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Atmospheric Measurement Techniques Discussions

Interactive comment on "Wind speed measurements using distributed fiber optics: a windtunnel study" *by* Justus G. V. van Ramshorst et al.

Anonymous Referee #2

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General comments

The manuscript describes a controlled laboratory evaluation of a recently introduced technique for wind speed measurements using actively heated fiber-optic cables combined with fiber-optic temperature sensing (AHFO-DTS), similar to hot-wire anemometry. The evaluation considers the wind speed, the angle between the mean flow and the sensing cable and the temperature offset between heated and unheated sections of the sensing cable in the experimental design. The results include a simplified model to help plan the heating requirements for experiments in similar conditions.

The study highlights aspects to consider for planning real-world applications of AHFO-DTS and as a major outcome shows that the potential bias due to sensing cable pitch angle may be low and previously used constants should be reconsidered. However, not all laboratory outcomes can be immediately translated to a real-world field application. The authors added a section to discuss this, but should elaborate on the specific conditions in the wind tunnel (compared to real-world) in more detail, to help the reader. The need to include certain outcomes, particularly time averages of wind speed estimates, is unclear to me. Removing those would improve the focus of the text/figures and reduce redundancy. White noise can be mitigated by spatial/temporal averaging, but the introduction does not clearly mention the relevance for this study; I think that the outcomes for high-end resolutions of AHFO-DTS (currently 1Hz, 0.3m) are conclusive enough without it. After major revisions the manuscript should be considered for publication, and I expect it to be a very helpful contribution for those interested in spatial wind speed measurements using this novel technique.

Specific comments

In their current form, Fig 4, 5 and 6 do not adequately highlight the differences between the applied corrections or experimental settings. Actually, the uncorrected regression (Fig. 4a) fits the range of observations in the center, making it look like a better fit. Please improve the figures.

The reason to present results for different averaging periods was not clearly introduced. I suspect those averaging details can be left out and this would help focus the result/discussion section (remove Fig 6 through 9). The precision and accuracy are most meaningful at the highest resolution, for combinations of different angle, wind speed and temperature offset (and heating rate) settings, and could perhaps be summarized in a single figure or table.

A fixed temperature difference between the reference and heated probe would require

a feedback system that adjusts the heating rate according to previous or expected wind conditions.

1. In the laboratory setup, was this adjustment in heating rate made manually or automatically? How accurate could this be set and were heating rate readjustments made during the 10-min steady periods? The text suggests that under low angles of attack, the heat exchange is less efficient and, consequently, a lower heating rate can be applied to achieve a 2/4/6 K differences compared to the reference. Please discuss the impact of such variable heating rates on the results.

2. In real-world applications, with more variable wind and radiation conditions, such a feedback system may become challenging. A constant heating rate (variable temperature difference) is perhaps more practical. Therefore, could you also present your results expressed as a function of heating rate, instead of fixed temperature offset?

Section 2.2.2 includes both a modification - a different set of constants - and a simplification of the set of equations from Sayde et al (2015) for applications in a wind tunnel. This is not reflected by the section title. Perhaps move the proposed modification (with figure) to the results section or rephrase the section title.

Why were there no (additional) reference measurement made downwind of the heated cable? In a controlled environment, this could help identify feedback between ref and heated cables in relation to separation distance. In a real-world application, would this make a setup less sensitive to wind direction shifts, or is the relative position of both sections irrelevant? Given the long-standing expertise among the authors, could further recommendations be made for follow-up evaluations of AHFO-DTS inside or outside the wind tunnel?

Technical corrections

- p1l1/p1l15: Either Active or Actively, choose one for the AHFO definition.

- p2l21: remove the comma after '(2015)'

- p3l16: 'cable (which encloses the FOs)': suggestion 'FO cable'

- p3l27: 'angles of attach': suggestion 'angles of attack with the mean flow'

- p3l27: Were the ref and heated cable also 8 cm apart in mean wind direction under these slanted angles? From the following sentences this is not immediately clear. If not, would it matter if they would come closer together? Please explain.

