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July 2nd-3rd, 2014, Skiathos island, Greece

Organized by:

Department of Planning and Regional Development, University of Thessaly

Institute of Nuclear and Radiological Science & Technology, Energy & Safety,

NCSR Demokritos

In collaboration with

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AXON Envirogroup Ltd

Environmental Engineering Department, Technical University of Crete

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Preface

LIFE 09 “ACEPT-AIR” Conference was held jointly with the Protection and Restoration of the Environment Conference XII on July 3rd, 2014. The main objectives of the conference were to disseminate the results of the LIFE 09 “ACEPT-AIR” project, as well as other LIFE projects, and to promote the exchange of ideas and knowledge in the topics related with:

- Air quality and pollution control strategies
- Environmental impact assessment and risk analysis
- Urban aerosols and health effects
- Modeling of Transport and fate of pollutants in the environment-

21 papers were included in the LIFE 09 “ACEPT-AIR” Conference and were presented in 3 sessions. Among them, 8 presentations were held by members of the consortium of ACEPT-AIR project and 4 presentations were held by other LIFE project beneficiaries.

Project Description

The LIFE 09 "ACEPT-AIR" project is an Environment Policy & Governance project funded by the European Commission, within the framework of the LIFE Environment programme. The project started on September 1st 2010 and ends on August 31st, 2014. The European Commission Contribution is 836.449 euros and the total Beneficiaries Contribution is 913.591 euros.

The Coordinating Beneficiary is NSCR "Demokritos", Institute of Nuclear & Radiological Sciences & Technology, Energy & Safety and the Project manager is Dr. Eleftheriadis Konstantinos.
Associated beneficiaries of the project are:

- the University of Thessaly, Department of Planning and Regional Development (Principal Contact: Professor Kungolos Athanasios)
- the Aristotle University of Thessaloniki, Department of Chemistry (Principal Contact: Professor Samara Konstantini)
- the AXON Envirogroup Ltd (Principal Contact: Dr. Progiou Athena)
- the Technical University of Crete, Environmental Engineering Department (Principal Contact: Professor Lazaridis Mihalis)

The stakeholders of the project are:

- The Ministry for the Environment, Energy and Climate Change (previously Ministry of the Environment and Public Works) and especially the Department of Air pollution and the Green Fund.
- The Coalition of 21 Local Authorities of North and East Athens
- The Region of Thessaly, Regional Units of Magnesia and Sporades (previously Prefecture of Magnesia
- The Municipality of Thessaloniki
- The Association of Motor Vehicles Importers – Representatives

ACEPT-AIR project aims to provide the National Authorities at Central Regional and Local level with the means to control $PM_{2.5}$ and PM_{10} concentrations in air. The project activities

focus on three urban areas of Greece (Athens, Thessaloniki and Volos). Its main objectives are to identify the main anthropogenic and natural sources of PM_{10} and $PM_{2.5}$ in the atmosphere, to document the relative contribution of secondary aerosol particles to those from primary emissions, and to develop a Policy Tool that will enable the planning of cost efficient mitigation strategies for the reduction of PM levels in the three studied areas. The overall objectives will be achieved by the end of August 2014, through the implementation of a number of actions:

- Construction of PM concentration databases
- Application of Source Apportionment techniques
- Construction of emission inventories
- Development of ACEPT-AIR Policy Tool operational platform
- Two-way direct interaction process with stakeholders
- Active application of ACEPT-AIR Policy Tool
- Organization of open forum and International Conference
- Dissemination and mobilization of society
- Action plan formulation for PM reduction.

Project Partners	Project Stakeholders
ΔΗΜΟΚΡΙΤΟΣ ΕΘΝΙΚΟ ΚΕΝΤΡΟ ΕΡΕΥΝΑΣ ΦΥΣΙΚΩΝ ΕΠΙΣΤΗΜΩΝ; ΑΙΩΝ	21 ΟΤΑ ΣΥΝΔΕΣΜΟΣ ΓΙΑ ΤΗ ΒΙΩΣΙΜΗ ΑΝΑΠΤΥΞΗ; Δήμος Θεσσαλονίκης; ΥΠΟΥΡΓΕΙΟ ΠΕΡΙΒΑΛΛΟΝΤΟΣ ΕΝΕΡΓΕΙΑΣ & ΚΛΙΜΑΤΙΚΗΣ ΑΛΛΑΓΗΣ; ΠΡΑΣΙΝΟ ΤΑΜΕΙΟ; ΣΥΝΔΕΣΜΟΣ ΕΙΣΑΓΩΓΕΩΝ ΑΝΤΙΠΡΟΣΩΠΩΝ ΑΥΤΟΚΙΝΗΤΩΝ

Table of Contents

Development of a Cost Efficient Policy Tool for PM reduction in the urban atmosphere. Challenges and achievements

K. Eleftheriadis[1*], E. Diapouli[1], C. Samara[2], A. Kungolos[3], A. Progiou[4], M. Lazaridis[5]
[1]Institute of Nuclear & Radiological Sciences & Technology, Energy & Safety, National Centre for Scientific Research "Demokritos", 15310 Ag. Paraskevi, Attiki
[2]Department of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloniki
[3]Department of Planning & Regional Development, University of Thessaly, Volos 38334
[4]AXON Enviro Group Ltd, Athens 11257
[5]Department of Environmental Engineering, Technical University of Crete, Chania
*Corresponding author: E-mail: eleftheriadis@ipta.demokritos.gr

Abstract
Deterioration of ambient air quality remains a major concern across Europe. Suspended particulate matter (PM) is one of the main pollutants, with significant impacts both on the environment and human health. As E.C. is moving towards the implementation of the thematic strategy on Air Pollution, national authorities will have to re-evaluate their environmental strategies. Among the problems faced by policy makers when developing mitigation measures for particulate air pollution are the variety of natural and anthropogenic sources contributing to the observed concentration levels.
This work has provided a comprehensive characterization of the PM pollution problem in three Greek big urban centers (Athens, Thessaloniki and Volos), with the final objective to assist the national and regional authorities to develop and implement appropriate control measures. PM measurement and chemical speciation campaigns have been conducted during warm and cold period of 2011–2012 at the three areas. In addition, detailed emission inventories for natural and anthropogenic sources have been developed for all three areas. Analysis of the study campaigns and historical data has revealed a clear decreasing trend in both PM_{10} and $PM_{2.5}$ concentrations over the last 10 years. Nevertheless, significant levels and frequent exceedances of the E.U. air quality limit values have been observed in traffic sites during warm season and in all sites during cold season, indicating the effect of central heating and possibly the intensive use of household fireplaces during the winter months of 2011 - 2012. Contributions to PM mass from the different major chemical constituents seem to be similar over the years, although traffic related components generally presented a significant decline. The results obtained by source apportionment models and emission inventories suggest that traffic and industrial activities remain the main anthropogenic sources, with the latter more pronounced in Thessaloniki and Volos. Nevertheless, contribution from natural sources as well, such as sea salt and soil dust, emitted though regional circulation of air or long-range-transport, is not negligible.
All the above results have been integrated in a comprehensive database which provides an insight into the environmental problem targeted. The achievement of the project is the incorporation of quantitative information into a software platform to assist cost efficient policy making by evaluating emission trends and source strength data and their current and projected contributions to PM concentration levels. The study's final objective is to promote the use of this Policy Tool by the national authorities, for the identification of the optimum emission reductions and measures, and for the development of cost efficient and sustainable air quality strategies.

