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Autofluorescence of Bioaerosol Standards – Characterization by Fluorescence Spectroscopy and Microscopy

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Primary biological aerosol particles (PBAP) such as pollen, fungal spores, bacteria, biogenic polymers and debris from larger organisms are known to influence atmospheric chemistry and physics, the biosphere and public health. PBAP account for up to ∼30% of fine and up to ∼70% of coarse particulate matter in urban, rural and pristine environment and are released with estimated emission rates of up to ∼1000 Tg/a [1].

Continuous measurements of the abundance, variability and diversity of PBAP have been difficult until recently, however. The application of on-line instruments able to detect autofluorescence from biological particles in real-time has been a promising development for the measurement of PBAP concentrations and fluxes in different environments [2,3]. The detected fluorescent biological aerosol particles (FBAP) can be regarded as a subset of PBAP, although the exact relationship between PBAP and FBAP is still being investigated.

Autofluorescence of FBAP is usually a superposition of fluorescence from a mixture of individual fluorescent molecules (fluorophores). Numerous biogenic fluorophores such as amino acids (e.g., tryptophan, tyrosine), coenzymes (e.g., NAD(P)H, riboflavin) and biopolymers (e.g., cellulose) emit fluorescent light due to heterocyclic aromatic rings or conjugated double bonds within their molecular structures. The tryptophan emission peak is a common feature of most bioparticles because the amino acid is a constituent of many proteins and peptides. The influence of the coenzymes NAD(P)H and riboflavin on the autofluorescence of bacteria can be regarded as an indicator for bacterial metabolism and has been utilized to discriminate between viable and non-viable organisms [4]. However, very little information is available about other essential biofluorophores in fungal spores and pollen.

In order to better understand the autofluorescence behavior of FBAP, we have used fluorescence spectroscopy and fluorescence microscopy to analyze standard bioparticles (pollen, fungal spores, and bacteria) as well as atmospherically relevant chemical substances. We found varying levels of fluorescent emission and significant differences in the spectral properties of major PBAP classes. The combination will support the quantitative interpretation of data obtained by real-time FBAP instrumentation.

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