the extract was concentrated and separated into five fractions with different polarity after flash chromatography and then measured with GC-MS. The first, second and third fractions were measured without derivatisation, the fourth fraction was silylated with BSTFA and the fifth fraction was methylated with BF3-Methanol. Many single compounds were detected and the highest concentrations were found for the polar components, especially for the dicarboxylic acids. Further quantified compounds include alkanes, ketones, aldehydes and carboxylic acids. Of special interest were the terpene oxidation products as pinonaldehyde, norpinic acid, pinic acid and pinonic acid. Typical concentrations of single compounds were in the sub ng m(-3) range. Concentrations of terpene oxidation products are low in comparison to the terpene
concentrations. More primary than secondary biogenic organic compounds were identified. *Classification: 0.*


Concentrations of tetrachlorobenzenes, pentachlorobenzene, hexachlorobenzene and alpha-, beta-, gamma- and delta-HCH in air and deposition were measured at three different contaminated sites in Greppin, Roitzsch (both near Bitterfeld) and Leipzig during five time intervals of 14 days in the summer months of 1998. The mean values of the chlorobenzene concentrations (gas phase and particle bound portions) over the whole sampling time were 0.11 ng/Nm(3) (Leipzig), 0.17 ng/Nm(3) (Roitzsch) and 0.37 ng/Nm(3) (Greppin), the mean values of the HCH concentrations were 0.22 ng/Nm(3) (Leipzig), 0.31 ng/Nm(3) (Roitzsch) and 0.69 ng/Nm(3) (Greppin). This increase of the concentration values from Leipzig over Roitzsch to Greppin indicates the influences of industrial waste sites in the Bitterfeld region on the atmospheric environment. The significantly higher values of hexachlorobenzene, alpha- and beta-HCH in Greppin are probably caused by emissions from the former chemical plant Bitterfeld-Wolfen and the landfill 'Antonie' near Greppin. Compared with literature data from other industrial impacted areas the measured air concentration and deposition values are relatively low. (C) 2000 Elsevier Science Ltd. All rights reserved. *Classification: 5.*


*Classification: 5.*


An annular denuder filter sampler has been tested for determination of both gaseous and particulate polycyclic aromatic hydrocarbons (PAH) in air. Collection efficiency and capacity over 6-h sampling at an air flow rate of 61 min(-1) were assessed. Concentrations were measured and phase distributions of the most important 2-6 ring PAH in air samples collected in downtown Rome during November 2002 to April 2003 were determined. The 2- and 3-ring PAH were found for more than 90% in the gas phase, whilst congeners with more than 4 rings were present almost entirely in the particle phase. Comparison with a high-volume filter-PUF sampler showed that similar results for total PAH contents (gas + particle) were observed only for congeners with molecular mass higher than 178 (phenanthrene and anthracene). (C) 2004 Elsevier Ltd. All rights reserved. *Classification: 0.*
PM characteristics of seven selected regions within the European Union (EU) were analysed and compared. Results of levels and speciation studies of PM10 and PM2.5 (with at least one year of data coverage from 1998 to 2002) at regional, urban background and kerbside sites were assessed. Based on the examples selected, PM10 levels (annual mean) ranged from 19 to 24 µg m$^{-3}$ at regional background sites, from 28 to 42 µg m$^{-3}$ at urban background, and from 37 to 53 µg m$^{-3}$ at kerbside sites. PM2.5 levels varied from 8 to 20 µg m$^{-3}$ at regional background sites, 20 to 30 µg m$^{-3}$ at urban background and 25 to 40 µg m$^{-3}$ at kerbside sites. The ratio PM2.5/PM10 is highly dependent on the type of site and varied widely between different EU regions. Source apportionment results showed that, on an annual average, the natural contribution (mineral and marine) at EU regional sites was in the range of 4–8 µg m$^{-3}$ in PM10 decreasing in PM2.5, but contributions up to 19 µg m$^{-3}$ were reported for specific locations. At urban sites, carbonaceous aerosols and secondary inorganic compounds accounted for a major fraction of PM10, and especially of the PM2.5 mass. Quantitative data on the contributions of the regional background, city background and local traffic to the mean annual levels of PM10, PM2.5 and major components were supplied. Climatic differences, long-range transport processes and winter traffic peculiarities (the latter in northern countries) contributed to the increase of PM10 and PM2.5 masses. At kerbside sites, an important dust contribution to PM2.5 is highlighted. Classification: 5.


This study examined temporal surface ozone patterns for two urban centres in Manitoba, Canada by analyzing hourly concentrations at the Winnipeg downtown (1995-1999), Winnipeg residential (1995-1999) and Brandon industrial (1998-1999) monitoring sites. The characteristic annual ozone cycle and diurnal cycles for June and December were attributable to: (1) the annual and diurnal solar radiation cycles, (2) temporal variations in the emissions of precursor chemical compounds, in particular the source strength of nitrogen oxides, (3) temporal variations in the height of the mixed layer, which determine the degree of dilution of these emissions by atmospheric dispersion, and (4) an in situ volatile organic compound sensitive photochemical regime, which resulted in decreased concentrations of ozone in response to increased concentrations of nitrogen oxides. Only one exceedance of the maximum acceptable level of 82 ppb was recorded in the study period; it occurred at the Brandon monitoring site on June 6, 1999. The sequence of weather and the hourly concentrations of ozone and nitrogen oxides indicated that: (1) ozone fumigation, with the transition from the nocturnal boundary layer to the daytime mixed layer, may have supplemented photochemical ozone formation during the morning hours, and (2) during the evening hours, the post cold-frontal downward flux of ozone rich air, which was in the region due to atmospheric transport, stratosphere-troposphere-exchange or, possibly, due to the multiplicity of thunderstorms in the area in late
afternoon - early evening, may have been the main cause of this rare exceedance event. Classification: 5.


Selection of numerical urban pollution dispersion models for regulatory purposes entails reliable prior validation against either physical modelling or field measurements. It is shown that an asymmetric geometry of the urban street canyon, in which measurement takes place, induces persistent gradients in pollution dispersion within it, irrespective of the wind vector meandering above the roofs. This influences field measurements taken there and, depending on canyon aspect ratio and roof geometry, favourable or unfavourable ventilation regions develop, on an annually-averaged basis. Therefore, inappropriate placement of the sampling probe can lead to systematic under- or over-predictions of actual air quality. Proper consideration of the potential influence of the near-field on pollution dispersion guarantees that the campaign's results remain free of systematic bias and, therefore, appropriate for regulatory model testing and validation. The repercussions of these findings for urban air quality monitoring are identified and discussed. Classification: 8.


To assist validation of numerical models of urban pollution dispersion, the boundary layer (BL) developing above a model town and the dispersion of street-level pollution on the surrounding buildings in typical street-canyon geometries, have been investigated in a wind tunnel under both neutral and stable thermal stratification conditions. Different street aspect ratios and roof configurations were used. The results indicate that stable stratification results in pollution 'capping' in the urban street canyons. The effect depends on the shape of the building roofs, with slanted roofs somewhat compensating for this 'capping' effect. As a rule, wider street configurations are more sensitive to oncoming thermal stratification than narrower canyons, irrespective of roof shape. Classification: 8.


The vertical wind profiles determined by Doppler sodar and the water vapour mixing ratio profiles obtained by Raman lidar are used to estimate the atmospheric water vapour flux profiles in the nocturnal urban boundary layer under unstable conditions. The experiment was conducted for several nights in the central area of Rome under a variety of moisture conditions and different urban boundary-layer flow regimes. Despite some scatter in the profiles, the latent heat flux is found to be positive

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throughout the depth of the nocturnal urban boundary-layer. The layer-averaged flux shows a variation between -4 to +40 W m(-2), while individual values of flux in excess of +150 W m(-2) pertain to a case of free convection during cold air advection caused by the sea breeze. The quality of flux estimates is found to be highly limited by the low sampling rates employed in the experiment resulting in errors to the order of 60%. Therefore, the results must be viewed as estimates rather than precise measurements. The skewness profiles of the turbulent fluctuations of vertical velocity and water vapour mixing ratio are also positive. Classification: 3,6,8.


The simultaneous operation of a three-axis Doppler sodar system in the central urban area of Rome and two similar systems in the suburban area, forming a triangle about 20 km on each side, provided evidence of solitary-type waves in the urban boundary layer. Three events, each lasting from a few minutes to about 30 min, and ranging in depth from the minimum range of the sodar (39 m) to over 500 m, are reported here. Two events were recognizable on all three sodar records while the third event could be observed at the urban location only. Time-height acoustic echo intensity records showed no-echo regions within the wave indicating transport of trapped recirculating air. This is typical of large amplitude solitary waves. The time series plots of sodar-derived vertical wind velocity revealed a maximum peak-to-peak variation of about 5 m s(-1) during periods of wave-associated disturbance. The vertical velocity is found to increase with height up to the top of the closed circulation within the wave and decreases further above. The normalised amplitude-wavelength relationship for the two events indicates that the observed waves are close to a strongly nonlinear regime. Classification: 8.


Observed hydroxyl (OH) and hydroperoxy (HO2) radicals, collectively called HOx, were compared with OH and HO2 calculated by a box model that used the regional atmospheric chemistry mechanism and was constrained to the ancillary measurements during the PM2.5 Technology Assessment and Characterization Study-New York (PMTACS-NY) summer 2001 intensive in New York City. The measurements are described in the companion paper, Ren et al. (HOx concentrations and OH reactivity observations in New York City during PMTACS-NY2001, Atmospheric Environment, this issue). This comparison enables an investigation of HOx chemistry in this polluted urban atmosphere. For HO2, the observed concentrations and diurnal variation were usually well reproduced by the model calculations, with an observed-to-modeled ratio of 1.24, on average, for day and night. For OH, the model was generally able to match the measured concentrations during daytime with an observed-to-modeled ratio of about 1.10, but the calculations significantly underestimated OH during nighttime. The budgets of HOx show that its production
was dominated by the photolysis of HONO, accounting for similar to 56% of HOx production on average, during daytime due to relatively high HONO concentrations, while nighttime HOx production was mainly from the O-3 reactions with alkenes. The OH reactivity measurements agree with the calculations to within 10% for both the composite diurnal variation and individual days. Calculations indicate that the reactions of OH with NO2, hydrocarbons, CO, NO, and carbonyls accounted for about 32%, 25%, 12%, 10% and 7% of total OH loss, respectively, in this urban area. Modeled instantaneous O-3 production from HO2 and RO2 reactions with NO was 150+/-100 ppbv day(-1). O-3 production rates from measured HO2(P(O-3)(obs)(HO2)) was greater than modeled HO2(P(O-3)(calc)(HO2)) at higher values of NO. Average daily cumulative P(O-3)(obs)(HO2) was similar to 140 ppbv day(-1), a factor of 1.5, greater than average daily P(O-3)(calc)(HO2). (C) 2003 Elsevier Ltd. All rights reserved. Classification: 5.


Scale modeling is of interest to physical geographers because it may permit physical systems to be reduced in complexity and size. However, for modeling results to have general applicability, formal scaling criteria must be met. This paper reviews scaling theory for hardware models for physical geographers, especially those interested in micro- and urban climates, and out-of-doors models. Criteria addressed dealt with physical domains (i.e., space, time, and temperature fields), physical processes such as radiation, conduction and convection, and discrete enclosures such as buildings. To demonstrate how theory can inform design, a case study is presented: the 1/8-scale, out-of-doors model constructed by the author to study urban dew. Dew deposition is temperature driven so, in this case, surface temperatures in the model needed to duplicate those seen at the full scale in real time. This was achieved using the Internal Thermal Mass (ITM) approach, wherein the thermal inertia of each scaled building was inflated by adding bottled water. Scaling criteria were also used to specify the layout, materials of construction and vegetation characteristics in the model, and the street-canyon length required to simulate an extensive urban neighborhood. Classification: 3, 6.


Dew has broad relevance to physical geography and many human activities. This paper reviews the observation and simulation of rural and urban dew, and the implications of dew as a climatic phenomenon. There is no universal protocol for measuring dew (i.e., condensation on cooled surfaces), its component fluxes (dewfall and distillation) or guttation, which is 'dewdrops' exuded from leaves. The many methods that exist to measure dew and surface moisture range from simple visual assessment, to electronic wetness sensors, lysimetry and remote sensing. Most studies of dew are rural; urban dew data are rare and studies seldom address dew in patchy landscapes, e.g., a forest clearing. Hardware dew models are rare. Numerous numerical models exist to simulate or forecast dew on rural crops but few address dew for surfaces other than leaves, e.g., a cocoa pod or road. There is a general consensus
in the literature that dew is reduced or absent in cities because of the urban heat island effect and reduced vapour supply. However, little data exist to test this. Given the broad relevance of dew to many topics, future studies of dew in complex landscapes, including urban areas, would prove valuable. Classification: 3,6.


There is growing interest in urban dew and its significance in questions of urban climate and air pollution deposition, but little research has been undertaken to study it. In this Study, a generic, urban residential neighbourhood is modelled out-of-doors at a scale of 0.125, using three wooden houses (1.08 m in tall), a concrete pavement (1.0 m in width), a grassed park (7.5 in in half-width) and several small trees (up to 1.5 m tall). The thermal inertia of each house is inflated, according to the internal thermal mass (ITM) approach, so that nocturnal surface temperatures are conserved. First-order validation was achieved through comparison with data collected at nearby full-scale site, in Vancouver, BC, Canada. Moisture accumulation (measured by blotting on grass and by lysimetry) is found to be primarily controlled by nocturnal weather conditions and the intrinsic nature of each substrate. e.g. dewfall is abundant on nights with few clouds and light winds, and on surfaces such as grass and asphalt-shingle roofs, which cool rapidly after sunset. However, these responses are modified by location effects related to the net radiation balance of the surface, which itself is strongly linked to site geometry as expressed by sky view factor and whether surfaces are isolated from heat source,. The dominant mechanism is argued to be the systematic increase in longwave radiation loss that is associated with increased sky view. Results agree with those observed at the full scale and suggest that maps of sky view factor and knowledge of dew at an open site, can potentially be used to create maps of dew distribution in urban and other complex environments. Copyright (C) 2002 Royal Meteorological Society. Classification: 3,6.


An extension of the numerical model MISCAM to account for effects of vegetation is presented. Computed wind and turbulence profiles agree reasonably with wind tunnel data. Furthermore, the extended model yields plausible results for flow fields and pollutant distributions in an idealized street canyon with and without vegetation. While wind speed is reduced within the vegetated street canyon, a slight increase of pollutant concentrations is found. Classification: 7,5.

The results of a field campaign carried out from early spring through to the late summer of 2000, in Bristol, England, are presented. Continuous measurements of over 40 hydrocarbons have been made at an urban background site, located at Bristol University, for approximately nine months using a Gas Chromatography - Flame Ionisation Detection (GC-FID) system and for a selection of halocarbons for approximately one month using a Gas Chromatography - Electron Capture Detection (GC-ECD) system. In this paper we present the time-series of the nine halocarbons and selected hydrocarbons. Daytime and night-time hydroxyl radical concentrations have been estimated based on the diurnal variations of a selection of the measured hydrocarbons. The average summer daytime concentration of OH was found to be 2.5 x 10^6 molecules cm\(^{-3}\) and the night-time concentration to be in the range 104 to 105 molecules cm\(^{-3}\). In addition, the role played by certain VOCs in the formation of ozone is assessed using the POCP (Photochemical Ozone Creation Potential) concept. 


A recently developed single-particle analytical technique, called low-Z electron probe X-ray microanalysis (low-Z EPMA), was applied to characterize urban aerosol particles collected in three cities of Korea (Seoul, CheongJu, and ChunCheon) on single days in the winter of 1999. In this study, it is clearly demonstrated that the low-Z EPMA technique can provide detailed and quantitative information on the chemical composition of particles in the urban atmosphere. The collected aerosol particles were analyzed and classified on the basis of their chemical species. Various types of particles were identified, such as soil-derived, carbonaceous, marine-originated, and anthropogenic particles. In the sample collected in Seoul, carbonaceous, aluminosilicates, silicon dioxide, and calcium carbonate aerosol particles were abundantly encountered. In the CheongJu and ChunCheon samples, carbonaceous, aluminosilicates, reacted sea salts, and ammonium sulfate aerosol particles were often seen. However, in the CheongJu sample, ammonium sulfate particles were the most abundant in the fine fraction. Also, calcium sulfate and nitrate particles were significantly observed. In the ChunCheon sample, organic particles were the most abundant in the fine fraction. Also, sodium nitrate particles were seen at high levels. The ChunCheon sample seemed to be strongly influenced by sea-salt aerosols originating from the Yellow Sea, which is located about 115 km away from the city.


Air temperature, vapour pressure and relative humidity differences at fixed hours in urban, suburban and rural districts of Cairo area, Egypt, have been investigated using data for the 1995-2000 period. It has been found that, on the basis of the vapour pressure differences, the urban atmosphere is drier throughout the year except for the months of December, January, May and September. In the afternoon, the atmosphere
in the urban area is more humid throughout the year if compared to the suburban area and during the months from October to January in addition to May if compared to the rural area. On the basis of relative humidity, the urban atmosphere is always drier than its surroundings throughout the year, except in the afternoon when the urban-rural differences fluctuated between positive and negative. The urban atmosphere is always warmer than its surroundings throughout the year, except in November when there is a cool island. Relationships between heat island intensity and both vapour pressure and relative humidity differences reveal that local effects can be significant. 

Classification: 4.


The urban environment is characterized by an intense use of the available space, where the preservation of open green spaces is of special ecological importance. Because of dynamic urban development and high mapping costs, municipal authorities are interested in effective methods for mapping urban surface cover types that can be used for evaluating ecological conditions in urban structures and supporting updates of biotope mapping. Against this background, airborne hyperspectral remote sensing data of the DAIS 7915 instrument have been analyzed for their potential in automated area-wide differentiation of ecologically meaningful urban surface cover types for a study area in the city of Dresden, Germany. The small urban structures and the high spectral information content of the hyperspectral image data require the development of special methods capable of dealing with the resulting large number of mixed pixels. In this paper, a new approach is presented that combines advantages of classification with linear spectral unmixing. Since standard unmixing techniques are not suitable for an area-wide analysis of urban surfaces representing a large number of spectrally similar endmembers (EMs), the mathematical model, were extended and a new method for pixel-oriented EM selection was developed. This method reduces the number of possible EM combination for each pixel by introducing spectrally pure seedlings and a list of possible EM combinations into a neighborhood-oriented iterative unmixing procedure. The results and their comparison with standard spectral classification methods show that the new pixel-and context-based approach enables reasonable material-oriented differentiation of urban surfaces. 

Classification: 3.


In order to examine the impacts of both large-scale and small-scale climate changes (urban climate effect) on the development of plants, long-term observations of four spring phenophases from ten central European regions (Hamburg, Berlin, Cologne, Frankfurt, Munich, Prague, Vienna, Zurich, Basle and Chur) were analysed. The objective of this study was to identify and compare the differences in the starting dates of the pre-spring phenophases, the beginning of flowering of the snowdrop
(Galanthus nivalis) and forsythia (Forsythia sp.), and of the full-spring phenophases, the beginning of flowering of the sweet cherry (Prunus avium) and apple (Malus domestica), in urban and rural areas. The results indicate that, despite regional differences, in nearly all cases the species studied flower earlier in urbanised areas than in the corresponding rural areas. The forcing in urban areas was about 4 days for the pre-spring phenophases and about 2 days for the full-spring phenophases. The analysis of trends for the period from 1951 to 1995 showed tendencies towards an earlier flowering in all regions, but only 22% were significant at the 5% level. The trends for the period from 1980 to 1995 were much stronger for all regions and phases: the pre-spring phenophases on average became earlier by 13.9 days/decade in the urban areas and 15.3 days/decade in the rural areas, while the full-spring phenophases were 6.7 days earlier/decade in the urban areas and 9.1 days/decade earlier in the rural areas. Thus rural areas showed a higher trend towards an earlier flowering than did urban areas for the period from 1980 to 1995. However, these trends, especially for the pre-spring phenophases, turned out to be extremely variable. Classification: 7.

Rooney, G. G. (2001) 'Comparison of upwind land use and roughness length measured in the urban boundary layer', *Boundary-Layer Meteorology*, 100, 469-486

The results of wind measurements taken in two studies at an urban site in Birmingham (UK) are presented. Displacement heights and roughness lengths are calculated that compare well with previous measurements in the urban canopy. Dimensionless windshear and vertical-velocity standard deviation are also shown to obey Monin-Obukhov similarity theory. The mean roughness lengths measured at the highest measuring position (45 m) increase with the fraction of upwind urban cover calculated using a source-area model. Classification: 8.

