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# ABSTRACTS

## MAJOR AIR QUALITY CONCERNS IN CROATIA

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This talk focuses on the Croatian anthropogenic emissions of pollutants. An overview of estimated source apportionment for the main pollutants (gaseous, particulates, heavy metals and persistent organic compounds) is also given, as well as a list of the main individual $SO_2$, $NO_x$ and CO sources. Finally, several recent incidents characterized with a very high, or even unlawful emissions are discussed.

## MAJOR AIR QUALITY CONCERNS IN EUROPE

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An overview will be presented of the current EU Air Quality Guidelines for PM 10 and PM 2.5, NO2 and Tropospheric O3. Major concern in Europe at the moment considering human health is PM 10 and PM 2.5.

The protection of the eco-system in view of S-and N-deposition, and groundlevel O3, is also of importance.

An optimal abatement strategy in urban areas, but also at the national scale, requires an accurate determination of the existing background concentrations. An example will be given for the determination of background concentrations on the European scale using a combination of modelling and observations by data assimilation.

## FRAMEWORK FOR U.S. AIR QUALITY MANAGEMENT AND DECISION-MAKING

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The 1970 U.S. Clean Air Act Amendments established the U.S. Environmental Protection Agency (EPA) to manage air quality on a nationwide basis. It gave the EPA authority to establish National Ambient Air Quality Standards (NAAQS) and to regulate stationary and mobile sources. NAAQS are established for six criteria pollutants based on public health and their justification is reviewed every five years. Each NAAQS consists of: 1) an indicator (O3, PM2.5, PM10, CO, SO2, NO2, Pb), 2) a concentration level (e.g., 0.08 ppm for O3, 15 µg/m3 for PM2.5); 3) an averaging time (e.g., 8

hour O3, 1 year for PM2.5); and 4) a form (e.g., one exceedance per year, never to be exceeded). Air quality is managed by determining which emission reductions are needed to attain NAAQS within defined areas in the U.S. Federal funding for highways can be withheld if the NAAQS are not attained within specified periods.

## POLLUTANTS OF CONCERN IN THE NORTH AMERICA AND EUROPE

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There are several air pollutant categories and concerns. Criteria Pollutants are indicators of air quality with maximum concentrations above which adverse effects on human health may occur. These include CO, $SO_2$, $NO_2$, $O_3$, Pb, and PM [TSP, RSP, $PM_{10}$, $PM_{2.5}$]. Hazardous Air Pollutants (HAPs), sometimes called air toxics, are emissions known or suspected to cause cancer or other serious health effects, such as reproductive effects, birth defects, or other adverse environmental effects. These include many VOCs, metals, PAHs, and diesel particles. Acid Deposition pollutants are highly oxidizing pollutants that destroy forests, crops, lakes. These include $H_2SO_4$, $HNO_3$, $O_3$. Materials are damaged by reactive or decolorizing pollutants that destroy or soil buildings, clothing, vehicles, antiquities ($SO_2$, $H_2SO_4$, $HNO_3$, $O_3$, soot [BC: black carbon], soil dust). Odors are unpleasant olfactory experiences (reduced sulfur compounds, certain VOCs). Mercury is included in HAPs, but also results in bioaccumulation in lakes and fish through deposition. Visibility-reducing PM includes sulfate, nitrate, ammonium, organic carbon, elemental carbon, sea salt, and soil. $NO_2$ absorbs light in plumes. Halocarbons deplete stratospheric $O_3$ (Freon-12, $SF_6$, halon, other fluorocarbons). Climate forcing gases and PM change the Earth's radiation balance directly by absorbing electromagnetic radiation or indirectly by changing cloud cover and water vapor ($CO_2$, $CH_4$, halocarbons, BC, ultrafine particles)

## HEALTH EFFECTS OF SUSPENDED PARTICULATE MATTER

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Air pollutant health effects are determined by epidemiological studies that associate sickness and death with measured levels of ambient pollution. Epidemiological studies are supported by toxicological studies, some on humans but mostly on animals, that provide a plausible explanation of the observed health effects. Health effects can be short-term, over a few hours to a few days, or long-term, over a year or more. An important aspect of these studies is the detection of a threshold below which no effects are observed. Effects are often found at levels far above those found in most current ambient situations. Young, old, and sick people appear to be the most susceptible to air pollution effects. Recent studies show evidence of increasing cardiovascular effects in addition to pulmonary effects. A better understanding is needed of pathophysiological pathways to link PM-related mortality and morbidity.

