Fluorescence based real-time measurements of atmospheric PBAP in urban environment

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Primary Biogenic Aerosol Particles (PBAP) such as fungal spores and bacteria can act as CCN and IN in the atmosphere, so they have an impact on the global climate and precipitation. PBAP may contain living organisms, which can have various health effects for humans and animals. For these reasons, information on the concentration, size distribution, sources and types of PBAP are needed in various environments. Laser induced fluorescence (LIF) is a potential real-time method to detect PBAP. The LIF technique is selective for detecting biological molecules such as tryptophan, NADH and flavins that are present in bacterial cells and fungal spores. The focus on our previous studies was developing LIF based real time measurement technique for biological weapons detection (e.g. Manninen et al., 2009). The idea is processed to use similar measurement technique for atmospheric relevant fungal spores and bacteria. In recent studies, we found that airborne fungal spores and bacteria may have dissimilar fluorescence spectra, so it can be usable criteria in classification of atmospheric fungal spores and bacteria (Saari et al., 2013).

Our previous studies have focused on obtaining information of effective fluorescence measurement parameters of airborne fungal spores and bacteria that are the dominant in the PBAP number concentration fraction. There are still many problems to solve in LIF-based PBAP measurements. The fluorescence intensity from the aerosol particle depends mainly on the PBAP size and chemical composition but also on the instrumentation parameters. For these reasons, there is always a detection limit for smaller PBAP. So the particle size information is always necessary in the classification. We made parallel tests with the commercial UV-APS (TSI Corporation) and a self-made LIF-instrument called by BioScout. We found significant differences in counting efficiencies between the instruments for some common bacteria in laboratory conditions.

In this study, outdoor measurements were made with UV-APS and BioScout in urban environment during four time periods at winter, spring, summer and autumn. The results indicate that there are two dominant fluorescence particle modes during the measurement periods. We assume that the modes are mainly coming from fungal spores and bacteria. The concentrations and ratio of the fluorescent particle modes vary between the season periods. Sometimes there is strong diurnal variation in the fluorescent particle concentrations (Fig. 1). We found also that BioScout have much better fluorescent particle counting efficiency as compared to UV-APS. This is consistent with our laboratory results.

In conclusion, two LIF based instruments were tested in laboratory conditions and in urban environment. Preliminary results of outdoor measurements are promising. Real-time LIF technique seems to be suitable for atmospheric PBAP detection, but there are still many questions to answer and work to do. Investigation of the emission sources and transportation of PBAP needs meteorological data analysis and long term PBAP measurements with several instruments in various environments.

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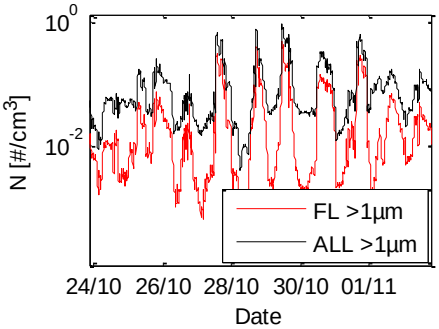

Fig. 1: Real-time data of the fluorescent and total particle concentrations measured by BioScout.

Manninen et al. (2009), Appl. Opt., 48, 4320

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