

## ***Interactive comment on* “Fluorescent biological aerosol particles (FBAPs) measured with the Waveband Integrated Bioaerosol Sensor WIBS-4: laboratory tests combined with a one year field study” by E. Toprak and M. Schnaiter**

**Anonymous Referee #2**

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The manuscript “Fluorescent biological aerosol particles (FBAPs) measured with the Waveband Integrated Bioaerosol Sensor WIBS-4: laboratory tests combined with a one year field study” by Toprak et al. presents data from a one-year ambient measurement of fluorescent biological aerosols using the bioaerosol monitor WIBS-4. In addition, the authors present supporting lab experiments which characterize the detection sensitivity of the WIBS-4 for different biological and non-biological standard aerosols.

Several important aspects are addressed in this study. It provides the first comprehensive dataset, which covers an entire seasonal circle of FBAP. A pronounced seasonality

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of fluorescent biological particles is shown and characterized in the study. In addition, a correlation of FBAP with relative humidity is presented, which is an important and interesting observation with regard to potential emission mechanisms. Beside the ambient measurements, systematic laboratory experiments were conducted which address part of the important question, how reliable biological and non-biological aerosol particles can be discriminated based on autofluorescence measurements. The authors show that for the samples analyzed the WIBS-4 is capable to detect biological particles in the presence of non-biological interferences. Moreover these experiments give an idea of differences in relative fluorescence intensity among certain PBAP types.

This study is an important contribution to the growing field of online bioaerosols measurements and it should be published in ACP. However, before publication, several aspects in the paper have to be clarified and improved, as listed below.

#### Specific Comments:

My feeling is that the title would be clearer and stronger without the abbreviation “FBAPs”. FBAP can be introduced and explained in the main text. Also, the use of the abbreviations FBAP and PBAP versus FBAPs and PBAPs is not consistent throughout the text. Please decide if you want to use the plural ‘s’ or not and align it in the entire text.

p. 17608 / l. 5-8: The sentence “This study aims to investigate the sensitivity of WIBS-4 to biological and non-biological aerosols, performance of WIBS-4 for discrimination of several types of aerosols, and the detection and identification of biological particles in the ambient aerosol.” is misleading. In particular, the words “detection and identification” suggest that beyond the “detection” of FBAP an “identification” of their nature (i.e. pollen, spore, bacteria) is performed. Also “discrimination of several types of aerosols” is not what the WIBS does - it provides a more or less reliable discrimination between biological and non-biological particles, but not really more.

p. 17608 / l. 9: Please replace “spores” by “fungal spores” to make sure that you are

not talking about bacterial or plant spores

p. 17608 / l. 9: Here, “pollen” (also “fluorescent polystyrene spheres”) are mentioned as biological standard particles for the chamber experiments but the results of these experiments are not shown in this paper. If aspects are omitted in the study, please do not advertise them in the abstract. Please also decide if you want to use the plural ‘s’ or not: in p17608 / l. 9 it is “pollen”, in p. 17609 / l. 8 it is “pollens”. By the way, is there a specific reason to not implement the pollen results in the study? Pollen are one of the major PBAP classes and it would be interesting to see how the WIBS responds to them.

p. 17609 / l. 10: Please add an appropriate reference for PBAP as CCN.

p. 17609 / l. 12: What is meant with “atmospheric processes”? The cloud microphysics (CCN and IN) is already mentioned earlier.

p. 17609 / l. 19-20: Replace “Mannitol” by “mannitol”. What does “organic carbon” mean in this context?

p. 17609 / l. 25: Mention the “specific size range”.

p. 17610 / l. 3: Jaenicke et al. 2007

p. 17610 / l. 28-29: Ascomycota have also developed active wet discharge mechanisms (e.g. Trail et al., 2005) and do occur in substantial concentrations in the atmosphere [e.g. 30% (Fröhlich-Nowoisky et al., 2009)]. Your argumentation is very focused on Basidiomycota – is there a reason?

p. 17612 / l. 8: I would not call four months a "short period“.

p. 17612 / l. 15: Make “FBAP” instead of “FPAB”

p. 17613 / l. 19-20: The sentence “These individual channels provide essential information about the nature of the detected particles.” is imprecise and too strong. The words “essential information” and “nature” sound as if the WIBS provides information

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about the type of particle (e. g. species, composition, etc.) which is not the case.

p. 17613 / l. 20-22: It would be helpful to add a statement why the combination F1/F3 is promising and why channel F2 is not used for the analysis although it provides additional information. Isn't it possible that the combination F1/F2/F3 provides an even higher sensitivity for biological particles?

p. 17616 / l. 17: "... bacteria and spores, never saturate the fluorescence detectors" – I guess this refers to the samples the authors have investigated in the chamber experiments. Or does this statement mean that all bacteria and spores in ambient air do "never" saturate the detectors? This is a strong statement – what is the evidence the authors can provide?

p. 17618 / l. 19: Please provide some information in the experimental section where the biological standard particles (e.g. *Penicillium notatum*) are derived from. Are the fungi cultivated to harvest the spores? Are all fungal hyphae separated from the spores?

p.17618/l.25 to p.17619/l.13 and Fig. 3: How do you explain the obvious difference in the FBAP size distribution between Fig. 3a and Fig. 3b? For the F1-mode: Fluorescent particles occur in wide size range 1-2.5  $\mu\text{m}$  whereas in the F1/F3-mode there is only a narrow peak of fluorescent particles  $\sim 2 \mu\text{m}$ . The fungal spores should have a defined and similar size distribution in both modes. The contribution of 'fluorescent' ammonium sulfate particles is too weak (1%) to explain it. Moreover, I am not really convinced by the viability explanation. Fungal spores as a reproductive unit do not really have an active metabolism. Do they provide a measurable NADH-signal? Moreover, it has been reported that there is a negative correlation between viability and autofluorescence intensity of fungal spores (Wu and Warren, 1984).

p.17622: A heading is missing here: "3.1.4 Bacteria"

p. 17622: Again, it would be helpful to have some information how the bacteria were cultivated and prepared for aerosolization. What bacterial species have been used?

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What is their physical size? How long did they stay in the chamber?

p. 17622/l.14: Maybe you mean “cells” instead of “species”.

p. 17622/l.1-21: In Fig. 6a and b there is again a pronounced difference in the particle size distribution. Fig. 6a shows a large amount of material in the size range of 0.8-1.5  $\mu\text{m}$ . Is this an artifact of the aerosolization process? Do you have any information about the identity of this material? Moreover, in Fig. 6b a constant signal around 1.5  $\mu\text{m}$  is shown. The narrow peak seems to indicate the presence of the bacterial cells. What is the average physical size of the bacterial cells that have been sampled? Is this consistent with the observed FBAP signal?

References: Fröhlich-Nowoisky, J., Pickersgill, D. A., Després, V. R. and Pöschl, U.: High diversity of fungi in air particulate matter, Proceedings of the National Academy of Sciences of the United States of America, 106, 12814-12819, 10.1073/pnas.0811003106, 2009.

Trail, F., Gaffoor, I. and Vogel, S.: Ejection mechanics and trajectory of the ascospores of *Gibberella zeae* (anamorph *Fusarium graminearum*), Fungal Genet. Biol., 42, 528-533, 10.1016/j.fgb.2005.03.008, 2005.

Wu, C. H. and Warren, H. L.: Natural autofluorescence in fungi, and its correlation with viability, Mycologia, 76, 1049-1058, 1984.

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