

Interactive comment on “A sampler for atmospheric volatile organic compounds by copter unmanned aerial vehicles” by Karena A. McKinney et al.

Anonymous Referee #1

Received and published: 26 September 2018

Overall, this is a well-written paper and a valuable technology. It should be published with minor revisions, however, there are some important discussion points and details that I would like to see addressed.

General Comments: 1) The dilution due to rotor-wash, which is a problem for all instruments without an inlet that extends beyond the turbulence induced by the multi-rotor platform, is not discussed until later in the paper. The authors conclude that their samples are representative of ambient mixing ratios; however, while this may be the case for isoprene and monoterpenes, the carbon fiber DJI M600 Pro body likely has some emissions of low molecular weight VOCs, which could pose problems for cartridge

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measurements of other VOCs. Second, simulations are shown for the legs extending in the landing position, although I imagine samples were collected when the legs are retracted (as is done automatically by the M600 software after takeoff). The differences in the flow with legs retracted or if samples were collected when the legs were in the landing position should be discussed.

2) The challenges associated with desorption of VOCs and OVOCs from cartridges and quantitative measurements of these compounds compared with whole air samples should be discussed.

3) Please discuss how atmospheric temperature was measured. For instance, what sensor was used to measure temperature, and was this done in the flow path as well or elsewhere on the sampling platform? This appears to be a critical measurement for determining the mixing ratios of VOCs, and it is not explicitly described anywhere.

4) A comparison of samples and blanks would be very useful in demonstrating the utility of this platform.

Specific Comments:

Line 2: Word Choic. Why “copter technology,” not “multi-rotor”?

Line 10: The phrase “close to 2 ppt” is vague. Please be more specific, and include the “3ppt or 20% (total) uncertainty in measured mixing ratios” in the abstract.

Line 27: delete “and” and insert comma and “from” before “tethered balloons”

Line 30-31: Which is less well characterized, horizontal gradients or vertical gradients at these scales? Discuss which of these is more important for models.

Line 31-35: “Thus, this scale . . . global atmosphere” Pease rewrite these sentences, as they read awkwardly. Also, what does “the primary scale for VOC emission” mean? Is that the finest resolution that models are able to represent? Also, “precisely the missing link” maybe be slightly overstating the importance of these measurements to

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understanding of VOCs in atmospheric chemistry (i.e. we don't know if this is the "only" missing link, and indeed, it likely is not). Finally, if these measurements are scarcer in the amazon then elsewhere, cite some studies that have adequately captured this horizontal or vertical resolution in other parts of the world, and discuss how it has informed our understanding of regional emissions and the subsequent atmospheric chemistry.

Line 35: replace "height" with "altitude"

Line 55-77: Although there are a number of advantages to multirotor UAV platforms, it would be helpful to discuss the importance of rotor-wash and potential of sample dilution due to rotor-wash (see general comment 1). I see this is in part addressed later in the paper, however, this should also be mentioned in the introduction.

Line 92-92: Is the detection limit of the VOCs entirely determined by the subsequent analysis (e.g. GC-MS or GC-ToF-MS)?

Line 93-94: This sentence isn't needed and is vague (please delete): "this suggests that detection of VOCs from multicopter flight. . ."

Line 95: insert "cartridge" prior to "sampler"

Line 115 and Figure 2: Label and discuss the 18V supply from the DJI M600 pro to the cartridge sampler, and its integration.

Line 139: Delete "the" before "cartridge sampling"

Line 152: Please comment in the text (here) on whether in the future, the use of filters prior to the cartridges could be helpful in preventing debris from making its way into the system. I see, filters are finally mentioned on Line 195, however, I think this should be discussed more fully and earlier.

Line 156: Please comment here on how atmospheric temperature was measured (see general comment 3)?

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Line 157: “It outputs analog voltage. . .” Is the same is true of the mass flow sensor, as well (i.e. produce an analog voltage that is converted into a flow value? Also, is this conversion based on laboratory or manufacturer based calibrations? Please comment in the text.

Line 162: Please comment on the inline, wetted of solenoid valves and their potential VOC emissions to which cartridge samples could be exposed. Could this influence the detection limit of this system, particularly with sensitive analyzers such as GC-ToF-MS?

Line 170: Are there additional sensors to system pressure and system flow on the sampling platform? If not, please specifically list these two sensors.

Line 172: “via the power distribution board” is awkward phrasing- consider rewording.

L182- L189: Discuss the benefits of be able to measure high molecular weight compounds (C9-C30) of this approach, compared with others.

Line 204-207: Do you base your sample volume collection on prior measurements in different environments? Can this be adjusted easily in the field or between flights?

Line 213-215: “not influence the results”- can you expand on this?

Line 221-222: Are these internal standards injected prior to sample collection as well or simply prior to sample analysis? Please explain this in the text.

Line 240: This is a good description of the uncertainty and the detection limit. This detection limit and uncertainty do not seem compatible with the “nearly 2 ppt” listed in the abstract. Are they? If so, please explain.

Line 242: Please 1) discuss the purpose of the CFD simulations and 2) the uncertainties in the SOLIDWORKS Flow simulations.

Line 264: It would be worthwhile to discuss the influence of rotor-wash potentially on measurements and their differences at altitudes of 60 m, 75 m, and 100 m. Are these measurements representative of 60 +/- 5m? Also note if these samples were taken on

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ascending vertical profiles or separate flights (related to general comment 1).

Line 267: Were cartridges at the tower collected using an identical cartridge sampling system, including a pressure sensor in the flow path and a mass flow sensor or only a pump? Please describe this in the text.

Line 285-290: Discuss in the text more explicitly what the impact is of deviations in pressure in the sampling region. How would this specifically impact the representativeness of cartridge measurements?

L346-347: This second half of this sentence is a bit confusing. Isn't pre-programmed GPS-based operation already employed? Is the goal to integrate that seamlessly into the DJI flight software? L356: How high were the winds on these days that operation of the solenoid, pump or sensors failed? How typical are winds this high?

P22 (Figure 4): The M600 Pro is not typically flown (and I imagine samples aren't collected) with the legs down for landing. How is the flow in these simulations altered when the M600 legs are retracted, if at all? See general comment 1.

P22 (Figure 4): Please add a vertical scale and horizontal scale on Fig. 4a and Fig. 4b.

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