Recent research indicates that ultrafine particles, which are currently unregulated, may have important adverse health effects. Compliance air quality networks need to be better designed for epidemiology studies. Measurements at central sites may not represent general population exposure. Toxicological studies need to establish associations from animal subjects to humans.

## EFFECTS OF POLLUTION ON VISIBILITY AND THE EARTH'S RADIATION BALANCE

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Haze is caused by the scattering and absorption of visibility light by particles and gases. Light is an electromagnetic wave; just as a plane water wave is deflected by a barrier from its original direction, light waves are scattered when they encounter particles and gas molecules that are approximately the same size as the light's wavelength. The sky is blue because particle-free air also scatters light, but the gas molecules are so small that they scatter the shorter wavelength blue light more than they scatter the longer wavelength red light. The United States uses a chemical extinction budget to track regional haze over long periods at more than 100 network locations. The value of the chemical extinction is that it can focus control efforts on the chemical components, and their sources, that are the major causes of the poor visibility. Shenandoah, Great Smoky Mountain, and Acadia national parks in the eastern U.S. have poor visibility caused mostly by sulfate concentrations. Other parks in the western U.S. have better visibility, but it is more evenly distributed among a number of chemical components. The implication is that sulfur dioxide reductions will be the most effective controls in the east, while many sources will need to be targeted to improve western visibility. Reducing regional haze requires emission reductions that cross local, provincial, and international boundaries. The U.S. has established five regional planning organizations with different states as members to track progress toward natural background levels at 156 national parks and wilderness areas. At each of these areas, chemical extinction will be tracked for the next 60 years relative to a baseline for the poorest 20% of the days established by measurements between 2000 and 2004. A linear glide path toward natural visibility conditions will be used to determine progress that will be evaluated at ten year intervals. There are differences in the rate of progress depending on how poor the initial visibility is and what are considered to be natural conditions for an area. Defining natural conditions is a scientific challenge. Annual average estimates are currently in use, but these will eventually need to be made more event-specific. Wildfires, dust storms, and other natural events will affect visibility on a case-by-case basis. Transport from outside of the U.S. will also need to be considered because this is largely beyond the control of national authorities.

## RELATING NEARBY POINT SOURCE EMISSIONS TO AMBIENT CONCENTRATIONS BY DISPERSION MODELING

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Atmospheric and topographic complexities that influence air quality monitoring, modeling, and forecasting will be discussed in the presentation. The complexities include uncertainties and errors in measuring and simulating evolution of the synoptic systems; local flows, circulations, and atmospheric stability; accurately specifying all characteristics of emission sources; and imperfection of models.

In the first step of the analysis, we will show the significance of details of the atmospheric, topographic, and model structure issues affecting the transport and dispersion of pollutants on the scales of meters to about 100 km or so. In this range the strong modification of the airflows and associated dispersion occur due to small-scale topographic features; development of upslope, downslope, and valley winds; urban, street-canyon, and building effects; pronounced changes in the surface roughness; discontinuities between the land and water bodies; occurrence of sea and land breezes; radiation and precipitation processes; cloud and fog effects; complex details of emission sources and their behavior on close range including environmental justice initiatives. All these complexities represent a significant challenge for atmospheric, dispersion, and air quality models in accurately predicting the transport, dispersion, and chemical transformations of pollutants. This challenge, examples of relevant air quality studies, and critical analysis of models of various sophistication will be also discussed.

