I Report on the work of the subproject*

1 Summary

The goal of SATURN is to lead to a better understanding of urban air pollution as a prerequisite for finding effective solutions to air quality problems and for a sustainable development in the urban environment. For this purpose, the subproject's main scientific objective is to substantially improve our ability of establishing urban scale source-receptor relationships. Specifically, new modelling tools are being developed and previous ones are being refined. Activities take place at all relevant scales, i.e. from microscale / local scale up to urban scale / regional scale. Ongoing work refers to the formulation of comprehensive modelling systems comprised of existing or novel sub-grid models and chemical modules. Most new developments will be evaluated in the frame of validation or model intercomparison exercises. Furthermore, these activities will be used for the analysis of physical and chemical processes.

SATURN is structured into three clusters. The *Local Cluster* deals with microscale and local scale phenomena investigated via wind tunnel and field experiments as well as numerical models. Accordingly, the *Urban Cluster* tackles urban-to-regional scale matters (without resolving individual obstacles) with field experimental campaigns and numerical models. Both clusters include development and validation of models and novel modules. The *Integration Cluster* gives special emphasis on the integration of models in Air Quality Management Systems (AQMS) and the testing/validation of such systems with collected data. The progress in these clusters considers advancement in model development and evaluation as well as performance of experimental campaigns and advances in the integration of the scientific results. Focus in all clusters gradually moved from gaseous pollutants to particulate matter.

Significant progress has been obtained within the *Local Cluster* in 2001 concerning field measurements, laboratory experiments and modelling studies:

- New high-quality data were collected. Several field studies were performed aiming mainly at investigating particle size distributions and their chemical properties, while mean and turbulent airflow data sets were collected in wind tunnels. The development of tools for urban air quality assessments according to the European legislation was also the focus of experimental work.
- There has been significant progress in the development and use of microscale models. Applications include simulations of the air motion, turbulent field, heat fluxes close to building walls, vehicles motion, pollution dispersion and assessment of road-user exposure to fine particulate air pollution using full-scale measurements and physical modelling in wind tunnels.
- Validating of microscale models was continued. Numerical modelling of airflow characteristics and particulate matter was evaluated against collected data.

Research activities progressed also in the *Urban Cluster*, the main achievements being:

- Intensive databases were established with regard to photochemical pollution and particulate matter. Several experimental campaigns were carried on during the reporting period in various European urban environments, and observations were made available to the scientific community.
- Urban scale models and methods used therein were substantially refined. Particular modules and parameterisations are now available for addressing specific features of the urban atmosphere, e.g. surface fluxes and physico-chemical characteristics of pollutants.

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- New knowledge regarding quality assurance of urban scale models resulted from model intercomparisons and sensitivity studies. In this respect, the ESCOMPTE-INT intercomparison exercise was launched. QA/QC measures adopted and implemented in SATURN were in accordance with the new requirements of the European legislation.
- The FOSEC activity was initiated for summarising the state-of-the-art on photochemical air pollution in Southern Europe.

Within the *Integration Cluster*, knowledge and tools acquired in SATURN were further synthesised in 2001, so that they can be used directly in support of urban air quality management. SATURN deliverables of policy relevance in the reporting period included:

- Versatile integrated Air Quality Management Systems. These systems may be operated by local authorities and other non-expert users.
- Improved tools for predicting the frequency and severity of air quality limit value exceedances in cities.
- Pollution exposure models and tools for analysing personal indoor and outdoor exposure, with emphasis on fine particulate matter.
- Methods for formulating cost-effective air quality abatement and for developing appropriate action plans.
- SATURN's Synthesis and Integration Report specially aimed at municipal air pollution professionals.

2 Aims of work in the reporting period

SATURN's final phase commenced during the reporting period. The main objective of this phase is the successful completion of the subproject. Particular scientific aims of this phase are: (i) Process description by the aid of models, (ii) Conclusive validation of model systems, (iii) Compilation of complete validation datasets, (iv) Conclusion of the Framework Project and (v) Completion of integrated Air Quality Management Systems. Work scheduled in each cluster for the reporting period is listed in the following sections.

2.1 Local cluster

<u>Model and module development</u>: Improvement of existing local scale models, simultaneous simulation of air motions, turbulent fields, dispersion and chemical transformations and most of their interactions at the local scale, development of novel aerosol modules.

<u>Field experiments</u>: Initiation and completion of local scale field campaigns, including urban aerosol experiments, and dissemination of information about available data.

<u>Laboratory experiments</u>: Support of field data by means of measurements in wind tunnels.

<u>Model evaluation</u>: Application of evaluation strategies for obstacle resolving models using field and wind tunnel data sets.

2.2 Urban cluster

<u>Model development</u>: Improvement of existing urban scale models, refined description of interactions between larger scale meteorological phenomena and urban scale processes.

<u>Scale interactions in models</u>: Adequate consideration of scale interactions in simulations of dispersion and chemical transformation processes in urban areas. Analysis of existing methods to link micro vs. meso vs. regional scales using appropriate module interfaces.

<u>Field experiments</u>: Initiation and completion of mesoscale field campaigns and dissemination of information about available data.

Model evaluation: Development of an evaluation strategy for urban air pollution models and model validation through procedures developed in SATURN and using data which fulfil the specifications worked out in the subproject.

2.3 Integration cluster

Framework project: Integration of knowledge and tools acquired in the frame of SATURN in order to make them directly suitable for applications related to environmental policy.

Development and improvement of integrated systems: Further improvement of urban Air Quality Management Systems (AQMS). Development of air quality assessment systems integrating monitoring networks and models. Development of specific deliverables to be directly used in support of AQMS.

Exposure and cost-benefit estimation: Links of AQMS to data on health and other risks, consideration of costs and benefits of measures: calculation of population exposure, inclusion of health effects, cost-assessment, cost-optimisation and cost-benefit analysis.

3 Activities in the reporting period

A steady progress of the scientific research in SATURN was achieved through close co-operation within each task of the subproject. From the application point of view, the Framework Project represents an additional guarantee for co-ordinated work in SATURN. The progress and future steps within SATURN were discussed at the 5th SATURN Workshop that was held in Loutraki, Greece, on 19 March 2001.

3.1 Local cluster

Experimental field studies as well as model development and evaluation progressed significantly in 2001. Focus has mainly been research related to urban aerosol.

Field studies. A key objective of experimental activities was to conduct measurements sufficiently detailed to study the dispersion and the fastest chemical and physical transformations of pollutants in streets, around point sources etc., with the aim to establish local scale source-receptor relationships based on measurements. Field studies aimed also at investigating particle mass/size distributions and their chemical properties. Such experiments were conducted in several European urban locations, including Stockholm, Copenhagen, Marseille, and Budapest as well as at a semi rural site in the UK. Elemental and organic carbon measurements were performed in a very busy street in Copenhagen and related to other traffic pollutants. Measurements of NO, NO_2 and O_3 were conducted in St. Petersburg.

Wind tunnel studies. Complex wind flows and dispersion characteristics at street intersections were studied in Surrey. Other laboratory experiments were carried out in the new wind tunnel of the Hamburg University.

Model development and validation. Microscale models were applied to various street-canyon geometries, in some cases taking into account windward-facing wall heating. Corresponding results were further assessed and analysed in comparison with high-quality wind tunnel data. Two building effects models were compared for assessing the uncertainty associated with their application. A Lagrangian particle model and a Eulerian-Lagrangian method accounting for moving vehicles were further developed and validated. Moreover, urban aerosol and pollution exposure models were refined and evaluated. Finally, episode forecasting models were improved and tested.

