Review of wes-2019-81

Flying UltraSonic - A new way to measure the wind

Martin Hofsäß, Dominique Bergmann, Jan Denzel, and Po Wen Cheng

Overview

The manuscript entitled “Flying UltraSonic - A new way to measure the wind” by Martin Hofsäß, Dominique Bergmann, Jan Denzel, and Po Wen Cheng introduces a measurement platform combining a sonic anemometer point-measurement system fixed to a small helicopter UAV. The value of collecting reliable, high-frequency wind velocity vector and temperature data at locations typically inaccessible by other means cannot be overstated and would add tremendous capability to field measurement campaigns in atmospheric science, resource characterization for wind energy and complex flow studies. That said, the methods and data presented in the manuscript suffer from serious faults that prevent the enclosed work from actually proposing a reliable method for making velocity measurements. Given that there does not appear to be any agreement between the fixed, met mast observations and the UAV measurements, the only conclusion available to the reader is that the system does not perform adequately, or that it was not measuring the same flow as the met mast. In either case, the manuscript as written does not provide any convincing arguments in support of the UAV-based measurement system.

Major points

The introduction does not sufficiently frame the problem at hand. Airborne wind speed measurements are not a new innovation. Many systems have been integrated by the aerospace community for years. Nor are they new in the context of UAVs. The literature review in this respect requires improvement. Additionally the paper would benefit greatly from a more concise description of the novelty of the method, not to mention uncertainty, repeatability, etc.

The manuscript is not adequately organized. Tables and figures should be placed as close as possible to their first reference in the text. This would make the presentation of results in line with narrative and prevent readers from getting lost flipping pages.

UAV and met mast measurements cannot be said to agree comparing either the time series or statistical results. The authors state that this is due to the separation between the measurement locations, but the results do not inspire confidence in the results. The fact that spectra generally agree is not sufficient to say that the system makes accurate measurements of the atmospheric flow. Why is the separation between systems so large? How much improvement do the authors think would be available for the measurements with smaller separation?

How much uncertainty exists in the positioning system in terms of ψ, θ, ϕ or s, y, and z? How would error in the positioning system impact the flow measurements?

Minor points

Abstract

The difficulty of measurements in complex sites is offered as a main motivation for the development of the UAV-based method, but is not discussed at all in the paper. Either add some more discussion or consider removing references to complex terrain.

Measurement deviation of 0.1 m/s is mentioned, but without some sense of what atmospheric conditions this refers to, the deviation is not very helpful. Consider a relative measurement of error (i.e. XX%).

'… PSDs show very good agreement' — this statement does not provide the reader with any sense of what is actually being compared.

Introduction

Page 1 line 9 — remove hyphen from 'time-consuming'

Page1 line 11 — Remove 'So-called'. Profiling lidars are a mature technology and familiar to the atmospheric science and wind energy research communities.

Compound adjectives should be hyphenated throughout the text (e.g. high-resolution wind measurements, fixed-wing aircraft)

Page 2 line 5 — is AMPAIR an acronym for something? Please define if so.

Section 2

Table 1 — the maximum flight time is listed as 25 min. How does this depend on the atmospheric conditions? Given the stated 25 min flight time, why are test flights limited to 10 min? Is this due to power draw of the instrument/data acquisition system?

Figure 3 — Consider adding a turbulence intensity rose in addition to the wind rose to more completely define the operating conditions at the test site.

Figure 4 — poor image quality. Please replace.

Figure 5 — why is there so much time for the system check and shutdown? Wouldn't more information be provided for a longer 'wind measurements' period? Why not extend to the 25 min limit of the system? Also, the figure says 'python' in the lower right corner. This doesn't seem related to the content of the figure.

Section 3

Page 7 line 21 — why are Y and Z axis listed in red?

Equation (1) — put full equation on a single line

Figures 7 & 8 — what are the sources of noise in the system check and shutdown phases?

Page 10 line 6 — Figure 10 appears 3 pages after in-text reference

Page 12 — provide variable name in first text reference (e.g. line 5, ‘The covariance, cov, …’). List for covariance, correlation coefficient.

Equation (13) — P_{xy}, P_{xx}, P_{yy} are not defined.

Section 4
Page 12 line 19 — replace ‘integrated’ with ‘integral’

Figure 11 — caption should say ‘normalized’ rather than ‘Normed’. What is the difference between ‘met mast’ and ’10-min met mast’ data? To which met mast data should the UAV data be compared?

Figure 12 — time series do not appear to match well. Are there other samples for which agreement is better? How many samples of 8 min were collected? Some sense of the population statistics could support confidence in the measurement system.

Figure 13 — correlation coefficients do not appear to match well except for v. Can the authors explain this figure more? How many time series were used to estimate ρ? Why do the results show such little agreement? Shouldn’t ρ for v and w approach 1 as the lag tends to 0 s?

Table 3 — provide relative comparison of error rather than simply and absolute deviation. Otherwise it is not immediately clear how much this deviation matters.

Table 4 — These results show that none of the measured velocity components are strongly correlated between the UAV and the met mast system. Don’t these results indicate that either the UAV measurements are unreliable or that the two systems are in fact measuring different flows? Either way, these results do not support the UAV system as a reliable measurement platform that can reproduce flow observations of the met mast.

Figure 15 — Caption references a dashed line for the met mast, which does not seem to apply to the figure. The coherence between met mast and UAV signals appears to be bounded between 10^{-1} and 10^{-2} and do not agree with the theoretical formulation supplied. Again, these data seem to indicate that the measurements are unreliable or that the two systems are measuring different things.

Conclusions
Page 18 line 6 — deviation in v is more than 1 m/s? This seems extremely large, even if the two systems are measuring different locations.

Page 18 line 11 — The authors state ‘ other statistical quantities (e.g. ρ, cov) show no similarities between measurements.’ What exactly is the purpose of this research if not to demonstrate agreement between the measurements? IF there is no agreement between the systems, how can readers have any confidence that the UAV system will be worthwhile?