## AMBIENT MONITORING NETWORKS AND MONITORING STRATEGIES

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Ambient air monitoring is needed at locations that represent regional, urban, neighborhood, and source-oriented spatial scales. Sampling periods and durations should represent a range of source contribution meteorological conditions. Long term records are needed to detect trends. Most existing networks are designed to determine compliance with ambient air quality standards, but the data are often needed for other purposes, such as health studies, air pollution modeling and source apportionment, and scientific research. Compliance monitoring methods are often set into regulatory law which prevents them from being replaced with more advanced technology. Sampler siting should consider the following: 1) adequate exposure (minimize nearby barriers and particle deposition surfaces); 2) minimum nearby emitters (monitors should be outside zone of influence of specific emitters); 3) collocated measurements (other air quality and meteorological measurements can aid in the interpretation of high or variable pollutant levels); and 4) long-term site commitment (sufficient operating space, accessibility, security, safety, power, and environmental control).

## CHARACTERIZING SOURCE EMISSIONS

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Important emissions sources include: 1) Fugitive dust from wind erosion, agricultural activities, construction, storage piles, and vehicle traffic on paved and unpaved roads; 2) ducted exhaust from industrial facilities (e.g., coal- and oil-fired power stations, smelting, cement plants, chemical plants, petroleum extraction and refining, glass manufacturing, paper making, shipping); 3) vehicle exhaust from cars, trucks, motorcycles, and buses; 4) burning and cooking from stoves, charbroilers, trash, forest fires, and agricultural burning; and 5) ammonia from animal husbandry and fertilization. Emission characteristics that need to be quantified are: 1) amounts of pollutant emitted per unit time or unit of activity (emissions rate); 2) particle size, to determine transport and deposition properties; 3) source profiles, fractional abundance of gaseous and particulate chemical components in emissions (used to speciate inventory and to apportion ambient concentrations to sources; and 4) temporal variations, emissions change on daily, weekly, seasonal, and annual cycles. Timing of emissions affects atmospheric transport and dilution as well as human exposure to outdoor air pollution. Emissions are measured for different purposes: 1) certification, to verify that a process design is capable of achieving emissions below a regulated limit. (e.g., FTP engine tests); 2) compliance, to determine that in-use processes are within permitted values (e.g., vehicle smog tests, periodic stack tests, opacity tests); 3) emissions trading, to relate actual emissions to allowances (e.g., continuous $SO_2$ monitors); 4) emission inventories, to obtain real-world emissions for pollution planning.; and 5) source apportionment, speciated emissions for source and receptor modeling. Emissions measured for one purpose are typically inaccurate for other purposes.

## REGIONAL SCALE MODELING OF AIR POLLUTION

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In the second presentation, we will discuss issues relevant to the regional scale air quality assessment and forecasting on a range of about several hundred kilometers or so. The discussion will focus on complexities of the regional scale flow patterns; interaction of the atmospheric boundary layer with the atmosphere above it; development and movement of synoptic weather systems; air-sea interaction; trajectories including trans-urban, trans-boundaries, and trans-continental pollutant transport; chemical transformation of the pollutants; and superposition of pollutants from various regional emission sources. There is a number of atmospheric, dispersion, and air quality models that have been used in regulatory and research studies on regional scales. We will elaborate on the model structure, verification studies as well as their uncertainties and errors due to their inherent predictability limitations in addition to natural variability and stochastic atmospheric processes. In recent years the interest for providing air quality forecasts has been rapidly growing which lead to complex forecasting systems composed of atmospheric, dispersion, and air chemistry modules that can be used for air quality applications. Advantages, but also the limitations of these multi-component modeling tools will be discussed.

## DETERMINING ALTERNATIVE FUTURES, URBAN DEVELOPMENT EFFECTS ON AIR QUALITY

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The structure and design of urban developments can have significant adverse effects on pollutant emissions as well as other ecological factors. When considering the future impact of growth on mobile source emissions, we generally scale the increase in vehicle kilometers traveled (VKT) on population growth. However, diverse and poorly planned urban development (i.e., urban sprawl) can force higher rates of motor vehicle use and in return increase levels of pollutant emissions than alternative land-use scenarios. The objective of this study is to develop and implement an air quality assessment tool that takes into account the influence of alternative growth and development scenarios. We introduce the development of an advanced interactive scenario-based land use and atmospheric chemistry modeling system coupled with a GIS (Geographical Information System) framework. The modeling system is designed to be modular and includes land use/land cover information, transportation, meteorological, emissions, and photochemical modeling components.

