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EXPOSURES TO EXHAUST-GENERATED PM_{2.5} IN TRAFFIC AND OTHER MICROENVIRONMENTS

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Abstract

Personal PM_{2.5} exposures are significantly increased by traffic-generated particles, especially while in traffic. Recent studies have indicated that exhaust particles may be more toxic than particles in general and therefore it is crucial to include them in health relevant environmental assessments. The current work uses personal and microenvironment PM_{2.5} and elemental concentrations measured in the EXPOLIS study in 1996-97 in Helsinki, Finland, to develop methods to apportion personal PM_{2.5} exposures to microenvironments and source categories. Special focus in the current presentation is in traffic. The results indicate that personal exposures of working age subjects are on the average increased by 30% to PM_{2.5} mass and by 50 % to exhaust particles due to direct exposures while in traffic.

Introduction

Different source apportionment techniques, based on source markers, chemical mass balances, and statistical regression and factor analyses have been used to numerically split ambient air particulate matter (PM) mass samples into mass fractions and chemical contributions from different sources (Brooke et al. 1997, Hildeman et al. 1994, Malm et al. 1994). The repeatedly observed, but still poorly understood health effects of PM, however, are based on the personal exposures to PM, not the PM measured at fixed ambient monitoring sites, and the source contributions to exposures are presumably very different from those of the ambient air. Apportioning the personal exposures to sources in outdoor and indoor microenvironments and personal activities, including commuting, is a much more complex task and requires the

application of source apportionment techniques to ambient, indoor and personal samples. Such samples were collected in the EXPOLIS study in seven European cities (Jantunen et al. 1998, Koistinen et al. 1999, Rotko et al. 2000). The unique feature of the study was that multiple air pollutants (PM_{2.5} with elemental composition and BS, 30 VOCs, CO, and NO₂) were monitored simultaneously inside and outside of their homes, in workplaces and personal exposures, separately for workday, including commuting, and for leisure time. This design allows source apportionment of outdoor, indoor, and personal samples.

Microenvironment-Specific Source Apportionment

Measurements took place in Helsinki in 1996-97 for a random sample of 201 working age citizens. Personal exposures and corresponding microenvironment concentrations at residences and workplaces were sampled for 48 hours. Elemental composition of the collected PM_{2.5} samples were analysed using X-ray Fluorescence (ED-XRF, Mathys et al. 2001). Using the elemental constituents of PM_{2.5}, the major source factors were first identified from outdoor, indoor, and personal samples using principal components analysis (Koistinen et al. 2005). Mass contributions from the major long distance, local, indoor, and traffic PM sources to outdoor air PM_{2.5} and personal PM_{2.5} exposures were then calculated using a deterministic source reconstruction technique. After subtracting the fractions with associated elemental markers (secondary particles, salt, and crustal particles) the remainder consists of elements not visible in the XRF-analysis (including carbon). The major source of these particles is combustion, including local point sources, long range transported combustion

particles, local traffic and any error terms from the other sources.

This fraction was used as input for the current work and was labelled combustion+other PM (CoPM) (Koistinen et al. 2004).

In the current work CoPM was further divided into (i) long-range transport, and local (ii) stationary and (iii) traffic source fractions based on emission inventories, dispersion models, black smoke and volatile organic compounds measured together with PM_{2.5}. Infiltration of ambient particles indoors was analysed and accounted for separately in individual residences and workplaces (Hänninen et al. 2004). Personal exposure in street traffic was calculated as a residual term, by subtracting the sum of the time-weighted average concentrations in residential and occupational microenvironments from the total personal exposure. The data allowed the consideration of 70 subjects for this analysis.

Results: Exposures to Sources within Microenvironments

Personal PM_{2.5} exposure levels were measured together with concentrations at home indoors, home outdoors and workplaces of the subjects. The observed mean levels, corresponding source apportionment results, and estimates of source specific exposure levels while in traffic are shown in Figure 1. It can be seen that the exposure level in traffic is over two times higher than the two-day mean exposure level for PM_{2.5} mass and substantially more so for the traffic CoPM (i.e. exhaust) particles. PM_{2.5} levels in the other environments are lower than personal exposures (excluding ETS exposures).

Exposure to secondary PM_{2.5} is very well characterised by both the respective ambient secondary PM_{2.5} and the total ambient PM_{2.5} mass. Exposure to salt particles is well characterised by ambient salt PM_{2.5}, but not at all by ambient PM_{2.5} mass. Exposure to primary combustion PM_{2.5} is equally poorly characterised by ambient PM_{2.5} mass and ambient combustion PM_{2.5}. Exposure to soil PM_{2.5} is quite poorly characterised by ambient soil PM_{2.5} and not at all by ambient PM_{2.5}. It

turns out that of those source fractions of PM exposures which have been considered candidates for the PM risks, only exposure to secondary PM_{2.5} is well characterised by respective ambient PM.

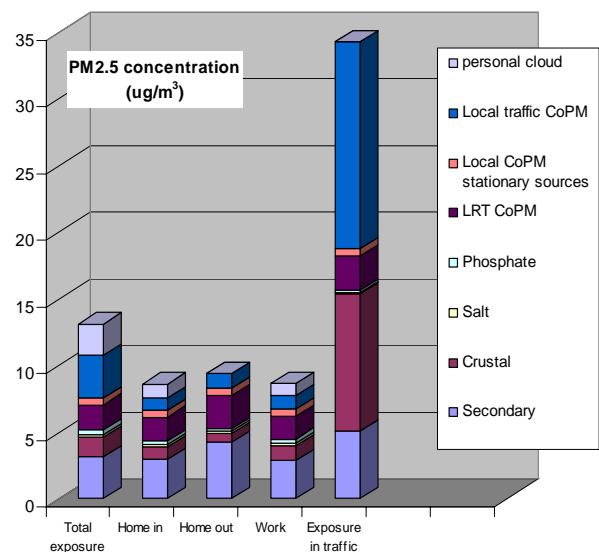


Figure 1: Source apportionment of exposures and concentrations in the main microenvironments affecting exposures. Note the high exposure levels in traffic.

For exposure simulation the corresponding distributions of personal source apportionment results were created and are shown in Figure 2 (concentrations scaled in the figure for daily average values). It is notable that the exposure level to crustal particles is relatively less elevated in traffic than levels of exhaust particles. Exposures to crustal particles are significantly affected by levels in indoor environments, where crustal material transported indoors is resuspended.

The scenario estimates for current (2002) and future (2025) situations indicated that total PM_{2.5} exposure levels in traffic has decreased only slightly (by 1 % from 1996 to 2002), and will decrease by 4 % till 2025. The exposure levels to exhaust emissions decreased substantially more, but still only moderately (by 6% and 34 %, respectively) due to the increasing traffic volumes. The road dust PM increases due to the increased vehicle mileage and almost completely compensates the favourable exhaust emission development.

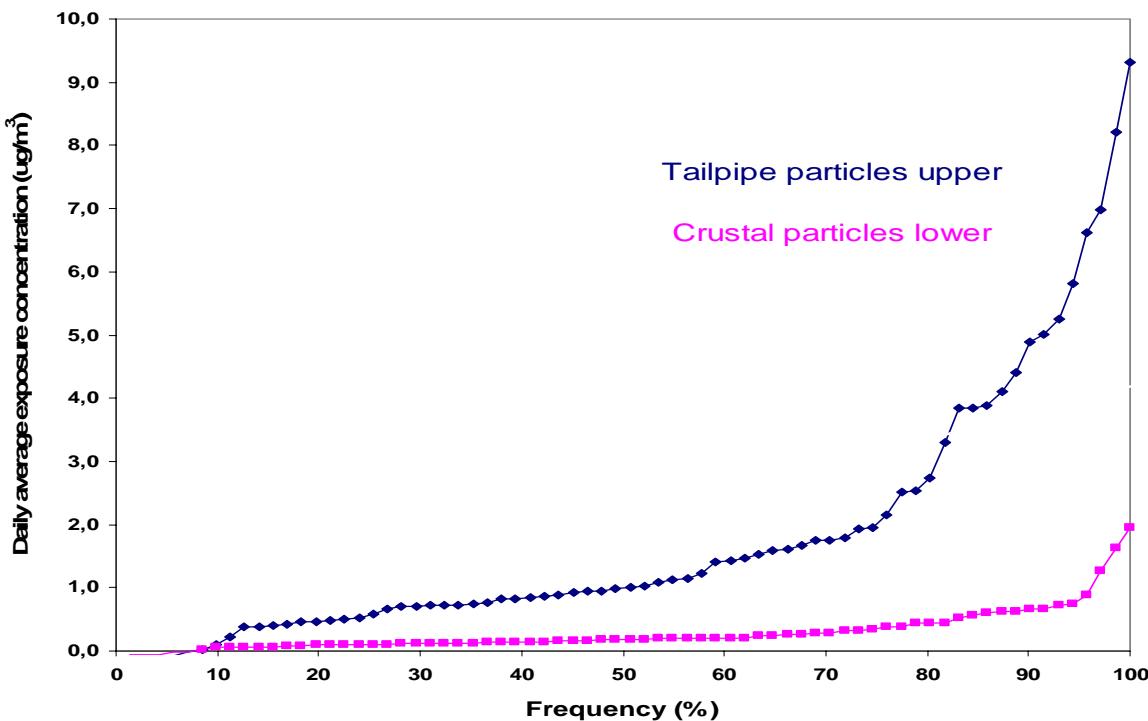


Figure 2: Exposures in traffic to the two major particle fractions generated by motor vehicles: combustion created tailpipe particles and crustal particles resuspended from the streets.