Roosli, M., Braun-Fahlander, C., Kunzli, N., Oglesby, L., Theis, G., Camenzind, M., Mathys, P. and Staehelin, J. (2000) 'Spatial variability of different fractions of particulate matter within an urban environment and between urban and rural sites', *Journal of the Air & Waste Management Association*, 50, 1115-1124

The spatial variability of different fractions of particulate matter (PM) was investigated in the city of Basel, Switzerland, based on measurements performed throughout 1997 with a mobile monitoring station at six sites and permanently recorded measurements from a fixed site. Additionally, PM10 measurements from the following year, which were concurrently recorded at two urban and two rural sites, were compared. Generally, the spatial variability of PM4, PM10, and total suspended particulates (TSP) within this Swiss urban environment (area = 36 km²) was rather limited. With the exception of one site in a street canyon next to a traffic light, traffic density had only a weak tendency to increase the levels of PM. Mean PM10 concentration at six sites with different traffic densities was in the range of less than +/-10% of the mean urban PM10 level. However, comparing the mean PM levels on workdays to that on weekends indicated that the impact of human activities, including traffic, on ambient PM levels may be considerable. Differences in the daily PM10
concentrations between urban and more elevated rural sites were strongly influenced by the stability of the atmosphere. In summer, when no persistent surface inversions exist, differences between urban and rural sites were rather small. It can therefore be concluded that spatial variability of annual mean PM concentration between urban and rural sites in the Basel area may more likely be caused by varying altitude than by distance to the city center. *Classification: 5.*


Based on recent knowledge concerning the vertical structure of turbulence statistics within the roughness sublayer (i.e., the layer directly influenced by individual roughness elements) over urban surfaces the problem of urban-scale dispersion is studied. On this scale it is impossible to resolve each roughness element so that the rough character of the surface has to be taken into account by introducing a roughness sublayer, which is generally not present in dispersion models even when employed in urban environments. Two types of simulations are presented here: one, called 'urban', takes into account the roughness sublayer's turbulence structure, while the other, 'non-urban', does not. A brief overview is given on what changes are required for an 'urban' simulation as compared to a 'non-urban' or standard dispersion simulation. In particular, a parameterisation is proposed for the vertical profile of Reynolds stress within the roughness sublayer. Using a Lagrangian stochastic particle dispersion model 'urban' and 'non-urban' simulations are compared for a variety of boundary-layer states and different source configurations. It is found that neglecting the roughness sublayer results in the largest errors for low source heights and under conditions of mechanically dominated turbulence. This is of particular importance due to the fact that urban surfaces tend to increase the mechanical portion of turbulence and, in addition, low sources, such as traffic and domestic heating, are predominant in urban environments. On the basis of three tracer data sets from urban release experiments it is shown that, in general, the 'urban' simulation improves the model performance yielding smaller fractional bias at the same time as the normalised mean square error is reduced and the correlation to the observations is increased. This indicates that indeed the physical description of the dispersion process is better taken into account in the 'urban' simulation. For stable stratification the above statement does not hold true either due to other processes masking the roughness-sublayer influence in this regime or, alternatively, due to a failure of the similarity relations for the turbulence statistics under extremely stable stratification. *Classification: 5.*


In this publication first results of an urban tracer experiment are reported. This experiment was realized in the framework of the "Basel UrBan Boundary-Layer Experiment" (BUBBLE) in an area with abundant information on turbulence and flow conditions available. Release height was close to roof level and so was the height of the concentration samplers. The meteorological conditions during the experiments
were mainly convective, but due to the rough character of the underlying surface also
the mechanical turbulence was substantial.

The concentration distribution is found to be essentially Gaussian in the horizontal
plane and some commonly used methods to estimate the plume widths in applied
dispersion models are compared to the observations. From measurements at one site
downwind of the source it is found that for a near-roof level source, only an
insignificant vertical gradient in tracer concentration is present within a street canyon.
Using a Lagrangian Particle Dispersion Model the tracer experiments are simulated. It
is shown that the exact form of the parameterization for the flow and turbulence
structure within the urban roughness sublayer is of great importance for the simulation
results. Also the numerical simulation results underline the necessity (and difficulty)
to describe the vertical profile of the dissipation rate of turbulent kinetic energy close
to an urban surface. Classification: 8,5.

Journal of the Royal Meteorological Society, 126, 941-990

This paper provides a comprehensive, critical review of turbulence observations over
cities. More than fifty studies are analysed with their experimental conditions
summarized in an appendix. The main results are based on 14 high-quality
experiments which met criteria based on stringent experimental requirements. The
observations are presented as non-dimensional statistics to facilitate comparison
between urban studies and work conducted over other rough, inhomogeneous
surfaces. Wake production associated with bluff bodies, and the inhomogeneous
distribution of sources and sinks of scalars, result in a roughness sub-layer which for
the studies reviewed extends to about 2.5 to 3 times the height of the buildings. It is
shown that within this region the basis of several traditional micrometeorological
approaches to describe the turbulent exchange is in doubt. There are strong
similarities to flow over plant canopies, and many of the turbulence characteristics
can be interpreted in the framework of a plane mixing layer. Future field observations
should concentrate on the turbulent exchange near the top and within the urban
canopy as well as within the urban boundary layer. Classification: 8.

Missouri, land use impacts on thunderstorms', Journal of Applied
Meteorology, 42, 716-738

A storm-resolving version of the Regional Atmospheric Modeling System is executed
over St. Louis, Missouri, on 8 June 1999, along with sophisticated boundary
conditions, to simulate the urban atmosphere and its role in deep, moist convection. In
particular, surface-driven low-level convergence mechanisms are investigated.
Sensitivity experiments show that the urban heat island (UHI) plays the largest role in
initiating deep, moist convection downwind of the city. Surface convergence is
enhanced on the leeward side of the city. Increased momentum drag over the city
induces convergence on the windward side of the city, but this convergence is not
strong enough to initiate storms. The nonlinear interaction of urban momentum drag
and the UHI causes downwind convection to erupt later, because momentum drag
over the city regulates the strength of the UHI. In all simulations including a UHI, precipitation totals are enhanced downwind of St. Louis. Topography around St. Louis also affects storm development. There is a large sensitivity of simulated urban-enhanced convection to the details of the urban surface model. Classification: 4,6.


Measurements of the kinetic isotope effect (KIE) for the reactions of light n-alkanes as well as for several unsaturated hydrocarbons, including alkenes, dienes, benzene, and ethyne with OH-radicals are presented. All measured KIEs are positive; that is, molecules containing only C-12 react faster than the C-13 labeled molecules. However, the KIEs for n-alkanes are quite small; between one and four permil. They can be explained mainly by the mass dependence of the collision frequency between the n-alkanes and OH-radicals. KIEs for the reaction of alkenes with OH-radicals are considerably higher. They can be explained by a fractionation of 24.5 +/- 1.1 parts per thousand for the addition of an OH-radical to a double bond. Inverse dependence on number of carbon atoms and mass dependence of the collision frequencies explain our observations. For benzene the KIE is slightly higher; for ethyne it is somewhat lower than expected from this simple model. For the reaction of many light nonmethane hydrocarbons (NMHC), especially of unsaturated hydrocarbons, with OH-radicals the KIEs are sufficiently large to have significant impact on the isotopic composition of atmospheric NMHC. A small series of stable carbon isotope ratio measurements of atmospheric NMHC were made in the greater Toronto area. Traffic related NMHC emissions were also studied for their stable carbon isotope ratios. From these data it is possible to quantitatively determine the extent of photochemical processing due to OH-radical reactions that the individual NMHC has experienced. Thus such measurements allow quantitative evaluation of the extent of chemical processing the different NMHC have gone through. This also includes the possibility to differentiate between the impact of local sources and regional or large scale transport. It is shown that in combination with concentration measurements isotope ratio measurements are extremely valuable to study the complex interaction between chemical removal mechanisms, mixing, and dilution processes. Classification: 0.


The stable carbon isotope ratios of nonmethane hydrocarbons (NMHC) emitted by traffic related sources are presented. Six sets of samples were collected in the greater Toronto area at locations heavily impacted by engine exhaust, fuel losses and fuel evaporation. Furthermore, two series of measurements were made in a suburban area. The stable isotope ratios of alkanes and arenes in the emission studies are on average -27.7 +/- 1.7 parts per thousand (relative to Vienna PeeDee belemnite, VPDB), fully compatible with the average composition of crude oils. On average alkenes are
enriched by 2parts per thousand in C-13 relative to alkanes and arenes. The differences between measurements at locations impacted predominantly by specific source types, e.g. tailpipe emissions, fuel evaporation, and losses, seldom are statistically significant and only occasionally exceed 2parts per thousand. Ethyne emitted from engine exhaust is enriched in C-13 by several tens of per mil relative to other NMHC studied. The ambient measurements at a suburban location in the greater Toronto area showed that the ambient stable carbon isotope ratios are close to the source composition, but not completely identical. On average ambient NMHC are enriched in 13 C relative to the average of the sources by a few per mil. Furthermore, for most NMHC the ambient measurements exhibit a higher overall variability than the source compositions. The small, but nevertheless often significant differences between source composition and ambient observations can be explained by the isotope fractionation associated with the reaction of NMHC with OH-radicals; the most important atmospheric loss process for NMHC. Overall the results demonstrate that for the metropolitan region the variability of the stable carbon isotope ratios of NMHC emitted from traffic related sources is small. (C) 2002 Elsevier Science Ltd.


Simultaneous continuous measurements of PM2.5, PM10, black carbon mass (BCae), Black smoke (BS) and particle number density (N) were conducted in the close vicinity of a high traffic road around Paris during a three-month period beginning in August 1997. In parallel some aerosol collection was performed on filters in order to assess the black carbon (BC), organic carbon (OC) and water soluble organic fractions (WSOC) of the freshly emitted traffic aerosols. The high hourly concentrations of PM2.5 (39 +/- 20 mug m(-3)), BCae (14 +/- 7 mug m(-3)), and N (220,000 +/- 115,000 cm(-3)), were found to be well correlated with each other. On average PM2.5 represented 66 +/- 13% of PM10 and appears to be composed primarily of BC (43 +/- 20%). On the contrary no correlation was found between PM2.5 and the coarse (PM10-PM2.5) mass fractions which was attributed to resuspension processes by vehicles. Black carbon mass concentrations obtained from both filter analyses (BC) and Aethalometre data (BCae) show a good agreement suggesting that the Aethalometre calibration based on a black carbon specific attenuation coefficient (sigma) of 19 m(2) g(-1) is well adapted to nearby roadside measurements. Daily BC (used as a surrogate for fine particles) concentrations and wind speed were found to be anti-correlated. Average daily variations of BC could be related to traffic intensity and regime as well as to the boundary layer height. As expected for freshly emitted traffic aerosols, filter analyses indicated a high BC/TC ratio (29 +/- 5%) and a low mean WSOC/OC ratio (12.5 +/- 5%) for the bulk aerosol. For these two ratios no day/night differences were observed, the sampling station being probably too close to traffic to evidence photochemical modification of the aerosol phase. Finally, a linear relationship was found between BC and BS hourly concentrations (BC = 0.10 x BS + 1.18; r(2) = 0.93) which offers interesting perspectives to retrieve BC concentrations from existing BS archives. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 5.

Temporal aspects of the urban heat island (UHI) of Vancouver, British Columbia, are demonstrated using differences of screen-level air temperature observed at an urban (downtown) and rural (farmland) site for three years. On an annual basis, the UHI is at its maximum near the middle of the night and its minimum is in mid-afternoon. Growth of the nocturnal UHI is driven by rural cooling rates in the early evening, which are much greater than the almost constant rates in the city. Growth starts earlier in winter. The largest UHI occurs in the fall, and the smallest in the spring. In daytime there is often a "cool island," especially in summer. There is an approximately inverse square root control of the UHI by wind speed and the effect of cloud type and amount follows the Bolt relation. Combining the two gives a "weather factor" that is linearly related to maximum UHI magnitude. Seasonal variation of the UHI is shown to be inversely related to the thermal admittance of the rural site, which itself is controlled largely by soil moisture status. This is done by calculating a "potential" UHI that is free of weather effects; a value that approximately conforms to that predicted by the SHIM numerical model. Surface wetting caused by recent rain, fog, or melting snow also is found to reduce UHI magnitude. While not quantified, marine advective effects appear to modify the UHI, especially the summer daytime cool island. *Classification: 3.1.*


The ratio of organic-mass-to-organic-carbon, typically taken to be between 1.4 and 1.7, has an uncertainty higher than 50%, but this value is used in every measurement to date of the organic fraction of atmospheric particles. A recently developed technique with errors reduced to between 9% and 33% provides measurements of this ratio that show its large variability for samples measured in northeastern Asia and the Caribbean. The technique uses functional groups measured by FTIR spectroscopy to estimate composite organic carbon from the number of carbon bonds present and organic mass from the molecular mass of each functional group associated with the measured bond type. The molecular masses associated with each functional group are not unique and do not account for highly branched organic compositions. For the organic mixtures described by the less than 20% of atmospheric organic mass that has been speciated by GCMS, the theoretical discrepancy in the composite organic-mass-to-organic-carbon ratio is less than 5%. The measured ratios for submicron particle samples are skewed: over 90% of the measurements collected lie between 1.2 and 1.6, with mean values just below 1.4. This variability highlights the importance of measured organic-mass-to-organic-carbon ratios to reduce the uncertainty associated with atmospheric organic aerosol. *Classification: 0.*

Eilat is a hyper-arid city, located at the northern end of the Gulf of Eilat. The summer weather conditions over the region are highly persistent, with offshore northerly winds of 5 to 7 m s\(^{-1}\) and a daily maximum temperature of 39 to 40 degrees C. The relatively cool (-26 degrees C) sea surface temperature (SST) to the south suggests that a southerly sea breeze would exist in spite of the opposing prevailing northerly winds and the small scale of the sea (10 to 20 km width). A 6 yr study (1994 to 1999) indicates that the sea breeze develops in only 25% of the days in July and August. The breeze typically lasts for about 4 to 6 h, with wind speeds of only 1 to 3 m s\(^{-1}\). A synoptic analysis indicates that the prevailing pattern, the Persian Trough, exists on 99% of the days, but on the 'breeze' days the synoptic-scale suppressive pressure gradient was 38% weaker. In 4 cases for which the synoptic scale gradient was negligible, the speed of the sea breeze reached 6 to 7.2 m s\(^{-1}\), indicating the effectiveness of the Gulf of Eilat as a source of sea breeze. A seasonal decrease of 49% found in breeze occurrence between July and August is explained by both a seasonal increase in the pressure gradient and a decrease in solar radiation. The daily maximum temperature on the 'breeze' days was 1.2 degrees C lower and the minimum relative humidity was 4% higher, whereas the heat stress regime did not differ significantly. An increase in the wet bulb temperature that was found at the same time implies that the efficiency of evaporative cooling devices is reduced when sea breeze exists. Our study suggests that in coastal areas subjected to hot and dry conditions, where the prevailing synoptic winds oppose the sea breeze, the effectiveness of the sea breeze depends strongly on the inter-diurnal variations of the synoptic pressure gradient. 

Classification: 8.


In this review article, recent understandings of the urban atmosphere are briefly presented, focusing on NO, (NO and NO\(_2\)), NO\(_3\) and HO\(_x\) (OH and HO\(_2\)), which are the key species for photochemical ozone production in the urban air. For NO\(_x\) chemistry, relationship between NO\(_x\) and HO\(_x\), and photostationary state (PSS) of the conversion between NO and NO\(_2\) are introduced with examples of recent research. Chemistry of nitrate radicals in the nighttime is also introduced. In addition, recent and representative techniques for the measurements of reactive nitrogen species in the troposphere are presented. As for HO\(_x\) radicals, important formation and loss processes and measurement methods developed recently are introduced. Recent campaign-based observations of HO\(_x\) radicals in the troposphere are also presented. (C) 2003 Japanese Photochemistry Association. Published by Elsevier Science B.V. All rights reserved. 

Classification: 5.


The pollutant dispersion in a two-dimensional street canyon is studied in this project. The principal parameter investigated is the height of the downstream building. The
pollutant source is situated in the middle of the street. The investigation is performed in two ways. Experiments have been carried out in the L-2B wind tunnel at von Karman Institute and numerical simulations have been done with the CFD software Fluent 5.2. The concentration measurements have been performed by means of light scattering technique and the velocity field has been measured with particle image velocimetry. In the numerical simulations, a preliminary study about the backward-facing step has been performed in order to select the best turbulence model in Fluent for these complex flows characterized by separation, stagnation, recirculation, reattachment, etc. The best model appeared to be the realizable k-epsilon model with the two-layer zonal approach to the wall, which predicts the reattachment length after the step with <1% error in comparison with the value obtained from direct numerical simulation by Le, Moin and Kim (Direct numerical simulation of turbulent flow over a backward-facing step, Report No. TF-58, 1996). This model has been applied in the street canyon simulations. Comparison with the experimental results has been made. Besides the height of the downstream building, the influence of a third building situated upstream of the street canyon in the flow and dispersion inside the street has been investigated. (C) 2002 Elsevier Science Ltd. All rights reserved. 


A generalized approach for estimating season-specific diurnal profiles of anthropogenic heating for cities is presented. Each profile consists of heat released from three components: building sector, transportation sector, and metabolism. In turn, the building sector is divided into heat released from electricity consumption and heat released from heating fuels such as natural gas and fuel oil. Each component is developed separately based on a population density formulation. The profiles are based on commonly available data resources that are mapped onto the diurnal cycle using seasonal profile functions. Representative winter and summer weekday profiles are developed and presented for six large US cities. The diurnal profiles have morning and evening peaks, with summertime maxima up to 60 W m-2. Anthropogenic heating in winter is generally larger, with maxima up to 75 W m-2. While these analyses were carried out at the city-scale the paper discusses how the same data sources could be applied at scales down to the individual census tract (or traffic analysis zone), resulting in high spatial resolution profiles and larger maxima corresponding to higher population densities in the urban core. Based on our analysis of San Francisco we find that the urban core region may have a daytime population density that is 5–10 times that of the city-scale value. Hence, the corresponding anthropogenic heating values in the urban core will be 5–10 times the magnitudes of the city-scale values presented in this paper. 

A fundamental experiment was conducted to approximately demonstrate the subscale thermal plume over constructions in the urban surface layer. Furthermore, a new subscale modeling for the urban surface layer was proposed. The feasibility of the proposed model was discussed by comparing the two-dimensional numerical simulation results with the experimental one. The present study clarifies, for the first time, subscale thermal plumes with many tiny vortices produced over a simplified model of urban structures. These vortices occur in the thermally stable stratified air layer and strongly promote the ambient temperature rise. The numerical simulation showed a significant temperature increase of more than 5 degreesC in the region over the urban structures. Information and results collected from this research can be used for future practical applications in planning, redevelopment, and restructuring of urban cities. (C) 2003 Elsevier Inc. All rights reserved. Classification: 3.


In this study, we measured the lead isotope ratios as well as trace metal concentrations (As, Cd, Cr, Ni, Pb and Zn) in the airborne particles collected at the Tokyo metropolitan area, where 9 municipal solid waste (MSW) incinerators locate nearby. Relationship between the concentrations of lead and other trace metals was investigated using data obtained both at the study site and at the 16 monitoring stations of the National Air Surveillance Network (NASN) of Japan sited mainly in urban areas. The results showed that lead isotope ratios were almost constant at the study site. The lead isotope ratios were very close to those for 7 cities throughout the whole country and also the fly ashes from MSW incinerators. This means that MSW incineration can account for the major portion of the lead in most Japanese urban atmosphere. The results also suggested that there are no significant differences in the concentration ratios of Cd, Zn and As to Pb in the airborne particles emitted from MSW incinerators across the country. Based on these results, the contributions from MSW incineration to the atmospheric metal concentrations were estimated to be 94% for Cd, 78% for Zn and 71% for As. Classification: 5.


In order to overcome the lack of the surface micrometeorological data required for air quality studies in the Mexico City Metropolitan Area (MCMA), a long-term micrometeorological campaign was carried out in this area along the 2001-Year. Three micrometeorological surface stations were installed at sites located at north, north-east, and south sectors of the MCMA. Each station was equipped with a 3D ultrasonic turbulence sensor and with conventional meteorological sensors for temperature, relative humidity, pressure, global radiation, net radiation, and rain. The sampling rates were 10 Hz for the ultrasonic sensor, and 1 Hz for the conventional sensors. One-hour averages were calculated for the meteorological parameters and for the turbulence parameters such as friction velocity, scale temperature, Monin-
Obukhov length, sensible heat flux and turbulent kinetic energy, among others. A simple micrometeorological database was prepared and mounted on a free access Internet page to furnish a specialized tool to the local Authorities to be utilized in health prevention and pollution regulation applications. *Classification: 8.*


A least squares variational approach is suggested to estimate the atmospheric mixed layer depth (or mixing height) under convective conditions from the vertical profile of virtual potential temperature. This method was implemented as a software application that could be a very useful tool to estimate the mixing height parameter required in air pollution modeling studies. The software was used to estimate Mexico City mixing heights from the atmospheric sounding data between January to May of 1993 and 1994, and the monthly statistics evolution of the 11:00z and 23:00z mixing height values is presented for this period. The estimations produced by this method for the afternoon mixing height were found in a good agreement with the daily maximum value calculated with the dry adiabatic temperature method. (C) 2003 Elsevier Ltd. All rights reserved. *Classification: 8.*


As part of an international research project, aerosol samples were collected by several filter-based devices on Nuclepore polycarbonate membrane, Teflon membrane and quartz fibre filters over separate daylight periods and nights, and on-line aerosol measurements were performed by TEOM and aethalometer within an urban canyon (kerbside) and at a near-city background site in Budapest, Hungary from 23 April–5 May 2002. Aerosol masses in PM2.0, PM10–2.0, PM2.5, PM10 size fractions and of TSP were determined gravimetrically; atmospheric concentrations of organic (OC) and elemental carbon (EC) for PM2.5 (or PM2.0), PM10 fractions and for TSP were measured by thermal–optical transmission method. Repeatability of the mass determination by Nuclepore filters seems to be 5–6%. Collections on Teflon filters yielded smaller mass on average by 8(±12)% than that for the Nuclepore filters. Quartz filters overestimated the PM10 mass in comparison with the Nuclepore filters due primarily to sampling artefacts on average by 10(±16)% at the kerbside. Tandem filter set-ups were utilised for correcting the sampling artefacts for OC by subtraction method. At the kerbside, the aerosol mass was made up on average of 35(±4)% of organic matter (OM) in the PM10 fraction, while the contribution of OM to the PM2.5 mass was 43(±9)% At the background, OM also accounted for 43(±13)% of the PM2.0 mass. On average, EC made up 14(±6)%, 7(±2)% and 4.5(±1.1)% of the mass in the PM2.5, PM10 fractions and TSP, respectively, at the kerbside; while its contribution was only 2.1(±0.5)% in the PM2.0 fraction in the near-city background. Temporal variability for PM mass, OC and EC concentrations was related to road traffic, local meteorology and long-range transport of air masses. It was concluded that a direct coupling between the atmospheric concentration levels and vehicle...
circulation can be identified within the urban canyon, nevertheless, the local meteorology in particular and long-range transport of air masses have much more influence on the air quality than changes in the source intensity of road traffic. Concentration ratios of OC/EC were evaluated, and the amount of secondary organic aerosol (SOA) was estimated by using EC as tracer for the primary OC emissions. Mean contribution and standard deviation of the SOA to the OM in the PM2.5 size fraction at the kerbside over daylight periods and nights were of 37(±18) and 46(±16)%, respectively. Classification: 5.