Keywords: $PM_{10}/PM_{2.5}$, chemical characterization, source apportionment, emission inventories, urban centers, mitigation measures, policy tool

Acknowledgements: This work is supported by the European Commission LIFE+ Environment Policy and Governance programme.

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Modelling for Particulate Pollution Abatement according to Stakeholders needs. Development of a Policy Tool Platform

A.G. Progiou[1*], I.C. Ziomas[2], N.M. Panagiotou[2], C.J. Boukouvalas[2]
[1]AXON Enviro-Group Ltd, 18 Troias str., 11257 Athens, Greece
[2]Laboratory of Process Analysis and Design, School of Chemical Engineering, National Technical University of Athens, 9 Heroon Polytehneiou str., Zografou Campus, 15780 Athens, Greece

*Corresponding author: E-mail: ap@axonenviro.gr

Abstract
Particulate matter concentrations are in most cities a major environmental problem. This is also the case in Greece where, despite the various measures taken in the past, the problem still persists. In this aspect, in the framework of the European Life Programme ACEPTAIR, a cost efficient, comprehensive policy tool was developed in order to help decision makers to take the most appropriate measures towards particulates pollution abatement. In the framework of the project, the tool was applied for the areas of three major Greek cities. The operational platform consists of two modules, a database and an algorithm for the calculation of particulates levels for different emissions scenaria. The database comprises historical measurements data, the corresponding emissions data from all sources as well as source apportionment data. In the second module, the algorithm can be applied in order to forecast particulates levels taking into account various reduction measures or the business as usual scenario. The tool can be used for future or past conditions giving thus the possibility to the decision makers to evaluate ex ante or ex post the effectiveness of specific abatement measures. Moreover, the ex post evaluation is useful for testing and validation reasons. Finally, the tool is user friendly and it can be easily updated when new input data are available.

Keywords: source apportionment, Policy Tool Platform, $PM_{2.5}/PM_{10}$, LIFE 09 "ACEPT-AIR"

Acknowledgements: This work was supported by the European Commission LIFE+ Environment Policy and Governance programme.

Chemical mass balance source apportionment of PM_{10} and $PM_{2.5}$ in Thessaloniki, Greece

G. Argyropoulos, D. Voutsa, A. Kouras, E. Manoli and C. Samara*
Environmental Pollution Control Laboratory, Department of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

*Corresponding author: E-mail: csamara@chem.auth.gr, Tel +30 2310 997805, Fax: +30 2310997747

Abstract
Source apportionment of PM_{10} and $PM_{2.5}$ was carried out at two urban sites (urban-traffic, UT and urban-background, UB) in Thessaloniki, Greece by employing the Robotic Chemical Mass Balance model (RCMB). Ambient concentrations of PM_{10} and $PM_{2.5}$ were measured during the warm and the cold months of the year (July-Sept 2011 and Feb-April 2012). Chemical analyses of PM_{10} and $PM_{2.5}$ fractions included major and trace elements (Mg, Al, Si, S, Ca, K, Ti, Mn, Fe, Co, Ni, Cu, Zn, Se, Br, Sr, Sn, Te, Pb), ionic species (NO_3^-, SO_4^{2-}, Cl^-, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) and carbonaceous species (OC, EC). Chemical source profiles, containing the same fitting species like the ambient samples, were constructed for a variety of local sources including marine aerosol, road dust, industrial emissions, vehicular traffic, residential oil combustion, wood burning, and uncontrolled open-air burning of agricultural biomass and municipal waste. Additional source profiles were obtained from literature for marine aerosol and various chemical forms of secondary aerosol, such as $(NH_4)_2SO_4$, NH_4NO_3, $CaSO_4$, $CaNO_3$, K_2SO_4, NH_4Cl and $NaNO_3$. All RCMB performance measures (Pcmas, x^2, R^2) were within acceptable values. Moreover, high correlation coefficients between model-calculated and measured concentrations of PM (R^2 0.92-0.96), and slope values close to 1 reveal the efficiency of the RCMB model to reconstruct the ambient PM mass at the two sites. Road dust was found to be the major source of PM_{10} at the UT site with average annual contribution 64%. Secondary aerosol contributed totally with 15% (sulfate was the prevalent secondary species in the warm months, while nitrate in the cold months), while biomass burning with 9% (15% in the cold months *vs.* 2% in the warm months). Traffic exhibited a total annual contribution of 8%. Road dust was also a significant source of PM_{10} at the UB site (46%) followed by secondary aerosol (22%), biomass burning (21%) and traffic (7%). When the $PM_{2.5}$ fraction is concerned, road dust was again the major source at the UT site with average annual contribution (35%) followed by secondary aerosol (23%), biomass burning (21%) and traffic (18%). At the UB site, the major $PM_{2.5}$ source was biomass burning with 33% (50% in the cold months *vs.* 5% in the warm months) and secondary aerosol (32%), followed by road dust (27%) and traffic (6%). In contrast to UT, where diesel prevailed among the different traffic types, catalytic cars were found to superimpose diesel vehicles at the UB site. When the source apportionment of PM_{10} is compared to the results obtained in Thessaloniki five years ago, it can be concluded that road dust continues to be a major source due to the continuation of works for the metro construction, however decreased traffic contribution and increased biomass contribution was revealed as an impact of the economic recession in Greece since 2010.

Keywords: chemical mass balance, chemical source profiles, receptor modeling, source contribution, fitting species, urban background

Acknowledgements
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Emissions of primary PM_{10} and gaseous aerosol precursors from natural sources in Athens, Thessaloniki and Volos

V. Aleksandropoulou and M. Lazaridis*
Department of Environmental Engineering, Technical University of Crete, 73100 Chania, Greece

*Corresponding author: E-mail: lazaridi@mred.tuc.gr, Tel +30 28210 37813, Fax: +302821037846