To investigate the impact of possible land use change and urbanization, we evaluated a set of alternative future patterns of land use developed for the southwestern region of California. Four land use and two population variants (increases of 500K and 1M) were considered. Overall the Regional Low-Density Future was seen to have the highest pollutant emissions, largest increase in VKT, and the greatest impact on air quality. On the other hand, the Three-Centers Future appeared to be the most beneficial alternative future in terms of air quality. For all cases, the increase in population was the main factor leading to the change on predicted pollutant levels.

## RECEPTOR MODELS FOR AIR QUALITY MANAGEMENT

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Receptor models utilize the variability in particle composition, concentration and size, in space and time, to identify source types. They provide a theoretical and mathematical framework for quantifying source contributions. Receptor models are based on the conservation of mass from the point of emission to the receptor. Their mathematical formulations express ambient chemical concentrations as the sum of products of species abundances in source emissions and source contributions. The models differ in their approach of solving the mass balance equations and the assumptions they use. Most of them fall into one of the four categories: 1) chemical mass balance (CMB); 2) factor analysis; 3) tracer-based; and 4) meteorology-based method. They differ in the purpose of modeling (e.g., source profile, contribution, or location), data needs (e.g., uncertainty estimate), numerical optimization approach, and outputs. Receptor models can apportion secondary particles using certain approaches: 1) "pure" secondary sulfate, nitrate, and secondary organic aerosol (SOA) source profiles in CMB; 2) OC/EC enrichment factors used to estimate SOA contributions; 3) secondary organic marker end-products; 4) aerosol evolution to represent changes in profiles; 5) $^{34}S$ or $^{35}S$ isotopes to follow sulfate changes; 6) regional source profiles; and 7) eigenvector-derived factors/profiles. In terms of model validation, a receptor analysis is considered valid if four criteria are met: 1) the receptor model is determined to be applicable, 2) the performance measures are generally within target ranges, 3) there are no significant deviations from model assumptions, and 4) the sensitivity tests reveal no unacceptable instability or consistency problems. Use of receptor models in conjunction with source-oriented models also help identify and quantify inaccuracies in each.

## AIR QUALITY MONITORING IN CROATIA

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Monitoring of air quality in urban and industrial areas in Croatia has started in Zagreb during the 60s and it was organised by the Institute for Medical Research and Occupational Health and regional authority. Since the early seventies air pollution monitoring has been gradually introduced in other Croatian towns by regional Institutes of Public Health together with the regional authorities. All regional monitoring networks use the same methodology for air quality monitoring and are connected in one common network. This network has plenty of manually operated stations and only a few automatic stations. Reorganization and harmonization of the regional network is provided step by step. Automatic equipment will be gradually introduced to replace the manually operated one. The first automatic monitoring station

in State monitoring network was established in Zagreb in 2003. In accordance with the Ordinance on locations of permanent air monitoring stations in the national network from 2002, 22 automatic stations for continuous monitoring of air pollution are expected to be installed in the State monitoring network till the end of 2007. Today, eight monitoring stations are working. The stations will be located in towns, industrial areas, national parks and islands. There are also some local monitoring stations in Croatia for monitoring specific air pollutants in industrial areas, gas fields and near waste dumps. Global indicators of air quality in Croatia are monitored by Meteorological and Hydrological Service.
During 2006 the surveillance of air quality was provided in 34 Croatian towns. This paper describes an ongoing air quality surveillance with the categorization of areas in regional network with respect to the results of sulphur dioxide, smoke, total suspended particulate matter, metals lead, cadmium and manganese in total suspended particulate matter, $PM_{10}$, nitrogen dioxide, ozone and polycyclic aromatic hydrocarbons measurements in seven the largest Croatian towns. The results refer to the entire monitoring period in each town where the surveillance was performed. This paper also describes trends of annual mean values and 98th percentiles of the air pollutants in Zagreb area.

