

***Interactive comment on* “Chemical and microbiological characterization of primary biological aerosol particles at the boreal forest” by Jose Ruiz-Jimenez et al.**

Anonymous Referee #2

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The study aimed to identify correlations between the concentration of primary biological aerosol particles (especially bacteria, fungi and *Pseudomonas* qPCR-based concentrations) and different atmospheric compounds (free amino acids, saccharides, VOCs) using different statistical approaches. Other environmental data such as meteorological data were also analyzed. The authors collected airborne particles of four different particle size fractions in the Finland boreal forest using a PM10 sampler. The dataset is relatively large (84 samples) and interesting. The results revealed several correlations but the discussion remained elusive.

Main comments

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-The authors used polycarbonate membranes to collect airborne particles of different sizes. Still, to characterize atmospheric chemistry, quartz fiber filters are mostly used in the literature due to their high retention rates (Innocente et al., 2017, Dommergue et al., 2019, Samake et al., 2019). Do the authors think that the use of these filters could have impacted the observed chemical concentrations?

-Could the authors specify why a relatively low volume of around 100 m³ has been used to collect airborne particles? 100 m³ is a low air volume considering the low microbial biomass in the air, especially if half of the filters has been used for molecular biology analyses.

-The authors have chosen to estimate the concentration of the *Pseudomonas* bacterial genus (based on qPCR gene copy number). Could the authors specify why they have chosen this bacterial genus? Is the choice based on some hypotheses or expectations that have not been specified in the text?

-The authors specified for each method what percentages of correct classification of the samples it provides, but what does a correct classification mean? And to what extend is it useful (i.e. what does it mean for the non-classified samples) and used in the result interpretation?

-L93: why this whole methodological paragraph? These methods are widely used in atmospheric chemistry and microbial ecology.

-The results and discussion section showed little discussion and limited literature references. It is not clear if the authors expected specific correlations between airborne microbes and atmospheric chemical compounds. Like specified by the authors in the Introduction section, lots of chemical compounds are produced and emitted by microorganisms. Still, the sampling site is located within a forest in which microorganisms are really abundant (on trees, plants, in the soil. . .). These microorganisms (not necessarily airborne) would produce these chemical compounds that could become airborne, so why correlations between airborne microorganisms and chemical compounds would

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be expected? Are the authors suggesting that atmospheric chemical compounds are emitted or composed airborne microorganisms?

In the same way, L530 (“In most of the cases, exception of methacrolein, these compounds were reported to be produced and emitted to the atmosphere by *Pseudomonas* (Effmert et al., 2012).”), do the authors suggest that *Pseudomonas* bacteria present in the air emit these compounds in the air? *Pseudomonas* bacteria present in the different ecosystems composing the forest (on the trees, plant leaves etc.) would also emit these compounds in the air.

Some recent papers relevant in the domain and that investigated the relationship between atmospheric chemistry and microorganisms are not referenced such as:

Samake, A., Jaffrezo, J.-L., Favez, O., Weber, S., Jacob, V., Canete, T., Albinet, A., Charron, A., Riffault, V., Perdrix, E., Waked, A., Golly, B., Salameh, D., Chevrier, F., Oliveira, D. M., Besombes, J.-L., Martins, J. M. F., Bonnaire, N., Conil, S., Guillaud, G., Mesbah, B., Rocq, B., Robic, P.-Y., Hulin, A., Le Meur, S., Descheemaeker, M., Chretien, E., Marchand, N. and Uzu, G. : Arabitool, mannitol, and glucose as tracers of primary biogenic organic aerosol : the influence of environmental factors on ambient air concentrations and spatial distribution over France, *Atmos. Chem. Phys.*, 19(16), 11013–11030, doi:10.5194/acp-19-11013-2019, 2019.

Samake, A., Jaffrezo, J.-L., Favez, O., Weber, S., Jacob, V., Albinet, A., Riffault, V., Perdrix, E., Waked, A., Golly, B., Salameh, D., Chevrier, F., Oliveira, D. M., Bonnaire, N., Besombes, J.-L., Martins, J. M. F., Conil, S., Guillaud, G., Mesbah, B., Rocq, B., Robic, P.-Y., Hulin, A., Meur, S. L., Descheemaeker, M., Chretien, E., Marchand, N. and Uzu, G. : Polyols and glucose particulate species as tracers of primary biogenic organic aerosols at 28 French sites, *Atmos. Chem. Phys.*, 19(5), 3357–3374, doi:10.5194/acp-19-3357-2019, 2019.

Innocente, E., Squizzato, S., Visin, F., Facca, C., Rampazzo, G., Bertolini, V., Gandolfi, I., Franzetti, A., Ambrosini, R., Bestetti, G., 2017. Influence of seasonality, air mass orig-

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inand particulate matter chemical composition on airborne bacterial community structure in the Po Valley, Italy. *Sci. Total Environ.* 593–594, 677–687.