Classification: 3,2.


Observational analyses and numerical simulations were carried out to study the characteristics of the winter urban boundary layer of a large city. The observations showed that with light winds the ground inversion at nighttime in urban areas was about 200 m deep. The heat island circulation, caused mainly by anthropogenic heating, induced reverse flow at the downwind part of the city. A shallow internal boundary layer with a depth of 50-80 m developed from the fringe of the city. In the daytime heavy smoke attenuated the solar radiation, and caused a cold island in the urban area, and retarded the development of a convective boundary layer. The features described above were well simulated by the numerical model. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 8.


Climatic measurements from almost 30 urban and suburban stations as well as specific measurements performed in 10 urban canyons in Athens, Greece, have been used to assess the impact of the urban climate on the energy consumption of buildings. It is found that for the city of Athens, where the mean heat island intensity exceeds 10 degreesC, the cooling load of urban buildings may be doubled, the peak electricity load for cooling purposes may be tripled especially for higher set point temperatures, while the minimum COP value of air conditioners may be decreased up to 25% because of the higher ambient temperatures. During the winter period, the heating load of centrally located urban buildings is found to be reduced up to 30%. Regarding the potential of natural ventilation techniques when applied to buildings located in urban canyons, it is found that, mainly during the day, this is seriously reduced because of the important decrease of the wind speed inside the canyon. Air
now reduction may be up to 10 times the flow that corresponds to undisturbed ambient wind conditions. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 1,2.


Continuous measurements of particle number (PN), particle mass (PM10), and gaseous pollutants [carbon monoxide (CO), nitric oxide (NO), oxides of nitrogen (NOx), and ozone (O-3)] were performed at five urban sites in the Los Angeles Basin to support the University of Southern California Children's Health Study in 2002. The degree of correlation between hourly PN and concentrations of CO, NO, and nitrogen dioxide (NO2) at each site over the entire year was generally low to moderate (r values in the range of 0.1-0.5), with a few notable exceptions. In general, associations between PN and O-3 were either negative or insignificant. Similar analyses of seasonal data resulted in levels of correlation with large variation, ranging from 0.0 to 0.94 depending on site and season. Summertime data showed a generally higher correlation between the 24-hr average PN concentrations and CO, NO, and NO2 than corresponding hourly concentrations. Hourly correlations between PN and both CO and NO were strengthened during morning rush-hour periods, indicating a common vehicular source. Comparing hourly particle number concentrations between sites also showed low to moderate spatial correlations, with most correlation coefficients below 0.4. Given the low to moderate associations found in this study, gaseous co-pollutants should not be used as surrogates to assess human exposure to airborne particle number concentrations. Classification: 5.


The mixing ratios of surface O-3 were measured at St. John's College, Agra, an urban and traffic influenced area for the period of 2000-2002. The monthly averaged O-3 mixing ratios ranged between 8 to 40 ppb with an annual average of 21 ppb. Strong diurnal and seasonal variations in O-3 mixing ratios were observed throughout the year except for monsoon season. The mixing ratios of O-3 follow the surface temperature cycle and solar radiation (r = 0.72 and r = 0.65 with temperature and solar radiation, respectively). Concentrations were higher with winds associated with NE and NW direction indicating the impact of pollution sources on surface O-3 concentration. Exceedance of ozone critical level was calculated using the AOT 40 index and found to be 840 ppb.h and 2430 ppb.h for summer and winter seasons, respectively. The present O-3 exposures are lower than the critical level of O-3 and suggest that the present level of O-3 does not have any impact on reduction in crop yields. Classification: 5.

A two-dimensional nonlinear model with physical parameterizations was applied to simulate the observed diurnal variation on the 5-km-wide flat tropical island of Nauru in the trade wind zone. Both the model and Atmospheric Radiation Measurement (ARM) campaign aircraft observations indicate vigorous mixing in the typical sunny daytime conditions, leading to a warm plume downstream of the island. The model's afternoon wind field displayed rising motion downstream and downwash ahead of the island with gravity wave structure, in accordance with linear models of steady flow over a heated island. The roughness difference between sea and land added local rising motion above the windward coast and sinking motion above the lee. Without large-scale wind $U$, a weakish sea-breeze (SB) pattern develops during the day in this model over the 5- km-wide island/peninsula. This pure SB circulation intensifies with increasing island width up to 40 km. When large-scale wind is present, the morning leeside SB cell is advected out to sea and disappears while the windward coast SB cell tilts over the island and is transformed into the steady heat island - type perturbation during the day. During the night, a reversed heat island - type weak and shallow perturbation develops for nonzero $U$. For $U = 0$, the sea breeze dies in the evening and no land breeze appears. If a 200-m-high central mountain is added to a 20-km-wide island/peninsula in calm daytime conditions, the SB circulation is enhanced by upslope winds followed by weak katabatic flow down the cool slopes during the night. When any large-scale flow is present, the forced flow up and down the slopes appears to dominate the wind perturbation patterns day and night. *Classification: 3,1.*


This paper is concerned with a preliminary experimental investigation of the interaction between large turbulent structures, generated in the wake of a circular cylinder, and the rough-wall turbulent boundary layer separated flow immediately downstream of a simple street canyon type geometry represented by backward-facing step. The motivation for the work was to provide some initial data for the validation of a 3-D k-epsilon turbulence model used for the prediction of flows and pollutant dispersion within the urban canopy. The aim has been to assess the extent of the perturbation of a simulated street canyon caused by regular large-scale eddies generated upstream. The research has involved the use of thermal anemometry to determine mean velocity and turbulence characteristics both upstream and downstream of the step, together with the mean reattachment length for the recirculating flow. The results indicate that the presence of the cylinder in the flow reduces the reattachment length. In addition, the periodic structures generated in the cylinder wake are rapidly mixed with the turbulence in the step shear layer such that no periodicity is detected at the reattachment zone. *Classification: 8.*

This paper summarizes results from a series of wind-tunnel experiments on the flow and dispersion behaviour at an idealized intersection of four long street canyons, formed by a group of four rectangular buildings. Flow visualization was used to explore the range of possible flow and dispersion patterns associated with various plan arrangements of the four buildings, and tracer dispersion experiments were then conducted for selected cases to measure dispersion quantitatively. It was found that flow and dispersion patterns can be very sensitive to small changes in the arrangement of the buildings and the incident wind direction, theta. They are also strongly influenced by differences in the heights of individual buildings and the presence of other nearby intersections. The complete set of experimental data is available on request. Classification: 8,5.


A wind tunnel study was performed to determine the dispersion characteristics of vehicle exhaust gases within the urban canopy layer. The results were compared with those from a field monitoring station located in a street canyon with heavy traffic load. The agreement found was fair. In the second part of the paper it is shown how wind tunnel data can be utilized to supplement and thereby enhance the value of field data for model validation purposes. Uncertainty ranges were quantified which are inherent to mean concentration values measured in urban streets. Classification: 5,8.


The diurnal and annual variation of distances for different odour thresholds is investigated by the dynamic Austrian odour dispersion model (AODM) consisting of an emission module, a dispersion module, and a module to calculate instantaneous odour concentrations. The effect of daily variations in odour production, ventilation rates and indoor air temperature are included in impact assessments. The ambient half-hour odour concentrations calculated by a regulatory Gaussian plume model are transformed to instantaneous values representative for the duration of a single breath by an attenuation function decreasing the peak-to-mean ratio with increasing wind velocity, stability, and distance from the source. The resultant distances for different odour thresholds and their dependence on meteorological parameters are investigated and discussed in detail, focussing on the distance for the detection limit, 1 OU m(-3), the so-called sensation distance. The results suggest a stronger dependence of the sensation distance upon variation in meteorological conditions than diurnal and annual variations in odour emission rates. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 5.
Odour emission of livestock buildings is major burden for ambient residential areas. Using a dispersion model to calculate ambient odour concentrations, the separation distance between livestock buildings and residential areas was defined by a pre-selected odour threshold and an exceeding probability. The dynamic Austrian odour dispersion model (AODM) was used to calculate the separation distance for several combinations of these two values, which represent the protection level of various land use categories. The AODM consists of three modules: (1) odour release on the basis of a simulation model for the indoor climate of livestock buildings; (2) a regulatory dispersion model (Gauss) to calculate hourly or half-hourly ambient odour concentrations; and (3) a fluctuation module, calculating the instantaneous odour concentration, depending on wind velocity and stability of the atmosphere. The calculated separation distances for a pig fattening unit of 1000 heads were compared with empirical guidelines used in some countries (Austria, Germany, Switzerland, The Netherlands, USA). For most guidelines, the separation distances were smaller compared to the model calculation, except for the German guideline applied for non-agricultural areas, Odour sensation occurred predominantly around sunset, with neutral or slightly stable atmospheric stability. The presented AODM is a useful tool for regulatory purpose. (C) 2001 Elsevier Science B.V. AR rights reserved. Classification: 5.

Using a dispersion model to calculate ambient odour concentrations, the separation distance between livestock buildings and residential areas is defined by the odour impact criteria incorporating the probability of exceeding a pre-selected odour threshold in odour units (OU) per cubic metre. The dynamic Austrian odour dispersion model (AODM), a Gaussian model, is used to calculate the direction-dependent separation distances for several combinations of these two values, which represent the protection level of various land use categories. The calculated direction-dependent separation distances are a function of the prevailing wind velocity and atmospheric stability conditions. At a site in the Austrian North-alpine foreland, the direction-dependent separation distance for a 1000-head pig unit (calculated on the basis of a 2-year time series of meteorological data) for pure residential areas (3% probability of threshold exceedance over the year for an odour threshold of 1 OU m⁻³) lies between 99 m (for northerly winds with a probability of less than 3% per year) and 362 m (for westerly winds with a probability of 34%). For the main wind directions, West and East, odour sensation can be expected more often for higher wind velocities and a neutral or stable atmosphere around sunset. North and South winds show the typical diurnal variation of a local valley wind system with predominantly northerly daytime up-valley and southerly nighttime down-valley winds. Odour sensation is therefore most likely around noon for North winds and...

A method was developed to produce hourly updated nowcasts of recommended sun protection factors (SPF) for different photobiological skin types. Actual UV (250-400 nm) measurements and a forecast of the UV index provide the basis of the method. The method, used operationally for the urban area of Vienna, provides a useful tool to inform people about the use of sunscreens, thereby lowering the risk of health damage from overexposure to solar ultraviolet radiation. The validation of the nowcast shows that deviations from the measured daily dose depend on the time of the nowcast. Forecasts made 2 h before solar noon produce deviations of the daily dose of less than +/-0.5 SPF (for skin type I) in 68% of all cases; forecasts made two or more hours after noon were, in every case, within +/-0.5 SPF of the observed value.


This study presents results of sensitivity calculations with the adjoint of the continental-scale Eulerian chemistry transport model CHIMERE. In the framework of the Atmospheric Pollution Over the Paris Area (ESQUIF) project, which was designed to improve the understanding of photochemical pollution events in the Paris region, a large number of aircraft and surface observations was performed in order to study the chemical composition around the agglomeration. Here the adjoint CHIMERE model is used to calculate sensitivities of ozone concentrations, in particular of air masses entering the Paris region, with respect to emissions on the continental scale. For 13 case studies the influence of ozone precursors, differentiated with respect to their source type, their geographical origin, and their time of emission, is quantified with the aim of facilitating the interpretation of the observations and to demonstrate the usefulness of adjoint models for such types of studies. It is shown that for all cases the regional peak ozone concentrations are more sensitive to emissions of NOx than to emissions of volatile organic compounds (VOCs). However, the influence of VOCs is extended over a longer time span than for NOx, which is reflected in the more distant source regions of highly influential VOC emissions. On average the sensitivity to biogenic VOCs is significantly smaller than to anthropogenic VOCs. The same is true for NOx emissions. However, as different uncertainties have to be associated with these four emission groups, the uncertainty of the modeled ozone concentration caused by the groups is of the same order of magnitude.

Classification: 5.

The total of 28 different C-2-C-6 non-methane hydrocarbons including isoprene emitted from natural and anthropogenic sources in urban and rural sites of Kathmandu, capital of Nepal, were characterized for the first time in Nepal, in November 1998. Thirty-eight whole air samples were analyzed by using GC/FID. Ethene, acetylene and C-4-C-5 alkanes were identified as the source signature in Kathmandu urban ambient air. Hydrocarbon emissions from vehicular exhaust and gasoline evaporation sources were confirmed to outweigh natural gas and biogenic sources. Comparison of NMHCs profile normalized by acetylene between Kathmandu and Tokyo, Japan showed prominent difference in C-2-C-5 alkanes relative to acetylene. Significant amount of ethene at the rural site was assigned as emitted from biogenic sources because of its significant correlation with isoprene (R-2 = 0.52). Predominant amount of isoprene (average 278 pptv) observed at the urban site were assigned to be emitted from vehicular exhaust as it exhibited high correlation with other anthropogenically emitted hydrocarbons (R-2 = 0.72 with acetylene). Photochemical aging analysis showed that the mixing ratio variation of urban air transporting towards the rural site took place through its OH radical initiated oxidation and the observed alkanes in the rural site were mostly from the transported urban air. (C) 2000 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Shashua-Bar, L. and Hoffman, M. E. (2000) 'Vegetation as a climatic component in the design of an urban street - An empirical model for predicting the cooling effect of urban green areas with trees', *Energy and Buildings*, 31, 221-235

The cooling effect of small urban green wooded sites of various geometric configurations in summer is the object of this study. It was studied experimentally at 11 different wooded sites in the Tel-Aviv urban complex during the period July-August 1996. An empirical model is developed in this study for predicting the cooling effect inside the wooded sites. The model is based on the statistical analysis carried out on 714 experimental observations gathered each hour from the 11 sites on calm days, when urban climate is expressed. Two factors were found to explain over 70% of the air temperature variance inside the studied green site, namely, the partial shaded area under the tree canopy and the air temperature of the non-wooded surroundings adjoining the site. The specific cooling effect of the site due to its geometry and tree characteristics, besides the shading, was found to be relatively small, about 0.5 K, out of an average cooling of about 3 K at noon. The cooling effect of the green wooded areas on their immediate surroundings at noon was also analyzed. The findings corroborate earlier studies that the range is noticeable. At small green sites, the cooling effect estimated in this study is perceivable up to about 100 m in the streets branching out from the site. The empirical findings in this study permit development of tools for incorporating the climatic effects of green areas in the urban design. Some policy measures are proposed accordingly, for alleviating the "heat island" effect in the urban environment. (C) 2000 Published by Elsevier Science S.A. All rights reserved. *Classification: 7,2.*
An analytical model, the Green CTTC (cluster thermal time constant) model, for predicting diurnal air temperature inside an urban wooded site, is the object of this study. The proposed model is based on the same principles as the CTTC model, developed earlier by M.E. Hoffman and colleagues, with the addition of vegetation effects. It is shown that the tree thermal effect can be evaluated either as the shade effect partly offset by the convection component of the tree radiation balance or, equivalently, as the combined effect of evapotranspiration and the change in the plant heat storage. In this paper, the former approach is adopted. Simulations for testing the validity of the Green CTTC model were carried out on summer data of 11 small urban wooded sites in the Tel-Aviv metropolitan area near the Mediterranean sea coast. Results show a satisfactory fit, with average root-mean-square-error < 0.5 K for all studied sites and time intervals at 09:00, 15:00, and 18:00 h (summer time). The CTTC values and the convection parameters were estimated from the empirical data, using a novel procedure. The proposed model, which can be enlarged to encompass the cases of groves and lawns, is an appropriate tool for assessment of the climatic impact of trees and other greeneries on urban design alternatives. (C) 2002 Elsevier Science Ltd. All rights reserved.

As streets usually cover more than a quarter of the urban area, canyon street morphology plays an important role in creating the urban climate. It directly influences the air temperature, moisture and wind flow within the streets as well as the urban surrounding area and has been the topic in several urban climatology studies. Recently, studies based on the street cluster thermal time constant (CTTC) model have been carried out by the authors with a view to assessing the thermal effects of alternative architectural designs of the flanking buildings and inner courtyards. The effect of green spaces, especially that of shade trees which plays a significant role in solar radiation penetration, has not yet been considered. In the CTTC model, passive cooling of the street by solar heating attenuation is governed mainly by the street orientation and its geometry as measured by the aspect ratio of flanking buildings height to street width. The tree shading coverage largely offsets the contribution of these two factors. Moreover, significant thermal effects are provided by the tree canopy, in addition to the direct solar radiation. Accordingly, adjustments are called for in the currently used canyon street models. The present paper discusses the geometry and orientation aspects of the canyon street climate and how these aspects are affected and can be reconciled in the presence of shade trees. Some consequences of environmental design of urban spaces and their effects on outdoor thermal comfort are also considered. (C) 2003 Elsevier Science B.V. All rights reserved.

This paper presents a quantitative analysis for predicting the air temperature variations within urban clusters with trees. The clusters considered are streets and attached courtyards which together constitute a major part of the residential areas. In this study, the cooling effect of trees is quantified, using the analytical "Green CTTC model" developed recently by the authors. The results are validated by empirical estimates of measurements in situ. The empirical and analytical approaches provide corroborative estimates and conclusions. Sensitivity analysis on the thermal impact of certain major control factors for design purposes, such as cluster deepening, albedo modification, and orientation in the presence of shade trees were obtained by simulations using the analytical model. The results indicate that the combined simulated cooling effect of the above three factors is about 4.5 K, at midday in summer (July August) in the Mediterranean coastal region of Israel, a cooling which is about 50% of the air temperature rise from sunrise to noon hours. (C) 2003 Elsevier Ltd. All rights reserved. *Classification: 1,3,7.*


A quantitative analysis is presented for evaluating the diurnal thermal impact of proposed building arrangements on the urban canopy layer (UCL) air temperature, in summer in a hot-humid region. Building configuration along an urban street is quantitatively specified in this study by the building dimensions, by the spacing of the units and by the width of the street. The generic model described here is representative of the actual form of residential buildings found mostly along urban streets in Israel's cities. Sixty different building configurations were studied. The diurnal air temperature pattern in summer was calculated for each configuration using the analytical Green CTTC model, and compared with that of a nearby representative meteorological station at an open site. The results indicate significant thermal effects in the UCL due to the building form. The extent of the maximum impact is about 6.8 K at 1500h, namely ranging from 4.7 K above the value measured at the reference meteorological station (for shallow open spaces with wide spacing), to 2.1 K below this (for deep open spaces with narrow spacing). The statistical analysis of the results indicates the feasibility of assessing the expected maximum thermal effect of building designs of the generic form studied here, through a general linear relationship. This, thereby, provides a useful tool in judging the expected climatic impact of a proposed building design. Copyright (C) 2004 Royal Meteorological Society. *Classification: 3,2.*


Whilst limited information on particle size distributions and number concentrations in cities is available, very few data on the very smallest of particles, nanoparticles, have been recorded. Measurements in this study show that road traffic and stationary combustion sources generate a significant number of nanoparticles of diameter < 10 nm. Measurements at the roadside (4m from the kerb) and downwind from the traffic (more than 25m from the kerb) show that nanoparticles (<10nm diameter) accounted for more than 36-44% of the total particle number concentrations. Measurements designed to sample the plume of individual vehicles showed that both a diesel- and a petrol- fuelled vehicle generated nanoparticles (<10 nm diameter). The fraction of nanoparticles was even greater in a plume 350 m downwind of a stationary combustion source. On a few occasions, a temporal association between nanoparticles in the size range 3-7 nm and solar radiation was observed in urban background air at times when no other local sources were influential, which suggests that homogeneous nucleation can also be an important source of particles in the urban atmosphere. (C) 2001 Elsevier Science Ltd. All rights reserved. *Classification: 5.*


During measurement campaigns at an urban background and a rural site, simultaneous measurements of particle size distributions using a scanning mobility particle sizer (SMPS)/aerodynamic particle sizer (APS) combination and Fuchs surface using an epiphaniometer have been made. The epiphaniometer was calibrated using sub-100 nm monodisperse aerosol and it was found that a calibration based upon particle electrical mobility diameters measured with a SNIPS was consistent irrespective of the use of singlet particles of sodium chloride and ammonium sulphate or clusters of carbon. The field intercomparison of surface areas derived directly from the epiphaniometer and calculated from the size distributions determined by the SMPS/APS combination showed a good agreement of Fuchs surface estimates at both measurement sites. However, attempts to estimate a "geometric" surface area from the epiphaniometer data led to significant divergence from the estimates of the SMPS/APS combination when there was a significant fraction of coarser (> 700 nm) particles contributing to the aerosol surface area. (C) 2001 Elsevier Science Ltd. All rights reserved. *Classification: 0.*

Plasmid DNA assay is a newly-developed in vitro method to investigate bioreactivity of particles. In this paper, this method was used to study the bioreactivity of PM10 (particulate matter with aerodynamic diameter of less than 10 μm) and PM2.5 (particulate matter with aerodynamic diameter of less than 2.5 μm). Samples and dust storm particles were collected in 2001 in an urban area, a satellite city and a clean air area in Beijing. A big difference was found for oxidative DNA stress induced by different particulate matter (PM) samples, with the TM50 (particle mass causing 50% damage to DNA) values varying by a factor over 10. This was closely dependent on the sizes of particles as well as the variation in relative proportion of mineral matter. PM2.5 samples generally impose larger oxidative stress on plasmid DNA than PM10 samples. Airborne particles collected during dust storm episodes, usually with a higher proportion of mineral matter, have a much lower oxidative capacity than those collected during non-dust storm episodes. PM samples and their water-soluble fractions usually have similar bioreactivities, demonstrating that oxidative capacity of Beijing airborne particles is mainly sourced from their water-soluble fractions. Classification: 7.5.