Abstract
An important step in improving air quality in an area is to assess the impact of specific human activities and natural sources responsible for air quality deterioration through the quantification of pollutants emissions. The objective of this study was to examine the seasonal and inter-annual variation of particulate matter ($PM_{2.5}$ and $PM_{2.5-10}$) primary and secondary emissions from natural sources and their contributions to total emissions over the Athens and Thessaloniki metropolitan areas (AMA and TMA respectively) and the greater area of Volos (GVA) during the period 2000 - 2010. Therefore spatiotemporally disaggregated emission inventories for PM_{10} from natural sources were created and compared to anthropogenic emissions in the areas. In particular, the inventories include primary windblown dust (WB) emissions from agricultural and vacant lands and primary sea salt particles emissions from the breaking of waves at the Sea Shore-surf zone (SS_SS) and the bursting of bubbles from oceanic whitecaps - Open Ocean (SS_OO). Additionally, emissions of BVOCs (Biogenic Volatile Organic Compounds) from the vegetation during photosynthesis, plant respiration and vaporization from stores within the plant tissue, precursor to PM, were estimated. The results showed that the contribution from natural sources to PM_{10} emissions was significant (64.9 Gg per year for AMA, ~79%; 4.99 Gg per year for TMA, ~46%; 5.3 Gg per year for GVA, ~83%). Sea-shore was the most abundant source of natural PM_{10} emissions in all areas. In particular, the average contribution from the sea surface to the total particulate pollution over the AMA, TMA and GVA during the decade was approximately 37%, 10% and 44% for $PM_{2.5}$, respectively, while it was approximately 85%, 65% and 84% for $PM_{2.5-10}$. Windblown dust accounted for a relatively small fraction of total natural PM_{10} emissions in AMA, TMA and GVA (~8%; ~12.5%; ~9%). In addition, BVOCs emissions accounted for approximately 0.3%, 1.6% and 1.1% of total PM_{10} emitted from the AMA, TMA and GVA, respectively. It was also found that except for AMA natural PM emissions have increased from the beginning to the end of the studied period whereas their relative contribution to total PM_{10} emissions has increased in all areas (from 0.9% in AMA to 88% in GVA). There was no significant seasonal variation observed in the natural PM_{10} emissions while BVOCs emissions were increased during the warm period due to the enhanced solar radiation and temperature. Also, there was no significant seasonal variation observed in the contribution of natural sources to total PM_{10} emissions. The decadal averaged share of primary PM_{10} and gaseous precursors to secondary aerosol formation from natural sources to total equivalent PM_{10} mass in the areas was approximately 32% in AMA, 12% in TMA and 30% in GVA.

Keywords: natural sources, BVOC, emission inventor, secondary aerosols

Acknowledgements
This work was supported by the European Community (LIFE + Environment Policy and Governance) in the framework of the ACEPT-AIR LIFE+ 09 ENV/GR/000289 project.

Source apportionment study by PMF on PM_{10} and $PM_{2.5}$ in the urban environment in major Greek cities

E. Diapouli[1,*], V. Vasilatou[1], D. Saraga[1], S. Pateraki[1], Th. Maggos[1], Th. Grigoratos[2], C. Samara[2], A. Kungolos[3] and K. Eleftheriadis[1]

[1]Institute of Nuclear & Radiological Sciences & Technology, Energy & Safety, National Centre of Scientific Research "Demokritos", 15310 Ag. Paraskevi, Attiki, Greece
[2]Department of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloniki
[3]Department of Planning and Regional Development, University of Thessaly, 38334 Volos, Greece

[*] Corresponding author: E-mail: ldiapouli@ipta.demokritos.gr.

Abstarct

Particulate air pollution remains a significant environmental problem in big urban centres in Europe and around the world. The development of effective control policies calls for the identification of the main particulate matter (PM) sources, as well as the quantification of their contribution to elevated concentration levels. The presence of significant natural sources further complicates the efforts to improve air quality and to ensure compliance with the EU guidelines. The objective of the present work was to identify the major PM sources in three big urban centres (Athens, Thessaloniki and Volos) and quantify their relative contribution to coarse and fine particle concentrations. The results were also assessed aiming to examine the evolution of source types and contributions over the last decade.

Source apportionment by positive matrix factorization analysis (Model PMF2, Version 4.2) was performed on PM_{10}/$PM_{2.5}$ datasets collected in the three cities in the framework of LIFE+ ACEPT-AIR project. The measurement campaigns were conducted during summer of 2011 and winter of 2012. 24-hr gravimetric measurements were performed with two different filter substrates (teflon and quartz) in order to allow for a comprehensive chemical characterization of the aerosol fractions. Elemental composition was quantified by electrothermal and flame atomic absorption spectrometry and by X-ray fluorescence. Ionic species (Na^+, Mg^{2+}, Ca^{2+}, K^+, NH_4^+, SO_4^{2-}, NO_3^-, Cl^-) were quantified by ion chromatography, while elemental (EC) and organic (OC) carbon were also measured by thermal-optical methodology. Two-dimensional Positive Matrix Factorisation (PMF) has been applied to each city's datasets. Details on input data preparation are provided in Karanasiou et al. (2009). Analysis was performed for different numbers of factors and the best solution was chosen based on goodness of fit parameters (Q value and the explained variation of the matrix F) as well as by examining the obtained factors profiles with respect to the possibility of associating them with specific source. In addition, multiple values of Fpeak (in the range -2.0 to 2.0) were examined in order to explore different rotations of the solutions.

The results indicated significant contribution of secondary aerosol to the measured PM levels and in particular to the fine particle fraction (30 - 50% in urban background sites and 20 – 25% in traffic sites). Biomass burning was also identified as a major PM source, especially during cold period. Its relative contribution reached up to 60% for $PM_{2.5}$ and 56% in PM_{10} in a residential area in Athens, suggesting increased use of wood burning for residential heating. Natural sources (soil dust and sea salt) contributed up to 35% in PM_{10} and 16% in $PM_{2.5}$. Comparison with previous source apportionment studies revealed a differentiation in PM source contributions over the last decade. This was also evident by the reduced concentration levels, attributed to a decrease in anthropogenic emissions either because of efficient mitigation measures (new-technology "cleaner" vehicles, traffic regulations etc.) and/or lower anthropogenic activity due to the financial crisis exhibited in the last years. The contribution

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of traffic emissions was greatly decreased in all three cities in comparison with earlier results (Karanasiou et al., 2002; Manoli et al., 2002). Nevertheless road dust (which is associated with vehicular traffic) was identified as a significant source for both particle fractions. The final results are expected to provide an interesting insight into the present air pollution situation in Greek urban environments and the potential "new" major contributors to the observed daily exceedances of air quality guidelines.

Keywords: source apportionment, PMF, $PM_{2.5}/PM_{10}$, urban centres

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Regional versus Local Sources of aerosols over Cyprus

S. Kleanthous[1], and N.Mihalopoulos[2,3*]
[1]Ministry of Labour and Social Insurance, Department of Labour Inspection (DLI), Nicosia, Cyprus
[2]Environmental Chemical Processes Laboratory, University of Crete, Greece
[3]Institute for Environmental Research and Sustainable Development (IERSD) National Observatory of Athens