## CROATIAN AIR QUALITY MONITORING STRATEGY: 2002 – ONWARD

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Notwithstanding the fact that monitoring of air quality in Croatia has a long history owing to initiatives taken by Institute for Medical Research and Occupational Health in early sixties of the 20th century and Meteorological and Hydrological Institute in late sixties, air quality monitoring strategy for Croatia at a broad national level has never been devised in a form of a coherent guiding document. Driving forces behind existing monitoring systems were mainly health issues in the cities and research guided by international programmes and leading organizations (WHO, WMO, UNEP). As a consequence, only until recently, environmental /air quality protection policy was not in a procreative mode to influence or shape existing monitoring programmes to underpin environmental goals and needs. It was restrained to a passive user of existing air quality information. This situation has gradually started to change since 2002, when the first Regulation on Sitting of National Network Stations for Continuous Air Quality Monitoring (OG No. 4/02) and respective Programme on Air Quality Measurement in the National Air Quality Monitoring Network (OG No. 43/02) have been passed. Elements of new national air quality monitoring strategy have been implicitly embeded into these new legislation documents serving as a basis for the State monitoring network enforcement. This paper describes the background and the reasoning for the evolved air quality monitoring strategy.

## OZONE STATIONS EVALUATION BY FREQUENCY ANALYSIS

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Tropospheric ozone concentrations exhibit a characteristic time variation with pronounced diurnal cycles and seasonal behaviour. The diurnal and seasonal variations are usually well defined. However, some additional oscillations in ozone concentrations can exist, ones that are much smaller in amplitude than 1-year and 1-day cycles. These small amplitude oscillations can be e. g. attributed to anthropogenic influences, specific meteorological and chemical influences on selected monitoring station and periodic maintenance of the instruments. That is, the spectral analysis of photochemical pollution data can point up hidden conditions that influence particular monitoring stations. Such an analysis, by Fourier transformation (FT) was applied to long-term data from 3 US and 14 European ozone monitoring stations. As expected, strong frequency signals are found for the 1-year and 1-day periods. However, several frequencies of lower signal intensity were observed and could be attributed to anthropogenic activities. A principal component analysis (PCA) was applied to the transformed data sets in order to find these other significant frequencies. Among others, the 7 and 3.5-day frequencies can be considered as markers of anthropogenic influences.

## PREPARATION OF CROATIAN ANNUAL EMISSIONS INVENTORY REPORT

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## EMISSION INVENTORIES IN WEST OF SWEDEN WITH EVALUATION AGAINST MEASUREMENTS AND DISPERSION MODEL CALCULATIONS

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## PERMITTING OF INDUSTRIAL FACILITIES IN CROATIA

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Presentation describes the implementation of system for environmental permitting in Croatia. Implementation of such a system exists from Croatian obligations in approximation process towards EU membership.

The current situation in environmental permitting in Croatia is considered, with the analysis of status of existing legislation. The parts of permitting system for environment already exist in Croatia (environmental impact assessment, water management, waste management, air quality management, construction and operational permitting, etc.). The goal is to establish the integrated system, in the beginning according to the IPPC Directive provisions. The existing system would be used in the implementation process as much as it is possible.

The preliminary past and future activities in the implementation process have been mentioned. The role of authorities, as well other stakeholders is also discussed.

KEY words: environmental permitting, facilities, implementation activities

## EFFECT OF $O_3$ AND PM10 ON MORTALITY INCREASE DURING A HEATWAVE

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Heat-wave conditions cause excess mortality in exposed population. Few studies indicated that a significant part of this excess mortality could be the result of air pollution. Based on the model by Rooney et al. it was attempted to provide evidence of a similar observation in Croatia. Exposures to elevated levels of particulate matter (PM10) and ozone in ambient air during the August heat wave in 2003 were found to be a possible cause to excess mortality in this episode.

## HEALTH IMPACT ASSESSMENT OF AIR POLLUTION ON ZAGREB POPULATION

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Estimation of health endpoints frequencies for Zagreb population was performed by means of AirQ computer program. Time series of total suspended particulate matter (TSP), black smoke (BS),

PM10 and PM2.5 particle fractions AND SO2 daily concentrations measured at Zagreb network stations were used. The following health endpoints frequencies were investigated: total mortality, cardiovascular mortality, respiratory mortality, hospital admissions respiratory disease, hospital admissions cardiovascular disease, hospital admissions asthma, hospital admissions COPD, acute myocardium infarction. From the results obtained, it could be concluded that fine particle fractions PM10 and PM2.5 represent the main threat to the population health, while SO2, TSP and BS because of their negative concentration trends during last decades give a false picture about the health endpoint incidences connected to the air pollution.

