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Volume Editors

Urban Airborne Particulate Matter

Origin, Chemistry, Fate and Health Impacts

Springer

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Preface

Particles have been a recognized ingredient in polluted air for decades if not centuries. Despite the fact that their atmospheric concentrations have decreased substantially in developed countries over the last 50+ years, due to government policies and evolving technologies, particles continue to be a high priority environmental issue. This is because of growing evidence, starting in the early 1990s, of significant health effects at lower ambient concentrations than expected and because of the recognition that our understanding of their net effect in regulating the Earth's climate is insufficient. In particular, the magnitude and direction of their indirect effect on the radiation budget and the extent to which particles will play a role in positive or negative climate feedbacks are not known. Geoengineering responses to climate change may also involve atmospheric particles, but much more information is needed before the risks and benefits of such measures can be properly evaluated. Engineered nanoparticles represent another pressing environmental issue for which our knowledge is incomplete.

There are many directions in need of research to further our understanding in support of wise environmental and public health management pertaining to particles. In this book readers will find unique contributions to our knowledge on atmospheric and indoor particles and related pollutants or exposures. The context for much of what is presented is geared towards pollution issues and health effects as opposed to climate and engineered nanoparticles. However, many of the methods developed and/or applied in the papers in this book are quite relevant to particle research related to these latter two issues. For example, there are several papers that describe and apply advanced particle measurement methods, including chemical analysis techniques, for trace and ultra-trace metals and gas/particle phase organics. While these methods are shedding new light on the chemical characteristics and sources of particles to the benefit of risk assessment and exposure reduction strategies, they can be turned towards studying particle properties related to global aerosols and climate. Other papers in this book present new data on concentrations and important chemical constituents, including levels in the biota, indoor dust and other microenvironments. These are helping to complete the picture for particles, their sources and sinks across the globe, and human and

biological exposures. Yet other papers focus on quantifying exposure to combustion nanoparticles or studying the fate of motor vehicle exhaust catalyst materials, both of which provide scientific insights that will benefit efforts to study the potential impacts of engineered nanoparticles. Rounding out this book are a number of subject reviews from health effects and the mechanisms of oxidative stress, to persistent organic pollutants and motor vehicle emissions and to the challenges of setting ambient and emissions standards.

PM2.5 and/or PM10 levels exceed current standards or guidelines in many countries and are they alarmingly high in several megacities, particularly in some developing nations. Solving these public health problems represents a tremendous scientific challenge as well as an economic one. This is especially the case in countries where the 'easier' policies have been implemented so the options that remain are potentially more complex and more costly to undertake. Therefore, in addition to scientific research to quantify, by size, concentrations of total mass, chemical constituents and the main sources contributing to the problem, devising more cost-effective ways to achieve maximum benefits to public health is important. This necessitates, as one of the papers in this book discusses, that research continues working towards identification of the types and/or sources of particles that pose greater risk, including consideration of the combined effects of particles and gaseous co-pollutants. While this seems to be a straightforward endeavour, there is more than one particle type and or pollutant mix that can be considered 'most harmful' given the range of acute and chronic health outcomes linked to particle exposure. Consideration of environmental impacts further expands the list of emission sources and subsequent particle types that might warrant preferential control. I am sure that readers will find that this book provides a diverse, yet complementary range of information helpful in gaining the insight needed to make further headway on the challenges posed by particulate air pollution.

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Preface of the Editors

The idea for this edited volume originated in 2008, after much discourse with colleagues regarding the need for a multidisciplinary book which pulls together the most up-to-date research on the chemistry and environmental fate of airborne particulate matter (PM) and its impact on exposed populations. Over the last decade, a great deal of evidence has been gathered which shows that airborne PM plays a strong role in patterns of morbidity and mortality among urban populations. Airborne PM with an aerodynamic radius of less than 2.5 μm has been especially implicated in eliciting negative human health effects in exposed individuals, particularly in more vulnerable persons such as children, the elderly and those with compromised immune systems and/or pre-existing health problems. While it is clear that fine and ultrafine fractions of airborne PM can impact human health, however, it is not known what chemical constituents found in PM may contribute to patterns in observed morbidity and mortality. Airborne PM contains a vast number of compounds, from metals to organic constituents such as lead and polyaromatic hydrocarbons, which have the potential to negatively impact human health. The composition of airborne PM can vary significantly over time and space, depending on number of factors such as season, prevailing meteorological conditions and the time of day, week, month and year, and may be associated with certain sources such as traffic and industry or even activities in specific world regions. Currently, most countries base their air quality and emissions policies and regulations on the measured mass of ambient PM (i.e. PM_{10} and/or $PM_{2.5}$). As the toxicity of the various constituents of airborne PM are likely to significantly vary, with some of the most toxic ones contributing little to the overall PM mass, this may not be the most effective way to minimize risks among exposed populations. As we begin to shed more light on the role of specific constituents found in airborne PM in cardiopulmonary and other health effects, countries will be in a better position to regulate emission sources and shape policy in a manner that is more protective of human health.

Despite the work yet to be done, we have made progress in recent years in developing analytical methods to measure the chemical constituents of airborne

PM, determining their sources and transport pathways, identifying the processes behind their environmental fate and transformation and the toxicological mechanisms involved in their human health effects. In pulling together the research on this highly interdisciplinary topic area, we have made an attempt to be as comprehensive as possible in both disciplinary and geographical terms, involving highly respected researchers from different fields and different parts of the globe.

This edited volume has a total of eight chapters. The contributions of invited authors have been divided into six chapters which correspond to specific theme areas that relate to the topic of airborne PM and its chemical composition, environmental fate, behaviour and impact on exposed populations, as follows: 1. Airborne Particulate Matter: Sources, Composition and Concentration, 2. Metals and Organic Compounds in Airborne Particulate Matter: Analytical Methods, 3. Airborne Particulate Matter: Environmental Pathways, Behaviour and Fate in Urban Environments, 4. Bioavailability and Toxicology of Airborne Particulate Matter, 5. Airborne Particulate Matter Exposures and Health Risks and 6. Protecting Human Health: Policy Measures and Scientific Uncertainty. Chapters 7 and 8 include the author and subject indices, respectively.

The individual contributions of the authors, which number 30 in total, have been compiled and sorted accordingly. It should be noted that many of the contributions fall under two or more of the major theme areas, given the interdisciplinary nature of much of the research that has been undertaken by the authors. As editors, we attempted to assign the specific papers to certain theme areas as best we could give the foci of the respective topics.

This book has truly been a transnational effort, involving 78 individuals from Algeria, Austria, Australia, Canada, Czech Republic, Denmark, Germany, Greece, Italy, Japan, Korea, Lebanon, Morocco, Singapore, Spain, Sweden, UK and USA. The editors would like to personally thank each author for their contributions and cooperative efforts in helping us compile this book in a very timely and efficient manner.

We would also like to extend our gratitude to the reviewers and the insightful comments they provided regarding the individual contributions. Many thanks go to Dr. R. Schierl from the Institute and Clinic for Occupational and Environmental Medicine, University of Munich, Prof. Dr. S. Hann from the Department of Chemistry, University of Natural Resources and Applied Life Sciences, Vienna, Austria, Prof. Dr. E. Helmers from Applied University FH Trier, Germany, Dr. Jeffrey Brook from Environment Canada and Prof. Dr. Athanasios Valavanidis from Department of Chemistry, University of Athens, Greece.

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Frankfurt am Main, Germany Toronto, Canada Prof. Dr. Fathi Zereini
February 2010 Prof. Dr. Clare L. S. Wiseman

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