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Editorial: Physicochemical Characterization of Aerosols in Diverse Environments and Climatic Conditions

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Editorial on the Research Topic

Physicochemical Characterization of Aerosols in Diverse Environments and Climatic Conditions

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This research topic gathers a number of contributions that describe the effects of emission sources on the atmospheric concentrations of gaseous pollutants and aerosols, as well as results and methods for the physicochemical characterization of aerosol samples. The studies that were included in the topic took place in Thailand, China, UAE (United Arab Emirates), and Brazil, providing data from very different environments.

The first study tackles the issue of smoke haze pollution in Northern Thailand (Khodmanee and Amnuaylojaroen). Biomass burning is a significant source of O_3 and its precursors in Southeast Asia. The target of the study was to quantify the impact of biomass burning on the surface concentration levels of O_3, CO, and NO_2 in Northern Thailand, using a modeling procedure. Specifically, the authors used the Weather Research and Forecasting Model with Chemistry (WRF-Chem, version 3.8.1). The model simulations were conducted for two scenarios: 1) simulations including biomass burning related emissions; and 2) simulations excluding biomass burning related emissions. A comparison of WRF-CHEM results for the aforementioned two scenarios indicated an increase in O_3, CO, and NO_x levels due to biomass burning. Biomass combustion contributed by over 60% to CO and NO_2 concentration levels through direct emissions, and by approximately 7% to surface O_3 levels, through indirect effects. The model's performance was evaluated by comparing modeled precipitation and temperature (at 2 m) and modeled O_3, CO, and NO_2 concentrations to ground-level measurements made by the Pollution Control Department of Thailand.

A fundamental characteristic of ambient particulate matter is its size distribution, which determines its physicochemical and optical properties and can also reflect the variability in local and regional sources and formation mechanisms. In Khan et al., different PM components' size distributions (carbonaceous, ionic, elemental, and saccharide species) were investigated, through size segregated PM samples (PM_1, $PM_{1–2.5}$, and $PM_{2.5–10}$) collected in Tianjin, China. The carbonaceous and ionic species exhibited bimodal distribution, with a higher presence in the fine mass fraction (PM_1) than coarse ($PM_{2.5–10}$). The elemental species exhibited unimodal distribution and were primarily distributed to the coarse size fraction of PM. The saccharide species showed different size distributions depending on their dominant emission sources. Glucose, fructose, and arabitol had a unimodal size distribution to the coarse size fraction of PM, indicating biogenic contributions as the dominant emission source. On the contrary, levoglucosan's bimodal mass size distribution (fine and coarse size fractions) indicated the significance of biomass burning-related emission in its ambient concentration.

The Middle East and North Africa are regions with increased particulate pollution due to anthropogenic (increased fossil fuel burning and other activities) and natural sources (dust storms). In the study of Hamdan et al., that took place in Sharjah, UAE, the authors present results on the PM chemical composition using various analytical techniques (x-ray fluorescence, XRF, x-ray diffraction, XRD, scanning electron microscopy, energy dispersive spectroscopy, SEM/EDS, and Multi-wavelength Absorption Black Carbon Instrument, MABI). The average mass concentration of PM_{10} during the cold season was 137 μg/m^3, while it was 210 μg/m^3 during the warm season. The warm season is associated with more frequent dust storm events, which are a significant source of PM_{10} in the region. XRF results indicated that the elements related to dust, such as Si, Ca, Al, and Fe, have high seasonal variation, with higher concentrations during the warm period (due to the dust storms), while other elements that originate from anthropogenic sources, such as S, displayed no seasonal variation. As dust was the source with the highest contribution, XRD, SEM, and EDS elemental maps were used to identify different mineral phases present in PM_{10}. Calcite, quartz, gypsum, halite, and nitratine were the most commonly observed phases in both the XRD and the elemental maps for most of the samples. Other minerals, such as palygorskite and chlorite-serpentine, were also observed in the XRD patterns. In addition to these natural minerals, secondary phases such as mascagnite and koktaite were also observed in most samples.

Several studies have indicated that the carcinogenic potential of PM is mainly due to the presence of polycyclic aromatic hydrocarbons (PAHs) and their oxy- and nitro-PAH derivatives. In the study of Scaramboni et al., the authors describe the optimization of an extraction method using small solvent volumes, for simultaneous determination of PAHs and their oxy- and nitro-derivatives by GC-MS. Additionally, they investigate the application of the methodology for the simultaneous extraction of levoglucosan. The method, which is based on ultrasonic extraction, is both simpler and faster when compared to other extraction techniques, such as Soxhlet refluxing. By following this approach, it was possible to reduce the required solvent volume by 97%, with no need to use the potentially hazardous solvent dichloromethane. The accuracy and precision were good, with low limits of quantification. The method can be applied to samples collected by both high- and low-volume samplers, and it is a good alternative to the most commonly used procedures.

This compilation of articles illustrates the wide range of techniques and methodological approaches that can be used for the study of particulate-related pollution specifically and air pollution in general, as well as the synergies between different techniques.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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