

Answer to Reviewer 2

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We would like to thank the reviewer for the comments and the constructive criticism that has contributed to the improvement of this manuscript. Please find below the **Specific/Technical** comments the reviewer (using blue fonts), along with our corresponding answer to each comment (using black fonts).

5 **Specific/Technical comments**

1. L5-6: Break into two sentences, it does not read well currently.

The sentence:

These conditions significantly affect power production, particularly below rated wind speeds, we find differences between 5% and 10% between wind profile cases with negative and positive shear.

10 is now written as:

These conditions can significantly affect power production. In particular in the below rated wind speed range, we find differences ranging from 5% to 10% between wind profile cases with negative and positive shear.

2. L27: The 'mainly' is too much and can be deleted.

The word 'mainly' is deleted.

- 15 3. L45: This sentence is confusing to me. For easier readability I would consider rephrasing to: *Thus, it is still unclear how the motions over six degrees of freedom, coupled with the wind profile characteristics, affect the power production of a FOWT.*

The sentence is rewritten based on the suggestion of the reviewer.

- 20 4. L74: Although not as much as onshore measurements, there are several campaigns and publications across several wind farms over the North Sea, I would refrain from using the word rare.

We think that they are not a lot of publications that report observations of the offshore conditions at the northern part of the North Sea. Yet, following the comment of the reviewer we have re-written the sentence:

Measurements at the northern North Sea are rare so the wind lidar measurements enable the study of the offshore wind profile characteristics

25 as following:

The wind lidar observations enable the study of the offshore wind profile characteristics at the northern North Sea.

5. L107: Please include a reference for the stability dependence of the dynamic turbine motions.

The reference of Jacobsen and Godvik (2021) has been added.

6. L121: Even when the turbine is not tilted, I would say that the furthest range gates would lie outside the rotor plane, is that not the case? The tilt does change the scanning location, but the furthest range gates are too far outside in the y -plane for the tilt to make a difference, correct me if I am wrong.

It is true that even when the tilt angle of the nacelle-mounted Doppler lidar is zero then the furthest range gates would lie outside the rotor plane. However, as the tilt angle is increasing the range gates of the top beams can be translated higher than the rotor and thus more range gates will be located outside of the rotor plane. For a 5 degree tilt one more range gate of the top beams is outside the rotor plane in comparison to the bottom beams. We therefore think that this statement is descriptive of the distribution of the range gates shown in Fig. 2(b).

7. L139: The 'data' is too much and should be deleted.

The word 'data' is deleted.

8. L146: Include final number of cases here, after mentioning the reduction of cases due to data availability.

40 To clarify the description of the data sets and the data availability we have edited the last sentence of the Section 2.3. The new version contains exactly the same information as in the previous version of the manuscript. The difference is that it is now re-structured for clarity reasons. In the revised manuscript the paragraph is as following:

To avoid including cases in which wakes from adjacent turbines distorted the inflow conditions at the HS4 turbine, only data acquired during turbine operation with yaw directions between 90° and 270° were selected, resulting in 13,247 ten-minute periods of SCADA data. The wind lidar data were filtered based on the data availability at each range gate. Only periods with at least 50% data availability were selected which reduced the initial wind lidar data set by 10% to 17,057 ten-minute periods. The SCADA data were post-processed to estimate statistics synchronized with the wind lidar measurements. However, concurrent lidar and SCADA data were available for only 6,729 periods. Additionally, some periods exhibited large yaw standard deviations. To focus on stable wind directions, only periods where the yaw standard deviation within a ten-minute interval was $\leq 10^\circ$ were retained. Applying this criterion resulted in a dataset of 6,659 cases (i.e. ten-minute periods). The selected dataset represents climatological conditions typical of summer and autumn.

9. L210 and Fig3: Here the mention of veer it still present (figure title). Please change it here also or create a term that could concisely describe this quantity, maybe veer* or something similar to but not the same as veer.

55 We have edited the text to correct few sentences where there could be a misunderstanding that the $\frac{\partial \bar{v}}{\partial z}$ is used a wind veer. In general, one of the corrections in the 2nd version of the manuscript was to not call the vertical gradient of the

transverse wind component $\frac{\partial \bar{v}}{\partial z}$ as veer. However, a non-zero values of $\frac{\partial \bar{v}}{\partial z}$ correspond to cases with a vertical change of wind direction. Such a case is presented in Fig. 3(b), therefore we think that it is justified the description of the cases with a non-zero $\frac{\partial \bar{v}}{\partial z}$ as cases with a *wind veer*.

60 10. L285: LLJ?

The LLJ acronym is corrected.

11. Section 4.4: You use shear and veer again in this chapter. Is this now the gradient of the horizontal wind speed and estimated wind direction, or again gradients of u and v ?

In Section 4.4 it is written:

65 *The variation of the produced power is attributed to both the shear and veer values of the wind profile. In the examined dataset negative shear values are usually related to negative veer values which results in reduction to the power production (see Appendix C).*

This statement concerns the gradients of the horizontal wind speed and estimated wind direction. We have added the symbols of the two gradients in the label of the figure to clarify this point.

70 12. L336: 'The variation of the produced power is...'

The sentence is corrected.

13. Fig. 8: (b) and (c) sub-figures seem to have the same curves for positive shear (solid black lines), without any minor differences as the points look to be identical in (b) and (c). Does this happen by chance due to low differences or is there a mistake in the plotted curves?

75 We would like to thank the reviewer for noticing this. The Figs. 8 (b) and (c) were the same. This is corrected in the revised version of the manuscript.

References

Jacobsen, A. and Godvik, M.: Influence of wakes and atmospheric stability on the floater responses of the Hywind Scotland wind turbines, *Wind Energy*, 24, 149–161, <https://doi.org/10.1002/we.2563>, 2021.