- p3l33-p4l1: 'The wind speed in the wind tunnel was fixed at a constant value to create a steady state flow.': perhaps remove, or rephase to be more specific. Do you mean: The engines in the wind tunnel were set to a constant rate, generating a steady (often laminar) flow after some time and, as a result, a dynamic steady state heat exchange of the FO cables with the moving air.

- p4l2: This paragraph contains a listing of three different experimental settings. Please help the reader by presenting them as such. 'First,... Second,...' or other rephrasing.

- p4l2: 'Furthermore, for all wind speeds and angles the temperature difference between the reference and heated section, delta T, wat set at 2, 4 and 6 K in order to evaluate the importance of hotwire signal magnitude.'

- p4l8: 'machine': maybe 'instrument'?

- p4l9: 'One cable segment was heated.', suggestion: remove this first sentence and rephrase the second sentence 'The stainless-steel casing of the heated section was ...'

- p4l10: Steel or other wire material?

- p4l11: a temperature difference should be reported in K (Kelvin). Also, those values were already mentioned. suggestion: cahnge ' to a fixed level, either 2, 4 and 6 °C, depending on the setup' to 'at fixed levels'.

- p5l4: what is an 'ambient bath'?

- p4l7/p5l8: double ended DTS measurement was applied (p4) but not used (p5). Please put these details together in a single paragraph. Are there quantitative criteria to reject the double ended method using the arguments here, perhaps described in literature (citation)?

- p5l21-p5l22: Somewhat vague. 'An energy balance ... advective energy transport from the heated cable, ...'. suggestion: 'An energy balance method ... heat dissipation from the heated section, ...'. The heat dissipation may not be a fully advective process. p6l14: please rephrase, introduce the abbreviation last, suggestion: 'The Nusselt number, Nu, is the ...'

- Match the citation style according to journal guidelines, throughout the text. Particularly the year notation with nested parenthesis seems odd, p2l3 should be "... (e.g., Goodberlet et al., 1989)".

- Fig. 4, Fig. 5, Fig. 6: Add a meaningful indication of the statistics of these point clouds - add means, or convert the presentation to boxplots - or remove the figures.

- p10l1-p10l21: contains details already mentioned before and details that should better be placed in an introduction.

- Eq 12 and 13: where is u_N defined?

- p10l26: Is the center of the wind tunnel cross section also the center of the ref/heated FO cable sections? Why use a section of 0.9 m and not 0.3 m, the advertised resolution of the system, nearest to the location of the sonic anemometer sensor path? Please show that the extended spatial range did not have an impact on the outcomes. Also, by taking a fixed length of FO, the observed positions in the cross section of the tunnel changed with angle; the 15 degrees angle of attack setting would only integrate approximately 0.2 m vertically. Since the bottom of the fiber was attached to the tunnel (p3l26-30), were the positions of the center of the ref/heated sections determined at different positions along the optical-fiber length for each angle?

- p10l26: 'Only the temperatures from the middle of the wind tunnel are used, to prevent using data with side/boundary effects.' If the center of the observed sections, independent of the angle of the cable, were centered at the same position in a cross-section of the tunnel as the sonic anemometer, please state this explicitly in the method section.

- p10l27: Referring to 'data' here is not very specific, please rephrase. suggestion: 'AHFO-DTS derived wind speed estimates'.

- p10l28: Averaging to 30 sec, including Fig. 6+7, shows no new information: better to leave it out?

- Fig. 5c: In the review copy, it seems like the 16 m/s data included values that had not reached steady state yet (variability in U_{sonic}, < 16 m/s). Could you please verify?

- p12l11: 'The precision is calculated for all 120 àT , angle and wind speed combination, using Eq. 15.' Please refer to the equation after it has been defined.

- p13;14: Are these numbers for T_{error} computed, based on the calibration bath sections? Or a specification of the instrument?

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