3.2 Urban cluster

Several improvements were achieved during the year concerning the development of model systems, individual models and modules as well as scale interactions in models. Field campaign data sets collected in the frame of SATURN served as the basis for validating models describing air pollution episodes and meteorological conditions favouring their occurrence. Furthermore, the FOSEC activity was launched with the aim to understand better the formation of ozone in South European cities.

Urban scale experiments. Several field studies were performed aiming to investigate pollution incidents (photochemical pollution, high particulate matter levels associated with increased human exposure), related physico-chemical transformations and corresponding meteorological conditions. Examples are the campaigns in Marseille and Milan as well as experimental activities in Greece (Finokalia and in the Aegean Sea). Experimental methods were developed for simultaneous measurements of ozone, ozone precursors and indicators. Progress was also achieved in the field of Lidar remote sensing. Finally, the roughness length was mapped for the area of Bonn in Germany.

Model development. Urban scale model systems were further developed during the reporting period. Mesoscale particle models were formulated, while modules and parameterisation schemes were developed for addressing specific features of the urban atmosphere, with emphasis on the heterogeneous chemistry related to the direct and indirect generation of fine particles. Furthermore, interactions between larger scale meteorological phenomena and urban scale processes were described with improved methods. In particular, coherent time dependent boundary conditions were used based on meteorological pre-processor results, and suitable model hierarchies were applied for nested simulations up to the regional scale.

Model evaluation. The ESCOMPTE_INT mesoscale model intercomparison was launched within the reporting period. It is related to the ESCOMPTE pre-campaign organised and conducted by French institutions in summer 2000. The intercomparison exercise aims at assessing the modelling capabilities for reproducing the mesoscale circulation and for describing the dispersion of a passive tracer released in the Marseilles region. Moreover, various modules were evaluated, including those dealing with pollutant transport, solar radiation, thermodynamics and chemistry.

The FOSEC activity. FOSEC is SATURN’s contribution towards a better understanding of photochemical pollution in South European areas, a topic that needs special attention due to its potential impact on human health in these regions. This action aims at summarising recent findings on urban photochemistry in southern Europe as reflected in the scientific results of various groups as well as raising questions for further investigation of this topic.

3.3 Integration cluster

The contributions to this cluster explicitly address the needs of air pollution information for policy makers and other stakeholders involved in air quality management. During the reporting period, many contributions supported urban air quality management while at the SATURN level further steps were taken for improving the interaction between the scientific community and municipal air quality specialists. In particular, work on Air Quality Management Systems (AQMS) focused on new data and models, uncertainty analysis and technical improvements, while concepts and purposes of AQMS were reconsidered. Furthermore, AQMS gradually started connecting to fields adjacent to the core air quality field: exposure, related environmental fields and, to a lesser extent, cost assessments. Finally, activities within this cluster in the reporting period include the successful testing of mesoscale models in Southern Europe, combinations of mesoscale and hotspot models and the practical application of prognostic modelling.

3.4 QA/QC measures

The Quality Assurance (QA) / Quality Control (QC) measures adopted and implemented in SATURN take into account the new requirements for the harmonisation of European air quality policy based on recent Framework (96/62/EC) and Daughter Directives. Ultimate objective is to provide air quality information of adequate merit to be used for policy support. Relevant activities in the reporting period focused on the compilation of databases, the improvement and evaluation of emission data, and the evaluation of numerical air quality models.

4 Principal results

4.1 Local cluster - Field studies

Field studies of particle size distributions and chemical properties had high priority for many groups. A summary is given in the following paragraphs.

A field campaign was performed at wintertime in the 1.1 km long Söderledstunnel in central Stockholm for measuring particle mass (TEOM) and number size distribution (DMPS). There is a pronounced daily variation in mass and number concentrations, principally reflecting the traffic variation. The variation of largest particles registered by the DMPS instrument (848 nm) resembles to that of measured $PM_{2.5}$ mass. At morning rush hours (between 8 and 9 am) ultrafine particles of the 52 nm size fraction show a pronounced peak, while the finer 12 nm particle fraction has a clear minimum. The data were compared with calculations carried out by a CFD model coupled with the aerosol dynamical model MONO32. In the case of the two finer modes, a good agreement is obtained for the particle number concentrations only with velocity corrected emission factors (Figure 1). Although qualitatively consistent with emission measurements, it was not possible so far to compare the magnitude of emission factors suggested for the Nucleation and Aitken 1 mode with published experiments. It should be noted that vehicle exhaust emission measurements rarely yield representative quantitative emission factors for particles smaller than 20-30 nm (Johansson).

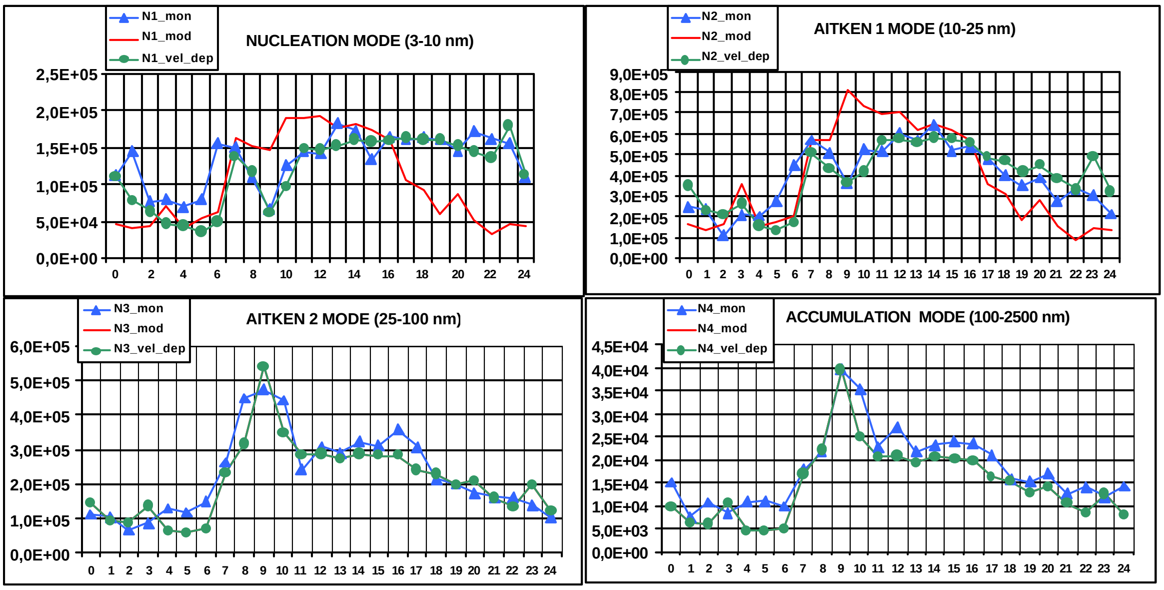


Figure 1: Particle number concentrations in Stockholm: Measured (solid line with triangles) vs. computed values (solid line: constant emission factor, solid line with circles: velocity dependent emission factors).

