

Atmos. Chem. Phys. Discuss., referee comment RC2
<https://doi.org/10.5194/acp-2021-991-RC2>, 2022
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Comment on acp-2021-991

Anonymous Referee #1

Referee comment on "Measurement report: An exploratory study of fluorescence and cloud condensation nuclei activity of urban aerosols in San Juan, Puerto Rico" by Bighnaraj Sarangi et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-991-RC2>, 2022

The manuscript describes measurements of aerosols in tropical regions, on the island of Puerto Rico. The authors had the interesting idea to shed light on the aerosol composition in San Juan, the capital city of Puerto Rico, and try to identify the role of biological aerosols as CCN. The authors used various measurement techniques (WIBS, CCN counter, CPC, Burkard trap) to characterize the aerosols with temporal resolution over a period of 8 days. The main findings of the paper can be summarized as follows:

- Most aerosol particles in the region are emitted from human emission sources, e.g. cooking and traffic. However, the authors were able to distinguish those from the bioaerosol fraction which was much smaller in number concentration (using fluorescence and fungal morphology data).
- The daily trend is different for the measurement methods, e.g., different aerosols categories and sizes follow different trends in time (due to primary and secondary aerosol formation mechanisms).
- High relative humidity triggers bioaerosol emissions, likely fungal spore production.
- Most fungal spores present in the area are from the phylum Basidiomycota or Ascomycota. Those contribute to the fraction of fluorescent particles detected with WIBS and follow a trend which peaks in the early morning hours.
- There is no evidence for a correlation between the CCN number concentration and the number of fluorescent bioaerosol. This suggests that bioaerosols emitted from tropical urban areas do not significantly contribute to cloud condensation in tropical clouds.

Although this manuscript provides interesting data and fills a lack of missing information from aerosols and bioaerosols from tropical cities, I would suggest major revisions (mainly in the introduction and in the discussion) before it is considered to be published:

First, I am wondering about the motivation behind the effort to link CCN concentrations to

bioaerosol measurements. It is well known, that bioaerosols are generally low in number concentration around the globe (Hoose et al., 2010) and that most aerosol particles can act as CCN when a certain supersaturation is present. The authors make a statement about giant CCN in the introduction (line 78) but do not explain why bioaerosols from the city could be an important source of CCN. I encourage the authors to extend the introduction with a more detailed statement of bioaerosols as CCN.

Second, the paper provides important data about bioaerosols in cities, measured close to emission sources. Tropical island, such as Puerto Rico are remote areas where a large fraction of aerosols comes from local emissions. Thus, it is very important to gain data about local, urban, aerosol compositions in order to make conclusions about human health, environmental and meteorological influence. Although, the authors make a few statements in the manuscript about the importance of their measurements, the paper would strongly benefit if the statements were more emphasized, and the knowledge gap would be identified more clearly in the introduction.

Third, the authors conclude that the influence of bioaerosols as CCN to be from minor importance. I was wondering if the paper would proliferate when highlighting the health effects which bioaerosol can have in more detail. Are those concentrations of fungal spores comparable to other cities? How is the concentration in rural and remote areas compared to this study (e.g. compare with El Yunque rainforest data if that is possible)? In addition to that it is well known that bioaerosols, especially fungal spores, are among the most active ice nucleating particles (see e.g. Kunert et al., 2019). Is it possible that those particles do not influence the budget of CCN drastically, but still have an influence on the INP budget? I would encourage the authors to include the role of bioaerosols as INPs in the discussion and to shortly state health effects. This can help transferring the results of the paper into a puzzle piece from the bigger picture of bioaerosols.

In summary, the paper provides an interesting insight to a pilot study of aerosol research in a tropical city. I hope that my feedback helps the authors to revise a manuscript with a clearer storyline. Furthermore, the manuscript would benefit from spelling and grammar checks. In terms of further field campaigns, I would encourage the authors to focus not only on CCN, but also on ice nucleation and/or health effects driven by urban bioaerosols.

Specific comments:

19 ... change to *are capable of* ...

20 ... What's the difference between plant spores and pollen?

27 ... change to *a population of 2,448,000 people* ...

68 ... change to *where vehicular and industrial emissions ...*

69 ... The reader might be confused reading about local aerosols and then African dust in the next sentence. Maybe it is important to highlight the long-range transport before explaining African dust as CCN.

96 ... What meteorological factors? Please elucidate more clearly.

101 ... This is an important statement why this time was chosen.

134 .. I was wondering how representative the location of the university is for the city center. Can you make a statement about the areas and the distance to the city center of San Juan in the text?

136 ... How much rainfall, can you state a yearly average in brackets?

202 ... Are Tryptophane and NADPH the only molecules excited by fluorescent light in that region. Are there other molecules that could potentially also show fluorescence in that area. If yes, please explain in more detail.

221 ... I have seen that the fluorescence signals alone can be misinterpreted in some cases (see e.g. Savage et al., 2017). Why are you sure that those are specific for bioaerosols in your case?

251 ... I have seen different forms of writing units in the manuscript (e.g. L min⁻¹ or liters of air/min) please make sure that all the units are consistent in the manuscript.

262 ... change to ... *from a weather station that is located around 800 m away from ...*

264 ... I am wondering how 100 m above ground level would correlate with your measurements at ground level? Do you assume the aerosol composition to be the same in those altitudes?

281 ... I was wondering if the number of CCN is always so low compared to CN. Is that

also seen in other studies?

285 ... This statement assumes that the WIBS and CPC would count the same number concentration for all aerosols above 500 nm. Can that be seen in your data or confirmed with literature?

Figure 2 ... I have a hard time seeing the daily trend for CCN and CN. Would it be better observable if one would include vertical lines whenever a day ends in the diagram as a grid?

318 ... very interesting finding

Figure 4 ... the letters (a) and (b) are poorly visible

Figure 5 ... I am confused by numbers on the y-axis in Figure5(c)

409 ... The findings about the relative humidity and the fungal spore production are interesting and one of the main findings in this work

444 ... I have a hard time in understanding this paragraph and the conclusions of it. 1. Why is ABC fluorescence related to Basidio & Ascospores? Are those spores simply bigger than the other fungal spores and therefore the fluorescence signal extends the threshold for ABC? 2. Why is the concentration of the spores in WIBS so much higher than from the Burkart trap (Figure 7)? 3. Did you also count bacteria, bacteria agglomerates, and pollen with the Burkart trap samples? If no, why not? If yes, how did they influence the measurements of the fungal spores in the WIBS?

473 ... I would be careful with this statement since you are assuming that the measurement techniques cover all particles in the area above 500 nm. Also, this would include that in terms of number concentration the study only looks at 2% of the particles closely. This further implies that bioaerosols are a very low fraction of the total aerosols, yet they are important for health and climate. Maybe the authors can state that more clearly and explain that coarse mode aerosol is typically smaller in number concentration, yet high in mass concentration.

504 ... This is a main message of the paper and should be extended with one or two more sentences of what particles matter for CCN.

Figure 8 ... It is hard to see the trend in the graph with the current color scale. Would it be helpful to consider a logarithmic color scale or other colors?

603 ... As far as I know Basidiomycetes and Ascomycetes are not fungal species but more of a phylum.

References:

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Savage, N. J., Krentz, C. E., Könemann, T., Han, T. T., Mainelis, G., Pöhlker, C., & Huffman, J. A. (2017). Systematic characterization and fluorescence threshold strategies for the wideband integrated bioaerosol sensor (WIBS) using size-resolved biological and interfering particles. *Atmospheric Measurement Techniques*, 10(11), 4279-4302.