Conclusions

PM_{2.5} exposure levels in traffic were 2.5 times higher and levels of exhaust PM almost an order of magnitude higher than the respective ambient levels. Therefore time spent in traffic is a very significant modifier of overall personal exposure levels. High exposures in traffic affect mostly the active, working age population and therefore probably the direct association with premature mortality is weak due to the lower background mortality rate in the active age groups. However, if the recent findings hold true (e.g. Künzli et al. 2005) that PM exposures are associated with the development of atherosclerosis, the exposures occurring in traffic may have severe long-term effects on the health of the population.

The findings support development of techniques and legislation requirements for filtration units used in vehicles. Such units can lower the PM_{2.5} exposures of working age subjects by tens of percents on the average and much more for those spending more time in traffic, and average exposures to exhaust particles by 75 percent.

Acknowledgement

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IDENTIFICATION OF SOURCE GROUPS FOR FINE DUST IN NORTH-RHINE WESTPHALIA, GERMANY

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Goals and scope of the project

Measurements of airborne particles and their chemical composition were carried out within a project funded by the Ministry of Environment, North Rhine-Westphalia. The measurements took place over a period of one year (February 2002 to March 2003) at one central site and during two intensive campaigns (April and May 2002; October to December 2002) at three sites simultaneously in the city of Duisburg. This project was based on expected exceedance of PM_{10} ambient air limit values (especially the daily limit value) and the ongoing discussion related to new EU regulations of air quality standards.

Major goals of the project were:

- Method comparisons of filter based measurements with corresponding continuous "on-line" methodologies
- Determinations of site characteristic concentrations for PM_{10} , $PM_{2.5}$, PM_1 , number concentrations and size distributions
- Site comparisons based on the parameters measured during the intensive campaigns
- Analysis of diurnal variations of continuous measured parameters as basis for further investigations to identify relevant particle sources and processes
- Application of source apportionment methods to identify relevant source groups for PM_{10} mass concentrations.

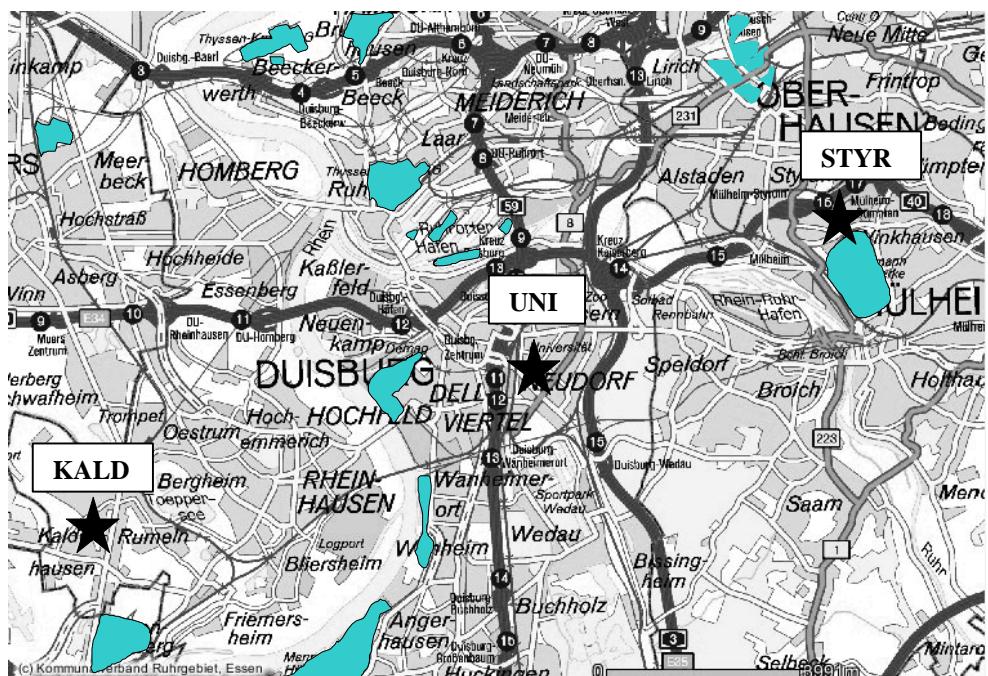


Figure 1: Site location

The locations of the three urban background measurement sites are shown in Figure 1; the sites were arranged roughly along the main wind direction (west-east) of this region. Table 1 provides an overview of the site characteristics.

Site	Casting	Northing	Type	Remarks
Duisburg-Kaldenhausen (KALD)	2545530	5695104	Urban background	LUQS*) measurement site, sub-urban area
Duisburg Universität (UNI)	2554501	5699925	Urban background	Measurement site of IUTA e.V.**); urban residential area influenced by industry and traffic
Mülheim-Styrum (STYR)	2560165	5702458	Urban background	LUQS measurement site, urban residential area influenced by industry and traffic

Table 1: Characteristics of measurement sites

*) LUQS: Air Quality Measurement Network of the State Environment Agency (LUA), North-Rhine Westphalia; **) IUTA: Institute for Energy and Environmental Technology, Duisburg, Germany.

An overview on measured parameters is given in Figure 2. Parameters which were only measured at the central site (UNI) are marked with circles. Additionally, local meteorological data were gathered at the

central site. Details on the measurement methods are summarized in Table 2.

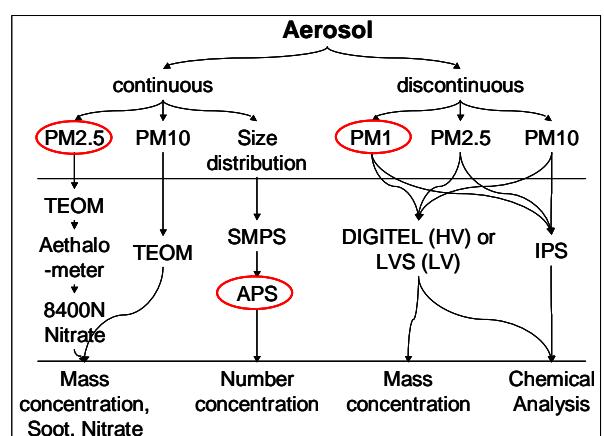


Figure 2: Scheme of methods and analysers used in the project

Method comparisons

PM_{10} mass concentrations determined by the TEOM (1400AB, 40°C) were about 70% (arithmetic mean) of the mass concentration values obtained with the manual filtration method. The filter/TEOM ratio increased to 0.99 (arithmetic mean) after adding the concentrations of semi-volatile compounds (ammonium, nitrate, chloride) that had been analysed from the filter samples. Regression analysis showed a slope of 0.97 and intercept

of 0.5 µg/m³. Hence, the differences between TEOM and filtration based mass concentrations are due to losses of semi-volatile compounds occurring within the TEOM-system.

More detailed analysis on the volatilisation of nitrate based on data obtained from chemical analysis of the filter and the on-line nitrate monitor (8400N, R&P) revealed significant losses of nitrate from the quartz fibre filter at mean daily temperatures above 20°C. Nitrate volatilisation from airborne particles became

significant in the temperature range of 25°C to 30°C.

Characteristic concentration data

Characteristic concentration data for PM mass concentrations at the three measuring sites are presented in Table 3. Average PM₁₀ mass concentrations cover the range from 32 µg/m³ to 35 µg/m³. These values compare well with annual concentration levels determined for the Duisburg area by the State Environmental Agency (LUA NRW, 2003 and 2004).