Measurements of ultrafine particles in Copenhagen with a Differential Mobility Analyser (DMA) continued at both the street station Jagtvej and the urban background station at H.C. Ørsted Institute. Data analysis allowed determining emission and number size distribution for the actual car fleet, separately for diesel and petrol vehicles. The measurements were supplemented with 24 hours and 1-hour measurements of PM_{10} by TEOM at street level. The on-road measurements of emissions from traffic were compared with dynamometer measurements on selected types of vehicles. Two measurement campaigns were performed in an apartment at Jagtvej for determining the penetration and indoor deposition of particles by fitting the concentration rate balance under the assumption of negligible indoor sources. Preliminary measurements with 1-hour time resolution of organic and elemental carbon (OC/EC) were performed during a campaign in a street in central Copenhagen. The monitoring of NO_x/NO, CO, TSP, O_3 etc. under the Danish Air Quality Monitoring Programme was continued and used in support of the data analysis. It was found that non-traffic sources contributed to the PM_{10} measurements by approx. 50%. In contrast to the correlations EC vs. CO and OC vs. NO_x/CO which were found to be rather low, a clear correlation between EC and NO_x was observed, indicating that diesel traffic affects significantly EC. Analysis of indoor particle deposition led to negligible rates in the particle size range 100 - 500 nm. In the size range below 100 nm the deposition rate increases with decreasing particle diameter to a value of approximately 1 h^{-1} at 10 nm. The penetration efficiency shows a maximum of 60% at 100 nm (Palmgren).

The activity in Marseilles focused on the preparation of the ESCOMPTE experiment and data analyses. A complete experimental system was set up at 30 m above street level on the roof of a building located downtown, close to a very busy street. Two counters (SMPS and an optical system) were used to measure size distributions in the range 10 nm-15µm. Aerosol particles were collected with a low-pressure 13 stages cascade impactor. PM_{10} and PM_1 mass concentrations were measured with two TEOM equipped units with the respective size selective inlets. One aethalometer was installed for BC measurements. Wind velocity and direction, air temperature and photometric information were also available on the experimental site. In the morning, the size distribution is largely dominated by the particles of the Aitken peak (30-40 nm), which increases from 10 h to 13 h to reach a value 3 times larger than in the morning. Then the peak value decreases by a factor 6 at 16 h, and the distribution becomes clearly bimodal. The evening traffic rush is not detected at roof level, likely because the sea breeze transports the particles away. The morning sequence indicates clearly photochemical secondary particle production lasting for about 2 hours. During a summertime episode the mass distribution is initially dominated by the coarse particles composed essentially of marine elements (Na^+, Cl^-) and nitrates. Three days later the mass distribution is largely modified and dominated by the particles of the accumulation mode. The particles are composed principally of sulphates (50-60%) and ammonium (about 30%), which represent more than 80% of the total ionic mass of this mode's size ranges, the 400–700 nm class being the most loaded. The marine signature dominates no longer in the coarse particles essentially composed of nitrates. The mass concentrations are globally reduced at the episode end, but are still dominated by particles of the accumulation mode. Compared to other classes, the smaller particles of this mode (100-400 nm) are least reduced. The coarse particles are totally dominated by nitrates and their concentrations are still much lower than those of the accumulation mode (Despiau).

A field campaign at the University of Hertfordshire, a semi rural site in the UK, was performed in the spring of 2001 to sample PM_{10} and size fractionated aerosol using MOUDI. Moreover, size fractionated aerosol was analysed for mass and metal species. The results included the particle mass concentration and the concentration of the metals, iron, zinc, nickel, copper and lead in various size fractions during two campaigns (Sokhi).

Source profiles of Cd, Cu, Ni, Pb, V and Zn for waste incineration, traffic, oil and coal burning were applied for model calculations. Aerosol sampling for fine size range aerosol particles was carried out by Harvard-type impactors at the sources and at two receptor points in central Budapest during November-December 1999, while samples were analysed and the data evaluated in 2000. Source signatures for coal and oil burning were adopted from the fine size range aerosol measurements carried out in the plume of power plants operating in the Czech Republic. It was found that high amount of Zn, Pb and Cu is emitted from a waste incinerator in Budapest, while regarding the traffic profile, the most important element is still Pb, in spite of the rapid decrease of its relative contribution during the past 5 years (Bozó).

The measurement campaign in St. Petersburg was continued in 2001. In addition to routine maintenance procedures, DOAS instruments were calibrated by using test gases. Parallel to the DOAS measurements, NO, NO_2 and ozone were monitored also using standard monitors. The collected data was analysed using different statistical techniques. Backward dispersion calculations performed with the OSPM (Denmark) and OND-86 (Russia) dispersion models led to the emission factor estimates for the actual car fleet structure in St. Petersburg. Data collected in the framework of the project was directly fed into the automatic municipal pollution monitoring and management system to be used by the city authorities for decision-making on environmental issues and for analysing air pollution levels in central St. Petersburg. These measurements show that concentrations of most of the species (except NO_2) are rather moderate and well inside Russian ambient air quality standards. The results of monitoring and modelling have also been used in preparation of the new version of the national guideline on dispersion modelling, which will go into effect in 2002 (Genikhovich).

4.2 Local cluster - Wind-tunnel studies

Dispersion at a simple urban intersection comprising two perpendicular streets was the subject of a wind tunnel study. Concentration and flow field measurements were undertaken to determine the importance of the exchange of pollutants between the streets and to investigate source-receptor relationships at the intersection. The results show that significant exchanges occur at intersections between two streets and that as a consequence pollution emitted in one street can penetrate far into the other. A further consequence is the development of a persistent structure in the concentration field within a street, with receptors on opposite sides being primarily affected by entirely separate sets of sources. The exchanges are driven by minor departures from symmetry in the geometry or orientation of the intersection and are likely to be the norm in practice. Based on the measured data the building effects models ADMS-BUILD and PRIME were compared. The similarities between the two models were identified and the consequences of their differences were quantified (Savory).

A detailed aerodynamic model of the city district of Hanover was built in the large boundary layer wind tunnel 'WOTAN' which was inaugurated at Hamburg University in 2001. A wind tunnel boundary layer corresponding to the model scale (1:250) was generated utilising a combination of vortex generators and floor roughness elements. Mean and turbulent boundary layer properties were determined, including wind profile, turbulence profile, roughness length, spectral density of the turbulent kinetic energy and integral length scales of all three components of the wind vector (Schatzmann).

4.3 Local cluster - Model development and validation

Several German research teams led by the University of Hamburg launched the AFO2000 project VALIUM "Development and validation of instruments for the implementation of European air quality policy in Germany". Representing the German core contribution to SATURN, VALIUM aims to develop a model system and other tools for urban air quality assessments according to the European Air Quality Framework Directive (96/62/EG) and its Daughter Directives. In a collaborative effort between the University of Stuttgart (IER) and Hamburg, the Research Centre Karlsruhe (IMK4 Garmisch), the Lower Saxony State Agency for Ecology (NLÖ, Hanover) and a private consultancy (Ingenieurbüro Lohmeyer, Karlsruhe), a comprehensive data set for the validation of the model system is being generated, based on a combination of field and laboratory data. Field measurements take place in a busy street canyon and its vicinity in Hanover, Germany. Both the model system and the data set will be made publicly available at the end of the project (Schatzmann).

The model VADIS was adapted and improved to be applicable for the local scale. It was validated against data obtained in Southern France and also against wind tunnel data, presenting in both cases a good performance (Borrego).

A Eulerian-Lagrangian method developed 1998/1999 for road tunnels was further extended and modified for pollutant dispersion in street canyons and crossroads. The method is based on CFD modelling and accounts for moving vehicles and the flow and turbulence induced by them. Work in 2001 focused on both theoretical advancement of the aforementioned method and applications to actual city areas. The theoretical development was oriented mainly to model dynamic situations of "stop-and-go" in intersections. The model was applied to real situations in the city of Brno and in the frame of an exercise also to a street structure in Hanover in Germany (Podbielski strasse). The predictions were favourably compared to field measurements in the Czech Republic (Jicha).