*Corresponding author: Email:mihalo@chemistry.uoc.gr

Abstract
Long term monitoring of PM concentrations in Cyprus reported the occurrence of a significant number of PM exceedances above the limits set by EU legislation and point out the need for abatement strategies. To address these critical issues, mass and chemical composition of daily PM_{10} aerosol samples were collected at a suburban site (Limassol; LIM RES), a natural background site (EMEP site, Ayia Marina) and an urban center (Nicosia, NIC TRA) from January 2010 to December 2010.
By considering the chemical composition measured at EMEP as representative of the regional background, the contribution of local sources at both NIC TRA and LIM RES sites can be also estimated. In total, "local" ions account for 1.7 and 2.4 $\mu g \cdot m^{-3}$, i.e 33 and 48% of the total ionic mass recorded in NIC TRA and LIM RES. Sea salt attained levels of 2.3 ± 1.2 $\mu g \cdot m^{-3}$, 1.9 ± 1.3 $\mu g \cdot m^{-3}$ and 3.5 ± 2.3 $\mu g \cdot m^{-3}$, contributing up to 10, 7 and 11% of the PM_{10} mass measured at EMEP, NIC TRA and LIM RES, respectively. The local concentrations of OC and EC were 3.3 ± 1.1 $\mu g \cdot m^{-3}$ and 3.2 ± 1.3 $\mu g \cdot m^{-3}$ for NIC TRA and 1.70±0.03 $\mu g \cdot m^{-3}$ and 1.39±0.42 $\mu g \cdot m^{-3}$ for LIM RES relative to the values measured at the EMEP site. The high EC concentrations in NIC TRA underline the major role of traffic-related emissions. As expected for the natural background site, OC/EC ratio equals 4.84, a strong indicator of secondary organic aerosol (SOA) formation, whereas in the urban and suburban sites, the OC/EC ratio is lower ranging from 1.46 to 1.84, denoting significant influence from fossil fuel primary emissions in the studied areas.
Considering that dust at EMEP is exclusively due to "regional" dust, the dust measured at both traffic related sites is the sum of "regional" and "local dust", the second most probably originating from soil dust and car/road abrasion. The "local dust" at NIC TRA and LIM RES accounted for 28% and 21% of the total PM_{10} mass, whilst regional dust at EMEP of 45%. The temporal variation of "local dust" concentrations in NIC TRA and LIM RES reveal higher levels during the cold season, following the annual variability in combustion tracers (EC) and prevailing weather conditions (low mixing layer), favouring road dust re-suspension.
Overall, the relative local contribution of the ionic mass, dust, POM and EC for NIC TRA and LIM RES varies from 3-23%, 52-54%, 18-27% and 7-13%, respectively. Thus, local dust is a major component of the total mass accounting more than 50% of the PM_{10} mass. Finally local ionic mass, accounts for a minor part of the PM_{10} mass.

Keywords: local dust, regional dust, mass closure, secondary aerosol

Acknowledgements: This work was supported by the European Commission LIFE+ Environment Policy and Governance programme.

A combined source apportionment approach for assessing the contribution of domestic wood burning emissions on wintertime $PM_{2.5}$ air pollution in Thessaloniki, Greece

N. Moussiopoulos[1]*, G. Tsegas[1], I. Douros[1], C. Samara[2], D. Voutsa[2], G. Argyropoulos[2], C. Sioutas[3], A. Kelessis[4]

[1]Laboratory of Heat Transfer and Environmental Engineering, Aristotle University of Thessaloniki, GR-54124 Thessaloniki, Greece

[2]Environmental Pollution Control Laboratory, Aristotle University of Thessaloniki, GR-54124 Thessaloniki, Greece

[3]Department of Civil and Environmental Engineering, University of Southern California, Los Angeles CA 90089, USA

[4]Environmental Department, Municipality of Thessaloniki, GR-54630 Thessaloniki, Greece

*Corresponding author: E-mail: moussio@eng.auth.gr, Tel +30 2310 996011, Fax: +30 2310 996012

Abstract

Emissions from domestic wood-burning devices have been recognised as one of the most significant sources of ambient $PM_{2.5}$ in residential areas, particularly under unfavourable wintertime conditions. During the last few years, a gradual deterioration of household incomes combined with the increased taxation of heating oil has triggered an unprecedented substitution of domestic central heating systems with low-quality wood-burning units in the Thessaloniki Greater Area. A recent study of wintertime levels of fine particles ($PM_{2.5}$) at a residential site in Thessaloniki during the winter of 2012 and 2013 indicated an overall increase of 30% in the $PM_{2.5}$ mass concentration, while a distinct diurnal variation was observed for wood smoke tracers, with significantly higher concentrations in the colder evening period compared to the morning. A lower increase (20%) has been calculated for the $PM_{2.5}$ levels at the traffic-impacted centre of the city. In this study, a combined receptor modelling and dispersion modelling approach was applied for the source apportionment of ambient $PM_{2.5}$ in Thessaloniki, in an effort to provide solid quantitative support to the hypothesis that biomass burning emissions represent the dominant contributor in wintertime particulate pollution. The source apportionment of ambient $PM_{2.5}$ was achieved at two urban sites in Thessaloniki (residential and traffic) during the wintertime periods of 2012 and 2013 using the Robotic Chemical Mass Balance (RCMB) receptor model. By employing the chemical source profiles of the RCMB model as actual emission sources in a chemical dispersion modelling system, a set of dispersion simulations were carried out in the framework of the zero-out sensitivity method. The combined results of the two source apportionment methods indicate a significant impact of wood smoke on PM ambient levels during wintertime in Thessaloniki.

Keywords: air pollution, biomass burning, domestic heating, source apportionment, air quality modelling, dispersion modelling, receptor modelling, robotic chemical mass balance model

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Overview of the AIRUSE LIFE+ project: How to improve air quality in the Mediterranean region

T. Moreno
Institute of Environmental Assessment and Water Research (IDAEA-CSIC), Barcelona, 08034, Spain

*Corresponding author: E-mail: tmpgeo@cid.csic.es

Abstract
In Europe, the current policy efforts have not fully delivered the expected results and many urban areas still do not meet the air quality standards (2008/50/EC Directive). This is especially true for Southern Europe, which is affected by important contributions of particulate matter from both anthropogenic and natural (Saharan dust, marine aerosols, etc.) origin.
Within this framework, the AIRUSE project aims at testing existing and future mitigation measures and at developing new strategies for the improvement of air quality in Southern European countries (www.airuse.eu). For the project, involving public and private institutions of Spain, UK, Portugal, Italy and Greece, PM10 and PM2.5 daily samplings were scheduled for one year (from January 2013) in four urban sites, Barcelona (Spain), Porto (Portugal), Athens (Greece), and Florence (Italy). Further, the project includes samplings with hourly resolution and coarse/fine particles segregation for limited periods (a couple of weeks in wintertime and summertime). The time-extensive daily data set gives an overall representative picture of the PM composition in these urban sites, while hourly samples may help in disentangling the contributions from different aerosol sources and give better source profiles due to the capability of tracking rapid changes as the ones occurring in most particulate emissions as well as in atmospheric transport and dilution processes.
Both daily and hourly samples have been analyzed by PIXE (Particle Induced X-ray Emission) for the simultaneous assessment of the concentration of all the elements with Z>10. First results on elemental composition on both daily and hourly samples will be presented. PIXE data give important information on re-suspended or African dust, as PIXE is highly sensitive to most of the crustal markers (e.g. Al, Si, K, Ca, Ti, Fe, Sr...), and on biomass burning. Furthermore, results on the source apportionment by PMF (Positive Matrix Factorization) based on hourly data will be also shown.

Keywords: Elemental concentration, mitigation measures, source apportionment

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The MAPEC LIFE study: monitoring air pollution effects in children for supporting public health policy

E. Ceretti[1], M.R. Marrese[2], A. Bonetti[3], S. Monarca[4], A. Carducci[5], M.A. De Donno[6], E. Carraro[7], U. Gelatti[1], and the MAPEC_LIFE Study Group.

