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A Modified Spectroscopic Approach for the Real-Time Detection of Pollen and Fungal Spores at a Semi-Urban Site Using the WIBS-4+

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Primary biological aerosol particles (PBAP) such as pollen and fungal spores has received attention in recent years owing to the increased awareness of their impacts on human and plant health. Real-time methods based on spectroscopy/holography are now favoured over the traditional volumetric Hirst method, which is very labour intensive and time consuming. The Wideband Integrated Bioaerosol Sensor (WIBS) and its generational models have been deployed previously for the detection of bioaerosols in a range of different environments. The WIBS operates on the basis of light induced fluorescence and provides information on a particle's size, shape and fluorescent characteristics. In this study, a modified Wideband Integrated Bioaerosol Sensor (WIBS) 4+ model was evaluated for its ability to detect and differentiate ambient PBAP classes. The WIBS-4 model was adapted to include 2 additional fluorescent detection bands designed to target pollen specific fluorophores such as chlorophyll which has been shown in previous work.

The WIBS-4+ was deployed for a period of 50 days at a semi-urban sampling site in Saclay. Following various filtering and unsupervised learning methods it was concluded that the WIBS-4+ was capable of detecting and differentiate between broad bioaerosol classes. The additional channels improved clustering attempts, making k-means clustering a possible solution for high-resolution WIBS data and also allowed for the improved differentiation between tree (R2 = 0.8), herbaceous (R2 = 0.6) and grass (R2 = 0.4) pollen and fungal spores (R2 = 0.8).

During the sampling campaign meteorological and air quality data were also recorded in order to examine the effects that these parameters play on the concurrent pollen and fungal spore concentrations sampled by the Hirst and the fluorescent aerosol particles sampled by the WIBS-4+. Temperature was the most influential parameter in terms of pollen production and release, showing strong positive correlation with herb and grass pollen and a notable negative correlation with tree pollen. On the other hand, relative humidity and rainfall were the most influential parameters for fungal spore concentrations.

Due to the proximity of the sampling site to a major urban the influence of non-biological pollutants on sampling site, and Hirst /WIBS signals, were also examined. The vast majority of air quality parameters had a negative association with fungal spore concentrations. Whereas SO4, organic matter, ozone (O3) and Less-Oxidized Oxygenated Organic Aerosols (LOOOA) illustrated notable positive correlations with daily pollen concentrations, attributed to similarities in preferential meteorological conditions and geographical origins. In the case of the WIBS-4+, several fluorescent aerosol particle classes showed strong correlation with recorded air pollutants. Black carbon and NOx concentrations possessed incredibly high associations (r>0.7) with B, BC and E type particles indicating the overall potential of the WIBS as not only a bioaerosol monitor but potentially as an air quality monitor.

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