frontiers | Frontiers in Environmental Science

TYPE Editorial
PUBLISHED 11 April 2025
DOI 10.3389/fenvs.2025.1601870

OPEN ACCESS

EDITED AND REVIEWED BY
Oladele Ogunseitan,
University of California, Irvine, United States

*CORRESPONDENCE
Mounia Tahri,
tahri@cnesten.org.ma,
tahri.mounia@gmail.com

RECEIVED 28 March 2025
ACCEPTED 04 April 2025
PUBLISHED 11 April 2025

CITATION
Tahri M and Benchrif A (2025) Editorial: Atmospheric aerosol and pollution: characterization techniques and source identification.
Front. Environ. Sci. 13:1601870.
doi: 10.3389/fenvs.2025.1601870

Editorial: Atmospheric aerosol and pollution: characterization techniques and source identification

Mounia Tahri* and Abdelfettah Benchrif

Unity of Geochemistry and Chemical Pollution (UGPC), Division of Earth Sciences and Environment (DSTE), National Centre for Nuclear Energy, Sciences and Technology (CNESTEN), Rabat, Morocco

KEYWORDS

atmospheric aerosols, characterization techniques, organic fractions, inorganic fractions, emission sources, receptor models

Editorial on the Research Topic
Atmospheric aerosol and pollution: characterization techniques and source identification

The complex behavior of atmospheric aerosols and air pollutants is an Research Topic of great interest in the quest for an integrative understanding of environmental health and climate change (Mushtaq et al., 2022; Zhang, 2020). Due to the worldwide trend of urbanization and fast industrialization, the need for intensive scientific research on atmospheric aerosols has become an urgent necessity (Yadav et al., 2023; Hussain et al., 2024). In this context, we present this special volume titled "Atmospheric Aerosol and Pollution Characterization Techniques and Source Identification," that seeks to provide an overview of the recent progress and methods in this area.

Atmospheric aerosols are a mixture of solid and liquid particles suspended in the air, of high ecological and societal importance, as they are related to the global Earth's climate and human health (IPCC, 2021; Travaglio et al., 2021; Pope et al., 2006). Their complex relationships with radiation, could formation, and precipitation can have far-reaching implications. Furthermore, aerosols have the potential to carry toxic agents and pathogens and cause considerable health and ecosystem consequences (Sokhi et al., 2022; Barnes et al., 2023). Therefore, information about their origin, their function, and their mechanism of action is very relevant.

This volume summarizes a multidisciplinary perspective on aerosol characterization, bringing together contributions from scientists all over the world, who are focused on the challenging issues of atmospheric science. Each paper gives useful information on the characterization techniques, including advanced spectrometric analysis, satellite remote sensing, and ground-based observational strategies, which help to promote more efficient observation of the aerosol composition, characterization, and identification of pollution sources, analysis of the effectiveness of mitigation strategies on air quality. The special emphasis coming out of our discussion is on source identification methods, which are the core issues for designing practical pollution control measures. Using chemical fingerprints, trajectory modeling, and statistical analysis, this volume highlights how scientists identify sources of pollution (e.g., vehicle exhaust, industrial discharge, biomass burning). Interpreting these sources is of great importance not only for regulatory compliance but

also for the effective development of useful interventions for both environmental and human health.

Zha et al. investigate the response of pak choi (*Brassica pekinensis*) to combined stress from acid rain (AR) stress plus cadmium-enriched atmospheric fine particulate matter (PM2.5-Cd). Based on integrated transcriptomic and metabolomic analyses, the authors found 735 differentially expressed genes (DEGs) and 451 differentially expressed metabolites (DEMs) as a response to stress. Major conclusions are the upregulation of genes in detoxification, antioxidant defense, and metabolic pathways, including flavonoid and phenylpropanoid biosynthesis. The findings indicate that these pathways are critical in the plant's response to AR-Cd stress and suggest directions for understanding potential mechanisms by which the tolerance of leafy vegetables to environmental pollutants can be improved.

Gaikwad et al. examined the morphology and phase state of fine particulate matter (PM2.5) collected near urban (Seoul) and coastal-rural (Seosan) regions in South Korea in June 2021. Researchers reported by means of optical microscopy and the poke-and-flow method that PM2.5 showed varied phases—liquid, semisolid phase, and (semi)solid phase—over a range of relative humidity (RH) and chemical composition. In Seoul, PM2.5 was mainly liquid-contaminated days and semisolid noncontaminated days, whereas in Seosan it mostly remained as a liquid because of higher levels of ambient VHR (relative humidity). Results underscore the necessity to clarify the physical properties of PM2.5 in atmospheric chemistry and air pollution prediction.

Li et al. provide information on the spatiotemporal variation of and sources of volatile organic compounds (VOCs) in a pesticide-polluted site in China from 2016 to 2021. This study presents a series of concentration-time curves of VOCs in four layers of the pollutant atmosphere (the urban level, the low-elevation hills, the middle-elevation hills, and the higher-elevation hills) and in the ground-level and near-soil levels under specific meteorological conditions. It characterizes BTEX (benzene, toluene, ethylbenzene, and xylenes) and alkanes as major contaminants with large time and space concentration fluctuations. The authors use statistical analysis, GIS spatial interpolation, and Positive Matrix Factorization (PMF), to study the VOC sources, and the contribution from site-specific emission, pharmaceutical production, and nearby petrochemical activities are found. The results demonstrate the necessity of future monitoring and efficient pollution management programs for ATSs.