[1]Department of Medical and Surgical Specialties, Radiological Sciences and Public Health, University of Brescia, 11 Viale Europa, 25123 Brescia, Italy

[2]Comune di Brescia, 1 Piazza Repubblica, 25100 Brescia, Italy

[3]Centro Servizi Multisettoriale e Tecnologico – CSMT Gestione S.c.a.r.l., 45 Via Branze, 2512, Brescia, Italy

[4]Department of Pharmaceutical Sciences, University of Perugia, 1 Piazza dell'Università, 06123 Perugia, Italy

[5]Department of Biology, University of Pisa, 13 Via Ghini, 56126 Pisa, Italy

[6]Department of Biological and Environmental Sciences and Technology, University of Salento, 165 Viale Provinciale Lecce-Monteroni, 73100 Lecce, Italy

[7]Department of Public and Pediatric Health Sciences, University of Torino, 8 Via Verdi, 10123 Torino, Italy

*Corresponding author: E-mail: ceretti@med.unibs.it, Tel +39 030 3717691, Fax: +39 0303717688

Abstract

Child exposure to air pollution is a matter of concern due to the well-known health effects of airborne pollutants and the relevance of early damage in childhood on the risk of developing chronic degenerative diseases in adulthood. The study, funded by the EU LIFE+ programme 2012, will be carried out in five Italian towns: Turin, Brescia, Pisa, Perugia, Lecce. It aims to assess the relationship between the concentration of air pollutants and air mutagenicity and toxicity, as well as to evaluate the early effects of air pollution in 1000 children aged 6-8 years, using biomarkers of early DNA damage. Biological samples of exfoliated buccal cells will be collected in all children and tested for DNA damage using the comet assay and micronucleus test. Moreover *in-vitro* tests will be performed on organic extracts of ultra-fine particulate (PM 0.5) samples collected in summer and winter seasons. The same samples will be analysed for PAH and nitroPAH contents. Also exposure to other pollutants and children life-style factors will be investigated via a questionnaire filled in by their parents. Finally, the project will propose a global model of risk of early biological effects based on total exposures analysed, in order to support policy-making and community interventions to protect children from possible health effects of air pollutants.

Keywords: air pollution, children health, DNA damage.

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Short-term effects of fine and coarse particles on mortality and morbidity in 4 Mediterranean countries

S. Rodopoulou[1], E. Samoli[1], M. Stafoggia[2], E Alessandrini[2], K. Katsouyanni[1], F. Forastiere[2]; the MED-PARTICLES Study group

[1]Department of Hygiene, Epidemiology and Medical Statistics, Medical School University of Athens, Greece

[2]Department of Epidemiology of the Lazio Region Health Service, Rome, Italy

MED-PARTICLES Study Group. Italy: E. Alessandrini, P. Angelini, G. Berti, L. Bisanti, E. Cadum, M. Catrambone, M. Chiusolo, M. Davoli, F. de' Donato,M. Demaria, M. Gandini, M. Grosa, A. Faustini, S. Ferrari, F. Forastiere, P. Pandolfi, R. Pelosini, C. Perrino, A. Pietrodangelo, L. Pizzi, V. Poluzzi, G. Priod, G. Randi, A. Ranzi, M. Rowinski, C. Scarinzi, M. Stafoggia, E. Stivanello, S. Zauli-Sajani; Greece: K. Dimakopoulou, K. Elefteriadis, K. Katsouyanni, A. Kelessis, T. Maggos, N. Michalopoulos, S. Pateraki, M. Petrakakis,S. Rodopoulou, E. Samoli, V. Sypsa;Spain: J. Alguacil, B. Artiñano, J. Barrera-Gómez, X. Basagaña, J. de la Rosa, J. Diaz, B. Jacquemin, A. Karanasiou, C. Linares, B. Ostro, J. Pey, X. Querol, J. Sunyer, A. Tobias; France: M. Bidondo, C. Declercq, A. Le Tertre, P. Lozano, S. Medina, L. Pascal, M. Pascal.

Background and Aims: Within the LIFE+ MED-PARTICLES project we investigated the short-term effects of PM with aerodynamic diameter less than 10μm (PM_{10}), less than 2.5μm ($PM_{2.5}$) and between 2.5 and 10μm ($PM_{2.5-10}$) on mortality and morbidity outcomes in 10 European Mediterranean areas. This was the first multi-city/multi-country study of fine and coarse PM effects in Europe. Results from the corresponding publications[1-3] will be presented here.

Methods: We analyzed data from each city using Poisson regression models, and combined city-specific estimates to obtain overall effects. We evaluated the sensitivity of our results to adjustment for co-pollutant exposures, city-specific model choice and investigated effect modification by age, sex or season. We applied distributed lag and threshold models to investigate the temporal pattern of the associations.

Results: A 10 $\mu g/m^3$ increase, in two days' $PM_{2.5}$ concentration was associated with 0.55% (95% confidence interval (95%CI): 0.27%, 0.84%) increase in all-cause mortality and 1.23% (95%CI: -1.63%, 4.17%) increase in diabetes deaths, while a corresponding weekly increase was associated with a 1.33% (95%CI: 0.27, 2.40%) in cardiac mortality, 1.91% (95%CI: 0.71%, 3.12%) increase in respiratory mortality, 2.53% (95%CI: -0.01%, 5.14%) in COPD deaths and 0.51% (95% 95% CI: 0.12%, 0.90%) in cardiovascular admissions. Coarse particles effects were non-significant in most mortality analyses, while associations with cause specific mortality were more variable depending on the exposure period, co-pollutant and seasonality adjustment. A 6.3 $\mu g/m^3$ increase in coarse particles concentration was associated with 0.46% (95% CI: 0.10%, 0.82%) increase in cardiovascular admissions, while higher effects on respiratory hospitalizations were estimated at lag 0-5, ranging from 1.15% for PM_{10} to 1.36% for $PM_{2.5}$.

Conclusions: We found adverse health effects of $PM_{2.5}$ on mortality and morbidity outcomes in the European Mediterranean region. Coarse particles mainly showed adverse effects on hospitalisations. The effects are more prolonged for respiratory outcomes and are modified by season and age.

1. Samoli et al. Environ Health Perspect 2013; 121: 932
2. Stafoggia et al. Environ Health Perspect 2013; 121: 1026
3. Samoli et al. Environ Int 2014; 67:54.

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Airborne particulate pollution in Zagreb atmosphere

K. Šega
Environmental Hygiene Unit, Insitute for Medical Research and Occupational Health,
Ksaverska cesta 2, 10000 Zagreb, Croatia

Corresponding author: E-mail: ksega@imi.hr

Abstract
Airborne particulate pollution monitoring in Zagreb atmosphere started in 1962 by determining Black Smoke (BS) concentrations using reflectometric method. Total suspended particulates mass concentration (TSP) monitoring begun at 1972 and lasted until 2005. Monitoring of PM10 and PM2.5 particle size fractions started at 1998, while PM1 particle fraction is monitored since 2009. Particles are analysed for metals, PAHs, anions and kations, elemental and organic carbon. General statistical parameters and trends for pollutant concentrations are presented as well as trend of Average exposure index for PM2.5 (AEI, EC50 2008).
Environmental Hygiene Unit obtained accreditation under the scope Determination of air quality and pollutants in the air for: SO2, CO, O3 and NOx, as well as for Determination of mass concentration of PM10 particle fraction (EN 12341:1998), Determination of mass concentration of PM2.5 particle fraction (EN 14907:2005) and Determination of the concentration of Pb, Cd, As and Ni in the PM10 fraction of suspended particulate matter (EN 14902:2005, EN 14902: 2005/AC:2006). Obtaining accreditations for PAHs and EC/OC determination are in the process and audit is expected 17 June 2014. Today the Unit is National Reference Laboratory for PM monitoring (member of JRC AQUILA).

