A Primer on -Omics Strategy for Untargeted Profiling of Organic Aerosols: Lessons Learned and Future Challenges

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Organic aerosols (OA) is an important component of air particles and one of the key drivers that impacts the Earth's radiative budget, ecosystems, and health. Understanding the processes involving OA in the atmosphere depends on how well the chemical composition of this component is decoded. Yet, obtaining this information for atmospheric OA faces a number of challenges, such as their collection, extraction, and chemical complexity. To overcome these challenges, we pioneered a multidimensional non-targeted analytical strategy (see Figure 1) that allows for detailed structural characterization and source attribution of OA from contrasting environments. This integrated approach includes state-of-the-art analytical techniques and data processing tools for assemble useful and usable information for the identification of chemical patterns of primary (anthropogenic and biogenic) and secondary OA.

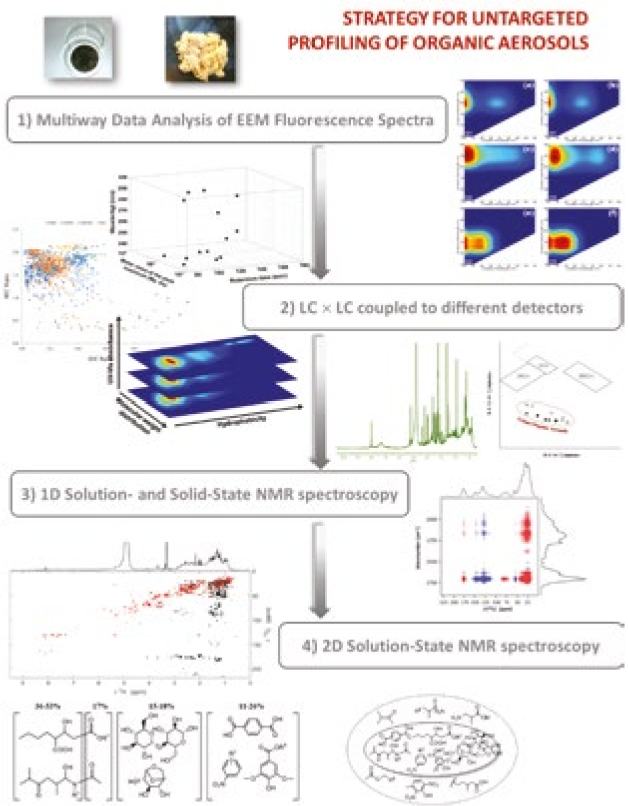

FIGURE 1
Multidimensional non-targeted analytical strategy for decoding OA chemical properties.

Excitation-emission matrix (EEM) fluorescence data, comprehensive 2D liquid chromatography (LCxLC) coupled to different detectors, and nuclear magnetic resonance (NMR) spectroscopy constitute the core of avant-garde analytical tools that have allowed us to perceive and resolve the chemical and size continuum of atmospheric OA. We have shown the existence of an "annual background" profile of the structural composition of OA, featuring a core with heteroatom-rich branched aliphatics from both primary and secondary origin, aromatic secondary organics originated from anthropogenic aromatic precursors, and biogenic primary saccharides and amino sugar derivatives. Lignin-derived structures, nitroaromatics, disaccharides, and anhydrosaccharides were also identified in smoke impacted OA, reflecting the impact of biomass-burning sources. These data were further used to develop a universal database of atmospherically relevant compounds, which is an invaluable asset for assessing and modelling the chemical properties and sources of OA.

This novel integrated strategy has paved the way into a future where we can, indeed, learn to read the wealth of molecular information within the OA pool in order to achieve a much clearer picture of their impact in a changing climate scenario. The complete characterization of OA could be achieved with the further development of high resolution hyphenated analytical techniques, which is an objective currently in progress in our research group. The multidimensional analytical platform can be applied to a diverse set of complex organic mixtures from different environmental matrices, allowing an in-depth and unified understanding of the molecular diversity and environmental functioning of such complex matrices.