Analyser/ method	parameter	Principle	Time resolution
TEOM (R&P)	Aerosol mass concentration (PM ₁₀ / PM _{2.5})	Quasi-continuous measurement; deposition on filter bound to a tapered oscillating element	10 min
Aethalometer (GIV)	Mass concentration of soot (ca. PM _{2.5})	Deposition on filter tape, infrared reflection measurement	10 min
8400N (R&P)	Mass concentration of particle- bound nitrate (PM _{2.5})	Impaction onto metal strip, flash pyrolysis, NOx-detection	10 min
SMPS (TSI)	Aerosol size distribution (14 nm to 700 nm)	Particle separation due to electrical mobility; condensation nuclei counter	5 min
APS (TSI)	Aerosol size distribution (0,5 µm to 14 µm)	Particle separation due to acceleration, optical detection	10 min
Digitel (Digitel)	Mass concentration, chem. composition (PM ₁ , PM _{2.5} , PM ₁₀)	High-Vol filtration (30 m ³ /h)	24 h
LVS (Derenda)	Mass concentration, chem. composition (PM _{2.5})	Low-Vol filtration (2,3 m ³ /h)	24 h
IPS	chem. composition (~PM ₁ , PM(2.5-1), PM(10-2.5))	Impaction on quartz-carriers (3-stage impactor), TXRF analysis	24 h

Table 2: Details of used measurement equipment and methodologies

Period:	Total		Comparable days							
	28 Feb. 2002– 01 April 2003		23 April – 27 May and 22 Oct. – 16 Dec. 2002*)			23 April – 27 May and 22 Oct. – 16 Dec. 2002*)			23 April – 27 May and 22 Oct. – 16 Dec. 2002*)	
Site	UNI		UNI		STYR		KALD			
Fraction	PM ₁₀	PM _{2.5}	PM ₁	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}	
days	184	180	111	78	76	78	77	78	61	
Mean [µg/m ³]	32.9	25.4	24.8	35.3	27.8	34.5	24.6	32.9	29.4	
Median [µg/m ³]	26.2	20.5	23.1	32.6	24.7	30.6	21.7	32.2	30.3	
25%-quantile [µg/m ³]	19.9	13.8	14.8	20.1	15.4	18.0	11.7	19.4	12.7	
75%-quantile [µg/m ³]	43.3	34.0	33.7	48.2	37.1	46.4	34.5	44.7	41.4	
Exceedance events > 50 µg/m ³	35			18		17		14		
Exceedance events (extrapolation)	69			84		80		66		

Table 3: Characteristic data on PM mass concentrations

*)given are total periods of the intense campaigns; only days with complete PM₁₀ data sets have been evaluated

No exceedance of the PM₁₀ annual limit value for PM₁₀ (40 µg/m³ by 2005) could be observed and is not to be expected in future. Contrarily, more than the 35 allowed exceedance events per year could be extrapolated for the daily limit (PM₁₀ > 50 µg/m³ by 2005) for all sites (Table 3) and may also be expected for 2005. Most days of exceedance of the limit value occurred between Tuesday and Friday.

It should be noted that the measurement period at the station UNI did not cover a calendar year and thus comprised two phases (December 2002 and February to March 2003) with high numbers of days with exceedance. These periods presumably are among the reasons for the unexpected increase of PM₁₀ concentrations that has been observed in Germany and adjacent countries (Belgium, The Netherlands, Switzerland and Czech Republic) in 2002 and 2003 (CAFE 2004) compared to the decreasing trend of the years 1991-2001.

Annual mean particle number concentrations at the central site amounted to 16.700 N/cm³ and 14.100 N/cm³ for the ultra-fine fraction. Comparable values were also determined for the satellite sites. This is to compare with figures of 3.000-28.000 N/cm³ and 2.000-25.000 N/cm³, respectively, given for urban and suburban sites in a „European aerosol phenomenology” study by Puteaud et al. (2003). From this data it follows that the three measurement sites have characteristics similar to other European cities.

Figure 3 shows the chemical composition of PM₁₀ as obtained for the central site (UNI) as an average of the whole campaign period. Accordingly, PM₁₀ comprises ca. 24% carbonaceous compounds, ca. 40% secondary ions (nitrate, sulphate, ammonia), approximately 5% sea salt components (Na, Mg, Cl), about 8% soil elements and metals as well as an unidentified residue of 23% (composed of silicates and water mainly). The chemical composition of PM₁ and PM_{2.5} is also shown in this figure for the purpose of comparison.

Site comparability

In general, a high degree of similarity was found for the three sites concerning the parameters PM₁₀, PM_{2.5}, chemical components, number concentration and particle size distribution. However, detailed analyses showed for the sites located in the urban agglomeration (UNI, STYR) a slightly better comparability to each other than to the more westerly located site KALD. Anyhow, each of the urban sites may be taken as representative for the larger Duisburg area with respect to particle characteristics.

Concentration differences of chemical components observed for the three sites were marginal and could be mainly found for trace compounds. In particular, at KALD elevated concentrations of titanium and zinc and lower levels of V, Mn, Co, Ga, Se, Rb, Sr, Sn, Ba were obtained compared to the UNI site. At STYR, higher shares of Cr, Ni, Zn and lower contributions of Ti, Mn, Co and Rb were observed.

Source apportionment

Five different approaches were applied to evaluate contributions of sources and source types to the PM₁₀ concentrations:

- Wind direction analyses
- Concentration related evaluation
- Episode analysis
- Analysis of diurnal variation
- Positive Matrix Factorisation (PMF).

From a detailed **wind direction analysis** of particular compounds or their statistically elaborated cluster a clear separation into three groups was obtained: sea salt emission, secondary particles and locally/regionally influenced side components. Some cases (cluster) could be assigned to specific industrial emission sources when compared to data taken from the State emission register. This concerned for example sources of manganese in the North-East of site UNI or a titanium source located in south direction from site KALD.

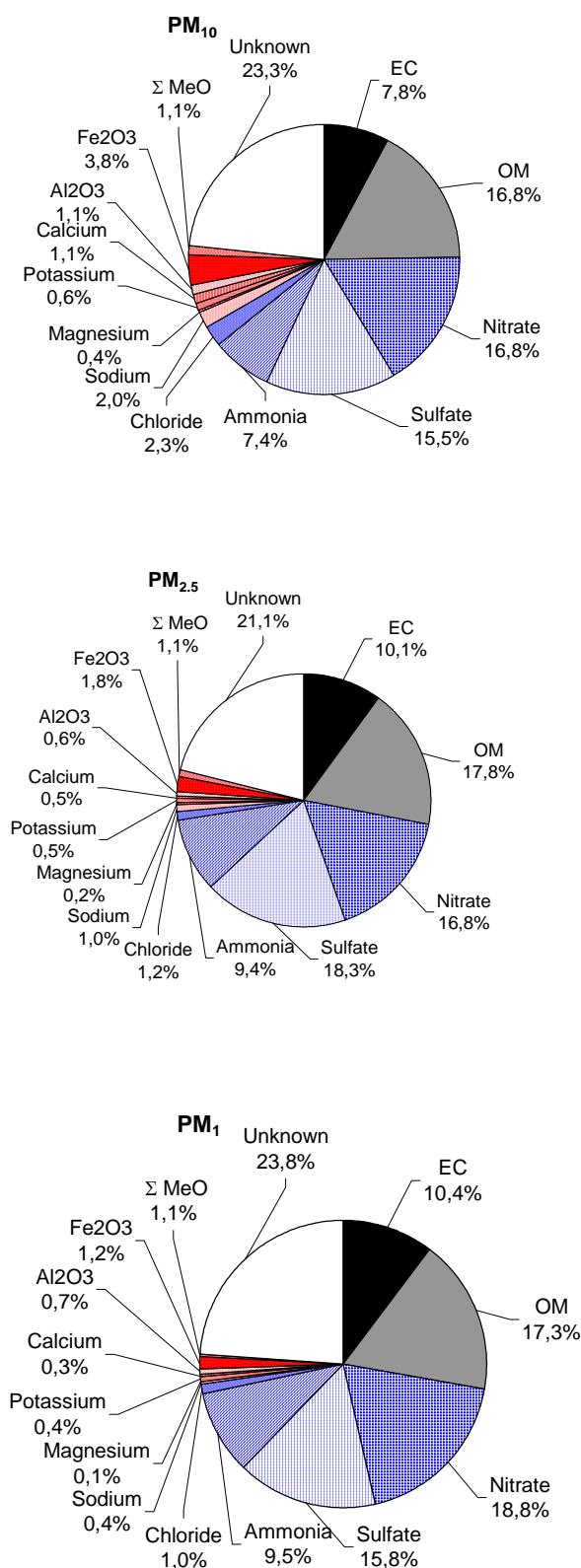


Figure 3: Chemical composition of PM₁₀, PM_{2.5} and PM₁ at the site UNI for the whole measurement period

Based on a **concentration-related evaluation** of the PM₁₀ chemical composition applied to days with PM₁₀ above 50 µg/m³, between 30 and 50 µg/m³ and below 30 µg/m³, respectively, it could be concluded that ammonia and nitrate are indicator components for days of exceedance. These secondary compounds are either ubiquitously formed or subject to long range transport mechanisms since they contribute equally to the increase of PM₁₀ at all sites. On the other hand, concentrations of the sea salt components decrease with increasing PM₁₀ mass concentrations. This may be seen as an indication for continental air masses flowing from south or eastern directions and/or stable meteorological conditions.