Keywords: Metals, PAH, ions Black Smoke, AQUILA

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Air quality in urban areas in terms of particulate matter concentrations – Results from a case study in North Greece

G. Gaidajis*, K. Angelakoglou and D. Aktsoglou
School of Engineering, Department of Production Engineering and Management, Democritus University of Thrace, 67100, Xanthi, Greece

*Corresponding author: E-mail: geogai@pme.duth.gr, Tel & Fax: +30 25410 79877

Abstract
The aim of the specific study is to assess the air quality of the urban area of Drama, North Greece, in terms of particulate matter concentrations with an aerodynamic diameter of 10, 2.5 and 1 μm (PM_{10}, $PM_{2.5}$ and PM_1) during the winter period of 2013-2014. Results have indicated that average concentrations occasionally exceeded the 24-hour guidelines proposed by World Health Organization for both PM_{10} and $PM_{2.5}$ (50 and 25 $\mu g/m^3$ respectively). The analysis of the daily concentration profile for all measurements indicated two distinct periods of elevated concentrations: a) during 08:00 to 10:00 and b) during 17:30 to 23:00. The observed periods of increased concentration coincided with the periods of increased urban traffic in the morning and wintertime heating period starting at late evening. Concentration levels during weekends and holidays were higher than weekdays both for PM_{10} and $PM_{2.5}$. Moreover significant correlation was observed between PM_{10}-$PM_{2.5}$ and $PM_{2.5}$-PM_1.

Keywords: wintertime urban air quality, particulate matter 10, 2.5 and 1 μm, Northern Greece

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Source attribution of fine atmospheric particulate matter in Asia using molecular tracers

G. Engling*, I.-T. Ku, and S.-T. Tang
Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University, 30013 Hsinchu, Taiwan

*Corresponding author: E-mail: guenter@mx.nthu.edu.tw, Tel +886 910916980

Abstract
Aerosol particles adversely affect human health, air quality, and climate, especially in Asia, where ambient concentrations are at alarming levels and sources as well as composition are more complex compared to other regions across the globe. Specifically, biomass burning activities are common and thus constitute the dominant source of carbonaceous aerosol. The main forms of biomass combustion in this part of the world are open burning of agricultural residues, land clearing fires, and residential use of biofuels for cooking. In this study, near-source and source aerosol samples were collected for different types of biomass burning under real-world combustion conditions, and ambient samples were collected at remote down-wind locations of fires acting as potential receptor sites with little influence of local anthropogenic emissions, in order to assess the contributions of long-range transported smoke aerosol. Molecular tracers, such as anhydrosugars, along with satellite-derived fire counts, air mass history analysis and WRF-Chem modeling, were utilized to constrain the extent and type of biomass smoke contributions. Particularly during the intensive spring-time burning season, large-scale burning activities in south-east Asia generated substantial amounts of smoke, which were measured at remote locations in Taiwan, demonstrating the regional impact of biomass burning emissions.

Keywords: PM2.5, molecular markers, biomass burning, long-range transport

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Diesel and biofuel PM exhaust from on-and off-road engines: characterization and nanotoxicity

O. Popovicheva[1,*], G. Engling[2]
[1]Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow, Russia.
[2]National Tsing Hua University, Hsinchu, Taiwan

*Corresponding author: E-mail:olga.popovicheva@gmail.com

Abstract
Changes in fuel and design of diesel engines are applied in last decades to reduce transport pollution emission. The growing anxieties about environmental impacts have resulted in increased use of alternative fuels. Complexity and large variability of PM emitted by on and off-road engines lead to necessity of comprehensive characterization of their physico-chemical and toxicological properties, remaining great uncertainties in health effect assessments.
Particles produced by combustion of diesel fuel and rapeseed oil were sampled from exhaust of an Opel Astra, tractor, and locomotive diesel engines. Alternative fuels were used in modern internal combustion BMW and John Deere engines in order to simulate the stationary and transient on-road driving conditions. Microscopic and chemical characterization of multicomponent diesel/biofuel exhaust particles are performed for morphology, elemental composition, organic/inorganic content, and microstructure. Quantification of particle types in terms of physicochemical relevance supports the identification of groups which may act as biomicromarkers discriminating between diesel and biofuel exhaust, thus providing a basis for exhaust nanotoxicity studies and correlative toxicological assessment of diesel/biofuel engine emissions with attention on fouling process in the exhaust system and atmospheric pollution.

Keywords: Diesel exhaust, biofuel, on-and off-road engines, nanotoxicity

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Chemical composition and mass closure of fine and coarse particles in Thessaloniki, Greece

Th. Grigoratos[1], D. Voutsa[1], A. Kouras[1], E. Manoli[1], C. Samara[1]*, Th. Maggos[2], D. Saraga[2], K. Eleftheriadis[2], A. Kelessis[3]

[1]Environmental Pollution Control Laboratory, Department of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

[2]National Centre of Scientific Research "Demokritos", Institute of Nuclear Technology and Radiation Protection, Environmental Research Laboratory, 15310 Ag. Paraskevi, Attiki, Greece

[3]Environmental Department, Municipality of Thessaloniki, Paparigopoulou 7, Thessaloniki 54630, Greece

*Corresponding author: E-mail: csamara@chem.auth.gr, Tel +30 2310 997805, Fax: +30 2310997747

Abstract

Concentrations and chemical composition of the fine ($PM_{2.5}$) and the coarse particle fraction ($PM_{2.5-10}$) were investigated at two urban sites in the city of Thessaloniki, Greece, through concurrent sampling of PM_{10} and $PM_{2.5}$ during the warm and the cold months of the year (July-Sept 2011 and Feb-April 2012). Chemical analyses included major and trace elements (Mg, Al, Si, S, Ca, K, Ti, Mn, Fe, Co, Ni, Cu, Zn, Se, Br, Sr, Sn, Te, Pb), ionic species (NO_3^-, SO_4^{2-}, Cl^-, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) and carbonaceous species (OC, EC). $PM_{2.5}$ concentrations at the urban-traffic site (UT) (25.6±6.1 and 37.6±13.2 μgm^{-3} in the warm and the cold period, respectively) were higher than those at the urban-background site (UB) (17.4±5.7 and 30.3±14.1 μgm^{-3} in the warm and the cold period, respectively), yet similar to the concentrations usually found at densely trafficked sites in large Greek and European cities. The $PM_{2.5}$ mass at the UT site was dominated by organic matter (OM, 34%), secondary sulfate and nitrate (SIA, 24%) and elemental carbon (EC, 19%), while SIA (39%) and OM (31%) were the most abundant $PM_{2.5}$ components at the UB site. $PM_{2.5-10}$ levels at the UT site (20.5±7.5 and 23.5±10.8 $\mu g\ m^{-3}$ in the warm and the cold period, respectively) were among the highest reported worldwide highlighting the impact of traffic-induced resuspension of road dust including brake and tyre abrasion and road wear emissions. The corresponding levels at the UB site were significantly lower (13.6±5.8 $\mu g\ m^{-3}$ and 10.5±6.0 in the warm and the cold period). Minerals (oxides of Si, Al, Ca, Mg, Fe, Ti and K) dominated the coarse fraction profile at both sites (53% at the UT, 45% at the UB site), with OM (18% and 15%, respectively) and secondary nitrate (11% and 12%, respectively) also contributing considerably to the $PM_{2.5-10}$ mass. The contribution of marine aerosol to the total $PM_{2.5-10}$ mass was larger than those to $PM_{2.5}$ (~4% *vs.* <1.5 %). The source origin of fine and coarse particles was investigated using surface wind data and atmospheric back trajectory modeling. Finally, the contribution of resuspension to $PM_{2.5-10}$ levels was also estimated for air quality management perspectives.

