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Atmospheric Measurement Techniques Discussions

Interactive comment on "Lidar arc scan uncertainty reduction through scanning geometry optimization" *by* H. Wang et al.

Anonymous Referee #2

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This paper concerns estimation of the uncertainty of the mean wind speed when estimated from a Doppler lidar arc scan, i.e. a certain fraction of a normal conical scan. The subject is timely, as more and more scanning Doppler lidars are used, especially in the wind energy industry. The authors has got accepted a similar paper in Journal of Oceanic and Atmospheric Technology (*Wind Measurements from Arc Scans With Doppler Wind Lidar* by Wang, Barthelmie, Clifton and Pryor), and although there is some overlap, the present paper contains a series of new experiments and an emphasis on the implication for annual energy production (AEP) estimation of wind turbines. The papers shows how wind direction relative to the direction of the arc is quite important for the uncertainty, and also that, in general, a wider arc gives lower uncertainty.

Some general improvement is needed at several sections:

- Much of the theory is very similar to the *JTECH* paper already published. I suggested that most of section 3 and 4 should be deleted and replaced with reference to the appendices in the *JTECH* paper. The same isotropic turbulence model is used, the same exponential correlation function is used, so what is new?
- also figure 1 seems superfluous. Isn't it concluded that random errors due to the instrument itself are swamped by the random errors due to turbulence?
- Figure 2 is about systematic errors, which is not the subject of the paper. I think it should be removed, since it is not used in the paper.
- The theory is about the relative uncertainty of the arc scan, while the data analysis is the relative uncertainty of the *difference* between the arc scan and the cup measurement. One could argue that if the uncertainty of V_{cup} is very small, then the two quantities are the same. But the uncertainty of V_{cup} over a 10-minute period is several percent, which is the same order of the uncertainty as that of the arc scan. Therefore, you should expect (17) to be larger than (16) (depending on how uncorrelated $\hat{V}_0$ and V_{cup} are, which also depends on the distance between the measurements). This difference is certainly something that should be investigated when comparing with data, and before it is concluded that theory predicts data well. The uncertainty given by (20) is inadequate because it relates to the variation of systematic errors a certain type of cup anemometers would have if they were subjected to a constant, laminar flow. The random error that also occur in the experiments is much larger and can be estimated by Lenschow et al (1994), which is very much along the same line of reasoning than the present paper in sections 3 and 4. So (20) is about what systematic errors you can expect on a cup, while the relevant ϵ_c is the one that has to do with the random error due to turbulence.
- It is simply not correct that a small azimuthal angle range should should let a

inhomogeneity in the horizontal wind have a smaller effect on the mean wind determination. Rereading Schwiesow 1985, I cannot find that statement anywhere.

- Section 7 should be shortened or removed. The point of random error is not that is gives uncertainty on the yearly average wind or AEP, which it actually doesn't at all as shown in much detail in the paper (a small fraction of a percent).

The manuscript should be reduced and streamlined, and the items listed above should be considered before a final publication.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 10429, 2015.