By means of detailed statistical **episode analysis** for days with limit value exceedance three episode types could be differentiated which however are not clearly separated from each other due to the limited data set. All days with PM₁₀ exceedance exhibited very short back trajectory distances that indicate stable weather conditions and slow mixing processes.

For episode **type A** which covered winter and springtime days elevated values for Al and Ca indicate soil materials or processes used in stone and earth industries. Hence this type may be denoted „transitional period/re-suspension“.

Regarding **type B**, elevated concentrations of vanadium in connection with predominant western wind direction (which however are not consistently supported by the backward trajectories) lead to the assumption of an influence by oil refineries or fuel oil combustion located in the Netherlands. Presumably very stable high-pressure summertime weather conditions caused the low trajectory distances for this episode type. Hence this episode type could be denoted „summer/high pressure“.

A lowered concentration of secondary aerosols correlating with also less global radiation is characteristic for episode **type C**. This type mainly covers winter days with

changing wind directions. Elevated contributions of many metals indicate a higher influence of local or regional emission sources. This might likely be due to lower atmospheric mixing heights during wintertime. According to these characteristics, this episode type is denoted "winter/local influence". In Table 4 some features of the main episode types are given; Figure 4 presents the relative contribution of the main episode types that are further split into sub-groups according to a more detailed cluster analyses.

	Season	Elevated chemical compounds	Mean trajectory distance [km]			Predominant wind direction	Global radiation [W/m ²]
			24h	48h	72h		
A	Winter/spring	Sec., Al, Ca	340	700	1000	easterly.	100
B	Early summer + other	Sec, Mn, V	260	500	700	westerly.	90
C	Winter + other	metals, OM, EC	290	900	1300	East./west.	56

Table 4: Characteristics of main episode types ($PM_{10} \geq 50 \mu\text{g}/\text{m}^3$)

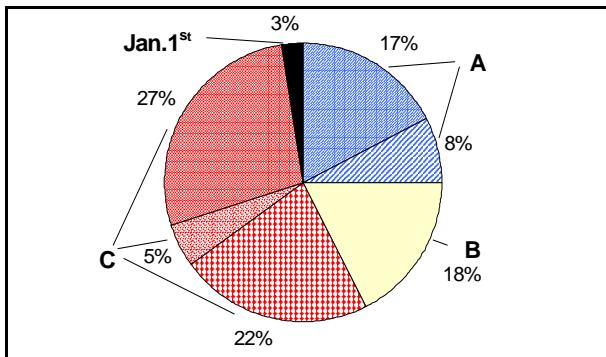


Figure 4: Percentage distribution of main episode types ($PM_{10} \geq 50 \mu\text{g}/\text{m}^3$)

Diurnal variations of the continuously determined particle parameters were used (after correction to the filter based data) to quantify the contribution of local to regional sources with regular fluctuating emission activities. All analysed parameters revealed significant diurnal and weekly profiles. A summary of this evaluation is given in Table 5.

Local to regional sources with regular activity fluctuations contributed $8-10 \mu\text{g}/\text{m}^3$ (termed excess concentration) to the PM_{10} mass

	Tuesday – Friday $\mu\text{g}/\text{m}^3$	Local contribution relative	Fraction of local contribution PM_{10}	Fraction of local contribution $PM_{2,5}$
PM_{10}	8-10	27-31%		
$PM_{2,5}$	4-6	19-24%		
Nitrate + NH_4^+	1.8-2.3	27-31%	18-29%	30-58%
Soot+OC	1.6-2.0	37-43%	16-25%	27-50%
20-40 nm		30-36%		
50-100 nm		23-30%		
150-300 nm		22-31%		
400-600 nm		22-33%		

Table 5: Relative local contribution due to sources with regular activity fluctuations

concentration. This comprises about 20-30% of ammonium nitrate and 15-25% of soot plus organic carbon. The weekly variation of the excess concentrations correlates well with the weekly variation of the exceedance of the PM_{10} daily limit value. Further, the diurnal profiles of soot and PM_{10} exhibit a clear time-correlation with rise and drop of traffic activities; on the opposite, in case of nitrate a time delay of about one day appears to occur. The calculations reveal maximum excess concentrations for soot and for particle number concentration in the size range of 20-40 nm. Taking into account the site location and the observed diurnal/weekly profiles this is most likely due to traffic emissions, maybe partly also due to domestic heating.

The excess concentration shares of ammonia nitrate and soot were calculated to be 30-60% and 30-50%, respectively, of the $PM_{2,5}$ fraction and are considerably higher than in PM_{10} . This agrees well with the mass size distribution for these compounds. These compounds are found mainly in the $PM_{2,5}$ fraction. It is concluded that different compounds are responsible for the excess concentrations of $PM_{2,5}$ and PM_{10} ; the overall excess concentration in PM_{10} are due to approximately equal part of increase of $PM_{2,5}$ and of $PM_{2,5-10}$.

For all parameters it was found that the concentration increase due to local to regional sources with regular activity fluctuations is higher on days with limit exceedance than for the yearly average. Moreover, the excess peak is superimposed to a significantly elevated baseline concentration on these days.

Finally, the relative excess input as calculated from the diurnal variations was compared to the “urban contribution to PM₁₀” that was evaluated according to Lenschow et al. (2001) for measurement data obtained at Ludwigshafen and Koblenz (Kuhlbusch et al., 2003) and at Berlin (John and Kuhlbusch, 2004). This “urban contribution” has been shown to be about 40-45% for Ludwigshafen and Koblenz and 50% for Berlin and thus are higher than the relative excess input observed at Duisburg based on the diurnal variation analysis. This is as expected since the relative excess input based on diurnal variations covers only a part of the “urban contribution” as determined with the Lenschow approach. Therefore the relative excess input calculated for Duisburg appears to be plausible.

Positive-Matrix-Factorisation (PMF) was applied to resolve sources and source groups from PM₁₀ and PM_{2.5} chemical composition data. In case of PM₁₀ eight different factors could be resolved whereas for PM_{2.5} only six factors were obtained. Based on their chemical composition in connection with wind direction dependency and inter-site-correlation it was possible to assign source groups and in some cases to identify source regions. In particular, factors denoted “industry” and “zinc/iron” could be assigned to specific local industrial sources. Quantitative factor distributions related to PM₁₀ and PM_{2.5} are shown in Figure 5.

With respect to source regions the source types “Secondary I”, “Secondary II” and “Sea salt/Holland” originate from long range transport, whereas “Traffic”, “Combustion/re-suspension” and “Crustal material” are due to mixed super-regional and regional source areas. Contrarily, the factors “Industry” and “Zinc/iron” are clearly influenced by local processes.

For the other sites a PMF analyses could be done only on basis of the shorter intense campaign periods. However, a comparison made for the UNI site between factor distribution obtained for the whole campaign period and the intensive campaign data showed good agreement. Hence the results obtained for KALD and STYR can be seen as representative.

In general, good agreement could be observed between the three sites also with respect to the PMF source apportionment results. Slightly increasing contributions of “traffic” in direction from KALD to STYR is in accordance with the related traffic densities and site-road distances. Higher industrial contributions at UNI (11%) and STYR (14%) compared to KALD (9%) originate from their location related to the most important industrial sites (distance as well as direction).

In PM_{2.5}, the factors “Secondary I”, “Traffic”, “Sea salt/Holland” and “Zinc/iron” could again be resolved; however “Traffic” was distributed to two highly correlating factors.