Similar work was done in Austria. Comprehensive air quality measurements and SF_6-tracer tests were performed in the vicinity of a road tunnel portal in Austria, and a suitable dispersion model for road tunnel portals was developed based on seven tracer experiments on two days. During all experiments wind speeds were quite low (0.6 to 1.6 m s^{-1}). The jet stream from the tunnel portal was found to depend strongly on the ambient wind field. Due to the observed large changes in wind direction during each experiment, the position of the jet stream varied enormously, i.e. receptor points in the vicinity of the tunnel portal were exposed to the polluted air of the jet stream only for a certain time during each experiment. This specific effect was found to be more important than the diffusion due to shear stresses along the surface between the jet stream and the ambient wind field. The rather simple Lagrangian dispersion model developed describes the momentum of the jet stream, buoyancy effects due to temperature differences between jet stream and ambient air, and the influence of changing ambient wind directions on the jet stream position. It is the first time that the latter process is considered in a dispersion model for road tunnel portals. Model results were compared with observations of the tracer tests and with results of a microscale Eulerian model using the standard k-ε model. While the new model agreed satisfactorily with the observations, the Eulerian model severely overestimated concentrations in the centre of the jet stream, apparently because it fails to treat the changing position of the jet stream (Almbauer).

Benzene concentrations for several streets in Antwerp were computed with the AURORA model. The results were compared with diffusive sampler measurements carried out in 101 street locations during four periods of five days in 1998. Calculated benzene concentrations based on hourly emissions obtained for 1963 road segments in Antwerp showed a very good agreement with the measurements when averaged over periods of 5 days and over all streets. For a more detailed analysis a streetwise comparison of measured and calculated benzene concentrations would be needed (Mensink).

Initial results of a new study of fluctuations in pollutant concentration at the intersection of two building-lined streets (or group of four buildings) are available. The hypothesis taken is that it is rather short periods of exposure to high concentrations of vehicle exhaust emissions at roadside locations that is causing annoyance, distress, and perhaps some asthma symptoms in the children studied. The large amount of variability at these fine scales also is likely to be the cause of the large individual-level variability in exposure of road-users The importance of transient, highly localised air pollution concentration maxima is discussed, looking forward to a major integrated field/lab/modelling study of microscale emissions, dispersion, and exposure at a Central London location that will take place over the coming four years (Colvile).

Modelled urban particulate matter concentrations were compared with field data sets. The influence of various chemistry and aerosol processes on aerosol evolution was evaluated quantitatively utilising the aerosol dynamical model MONO32. The OSPM model was evaluated against the data set measured in Runeberg St. and the CAR-FMI and GRAL models against a field dispersion data set in a roadside environment (Kukkonen).

Research has continued on the application of modelling to investigate abatement strategies in the context of attaining targets set for London in the UK Air Quality Strategy and EU Directives. The two most difficult pollutants are PM_{10} and NO_2, for both of which it is necessary to superimpose the contributions from local roads or hot spot areas on urban background levels across the city. Thus, the Urban Scale Integrated Assessment Model, USIAM, has been applied to investigate a wide range of abatement scenarios for PM_{10} from transport, based on source apportionment to distinguish contributions from different types of vehicles in different districts or specific roads. There are two areas of London where attainment of standards appears particularly difficult, one in central London, and the other in the vicinity of Heathrow airport to the west of London. A separate study has therefore started, based on similar principles to the USIAM model, but addressing in detail the limited area surrounding the airport. More fundamental research on modelling dispersion has continued using the MIMO model. MIMO has been used to extend previous 2 dimensional studies of parallel canyons of varying geometry to three-dimensional flow patterns (ApSimon).

Transport-chemistry models are powerful tools for the evaluation of emission reduction strategies, for providing information to the public, and as the central part of models for forecasting episodes. NERI has developed the THOR system as an air pollution forecasting tool that provides 72-h air pollution forecasts four times a day for three different scales: rural areas, urban background and street level. The forecasts from the THOR system are available at www.dmu.dk/AtmosphericEnvironment/thor (Hertel).

4.4 Urban cluster - Urban scale experiments

Associated with ESCOMPTE, the UBL/CLU experiment was performed from June 5 to July 15, 2001 focusing on the urban atmosphere of the city of Marseilles. Apart from its relevance regarding model validation, the project aimed at documenting the 3D structure and diurnal variation of the urban boundary layer over a large city, within coastal breeze systems and under sunny low wind conditions. Moreover, information was collected for describing the radiation and energy budget over the urban canopy (Mestayer).

Aerosol concentrations were measured at two sites in the Mediterranean: the Finokalia site on the island of Crete (Greece) and aboard the Aigaion, which was located in the Eastern Mediterranean area between the Greek mainland and the island of Crete. The campaign indicated that fine particulate matter in the Eastern Mediterranean is a complex mixture of different inorganic and organic species. Nucleation events were observed more often in the winter period compared to the summer and the aerosol mass concentration was lower in winter compared to summer data. Resuspension of dust and other natural sources (e.g. sea salt, Saharan dust) have a significant contribution to the aerosol mass (Colbeck).

Two experimental campaigns performed in Milan (winter and summer 2001) focused on the analysis of particulate matter (PM_{10}, $PM_{2.5}$, HNO_3, HNO_2, particulate nitrate and sulphate) with the aim to investigate the chemical composition of gaseous pollutants and aerosol and to detect the related spatial patterns (Finzi).

The Raman Lidar and Pump and Probe OH techniques, which are both ideally suited for comparison with model results, were further developed. The Raman lidar allows simultaneously measuring the ozone and water vapour even in highly polluted atmospheres.

The Pump and Probe OH experiment is a novel in situ method for measuring the total hydrocarbon reactivity with OH. Measurements with the latter method for different air pollution conditions allow computing a new indicator for characterising NO_x vs. VOC sensitivity of photochemical pollution. Thus, the Pump and Probe OH technique may directly contribute to testing and validating model results (Calpini).

Measurements have been carried out within the limits of Kiev with the purpose of studying features of surface ozone formation. The sites of measurements were located in a southern part of the city at the distance of several hundreds of meters up to 2 km from motorways and 4-8 km from high stacks of large-scale thermal power stations. The obtained data were analysed together with emission rates of ozone precursors, meteorological and aerological parameters. The results of measurements show that the Kiev city domain involves both NO_x and VOC controlled areas of ozone pollution (Sosonkin).

Several tests with synthetic mode ERS SAR interferometry data as well as with CORINE land use data were performed for an area near Bonn, Germany. The major aim of the tests was to investigate how the typical scattering of the relative phase measurement found in the synthetic interferometry correlates with the aerodynamic roughness length. The results show a high correlation between roughness classes derived as a function of the standard deviation of the unwraped phase within a 500m×500m grid cell and the roughness for all major land use categories (Smiatek).

4.5 Urban cluster - Model development

Urban scale model algorithms progressed significantly in the reporting period. Many of them followed the demand for various spatial resolutions rising by the need to identify hot spots in the polluted urban areas. In particular, model areas for urban pollution problems span from tens to hundreds of kilometres at resolutions that can be as low as a few meters. To match these requirements, new developments were necessary regarding scale interactions in models.