-L248: The sentence “Multiple linear regression, [. . .], was used to evaluate the effect of the microbial species on the chemical composition of the aerosol particles.” How linear regression could evaluate this? A correlation does not mean a cause-effect relationship, and even if it was the case, could the atmospheric chemical composition affect airborne microbial species composition and not the other way around? The part 3.4 is called “Influence of the concentration of atmospheric gases, aerosol, meteorological and environmental parameters on the microbiological and chemical composition of the aerosol particles”. Could it be the other way around?

-L419: Part 3.5 “Potential elucidation of chemical signals from microbes in aerosol particles”, what does it mean? Could the authors try to make clearer subtitles in the Result and Discussion section.

Specific comments

-L19: In the abstract the authors wrote “The contribution of pollen, plant fragments, spores, bacteria, algae and viruses to PBAPs is well known.” while it appears that the literature does not say so. The quantitative contribution of all these different PBAPs at any specific location is unknown.

-L47: The reference Reponen et al., 2001 (“Aerodynamic versus physical size of spores: Measurement and implication for respiratory deposition”) is about the respiratory deposition of spores. Could the authors explain how it is related to the sentence on the potential long residence time of PBAPs?

-L74: Please correct the sentence, for example like that: “uncultivable or dead microorganisms, as well as fragments of plant. . .”

-L77: Please correct the sentence (“in the airborne”)

-L86: Please correct the sentence: either add a comma after fragments or remove

“Fungi”.

-L90: Sentence not clear. Do allergenic processes in humans induce considerable economic losses?

-L112: Please correct the sentence “microbial species (bacteria, fungi and Pseudomonas)” is incorrect as neither bacteria, fungi or Pseudomonas are species.

-L156 and L126: Please avoid repetitions in the Material and Methods section, for example regarding the different fraction sizes and the PM used.

-L339: Please could the authors explain what "growing mechanism" means.

-L341: Please explain “These results can be caused by the large number of potential PBAP sources present at the sampling site and their different contribution to the atmospheric aerosols.” Please provide more details about what you think when giving suggestions (here regarding the potential other sources). The same shall apply for L80 (“under the influence of different environmental factors”) and for L537 (“However, additional emission sources might not be discarded.”) and the authors should add references.

-L463: “This could be explained by the role of the AA on the oxidant induced DNA damage of the organisms (Cantoni et al., 1992).” Do the authors suggest that the presence of histidine AA in the air would “kill” airborne microorganisms? Where would this AA come from?

-L472: “The presence of trehalose has been reported for a wide variety of microorganisms, including bacteria, yeast, fungi and insects (Elbein et al., 2003).” Do the authors mean “in”? Does trehalose a microbial cellular component?

-L486: “Pseudomonas had a clear correlation with Gly.” Could the authors give in parentheses the R and pvalue associated, as a clear correlation is relatively subjective. In general, the authors should give the correlation values when talking about the presence of a correlation, even if the results are given in SI.

-L500: What do "accumulation processes" mean?

-L566: Please remove the comma at the end, add references and name the actual roles to inform the readers. "The role of plants in the production and emission of monoterpenes to the atmosphere is well known."

-L568: Please make the sentence clearer "In this way, it is not possible to discard the contribution of bacteria to the monoterpene concentration or the role of environmental and meteorological parameters in the common emission of terpenes and bacteria to the atmosphere." Do "bacteria" mean airborne bacteria? Does "contribution" mean emission and/or composition?

References:

Innocente, E., Squizzato, S., Visin, F., Facca, C., Rampazzo, G., Bertolini, V., Gandolfi, I., Franzetti, A., Ambrosini, R., Bestetti, G., 2017. Influence of seasonality, air mass origin and particulate matter chemical composition on airborne bacterial community structure in the Po Valley, Italy. *Sci. Total Environ.* 593–594, 677–687.

Dommergue, A., Amato, P., Tignat-Perrier, R., Magand, O., Thollot, A., Joly, M., Bouvier, L., Sellegri, K., Vogel, T., Sonke, J.E., Jaffrezo, J.-L., Andrade, M., Moreno, I., Labuschagne, C., Martin, L., Zhang, Q., Larose, C., 2019. Methods to investigate the global atmospheric microbiome. *Front. Microbiol.* 10.

Samake, A., Jaffrezo, J.-L., Favez, O., Weber, S., Jacob, V., Canete, T., Albinet, A., Charron, A., Riffault, V., Perdrix, E., Waked, A., Golly, B., Salameh, D., Chevrier, F., Oliveira, D. M., Besombes, J.-L., Martins, J. M. F., Bonnaire, N., Conil, S., Guillaud, G., Mesbah, B., Rocq, B., Robic, P.-Y., Hulin, A., Le Meur, S., Descheemaeker, M., Chretien, E., Marchand, N. and Uzu, G. : Arabitol, mannitol, and glucose as tracers of primary biogenic organic aerosol : the influence of environmental factors on ambient air concentrations and spatial distribution over France, *Atmos. Chem. Phys.*, 19(16), 11013–11030, doi:10.5194/acp-19-11013-2019, 2019.

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2020-1065>, 2020.

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