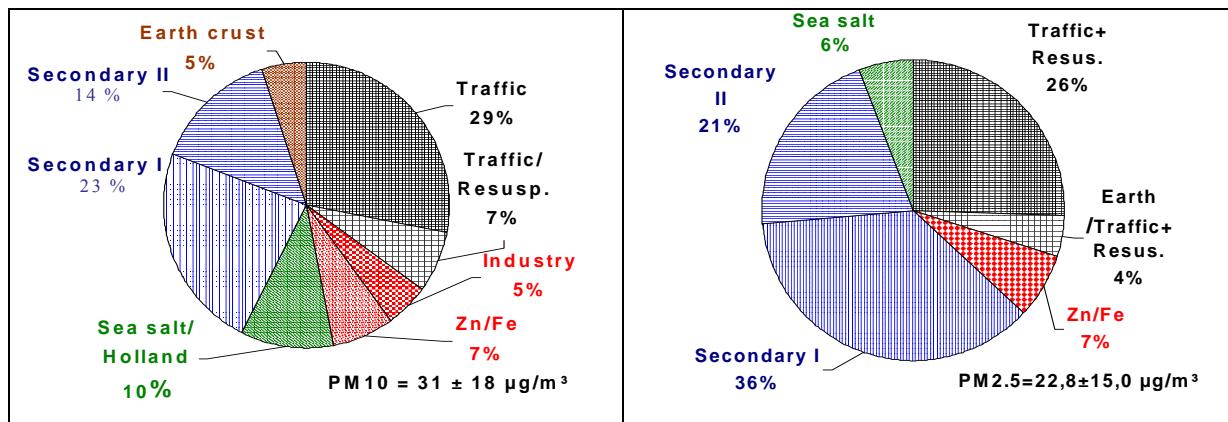


Figure 5: Source apportionment for PM₁₀ and PM_{2.5} by means of PMF (UNI, whole campaign period)

The factors "Industry" and "Crustal material" were not resolved in the PM_{2.5} fraction; further, the factor "Secondary II" was found to be not robust.

Calculating the PM_{2.5}/PM₁₀ ratio for the assignable factors revealed a plausible picture with a ratio of nearly 1 for "Secondary I" and 0.3 for "Sea salt/Holland". This comparison also showed that the factor "Zinc/iron" was related to the fine particle fraction (presumably due to a hot thermal source). Contrarily, from the impossibility to find the "Industry" factor in PM_{2.5} it may be concluded that this factor is mainly influenced by "cold" sources emitting coarse particles. Finally, a comparison of factor contributions of average with elevated PM₁₀ mass concentrations revealed a clear super-proportional influence of the factors "Combustion/re-suspension", "Secondary I" and "Secondary II" (actual ranking).

Conclusions

From the results of these investigations the following conclusions can be drawn with respect to the pollution by PM in the area of Duisburg:

- PM₁₀ and PM_{2.5} mass concentrations and the chemical composition of dust particles are similar at all three measurement sites. Hence the airborne fine dust fraction originates mainly from regional (here: ~ 30 km surroundings) or super-regional processes and can be determined with sufficient reliability at any urban background site located in the regional area.
- Emission sources located in the regional area affect the PM₁₀ trace compound composition which in some cases allows to localise them.
- From the observation of time dependent variability of PM_X mass concentration and some compounds it can be concluded that a significant fraction of the atmospheric load is caused by traffic and other sources with weekly or diurnal activity fluctuations.
- Exceedance of the PM₁₀ daily limit value is likely if the input by these variable sources

occurs together with elevated baseline pollution due to super-regional processes and favourable meteorological conditions.

- Such episodes with elevated concentrations occur during all seasons; the relative importance of the super-regional and regional/time variable contributions appears to fluctuate with season resulting in increased relevance during the cold months.

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CLUSTER OF EUROPEAN AIR QUALITY RESEARCH (CLEAR)

R. S. Sokhi

Introduction

The CLEAR cluster was launched in December 2002 and consists of 11 EU funded projects on urban and regional air quality research. The cluster as a whole represents over 200 researchers across the EU with an EC financial contribution of about 15M€ for the 11 projects.

CLEAR is focussing on key topics to strengthen synergies between the projects and to maximise the benefits to users. These include (coordinating organisation and project are given in parenthesis):

- CLEAR Web Portal (NILU, URBAN Exposure)
- Air quality and related data (University of Birmingham, SAPPHIRE)
- Personal exposure to air pollutants (ENEA, ISHTAR)
- Air quality modelling tools (University of Hertfordshire, OSCAR)
- Meteorological parameters systems (DMI, FUMAPEX)
- User Networks (Eurocities, INTEGAIRE)

Aim and Objectives of CLEAR

The main aims of CLEAR are:

- (i) To improve our scientific understanding of atmospheric processes, composition and pollution variabilities on local to regional scales
- (ii) To provide next generation tools for end users and stakeholders for managing air pollution and responding to its impact
- (iii) To help create a critical mass of expertise and ambition to address future research needs in the areas of air pollution, its impact and response strategies.

CLEAR activities have focussed on improving our understanding of sources,

behaviour and prediction of priority pollutants such as particles, NO₂ and O₃ relevant to urban areas. The research programme considers interactions and inter-relationships affecting urban areas involving all relevant temporal and spatial scales.

Overview of project activities

Table 1 gives an overview of the CLEAR project activities. AIR4EU aims at examining and providing recommendations on how to conduct air quality assessment from local to continental scales. FUMAPEX also considers multiscale interactions and is demonstrating the use of Numerical Weather Prediction (NWP) Models coupled with chemistry and transport models to predict air quality in urban areas. The methodologies adopted incorporate predictions of population exposure in urban areas. MERLIN has developed integrated assessment tools for Europe incorporating macroeconomical as well air quality assessment to investigate pollution control strategies. ATREUS is developing methodologies which employ a combination of methods (including NWP and CFD models) to investigate air pollution affected by complex topographical situations as well as energy usage for microenvironments. OSCAR and ISHTAR are producing improved tools for assessing the impact of traffic on local and urban scale air quality. These tools will provide users with improved capabilities to quantify the impact of traffic in relation to air quality as well as cultural heritage (ISHTAR). The OSCAR System will also enable the users to identify impact reduction options including those relying on technological and traffic management measures. URBAN AEROSOL and URBAN EXPOSURE are leading to improved methods for assessing personal exposure to a range of pollutants. Whereas other CLEAR projects are focussing on improving dispersion models, SAPPHIRE will lead to a user-orientated methodology for

apportioning particle and PAH (polycyclic aromatic compound) sources in urban areas using receptor modelling techniques. INTEGAIRE focuses on examining the interactions at an urban governance level and on strategies that will improve these interactions for achieving the objectives of major policy initiatives such as the European Air Quality Directives and CAFE. BOND,

OSCAR, SAPPHIRE and URBAN AEROSOL have also yielded extensive new data on NO₂, O₃, PM₁₀, PM_{2.5} and a range of inorganic and organic atmospheric species. OSCAR will yield new exhaust emission factors for urban conditions. Figure 1 illustrates the interactions between the projects and the main research themes with the cluster.