Fekadu et al. detail the effects of different types of wood cookstoves on indoor and outdoor air pollution and deforestation in rural Ethiopia. It concludes that better cookstoves reduce considerably carbon monoxide and particulate matter emissions compared to the simple three-stone stove, and CO exposure in some places is higher than WHO standards. Improved stove' use has further contributed to decreasing deforestation rates. This study underscores the importance of improved cooker designs, effective ventilation, and an improved understanding of the health hazards of indoor air pollution along with stricter regulatory authorities to deal with those problems.

Renna et al. reviewed the major role of agricultural activities in PM10 pollution and its health consequences in Lombardy. The authors show that the ammonium salts represent over 30 of the PM10 daily burden, PM10 annual contribution is close to the limit set by the European Union. They reported that agricultural emissions, especially livestock emissions, cause around 589 deaths per year in the city of Milan, and this causes a loss of about 7,000 years of life. The paper also stresses the need for practical action of integrated policies, aimed at emission from multiple sectors for truly effective reduction of air pollution and its impact on human health.

Harm-Altstädter et al. explore the vertical distribution of aerosol particles in the vicinity of Berlin Brandenburg Airport (BER) based on fixed-wing drone ALADINA. Carried out between 11 and 19 October 2021, the study obtained 140 vertical profiles of aerosol concentrations and meteorological variables up to 750 m above ground level. The results show that aerosol concentrations tend to be highest close to the ground, driven by atmospheric boundary layer stability and by aircraft and roadside emissions generated at the airport and roadside sources, respectively. The research shows the crucial role of ultrafine particles (UFP) in ambient air quality and the potential health effects of both, in particular the importance of a further investigation of airport pollution.

In this special volume, the importance of international collaboration and data sharing to overcome these challenges is highlighted. Air pollution is all about borders and therefore effective strategies and policies need to be collaborative across countries, research institutions, and communities. We appeal to readers to envision the interdisciplinary character of aerosol science encompassing meteorology, environmental science, and public health data science as a base for future research and policymaking.

Finally, we express our deepest thanks to all the authors, the reviewers, and other contributors who have made this volume possible. Your dedication to advancing our understanding of atmospheric aerosols and pollution is commendable. We expect this compilation not only to be a reference tool for the current approaches and results but also to stimulate new investigations and creative approaches for addressing international air quality issues.

Author contributions

MT: Conceptualization, Writing – original draft. AB: Writing – review and editing.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

References

Barnes, P. W., Robson, T. M., Zepp, R. G., Bornman, J. F., Jansen, M. A. K., Ossola, R., et al. (2023). Interactive effects of changes in UV radiation and climate on terrestrial ecosystems, biogeochemical cycles, and feedbacks to the climate system. *Photochem. and Photobiological Sci.* 22 (5), 1049–1091. doi:10.1007/s43630-023-00376-7

Hussain, S., Hussain, E., Saxena, P., Sharma, A., Thathola, P., and Sonwani, S. (2024). Navigating the impact of climate change in India: a perspective on climate action (SDG13) and sustainable cities and communities (SDG11). *Front. Sustain. Cities* 5. doi:10.3389/frsc.2023.1308684

IPCC (Intergovernmental Panel on Climate Change) (2021). "Climate change 2021: the physical science basis," in *Contribution of working group I to the sixth assessment report of the intergovernmental panel on climate change* (Cambridge University Press).

Mushtaq, Z., Sharma, M., Bangotra, P., Gautam, A. S., and Gautam, S. (2022). Atmospheric Atmospheric Aerosols: Some Highlights and Highlighters, Past to Recent Yearserosols: some highlights and highlighters, past to recent years. *Aerosol Sci. Eng.* 6, 135–145. doi:10.1007/s41810-022-00133-w

Pope, C. A., and Dockery, D. W. (2006). Health effects of fine particulate air pollution: lines that connect. *J. Air and Waste Manag. Assoc.* 56 (6), 709–742. doi:10.1080/10473289.10464485

Sokhi, R. S., Moussiopoulos, N., Baklanov, A., Bartzis, J., Coll, I., Finardi, S., et al. (2022). Advances in air quality research – current and emerging challenges. *Atmos. Chem. Phys.* 22 (7), 4615–4703. doi:10.5194/acp-22-4615-2022

Travaglio, M., Yu, Y., Popovic, R., Selley, L., Leal, N. S., and Martins, L. M. (2021). Links between air pollution and COVID-19 in England. *Environ. Pollut.* 268 (Part A), 115859. doi:10.1016/j.envpol.2020.115859

Yadav, N. K., Mitra, S. S., Santra, A., and Samanta, A. K. (2023). Understanding Understanding Responses of Atmospheric Pollution and its Variability to Contradicting Nexus of Urbanization–Industrial Emission Control in Haldia, an Industrial City of West Bengalesponses of atmospheric pollution and its variability to contradicting nexus of urbanization–industrial emission control in haldia, an industrial city of West Bengal. *J. Indian Soc. Remote Sens.* 51 (3), 625–646. doi:10.1007/s12524-022-01649-x

Zhang, B. (2020). The effect of aerosols to climate change and society. *J. Geoscience Environ. Prot.* 8, 55–78. doi:10.4236/gep.2020.88006