Recent Advances in the Measurement of Atmospheric Bioaerosols by Fluorescence Detection and Complementary Techniques

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Biogenic and biological aerosols are ubiquitous in the Earth's atmosphere, influencing atmospheric chemistry and physics, the biosphere, climate, and public health. They play an important role in the spread of biological organisms, can cause disease, and may form nuclei which initiate water (CCN) and ice (IN) formation. However, systematic measurements of outdoor bioaerosols have been challenging and relatively rare, contributing significant uncertainty to our understanding of their properties and effects. The recent development of instruments capable of detecting biological aerosols in real-time have improved our ability to perform detailed ambient observations leading, in part, to a surge in interest within the outdoor aerosol research community.

As means of providing perspective and contrast to research focusing on bioaerosols in the built environment, I will give an overview of techniques we have utilized and observations we made over the last several years to measure concentrations and properties of outdoor bioaerosols. A key piece of these studies have been laser-induced fluorescence (LIF) techniques able to provide real-time proxies of supermicron biological aerosols. The ultraviolet aerodynamic particle size (UV-APS) and wide-issue bioaerosol sensor (WIBS) are the two most easily available commercial instruments that utilize fluorescence for real-time detection of bioaerosols. We operated such instrumentation continuously in several different vegetated environments, including: semi-urban central Europe (Mainz, Germany), rural forested park (Killarney, Ireland), a boreal pine forest (Hyytiälä, Finland), mid-latitude pine forest (Teller Co, Colorado), and a tropical rainforest (Amazonia, Brazil). In several studies we also added: DNA analyses, culturability tests with collected aerosols, offline analyses with optical, fluorescence, and scanning electron microscopy techniques, and ice nucleation activity experiments. Measurements will be shown that highlight the utility of simple LIF techniques to provide first approximations of bioaerosol concentrations and temporal patterns, showing expected strong seasonal patterns, but also surprising similarities across geographical locations.