

# ***Interactive comment on “An Approach to Minimize Aircraft Motion Bias in Multi-Hole Probe Wind Measurements made by Small Unmanned Aerial Systems” by Loiy Al-Ghussain and Sean C. C. Bailey***

## **Anonymous Referee #3**

Received and published: 22 September 2020

### Content:

The paper presents an introduction on where and why sUAS are used in atmospheric wind measurements, how MHPPs are calibrated and how they are used to determine the wind vector. The most important errors in this measurement are a misalignment of the probe and the aircraft axes, calibration errors, aerodynamic distortion by probe and aircraft body (which might also depend on the lift coefficient), transducer errors and time synchronization errors. A correction procedure for uncertainties in the roll, pitch and yaw angle alignment, as well as for the measurement of the dynamic pressure and

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time synchronization are presented. The correction assumes that vertical wind speed is zero on average.

I am surprised that there is such a large cross-talk between ground speed or aircraft attitude and wind speed in fixed wing aircraft. However, I have experience with wind-measuring rotary wing devices only, where these problems seem to be much smaller, most likely due to smaller vehicle velocities. Suitable correction algorithms for fixed-wings seem to be particularly important. The paper therefore addresses relevant scientific questions and is suitable for publication in AMT. I wonder why there is no example dataset and example correction code available. In my opinion, this must be the case.

Specific comments:

Line 26: Temperature? (e.g. Witte2017)

Line 32: The difference between the three approaches is not clear: An onboard wind sensor measures air speed, and aircraft kinematics are used to determine ground speed. This seems to be the same as the second approach that you mention. Please briefly explain the differences, it might be helpful to add a reference for each approach (the first approach lacks a reference).

Line 34: Typo “kinmatic”.

Line 36: Sensor-based wind measurements: Isn't everything that measures wind sensor-based? An IMU can be used to determine wind, but it is also a sensor (typically it consists of even 3x3 sensors). Which sensors do you mean?

Line 38: Witte2017 writes “Typically, these measurements employ wind velocity probes with a temporal response that is little better than that of sonic anemometers”, and “Increasingly, UAVs are utilizing five-hole pressure probes [32,33,40], which can resolve to 40 Hz while flying at approximately 20 m/s.”. Today's 3D sonic anemometers can have a data output rate of 100 Hz (e.g. Gill R3-100). So, I am not sure if this is true

anymore.

Multi-hole probe implementation: very clear

Line 142: A change in direction (what direction? Flight direction? Yaw angle?) will result in an acceleration due to a curvature of the flight path. So what kind of acceleration (rate of change of velocity) do you mean? Flight velocity changes? Vertical acceleration?

146: incomplete sentence

I can not scientifically judge the appropriateness of the optimization algorithm presented in section 3, however, it seems appropriate to me.

Line 194: When you argue with periodicity, then why not show it in a FFT plot?

Line 202: Does  $\delta_Q$  have a unit?

Why are figures 5+6 bitmaps and not vector graphs? Is there a way to omit the wrapping-around at  $360^\circ$ ? Is there a better way to convince the readers that the correction improves the accuracy of the data? Because the true velocities are apparently unknown, I would again prefer spectral analyses, that show that the motion of the aircraft becomes less apparent in the corrected data. Color schemes in figures might be better if same colors are used for same objects (e.g. red = sUAS and black = reference). Please also check that colors correctly convert to a gray scale that is distinguishable in black and white print outs.

Line 250-266: This seems to be a discussion of the specific weather conditions of that day on that site, I don't see how this adds to the message of the manuscript. Please explain.

Line 267: "Corrections work": do they improve the data? How do you prove this?

Line 279: is there a word missing in the first sentence?

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