The possibility of retrieval of urban aerosol physical properties from downwelling atmospheric infrared radiation spectra between 700 and 1400 cm(-1) with 0.24-cm(-1) spectral resolution, which can be obtained from the tropospheric infrared interferometric sounder developed by the Central Research Institute of Electric Power Industry, was estimated from error analysis of the least-squares fit method. The error analysis for retrieval of the aerosol extinction coefficient spectra in three atmospheric layers (boundary, free troposphere, and stratosphere) showed the retrievability only of the boundary layer.; Based on this result, we propose the retrieval for particle number density of each aerosol component, which is one of the parameters for the aerosol size distribution function, using the boundary aerosol extinction coefficient spectra. We assume that aerosols in urban areas consist of three types of component, namely, water soluble, soot, and dustlike. Under this assumption, we estimated the error of the retrieved volume density for each aerosol component. For the estimation we used the least-squares fit of Mie-generated spectral extinction coefficients. The estimated error shows that the Volume density of each aerosol component in an urban boundary layer is equivalent to the retrieval target. We also show that the aerosol properties can be retrieved with higher accuracy when the effects of multiple scattering by aerosols are included in the retrieval procedure. (C) 2001 Optical Society of America. Classification: 3.


Classification: 7.
Organic compounds containing a variety of functional groups have been analyzed using aerosol time-of-flight mass spectrometry. Both positive and negative laser desorption/ionization mass spectra have been acquired for compounds of relevance to ambient air particulate matter, including polycyclic aromatic hydrocarbons, heterocyclic analogues, aromatic oxygenated compounds such as phenols and acids, aliphatic dicarboxylic acids, and reduced nitrogen species such as amines. In many cases, positive ion mass spectra are similar to those found in libraries for 70-eV electron impact mass spectrometry. However, formation of even-electron molecular ions due to adduct formation also plays a major role in ion formation. Negative ion mass spectra suggest that organic compounds largely disintegrate into carbon cluster fragments (C-n(-) and CnH-). However, information about the heteroatoms present in organic molecules, especially nitrogen and oxygen, is carried dominantly by negative ion spectra, emphasizing the importance of simultaneous analysis of positive and negative ions in atmospheric samples. Classification: 0.

A high throughput thermal gravimetric method was developed to measure the carbonaceous aerosols and particulates collected on filters. Representative portions or the whole piece of a loaded or blank filter was sampled and conditioned at 105 +/− 5 degreesC for 4 h to drive away water moisture. The sample was then treated at 550 +/− 10 degreesC for 4 h. After each of the heat treatment steps, the sample was conditioned in a humidity and temperature-controlled cabinet for 12 h till constant weight. The weight of the filter before and after the heated treatment was measured and the weight difference between the treatment at 550 and 105 degreesC was calculated as the weight of the carbon containing substances (CCS). Reference chemical standards and certified reference materials SRM 1649a and 1650a were used to validate the method. CCS concentrations of real aerosol samples collected in the city of Hong Kong during the summer of 2001 were also measured, compared and correlated with the concentrations of total carbon (TC), elemental carbon (EC) and organic carbon (OC) of the samples determined using a thermal optical transmittance (TOT) method as specified in NIOSH method 5040. The weight of organic compounds in airborne particulate matters is usually estimated by multiplying the weight of TC. which is determined by thermal/thermal optical methods, by a factor of 1.2 or 1.4. To this end, a correction factor of approximately 1.6 was found to relate TC to the measured values of CCS in aerosol samples collected in the urban atmosphere of Hong Kong. The proposed procedure for measurement of CCS is simple, easy to follow and requires simple laboratory instrumentation. Typically, the analysis of more than 100 filter samples can be completed within three working days with minimal attention. (C) 2003 Elsevier B.V All rights reserved. Classification: 5.

This paper reports the monitoring results of eleven polycyclic aromatic hydrocarbons (PAHs), four to six-ring, at two urban sites-Central & Western (CW) and Tsuen Wan (TW) in Hong Kong from January to December 2000; and the findings of a study conducted in 2001 of the partitioning of the gaseous and particulate phases of PAHs. The sum of the eleven PAHs under study (SigmaPAHs) was found to range from 6.46 to 38.8 ng m\(^{-3}\). The annual mean levels at 12.2 ng m\(^{-3}\) and 15.8 ng m\(^{-3}\) for CW and TW respectively are comparable to those recorded for the previous two years and are also within the reported ranges for other metropolitan cities in the Asia Pacific region. Amongst the selected eleven PAHs, fluoranthene and pyrene were the two most abundant found in the urban atmosphere of Hong Kong during the study period accounting for approximately 80% of the total PAHs. The ratios of benzo(a) pyrene to benzo(g,h,i)perylene (BaP/BghiP) and indeno(1,2,3-cd)pyrene to benzo(g,h,i)perylene (IDP/BghiP) indicate that diesel and gasoline vehicular exhausts were the predominant local emission sources of PAHs. Seasonal variations with high winter to summer ratios for each of the individual PAHs (CW: 1.6-16.7 and TW: 0.82-8.2) and for SigmaPAHs (CW: 1.9 and TW: 1.8) and a spatial variation of BaP amongst the air monitoring stations are noted. Results of correlation studies illustrate that local meteorological conditions such as ambient temperature, solar radiation, wind speed and wind direction have significant impact on the concentrations of atmospheric PAHs accounting for the observed seasonal variations. A snapshot comparison of the concentrations of PAHs at four sites including a roadside site, a rural site and the two regular urban sites CW and TW was also performed using the profiles of PAHs recorded on two particulate episode days in March 2000. *Classification: 5.*


The concentrations of C-1-C-8 carbonyl compounds were measured at two urban sites in Hong Kong from October 1997 to September 2000. The daily total carbonyl concentrations were found to range from 2.4 to 37 mug m\(^{-3}\). Formaldehyde was the most abundant species, which comprised from 36 to 43% of the total detected carbonyls, followed by acetaldehyde (18-21%) and acetone (8-20%). The highest 24-hour average concentrations measured were 10 and 7.7 mug m\(^{-3}\) for formaldehyde and acetaldehyde, respectively. Seasonal and temporal variations in the concentrations of formaldehyde and acetaldehyde were not obvious, but lowest concentrations often occurred from June to August. The mean formaldehyde/acetaldehyde molar ratios at the two sites in summer (2.8 +/-1.1 and 2.5 +/-1.2) were significantly higher (p less than or equal to0.01) than those in winter periods (1.9 +/-0.6 and 2.0 +/-0.6). The phenomena were explained by influences of both photochemical reactions and local meteorological conditions. Better correlations between formaldehyde and acetaldehyde, and between NOx and each of the two major carbonyls were obtained in winter periods indicating direct vehicular emissions were the principal sources. The ambient formaldehyde and acetaldehyde concentrations in the urban atmosphere of
Hong Kong were within the normal ranges reported in the literature for other urban sites world-wide. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 5.


A project on monitoring urban CO2 budgets has been conducted since the year 2000 focusing on the Metropolitan area of Copenhagen, Denmark. Methodologically, the project combines remote sensing with CO2 fluxes measured by eddy covariance technique from the top of a 40-m mast located in the center of Copenhagen. These data are supplemented by flux measurements from a mobile system on a 10-m mast which is moved between different urban types, including a major entrance road, and residential and industrial areas. By comparing the time series of vertical CO2 exchange and the number of cars on the major entrance roads, it is demonstrated that the traffic intensity has a major impact on the urban carbon budget. The spatial distribution of the CO2 emission rates is examined through texture-based classification of Landsat-TM satellite images. Local traffic intensity and local heating is seen as a function of specific local urban land use and activities, and the corresponding satellite image texture is used as a proxy for the CO2 emission from these components. The urban scene is divided into urban land use classes that constitute homogenous areas in terms of main types of activity and these are linked to specific levels of CO2 emission. For this purpose, a multi-scale approach based on co-occurrence matrices has been developed and applied. The paper outlines how the CO2 exchange from the urban sources and sinks can be estimated from continuous flux measurements in central Copenhagen. It is shown that traffic is the largest single CO2 source in the city. The mobile measurements demonstrate that the emission rates ranges from less than 0.8 g CO2 m(-2) h(-1) in the residential areas up to a maximum of 16 g CO2 m(-2) h(-1) along the major entrance roads in the city center. An average annual CO2 exchange rate of 35 g CO2 m(-2) day(-1) is calculated by assigning fluxes to each land use type and excluding the effect of remote sources (power plants, air and sea traffic). This value can be compared to a carbon budget recently calculated from national statistics showing that the local urban sources (road traffic, industry, service and household) have a comparable net emission rate of 38 g CO2 m(-2) day(-1). The perspective of having more precise knowledge of the distribution of sources and sinks is finally discussed in relation to changing land use patterns. (C) 2003 Elsevier B.V. All rights reserved. Classification: 5.


The role of Secondary Biogenic Organic Aerosol in aerosol budget is examined using the Atmospheric Dispersion of Pollutants over Complex Terrain-Urban Airshed Model-Aerosols (ADREA-I/UAM-AERO) modeling system in two representative Mediterranean areas. The areas have been selected, because of their elevated biogenic emission levels and the sufficient degree of meteorological and land use diversity
characterizing the locations. Comparison of the model results with and without biogenic emissions reveals the significant role biogenic emissions play in modulating ozone and aerosol concentrations. Biogenic emissions are predicted to affect the concentrations of organic aerosol constituents through the reactions of terpenes with O-3, OH and NO3. The ozonolysis of terpenes is predicted to cause an increase in OH radical concentrations that ranges from 10% to 78% for Athens, and from 20% to 95% for Marseilles, depending on the location, compared to the predictions without biogenic emissions. The reactions of this extra hydroxyl radical with SO2 and NOx have as final products increased concentrations of sulfates and nitrates in the particulate phase. As a result, biogenic emissions are predicted to affect the concentrations not only of organic aerosols, but those of inorganic aerosols as well. Thus biogenic emissions should be taken into consideration when models for the prediction and enforcement of abatement strategies of atmospheric pollution are applied. Classification: 5,7.


The transport and dispersion of pollutants in a street canyon, and the intersection between two streets, have been studied using wind-tunnel experiments and numerical simulations. The study of the street canyon demonstrates the importance of the geometry of the canyon (aspect ratio, asymmetry) in determining both the topology of the flow and the concentration distribution; the flow is also very sensitive to wind direction. The study of the street intersection shows how the intersection influences the flow and dispersion in the adjoining streets. This work has been used to develop new and practical models for flow and dispersion in city streets; these models are compared here with the results from wind-tunnel experiments and numerical simulations. Classification: 5,8.


Whilst the measurement of radiation emissions from a surface is relatively straightforward, correct interpretation and proper utilization of the information requires that the surface area 'seen' be known accurately. This becomes non-trivial when the target is an urban surface, due to its complex three-dimensional form and the different thermal, radiative and moisture properties of its myriad surface facets. The geometric structure creates shade patterns in combination with the solar beam and obscures portions of the surface from the sensor, depending on where it is pointing and its field-of-view (FOV). A model to calculate these surface-sensor-sun relations (SUM) is described. SUM is tested against field and scale model observations, and theoretical calculations, and found to perform well. It can predict the surface area 'seen' by a sensor of known FOV pointing in any direction when placed at any point in space above a specified urban surface structure. Moreover, SUM can predict the view factors of the roof, wall and ground facets 'seen' and whether they are sunlit or shaded at any location and time of day. SUM can be used to determine the optimal placement
and orientation of remote sensors to study urban radiation emissions; if the facet
temperatures are known or modelled it can calculate the average temperature of the
system, and it can determine the directional variation of temperature (anisotropy) due
to any particular surface-sensor- sun geometric combination. The present surface
geometry used in SUM is relatively simple, but there is scope to make it increasingly
realistic. Classification: 3.

Souza, S. R. and Carvalho, L. R. F. (2001) 'Seasonality influence in the
distribution of formic and acetic acids in the urban atmosphere of Sao
Paulo City, Brazil', Journal of the Brazilian Chemical Society, 12, 755-762

Ambient levels and diurnal profiles of formic and acetic acids were measured in the
atmosphere of Sao Paulo City in winter and spring 1996. A comparison between two
different urban sites was done. Results demonstrate that carboxylic acid levels were
affected by seasonality in the site with high vehicular emission density, while no
seasonal influence was observed for the other site studied. Ranges of mixing ratios
from 0.64 to 11.8 ppbv for formic acid and 0.51 to 10.7 ppbv for acetic acid were
recorded. The results concerning the carboxylic acid concentrations were discussed
with respect to direct emission and in situ photochemical production. Classification: 5.

hydrogen peroxide concentrations in urban and mountain air in
southwestern Poland', Water Air and Soil Pollution, 155, 321-338

The concentrations of ambient gas-phase hydrogen peroxide were measured during
the summer of 1998, 1999 and 2000. The experiments were performed in the city of
Wroclaw and in the vicinity of Mount Szrenica, 1362 m a. s. l., Poland. Analysis was
carried out by the chemiluminescence method. Typical mean ranges of 30 min H2O2
concentrations measured were 1.4 - 6.0 mug m(-3) at Mount Szrenica, whereas in the
urban atmosphere H2O2 concentrations were in the range of 2.7 - 11.7 mug m(-3). In
the case of the urban atmosphere, H2O2 concentrations were well correlated only
with solar radiation and temperature. In the mountain air, H2O2 concentrations
increased along with the increase of temperature, O-3, CO and the decrease of
humidity. The diurnal variation was not only caused by photochemical processes.
Classification: 5.

modelling: The Sydney hails storm of 14 April 1999', Meteorology and
Atmospheric Physics, 87, 161-166

Classification: 6, 8.

suburban energy fluxes in Christchurch, New Zealand', International
Journal of Climatology, 22, 979-992
Knowledge of the surface energy balance is fundamental to understanding the boundary layer meteorology and climatology of urban areas. This study reports some of the first direct measurements of energy fluxes over the city of Christchurch, New Zealand, during both summer and winter. Observations of the surface energy balance were made over two mainly residential suburbs: St Albans and Beckenham. Net all-wave radiation $Q^*$ was measured with a net radiometer, the eddy covariance approach was used to measure the turbulent heat fluxes (sensible heat $Q(H)$, and latent heat $Q(E)$), and the heat storage flux $\Delta Q(s)$ was estimated as the energy balance residual. During the predominant northeasterlies and unstable conditions in summer, the fetch at St Albans includes a commercial warehouse as well as residential areas. In summer, on a daily basis, $Q(H)$ is the dominant heat sink followed by $\Delta Q(s)$ and $Q(E)$. However, during daytime $\Delta Q(s)$ can be considerable and may approach the magnitude of $Q(H)$. Evaporation is low because the turbulent flux source areas are mainly centred over the commercial warehouse and yard, which have little greenspace. In winter the flux source areas are mainly residential for both sites, and the small daily surplus of $Q^*$ is partitioned mostly into $\Delta Q(s)$, with some $Q(E)$ and a small $Q(H)$ that may be directed either towards or away from the surface depending largely on the synoptic conditions. Under strong inversion conditions, which occur frequently in Christchurch during winter, the turbulent heat fluxes are very small and $Q(H)$ may be directed towards the surface for many hours overnight and early in the morning. During foehn events the energy partitioning is significantly altered, particularly in winter. Net radiation may be substantially decreased, evaporation is usually markedly increased and in winter $Q(H)$ may be directed towards the surface for much of the event. The results highlight the importance of seasonal and synoptic controls in energy partitioning at this location, although difficulties with fetch complicate the analysis. Copyright (C) 2002 Royal Meteorological Society. Classification: 3.


The surface energy balance in an irrigated urban park in suburban Sacramento, CA is observed. Three sites extend from the edge of the park to its centre, along a transect which is aligned with the prevailing wind. Direct measurements of the fluxes of net radiation, soil heat flux and evaporation are made at each site and the convective sensible heat is found by residual. Strong advective effects on evaporation are observed, especially in the afternoon and evening. The driving forces for this are the differences in surface and air temperature, and humidity, between the cool, wet park and its warmer, drier built-up surroundings. The control of the surroundings on park evaporation is demonstrated by comparing values with those from synchronous observations in the surrounding suburbs and at an irrigated sod farm just outside the city. Greatest evaporative enhancement is observed at the upwind edge. Throughout the afternoon evaporation considerably exceeds the net radiation. This is interpreted to be due to the microscale leading-edge effect which appears to be restricted to a fetch of about 20 m. Further into the park evaporation also exceeds the net radiation in the afternoon due to the oasis effect. At all sites the sensible heat flux density in the afternoon is negative. Daily and daytime total evaporation from the park is more than
300% that from the integrated suburban area, and more than 130% that from the irrigated rural grass site. The unlimited water supply and the high temperatures of the park allow it to behave like a wet leaf in that its surface temperature seems to be 'thermostatically' controlled—it never rises more than a few degrees above that of the park air and for much of the day is cooler than the park air. Copyright (C) 2000 Royal Meteorological Society. Classification: 3,7.


During the Pittsburgh Air Quality Study (PAQS) aerosol size distributions between 3 nm and 680 nm were measured between July 2001 and June 2002. These distributions have been analyzed to assess the importance of nucleation as a source of ultrafine particles in Pittsburgh and the surrounding areas. The analysis shows nucleation on 50% of the study days and regional-scale formation of ultrafine particles on 30% of the days. Nucleation occurred during all seasons, but it was most frequent in fall and spring and least frequent in winter. Regional nucleation was most common on sunny days with below average PM2.5 concentrations. Local nucleation events were usually associated with elevated SO2 concentrations. The observed nucleation events ranged from weak events with only a slight increase in the particle number to relatively intense events with increases of total particle counts between 50,000 cm(-3) up to 150,000 cm(-3). Averaging all days of the study, days with nucleation events had number concentrations peaking at around noon at about 45,000 cm(-3). This is compared to work days without nucleation, when the daily maximum was 8 am at 23,000 cm-3, and to weekends without nucleation, when the daily maximum was at noon at 16,000 cm(-3). Twenty-four-hour average number concentrations were approximately 40% higher on days with nucleation compared to those without. Nucleation was typically observed starting around 9 am EST, although the start of nucleation events was later in winter and earlier in summer. The nucleation events are fairly well correlated with the product of [UV intensity * SO2 concentration] and also depend on the effective area available for condensation. This indicates that H2SO4 is a component of the new particles. Published correlations for nucleation by binary H2SO4-H2O cannot explain the observed nucleation frequency and intensity, suggesting that an additional component (perhaps ammonia) is participating in the particle formation. Classification: 5.


Outdoor human comfort in an urban climate may be affected by a wide range of weather and human factors. This paper describes a research program investigating the comprehensive relationship between the comfort level of typical human activities and major weather parameters through questionnaire surveys, field measurements and statistical analyses. The study reveals the integrated effects of wind speed, air temperature, relative humidity and solar radiation on the human perception, preference and overall comfort in an urban environment. An equivalent temperature
has been defined and related to the outdoor human comfort by considering acclimatization and other bio-meteorological principles. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 7,1,3.


Our objective was to explore and compare, in the context of other exposures, lay and professional perceptions of the links between urban air pollution and children's asthma. We used a triangulated survey approach, using quantitative questionnaire surveys enriched by qualitative interviews. Derivation of indicators of actual local air quality used modelled air pollution and a geographical information system. Our setting involved families and community health professionals in the London borough of Ealing, and pediatric respiratory specialists across the United Kingdom. Participants included 863 parents of children aged 3-11 years, 151 reporting currently asthmatic children, of whom 20 were extensively interviewed; 98 local general practitioners and 50 practice nurses; and 75 paediatric respiratory consultants and 55 specialist nurses. Main outcome measures involved views about the links between urban air pollution and children's asthma, relative to other triggers. Comparison of assessments of local air quality, with actual pollution levels, was made by parents with and without asthmatic children. Many parents were unsure as to what factors initiate asthma, but the most frequently cited was traffic pollution; it was also considered important in the exacerbation of asthma. Health professionals' assessments were inconsistent: specialists conformed to the dominant literature dismissing strong links between air pollution and asthma, while local clinicians reflected the views of parents in their community. Surrounding parents' views were difficulties defining exposures to urban air pollution, underlying concerns about risks to general health, perceived lack of control, unclear expert opinion, and widely accepted informal "messages" which assumed strong links. Parents with experience of asthma were found to have significantly less accurate (negatively biased) perceptions of local air quality. In conclusion, reactions to uncertainty surrounding associations between asthma and urban air pollution varied: parents' concerns were heightened (and propagated by other influences), specialist clinicians were dismissive, and community clinicians fell between these extremes. (C) 2004 Wiley-Liss, Inc. Classification: 7.


This paper deals with the application of the FTIR and XPS spectroscopies in the chemical and phase analysis of patina layers. Relationship between the composition of copper patinas and the characteristics of the atmosphere in which they were formed has been clearly demonstrated. Since copper possesses an ability to interact with different atmospheric species retaining a variety of signatures of those interactions in a stable patina layer, it is the particularly appropriate material for a study of corrosion processes. The analysis of many samples demonstrate that copper roofs are covered with a complex patina reflecting corrosion stimulated by atmospheric pollutants,
extraneous deposits from wind blown materials and birds. (C) 2001 Elsevier Science B.V. All rights reserved. Classification: 5.


