Wind Energ. Sci. Discuss.,
doi:10.5194/wes-2016-59-RC3, 2017

WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Demonstration and uncertainty analysis of synchronised scanning lidar measurements of 2D velocity fields in a boundary-layer wind tunnel" *by* Marijn F. van Dooren

Anonymous Referee #3

Received and published: 14 March 2017

The paper combines hot-wire and lidar measurements in a wind tunnel. Main focus is on the uncertainty analysis. The experiments seem to be carefully designed and executed. The results are interesting for a large audience. I recommend publication of the paper in the Wind Energ. Sci after following mostly minor issues are addressed.

How did the authors calibrate 3D hot-wire probe? How about accuracy of the calibration? Is there any particular reason for choosing a 3D hot-wire probe even though the lidar measurements were 2D?

The authors worry about heating of the hot-wire probe. There have been many studies

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Discussion paper

in literature where LDA and hot-wire or PIV and hot-wire were used in order to measure different flows both in and outside of wind tunnels. Why in this case the heating caused by the laser beam becomes an issue.

The authors carried out the measurements of three different types: In the second case, the complete line was covered every 1 s with equally sampled measurements. Here, the characteristics scales of turbulence should be given for quantitative comparison. For example, what is the corresponding integral scale for this 1 s measurements. Is 1 sec statement correct?

Right before the results the authors give information about the wind velocity profile. Since the work compares the two system, it is of interest to see the velocity and turbulence profiles upstream of the turbines. These profiles should also be compared again the theoretical profiles like the power law instead of giving turbulence intensity at one single location.

It is not clear why they carried out the measurements at 2500 Hz for hot-wire and 390 Hz for lidar and then compared at 1 Hz. Any particular reasoning for carrying out the measurements this way?

It is not clear if the figures 8 and 9 are based on instantaneous readings or the mean quantities, or turbulence. The authors call the figures correlation, but as far as seen in these figures they are individual (or mean) points from one instrument and corresponding reading from the other instrument. How accurate the time lag was introduced into these computations? Also it is difficult to figure out the motivation for red fits in these figures, 8 and 9. Is there any particular significance? It would also be nice to see how they compute what is presented in figures 8 and 9.

Figure 10 and 11 show very good agreement between these two signals. Can the authors elaborate effect of down sampling from higher sampling rates on the line plots?

Discussion regarding the figure 16 needs to be further detailed. For example what is the record length for these spectral computations, and how many blocks of data are used. Even though the Taylors theorem indicates 28 Hz, lidar seems to be rolling off much earlier around at 10 Hz. Any explanation for this? In addition, the authors should write the formulation used for computing spatial averaging when finding 28 Hz. The authors should also write how they computed the spectra.

Figure 17 and 18: Here it is interesting to know about how many effective uncorrelated samples in these 1 minute recordings across the wake. Statistical accuracy changes for a fixed record length since the turbulence intensity vary a lot. What do the author mean by binned average? is this average of the open circles?

The authors note that it is hard to give any hard conclusion on the lidar's ability to measure small scale turbulent fluctuations. Previously the authors showed this when presenting the spectra. According to their approximation the cut-off frequency is about 28 Hz, which is rather low considering the probable length of the cascade, which is hard to find out since the Reynolds number is not stated as far as seen.

On page 13 and in line 15, the authors writes about the small scale effect such as wake. What do they mean here? I think it is not possible to capture the small scales using this setup due to the size of measurement volume, and wake itself cannot be considered small scale.

From the formulation given in the text, it is not obvious that the uncertainty in the y-direction has the most significant contribution. Further explanation is needed for this statement.

When the author discuss about the total uncertainty, they mostly relate it to angle difference. Due to the nature of the flow, however, turbulence intensity also plays an important role in any uncertainty computation due to the statistical convergence. Toward the edges of the wake, the mean velocity drops and turbulent fluctuations as well. But the intensity can be very high? What would be the effect of this on their uncertainty calculations. Another question in relation to this one is that the wake develops downstream and velocity deficit gets smaller and smaller, and this leads to stronger demand on resolution. What would be the effect of this on the performance of lidar data, and the uncertainty. One can look at figure 21 and 22 to get an idea, but there the uncertainty is higher along the tip vortex, and wake development does not matter.

Interactive comment on Wind Energ. Sci. Discuss., doi:10.5194/wes-2016-59, 2017.