Atmos. Meas. Tech. Discuss., 8, C3283–C3286, 2015
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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 #1

Received and published: 15 October 2015

1 General comments

- Content:
  This is a very interesting and relevant paper for the wind energy community. It is a good idea to revitalize the approach of Banakh et al. (1995) using homogenous isotropic turbulence theory for an error estimation of the lidar measurements. I find it very remarkable that this rather idealized theory together with other strong assumptions could still be able to offer some guidance for the three different atmospheric measurement scenarios investigated in the paper. However, I still cou have some major and minor comments or questions which should be thoroughly answered before publication.

- Language:
  Good to understand with almost no spelling errors. There might be some missing commas which I suggest to check for again (e.g. P10446 L5).

2 Specific Comments

1. P10438 L13: How do you know the magnitude of A at this point? Please elaborate.
2. Further model investigation: In Sect. 4 you investigate hypothetical output of the model. You observe e.g. an approx. linear dependendence (for bigger TI) on the TI.
   - Could you also plot a the error versus the mean velocity?
   - Can you comment on the robustness of the pure model results? For example, how strongly do the results change with another lidar window $w(r-s)$. How sensitive are they to small changes of the integral length scale which can only be estimated approximately.
3. Is there definitely no way to estimate the standard deviation σ_V directly from the data without the comparison to cup measurements? For example, the inverse method you use to obtain the lidar estimate can be seen as a linear regression also yielding estimated uncertainties for the estimated regression coefficients u_0 and v_0. Maybe you can use that or even estimate σ_V more directly? Can you comment on that?
4. In Sect. 4 you estimate the standard deviation of the difference between the lidar estimate and the cup estimate of the ten minute mean. For the cup you use an error which is independent of turbulence intensity and is probably just an

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estimation of the pure measurement error?! However, I am not completely sure if this is the way to go here. For example, if you had two perfect point measurement devices with a distance d there would still be a non zero standard deviation for their difference depending on the turbulence intensity and the spatial correlation between the points. This is probaly also revevant in the lidar and cup scenario which are not exactly at the same point. Can you comment on that? Do you think this effect is negligible?

5. The rescaling procedure in Eq. 21 is obviously not exact. Please remark this clearly. As far as I can see the effect of β is not included to investigate the dependence on $\Delta\theta$. Please comment on that.

3 Minor Comments

1. P10432 L25: please check english in “propagates through into uncertainty”
2. The word “uncertainty” is used a bit too much in my opinion, and sometimes it is not a 100% clear to me if you just mean the standard deviation. Please check if you define uncertainty clearly or use other terms like standard deviation, where possible.
3. In Eq. (2): I do not really like $\langle v_R \rangle$ as true and v_R as measured radial velocity. The brackets are often used to indicate averaging but here $v_R \neq \langle v_R \rangle$ since generally $\langle \delta \rangle \neq 0$.
4. Can you give a citation for Eq. (3). ?
5. Please check if σ_V should not be σ_{V_0} throughout the paper (e.g. Eq. (11))?
6. Could you simply reread the paragraph starting at P10433 L23. I find it bit difficult to follow. Maybe you can rewrite it slightly.

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7. I am sometimes confused by the usage of the hat notation. Please check where the hat should be and where not. In stochastics a hat is sometimes used to distinguish between stochastic variables and their estimates. This is not always case here (e.g. C and $\hat{C}$) I suggest to change that. In Eq. (10) a hat on the left hand side of the Eq. would make sense in my opinion...

8. I am not content with the notation for AEP estimation. In Eq. (11) for example it shoul.d be clear that σ_V depends on speed and direction but you just used V_i so far. Or did I misunderstand?

9. P10434 L17: I would not use “Thus” since you have not shown the other results yet. Maybe you can write: “As shown in the next section,” in the beginning of the sentence.

10. P10435 L13: r_i and r_j should be vectors here.

11. P10437 L14: than not “that”.

12. P10443 L24 following: I do not completely agree. Without cup error it seems to be partially much better $\beta < -20^o$.

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