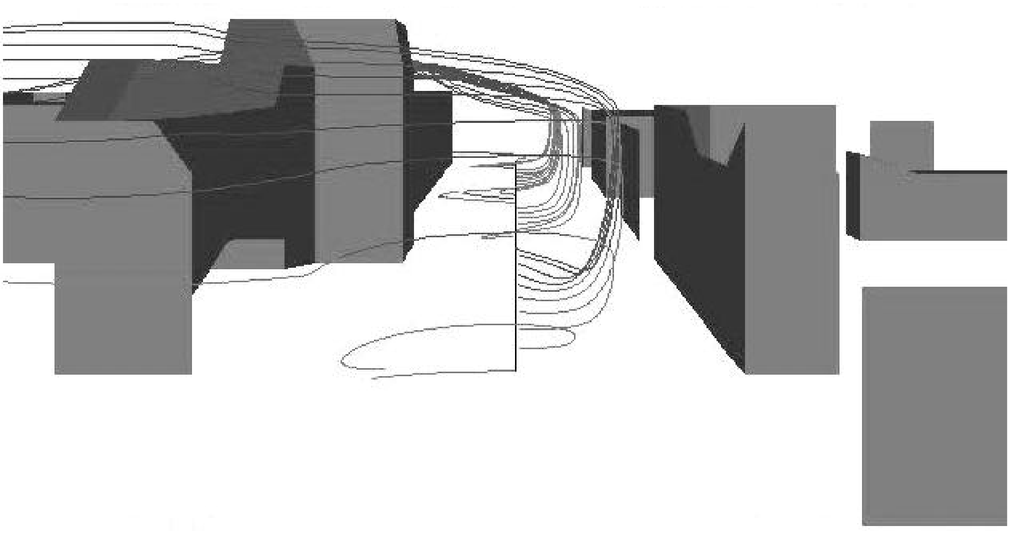


Figure 2: Simulation of a tracer experiment in an urban street canyon with MITRAS. Buildings are indicated as shaded blocks. The tracer is released at a line source in the centre of the street. Advection of the tracer is visualised by streamlines. Above the urban canopy, the wind is blowing from right to left.

Within the German VALIUM project, the model system M-SYS is under development for evaluating air quality in different spatial detail. The system is based upon the 3D meteorological microscale model MITRAS (Figure 2), the mesoscale model METRAS and the respective chemical transport models MICTM and MECTM. The basic approach is to nest an obstacle-resolving microscale model (MITRAS) into a mesoscale model (METRAS), and similarly the microscale chemical transport model MICTM into the mesoscale MECTM. M-SYS shall generate air quality maps with different horizontal resolution ranging from several kilometres down to a few meters within street canyons. These air quality maps represent statistics of air concentrations as required by the European Air Quality Framework Directive and its Daughter Directives (Schlünzen).

In the last year the mesoscale model GRAMM was extended and successfully validated for the city of Graz. Air quality in cities located in pre-alpine regions is much affected by the frequent occurrence of low wind conditions. The Lagrangian Particle Model GRAL was developed to allow for the special features of pollution dispersion under low wind conditions. The effect of meandering on the Eulerian autocorrelation function is taken into account in the model by means of a more generalized interpretation of the inter-correlation function ρ. This allows for an auto-adaptation of the model from the low wind formulation to the standard formulation of Lagrangian particle models depending on the mean wind speed (Almbauer).

The mesoscale model MEMO was successfully used to simulate NO_x concentrations across London over a 3-day period in 1999, and the results were found to be in fair agreement with measurements. This is the first time an Eulerian model has been applied and tested in such a way for London (ApSimon).

The newly developed 3D Finite Volume Model FVM uses the finite volume approach for solving the pressure and transport equations. A new parameterisation for heat and momentum fluxes in the urban environment was developed and implemented into the model. Moreover, the TAPOM model was developed for simulating pollutant transport and chemical transformation. TAPOM describes aerosol formation and its interaction with solar radiation (Calpini).

Two model systems were developed and applied for the Lombardy Region. The first one consists of 3D Eulerian photochemical simulation models (STEM-FCM, CALGRIDFCM or UAM-V), meteorological pre-processors (CALMET, RAMS) and emission modules (POEM, POEM-PM, TESEA). The second system combines stochastic models and soft computing techniques for setting up real time predictors to be used as alarm system. Furthermore, the CALGRID model was modified to allow for changes in chemical schemes; this goal was obtained by implementing the Flexible Chemical Mechanism (FCM) interface (Finzi).

Filtering of computed concentration fields was proposed as a new approach for dispersion calculations at the urban scale. Moreover, a new PDF approach to tracer experiments data treatment for validation of dispersion models was developed. Finally, an innovative description of urban air pollution and urban meteorology was introduced that uses equations of hydro- and thermodynamics of porous media (Genikhovich).

A modelling system was developed for predicting traffic volumes, emissions from stationary and vehicular sources and atmospheric pollutant dispersion in an urban area. A semi-empirical model for evaluating the mass-based concentrations of urban particulate matter was proposed, starting from the assumption that local vehicular traffic is responsible for a substantial fraction of the street level concentrations of both PM_{10} and NO_x, either due to primary or secondary emissions, i.e. re-suspension from street surfaces (Kukkonen).

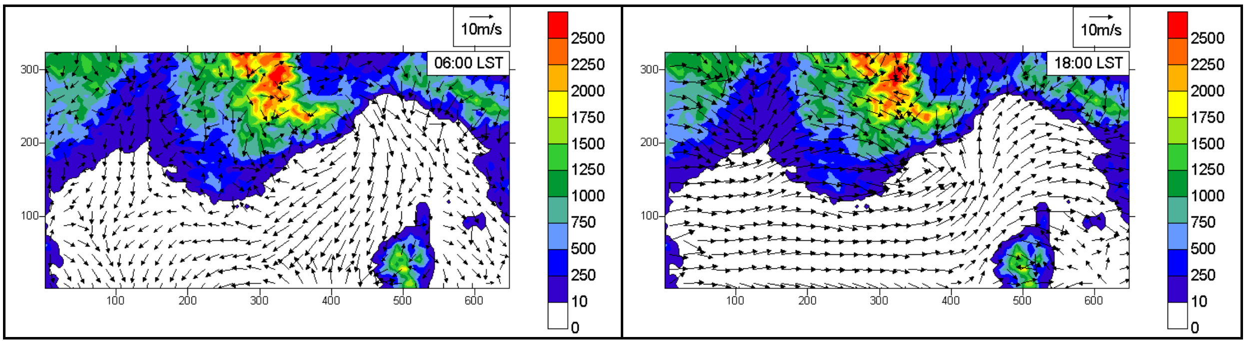
Statistical modelling and forecasting of NO_x concentrations in the urban area of Tel Aviv was carried on during the reporting period. Results were based on 1995-1998 measurements from three automatic monitoring sites, located within the Tel Aviv conurbation near the main arterial roads. The results show a seasonal trend of maximum daily NO_x concentrations from high levels in winter to lower concentrations in summer. During workdays the diurnal cycle of NO_x concentration is characterised by a double peak which mainly reflects the traffic flow pattern; O_3 cycles reveal a single peak. Maximum ozone concentrations occur during the spring/summer months and are lower in winter (Levitin).

The French communal model SUBMESO was developed for simulating the air flow, the turbulent fields, the physics and microphysics, and the transport-diffusion-transformation of reactive pollutants within an urban area. It includes modules for dynamics (Reynolds averaged or LES), microphysics, terrain and soils, chemistry (transport-diffusion-transformation), and a grid generator designed for complex terrain. The tropospheric chemistry model MOCA is implemented in the chemistry-transport module TRANSCHIM. Recent developments include turbulence schemes, a novel meteorological pre-processor, the urbanised soil/canopy model SM2-U, and a domain-nesting controller. These developments aim at very high-resolution simulations over strongly heterogeneous urban areas (Mestayer).