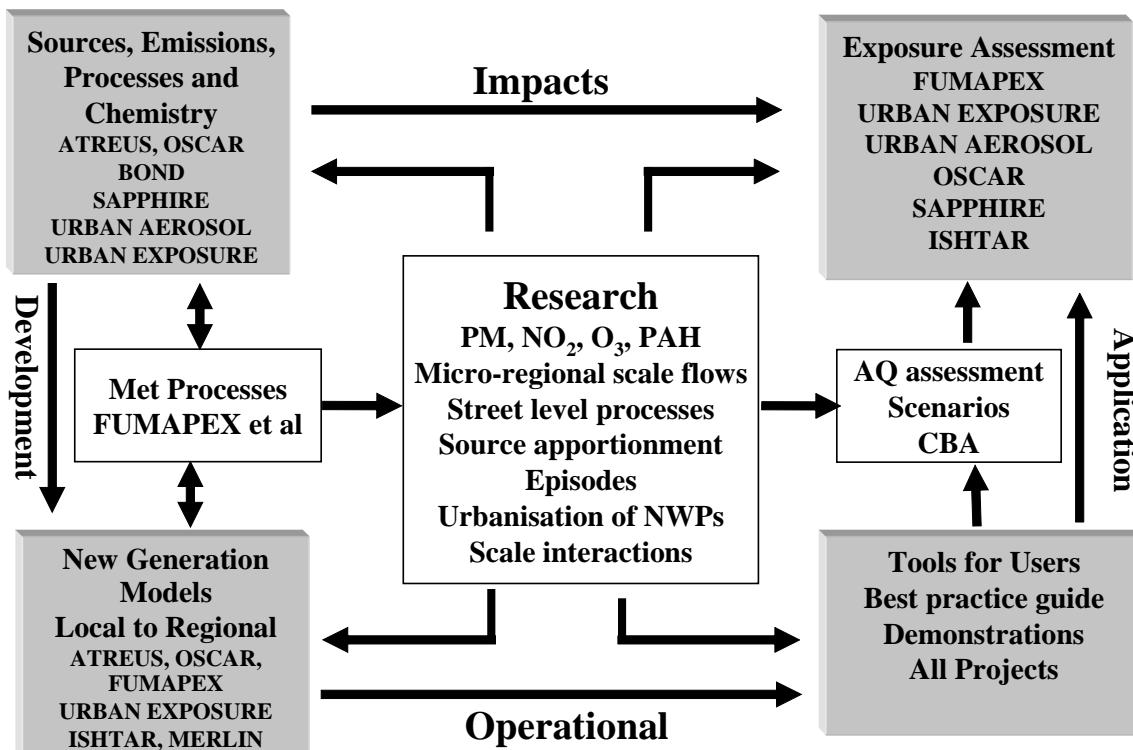


Figure 1: Interactions within the CLEAR Cluster

Examples of CLEAR Activities

1. Urban datasets

CLEAR projects are involved in both generating new data and collating previously disparate databases of existing information relating to concentrations of air pollutants and other parameters such as meteorological data. The principal projects involved with data generation are SAPPHIRE, OSCAR, URBAN AEROSOL, URBAN EXPOSURE and BOND. A large amount of datasets are being developed and will be useful for the wider atmospheric science community.

These include:

- (i) Ultra-fine particles, PM₁₀, PM_{2.5}, NO_x
- (ii) Individual chemical components of particles; specifically:
 - Metals (including Pb, Cr, & As)
 - Inorganic anions (e.g. nitrate, sulfate)
- (iii) Semi-volatile organics (vapour phase component measured also) - principally PAH, but indicators of both anthropogenic and biogenic aerosol
- (iv) Meteorological parameters
- (v) Emission factors for urban conditions.

Measurements have been conducted in several cities including Athens, Birmingham, Copenhagen, Helsinki, Katowice, London, Madrid, Marseille, Oporto, Oslo and Prague.

2. Personal Exposure

Projects such as ISHTAR, FUMAPEX, URBAN AEROSOL and URBAN EXPOSURE have a specific focus on personal exposure assessment. Within FUMAPEX probabilistic and deterministic model components have been evaluated

against experimental data separately. As part of ISHTAR activities integrated models/toolboxes have been developed to assess the effect of air pollution and noise on the urban environment. A particulate matter exposure model has been developed as part of URBAN AEROSOL. Such work has been extended to examine exposure resulting from water pollution in URBAN EXPOSURE. The OSCAR System has been designed with a flexible architecture to incorporate other modules such as exposure models.

Project Acronym and website	Coordinating Organisation	Country
AIR4EU Air Quality Assessment for Europe: Local to Continental Scales http://www.Air4EU.nl/	TNO	Netherlands
ATREUS Advanced Tools for Rational Energy Use towards Sustainability http://aix.meng.auth.gr/atreus/index.htm	Aristotle University	Greece
BOND Biogenic Aerosols And Air Quality In The Mediterranean Area http://milos.ipptd.demokritos.gr/bond/	NCSRDI	Greece
FUMAPEX Integrated Systems for Forecasting Urban Meteorology, Air Pollution and Population Exposure http://fumapex.dmi.dk/	DMI	Denmark
INTEGAIRE Integrated Urban Governance and Air Quality Management in Europe http://www.integaire.org	EUROCITIES	Belgium
ISHTAR Integrated Software for Health, Transport Efficiency and Artistic Heritage Recovery http://www.ishtar-fp5-eu.com	ENEA	Italy
MERLIN Multi-Pollutant Multi-Effect Modelling of European Air Pollution Control Strategies http://www.merlin-project.info/	University of Stuttgart	Germany
OSCAR Optimised Expert System for Conducting Environmental Assessment of Urban Road Traffic http://www.eu-oscar.org	University of Hertfordshire	UK
SAPPHIRE Source Apportionment of Airborne Particulate Matter and Polycyclic Aromatic Hydrocarbons in Urban Regions of Europe http://www.gees.bham.ac.uk/research/sapphire/	University of Birmingham	UK
URBAN AEROSOL Characterisation of Urban Air Quality Indoor/Outdoor Particulate Matter Chemical Characteristics and Source-to-Inhaled Dose Relationships http://www.nilu.no/projects/urban-aerosol/	NILU	Norway
URBAN EXPOSURE Integrated Exposure Management Tool Characterising Air Pollution Relevant Human Exposure in Urban Environment http://www.nilu.no/urban_exposure	NILU	Norway

Table 1: List of CLEAR Projects

3. Modelling Tools

CLEAR represents a unique expertise in this area. Most projects are involved in the development, improvement or use of local to regional scale air quality models. As FUMAPEX is primarily focussed on modelling of urban air pollution it contributes a large number of tools to CLEAR. The models address spatial scales from continental down to microenvironments and temporal resolutions as high as hourly. The approaches being investigated range from simple screening tools up to sophisticated numerical 3D models. Many of the priority pollutants can be assessed including O₃, NO₂ and PM_{2.5}. Research is also being conducted in improving our capability to predict levels of PM_{2.5} in urban areas. Projects such as OSCAR have resulted in a user-friendly air quality assessment system. FUMAPEX has developed methodologies for employing and linking NWPs with urban scale models with the added capability of assessing population exposure. AIR4EU is examining methodologies of air quality assessment by employing both models and measured data in order to recommend how these can be improved. BOND is specifically addressing

the area of photochemical models especially for O₃ and aerosols.

4. User Networks

It is vital to have effective user networks for the purposes of disseminating CLEAR outcomes to European and other stakeholders. All projects within CLEAR have networks of users and the cluster is encouraging collaboration and exchange of information to maximise the benefits to users. Projects such as OSCAR alone have a database of 1500 users. EUROCITIES is coordinating such activities to ensure that the key CLEAR outcomes are disseminated as widely as possible.

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NOTES AND NEWS**PM₁₀ Intercomparison Field Measurement Campaign in Germany**

Under the lead of the two German Reference Laboratories Federal Environmental Agency and State Environmental Agency of North-Rhine Westphalia a field measurement Campaign of all German Länder was performed in Wiesbaden in 2003 over eight months in order to compare gravimetric and continuous monitoring methods for PM₁₀. The main objective was the evaluation of data quality of gravimetric methods used in German networks. In addition, information should be gathered about continuous methods based on different principles.

23 PM₁₀ monitors were compared in the measurement campaign. These were 15 gravimetric devices (low and high volume, single filter instruments, filter changer) and 9 automatic monitors (FH62, TEOM, optical devices). The measurements lasted from 1 February until 30 September 2003.

Evaluations are based on EN 12341 and the Guide to the Expression of Uncertainty in Measurement ENV 13005.

88 % of the gravimetric devices met the requirements of EN 12341. Compared with low volume single filter instruments, filter changers of the type DHA-80 and SEQ underestimated the PM concentrations (range from -1 % to -13 % for DHA-80; from -4 % to -8 % for 2 of 4 SEQ).

Continuous monitors met the requirements of the standard EN 12341 only in special cases and after correction. The default correction factor of 1.3, recommended by an EC working group on particulates in case results from proper intercomparison measurements are not available, can only be taken as a first approach: 2 of 9 instruments fulfilled the requirements after correction with 1.3. For the special circumstances of the Wiesbaden experiment an “optimal correction factor” of

1.15 was found. After correction with this value, 4 of 9 automatic devices met the EN 12341 requirements.

For the uncertainty calculations reference values calculated from 3 low volume single filter devices were used, associated with an 95 %-expanded uncertainty (U) of less than 4 % at a concentration of 40 µg/m³. All gravimetric instruments met the data quality objective (DQO) of the directive 1999/30/EC of $U \leq 25\%$ at 40 µg/m³. However, the ranges found for 95 %-expanded uncertainty were considerably high: 12 to 24 % for DAH-80 and 16 to 21 % for SEQ.

Continuously measuring instruments normally need data correction: only two instruments (1 FH62, 1 optical device) met the DQO mentioned above without correction. Treatment with the default factor 1.3 yielded no significant improvement. Using the “optimal factor” of 1.15 for the Wiesbaden experiment, 4 of 9 continuous devices met the DQO of $U \leq 25\%$ of the EU.

The report also contains various special evaluations of some participants. In addition, detailed recommendations for gravimetric PM₁₀ measurements were elaborated, dealing with measurement, calibration, and weighting of filters.

Abstract taken from: Materialien, Band 66, PM₁₀-Vergleichsmessungen der deutschen Bundesländer, Teil 1: PM₁₀, Landesumweltamt Nordrhein-Westfalen, Essen 2005.

