

## ***Interactive comment on “A new multicopter based unmanned aerial system for pollen and spores collection in the atmospheric boundary layer” by Claudio Crazzolaro et al.***

### **Anonymous Referee #1**

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The ms by Crazzolaro et al. describes a new collection device onboard a commercial rotary-wing UAS to collect particles in the lower atmosphere. The authors report bioaerosol data from 9 different flights conducted over three days in March, 2017. They also did some rather crude examinations of airflow over the device using colored smoke emitted from a pole at three different heights. They attempted to quantify the collection efficiency of the sampling device by putting two of the trapping surfaces inline for a single sampling interval. The manuscript has numerous formatting issues with the figures and tables (these are not even close to being ready for publication), and needs a major overhaul. There appear to be some errors with how fungi were identified (labeled fungal spores in one of the figures do not match the genera listed in the manuscript).

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Some key references are missing from the manuscript regarding the sampling of fungi and pollen in the lower atmosphere with UAS. Comments below.

1. UAV should be replaced with UAS (unmanned aircraft system) throughout. Multi-copter should be replaced with rotary-wing UAS or hexacopter (the S900 is a hexacopter platform). Moreover, the platform itself is not new. It is the collection system being used on the UAS that is new and interesting. This needs to be re-shaped in the text.

2. The introduction and results and conclusions are missing some key references regarding the sampling of the lower atmosphere with UAS:

Aylor, D.E., Boehm, M.T. and Shields, E.J., 2006. Quantifying aerial concentrations of maize pollen in the atmospheric surface layer using remote-piloted airplanes and Lagrangian stochastic modeling. *Journal of Applied Meteorology and Climatology*, 45(7), pp.1003-1015.

Boehm, M.T., Aylor, D.E. and Shields, E.J., 2008. Maize pollen dispersal under convective conditions. *Journal of Applied Meteorology and Climatology*, 47(1), pp.291-307.

Gottwald, T.R. and Tedders, W.L., 1985. A spore and pollen trap for use on aerial remotely piloted vehicles. *Phytopathology*, 75(7), pp.801-807.

Hardin, P.J. and Hardin, T.J., 2010. Small-scale remotely piloted vehicles in environmental research. *Geography Compass*, 4(9), pp.1297-1311.

Jimenez-Sanchez, C., Hanlon, R., Aho, K.A., Powers, C., Morris, C.E. and Schmale III, D.G., 2018. Diversity and ice nucleation activity of microorganisms collected with a small unmanned aircraft system (sUAS) in France and the United States. *Frontiers in microbiology*, 9.

Lin, B., Ross, S.D., Prussin II, A.J. and Schmale III, D.G., 2014. Seasonal associations and atmospheric transport distances of fungi in the genus *Fusarium* collected with unmanned aerial vehicles and ground-based sampling devices. *Atmospheric en-*

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vironment, 94, pp.385-391.

Schmale III, D.G. and Ross, S.D., 2015. Highways in the sky: Scales of atmospheric transport of plant pathogens. *Annual review of phytopathology*, 53.

Schmale, D.G., Ross, S.D., Fetters, T.L., Tallapragada, P., Wood-Jones, A.K. and Dingus, B., 2012. Isolates of *Fusarium graminearum* collected 40–320 meters above ground level cause *Fusarium* head blight in wheat and produce trichothecene mycotoxins. *Aerobiologia*, 28(1), pp.1-11.

3. Details on the operation of the sampling device are limited. Was the device powered on remotely once the UAS had reached the desired altitude? Or was it sampling on its way up and down from the target sampling altitude? Is this why you conducted the profile missions? If not, why didn't include a remote switch to power a unit? In fact, you can use a light activated trigger sensor and turn the LEDs on and off from a DJI platform to act as a switch for this using the DJI platform and software.

4. What precautions were taken to clean the inlet and the inlet pipe in between sampling missions?

5. In general, the figure legends do not contain enough information for the figure to stand alone without referencing back to the text. Figure 5 is a great example of this.

6. What sort of quantitative data were measured for experiments described in Figure 6? There appear to be only qualitative observations. Could you use image-processing tools like ImageJ to formally track the plume of smoke? Did you trap any of the smoke particles on your collection device?

7. Your particle trapping efficiency experiments based on two inline trapping surfaces and a single experiment are just not enough. You should aerosolize known particle sizes (such as fluorescent microspheres that you can buy at set size ranges), and attempt to trap them on your sampling device. Your efficiency will likely be linked to the size of your particle. Many of the smaller particles probably go cruising on by the

initial trapping surface. Your final inline sampler could be an impinger, to collect all of the material in a liquid and use that as a basis of quantification.

8. Table 1 needs to be overhauled. Order by start time, not by altitude. Also, list stop time of collection. Why did the authors choose different sampling times on different days? What is the justification for this? Why not sample the same altitude at multiple times throughout a single day? As it stands, you only present 3 reps of data for 25m and 200 m. 100m is not replicated, and 300 m was only flown twice.

9. Delete Figure 8. This is really just meant for the discussion.

10. Table 3 needs to be completely overhauled. Consider separate rows for each flight, and separate columns for the pollen and fungi analyzed. I am concerned about the fungal genera presented in this table. The authors report *Puccinia* and *Epicoccum*, but the 'fungal spores' they show in Figure 9 do not appear to be representative of either of these genera.

11. Figure 10 needs to be formatted for publication. I'm not sure what the authors are trying to do here, since they show these data in Table 3.

12. I don't understand the need for Figure 11. Why was 25 m reported? Was this the altitude the reference data were recorded at?

13. Finally, no hypotheses are stated or tested. This makes it very difficult to judge the merits of this work. Did you expect to find different concentrations of pollen at different altitudes? If so, why? How might the concentrations of pollen change throughout a day or night? Did you hover at a single location? What about hovering at multiple locations, but maintaining precise altitudes? More flights are needed to really show the value of this platform. Do you know where the pollen is coming from? Just because a forest is nearby doesn't mean the pollen was coming from there...

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