Reply to the Reviewer #1 of "Brief communication: A note on the variance of wind speed and turbulence intensity"

December 16, 2024

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

- *This paper deals with the difference between the variance of the wind component along the mean wind vector and the variance of the length of the wind vector, also called the wind speed. It is well known that those quantities are under most circumstances (i.e. not too high turbulence intensity) almost equal (e.g. L.. Kristensen 1998, JTech, vol 5, p6). The transverse component enters only the speed variance to second order in the turbulence intensity (see eq 8 in the mentioned paper). These observations do not change if the coordinate system is not aligned with the wind.*

  First of all, even if the variance of the wind speed and the variance of the mean wind vector were almost equal, what I am trying to convey in this note is that the two are not identical and, more importantly, that one should not be used as the definition for the other.

  Second, the paper by Kristensen (1998) deals with the calibration of cup anemometers in wind tunnels under steady-state conditions. Eq. 8 in particular is:

  $$U = \sqrt{u^2 + v^2} \approx \bar{u} + u' + \frac{v'^2}{2\bar{u}}. \tag{1}$$

  The Reviewer cites this equation to support that transverse perturbations only affect the variance of wind speed to the second order; however, this is **not** an equation for the variance of wind speed, thus the point is not proven with this equation. Also, while in wind tunnels (a rather artificial setup) the transverse fluctuations might be smaller than those along the mean wind, atmospheric turbulence is generally considered to be homogeneous and isotropic, thus the statistics of turbulence, such as variances, must be the same along any direction and do not vary if the coordinate system is changed. We know that atmospheric turbulence is not isotropic along the vertical due to the presence of the ground, but turbulence isotropy is a well accepted hypothesis for the horizontal directions. As such, it is not possible that the transverse fluctuations be always smaller than those along the mean wind; they might be under certain circumstances (e.g., wind tunnels), but not always.

- *The other subject paper is an apparent mistake in the literature. The author states that the variance of the wind speed is sometimes mistakingly said to be equal to the sum of the variances of the two horizontal components. This is obviously wrong, as the author clearly states, but I'm am unaware of these mistakes in the literature. The author does not provide evidence for these mistakes, which makes the need for this paper limited. The author might be wary to point out mistakes in specific papers, but this is unfortunately what has to be done in order to advance science. You cannot leave it to the readers to find documentation for this possible mistake in the literature.*

  I am indeed uncomfortable publishing a note that directly points out mistakes by fellow scientists. The point of my note is to provide a clear reference as to why the two variances are not the same. As such, I provide below a list of four papers with the above-mentioned error. My intention here is to satisfy the Reviewer's request for evidence, but I do not intend to add this list in the main document. Since

the entire review process is public in WES, it will be possible in the future to find this information anyway, but, as far as I am concerned, not in the main manuscript.

- Eq. 6 in Joffre and Laurila (1988);
- Eq. 1 in Mortarini et al. (2016);
- Eq. 1 in Bodini et al. (2020); and
- Eq. 11 in Klemmer et al. (2024).

References

Bodini, N., Lundquist, J. K., and Kirincich, A.: Offshore wind turbines will encounter very low atmospheric turbulence, Journal of Physics: Conference Series, 1452, 012 023, https://doi.org/10.1088/1742-6596/1452/1/012023, 2020.

Joffre, S. M. and Laurila, T.: Standard deviations of wind speed and direction from observations over a smooth surface, Journal of Applied Meteorology and Climatology, 27, 550 – 561, https://doi.org/10.1175/1520-0450(1988)027⟨0550:SDOWSA⟩2.0.CO;2, 1988.

Klemmer, K. S., Condon, E. P., and Howland, M. F.: Evaluation of wind resource uncertainty on energy production estimates for offshore wind farms, Journal of Renewable and Sustainable Energy, 16, 013 302, https://doi.org/10.1063/5.0166830, 2024.

Mortarini, L., Stefanello, M., Degrazia, G., Roberti, D., Trini Castelli, S., and Anfossi, D.: Characterization of wind meandering in low-wind-speed conditions, Boundary-Layer Meteorology, 161, 165–182, https://doi.org/10.1007/s10546-016-0165-6, 2016.