The source of nitrous acid, HONO, in the troposphere remains uncertain, even after two decades of research. It is currently believed that HONO is formed by heterogeneous conversion of NO2 on either the ground or the aerosol surface. While this conversion has been studied in the laboratory, few atmospheric studies have been reported. Here we present the first simultaneous determination of the vertical gradients and fluxes of HONO, its precursor NO2, and SO2 over a flat grass surface in the polluted atmosphere. The measurements were performed in Milan, Italy, during the Limitation of Oxidant Production/Pianura Padana Produzione di Ozono (LOOP/PIPAPO) study in summer 1998, using differential optical absorption spectroscopy. While deposition of NO2 onto the ground was frequently observed, heterogeneous HONO formation was much smaller than expected. We can explain our observation by a mechanism that consists of a combination of NO2 and HONO deposition, and a heterogeneous conversion of NO2 to HONO on the ground. The compensation point for deposition and formation of HONO is characterized by a HONO/NO2 ratio of similar to0.03, indicating that only one HONO molecule is released into the gas phase for every 33 NO2 molecules deposited. Our measurements also show that direct emission of HONO is an important source in strongly polluted areas. Classification: 0.


A thermal property parameter for expressing the ground heat flux (cplambda; product of the heat capacity and the thermal conductivity) of urban complex terrain was estimated. The surface temperature time series was observed during nocturnal radiative cooling, and employed in the estimation. The surface temperature was obtained using the airborne-measured upward longwave radiation in order to consider the directional anisotropy of radiometric surface temperature. The effective thermal property parameter for a town-scale urban area was found to be two to four times larger than that of the surface material component. The explanation for this, shown by several model simulations and other radiometric observations, was total surface area increased due to urban canyon structure. The parameter cplambda on the town-scale was expressed by the canyon shape, and the cplambda of its component material. Classification: 3.

Sugawara, H., Narita, K.-i. and Mikami, T. (2004) 'Representative Air Temperature of Thermally Heterogeneous Urban Areas Using the
A method to measure an area-averaged ground air temperature based on the hydrostatic equation is shown. The method was devised to overcome the problem of finding the most representative surface air temperature over a wide region, a problem that has seriously hindered the description of urban heat islands. The vertical pressure gradient is used and the hydrostatic equation is applied to estimate the average air temperature between two barometers, which is here called the hydrostatic temperature. The error analysis shows that the hydrostatic temperature can be estimated with a systematic error of 1.8 degrees C and a random error of 0.7 degrees C in the case in which the two barometers have a vertical separation of 228 m. The measured hydrostatic temperature agreed with the average of the directly measured temperature within 0.7 degrees C rms. For this barometer separation, the representative area of the hydrostatic temperature was experimentally found to be a 12-km-radius circle. The size of this area decreased when the vertical separation of the barometers decreased. The hydrostatic temperature is compared with the average directly measured temperature for various areas. The maximum correlation between them occurred for a circular area with a 12-km radius centered on the pressure measurements. The size of the representative area for this method is larger than that for the direct measurement of air temperature. Classification: 3.


A number of heterogeneous reactions of atmospheric importance occur in thin water films on surfaces in the earth's boundary layer. It is therefore important to understand the interaction of water with various materials, both those used to study heterogeneous chemistry in laboratory systems, as well as those found in the atmosphere. We report here studies at 22 degrees C to characterize the interaction of water with such materials as a function of relative humidity from 0 - 100%. The surfaces studied include borosilicate glass, both untreated and after cleaning by three different methods (water, hydrogen peroxide and an argon plasma discharge), quartz, FEP Teflon film, a self assembled monolayer of n-octyltrichlorosilane (C8 SAM) on glass, halocarbon wax coatings prepared by two different methods, and several different types of Teflon coatings on solid substrates. Four types of measurements covering the range from the macroscopic level to the molecular scale were made: (1) contact angle measurements of water droplets on these surfaces to obtain macroscopic scale data on the water-surface interaction, (2) atomic force microscopy measurements to provide micron to sub-micron level data on the surface topography, (3) transmission FTIR of the surfaces in the presence of increasing water vapor concentrations to probe the interaction with the surface at a molecular level, and (4) X-ray photoelectron spectroscopy measurements of the elemental surface composition of the glass and quartz samples. Both borosilicate glass and the halocarbon wax coatings adsorbed significantly more water than the FEP Teflon film, which can be explained by a combination of the chemical nature of the surfaces and
their physical topography. The C8 SAM, which is both hydrophobic and has a low surface roughness, takes up little water. The implications for the formation of thin water films on various surfaces in contact with the atmosphere, including building materials, soil, and vegetation, are discussed. Classification: 0.


We have used Raman spectroscopy to characterize a variety of carbon-containing particulate matter, including samples collected in ambient urban atmospheres. Based on the Raman spectra of known, commercial particles, we derive a simple empirical model that reflects their microchemistry and microphysics. This model gives information on the crystal size and morphology of the graphitic component, which correlates with the known characteristics of the commercial samples. We derive similar information about the graphitic component of the ambient particles, and suggest that this method might be used to characterize ambient particles systematically in the future. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 0.


Diurnal variation in the atmospheric CO(2)Z concentration and the carbon isotopic composition (Delta(14)C and delta(13)C) was measured in a forest in an urban area on 9 February 1999. The carbon isotope approach used in the present study differentiated between the quantitative contributions from anthropogenic and biogenic CO, sources in the urban atmosphere. The anthropogenic (fossil fuel) and biogenic (soil respiration) contributions was estimated, and they ranged from 1 to 16% and from 2 to 8% of the total atmospheric CO2. The diurnal variation of the anthropogenic CO2 was the major cause of the total atmospheric CO2 variation, while the biogenic CO2 remained relatively constant throughout the day. Estimating the contribution of soil respired CO2 provided the mean residence time of soil respired CO2 within the forest atmosphere. Classification: 5.


Classification: 4,7.

After a brief summary on environmental pollution and commonly used materials for NO2 and O-3 sensing, simple InP-based resistive sensors are studied. The gas sensitive device is a thin n-type InP epitaxial layer grown on a semi-insulating InP substrate. The electrical resistance of the layer, measured between ohmic contacts, increases in the presence of oxidising gases, the most important variations occurring in NO2 and ozone-containing atmospheres. A complete study performed in laboratory at a moderate operating temperature of 80 degreesC on the sensor exposed to nitrogen dioxide enabled to obtain a precise NO2 calibration curve. In an outdoor application, only NO2, ozone and humidity seem to act on the sensor resistance, confirming laboratory experiments. One of these devices was used to monitor air pollution in an urban atmosphere. The resistance changes were compared with the readings of a commercial analysing equipment. The results clearly show that the sensor resistance variation follow the total O-3 and NO2 concentrations variation in air. Different operating methods are discussed for these type of sensors, depending on what of these two pollutants has to be measured. (C) 2001 Elsevier Science B.V. All rights reserved. Classification: 0.


Classification: 7,5.


Chlorine chemistry has been incorporated into the carbon bond IV mechanism and employed in a regional photochemical model (the Comprehensive Air Quality Model with Extensions (CAMx)) for preliminary use in assessing the regional impact of chlorine on ozone formation in Houston, Texas. Mechanisms employed in regional photochemical models do not currently account for chlorine chemistry. However, when chlorine chemistry is accounted for, predicted ozone levels are enhanced by up to 16 ppb(v) in the Houston area, with the greatest enhancement predicted for morning hours after sunrise. Thirteen reactions have been added to the chemical mechanism used by CAMx to describe chlorine chemistry in the urban atmosphere. The reactions include photolysis of chlorine radical (Cl.) precursors, Cl.+ hydrocarbon reactions, and Cl.+ ozone reactions. The hydrocarbon reactions include the reactions of Cl. with isoprene and 1,3-butadiene that yield unique reaction products, or marker species. The development of this mechanism is presented along with a discussion of the initial set of predictions of chlorine-based ozone enhancement in the Houston area. Of significant interest is that methane may be activated by chlorine to contribute significantly to the predicted ozone enhancement in the Houston area. Such behavior suggests that the impact of chlorine chemistry would be
proportional to the availability of Cl. precursor. In urban areas with anthropogenic sources of chlorine radical precursors, chlorine radical chemistry may be important to more accurately predict ozone formation. Classification: 0.


The computer software AUSSSM TOOL, originating from the methodology of the revised-architectural-urban-soil- simultaneous simulation model (revised-AUSSSM), was developed by adopting the graphical user interface (GUI) features to support users, who can use the interactive computer display for parameter settings, simulating, visualizing, and reporting the numerical calculation results instead of complicated programming. The purpose of the AUSSSM TOOL is to determine quantitative parameters such as air temperature, exhaustive heat from air conditioning systems, energy heat balance, etc. within the urban canopy structure, which data enables the evaluation of effects of urban heat island (UHI) in concrete terms useful to urban planners, architects, engineers, and so forth in the field of urban climatology involving building scale. In addition to conducting a full numerical simulation, in order to simplify a comparison among complex factors influencing UHI, numerical experiments based on Taguchi design of experiment theory (DOE) were carried out. The results of the numerical experiments were stored in a database and ready to be instantly grasped by any inexperienced user corresponding to their specified conditions. This paper describes the fundamental method of the revised-AUSSSM, the objectives of related software development, and the structures of the AUSSSM TOOL and the techniques comprising its algorithm to present the numerical simulation results in particular. (C) 2004 Published by Elsevier B.V. Classification: 1,2,3.


Results from the first study in Hong Kong, Southern China, to investigate the concentrations of organic acids in bulk deposition, aerosol and gas phase samples are presented. 57 daily bulk deposition samples were collected in central Kowloon and analyzed by ion chromatography, from May 1999 to May 2000. The volume-weighted (vw) mean concentrations for formate, acetate, propanoate and oxalate were 6.1, 4.5, 0.4 and 1.4 mueq dm(-3), respectively, with vw mean pH being 4.65. The maximum acidity contributions by formic and acetic acids for bulk deposition samples collected on a daily basis, with pH < 5.0, were 17 and 14%, respectively. The concentrations of these acids were significantly correlated with each other, but not with pH. Higher organic acid concentrations were found in the dry, winter season, and for the synoptic weather system types: approaching cyclone and cold front. Oxalate levels were generally higher in bulk deposition samples for north/northeasterly air masses, higher surface windspeeds, and low rainfall amounts. Formic and acetic acids were present at higher concentrations in the gas phase (mean concentrations at two sites were in the range from 3.2 to 6.5 &mu;g m(-3), with formate usually < acetate), than in aerosols (mean concentration of formate, acetate or oxalate less than or equal to2.2 mug m(-3)). Higher levels of organic acids both in aerosols and in the gas phase were found at
a busy roadside site than at a residential site. Deposition fluxes for formic and acetic acids are reported. *Classification: 5.*


Aerosol composition data, simultaneously collected from collocated samplers at an urban, a rural and a background site in the Tennessee Valley, have been compared for all seasons in 2001. Consistent with previous data, organic aerosols and sulfates are the two largest contributors to fine mass throughout the year at all three sites. Levels of major constituents were not significantly different at the rural and background sites during any season, but levels of organic and elemental carbon were higher at the urban site during fall and winter periods. Seasonal trends at all sites showed maxima in summer for sulfate and significant nitrate levels only in winter, but no significant seasonal trend was observed for organic aerosol mass at any site. Year-to-year variability in aerosol composition at the background site is small compared to day-to-day variability within seasons. The appropriate factor for converting organic carbon to organic mass (conventionally *1.4), used in calculating aerosol chemical composition, may vary with season-larger in warm seasons, smaller in cool seasons. (C) 2004 Elsevier Ltd. All rights reserved. *Classification: 5.*


Low molecular weight carboxylic acids are one of the important classes of organic compounds in the atmosphere. Due to their significant water-solubility they can contribute to the acidity of the precipitation and they might play a role in condensation processes. In this work an analytical method based on capillary electrophoresis was developed for the quantitative determination of carboxylic acids in background atmospheric aerosol samples. The method was optimised for high sensitivity and best resolution, and then was used for the study of regional, continental background atmospheric aerosol collected at K-puszta (Hungary). Oxalic acid was the predominant component in the samples. *Classification: 0.*


The Computational Fluid Dynamics code CFX-TASCflow is used for simulating the wind flow and pollutant concentration patterns in two-dimensional wind-tunnel models of an urban area. Several two-dimensional multiple street canyon configurations are studied corresponding to different areal densities and roof shapes. A line source of a tracer gas is placed at the bottom of one street canyon for modelling street-level traffic emissions. The flow fields resulting from the simulations
correspond to the patterns observed in street canyons. In particular and in good agreement with observations, a dual vortex system is predicted for a deep flat-roof street canyon configuration, while an even more complex vortex system is evidenced in the case of slanted-roof square street canyons. In agreement with measurement data, high pollutant concentration levels are predicted either on the leeward or the windward side of the street canyon, depending on the geometrical details of the surrounding buildings. Classification: 8.


Urban areas can represent a considerable part of the model domain in meso-scale numerical simulations with typical horizontal domain lengths of 20-200 km. This paper addresses the question of the extent of the influence of urban surfaces on the development of convective precipitation in meso-gamma-scale numerical models. For this purpose, a spatially variable parameterization scheme for surface sensible heat flux, surface latent heat flux, and roughness is introduced into a meso-scale numerical model. A sensitivity study in 2D is performed to assess the impact of variations of the individual parameters on the development of precipitation. The results indicate that surface conditions should not be neglected and can have considerable influence on convective rainfall. It appears that within a time frame of 4 h it is particularly the sensible heat flux variations that have the most significant impact. (C) 2000 Elsevier Science B.V. All rights reserved. Classification: 6,4.


Interpretations of source contributions and the behaviour of particles in the urban atmosphere of Brisbane were made by comparing the results of elemental analyses with the measured meteorological conditions, PM10, light scattering, gaseous pollutant concentrations and particle size distributions. Carbon was determined to be the most abundant element in the fine particles (FP). Although many of the other elements in the greater relative abundances are usually associated with natural origins, the major influence resulting in changes to FP mass was concluded to be by elements from anthropogenic sources. This conclusion was based on the significant positive relationships between the anthropogenic elements (e.g., Pb, Br, C, Ti, V, Mn, etc.) with the FP mass. The major influence on the PM10 mass concentrations was determined to be the elements usually associated with natural origins such as Na and Cl. In addition, the positive relationship of submicrometre particle number concentrations with FP carbon and with vehicular-emitted gaseous species including NOx and CO implied a significant contribution of vehicle exhausts to aerosols in this size range. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.
People in urban areas frequently use parks for recreation and outdoor activities. Owing to the complexity of the outdoor environment, there have only been a few attempts to understand the effect of the thermal environment on people's use of outdoor spaces. This paper therefore seeks to determine the relationship between the thermal environment, park use and behavioural patterns in an urban area of Sweden. The methods used include structured interviews, unobtrusive observations of the naturally occurring behaviour and simultaneous measurements of thermal comfort variables, i.e., air temperature, air humidity, wind speed and global radiation. The thermal environment is investigated through the mean radiant temperature (T-mrt) and the predicted mean vote (PMV) index. The outcome is compared to the subjective behaviour and thermal sensation of the interviewees. It is found that the thermal environment, access and design are important factors in the use of the park. In order to continue to use the park when the thermal conditions become too cold or too hot for comfort, people improve their comfort conditions by modifying their clothing and by choosing the most supportive thermal opportunities available within the place. The study also shows that psychological aspects such as time of exposure, expectations, experience and perceived control may influence the subjective assessment. Comparison between the thermal sensation of the interviewees and the thermal sensation assessed by the PMV index indicates that steady-state models such as the PMV index may not be appropriate for the assessment of short-term outdoor thermal comfort, mainly because they are unable to analyse transient exposure. 

Classification: 3, 7.


Two-dimensional numerical simulation for investigating wind and concentration field around a double-decked road structure was performed using a standard k-epsilon turbulence model. The main objective of this paper is to study how road fences installed at a double-decked road affect ambient air quality, especially, pollutant concentration at some downstream locations. For model validation, calculated results were compared with available field experiment. Performance of the standard k-epsilon model was also compared with that of the renormalization group k-epsilon model for the double-decked road. Obtained results clarified how and how much pollutant concentration distribution is influenced by road structures with and without fences: the fences on the upper deck have generally positive effect on decreasing of air pollution near ground level while those on the ground always not. The computer code we used is CFX4. (C) 2003 Elsevier Ltd. All rights reserved. 

Classification: 2.

Hourly measurements of ozone concentration in the urban atmosphere of Istanbul were carried out from February 1998 to July 1999. An assessment of the annual variations and relationships of ozone concentrations and meteorological variables was made. Annual variations were first examined without considering meteorological variables, then meteorological influences on ozone seasonal values were examined. Furthermore, a typical ozone threshold period was analysed by considering meteorological variables for a case study. Meteorological conditions favourable for high ozone concentrations appeared when Istanbul and its surrounding region were dominated by an anticyclonic pressure system. During conducive ozone days, southerly and southwesterly winds with low speeds (daytime mean value <1 in s(-1)) influence Istanbul. Classification: 5.


History of photochemical air pollution in Istanbul is not long. In recent years, the number of motor vehicles in Istanbul increased at a very fast rate. As a consequence, air quality problems in this city shifted from conventional pollutants to the secondary pollutants such as O-3. In this study we present the recent both chemical and meteorological data for a typical summer month in Istanbul. The purpose of this analysis is to examine the variations in ozone-conducive meteorological conditions in the urban atmosphere of Istanbul. Classification: 5.


A 4-day photochemical smog event in the Melbourne, Victoria, Australia, region (6-9 March 2001) is examined to assess the performance of the Australian Air Quality Forecasting System (AAQFS). Although peak ozone concentrations measured during this period did not exceed the 1-h national air quality standard of 100 ppb, elevated maximum ozone concentrations in the range of 50-80 ppb were recorded at a number of monitoring stations on all four days. These maximum values were in general very well forecast by the AAQFS. On all but the third day the system predicted the advection of ozone precursors over Port Phillip (the adjacent bay) during the morning, where, later in the day, relatively high ozone concentrations developed. The ozone was advected back inland by bay and sea breezes. On the third day, a southerly component to the background wind direction prevented the precursor drainage over the bay, and the characteristic ozone cycle was disrupted. The success of the system's ability to predict peak ozone at individual monitoring stations was largely dependent on the direction and penetration of the sea and bay breezes, which in turn were dependent on the delicate balance between these winds and the opposing synoptic flow. Classification: 5.
This paper analyses the meteorological numerical simulation in Paris during two days (March 10 and 13, 1995) observed during ECLAP (Etude de la Couche Limite en Agglomeration Parisienne - the boundary-layer study of the Paris area), a recent measurement campaign over the Paris area, in which both in-situ and remote-sensing devices at urban and rural locations have been deployed in addition to the operational meteorological network. The chosen days are well documented and correspond to different meteorological situations leading to pollution events (regarding wind direction, cloud cover, surface and synoptic inversion strength). Comparisons of three-dimensional mesoscale model results with the ECLAP observation data are presented, focusing on the temperature field and turbulent fluxes along with the urban heat island and the evolution of the mixing height. It is shown that the model correctly reproduces the main characteristics of the temperature field, its diurnal evolution (near the ground and higher up) especially the gradient between Paris and the surrounding countryside. The mixing-height evolutions are in a good agreement with the observations and the model is also able to reproduce the turbulent features of the atmosphere. The small difference observed between the urban and rural mixing-height evolution is also well reproduced.

Classification: 8.


The concentrations of gaseous pollutants carbon monoxide, nitrogen oxides (NOx=NO+NO2), and sulfur dioxide were measured, and the vehicle type and traffic flow rates in an urban street canyon with an aspect ratio of 0.8 and a length to width ratio of 3 were recorded. Three-dimensional (3D) airflow and dispersion of pollutants were modeled using the RNG k–e turbulence model, which was solved numerically using the finite volume method. Vehicle emissions were estimated from the measured traffic flow rates and modeled as banded line sources along the street. Both measurements and simulations reveal that pollutant concentrations typically follow the traffic flow rate; they decline as the height increases, and are higher on the leeward side than on the windward side. 3D simulations reveal that the vortex line, joining the centers of cross-sectional vortices of the street canyon, meanders between street buildings, and the flows leave the canyon through the top. Entrainment of outside air reduces pollutant concentrations near the street outlet, where counter-rotating vortices or secondary flows are present. Numerical predictions agree reasonably well with measurements. Classification: 5, 8.

Classification: 5,8.


Urban aerosol samples for PM10 and PM2.5 were collected during summer (August) and winter (December) 2000 in southern Taiwan (Tainan City) to demonstrate the
temporal variations of Hg and As in particulate matter (PM). The mean mass concentrations with standard deviations were 80.0+/-26.8 mug m(-3) for PM10 and 50.6+/-16.6 mug m(-3) for PM2.5. The average PM2.5/PM10 mass ratio for the two periods combined was 63%, indicating that fine particles were a large portion of PM10. Particulate samples of Hg and As were analyzed within 2 days following sampling and weighing, because of the highly volatile nature of PM Hg and As. The average Hg and As values in PM10, PM2.5 and PM2.5-10 in summer were significantly lower than those in winter. PM2.5 Hg constituted 0.34 to 5.8 ng m(-3) and PM2.5-10 Hg 0.05 to 3.1 ng m(-3). PM2.5 As constituted 1.09 to 9.51 ng m(-3) and PM2.5-10 As 0.18 to 4.14 ng m(-3). In summer and winter PM10, the Hg contents showed regular daily variation, with the higher values at daytime and lower values at nighttime, indicating conversion of gaseous Hg to the particulate phase by reaction with atmospheric oxidants under strong solar radiation during the daytime in both summer and winter. PM As behaved similar to Hg in the summer, but in the winter higher concentrations were observed during the nighttime than during the daytime, implying that the stable temperature inversion during winter nighttime caused the accumulation of PM As near the ground. In summer, SE-WSW winds carried As from an As-emitting fossil power plant to the sample area. In a similar vein, NE-WNW winter winds contributed to aerosol Hg, especially in PM2.5, originating from a waste incinerator located NW of Tainan City. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5.


The method presented in this paper is a practical procedure for the derivation of a street canyon's albedo, by taking into account the angle-dependent optical properties of a typical coated (SnO2) glazing. The development of the method is based on the flux transfer theory and can be easily implemented in a computer code permitting exploitation of a series of possibilities, such as street canyon geometry and window to wall ratios (WWRs). (C) 2002 Elsevier Science B.V. All rights reserved. Classification: 3.

