Source apportionment of airborne particulate matter for three urban centres in Greece

K. Eleftheriadis[1], E. Diapouli[1], M.I. Gini[1], V. Vasilatou[1], C. Samara[2], G. Argyropoulos[2]

[1]Institute of Nuclear Technology and Radiation Protection, Environmental Radioactivity Laboratory, National Centre of Scientific Research "Demokritos", 15310 Ag. Paraskevi, Attiki, Greece
[2]Department of Chemistry, Environmental Pollution Control Laboratory, Aristotle University of Thessaloniki, University Campus, 54124 Thessaloniki, Greece
Keywords: Ambient aerosols, Source apportionment
Presenting author email: csamara@chem.auth.gr

Suspended particulate matter (PM) is a major environmental problem in several countries in the E.U., while new evidence regarding its detrimental impact on human health has emerged. Implementation of the Thematic strategy on Air Pollution by the E.C., through the most recent Directive 2008/50/EC, will require lower limit values for PM in air. In this framework, the identification of PM sources, as well as the quantification of their contribution to the observed concentration levels, acquires increased interest since it may assist towards the development of source-specific control measures and mitigation policies. Greece is a European country, where a great deal of improvement with respect to emission control strategies can be made. The aim of this work is to review the source apportionment studies conducted so far in Greek urban centres in an attempt to summarize the main anthropogenic and natural sources influencing the ambient PM levels.

Figure 1 summarizes the available data on PM_{10} and $PM_{2.5}$ yearly ambient concentrations measured at two major Greek cities, Athens and Thessaloniki, during the last two decades.

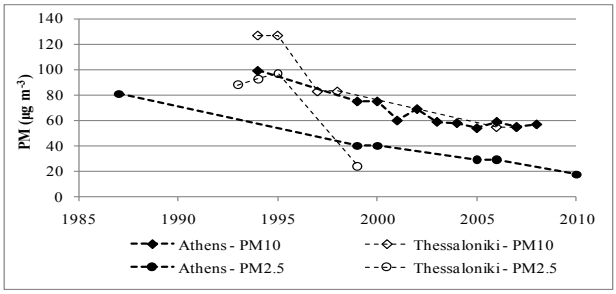

Figure 1. Long term trend of PM_{10} and $PM_{2.5}$ yearly concentration levels in Athens and Thessaloniki

Source apportionment of ambient PM has been carried out at three urban areas (Athens, Thessaloniki and Volos). Different receptor modelling approaches were employed for this purpose, based on the ambient concentration levels of particles and their chemical speciation. Chemical source profiles were constructed for the Chemical Mass Balance (CMB) receptor modelling. The different sources identified and their relative contributions (%) are listed, along with the source apportionment models used in Table 1.

In the studies where PMF was employed (Athens, Volos), the generated factors provided information on chemical source profiles and source contribution. For the CMB modelling (Thessaloniki, Volos) the chemical source profiles from the receptors were successfully reconstructed by local source profiles. In the cases were simple statistical procedures were used (PCA and FA/MR), unidentified sources were resolved.

Table 1. Mean source contributions (%) to the ambient PM mass in Athens, Thessaloniki and Volos

Study / PM fraction	***S1***	***S2***	***S3***	***S4***	***S5***	***S6***	***Model used***
Thes 1994 TSP*	**4-9**	**4-5**	**21-42**			**44-70**	APCA
Thes 1994 TSP*	**7-11**	**4-5**	**25-33**			**54-66**	FA/MR
Thes 2002 fine	**28**	**38**	**14**			**20**	APCA
Thes 2002 coarse	**57**	**9**	**26**			**8**	APCA
Thes 2003 PM10*	**18-22**	**45-65**	**10-35**				CMB
Thes 2007 PM10*	**20-25**	**23-39**	**20-38**	**1-4**	**1**	**13-15**	CMB
Athens 2002 fine	**20**	**27**	**12**	**15**	**19**	**7**	PMF
Athens 2002 coarse	**54**	**8**			**16**	**22**	PMF
Volos 2001 fine	**30**		**27**		**20**	**23**	PMF
Volos 2008 PM10*	**3-12**	**28-40**	**15-39**	**22-27**	**1-2**	**2-9**	CMB

S1: Road / Soil dust, S2: Traffic, S3: Oil burning/Industrial emissions, S4: Biomass / refuse burning, S5: Marine aerosol, S6: Secondary aerosol / Unidentified sources, APCA: Absolute Principal Component Analysis, FA/MR: Factor analysis / Multiple Regression, CMB: Chemical Mass Balance, PMF: Positive Matrix Factorization; * More than one receptor sites

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Aknowledgements

This work was supported by the European Community (LIFE + Environment Policy and Governance).