Authors: R. Beier, F. Bunzel, E. Klasmeier, L. Laskus, G. Löschau, M. Lohberger, R. Lumpp, F. Palme, U. Pfeffer and W. Travnicek.

Contact: Ulrich Pfeffer, State Environmental Agency of North-Rhine Westphalia, Wallneyerstr. 6, 45133 Essen, Germany. www.lua.nrw.de

ExpoFacts – European Exposure Factors Sourcebook

The ExpoFacts project has created a European database of statistics on matters affecting exposure to environmental agents. The aim is similar to the Exposure Factors Handbook by the US EPA, which has been widely used by European researchers, but with European data. In addition to the exposure route information, the database contains physiological and demographic information in order to allow the database to be used as a tool for population wide exposure modelling and risk assessment. The database does not contain information on concentrations, emission sources or impact on human health. ExpoFacts has collected and combined data, which have been made available, from over 100 national and international sources. The project has been externally reviewed by a board of international experts.

The database is free to use and easily accessible for all interested parties over the Internet. ExpoFacts is primarily aimed at being a tool for environmental exposure analysis and risk assessment but it can also serve as a data source for administration, NGOs and anyone interested in European statistics.

The database is kept up to date by adding new data sets and by updating the old ones. Suggestions for new data and other improvements are welcome.

The data available at ExpoFacts are:

- Demographic data
- Socio-economic data
- Dietary data
- Time use data
- Housing data
- Physiological data
- Non-dietary ingestion data.

Also available at ExpoFacts are sources like references for the data used and lists of other interesting data sources. Additionally, available links for the database references and other data sources are provided. The data in the database are provided with basic data quality information.

The project group is located at the KTL – National Public Health Institute in Kuopio; Finland.

For more information, see the ExpoFacts website: www.ktl.fi/expofacts

EURAQHEM – Optimized European Air Quality and Health Effect Monitoring

As part of the CAFE (Clean Air For Europe) programme the air quality and air emissions directives will be reviewed and may lead to further guidance or regulation of air pollution monitoring, streamlining of reporting and revision and amendment of air pollution related directives. This process is supported by WHO within the “WHO Systematic Review of Air Pollution Health Aspects in Europe” and the European Environment Agency which is collecting air quality monitoring data from the Member States.

Preliminary evaluation of data sets delivered so far indicate that the air quality (AQ) assessment is made following slightly different criteria and hence the coherence, consistency and comparability between

different networks and countries are not always ascertained. The present and future evaluations of air pollution health effects are to a large extent based on information gathered under the public air quality monitoring networks, although the health relevance of the networks is not always verified. Therefore the information provided by regular monitoring networks is sometimes complemented by specific air pollution assessment to obtain improved data on exposure to individuals and the general pollution. A further difficulty for a pan-European evaluation of health effects related to air pollution is the lack of EU reporting obligations on health impact and the lack of commonly applied criteria for the evaluation

of the health effects, giving a low comparability between the Member States (MS).

Air pollution monitoring that is harmonized and that is relevant to the assessment of health effects, as well as improved monitoring of the air pollution, related health effects would greatly improve risk assessment and management of air pollution in Europe. It would be also an improved basis for in-depth research in air pollution science and health research such as epidemiology and toxicology.

The DG Environment of the European Commission therefore launched a project contract (until the end of 2005) that overall aims to prepare for new legislation in the framework of the CAFE programme and the thematic strategy on air pollution so that the air pollution assessment will be more health relevant and that health effects related to air pollution are assessed in an appropriate way.

The project will be based on an analysis of the current practice of air quality and health status/impact monitoring in the EU Member States. Major problems regarding the health relevance of pollution monitoring shall be identified by comparing the current approach with ideal models on exposure and health effect monitoring derived from recent scientific knowledge. The project finally will provide a proposal of a new concept for a more integrated air pollution and health effect monitoring system.

Contractors are:

- Dr Kuhlbusch, IUTA
- Prof Wichmann, University of Munich
- Dr Quass, Fa. Müller BBM, Munich.

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The European Commission's public consultation on air pollution

The European Commission (DG Environment) has collated results of a consultation on the EU's forthcoming Thematic Strategy on Air Pollution (Clean Air for Europe - CAFE). Between December 2004 and January 2005 the consultation drew 11.500 responses – the highest number yet for a European Commission online questionnaire. In view of the setup, the results should not be seen as the opinions of the EU population at large, but as a representation of the views of those interested in air pollution, aware of the consultation and able to fill in the questionnaire.

The response was far from being evenly distributed over the countries; half was from Portugal. Three quarters of the replies came from the age group of 18-44 years – twice its share in the EU population. A comparison with comparable questions of a representative poll in the framework of the Eurobarometer

suggested that the differences were not extremely large.

Most respondents (89%) were 'individuals', 6% labelled themselves as 'experts' (from research bodies or public authorities), 2% indicated to represent business and 2% to represent an NGO. There were differences between respondent types, with representatives of NGOs tending to be somewhat more concerned and in favour of ambitious reduction measures than individuals, and representatives from business less. Experts from research and public authorities were on average somewhat less concerned than other citizens.

There were substantial differences between countries, but the differences between geographically grouped countries were not so large. Respondents from Scandinavia and from new Member States tended to have a somewhat more positive view on air pollution

problems, while those from countries around the Mediterranean Sea were on average more negative.

Two thirds of the respondents felt that the present air quality was satisfactory or very good in their neighbourhood and country, one third considered it poor or very poor; for their (or nearest) city, a slight majority considered present air quality poor or very poor. Most respondents did not feel well informed about air pollution. The majority of the respondents was concerned about health effects and some other impacts of air pollution.

Compared with several other societal issues, air quality was by most rated equally or more important. The majority felt that a high ambition level was needed: a low acceptable risk level for air pollution and substantial funding to be spent for improving air quality.

For a list of possible policy approaches, the majority of the respondents wished most approaches to be carried out as soon as possible. A majority regarded the international and EU level as the most appropriate level of competence for taking measures, but many rated national, local and individual measures also positively.

About 80% identified industrial production and existing cars, trucks or buses as the most prominent targets for actions; this was followed by energy production, new cars, trucks or buses and aviation (50% of the respondents). Preferences were expressed for various more specific actions regarding traffic and industry.

Most of the respondent indicated that they were prepared to take individual action to improve air pollution, including paying individually for this.

About 3.500 respondents (31%) used the opportunity to give additional comments, often encouraging or urging the Commission to take measures or act otherwise to reduce air pollution. Many suggested specific measures or packages of measures.

Several conclusions relevant for the forthcoming Thematic Strategy on Air Pollution can be drawn from the consultation. There are good reasons for the European Commission to continue its policy of stimulating air quality information to be available to the public. Very many respondents were concerned about air quality, particularly about the impacts on environment and health. They attached a high priority to improving air quality and called for a high ambition level. The international and European level were seen as the most appropriate competence level for taking action. Industrial production and traffic were indicated mostly as targets for measures, and the respondents also indicated to be prepared to take individual action themselves to improve air quality.

The final report is available from the following link:
http://europa.eu.int/comm/environment/air/cafe/pdf/report_bo_2005_100.pdf

Dick van den Hout and Jef van Dongen
TNO, The Netherlands.

MEETINGS AND CONFERENCES

5th International Conference on Urban Air Quality 29 to 31 March 2005 in Valencia, Spain

The UAQ conference was co-organized by the University of Hertfordshire, UK, Centre for Environmental Studies in the Mediterranean Region, Spain, and Aristotle University, Greece, and jointly held with the Workshop on Air Quality Assessment - Science and Tools for Policy coordinated by the Cluster of European Air Quality Research (CLEAR) and the Workshop on Atmospheric Transport at the Urban/Local Scales coordinated by the Atmospheric Composition Change - A European Network of Excellence (ACCENT).

The conference provides a forum for scientists, engineers, decision and policy makers to meet and discuss the latest advances in urban air quality, and it encourages international collaboration to help solve the problems affecting the urban environment, discuss new research findings, exchange information and to stimulate future air quality management and assessment strategies. The conference was attended by more than 250 participants presenting their urban air quality study results related to the topics: aerosols, emissions, air quality management, policy, chemical composition, urban meteorology, modelling and exposure.

Generally, it was shown that many projects are related to current EC activities, e.g. COST and CAFE. With financial support of the EC concerted actions and clusters between universities, environment and health experts, and decision makers have meanwhile successfully been started, which built up networks and co-operations, e.g. between institutes or cities. But in some cases project grants ended recently before such collaboration was established to release outcomes of added-value for the contractors and the programme. Future perspectives of such networks are unclear, and the pessimism was formulated that experiences, contacts and motivations will get lost.