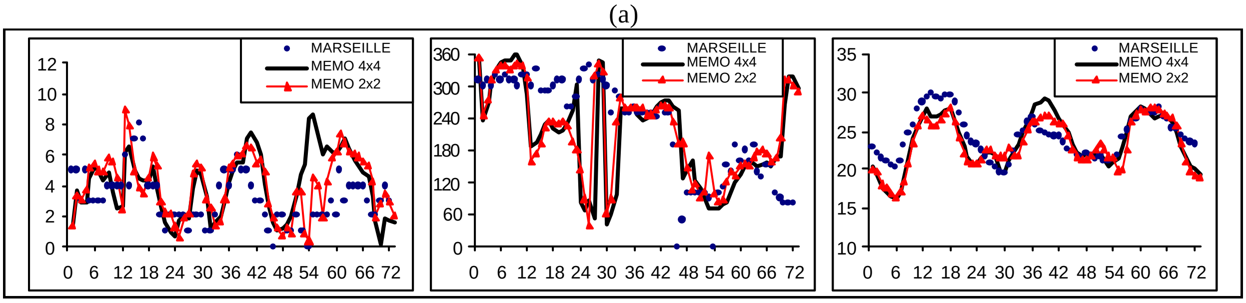
4.6 Urban cluster - Model evaluation

The model intermomparison ESCOMPTE_INT is based on the database of measurements set up after the pre-campaign performed in 2000. The study aims at verifying the performance of mesoscale models in a real case application when observations exist and the model user is allowed to freely adopt the best configuration for the exercise. ESCOMPTE_INT started in July 2001 with the participation of 16 European research groups (Galmarini).

The already mentioned urban boundary layer UBL/CLU experiment is supposed to lead to a data base allowing for testing and validating urban energy exchange schemes and high resolution meteorological and chemical transport models. Aiming to apply the model validation concepts, the project has the objectives: (i) to validate the urban canopy thermodynamic schemes which are the basis of high resolution simulations of the urban atmosphere with "obstacle resolving" boundary layer models; (ii) to validate high resolution modelling methods, including domain nesting, and to run sensitivity studies of high resolution urban air quality simulations; (iii) to provide data allowing to develop and/or validate satellite data analysis methods for providing input data to urban scale models (Mestayer).



(a)



(b)

Figure 3: (a) Results of MEMO for the wind field over the Marseilles area on 30 June 2000 at 06:00 and 18:00 LST at a resolution of 2×2 km^2. The colour scale corresponds to the orography. (b) Comparison of simulated wind speed, wind direction and temperature in Marseilles at 10m over ground at two different resolutions (2×2 km^2 and 4×4 km^2).

The urban scale model MEMO was evaluated in order to assess the model's ability to predict the mesoscale wind flow patterns over complex terrain. For this purpose, the simulation of the mesoscale wind flow patterns in the complex area of Marseilles was selected as a major case study, the detailed ESCOMPTE pre-campaign experimental results serving as the basis for the validation. Comparison between model results and measurements (Figure 3) reveals that the model successfully reproduces the wind flow patterns, the performance improving with the resolution, especially for areas close to the sea (Louka).

4.7 Urban cluster - The FOSEC activity

Several inter-related thematic areas were identified within FOSEC as important topics linked with the ozone formation: (i) the meteorological conditions favouring high photochemical pollution in South European cities, (ii) the scale interactions and ozone formation, (iii) the regional and local emissions of ozone precursors, (iv) the indicators of photochemical pollution and the NO_x and VOC sensitivity and (v) the role of aerosols. Apart from gathering the available scientific work on urban photochemistry in Southern Europe, FOSEC aims at raising some questions for further investigation of the topics concerning each of the above thematic areas. These questions are related to (i) the development of a synoptic classification for indicating the occurrence probability of photochemical pollution and the most severe episodes, (ii) the provision of experimental/numerical studies showing the importance of scale interactions regarding ozone formation and the related impact of the background concentration of precursors in North and Central Europe, (iii) the contribution and relation of regional and local emissions to the photochemical pollution in South European cities, (iv) the importance of biogenic VOCs as ozone precursors, (v) the main indicator compounds used so far, (vi) the identification of the dominant sensitivity regimes in particular South European cities, and (vii) the role of aerosols, namely secondary and sea-salt aerosols as well as Saharan dust, and the importance of nitrous acid emissions.

4.8 Integration cluster

In 2001 further progress was made in the integrated model development. This included conceptual and technical improvements of Air Quality Management Systems (AQMS). Steps were taken to utilise the possibilities that are being opened by new communication techniques, not only for better information exchange between professionals, but also for public information purposes. To provide better information on benefits of measures to users, further work was done on population exposure. As usual, most activities took place within the PI contributions. However, some important parts of the work were carried out in collaborative projects. There were also special activities at the SATURN level. The progress of the application-oriented Framework Project is described in the section on policy-relevant results.

A short inquiry on the use of AQMS in Europe was carried out within the SATURN community. The replies indicated that such systems were not yet commonly used, with the exception of Sweden and UK and, to a lesser extent, Russia. In several other countries, single cities existed which used an AQMS and others were known to consider this as an option.

Work on modelling population exposure has progressed further. The model EXPAND ("Exposure to air pollution, especially nitrogen dioxide and particulate matter") has been developed for the evaluation of population exposure and is very relevant for the Integration Cluster. The model calculates exposure both in traffic and elsewhere (work, home, other). It has been designed to be utilised by the municipal authorities for urban planning (Kukkonen).

AirGIS is a GIS based system for human exposure modelling. It was developed for automatically depicting from digital maps input parameters needed and for registering data required for mapping street pollution levels, e.g. in entire urban areas, using the street pollution model OSPM. Various human exposure studies have been and are being carried out in Denmark and serve as the basis for further model development and validation. Personal monitoring of particulate matter indicates that exposure to indoor air pollution plays an important role for the $PM_{2.5}$ exposure. The next few years the AirGIS system will be applied for calculating human exposures of cohorts in ongoing and historical epidemiological studies in Denmark. A description of the methodologies used in the Danish exposure studies is available on www.dmu.dk/AtmosphericEnvironment/Exposure (Hertel).

The EU research project ISTHAR ("Integrated software for health, transport efficiency and artistic heritage recovery") was launched. Its aim is to create an advanced software suite for the analysis of the effects of measures implemented in time scales ranging from a few hours to a year to improve the quality of the environment, citizens health and conservation of monuments. The suite will include both existing and newly developed models, covering the areas of citizens' movements, transport, vehicle emissions, noise and safety, pollutant dispersion, building related atmospheric emissions, health, and monument degradation. These tools will be integrated by the use of a GIS and a user-friendly interface software. The model suite will be an innovative tool for advanced urban management and will allow the integrated analysis of the various environmental effects of technical and non-technical measures. This will represent an attractive alternative to the usual separated analysis of the effects of such measures on the various elements of the urban environment (Almbauer).

The development of the URBIS system was continued. In this work improvements were made both in terms of refinement and in scope. As URBIS aims to cover both the mesoscale and the local scale, the system has a very high demand on computer time to be able to fully resolve the hot spots that are usually the main cause of limit value exceedance. The calculation efficiency was improved significantly. The system also aims at the support of assessment and integrated decision-making on various environmental fields. For this purpose, a combined study for air quality, noise and external safety, harmonising approaches and data structures, was underway in 2001 (Van den Hout).