Turkington, A. V., Martin, E., Viles, H. A. and Smith, B. J. (2003) 'Surface change and decay of sandstone samples exposed to a polluted urban atmosphere over a six-year period: Belfast, Northern Ireland', Building and Environment, 38, 1205-1216

Test blocks of a siliceous sandstone (Dunhouse sandstone) and a calcareous sandstone (Baumberger sandstone) were mounted in vertical aluminium racks, both sheltered and exposed to rainwash, in a range of locations within the Belfast urban area, Northern Ireland, UK. Blocks were retrieved after 3 months, 2 years, 4 years and 6 years of exposure. Visual and chemical analyses of the sandstone samples revealed a variable response to polluted atmospheric conditions, dependent on stone type and exposure conditions. An exponential increase in salt content was recorded in several sheltered samples; exposed samples displayed an inconsistent change in salt content over time. Visual analysis by scanning electron microscopy demonstrated variable
amounts of gypsum crust development, biological growth and depositional material. Results indicate that stone surface alteration in a polluted atmosphere may be significant during initial exposure of fresh or cleaned stone. (C) 2003 Elsevier Ltd. All rights reserved. 


The effects of atmospheric stability on how in urban street canyons were studied using a stratified wind tunnel. We conducted experiments using a model that represented city streets with simply shaped block forms, while varying atmospheric stability across seven stages from stable (Rb = 0.79) to unstable (Rb = - 0.21). We used a laser Doppler anemometer (LDA) and a cold wire to measure the flow field and temperature within and above the street canyon. In addition to mean values of wind speed components and temperatures, we measured turbulence intensity, shear stress, and heat flux distribution. Our results led to the following conclusions: Cavity eddies that arose in the street canyon tended to be weak when the atmosphere was stable and strong when unstable. Stable atmospheric conditions led to a positive feedback effect in which the downward flow into the street canyon weakened due to buoyancy, which facilitated the formation of a more highly stable stratification. As a result, when stability exceeded a certain threshold (somewhere in the range of Rb = 0.4-0.8), the wind speed in the street canyon dropped nearly to zero. (C) 2000 Elsevier Science Ltd. All rights reserved. 


Reynolds-number dependence of flow fields within a modelled urban area was studied in a wind tunnel. We measured flow around a single model building and around model city blocks at various wind speeds, and studied Reynolds number indices more appropriate than the building Reynolds number. Our results led to the following conclusions. Firstly, the flow around the models in the wind tunnel was roughly divided into three parts according to the intensities of viscous stress and Reynolds stress as follows: (1) the flow in the vicinity of the ground or the surfaces of the model, where viscous stress became dominant under certain conditions; (2) the flow detached from the surfaces of the model, where Reynolds stress was always dominant; and (3) the flow around the separation bubble at the leading edge of the building model, where the influences of both viscous stress near the wall and the Reynolds stress in the separated boundary layer were mixed. Secondly, the critical Reynolds number of the flow in the modelled urban area could be defined by using both the roughness Reynolds number Re-z0 (= z(0)u(*/nu)) and the dimensionless height z(+) (= zu(*/nu)). Reynolds-number independence could be expected for whole flow fields in the modelled urban areas as long as the critical values of Re-z0 and z(+) were satisfied. 

Classification: 8.
A study of the climatology of ventilation properties of the atmosphere in Buenos Aires city has been carried out. From routinely available observational data, the daytime stability conditions and related ventilation factors and air flow characteristics are obtained and studied. In all cases the seasonal and annual behaviour is analysed. The frequencies of occurrence of daytime reduced ventilation factors are important, being 55% over the whole year and, respectively, 67% and 44% in the cold and warm periods. The prevailing daytime atmospheric stability conditions are near neutral, slightly unstable and unstable. The most frequent day-time wind directions occur in the north-southeast sector and during the cold period are mainly associated with the smallest ventilation factor ranges. The results obtained suggest that, during the cold season, conditions for elevated air pollution concentrations occur with high probability in the atmosphere of Buenos Aires city. Classification: 5.


Classification: 8,5.


Classification: 1,2,3.


This study examines the connection between the built-up urban surface and near-surface air temperature. The studied city (Szeged, Hungary) is located on a low and flat flood plain with a population of 160,000. Data were collected by mobile measurements under different weather conditions between March 1999 and February 2000. The efforts have been focussed on investigating the maximum development of the urban heat island (UHI) along an urban cross-section. According to the results, the UHI intensity changed according to season and month, as a consequence of the prevailing weather conditions. The role of cloudiness and wind speed on the temporal variation of the largest UHI, which represents the increasing effect of Szeged on temperature, is clearly recognized during most of the time in the studied period. The seasonal profiles follow remarkably well the general cross-section of the typical UHI described by Oke (Oke, T.R., 1987. Boundary Layer Climates. Routledge, London) who defines its characteristic parts as 'cliff', 'plateau' and 'peak'. The usefulness of the normalized values in the investigation is proved, the form of the seasonal mean UHI profile is independent of the seasonal climatological conditions, and is determined to a high degree by urban surface factors. As a conclusion, we suggest a modified model describing the metropolitan temperature variable for cities situated in simple
geographical conditions: it is equal to the sum of components of the basic climate of the region and of the production of urbanization at the surface, where this last term is a multiplication of weather and urban surface factors. (C) 2001 Elsevier Science B.V. All rights reserved. Classification: 1.4.

Unkasevic, M., Jovanovic, O. and Popovic, T. (2001) 'Urban-suburban/rural vapour pressure and relative humidity differences at fixed hours over the area of Belgrade city', Theoretical and Applied Climatology, 68, 67-73

In the study, urban-suburban/rural vapour pressure and relative humidity differences at fixed hours in the Belgrade area were analysed and compared. The data from one urban, two suburban and one rural stations (0700, 1400 and 2100 hours LTC), for the period 1976-1980 were used. It has been found, on the basis of the vapour pressure differences that the atmosphere in urban areas is more humid than that in the suburban and rural areas at 0700 and 2100 hours, in the period from September to February, while from February to September the urban atmosphere is drier. At 1400 hours, urban atmosphere is drier throughout the year. However, relative humidity differences indicate that urban air is less humid than the air in suburban and rural areas throughout the year. Relationships between urban-suburban/rural vapour pressure differences and heat island intensity revealed that the local effects could be significant. Classification: 4.


High resolution temporal and spatial control of atmospheric pollutants is of crucial importance for environmental health monitoring. Passive sampling using natural vegetation biomonitoring allows acquisition of well-defined samples at affordable costs. We here present results from a study conducted in the conurbation of Cologne, Germany, based on airborne pollutants accumulated on pine needles. This integrated study includes (i) the microscopic analysis of pine needles and analysis of their magnetic properties, (ii) PAH, and (iii) selected trace elements (Fe, Cd, Pb, Ni, Cr, Cu). A major proportion of atmospheric pollutants is bound to particles, for which in part I of the study we present data on magnetic susceptibility, remanence measurements (IRM, ARM) and total Fe content. SEM-analysis indicates that particles accumulated on needles are mostly <2.5 m in diameter and comprise pollen or spores, mineral dust and silica-glassy or metallic spheroids. The latter were identified as magnetite with minor pyrrhotite. These particles derive from combustion of coal in power plants or fuels in vehicular engines. A close correlation of magnetic properties (susceptibility, SIRM, ARM) and Fe content shows that non-destructive, time-efficient enviromagnetics of needles serves as an excellent proxy for biomonitoring of combustion pollutants. Their spatial distribution within the conurbation of Cologne was determined for 43 locations integrated in a GIS-database. The dominant sources of fine metallic particulates (PM2.5) are emissions from road traffic, including fuel combustion, corrosion and brake-wear and from railroad and tram traffic preferentially due to material wear. Parks, forests and agricultural areas show the lowest levels of pollution by magnetic particles, followed by residential
areas. This implies that traffic emissions with short transportation distances (<1.0 km) are dominant in the Cologne conurbation, whereas the contribution from power plants is negligible. *Classification: 7.*


Exposure to airborne particulates containing low concentrations of heavy metals, such as Pb, As, and Se, may have serious health effects. However, little is known about the speciation and particle size of these airborne metals. Fine- and ultrafine particles with heavy metals in aerosol samples from the Detroit urban area, Michigan, were examined in detail to investigate metal concentrations and speciation. The characterization of individual particles was completed using high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) combined with conventional high-resolution TEM techniques. The trace elements, Pb, As, La, Ce, Sr, Zn, Cr, Se, Sn, Y, Zr, Au, and Ag, were detected, and the elemental distributions were mapped in situ at the nanoscale. The crystal structures of the particles containing Pb, Sr, Zn, and Au were determined from their electron diffraction patterns. Based on the characterization of the representative trace element particles, the potential health effects are discussed. Most of the trace element particles detected in this study were within a range of 0.01-1.0 μm in size, which has the longest atmospheric residence time (similar to 100 days). Increased chemical reactivity owing to the size of nanoparticles may be expected for most of the trace metal particles observed. *Classification: 5.*

Valerio, F., Stella, A. and Munizzi, A. (2000) 'Correlations between PAHs and CO, NO, NO2, O-3 along an urban street', *Polycyclic Aromatic Compounds, 20*, 235-244

Since 1997 to 1999, bimonthly measures of daily PAH concentrations, adsorbed on airborne particulate (PM10) have been carried out in Genoa (Italy), along a canyon street, crossed daily by about 27,000 vehicles. Simultaneous concentrations of CO, NO, NO2 were evaluated in the same sampling site. Ozone concentrations were measured in two sampling stations, far from traffic, and their daily mean was used as a measure of oxidative strength of urban air in Genoa. PAHs correlate positively with CO and NO. Negative correlations were found with NO2 and particularly with O-3 Cyclopenta(cd)pyrene was confirmed the most reactive PAH, while benzo(e)pyrene showed a relative stability. Multiple linear regression analyses confirmed that PAH concentration covariates mainly with CO and O-3, while NO2 has negligible correlation. According to these results, benzo(a)pyrene concentrations are well predicted (standard error = 0.35 ng/m3), by the following equation: [BaP] = 1.4 + 0.31 [CO] - 0.015 [O-3] R-2 = 0.75 d.f. = 55 These results suggest that traffic is the main PAH source in the studied site and in urban atmosphere PAHs adsorbed on suspended particulate may be degraded also by oxidation. *Classification: 5.*
A new approach for the estimation of trace metal emissions in Vilnius city was implemented, using vertical concentration profiles in the urban boundary layer and road tunnel measurement data. Heavy metal concentrations were examined in fine and coarse particle fractions using a virtual impactor (cut-off size diameter 2.5 μm). Negative vertical concentration gradients were obtained for all metals (Ba, Pb, V, Sb, Zn) and both fractions. It was estimated that the vertical concentration gradient was formed due to emissions from an area of about 12 km². Road tunnel measurements indicated that trace metal concentrations on fine particles were lower than those on coarse particles, which suggested that re-emitted road dust was highly enriched in trace metal due to historic emissions within the tunnel. Emission rates of different pollutants in the road tunnel were calculated using pollutant concentration differences at the tunnel entrance and exit and traffic flow data. Heavy metal emission rates from the area of Vilnius city were estimated using the vertical gradient of heavy metal concentrations and the coefficient of turbulent mixing, as derived from meteorological measurement data. The emission values calculated by the two different methods coincided reasonably well, which indicated that the main source of airborne trace metals in Vilnius city is traffic. The potential of the vertical concentration gradient method for the direct estimation of urban heavy metal emissions was demonstrated.

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Mass concentrations of ambient particulate matter were measured in terms of daily average values of PM1, PM2.5, and PM10 for 6 months during the winter of 1996-1997 at a fixed sampling site in Helsinki, Finland, along with meteorological parameters and particle number concentrations in the size range 0.01-1 μm. In addition, the PM filters were subjected to reflectometric analysis to determine absorption coefficients for the various fractions of urban particulate matter. The data were divided into two periods (winter and spring) in order to study more closely seasonal phenomena that have an effect on air pollution patterns. The variations in PM10 and PM2.5 concentrations differed in pattern during resuspended dust episodes, whereas those in PM1 concentrations followed those in PM2.5 fairly well throughout the 6-month measurement period. Thus it seems that PM1 does not provide much additional information on mass concentrations relative to PM2.5 Number concentrations in the ultrafine particle size range from 0.01 to 0.1 μm, especially in wintertime, were much better correlated with absorption coefficients than with any of the three PM mass-based concentrations, indicating that Black Smoke particles are related to that size range. The results also indicate that coarse particle concentrations in ambient air are affected more by seasonal factors than are fine particle concentrations. Classification: 5.
An intensive sampling program has been undertaken in the absence of precipitation at an urban site, Chicago, to characterize the atmospheric concentration and partitioning of PAHs. Two different sampling programs have been carried out with a large number of samples. Measured ambient concentrations of PAHs were classified as Land and Lake samples based on wind direction and back trajectory calculations. Differences in ambient concentrations of PAHs were observed between Land and Lake samples. The concentrations of PAHs when air originated over the Land were approximately two-four times higher than the concentrations measured when air originated over the Lake. It has been demonstrated that partitioning of PAHs shows a consistent difference between samples taken when wind came from off the land rather than off the water. This was most evident by more shallow slopes for Lake samples compared to the slopes for Land samples, when partition coefficient ($K_p$) is plotted on a log-log scale vs. the subcooled liquid vapor pressure ($P_{L(0)}$). Experimentally, determined $K_p$ values were compared with the results obtained using two different models, one based on absorption into aerosol organic matter and the other adsorption onto soot carbon. Experimental $K_p$ values generally agreed well with the soot+ octanol based model predictions. (C) 2003 Elsevier B.V. All rights reserved. Classification: 5.


High pollution levels have been often observed in urban street canyons due to the increased traffic emissions and reduced natural ventilation. Microscale dispersion models with different levels of complexity may be used to assess urban air quality and support decision-making for pollution control strategies and traffic planning. Mathematical models calculate pollutant concentrations by solving either analytically a simplified set of parametric equations or numerically a set of differential equations that describe in detail wind flow and pollutant dispersion. Street canyon models, which might also include simplified photochemistry and particle deposition-resuspension algorithms, are often nested within larger-scale urban dispersion codes. Reduced-scale physical models in wind tunnels may also be used for investigating atmospheric processes within urban canyons and validating mathematical models. A range of monitoring techniques is used to measure pollutant concentrations in urban streets. Point measurement methods (continuous monitoring, passive and active pre-concentration sampling, grab sampling) are available for gaseous pollutants. A number of sampling techniques (mainly based on filtration and impaction) can be used to obtain mass concentration, size distribution and chemical composition of particles. A combination of different sampling/monitoring techniques is often adopted in experimental studies. Relatively simple mathematical models have usually been used in association with field measurements to obtain and interpret time series of pollutant concentrations at a limited number of receptor locations in street canyons. On the other hand, advanced numerical codes have often been applied in combination
with wind tunnel and/or field data to simulate small-scale dispersion within the urban canopy. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.


We present two applications of adjoint modelling with the objective of diagnosing and simulating air pollution in an urban atmosphere. The concerned city is Paris and its surroundings. The first application is the sensitivity of an afternoon ozone peak to anthropogenic emissions and reaction rates. We show in particular the diurnal profile of sensitivity. Despite the paper being mostly methodological, some interesting results come out: we show that (i) the ozone peak is mostly sensitive to morning solvent releases and traffic emissions, and (ii) that only a few reactions are sensitive although the chemical mechanism used is fairly complete. The other application is inverse modelling of the ozone concentrations at the boundaries of the region considered. We demonstrate that the boundary concentrations are in good agreement with independent airborne measurements. (C) 2000 Published by Elsevier Science Ltd. Classification: 5.


During the Atmospheric Pollution Over the Paris Area (ESQUIF) experiment a series of airborne measurements were collected in the vicinity of the city of Paris during smog episodes. They are used in combination with an air quality photochemical model in order to diagnose uncertainties in the current emission inventory. Diagnostics are made by comparing simulated with observed concentrations for nitrogen oxides, carbon monoxide, and primary hydrocarbons, taking into account the chemistry and transport processes of these compounds. An emphasis is put on the uncertainty of the results, taking into account the finiteness of the measurement samples, possible errors in the model transport, and chemistry and measurement errors. We examine, in particular, possible sources of bias in the model. For instance, we show that boundary layer depth is underestimated by at most 30% on average. However, sensitivity experiments showed that these model biases, taken individually, cannot alter the qualitative aspects of our results. Only a conspiracy of these biases could possibly shift all our diagnostics toward significantly different results. There is reasonable consistency between simulated and measured concentrations. NOy simulations agree with measured concentrations to within 35%; CO concentrations agree to within a factor of 2. There are significant underestimations and overestimations in some individual primary hydrocarbons. However, the total mass and reactivity of the measured hydrocarbon mixture, which accounts for only about half of the total emitted mass, agree with modeled values to within an estimated uncertainty of 40%. The analysis of results provides clues for improving emission inventories. It is found, for instance, that temperature dependence, which is not
considered here, can be a key factor and that hydrocarbon emissions from solvent use may suffer from inaccurate totals or speciation. Another source of uncertainties may be the temporal or spatial distributions of solvent activities. Classification: 5.


Tropospheric photooxidant pollution was investigated in detail for the first time over the Paris area during the Air Pollution Over the Paris Region (ESQUIF) project. From 1998 to 2000, 12 intensive observation periods (IOPs) were carried out. They represented various meteorological situations, all leading to strong polluted events over Paris and its surroundings. During these periods, measurements were performed with a new strategy of circular flights around the city, coupled to stations or remote sensing surface measurements. Such data obtained at various altitudes and at different ranges from the city center document the evolution of pollution events on horizontal and vertical scales. In addition, ESQUIF also allowed for the evaluation of models developed in parallel to the project. In this overview, ESQUIF is presented in terms of the set of IOPs. Periods are compared in terms of meteorology and resulting types of pollution episodes. The occurrence of these latter events is discussed in terms of local production and influence of long-range transport. Using both measurements and model simulations, some important results are highlighted, especially concerning accuracy of boundary conditions, processes of mixing within the boundary layer, surface emissions estimation (including biogenic), and photolysis attenuation. Finally, results from data assimilation studies and sensitivity studies using adjoint modeling and a Monte Carlo approach are also presented. Classification: 5.

Vecchi, R., Marcuzzan, G., Valli, G., Ceriani, M. and Antoniazzi, C. (2004) 'The role of atmospheric dispersion in the seasonal variation of PM1 and PM2.5 concentration and composition in the urban area of Milan (Italy)', *ATMOSPHERIC ENVIRONMENT.*, 38, 4437-4446

The seasonal variation of PM1 and PM2.5 mass concentration and composition has been investigated in the great urban area of Milan. PM samplings were carried out 3 times a week during the year 2002. Mass and elemental concentrations were measured in all samples and in a limited number of filters also the elemental and organic carbon contribution (EC and OC) was determined. In the urban area of Milan, PM2.5 comprises about 60% and 70% of the PM1 mass in summer and in winter, respectively. Among the measured PM components carbon compounds and sulphates are by far the major contributors and a significant contribution likely due to nitrates (not measured) should also be considered. PM1 and PM2.5 concentration and composition show a strong seasonal behaviour, which was studied in relation to atmospheric dispersion conditions. Our approach is based on the use of Radon concentration as a natural tracer of differences in the average mixing layer height during the year. The application of a suitable "Radon index" allows the normalisation of PM mass and elemental data to
account for the seasonal effect due to differences in atmospheric dispersion conditions. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 5.


The analysis of three years of 8-h CO concentration values registered in a deep street canyon downtown shows high frequency of values that exceed WHO health protection guidelines. An inverse relationship between opposing percentiles of the distributions of CO concentrations and mean wind speed could be found. Data also showed a variation of mean CO values with prevailing wind direction. The averaged concentration value obtained when the sampler probe is on the leeward side is lower than the obtained when it is on the windward wall. A preliminary explanation of this feature may be related to the advection of polluted air from a high traffic density area nearby. Classification: 5.


Classification: 5.


Hydrogen is likely to be the most important future energy carrier, for many stationary and mobile applications, with the potential to make significant reductions in greenhouse gas emissions especially if renewable primary energy sources are used to produce the hydrogen. A safe transition to the use of hydrogen by members of the general public requires that the safety issues associated with hydrogen applications have to be investigated and fully understood. In order to assess the risks associated with hydrogen applications, its behaviour in realistic accident scenarios has to be predicted, allowing mitigating measures to be developed where necessary. A key factor in this process is predicting the release, dispersion and combustion of hydrogen in appropriate scenarios. This paper illustrates an application of CFD methods to the simulation of an actual hydrogen explosion. The explosion occurred on 3 March 1983 in a built up area of central Stockholm, Sweden, after the accidental release of approximately 13.5 kg of hydrogen from a rack of 18 interconnected 50 l industrial pressure vessels (200 bar working pressure) being transported by a delivery truck. Modelling of the source term, dispersion and combustion were undertaken separately using three different numerical tools, due to the differences in physics and scales between the different phenomena. Results from the dispersion calculations together with the official accident report were used to identify a possible ignition source and estimate the time at which ignition could have occurred. Ignition was estimated to occur 10 s after the start of the release, coinciding with the time at which the...
maximum flammable hydrogen mass and cloud volume were found to occur (4.5 kg and 600 m(3), respectively). Classification: 5.