Recently the topic personal exposure became part of the UAQ community. About twenty exposure-related papers were presented dealing with the indoor/outdoor problematic, exposure modelling, as well as single and multi pollutant exposure studies. On the one hand multi-centre projects (e.g. EMECAS and APHEIS) studied and assessed the health impacts of ambient air pollutants. With regard to the Children Environmental Health Action Plan for Europe the project 'Exposure to Air Pollution during Pregnancy and Infant Development (INMA)' started this spring in Valencia. On the other hand exposure studies dealt with time and spatial variations of air pollutants as well as time activity patterns in urban areas. In the majority, such studies were related to particulate matter (PM_{10} , $PM_{2.5}$ and Ultra fine particles).

Besides, the conference concluded the importance to integrate air pollution into the European Environment and Health Action Plan and assessment processes; to treat air quality, climate and health as inter-related areas and not as separate areas of research; and to strengthen the interaction between scientists, city authorities, policy makers and the citizen. Several additional research areas were identified, such as air pollution in Megacities (e.g. in central and eastern Europe), influence of urban regions on all scales (local, regional and global), methods for emergency and hazard assessment, and economic cost analysis of air pollution.

The conference proceedings are compiled on a disc which was published by the University of Hertfordshire (ISBN Number: 1-898543-92-5), which can be obtained from: Prof Ranjeet Sokhi, Atmospheric Science Research Group (ASRG), Science and Technology Research Institute, University of Hertfordshire, College Lane, Hatfield, AL0 9AB, UK (e-mail: r.s.sokhi@herts.ac.uk).

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PUBLICATIONS

WHO

Review of Methods for Monitoring of PM_{2.5} and PM₁₀ – Report on a WHO Workshop, Berlin, Germany, 11-12 October 2004

WHO Regional Office for Europe, Copenhagen 2005, 15 pages, ISBN 5046019. Available through the net: www.euro.who.int/Document/E85769.pdf.

Children's Health and Environment Case Studies Summary Book – Fourth Ministerial Conference, Budapest, Hungary, 23-25 June 2004

WHO Regional Office for Europe, European Centre for Environment and Health, Rome Office 2005. Available through the net:

www.euro.who.int/Document/CHE/CHECSSBook.pdf

Increasing hazards where European children live are raising concern about the effects of the deterioration of the environment on their health. Children have a special vulnerability to a number of environmental risk factors and their specific exposure patterns put them at risk for higher exposures. This summary book presents a collection of children's health and environment case studies on actions or implementation experiences

carried out by the member states of the WHO Regional Office for Europe to protect children from environmental risk factors. As this is a work in progress, more case studies will be collected with the final aim to facilitate the sharing of successful experiences among Member States. It is foreseen that these and new case studies will be made available on the CHE website (www.euro.who.int/childhealthenv) in the near future.

IPCS Harmonization Project: IPCS Risk Assessment Terminology, Part 1 &2

WHO Publications, Geneva, Switzerland 2004, 118 pages, ISBN 92 4 156267 6, Sw. Fr. 40,-.

The objective of this joint IPCS/OECD project is to develop internationally harmonized generic and technical terms used in chemical hazard/risk assessment, which will help facilitate the mutual use and acceptance of the assessment of chemicals between countries, saving resources for both governments and industry. The project covers two categories of terms: Part 1 of this report presents generic terms, Part 2 presents exposure assessment terms.

OTHERS

Advances in Air Pollution, Vol. 12: Regional and Local Aspects of Air Quality Management

D. M. Elsom, Oxford Brookes University, UK and J. W. S. Longhurst, University of the West of England, UK. WIT Press 2004, 336 pages, ISBN 1 85312 952 6, € 186.00.

The resolution of local and regional air pollution problems requires the development of an appropriate scientific and decision-making framework within which effective air quality management may be undertaken. Case studies were collected from nine countries around the world: Argentina, Australia, Colombia, India, Iran, Italy, Mexico, the United Kingdom and United States. They describe the development and implementation of selected aspects of local and regional management frameworks and/or measures adopted in the pursuit of achieving and sustaining acceptable air quality.

Aerosols Handbook – Measurement, Dosimetry, and Health Effects

Lev S. Ruzer, Lawrence Berkeley National Laboratory, California, USA and Naomi H. Harley, New York University, USA. CRC Press 2005, 728 pages, ISBN 1 56670 611 4, £ 115.00, www.crcpress.com.

The book covers a multitude of topics on indoor, outdoor, and industrial aerosols, including aerosol measurement, deposition, particle size distribution and biokinetic processes. This book discusses how the size, shape, and chemical properties of particles affect aerosol deposition in the lungs, possibly other organs, and the overall toxicity. The authors discuss Chernobyl accident and minor's lungs in detail to illustrate the effects of radioactive aerosols. The final section focuses on the health effects of specific aerosols, such as diesel aerosols and ultrafine particles, and discusses all relevant aspects from epidemiology to molecular biology.

Air Quality, Fourth Edition

Thad Godish, Ball State University, Muncie, Indiana, USA. CRC Press 2005, 480 pages, ISBN 1 56670 586 X, £ 44.99, www.crcpress.com.

This edition provides a comprehensive overview of air quality issues, including atmospheric chemistry, the effects of pollution on public health and the environment, and the technology and regulatory practices used to achieve air quality goals. Added sections cover toxicological principles and risk assessment.

COMING EVENTS

2005

August 2005

16th IUAPPA Regional Conference – Clean Air and Environment in the Asian Pacific Area

2-4 August, Tokyo, Japan.

For more information, see: www.jemai.or.jp .

September 2005

Indoor Air 2005 – 10th International Conference on Indoor Air Quality and Climate

4-9 September, Beijing, China. For more information, see: www.indoorair2005.org.cn/ .

17th Int. Congress on Biometeorology 2005

5-9 September, Garmisch-Partenkirchen, Germany.

For more information, see: www.icb2005.de .

ISEE 2005 – 17th Conference of the International Society for Environmental Epidemiology

13-17 September, Johannesburg, South Africa.

Theme: Sustaining World Health Through Environmental Epidemiology: Setting a New Global Research Agenda. For more information, see: www.isee2005.co.za .

Environmental Health Risk 2005 – Third International Conference on the Impact of Environmental Factors on Health

14-16 September, Bologna, Italy.

For more information, see:

www.wessex.ac.uk/conferences/2005/ehr05 .

14th IUAPPA Regional Conference - 3rd Int. Symposium on Air Quality Management at Urban, Regional and Global Scales

26-30 September, Istanbul, Turkey.

For more information, see:

<http://web.deu.edu.tr/tuncap/aqm2005> .

October 2005

First International Conference on Environmental Exposure & Health 2005

5-7 October, Atlanta, USA. For more information, see:

www.wessex.ac.uk/conferences/2005/eeh2005/1.html

XIII. GHU Conference, IX. ISEM Conference and LGL Congress

19-21 October, Erlangen, Germany.

For more information, see: www.ghuisem2005.de .

ISEA 2005 – 15th Annual Conference of the International Society of Exposure Analysis

30 October – 3 November, Tucson, Arizona, USA.

For more information, see: www.iseaweb.org .

2006

May 2006

Air Pollution 2006

22-24 May, The New Forest, UK.

For more information, see:

www.wessex.ac.uk/conferences/2006/air2006/cfp.html

June 2006

Healthy Buildings 2006

4-8 June, Lisbon, Portugal.

For more information, see: www.hb2006.org .

Ninth Environmental Health Congress of the Int. Federation of Environmental Health (IFEH)

17-21 June, Dublin, Ireland. For more information, see:

www.ifeh.org/ifehcongresses.html .

IEA-EEF European Congress: Epidemiology and Health Care Practice

28 June-1 July, Utrecht, The Netherlands.

For more information, see: www.euroepi2006.org .

September 2006

Joint ISEE/ISEA Int. Conference on Environmental Epidemiology & Exposure

2-6 September, Paris, France. Theme: Science, Population Diversity, Caution and Precaution. For more information, see: www.paris2006.afsse.fr .

2007

14th World Clean Air and Environmental Protection Congress

9-13 September, Brisbane, Australia.

For more information, see:

www.icms.com.au/iuappa2007 .

NEWSLETTER

EDITORS' NOTE

We appreciate submissions to NOTES AND NEWS regarding programmes and projects within the field. Notes (100-500 words) should be sent directly to the WHO Collaborating Centre for Air Quality Management and Air Pollution Control.

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