An urban transport emission model was developed for the City of Antwerp based on hourly emissions for streets and road segments in the Antwerp area. The hourly emissions are computed as functions of road type, vehicle type, fuel type, traffic volume, vehicle age, trip length distribution and the current ambient temperature. The urban transport emission model was integrated in the urban air quality management system AURORA. This system was designed for urban and regional policy support and reflects the state-of-the-art in air quality modelling, using fast and advanced numerical techniques (Mensink).

Applications that can serve as modules of a contemporary IUEMIS (Integrated urban environmental management and information system) were materialised in the reporting period, in particular components that are flexible and modular, and also re-usable. In parallel, theoretical investigations were done regarding related aspects and characteristics (i) to further investigate the requirements related to the system design and development in air quality related IUEMIS, (ii) to develop air quality forecasting tools based on statistical methods, and (iii) to develop the methodological and technical framework that will allow for a step-by-step development of IUEMIS developments (Karatzas).

The development of an air quality management system for urban areas was the purpose of work combining several activities, including (i) the development and implementation of the transport emission model TREM; (ii) the adaptation and improvement of the local scale model VADIS; and (iii) the validation and application of the models. The integrated system is planned to be used as a tool for decision support in urban air quality management. The overall work included also the development of a suitable graphical interface (Borrego).

A decision support system has been set up for the Lombardy Region. Among its constituents, forecast and alarm systems were developed based on the application of models. Examples for further system components are routines for sensitivity analyses and databases from experimental campaigns (Finzi).

The already mentioned German project VALIUM aims to develop and validate a hierarchy of numerical models in the software package M-SYS. This model system is supposed to provide the input for local and regional air quality maps to serve as tools for the execution of European air quality policy. Guidance will be worked out for the preparation of emission data, as they are needed for the application of the model system. A method for the statistical analysis of time series will be developed which allows classifying the dispersion situations into representative clusters. In addition, a high quality data set for the validation of the modelling system will be developed. This data set will be based on a combination of field and corresponding wind tunnel experiments (Schatzmann).

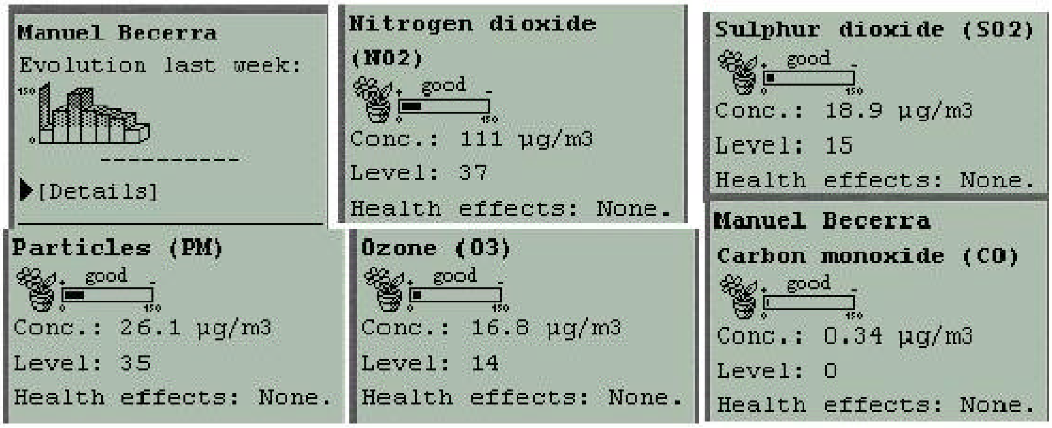


Figure 4: WAP service to provide air quality monitoring and forecasting data.

A contribution to the IST project APNEE ("Air pollution network for early warning and on-line information exchange in Europe") showed how the citizen can benefit by new mobile and Internet technologies. A tool was developed and demonstrated that allows the citizen to receive customised air quality information via e-mail or by subscribing to the SMS service which produces messages related to alert levels for various pollutants in terms of monitored or predicted data. The SMS messages are associated to health warnings depending on the characteristics of the pollutant concentrations. The tool provides to the user the capability to see air quality monitoring and forecasting data as well as, within a WebGIS application, the pollution information at different times and spatial scales. Figure 4 displays some examples of the WAP service for Madrid. The system is also running for other European cities (San José).

The AirQUIS system was further developed in the reporting period and its functionalities and operation speed were improved. The system was applied on various occasions to support air quality management. Demonstration of the use of the AirQUIS system linked to telecommunication networks and services to provide air quality data readily available to citizens was performed through the Grenland urban area server site of the APNEE project (Larssen).

Atmospheric variables were included in time-series models for short-term predictions of urban air pollution and tests were performed for different European urban areas. In particular, the problem of identifying transfer-function models for data series of ozone from two European regions, one continental site in the urban area of Berlin and one Mediterranean site in Sicily, has been addressed. The multivariate approach was found to be not much superior to the higher-order autoregressive approach used. It was also observed that using predictions for meteorological variables like temperature results in considerable improvement in prediction accuracy, so the group recommends using the temperature forecast (Herbarth).

4.9 QA/QC measures

The harmonisation of European air quality policy based on recent Framework (96/62/EC) and Daughter Directives establishes new requirements for air quality modelling including definition of the Modelling Quality Objectives as a measure of modelling results acceptability. In this context, the uncertainty for modelling and objective estimation is defined as the maximum deviation of the measured and calculated concentration levels, over the period considered, by the limit value, without taking into account the timing of the events. The Quality Objectives for air quality modelling established by the directives are presented in Table 1.

Table 1: Modelling Quality Objectives established by European Directives

Pollutant	Quality Indicator	Quality Objective	Directive
SO_2, NO_2, NO_x	Hourly mean	50-60%	1999/30/EC
	Daily mean	50%	
	Annual mean	30%	
PM, Pb	Annual mean	50%	
CO	8-hour mean	50%	2000/69/EC
Benzene	Annual mean	50%	

The QA/QC measures adopted and implemented in SATURN take into account these new requirements in order to provide air quality information of adequate merit to be used for policy support. During the reporting period, principal activities of the project related to QA/QC implementation focused on:

i) Compilation of the databases of known and adequate quality to be used for model validation. This work is based on information obtained during field campaigns and wind tunnel measurements. During the reporting period, the regional photochemical campaign ESCOMPTE (Mestayer), local scale campaign in Hanover and large boundary layer wind tunnel experiment at Hamburg University (Schatzmann) are reported.

ii) Improvement and evaluation of emission data. A new model for traffic emission calculations using improved vehicle emission factors is developed and evaluated for Hanover area. The transport emission model TREM specially adapted for line sources was developed and integrated in a GIS environment for improving spatial data processing (Borrego). To guarantee the quality of emission data generated in the project, the SATURN guidelines for setting-up urban emission inventories are being followed (Sturm).

iii) Evaluation of the numerical air quality models based on comparison of model results with measured data and model intercomparison. Several contributions reported by the Pls are related to the model evaluation at meso- and local scales (Louka, Calpini, Finzi) and are based on validation data sets collected within the project. The model intercomparison exercise MESOCOM is ongoing (Galmarini).

5 Main conclusions

Substantial progress was achieved in 2001 in all three SATURN clusters. The main findings may be summarised as follows:

Field experiments led to a better insight into the characteristics of polluted urban air. Special focus was given on the particulate pollution. Specifically, it was found that traffic is the dominating source of ultrafine particles in busy streets, but also the traffic contribution to PM_{10} is significant. The PM_{10} mass and most of the analysed species are dominated by the fine fraction. The contribution of waste incineration to toxic metal load was also investigated together with the relative contribution of traffic sources. The application of averaged PM data, collected continuously, in combination with routine monitoring data and manually counted traffic rates, is a powerful tool to determine contribution and emission factors of particles from diesel and petrol vehicles from the actual car fleet under normal driving conditions. The method is useful for demonstrating the effect of air pollution abatement measures.

