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An Omics Perspective on Saharan Dust Aerosol Emissions

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Saharan dust contains high concentrations of biological material (bioaerosols), originating mainly from microorganisms and plant detritus. This material becomes further enriched with biological loads and anthropogenic emissions as the Saharan dust plume moves over terrestrial and aquatic environments. In this work, we combined metagenomic identification of biological material with lipidomics analyses in order to better understand how airborne cells adapt and respond to the harsh conditions encountered in the atmosphere, especially during dust events. This approach provides critical information on how atmospheric bioaerosols change over time and how they impact receiving environments upon deposition, as well as public health. In particular, lipidomics is an emerging analytical field that enables the simultaneous identification of hundreds to thousands of lipid species. Despite their importance in other research areas, the lipidome of airborne biogenic particles remains largely unexplored. In the atmosphere, the major sources of lipids are biogenic particles, including bacteria, fungi, pollen, plant debris, and viruses. Characterizing these lipid profiles can provide unique insights into bioaerosol composition, physiological stress states, and exposure to atmospheric oxidants.

Saharan dust aerosols were sampled in the eastern Mediterranean (Crete, Greece), while size-segregated aerosol samples were collected in the western Mediterranean (Marseille, southern France), a region influenced by both anthropogenic emissions and marine sources. A robust analytical workflow for aerosol lipidomics was developed, enabling the identification of approximately 500 lipid species, primarily triglycerides, phospholipids, and their corresponding oxidation products. In addition, comprehensive biological and chemical characterizations were performed, including analyses of metals, major ions, and oxidative potential; these results will be discussed in detail.