## SOME RECENT FINDINGS ABOUT VERY STABLE BOUNDARY LAYERS

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The focus of this short talk is on two recent results related to strongly stable ABL. First and more elaborated part here is katabatic flow over long cool slopes. Since it was verified that classical scaling via Monin-Obukhov length performs over such slopes rather poorly, a modified Prandtl model is used instead. This linear analytic 1D model is extended for 1.) almost any gradual eddy diffusivity K(z) via the WKB method, and 2.) it includes the Coriolis effect. The result agrees well with the MIUU numerical mesoscale model; moreover, it can be useful in parameterizing shallow persistent katabatic flows in NWP and climate models and in data interpretation. Second part relates only to numerical modeling with the concept of total turbulent energy parameterization. This promising approach appears suitable for modeling stable ABL, when compared to data and various LES, because it allows for turbulence at high Richardson number.

## DISPERSION DUE TO MEANDERING

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Meandering of the wind vector has been shown to affect horizontal dispersion under weak-wind conditions. It can be attributed to a variety of mesoscale motions but its origin and dynamics are still unknown.

This study deals with the effects of meandering on dispersion using a Lagrangian stochastic particle model, where the wind field for the model is taken from the observations. The focus is on the behavior of flow due to meandering and on the relative contributions of meandering and turbulence to dispersion.

## EMEP4HR-PROJECT OVERVIEW – ATMOSPHERIC FORCING AND NESTING

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EMEP4HR is a joint project between Norwegian met.no and Croatian Meteorological and Hydrological Service (MHSC), Andrija Mohorovicic Geophysical Institute (AMGI) and EKONERG Energy Research and Environmental Protection Institute, funded through a grant by Norwegian scientific council. It aims at developing Croatian capacities in the area of air pollution control and modeling and at implementing an operative framework for environmental control of air pollution problems in Croatia.
The project objectives will be met through:

- development of high resolution emission inventories of air pollutants in Croatia and in selected urban areas
- implementation and further development of Eulerian EMEP Unified chemical transport model coupled with ALADIN and WRF NWP models
- the development of new capability for the assessment of urban air quality in main Croatian cities
- evaluation and testing of the new modeling capability according to international standards

The project is currently under way and is developing toward the stated goals. Current status of the project will be presented and discussed.

## VERTICAL DIFFUSION VERIFICATION IN THE EMEP MODEL

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Atmospheric boundary layer (ABL) turbulence is an important transport mechanism in the troposphere. All species emitted at the surface must pass through the ABL. Because turbulence acts on spatial scales that are much smaller than the typical size of the grid cells, turbulent diffusion must be parameterised in models. One of the objectives of EMEP4HR project is a implementation of a new scheme for vertical diffusion calculation. A new vertical structure of the EMEP4HR model will be defined and it needs to be tested with respect to the model's vertical diffusion parameterisation to secure a consistent description of vertical exchange. Presently in the EMEP model vertical diffusion coefficient, K(z), is calculated with Blackadar (1979) method in stable conditions and in unstable conditions K(z) is calculated due to O'Brien (1970) formula. The new approach uses generalized form of O'Brien's third-order polynomial K(z). It is an linear-exponential function with convenient analytic properties (Grisogono and Oerlemans, 2002). Here the new method for K(z) and the old one are tested and compared with measurements of surface $NO_2$, $SO_2$ and $SO_4$ daily concentrations for January and July 2001 on EMEP model domain. First results of this study indicate improvements with the new method.