Other local experiments concentrated on photochemical pollution especially in South Europe showing that photochemical processes lead to secondary particle generation. Regarding the chemical composition, the coarse mode (composed of sea salts and nitrates) is most important at the beginning of the event, but decreases strongly when the pollution increases, to become much lower than the accumulation mode. The latter mode is totally dominated by sulphates and ammonium and the smaller particles of this mode become progressively more important during the event. Special attention was given to the physico-chemical properties of aerosols in marine environments in the Eastern Mediterranean showing that fine PM is a complex mixture of different inorganic and organic species, while resuspension of dust and other natural sources (e.g. sea salt, Saharan dust) contribute considerably to the aerosol mass.

The focus of other experiments was the investigation of the thermal characteristics of the urban atmosphere and their effects on the boundary layer flows and structure. Proof was also provided that open-path optical gas analysers are efficient tools for monitoring urban air pollution, while further development of the Raman Lidar and Pump and Probe OH techniques was performed as well as further collection of interferometry data.

Dispersion and emission models have been developed in order to evaluate urban particulate matter concentrations. Work has included evaluating the aerosol behaviour in urban areas using detailed chemical and aerosol dynamical models. In addition, transport-chemistry models for evaluation of emission reduction strategies, for providing information to the public, and as the central part of models for calculation of human exposure and for forecasting episodes have been developed.

Valuable new knowledge regarding quality assurance of urban scale models resulted from sensitivity studies and intercomparison activities, the main example for the latter category being ESCOMPTE_INT, an exercise which was recently launched based on the ESCOMPTE pre-campaign data sets. Moreover, SATURN stimulated numerous fruitful discussions between numerical model developers and experimentalists, which resulted into an improved model validation strategy. It is characteristic for the urban canopy layer that the velocity and concentration fluctuations are larger than the corresponding mean values causing a large inherent uncertainty in the data, and need to be quantified before the data can be used for validation purposes. Methodology for the quantification was developed and applied. On the other hand, wind-tunnel experiments have been carried out to quantify up to which degree numerical model results depend on domain size and geometrical resolution. SATURN provided the opportunity for physical model studies within which the sensitivity of model results with respect to these two variables was investigated and quantified.

Several groups continued their work on AQMS. This work included extension of the systems with new types of data and models, analysis of the uncertainties in the results, increasing the efficiency of the systems, improving the user-friendliness, adapting the systems better to the needs of users. The activities were not limited to improvement of given systems, but also addressed more basic issues such as rethinking AQMS concepts and reconsidering their purposes. In is interesting to see that there are both converging and diverging tendencies. On the one hand a convergence of the approaches and techniques is visible, which is caused by the growing European component in this work field (both scientifically, due to the collaboration in SATURN and in EU projects, and from the users' view, due to the increasing impact of EU legislation). The systems are designed more and more to address air quality in terms of the European air quality directives. Furthermore, databases, and, to some extent the modelling techniques as well, become more and more harmonised. On the other hand, the emerging ITC techniques provide possibilities that in the current exploratory phase tend to cause divergence in the approaches and techniques. The AQMS are slowly connecting also to fields adjacent to the core field of SATURN, i.e. exposure of population and related environmental fields. Progress is slower, however, regarding the addition of methods to assess costs of measures. This is probably due to the difficulty of allocating air quality related costs to so-called non-technical measures that are typically taken in cities, such as spatial planning or traffic management.

Other important results of the work in 2001 include the successful testing of mesoscale models in various areas in Southern Europe, the further development of combinations of mesoscale and hot spot models and the improvement of deterministic and statistical prognostic models (of which some address long-term predictions for future years, others short-term forecasts for tomorrow). Another interesting development is the set up of a methodological framework for evaluating air quality in different spatial detail with the aim to generate air quality maps representing concentration statistics as required by the EU air quality legislation. It should be noted that methodology and general requirements for the QA/QC measures adopted and implemented in SATURN take into account the legislative requirements for providing air quality information of adequate merit to be used for policy support.

6 Policy-relevant results

SATURN's orientation towards application by policy-makers is structured along two strands: (i) the policy relevance of the work in individual contributions, as defined in the project definition; and (ii) the orientation of SATURN as a whole, which is largely being shaped by SATURN's Framework Project.

Policy-relevant results of the individual contributions

Some of the activities in the Local and Urban Clusters were focusing primarily on scientific objectives, with an only indirect link to the final use by decision makers. Apart from its scientific value, this work is also needed to improve and verify the methods and tools that are eventually used to support air pollution policy making. Important examples are the systematic and coordinated activities that aim at verifying model reliability. ESCOMPTE_INT, the new model intercomparison exercise, will contribute to the amelioration of modelling tools used for policy definition and assessment. In the Local and Urban Clusters there were several activities that directly supplied results to city authorities for the support of decision making. Most of the activities in the Integration Cluster were primarily aiming at providing to city authorities the insights and tools that have been developed in more basic research. Most of that work focuses on the development and further improvement of integrated computer systems (Air Quality Management Systems), which are capable of assessing urban air quality, calculating forecasts (depending on the system type, this concerns projections to future years or forecasts for the next day(s)) and analysing the effectiveness of measures to reduce air quality problems. Apart from city authorities, also the public is an important target of such systems. An overview of the work in the Integration Cluster was given in previous sections.

The activities at the SATURN sub-project level

This section has been written from the perspective of SATURN's Framework Project. For a general analysis of the application-orientation of SATURN (where basic research is linked through various steps to direct application oriented work) and the role of the PI contributions to this process, the reader is referred to the policy relevance section of the 1998 report. The policy relevance section in the 1999 report focused on the perspective of city authorities: how do their needs relate to SATURN's research priorities? Further steps have been taken at the SATURN level for improving the interaction between the scientific community and municipal air quality specialists.

The draft report 'The assessment of urban air quality', written under SATURN's Framework Project and finalised in 2001, discusses the implications of the new European air quality legislation and is aiming on the one hand at municipal air quality professionals, to explain the legal requirements and scientific/technical possibilities, and on the other hand at the scientific community, to clarify one of the major perspectives of potential users of their results.

Another important activity in 2001 carried out within the Framework Project was the drafting of SATURN's Synthesis Report. In contacts with potential users of SATURN's results, it had become clear that the scientific reports as produced by PIs were, although quite adequate for communication within the scientific community, hardly suitable for communication with potential users. Also the Annual Report, in which SATURN's progress is summarised in a more accessible way, turned out to be unattractive, and partly even not readable for municipal air pollution professionals. It was therefore decided to write, as part of SATURN's Framework Project, a report on SATURN in a different form, specially aimed at municipal air pollution professionals.

7 Aims for the coming year

All SATURN activities will be completed in the coming year. From the scientific point of view, this requires achieving the following milestones:

- Interpretation of campaigns and set-up of experimental data sets.
- Completion of the ESCOMPTE_INT model intercomparison exercise and FOSEC.
- Conclusion of model development and validation based on data sets collected in EUROTRAC-2.
- Presentation of improved integrated urban Air Quality Management Systems.
- Completion of Framework Project and compilation of the SATURN Final Report

The application oriented aims in the year 2002 are:

- Finalisation of concepts for integrated urban AQMS taking advantage from advances in computer technology and telematics.
- Linking of AQMS with health effects and cost-effectiveness analyses
- Establishment of structural contacts between SATURN and urban authorities.