Second reply to the Reviewers of “Brief communication: A note on the variance of wind speed and turbulence intensity”

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Please note that the Reviewers’ comments are in *italic*, my responses in regular font, and the changes to the manuscript in blue color.

Reviewer # 1

- *Change “x-axis” to “x-axis, “u-component” to “u-component” , etc.*

  Done.

- *It would be nice with a column in table 1 for the special case of ave(v) = 0. Then the equations would mostly look like many people have seen them before.*

  Since Table 1 is calculated from the AWAKEN data, for which $\bar{v} \neq 0$, I should not do what this Reviewer is suggesting. In addition, the WES readers can easily figure out the final form of any equation in the manuscript for the case of $\bar{v} = 0$.

- *I think there is still a small issue with the equations. Eq (23) is slightly wrong. Consider the case where ave(v) = 0, v´= 0, ave(w) = 0 w´= 0 so we are left with ave(u) and the fluctuations in u, u´. Obviously, eqs (20), (22) and (23) are incorrect because they give ave(U) = ave(u)*(1+1/2 sigma_uˆ2 /ave(u)ˆ2.*

  This brings me back to eq (1) in my first reviewer comment. If the average is taken of this equation, and you assume v´=0, then you end up with the correct result in this case, which is ave(U) = ave(u). Thus the approximation in (23) is not the best and that unfortunately propagates to the “(proposed)” results in table 1, only Eq 29 and Eq 23.

  As it stands now, ave(U) approx ave(u)(1+1/2 (sigma_uˆ2 + sigma_vˆ2 + sigma_wˆ2), which is not entirely correct. This should be fixed before publication of an otherwise valuable contribution.

  First of all, Eq. 20 is absolutely correct in all cases with no exceptions because it is the result of simple mathematical steps without any assumption whatsoever.

  Second, what the Reviewer is suggesting is a purely hypothetical case in which $v' = 0$ and $w' = 0$ at all times. This is a wind with a deterministic and fixed wind direction at <u>all</u> times, meaning that this wind vector has no fluctuations in <u>direction</u> (only in magnitude along x, the only relevant direction in this case). This situation is neither real nor realistic. In such an unrealistic case, then Eq. 22 does not reduce to $\bar{U} = \bar{u}$. However, this case cannot and will never happen in reality, thus I do not think it should be discussed in the manuscript.

  However, I acknowledge that, if the axes are rotated in such a way that the x-axis is aligned with the mean wind direction, then the Kristernsen(1998)’s formula provides an excellent approximation, in particular also in the (unrealistic) case described above by the Reviewer. I added this at line 133:

  “In this rotated coordinate system with the x-axis aligned with the mean wind, a better alternative to Eq. 23 for $\bar{U}$ is the approximation from Kristensen (1998):

$$\bar{U} = \bar{u} + \frac{\sigma_v^2}{2\bar{u}^2}." \quad (1)$$

Reviewer # 2

- *I think the essence of your answer "I think the origin of the error is in the calculation of σ_U^2, which is equal to the original wrong formula if and only if the x- and y-components are independent from each other and therefore the co-variances are zero; in other words, if turbulence is purely isotropic (never in the real atmosphere). Only in such a case would the original formula be correct." should stand in section 2 to help the reader understand. I would not use isotropic though, which does not mean uncorrelated.*

  I added the following at line 24:

  "Note that σ_U^2 would be equal to sum of the variances of the wind components if and only if the wind components were independent from each other and therefore their co-variances were zero. This, however, never happens in the real atmosphere."

- *Else I agree with the editor's comment on the lack of physical sense of characterising turbulence using one TI based on U versus having different TIs for u,v and w as we would typically do in wind systems engineering. Now, that is in practice combined with an assumption of uncorrelated components which I agree is discussable. What would be needed is a covariance matrix.*

  I agree, but the IEC standard nonetheless applies.