## EUROPEAN UNION INITIATIVES AND REQUIREMENTS: AIR QUALITY ASSESSMENT AS A COMMON AND OBLIGATORY POLICY RELEVANT TOOL

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Under Council Directive 96/62/EC on Air Quality Assessment and Management, Member States of the EU are required to assess air quality throughout their territory. The requirements for those assessments depend on the nature of the area and the levels of air pollution, in relation to limit values as defined in Daughter Directives. In Article 5 it is stated that Member States which do not have representative measurements of the levels of pollutants for all zones and agglomerations shall undertake series of representative measurements, surveys or assessments in order to have the data available in time for implementation of the Daughter Directives. It is recommended that the results obtained from these assessment methods be presented as maps, where the spatial extent of an area exceeding limit values, or requiring a certain assessment methodology, can be easily seen. Unlike previous EC legislation on air quality the FWD envisages the use of tools other than measurement to provide the full picture needed to underpin successful air quality management. Article 2 defines "assessment" as "any method used to measure, calculate, predict or estimate the level of a pollutant in ambient air". Three main assessment methods or tools can be used singly or in combination for preliminary air quality assessment: preliminary air quality measurements; air emission inventories; and air pollution modelling.

In order to fulfill requirements set by EC as well as recently adjusted Croatian air quality legislation, first preliminary assessment report has been prepared. Scope and results of this assessment are briefly discussed in this paper.

## DEVELOPEMENT OF THE ATMOSPHERIC LAGRANGIAN PARTICLE STOHASTIC (ALPS) DISPERSION MODEL

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The Atmospheric Lagrangian Particle Stochastic (ALPS) dispersion model was created as an experimental student project and tested under idealized and complex atmospheric and topographic conditions. The model is based on statistical approach and uses an Eulerian meteorological model output fields to estimate Lagrangian scales and turbulence. Dispersion of a passive scalar in the atmosphere is simulated by calculating a large number of Lagrangian particle trajectories. ALPS was built based on the same set of basic equations as in the LAP model from Koracin et al. (1998, 1999). All other issues in the model were left for the students to research and implement. Series of idealized tests were conducted and it has been shown that ALPS correctly responds to different atmospheric stability conditions and their respective level of turbulence. The well-mixed criterion was met by adding a drift correction term to the vertical component of the subgrid-scale velocity. In the future developments of this model complete solution for all conditions in the convective PBL must be solved prior to its applications to experiments in such conditions.

## ECOTOXICOLOGICAL BENEFITS OF THE THERMAL WASTE TREATMENT PLANT IN ZAGREB

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## EXAMPLE OF A POWER PLANT AND OTHER SOURCE HEALTH EFFECTS STUDY IN TONG LIANG, CHINA

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Chemically speciated PM2.5 and particle-bound polycyclic aromatic hydrocarbon (PAH) measurements were made at three sites near urban Tong Liang, Chongqing, a Chinese inland city where coal combustion is used for electricity generation and residential purposes outside of the central city. Elevated PM2.5 and PAH concentrations were observed at all three sites, with the highest concentrations found in winter and the lowest in summer. This reflects a coupling effect of source variability and meteorological conditions. The PM2.5 mass estimated from sulfate, nitrate, ammonium, organics, elemental carbon, crustal material, and salt corresponded with the annual average gravimetric mass within ± 10%. Carbonaceous aerosol was the dominant species, while positive correlations between organic carbon and trace elements (e.g., As, Se, Br, Pb, and Zn) were consistent with coal-burning and motor-vehicle emissions. Ambient particle-bound PAHs of molecular weight 168-266 were enriched by 1.5 to 3.5 times during the coal-fired power plant operational period. However, further investigation is needed to determine the relative contribution from residential and utility coal combustion and vehicular activities.

In order to support an ongoing epidemiological health-effect study, we have performed a dispersion modeling study of the transport and dispersion of $SO_2$ pollutants emitted from the Tong Liang power plant. The dispersion modeling study for the periods of the power plant operation in 2002 and 2003 was conducted using an EPA preferred regulatory dispersion model Industrial Source Complex 3 Short Term (ISC3ST). The simulated extremes in $SO_2$ monthly averages, daily averages, and 3-hr averages are over 100, 300, and 600 μg $m^{-3}$, respectively. These are very high values and their possible impact should be carefully analyzed. The other issue of concern is that the extremes and high concentrations are simulated with similar values for both years. This can imply that the impact of the power plant can be expected for many years on a similar level. The results from the dispersion modeling study have been used to correlate with the ongoing epidemiological health-effect study.

# SOURCES, CONCENTRATIONS AND HEALTH EFFECTS OF ULTRAFINE PARTICLES

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