This paper describes the design and implementation of a field study to understand dispersion in an urban area, characterized by buildings whose heights are less than 5m. The study site, Barrio Logan, is located on the San Diego shore line, where most of the industry is located. The predominant wind from the SW brings emissions from the industrial area into the residential area located downwind in the NW. The field study was conducted during the period 21-31 August 2001 on 5 days. The tracer, SF6, was released at a height of 5 m from a shipyard on the shoreline, and the concentrations of the tracer were sampled on four arcs at 200, 500, 1000, and 2000 m from the source during 10 h of each day starting at 10 am. This experiment was designed to provide data during both daytime and nighttime conditions. The meteorological conditions that governed dispersion were measured using sonic anemometers and a SODAR with a range of 200 m in the vertical. The maximum concentrations (normalized by the emission rate) measured during the experiments ranged from 100 musm(-3) at 200m to 1 musm(-3) at 2000m. An analysis of the concentration observations indicated that the maximum concentrations followed: C-max/ Q = 1/ piU(dil)x(2) where the dilution velocity is given by U-dil = sigma(w)sigma(v)/ U U-dil, a measure of the dilution capability of the boundary layer, varied between 0.1 and 0.2ms(-1) during most of the field study hours. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 5.


This paper describes the evaluation and improvement of dispersion models for estimating ground-level concentrations in the vicinity of small sources located in urban areas. The models were evaluated with observations from a tracer study conducted at the University of California, Riverside. This experiment simulated a non-buoyant release from the top of a small source in an urban area. The tracer, SF6, was sampled at several receptors within 20 m from the source. Several receptors were located upwind of the dominant westerly wind direction. Model estimates from ISC-PRIME and AERMOD-PRIME were evaluated with hourly observed concentrations. The evaluation indicated that the highest concentrations were overestimated by these models. At the same time, the lower range of concentrations was underestimated. A diagnostic study with a simple Gaussian dispersion model that incorporated site specific meteorology indicated that these errors could be reduced by accounting for the lateral meandering caused by increased horizontal turbulence in urban areas. While AERMOD incorporates lateral meandering, it switches it off in the near field affected by PRIME estimates. This study found that using onsite turbulence information in a simple model for meandering can lead to adequate estimates of
observed concentrations even when downwash effects are not modeled explicitly. Classification: 5.


Tobacco plants, heterozygous for two independent loci involved in the chlorophyll parenchyma differentiation, allow the genotoxic effects of the atmosphere of the industrial estate South of Toulouse to be estimated. Somatic spots of green cellular colonies on yellow-green background, were counted to calculate the cellular rates of reversion. Two experiments were carried out in 1981, and in 1997. A general decrease of genotoxic effects was observed. These observations were interpreted as being due to a general decrease of the air pollution evaluated by the development of the concentrations of three toxic gases before and after the implementation of cleanup devices. The results obtained demonstrate the efficiency of this bio-indicator, which is easy to use and capable of integrating, in situ, genotoxic variations throughout the duration of plants' growth. Classification: 0.


Classification: 8.


The results from a 1-year measurement period concerning the diurnal PM2.5 and PM10 organic carbon (OC) and black carbon (BC) concentrations are presented for a traffic-influenced site in the Helsinki metropolitan area. The measurements were based on aerosol sampling using a virtual impactor and the subsequent thermal-optical analysis to distinguish between OC and BC. Backup filters were used to estimate and correct for the positive sampling artefact. Daily-average concentrations in PM2.5 varied between 1.0 and 8.5 mug C m(-3) for OC, and between 0.3 and 5.7 mug C m(-3) for BC. Annual-average concentrations of OC and BC were 3.0 and 1.2 mug C m(-3), respectively, in PM2.5, and 4.2 and 1.3 mug C m(-3) in PM10. On an annual level, particulate organic matter (POM = 1.6 x OC) accounted for 50 +/- 14% and 36 +/- 8% (average +/- 1sigma) of the total PM2.5 and PM10, respectively, whereas BC stayed lower at 14 +/- 8% and 7 +/- 4%. Typically more than 90% of BC resided in the PM2.5 size fraction. The contribution of coarse particles (> 2.5 mum) to the overall OC varied between the 0% and 67% (median 27%). The effect of meteorological conditions on the variability of OC and BC concentrations was examined, and the
contribution of secondary organic aerosol to the total fine organic aerosol was estimated. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.


Sensible heat fluxes over a light industrial area in Vancouver, British Columbia, Canada, are analyzed from observed tower fluxes and modeled using a bulk heat transfer approach. The bulk transfer models are initialized using remotely sensed surface temperatures from both airborne and ground-based observing platforms. The remotely sensed surface temperature, in conjunction with a surface database, is used to create area-weighted temperature estimates representative of the complete urban surface. Sensitivity analyses of the various surface temperature estimates are performed. Estimates of $k_B(-1)$, the ratio of roughness length of momentum to heat, for this area are in general agreement with theoretical estimates for bluff-rough surfaces and are larger than those documented for vegetated and agricultural surfaces. Back-calculated values do vary depending on the method used to determine surface temperature but vary more with the time of day. Empirical relations derived previously for vegetated surfaces are shown to agree well with the results for a dry urban environment. Approaches based on microscale variability in temperature fields are problematic. Classification: 3.


Thermal remote sensing has been used over urban areas to assess the urban heat island, to perform land cover classifications and as input for models of urban surface atmosphere exchange. Here, we review the use of thermal remote sensing in the study of urban climates, focusing primarily on the urban heat island effect and progress made towards answering the methodological questions posed by Roth et al. [International Journal of Remote Sensing 10 (1989) 1699]. The review demonstrates that while some progress has been made, the thermal remote sensing of urban areas has been slow to advance beyond qualitative description of thermal patterns and simple correlations. Part of the difficulty lies in the tendency to use qualitatively based land use data to describe the urban surface rather than the use of more fundamental surface descriptors. Advances in the application of thermal remote sensing to natural and agricultural surfaces suggest insight into possible methods to advance techniques and capabilities over urban areas. Improvements in the spatial and spectral resolution of current and next-generation satellite-based sensors, in more detailed surface representations of urban surfaces and in the availability of low cost, high resolution portable thermal scanners are expected to allow progress in the application of urban thermal remote sensing to the study of the climate of urban areas. (C) 2003 Elsevier Inc. All rights reserved. Classification: 3.

*Classification: 3.*


Three-dimensional large-eddy simulations are performed with the dynamic sub-grid scale model for an idealised urban canyon with pollution modelled as a passive scalar. In addition to concentration distributions, turbulence statistics for the canyon are presented. Higher turbulence intensities are predicted in the core of the vortex compared to the widely used k-epsilon model. This results in a more homogeneous distribution of pollutants, in agreement with experimental studies reported in the literature. Regions of enhanced turbulence are also observed near the walls leading to a lateral dispersion of pollutants along the canyon. The centre of the vortex is observed to precess around the canyon and also meanders along the length of the canyon. Puffs of pollution are ejected from the top of canyons intermittently rather than smoothly, with a characteristic time scale of the order of 30-60s. (C) 2002 Elsevier Science Ltd. All rights reserved. *Classification: 8,5.*


Large-eddy simulations (LESs) are applied to the problem of pollution dispersion within the urban canopy layer, specifically street canyons. The objective is to study the turbulence structure and hence the physical dispersion mechanisms of pollutants. LESs are implemented by incorporating the dynamic sub-grid scale stress model into the commercial computational fluids dynamics code CFX. To gain confidence in the approach, simulations are performed for a canyon-like geometry (roof garden) for which experimental measurements were also made. The experimental campaign consisted of using sonic anemometers to measure mean flow and turbulence intensities at a high sample rate of 60Hz. Good agreement between simulations and experimental data are obtained. Real geometric features, such as non-uniform wall heights, result in a very much three-dimensional flow distribution. Comparisons with the k-epsilon model show that LESs are able to predict more accurately the turbulence statistics of the flow. (C) 2002 Elsevier Science Ltd. All rights reserved. *Classification: 8,5.*


*Classification: 8.*

In this study aerosol samples of PM 10 and PM2.5 collected from 18 February 2001 to 1 May 2001 in Nanjing, China were analyzed for their water-soluble organic compounds. A series of homologous dicarboxylic acids (C2-10) and two kinds of aldehydes (methylglyoxal and 2-oxo-malonaldehyde) were detected by GC and GC/MS. Among the identified compounds, the concentration of oxalic acid was the highest at all the five sites, which ranged from 178 to 1423 ng/m$^3$. The second highest concentration of dicarboxylic acids were malonic and succinic acids, which ranged from 26.9 to 243 ng/m$^3$. Higher level of azelaic acid was also observed, of which the maximum was 301 ng/m$^3$. As the highest fraction of dicarboxylic acids, oxalic acid comprised from 28% to 86% of total dicarboxylic acids in PM 10 and from 41% to 65% of total dicarboxylic acids in PM2.5. The dicarboxylic acids (C-2, C-3, C-4) together accounted for 38-95% of total dicarboxylic acids in PM10 and 59-87% of dicarboxylic acids in PM2.5. In this study, the total dicarboxylic acids accounted for 2.8-7.9% of total organic carbon (TOC) of water-soluble matters for PM 10 and 3.4-11.8% of TOC for PM2.5. All dicarboxylic acids detected in this study together accounted for about 1% of particle mass. The concentration of azelaic acid was higher at one site than others, which may be resulted from higher level of volatile fat used for cooking. The amounts of dicarboxylic acids (C-2,3,C- 4,9) and 2-oxo-malonaldehyde of PM2.5 were higher in winter and lower in spring. Compared with other major metropolitans in the world, the level of oxalic acid concentration of Nanjing is much higher, which may be contributed to higher level of particle loadings, especially for fine particles. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 0.


In this work, PM10 samples were collected in a winter and a summer in Christchurch, a New Zealand city having intensive wood and coal burning and a serious air pollution problem in winter. Oxalic, malonic, succinic, maleic, glutaric and adipic acids in the samples were analysed using ion chromatography. It was suggested that solid fuel burning had large influence on the occurrence of these low molecular weight dicarboxylic acids resulting in significantly higher wintertime concentrations of maleic acid, oxalic acid and glutaric or adipic acid. The most pronounced feature observed was that maleic acid was the second most abundant species of the detected DCAs in the winter (with a mean of 74 ng m$^{-3}$ and the highest concentration ever reported of 231 ng m$^{-3}$). In contrast, malonic acid experienced a low abundance in both seasons. The observed seasonal patterns and molecular distribution were inconsistent with those in most other urban areas. On an average, the total detected dicarboxylic acids accounted for about 0.5% of PM10 mass with a maximum of 1.4% in the winter. The relative importance of different sources to individual dicarboxylic acids varied with seasons and is discussed in detail. (C) 2004 Elsevier Ltd. All rights reserved. Classification: 5.
The tracer releases of the "URBAN 2000" urban tracer and meteorological field experiment conducted in Salt Lake City, Utah, in October 2000 provided a wealth of data for comparison with the predictions of transport and dispersion models. Comparisons of several sets of predictions created with the U. S. Defense Threat Reduction Agency's urban Hazard Prediction and Assessment Capability (HPAC) model are compared with the observations of the URBAN 2000 field study. This analysis focuses on paired-in-space-and-time comparisons of predictions and observations and uses conventional statistics as well as a previously described transport and dispersion model user-oriented measure of effectiveness. Four urban HPAC model configurations and five weather input options were examined, and, thus, 20 sets of URBAN 2000 predictions were created. Novel features of this analysis include 1) an inclusive data protocol that allowed for the use of 94% of the observed URBAN 2000 sulfur hexafluoride (SF6) 30-min average concentrations, 2) the application of the previously developed user-oriented measure of effectiveness (MOE) to urban predictions and observations, and 3) the use of nonparametric hypothesis test procedures to guide objectively the search for significant performance differences between urban HPAC model configurations through over 25 000 comparisons of metrics. Robust findings are reported that include the statistical discernment of general trends associated with urban HPAC predictive performance as well as the identification of differences in performance among various model configurations. Classification: 5.


Classification: 5,7.


The ballast facet of a goods station with its railway track leading towards the rural surroundings of the city of Osnabrack, Germany, was studied in terms of its thermal behaviour and its significance as an urban ventilation path for nocturnal cold-air transport from the rural surroundings. The investigations are based on sulfurhexafluoride (SF6) tracer experiments, tethersonde soundings and energy-balance measurements. Although the ballast facet absorbs much of the incoming solar radiation during the day it is able to cool significantly throughout the night. The dispersion of nocturnal cold-air about the urban centre of Osnabrack is shown to be spatially and temporally variable and affected by the vertical structure of the nocturnal...
boundary layer. Even in moderate topography the near-surface flow is able to partly decouple from the flow aloft resulting in a two-layered structure of the nocturnal boundary layer above the goods station area. The bottom part can be attributed to the cold-air flow from the eastern surroundings with a vertical extension of about 20-30 m while the upper part is influenced by the larger scale orography. 

Wehner, B., Birmili, W., Gnauk, T. and Wiedensohler, A. (2002) 'Particle number size distributions in a street canyon and their transformation into the urban-air background: measurements and a simple model study', *Atmospheric Environment*, 36, 2215-2223

Car traffic is one of the main anthropogenic aerosol sources in modern cities. The characterization of these emissions is important for describing the quality of urban air. Measurements in a street canyon in a German urban area were made. Maximum number concentrations occurred during morning hours from Monday to Friday when the traffic density is highest. The maximum of the number size distribution measured during rush hour near a busy city street was at a particle diameter of 15 nm. This differs significantly from size distributions directly measured in vehicle exhaust (vehicles placed on chassis dynamometers used for vehicle emissions certification), typically about 50 nm. The size distributions measured in the urban area depended on the distance to the nearest road. With increasing distance, the maximum of the size distribution increased, and the total number concentration decreased. This seems to be a result of particle growth due to processes such as coagulation and condensation, and dilution with the surrounding air. To clarify the transformation of the particle number size distributions measured in a street canyon into the urban-air background, a sectional aerosol model was used to calculate the evolution of the number size distribution, and included the effect of condensation, coagulation, dilution, and continuous entrainment of freshly emitted particles yielding good agreement with measurements. (C) 2002 Elsevier Science Ltd. All rights reserved. 


Long-term measurements (over 4 years) of particle number size distributions (submicrometer particles, 3 800 nm in diameter), trace gases (NO, NO2, and O-3), and meteorological parameters (global radiation, wind speed and direction, atmospheric pressure, etc.) were taken in a moderately polluted site in the city of Leipzig (Germany). The resulting complex data set was analyzed with respect to seasonal, weekly, and diurnal variation of the submicrometer aerosol. Car traffic produced a peak in the number size distribution at around 20 nm particle diameter during morning rush hour on weekdays. A second peak at 10-15 nm particle diameter occurred around noon during summer, confirmed by high correlation between concentration of particles less than 20 nm and the global radiation. This new-particle formation at noon was correlated with the amount of global radiation. A high concentration of accumulation mode particles (between 100 and 800 nm), which are associated with large particle-surface area, might prevent this formation. Such high
particle concentration in the ultrafine region (particles smaller than 20 nm in diameter) was not detected in the particle mass, and thus, particle mass concentration is not suitable for determining the diurnal patterns of particles. In summer, statistical time series analysis showed a cyclic pattern of ultrafine particles with a period of one day and confirmed the correlation with global radiation. Principal component analysis (PCA) revealed a strong correlation between the particle concentration for 20-800 nm particles and the NO- and NO2-concentrations, indicating the influence of combustion processes on this broad size range, in particular during winter. In addition, PCA also revealed that particle concentration depended on meteorological conditions such as wind speed and wind direction, although the dependence differed with particle size class. Classification: 5.


The spatial variability of aerosol number and mass along roads was determined in different regions (urban, rural and coastal-marine) of the Netherlands. A condensation particle counter (CPC) and an optical aerosol spectrometer (LAS-X) were installed in a van along with a global positioning system (GPS). Concentrations were measured with high-time resolutions while driving allowing investigations not possible with stationary equipment. In particular, this approach proves to be useful to identify those locations where numbers and mass attain high levels ('hot spots'). In general, concentrations of number and mass of particulate matter increase along with the degree of urbanisation, with number concentration being the more sensitive indicator. The lowest particle numbers and PM1-concentrations are encountered in a coastal and rural area: <5000 cm-3 and 6 g m-3, respectively. The presence of sea-salt material along the North-Sea coast enhances PM>1-concentrations compared to inland levels. High-particle numbers are encountered on motorways correlating with traffic intensity; the largest average number concentration is measured on the ring motorway around Amsterdam: about 160 000 cm-3 (traffic intensity 100 000 veh day-1). Peak values occur in tunnels where numbers exceed 106 cm-3. Enhanced PM1 levels (i.e. larger than 9 g m-3) exist on motorways, major traffic roads and in tunnels. The concentrations of PM>1 appear rather uniformly distributed (below 6 g m-3 for most observations). On the urban scale, (large) spatial variations in concentration can be explained by varying intensities of traffic and driving patterns. The highest particle numbers are measured while being in traffic congestions or when behind a heavy diesel-driven vehicle (up to 600×103 cm-3). Relatively high numbers are observed during the passages of crossings and, at a decreasing rate, on main roads with much traffic, quiet streets and residential areas with limited traffic. The number concentration exhibits a larger variability than mass: the mass concentration on city roads with much traffic is 12% higher than in a residential area at the edge of the same city while the number of particles changes by a factor of two (due to the presence of the ultrafine particles (aerodynamic diameter <100 nm). It is further indicated that people residing at some 100 m downwind a major traffic source are exposed to (still) 40% more particles than those living in the urban background areas. Classification: 5.

The purpose of this article is to describe determinants and spatial patterns of atmospheric carbon dioxide (CO2) in Phoenix, Arizona. Specifically, we use geographic information systems (GIS) and regression-based analyses to identify the human and biological factors that contribute to spatial and temporal variations in near-surface (2-meter height) atmospheric CO2 levels. We use these factors to create estimated surfaces of CO2 concentrations for the area. We evaluate the surfaces using records of CO2 from independent monitoring stations and transects. To investigate the temporal patterns and variations in CO2 concentrations, we estimate CO2 surfaces for the early mornings and the afternoons, on weekdays when traffic is heavy and spatially focused and on weekends when it is lighter and more spatially dispersed. Findings suggest there is a distinct relationship between the structure of Phoenix CO2 levels and spatial patterns of human activities and vegetation densities. Morning CO2 levels are higher than afternoon levels and correspond closely to the density of traffic, population, and employment. The spatial structure of human activity explains the pattern of CO2 better on weekdays than on weekends. CO2 surfaces reflect declining densities of human activity with distance from the city center, the pattern of irrigated agriculture in the Phoenix area, and riparian habitats on the urban fringe. Spatial and temporal patterns of CO2 concentrations are useful in understanding urban climate and ecosystem processes. *Classification: 5,4.*


We used a 10-year record (1990-99) of composited and cloud-screened reflectances from the Advanced Very High Resolution Radiometer (AVHRR) to test for phenological differences between urban and rural areas in the eastern United States deciduous broadleaf forest (DBF). We hypothesized that well-documented urban heat island effects would be associated with alterations in temperature-sensitive vegetation phenology. Our objectives were thus (a) to investigate possible differences in the start of the growing season (SOS) and end of the growing season (EOS) between the urban and DBF land covers, (b) to investigate related differences in greenness amplitude and fractional cover, and (c) to develop a generalized additive model (GAM) to predict the spatial variation of observed differences. By analyzing individual 1 degrees latitude by 1 degrees longitude blocks, we found that, on average, urbanization is associated with a growing season expansion of 7.6 days. Most of this effect is caused by an earlier SOS in urban areas. In all cases, urban regions had lower fractional cover and greenness amplitude. The GAM model failed to produce a viable model for differences in EOS, probably because it is dominated by photoperiod controls with only a minor temperature impact. SOS differences were predicted with an accuracy of about 2.4 days, with a GAM consisting of smoothed functions of mean annual average temperature, urban fractional cover, and the urban vs DBF greenness.
amplitude difference. We speculate that evidence of a phenological response to warming indicates that global warming, without reduction in DBF vegetation cover and greenness amplitude, may increase carbon sequestration in mesic deciduous forests. Classification: 7.


The origin of particulate matter in the urban atmosphere and the impact of its various sources are still subject to debate. This uncertainty cannot be alleviated by the sole use of 'classic' chemical parameters, creating a need for complementary indexes. We show that the use of coupled carbon and lead isotopes allows the identification of aerosol sources in the atmosphere of Paris, permitting a semi-quantification of their respective contributions. The two study sites, representative of background pollution and the influence of heavy road traffic, both show the domination of diesel exhaust fumes to the level of carbon in aerosols (either PM2.5 or PM10), while industry is the main vector for lead, with a contribution generally superior to 50%. Within the last 10 years, the origin of the inorganic phase shifted from road traffic towards industrial activities. (C) 2003 Elsevier Ltd. All rights reserved. Classification: 5.


Pollutant dispersion in street canyons with various configurations was simulated by discharging a large number of particles into the computation domain after developing a time-dependent wind field. Trajectory of the released particles was predicted using a Lagrangian particle model developed in an earlier study. A concentration correction scheme, based on the concept of "visibility", was adopted for the Lagrangian particle model to correct the calculated pollutant concentration field in street canyons. The corrected concentrations compared favourably with those from wind tunnel experiments and a linear relationship between the computed concentrations and wind tunnel data were found. The developed model was then applied to four simulations to test for the suitability of the correction scheme and to study pollutant distribution in street canyons with different configurations. For those cases with obstacles presence in the computation domain, the correction scheme gives more reasonable results compared with the one without using it. Different flow regimes are observed in the street canyons, which depend on building configurations. A counterclockwise rotating vortex may appear in a two-building case with wind flow from left to right, causing lower pollutant concentration at the leeward side of upstream building and higher concentration at the windward side of downstream building. On the other hand, a stable clockwise rotating vortex is formed in the street canyon with multiple identical buildings, resulting in poor natural ventilation in the street canyon. Moreover, particles emitted in the downstream canyon formed by buildings with large height-to-width ratios will be transported to upstream canyons. (C) 2001 Elsevier Science Ltd. All rights reserved. Classification: 5,8.
A 2D numerical investigation of the relationships between building height, gap distance, and wind velocity for flow in a street canyon is conducted using the computational fluid dynamics technique. The numerical scheme is first applied to a backward-facing step flow over a wide range of Reynolds numbers. Good agreement with experimental data from literature is found. It is then applied to study the Row around two rectangular buildings with various building heights, gap distances, and approaching wind velocities. Simulations show that the wind profile upstream of buildings is similar under different inflow wind velocities for a fixed building height. The maximum wind velocity in the street canyon largely depends on the configuration of the buildings. It increases dramatically when the gap-to-height ratio (G/H) of the buildings is increased from 0.75 to 1.0 but increases only mildly for G/H rising from 1.0 to 1.5. No significant increase in velocity can be found for a further increase in G/H. The how pattern in the street canyon becomes more complex with an increasing height to-gap ratio (H/G), particularly at low inflow velocity. Two or more stable recirculation vortices, which stack vertically in the street canyon, are found for H/G greater than or equal to 3. For those simulations with nonidentical buildings, natural ventilation tends to be better in the case of the higher building located upstream.

