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Referee comment on wes-2021-51

Anonymous Referee #1

Referee comment on "On Turbulence Models and LiDAR Measurements for Wind Turbine Control" by Liang Dong et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-51-RC1, 2021

Review of

Dong et al.
"On Turbulence Models and LiDAR Measurements for Wind Turbine Control"

submitted to Wind Energy Science, wes-2021-51

The paper numerically investigates the spectral coherence between a simulated lidar measurement of the wind inflow to a wind turbine on the one hand, and the rotor-effective wind speed (REWS) at the turbine on the other hand. The incoming wind field is simulated by two different, commonly used turbulence models, namely the Kaimal and the Mann model. Results are evaluated for three different rotor diameters, namely 52 m, 126 m, and 178 m. It is found that the above-mentioned coherence significantly differs between the turbulence models as well as between the rotor diameters. Namely, the coherence decreases with the rotor size, and this decrease is stronger for the Mann model.

The methodology and investigations are based on results by Held and Mann (2019) where a significant difference in coherence was found between the same turbulence models. In that paper, only a 52 m rotor diameter was investigated, and additional validation against experimental field data was performed. As a consequence, it was found that the predictions of the Mann model came closer to reality than those of the Kaimal model.

The paper under review investigates a relevant and interesting topic, namely systematic differences between turbulence models, and their relevance for wind turbine applications. The numerical investigations are performed systematically and they deliver clear results. The main conclusion of the paper is that the systematic differences in coherence depending on the turbulence model should be considered as uncertainties for relevant applications.

One fundamental weakness of the paper is that turbulence models, including the two under investigation, differ significantly from real turbulence. Conclusions from the results of the paper for real-world applications are therefore very difficult and should be discussed with care. Other than in Held and Mann (2019), no experimental validation was performed here.

General remarks

The text of the paper is not strictly systematic. A more strict systematic would improve the text.

Especially, conclusions are already drawn in section 4.3 (last paragraph), but they should be moved to section 5. In the conclusions themselves, these findings are missing. Moreover, two further important findigs of the paper are completely missing:

* The rotor size influences the difference in coherence between the turbulence models.

* An experimental validation of the findings, especially for large rotors, is essential for further application.

A few inappropriate terms make the understanding of the unneccessarily difficult. Those are

* Lidar measurement quality (P1L23)

  This term is used frequently throughout the paper. It does make no sense at all in a simulation study, because the quality of the lidar measurement is not accessible and also not investigated here. This causes unneccessary confusion. What is meant (to my understanding) is the quality of the prediction of the REWS by the two turbulence models, given the information of a simulated lidar measurement upstream of the rotor.

  The term should be replaced by something more appropriate, like "REWS prediction quality" (this is probably not the best term either), and it should be clarified and explained when first used.

  In contrast to this, the term "lidar measurement coherence", which is also used frequently, does actually make sense, even though no real measurement is performed.

* Value creation of LAC (P1L8)

  Without any relation the field measurements, it is not appropriate to speak of "value creation" in this context. There is no way to evaluate the real benefits of LAC based on the presented results.

* Lidar measurement error (P5L138)

  It is not clear what this term means here. Error of what compared to what exactly?

Moreover, please make sure that all technical terms are clearly defined or explained at their first occurence.

Detailed remarks

1. P7L159: "the choice of turbulence model strongly influences the coherence of LiDAR measurements"
See above, "lidar measurement quality". Reformulate to what is actually meant.

2. P9L178: "the true velocity measured by a lidar"
What is meant by "true velocity"? Is is the LOS component a a certain point? Keep in mind that velocity is a vector by definition. Make clear.

3. Section 4.1: Was the lidar measurement modeled after section 3.2? Was the REWS evaluated after section 3.3? What are the time constants in the measurement?

4. Section 4.2: The discussion of eddy sizes (line 219 ff) is confusing. First, the mentioned integral length scale is questionable and will most probably depend strongly on the time window used for the analysis. Moreover, what is meant by "the eddy size" is probably "the size of the largest eddies", which in turn is a questionable quantity.
A spherical eddy is hard to imagine. Morover, if it would exist, pitching the blades to "feather" would not help in decreasing the loads.

These aspects are, however, unneccessary for the relevant part of the discussion. Namely that, given Taylor's hypothesis of frozen turbulence, the smallest relevant time and length scale for collective pitch control is of the order of the rotor diameter. The authors should restrict the discussion to this aspect.