Keywords: coarse particles, elemental carbon, fine particles, minerals, organic carbon, resuspension, sea salt, urban background

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Assessment of ambient air quality in European countries using CMAQ

E. Tagaris[1,*], R.E.P. Sotiropoulou[1,2], N. Gounaris[1], S. Andronopoulos[1] and D. Vlachogiannis[1]

[1]Environmental Research Laboratory, NCSR Demokritos, 15310 Athens, Greece
[2]Department of Mechanical Engineering, University of Western Macedonia, 50100 Kozani, Greece

*Corresponding author: E-mail: tagaris@ipta.demokritos.gr, Tel +30 210 650 3405, Fax: +30 210 652 5004

Abstract

Gaseous (i.e., O_3, NO_2, SO_2) and particle (i.e., $PM_{2.5}$) concentrations are estimated over Europe for winter (i.e., January 2006) and summer (i.e., July 2006) months using CMAQ modeling system. Max8hrO_3 concentation during July is simulated up to 75ppbV while a large portion of the domain has values higher than 50ppbV. Higher NO_2 concentrations are simulated over western Europe, northern Italy and the United Kingdom for both seasons (higher concentrations during January compared to July). Elevated SO_2 concentrations are simulated over eastern Europe (higher concentrations during winter). Elevated $PM_{2.5}$ levels are simulated over eastern and western Europe with concentrations up to 30 ug/m^3 during winter. Statistical analysis between observed and predicted concentrations for the European countries found, in general, that NO_2 and $PM_{2.5}$ are underpredicted, SO_2 is overpredicted while Max8hrO_3 is overpredicted for low concentrations and is underpredicted for the higher ones. However, the findings of the current study suggest a number of European countries where observed and predicted concentrations are in good agreement for the pollutants examined here.

Keywords: air quality, ozone, particulate matter, Europe, CMAQ

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PM_{10} and $PM_{2.5}$ chemical composition, sources, metals and ions in the greater area of Volos during the LIFE+ACEPT-AIR Project

G. Proias[1], T. Grigoratos[2], E. Diapouli[3], C. Samara[2], T. Kouras[2], S. Kipouros[1], A. Kungolos[1] and K. Eleftheriadis[3]

[1]Department of Planning and Regional Development, University of Thessaly, 38334 Volos, Greece
[2]Environmental Pollution Control Laboratory, Aristotle University, Thessaloniki 54124, Greece
[3]Environmental Radioactivity Laboratory, National Centre for Scientific Research "Demokritos", 15310 Ag. Paraskevi, Attiki, Greece

*Corresponding author: E-mail: giproias@prd.uth.gr, Tel +30 24210 74452, Fax: +302421074380

Abstract

Daily and seasonal variation in the total elemental, organic carbon (OC) and elemental carbon (EC) content and mass of particulate matter with aerodynamic diameter less than 10 micrometers (PM_{10}) and less than 2.5 micrometers ($PM_{2.5}$) were studied in the urban area of Volos. The city of Volos is a coastal city of medium size in the Thessaly region and extends along the northern Gulf of Pagassitikos, on the east coast of Central Greece. The case of Volos is an interesting example, where in recent decades urbanization and increased industrialization have resulted in deterioration of air quality in the region. The meteorological factors play an important role in the development of air pollution, and the complex topography of Volos favors air pollution episodes. Ca, K, Fe, S and Si appeared to be the dominant elements determined, in agreement with previous findings from the greater area. Additionally, Zn and Pb exhibited relatively high concentrations compared to other urban environments, which taking into consideration their statistically significant correlation, suggests common sources with the most probable being metallurgical activities such as loading and unloading of scrap. Mg, Al, Si, Ti, Mn, Fe and Sr exhibited higher concentrations over the warm period, in both $PM_{2.5}$ and PM_{10} fractions. These elements are mostly crustal and their elevated concentrations during this period can be attributed to increased dust resuspension due to higher temperatures over the warm period. Finally, V, Ni, Cu, Zn, Se, Sb, Ba and Pb exhibited higher concentrations over the cold period suggesting increased anthropogenic activity such as traffic density and central heating during the winter. Moreover, SO_4^{2-}, NO_3^-, NH_4^+ and Ca^{2+} were the prevalent ions in the PM_{10} fraction vs. SO_4^{2-}, NO_3^-, NH_4^+ in the $PM_{2.5}$ fraction. Na^+ and Cl^- (sea salt) were in both fractions

Keywords: PM_{10}; $PM_{2.5}$; organic carbon; elemental carbon; metals; sources; ions; Volos; Greece.

Acknowledgements: This work was supported by the European Commission LIFE+ Environment Policy and Governance programme.

Effect of atmospheric pollutants on solar radiation

H.D. Kambezidis[1]*, L.D. Melas[2], D.H. Kampezidou[2] and D.K. Papanastasiou[3]
[1]National Observatory of Athens, GR-11810 Athens, Greece
[2]Collaborating with NOA
[3]Centre for Research and Technology Hellas, GR-38333 Volos, Greece

*Corresponding author: E-mail: harry@noa.gr, Tel +30 210 3490119, Fax: +30 210 3490113

Abstract
Incoming solar radiation interacts with the constituents of the Earth's atmosphere. This interaction is expressed as absorption, scattering and reflection. The occurrence of each of these mechanisms depends on the size of the atmospheric molecules in comparison with the wavelength of the incoming radiation. Recently, the scientific interest has been focused on the interaction of solar radiation with atmospheric aerosols, among which the atmospheric (anthropogenic) pollutants paly significant role. The present study deals with this issue. Mean daily solar radiation values from the Actinometric Station of the National Observatory of Athens (ASNOA) are compared with simultaneous ones of selected atmospheric pollutants taken from the stations of the Greek Ministry of Environment network located within the Athens basin, in the period 1985-2004. The study reveals some interesting correlations between the variability of the incoming solar radiation and the concentrations of the pollutants, concluding that an influence of some of the pollutants in the Athens area on incoming solar radiation has taken place in the mentioned period. The study examines the influence of the selected pollutants on both global and diffuse solar radiation components.

