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Size-resolved Single-particle Fluorescence Spectrometer (S2FS) for Real-time Measurements of Biological Aerosols and Non-biological Fluorescent Aerosols

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Characteristic size, fluorescent intensity, and fluorescence spectra are important features crucial to distinguish biological aerosols from other aerosols. Here we developed a Size-resolved Single-particle Fluorescence Spectrometer (S2FS), which has three advantages over commonly used instruments. (1) The S2FS can measure the fluorescence intensity sensitively. Cellulose and chitin exhibit strong fluorescence by S2FS while they did not exhibit observable fluorescence by Wideband Integrated Bioaerosol Sensor (WIBS). (2) The S2FS can measure the fluorescence spectra accurately in a range between 370 and 610 nm, resolved in 512 channels with a width of 0.47 nm for each channel. These fluorescence spectra measured by S2FS are consistent with that by offline fluorescence spectrometer and other literatures, which confirms that S2FS is accurate in measuring airborne particles. (3) It allows to simultaneously identify emitted fluorescence of single particles and respective aerodynamic diameters between 0.5 to 20 μm. The performance and limitations were evaluated by screening particles in the solid state. Apart from biological fluorophores such as nicotinamide adenine dinucleotide (NADH) and nicotinamide adenine dinucleotide phosphate (NADPH), pure polycyclic aromatic hydrocarbons (PAH) also emit strong fluorescence. Diesel soot and biomass burning particles do not emit observable fluorescence although they contain PAH. Pollen in their natural physical integrity were tested. The shapes and peaks of two types of pollen are slightly different. In order to make the fluorescence spectra of pollen reproducible, at least 30 events of pollen are averaged before. In our case, we reduce the number of averaged pollen particles down to 5.