Part I
Airborne Particulate Matter: Sources, Composition and Concentration

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Airborne particulate matter (PM) is a complex mixture of solid and liquid particles of primary and secondary origin, which contain a wide range of inorganic and organic components. PM mass and composition is also highly variable in spatial–temporal terms and is strongly influenced by climatic and meteorological conditions. It can be emitted from both natural and man made sources, including forest fires, dust storms, traffic and industry, and is found both outdoors and indoors. In terms of the latter, PM may be generated within the built environment or may be transported from outside via various mechanisms. Typically, PM is defined according to size or the diameter of the particles which make up a particular fraction, as this is what determines how long they will reside in the air, how far they may be transported and, in terms of health, how they will be deposited in the respiratory system. Air quality policy and emissions regulations are typically based on the mass of size fractions PM_{10} and/or $PM_{2.5}$, for these fractions are the most likely to impact human health as they are small enough to be inhaled and respired. Particles in PM_{10} are inhalable and may reach the upper part of the airways and lung, while smaller $PM_{2.5}$ particles are more able to deeply penetrate the lungs and perhaps reach the alveoli. Ultrafines, which have a cut-off of 0.1 μm, may make up a small proportion of the total mass but may have the greatest health impacts due to their ability to pass from the lung directly into the bloodstream and their larger reactive surface area which may be capable of inducing greater damage.

In addition to size, PM mass and number concentrations, volatility, morphology and chemical composition (e.g. organic, metal, salt content) are critical factors to be considered in the assessment of risk. The evidence regarding the relationship between airborne PM mass exposures (i.e. $PM_{2.5}$) and patterns of cardiopulmonary morbidity and mortality is quite solid. It is not clear, however, what chemical constituents may be particularly responsible for the observed effects.

This part includes six chapters which address various issues and topics which relate to how airborne PM is generated, where it comes from, its chemical composition and concentrations. In the first chapter, Saliba and Massoud summarize research on the levels and origins of airborne PM and related chemical processes and implications for human health in the Eastern Mediterranean region. In the studies discussed, they reveal the complexity of airborne PM and how its concentrations and composition are strongly impacted by source (e.g. local industry, marine, Sahara Desert) and season. Celo and Ewa Dabek-Zlotorzynska discuss the concentration and origins of trace metals measured in collected $PM_{2.5}$ from May 2004 to December 2006 at various monitored sites in Canada as part of the Canadian National Air Pollution Surveillance network in the second chapter. They compare data collected from both rural and urban sites as a function of annual and seasonal trends and source origin and discuss how the major sources of trace metals in $PM_{2.5}$ at urban sites include natural dust resuspension processes, industrial and traffic emissions and fossil fuel refining/burning. $PM_{2.5}$ mass concentrations at rural sites were found to be most strongly impacted by season. In the third chapter, Lammel et al. also discuss the strong influence of seasonality on the concentratraion, source and mass size of polyaromatic hydrocarbons (PAHs) in ambient PM collected at urban and rural sites of central (Czech Republic) and south-eastern Europe (Bosnia and Herzegovina) in 2006–2008. In addition, they also present their results on the phase distributions of parent PAHs and their toxicity. They found that PAH levels were higher in winter compared to the summer, due to higher emissions and slower photochemical degradation and mixing during this time of year. Limbeck and Puls provide a comprehensive review of the literature on particulate emissions from on-road vehicles under real world conditions in the fourth chapter. As they argue, data on traffic emissions, as they occur under real world conditions, are critical in assessments of risk and have been shown to differ from that obtained in the lab using dynamometer-based studies. As part of this, they focus on published data on size segregated emissions factors of particle mass, elemental and organic carbon, as well as crustal components and selected trace metals. In the fifth chapter, Ki-Hyun et al. present data collected on the trace metals Pb, Mn, Cr and Cd over a 16-year period from 1991 to 2006 in 15 major cities in Korea. They discuss the temporal and spatial variability of these elements over time and how concentrations are influenced by varying environmental conditions and source–sink processes. Part I then concludes with a contribution from Marx and McGowan on the long-distance transport of urban and industrial metals and their sources and environmental fate over time (sixth chapter). Their contribution discusses the importance of historical trends in understanding regional and global patterns of metal contamination in spatial–temporal terms and the importance of considering long-range pollution sources and pathways as contributors to local pollution levels. As they point out, this is often overlooked with the result that many urban studies incorrectly ascribe pollution to local sources.