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Performance evaluation of two real-time fluorescent particle monitors in an office environment: measurements, comparisons and main evidence

Introduction
Bioaerosols represent a relevant component of both indoor and outdoor environments with the potential to cause serious adverse effects on human health [1,2]. Therefore, bioaerosols monitoring becomes a key element in risk evaluation and assessment. To date, new real-time instruments based on the induced fluorescence have been developed, allowing continuous monitoring as opposed to the traditional sampling methods (such as plate count) [3]. However, these innovative approaches also present new challenges concerning data acquisition, elaboration and analysis.
Objective
In this research, the main objective was to evaluate the performance of two instruments for real-time bioaerosol monitoring, specifically a WIBS-5/NEO and a Rapid-E+, in terms of comparability concerning total and fluorescent particles (assumed as proxy for the bioaerosols), within an office context considering its background conditions.
Methods
A monitoring campaign was performed in a university basement office in Como, during 31 July –7 August 2024, through a WIBS-5/NEO, a Rapid-E+ and an Optical Particle Counter (OPC), assumed as the reference for the total particle count. Data were collected and compared across four different particle size fractions (0.3-0.5 µm, 0.5-1 µm, 1-5 µm, >5 µm). For each size fraction the following analyses were performed: 1) comparison of total particles concentration and temporal trend measured by WIBS and Rapid-E+ respect to the OPC; 2) comparison of fluorescent particle concentrations and temporal trends between WIBS and Rapid-E+; 3) evaluation of fluorescent particle concentrations based on different boundary conditions (activities performed, n° of people, office door open/closed).
Results
Concerning total particles, it was observed that Rapid-E+ recorded lower concentrations across all fractions, while WIBS measured more similar concentrations to OPC for the two intermediate fractions, much lower for particles in the 0.3-0.5 µm size range and slightly higher for those >5 µm. Despite these differences in the magnitude of particle count, comparable temporal trends were observed across all the size fractions, as further supported by linear regressions, most of them with a R2 higher than 0.8.
The same analyses were performed for fluorescent particles. Overall, it was observed that WIBS measured higher concentrations than Rapid-E+ for each size fraction, with the smallest differences observed for the coarsest particles (1-5 µm and >5 µm). For these two fractions, the instruments also exhibited a comparable temporal trend, with the R2 from linear regressions exceeding 0.7. Instead, the finer fractions, WIBS and Rapid-E+ measured different trends over time, as highlighted by the extremely low correlations (R2 lower than 0.1).
Finally, fluorescent particle concentrations were measured for each boundary conditions. Results indicated that "more dynamic activities"(e.g., movement within the office, lunch time and breaks) led to higher fluorescent particle concentrations compared to the more static desk work, except for the fine fractions for which no clear differences were observed. Similar outcomes were noted considering the number of people in the room. Especially, higher fluorescent particle concentrations were observed as the number of people increased when considering three different "cluster": no people, 1-6 people, 7-9 people. Lastly, with respect to open- or closed-door condition, higher concentrations were clearly observed for larger particles (1-5 µm and >5 µm) measured with both instruments and for particles in the 0.5-1 µm size range measured with the Rapid-E+, while for the other finer fractions a more variable and less clear situation is observable.
Conclusion
To conclude, this study highlighted the potential of the new real-time instrument in detecting the variability

of fluorescent particles concentration (as surrogate of bioaerosols) but also pointed out some limits. According to the results, WIBS and Rapid-E+ allow to observe a real-time continuous temporal trend concerning the bioaerosols concentrations, offsetting the disadvantages of the traditional sampling methods, and therefore to analyse the variations during different conditions with a high time-resolution. This applies for all total particles and for fluorescent particles larger than 1 μm, but not for finer fluorescent particles. Moreover, a relevant aspect is the differences in terms of magnitude of concentrations measured by the different instruments, with the Rapid-E+ showing a lower counting efficiency, both for total and fluorescent particles, may lead to an underestimation in the risk assessment. This highlights the need to improve these new measurement techniques or, at least, the data analysis, for example, through a correction factor.

References

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