Classification: 8.

The effects of building configurations on pollutant dispersion around street canopies were studied numerically. The dispersion of pollutants emitted from ground sources was simulated by continuously discharging large number of particles into the computation domain. The mean wind velocities at each time-step were firstly computed by solving the time-dependent incompressible Navier-Stokes equations, while the fluctuated velocities were determined using a statistical procedure. The trajectories of the discharged particles were obtained from a Lagrangian particle model. Three categories of numerical simulation were conducted to study the effect of different canopy geometries on the pollutant dispersion. The computed wind field data were consistent with the wind field characteristics described in the previous wind tunnel studies. A counter-clockwise vortex was found resulting in high pollutant concentration at the windward side of the downstream building of the street canopy and low pollutant concentration at the leeward side of the upstream building. The increase in height of the urban roughness buildings would facilitate the pollutant dispersion in urban street canopy under certain building configurations. Two or more vortices stacked vertically in a street canopy were found when height of the upstream and downstream buildings of a street canopy was increased, preventing pollutants from escaping out of the canopy. (C) 2001 Elsevier Science Ltd. All rights reserved.

Classification: 5.

Spatial distribution of traffic-related pollutants within the street canyons in Guangzhou, China was monitored using a self-developed automatic sampling system of vertical section. The wind fields at the roof and street level were also field investigated. The results showed that average horizontal and vertical profiles of traffic-related pollutant concentrations within street canyon depended on wind direction at the roof level, leeward average concentrations were about I time higher than those observed at the windward side and there were differences in the daily variation profiles of pollutant concentrations between them; however, these concentration profiles at different heights of each side were similar, with CO, NO, NO2 and NOx concentrations decreasing with height above the ground. For ambient air at roof level, the daily variation profiles of the leeward pollutant concentrations with distinct diurnal fluctuation were different from those at different height level in the street canyon, but daily variation profiles of CO, NO, NO2 and NOx concentrations at windward roof level were consistent with those within the canyon, which corresponded with the traffic volume variation, except for O-3. It was deduced from these observed phenomena that pollutants from vehicular exhaust emissions in the urban street canyon were advected by wind vortices that covered most of the canyon from the windward side to the leeward side and ascended to the leeward roof edge with vortex. Then one part of these pollutants became part of circulating pollutants within the canyon by vortex being carried back to the windward side and sinking into the bottom of the street canyon and the rest of them diffused to the windward roof, but ambient air pollutant concentrations at the leeward roof were less affected by pollutants within the street canyon. Additionally, it was observed that O-3 daily variation with the concentration level increasing with height at the roof and on windward side of the street showed obvious diurnal fluctuation characteristic, and O-3 concentration levels at the roof were higher than those below the roof and there was no clear daily variation or vertical gradient at leeward side below the roof. (C) 2003 Elsevier Science Ltd. All rights reserved. Classification: 5.


The Beijing City Air Pollution Observation Field Experiment (BECAPEX) is described with emphasis on the "point-surface" research approach and composite analysis. The analysis results of measurements from four observation sites across the Beijing urban area from January to March indicate that the overall impact of urban emission sources in the heating season is significant, and the staggered impact of urban emission sources has different features at observation sites over different parts of Beijing in both heating and non-heating seasons. The pollutants NOx, SO2 and CO in the urban boundary layer have the in-phase variation features over a large area. O-3 concentrations at different sites have the same variation trend but its change is reversed phases with above pollutants. The pollutants over the urban area in heating and non-heating seasons also have the synchronous variation trend. The
comprehensive sounding of BECAPEX indicates that pollutants and aerosol vertical profiles are closely correlated to the vertical structure of the large-scale inversion layer in the urban boundary layer over the urban area. The localized 3D-structural features of local urban polluting processes associated with the peripheral areas are discussed with a "point-surface" comprehensive sounding technique. *Classification: 5,8.*


Ground-based, optical monitoring of the NO2 column density and aerosol optical thickness is described. The instrument consists of a solar radiation spectrometer and a conventional sunphotometer, both mounted on a sun-tracker and operated automatically. From daytime measurements in Chiba during the winter of 1998, variations of NO2 and aerosol are analyzed. Because of the capability of simultaneous, real time measurement, this method is particularly suitable for air pollution studies in city areas. *Classification: 5.*


Continuous measurements of air pollutants (NOx, SO2, O-3) by passive samplers and chemical components of rainwater in Kyoto were made from 1996 to 2002. An eruption on Miyake Island and urban climate changes were found to greatly affect the seasonal changes of air pollutants and chemical components of rainwater in 2000 and 2001. Several peaks of NO2 concentrations at mountains around the Kyoto basin occurred in the spring and summer of 2000 and 2001. The higher NO2 concentration in the summer of 2000 and 2001 may be attributed to the formation of a temperature-inversion layer. Atmospheric SO2 concentrations became abruptly higher in September 2000, and the concentration range of atmospheric SO2 in mountains around the Kyoto basin was 1.0-7.9 ppb from September 2000 to July 2001, which was about two-times higher than that until 1999. These results suggest that a large quantity of SO2 discharge by the eruption on Miyake Island may have affected the increase of atmospheric SO2 concentrations in Kyoto. The O3 concentrations in the summer of 2000 and 2001 were higher than that until 1999. The cause may be O3 production by a photochemical reaction with an increase of anthropogenic NOx in the warm months after 2000. The concentration of gaseous H2O2 was very low when the SO2 content was high in September, 2000, and in June and July, 2001, which may have been due to a large quantity of SO2 discharge that occurred as a result of the eruption on Miyake Island. These results indicate that gaseous H2O2 may largely determine the formation of aerosol sulfate in the warm months. Thus, the increase of anthropogenic or natural SO2 emission may significantly affect the increase Of SO42-concentration in rainwater. *Classification: 6,5.*
Measurement of the hydrogen isotope ratio (D/H ratio) in atmospheric methane by isotope ratio mass spectrometry has been less developed so far, compared to that of the carbon isotope ratio (C-13/C-12 ratio). This is because of the requirement for a large sample size (about 1001 of atmosphere, assuming a methane concentration of similar to 1.8 ppm) and the complicated and time-consuming method of sample preparation. In this study, we examined an on-line method for measurement of the D/H ratio of atmospheric methane by a gas chromatography/high-temperature conversion/isotope ratio mass spectrometry (GC/TC/IRMS) technique. This method is less laborious, more rapid (about 1 h per sample) and attains high precision (+/- 3.1 parts per thousand) using a much smaller sample (similar to 120-360 ml of atmosphere). Its application to isotopic characterization, and hence identification of source of methane and estimation of methane budgets, was demonstrated by examination of urban atmosphere samples collected in November 2001 at Yokohama, Japan. The D/H ratio of atmospheric methane in the urban area ranged throughout the day from -98 parts per thousand to -118 parts per thousand, showing a fluctuation with time that correlated with that of the methane concentration. Assuming that the fluctuation was caused by local methane emissions from anthropogenic sources, i.e., vehicles, industries, and landfill sites, the contribution from each source to the local methane was estimated by a combination of the D/H ratio with the C-13/C-12 ratio of atmospheric methane. The estimation indicates that the contribution from each source varied considerably throughout the day and that the methane emitted from landfill sites averaged 70%. 


Urban air concentrations of six selected volatile aromatic and five selected volatile chlorineated compounds were measured at Hiyoshi in Yokohama, Japan, from November 1994 to October 1997 using an automated gas chromatographic (GC) system. Continuous measurements were made with 1 h cycles over a 1- or 2-day period. The data from these studies were analyzed and interpreted with respect to variabilities in the urban air concentrations and the diurnal changes in relation to prevailing sources. The mean concentrations of aromatic hydrocarbons were in the range of 0.38-1.13 ppb benzene, 1.13-8.95 ppb toluene, 0.12-0.88 ppb ethylbenzene, 0.03-0.18 ppb m-, p-xylene, 0.23-0.46 ppb o-xylene and 0.24-0.38 ppb 1,2,4-trimethylbenzene. Although variations exist in the measurements, the mean distributions in the aromatic hydrocarbons were 10.4% benzene, 69.7% toluene, 7.7% ethylbenzene, 5.4% m-, p-xylene, 1.6% o-xylene and 5.3% 2,4-trimethylbenzene. Diurnal variations in the aromatic hydrocarbons were found to be very similar to each other and positively correlated with traffic activities. On the other hand, the mean concentrations of 1,1-dichloroethene, 1,1,1-trichloloethane, trichloroethene,
tetrachloroethene and 1,4- dichlorobenzene were 0.08-0.86, 0.08-0.93, 0.24-0.79, 0.03-0.24 and 0.07-0.42 ppb, respectively. The concentrations of these chlorinated hydrocarbons were always lower and less variable than those of the aromatic hydrocarbons. (C) 2000 Elsevier Science Ltd. All rights reserved. Classification: 5.


A wide range of urban ecosystem studies, including urban hydrology, urban climate, land use planning, and resource management, require current and accurate geospatial data of urban impervious surfaces. We developed an approach to quantify urban impervious surfaces as a continuous variable by using multisensor and multisource datasets. Subpixel percent impervious surfaces at 30-m resolution were mapped using a regression tree model. The utility, practicality, and affordability of the proposed method for large-area imperviousness mapping were tested over three spatial scales (Sioux Falls, South Dakota, Richmond, Virginia, and the Chesapeake Bay areas of the United States). Average error of predicted versus actual percent impervious surface ranged from 8.8 to 11.4%, with correlation coefficients from 0.82 to 0.91. The approach is being implemented to map impervious surfaces for the entire United States as one of the major components of the circa 2000 national land cover database. *Classification: 4,6.*


The concentrations of particulate organic matter were measured from May to September 1998 in urban area of Algiers and in municipal waste landfill of Oued Smar. For the sake of comparability, organic aerosols were also monitored at Montelibretti (Italy) in June of the same year. In addition to n-alkanes and polycyclic: aromatic hydrocarbons (PAH), monocarboxylic n-alkanoic acids accounted for a large portion of identified organic compounds of aerosol at both Algerian sites. All these species were more abundant at Oued Smar than in downtown Algiers. At the urban site, concentration levels reached by n-alkanes and PAH highlighted the strong impact of motor vehicle emission resulting over the city area. Instead, at the Oued Smar landfill n-alkane and PAH contents depended upon the nature and account of the wastes burnt, and their behaviours were consistent with a pyrolytic origin. Il-Alkanoic acids rather originated from the bacterial activity. By contrast, n-alkanes and n-alkanoic acids at Montelibretti seemed to be released by biogenic sources, whereas PAH presence was related to downwind transport of air parcels from Rome metropolitan area, (C) 2001 Elsevier Science Ltd. All rights reserved. *Classification: 5.*

Classification: 5,2.


Atmospheric aerosol particles were collected at Qingdao (36 degrees 04'N, 120 degrees 21'E) in October 1996 in order to investigate the characteristics of aerosols in coastal areas of China. Morphologies and element compositions of individual particles were analyzed using a transmission electron microscope and an energy dispersive X-ray spectrometer. Particulate sulfate and nitrate were detected with nitron and barium chloride films pre-coated on the collecting grids. The collected particles were classified into two modes according to their diameter: fine mode (D-p < 1.0 mu m) and coarse mode (D-p greater than or equal to 1.0 mu m). It was found that spherical particles dominated the fine mode in all urban and marine samples. Analyses of morphology and composition suggested that these particles were droplets containing ammonium sulfate. Diameters of the droplets were mainly in the range of 0.04-0.11 mu m. Sulfuric acid or partially neutralized sulfate particles were not found in any samples. These results suggested that sulfuric acid was neutralized by ammonia rapidly in the gas- or aqueous-phase after it was formed through homogeneous or heterogeneous reactions, and the droplets were formed through gas-phase nucleation followed by condensation, aqueous-phase chemistry and coalescence. Particles internally mixed with sulfate and nitrate were detected in both coarse and fine modes. Element analysis indicated that most of them contained mineral elements, suggesting that the soil particles were more suitable for the internal mixture of sulfate and nitrate than other kinds of particles. In terms of number frequency, sulfate-containing particles dominated the line mode and nitrate-containing particles dominated the coarse mode. Some particulate nitrate was attributed to the formation of soot particles. (C) 2000 Elsevier Science Ltd. All rights reserved. *Classification: 0.*


A comprehensive study of the turbulent structure of the atmospheric boundary layer in unstable conditions has been carried out using turbulence data obtained from the Gobi desert, grassland, suburban and urban sites based on the same instrumentation, data acquisition and data processing systems. The normalized standard deviations of u and v over the suburban and urban sites are systematically smaller than those over the Gobi desert and grassland sites. However, the normalized standard deviations of w, temperature theta and humidity q over the suburban and urban sites are quite close to those over the Gobi desert and grassland sites. The normalized humidity standard deviations are quite similar to those of temperature over the grassland and suburban
sites. The temperature and humidity spectra are found to be independent of atmospheric stability in all frequency ranges, but spectra obtained from the Gobi desert and grassland sites reveal flatter peaks than those of the suburban and urban sites in the lower frequency range. The normalized spectral curves of temperature and humidity are independent of atmospheric stability both at high and low frequencies. The spectral characteristics of humidity over the grassland and suburban sites are similar to those of temperature, but the humidity spectra over the Gobi desert site are quite different from temperature spectra due to evaporation and/or large eddies in the boundary layer. 


Classification: 2.

Zhang, N., Jiang, W. M. and Hu, F. (2004b) 'Numerical method study of how buildings affect the flow characteristics of an urban canopy', Wind and Structures, 7, 159-172

The study of how buildings affect wind flow is an important part of the research being conducted on urban climate and urban air quality. NJU-UCFM, a standard k-epsilon turbulence closure model, is presented and is used to simulate how the following affect wind flow characteristics: (1) an isolated building, (2) urban canyons, (3) an irregular shaped building cluster, and (4) a real urban neighborhood. The numerical results are compared with previous researchers' results and with wind tunnel experiment results. It is demonstrated that the geometries and the distribution of urban buildings affect airflow greatly, and some examples of this include a changing of the vortices behind buildings and a "channeling effect". Although the mean air flows are well simulated by the standard k-epsilon models, it is important to pay attention to certain discrepancies when results from the standard k-epsilon models are used in design or policy decisions: The standard k-epsilon model may overestimate the turbulence energy near the frontal side of buildings, may underestimate the range of high turbulence energy in urban areas, and may omit some important information (such as the reverse air flows above the building roofs). In ideal inflow conditions, the effects of the heights of buildings may be underestimated, when compared with field observations. 

Classification: 8.

Zhang, R. J., Xu, Y. F. and Han, Z. W. (2004c) 'A comparison analysis of chemical composition of aerosols in the dust and non-dust periods in Beijing', Advances in Atmospheric Sciences, 21, 300-305

Dust events occurred frequently in Beijing in recent years. In this work, 120 aerosol samples were collected in two typical dust events (21-22 March and 15 May) and a non-dust period in Beijing from March to May 2001. Samples were analyzed for major elemental components by the Proton Induced Xray Emission (PIXE) method. Results show that the enrichment factors of crustal elements such as Mg, Al, and Ti
had little differences between the dust period and the non-dust period in Beijing, while the enrichment factors of other elements that have a relation to anthropogenic emissions were very low during the dust period. The results derived by using multivariate factor analysis from the observation data show that the sources such as soil dust, industry, and fuel combustion were among the major contributors to the particles in Beijing. Classification: 5.


Toxic air pollutants in street canyons are important issues concerning public health especially in some large Asian cities like Guangzhou. In 1998 <18% of Guangzhou citizens used public transportation modes, with a majority commuting on foot (42%) or by bicycle (22%). Of the pedestrians, 57% were either senior citizens or students. In the present study, we measured toxic air pollutants while walking along urban streets in Guangzhou to evaluate pedestrian exposure. Volatile organic compounds (VOCs) were collected with sorbent tubes, and PM10 and CO were measured simultaneously with portable analyzers. Our results showed that pedestrian exposure to PM10 (with an average of 303 µg m-3 for all samples) and some toxic VOCs (for example, benzene) was relatively high. Monocyclic aromatic hydrocarbons were found to be the most abundant VOCs, and 71% of the samples had benzene levels higher than 30 µg m-3. Benzene, PM10 and CO in walk-only streets were significantly lower (p<0.05) than in traffic streets, and the differences in exposure levels between new urban streets and old urban streets were highly significant (p<0.01). Pedestrian exposure to toxic VOCs and PM10 was higher than those reported in other public transportation modes (bus and subway). The good correlations between BTEX, PM10 and CO in the streets indicated that automotive emission might be their major source. Our study also showed that the risk to pedestrians due to air pollution was misinterpreted by the reported air quality index based on measurement of SO2, NOx and PM10 in the government monitoring stations. An urban roadside monitoring station might be needed by air quality monitoring networks in large Asian cities like Guangzhou, in order to survey exposure to air toxics in urban roadside microenvironments. Classification: 5.


Classification: 5.

Motor vehicle emissions usually constitute the most significant source of ultrafine particles (diameter < 0.1 pm) in an urban environment. Zhu et al. (J. Air Waste Manage. Assoc., 2002, accepted for publication) conducted systematic measurements of the concentration and size distribution of ultrafine particles in the vicinity of a highway dominated by gasoline vehicle. The present study compares these previous measurements with those made on Interstate 710 freeway in Los Angeles. The 710 freeway was selected because more than 25% of the vehicles are heavy-duty diesel trucks. Particle number concentration and size distribution in the size range from 6 to 220 nm were measured by a condensation particle counter and a scanning mobility particle sizer, respectively. Measurements were taken at 17, 20, 30, 90, 150, and 300 m downwind and 200 m upwind from the center of the freeway. At each sampling location, concentrations of carbon monoxide (CO) and black carbon (BC) were also measured by a Dasibi CO monitor and an Aethalometer, respectively. The range of average concentration of CO, BC and total particle number concentration at 17 m was 1.9-2.6 ppm, 20.3-24.8 mg/m(3), 1.8 x 10(5)-3.5 x 10(5)/cm(3), respectively. Relative concentration of CO, BC and particle number decreased exponentially and tracked each other well as one moves away from the freeway. Both atmospheric dispersion and coagulation appears to contribute to the rapid decrease in particle number concentration and change in particle size distribution with increasing distance from the freeway. Average traffic flow during the sampling periods was 12,180 vehicles/h with more than 25% of vehicles being heavy-duty diesel trucks. Ultrafine particle number concentration measured at 300 m downwind from the freeway was indistinguishable from upwind background concentration. These data may be used to estimate exposure to ultrafine particles in the vicinity of major highways. (C) 2002 Elsevier Science Ltd. All rights reserved. Classification: 5.


Motor vehicle emissions usually constitute the most significant source of ultrafine particles (diameter <0.1 mum) in an urban environment, yet little is known about the concentration and size distribution of ultrafine particles in the vicinity of major highways. In the present study, particle number concentration and size distribution in the size range from 6 to 220 nm were measured by a condensation particle counter (CPC) and a scanning mobility particle sizer (SMPS), respectively. Measurements were taken 30, 60, 90, 150, and 300 m downwind, and 300 m upwind, from Interstate 405 at the Los Angeles National Cemetery. At each sampling location, concentrations of CO, black carbon (BC), and particle mass were also measured by a Dasibi CO monitor, an aethalometer, and a DataRam, respectively. The range of average concentration of CO, BC, total particle number, and mass concentration at 30 in was 1.7-2.2 ppm, 3.4-10.0 mg/m(3), 1.3-2.0 x 10(5)/cm(3), and 30.2-64.6 mg/m(3), respectively. For the conditions of these measurements, relative concentrations of CO, BC, and particle number tracked each other well as distance from the freeway increased. Particle number concentration (6-220 nm) decreased exponentially with downwind distance from the freeway. Data showed that both atmospheric dispersion and coagulation contributed to the rapid decrease in particle number concentration and change in particle size distribution with increasing distance from the freeway. Average traffic flow during the sampling periods was 13,900 vehicles/hr. Ninety-
three percent of vehicles were gasoline-powered cars or light trucks. The measured number concentration tracked traffic flow well. Thirty meters downwind from the freeway, three distinct ultrafine modes were observed with geometric mean diameters of 13, 27, and 65 nm. The smallest mode, with a peak concentration of $1.6 \times 10^5$/cm$^3$, disappeared at distances greater than 90 m from the freeway. Ultrafine particle number concentration measured 300 m downwind from the freeway was indistinguishable from upwind background concentration. These data may be used to estimate exposure to ultrafine particles in the vicinity of major highways. 

Classification: 5.


This article presents the results of measurements of the isotopic composition and concentration of atmospheric carbon dioxide, performed on air samples from Krakow (Southern Poland) in different seasons of the year. A simple isotope mass balance model has been applied to determine the contributions of different sources of CO2 to the urban atmosphere of Krakow city: the latitudinal/regional background, biospheric contributions and anthropogenic emissions. The calculations show that during the summer and early autumn the dominant contribution to local CO2 peaks is the biosphere, making up to 20% of atmospheric CO2 during the nocturnal temperature inversion in the lower troposphere. During early spring and winter, anthropogenic emissions are the main local source. Classification: 5.