Keywords: solar radiation, atmospheric pollutants, Athens

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Assessing the effect of multiscale interactions on air quality modelling: application and validation of a coupled mesoscale-microscale model

G. Tsegas*, Ph. Barmpas, I. Douros, N. Moussiopoulos and V. Akylas
Laboratory of Heat Transfer and Environmental Engineering, Aristotle University of Thessaloniki, GR-54124 Thessaloniki, Greece

*Corresponding author: E-mail: gtseg@aix.meng.auth.gr, Tel +30 2310 996054, Fax: +30 2310 996012

Abstract
Pollutant dispersion in the surroundings of densely built-up areas is governed by mesoscale wind flow systems, such as thermally induced valley winds, land- and sea-breeze circulations in coastal areas or channelled flow along valleys. Nevertheless, the intense surface in-homogeneities of the urban canopy result in the generation of additional terms in the turbulent transport within the urban atmospheric boundary layer (ABL), which in effect generate equally intense temporal in-homogeneities. Particularly in street canyons or around buildings the microscale flow appears to play the dominant role in the dispersion of pollutants. Comparisons of field measurements with results from a number of mesoscale model simulations have shown that the existence of urban areas in the domain does compromise the accuracy of air quality simulations, pointing to a need for new approaches for the description of urban effects. Aiming to address these limitations, a two-way coupling scheme was developed for coupling the mesoscale flow model MEMO and the microscale model MIMO, based on a collection of interpolating metamodels. By introducing this coupled system as the driving meteorological model in pollutant dispersion calculations using the MARS-aero model, the performance of the coupling scheme in reproducing multiscale turbulent transport effects within the urban canopy was assessed. Statistical indexes of agreement between calculated and measured concentrations were used as performance indicators of the model system, in a case study of wintertime air pollution patterns in the urban area of Paris, France. Pollutant concentration timeseries were obtained both from the permanent Paris monitoring network as well as from the 2010 MEGAPOLI measurement campaign. The sensitivity of the coupled model on the size and resolution of calibration data sets, as used by the metamodel layer, was also investigated. Simulation results reveal a marked improvement of the predictive skill of the system over the non-coupled models, particularly in the case of photochemically active pollutants as well as for major localized pollution sources.

Keywords: air pollution, modelling, mesoscale, microscale, urbanization, two-way coupling, model assessment and verification

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Some implications from PM_{10} levels in the air of Patras, Greece

A. Bloutsos and P. Yannopoulos*
Environmental Engineering Laboratory, Department of Civil Engineering, University of Patras, 265 04 Patras, Greece

*Corresponding author: E-mail: yannopp@upatras.gr, Tel +30 2610 996527, Fax: +30 2610 996573

Abstract
The present work deals with the PM_{10} concentration levels in the air of a suburban area of Patras located at the north entrance of the city. The Environmental Engineering Laboratory of the Civil Engineering Department of the University of Patras conducted a sampling program during a winter period that extended from 04/10/2002 until 02/03/2003. The mean daily PM_{10} concentrations were 35.5±12.7 μg m^{-3}, lower than the corresponding values of downtown monitoring stations. In this paper, the analysis of recorded data led to the diurnal variation of PM_{10} concentrations and frequencies for a typical weekday and weekend of the monitoring period. The results of this study may be utilized to provide a cost-effective strategic plan of air quality monitoring with a representative sampling program during a restricted period and redefinition of sampling locations.

Keywords: air pollution, airborne particulates, suburban, diurnal, daily, monthly, frequencies

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$PM_{2.5}$ / PM_{10} concentration ratios of particle mass and chemical constituents in Thessaloniki, Greece, in relation to wind speed

D. Voutsa[1], M. Petrakakis[2], P. Tzoumaka[2], E. Manoli[1], A. Kouras[1], A. Kelessis[2] and C. Samara[1,*]

[1]Environmental Pollution Control Laboratory, Department of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

[2]Environmental Department, Municipality of Thessaloniki, Kleanthous 18, 54642 Thessaloniki, Greece

*Corresponding author: E-mail: csamara@chem.auth.gr, Tel +30 2310 997805, Fax: +30 2310997747

Abstract

The mass concentration ratio of $PM_{2.5}/PM_{10}$ was investigated at two urban sites in the city of Thessaloniki, Greece, throughout the three years preceding the beginning of the economic crisis (2007-2009) and the three years following (2010-2012). Measurements were carried out at two stations of the Air Quality Monitoring Network of the Municipality of Thessaloniki located at an urban-traffic site (UT) in the commercial city center with heavy traffic and an urban-background site (UB) with minor traffic influence. At the two sites, PM_{10} and $PM_{2.5}$ were measured at 3.5 m above ground level using the beta-absorption method. 24-h $PM_{2.5}$ and PM_{10} samples were also collected at the two sites during the 2011-12 and analysed for several chemical constituents including major and trace elements (Mg, Al, Si, S, Ca, K, Ti, Mn, Fe, Co, Ni, Cu, Zn, Se, Br, Sr, Sn, Te, Pb), ionic species (NO_3^-, SO_4^{2-}, Cl^-, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) and carbonaceous species (OC, EC). The wintertime (Nov-Feb) $PM_{2.5}/PM_{10}$ ratios during the crisis period (0.77 and 0.75 at the UT and the UB site, respectively) was considerably higher than those during the before-crisis period (0.57 and 0.61, respectively) as a result of increased biomass burning for residential heating. Small variations of the $PM_{2.5}/PM_{10}$ ratio were found in summer given that the major summertime sources of particles are traffic emissions and resuspension of road dust. During the crisis period, the $PM_{2.5}/PM_{10}$ ratio was higher in the cold than the warm months at both sites. At the street canyon conditions prevailing at the UT site (average wind speed 0.3 ms^{-1}), a statistically significant (p<0.001) negative linear relationship between the $PM_{2.5}/PM_{10}$ ratio and wind speed was apparent, particularly in winter, probably due to enhanced resuspension of road dust due to the action of moving vehicles. At the UB site, that experiences stronger winds (average wind speed 2.5 ms^{-1}), no influence of wind speed on the $PM_{2.5}/PM_{10}$ ratio was observed suggesting that wind-driven is overwhelmed by a wind dilution effect. The $PM_{2.5}/PM_{10}$ ratio during 2011-2012 averaged 0.65 and 0.76 at the UT and the UB site, respectively, indicating larger contribution of the coarse fraction at UT as a result of traffic-induced resuspension of road dust. Among chemical constituents, high ratios (0.6-1) were observed for carbonaceous and ionic species, as well as for many trace elements (S, As, Se, Br, V, Pb, etc.) thus suggesting that these constituents are primarily emitted from combustion sources (e.g. elemental carbon, organic carbon, trace elements) or are produced in the atmosphere via secondary particle formation processes (e.g. sulphate, nitrate, secondary organic carbon). On the contrary, mineral elements (Al, Si, Ti, Fe, Mn, etc) exhibited lower ratio values (<0.3) attributable to their crustal origin.

Keywords: coarse particles, fine particles, minerals, organic carbon, resuspension, road dust, traffic

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Authors Index

Author index

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