

**Review of WES-2019 22:** 'The effect of wind direction shear on turbine performance in a wind farm in central Iowa' by Miguel Sanchez Gomez and Julie K. Lundquist

The authors present a statistical analysis of wind power of four wind turbines and wind direction shear, measured using a nearby Lidar. They discriminate between clockwise and counter-clockwise wind direction shear and show a correlation between under performance of the wind turbine and mean directional wind shear. This under performance is primarily visible for lower wind speeds. In general, the paper is very well written. Introduction, choice of data and statistical analysis are clear. The figures are suitable to present the data. My comments are therefore very minor asking for some clarification and some improvements of text and figures. I recommend that the paper is accepted after minor revisions.

## General comments

The fact that turbine performance decreases by more than 15% for strong wind shear conditions is very relevant; I can clearly see that. I found the fact that is is mostly high veering that is related to a drop in normalized power very interesting. However, I was missing any attempt for a physical explanation on why high veering has such a strong effect whereas high backing does not show the same signal. It seems that you are too defensive here, and a little bit of speculation could be appropriate in the discussion.

Furthermore, I wonder if the unit  $\text{deg m}^{-1}$  is indeed the right one in this context. In my opinion, it depicts a certain generality that cannot be drawn from your dataset, given that you looked only at four wind turbines with the same rotor diameter. Given that directional shear is not linear, this may be relevant. Multiplying by 80 and using  $\text{deg D}^{-1}$  may help to communicate this important limitation.

Third, I found that the directional wind shear is a function of height was overlooked in the analysis. This fact is clearly stated in the beginning, but is ignored later on and only average directional shear is analysed. I wonder especially, what the effect of misalignment (with respect to the ideal 90 degree angle) would be if this misalignment is primarily below or above hub height. Given that wind speed generally increases with height, this seems important. You probably lack data on rotor orientation, but could you expand on this point in the discussion nonetheless? Splitting the analysis to the levels 40-80 and 80-120 may provide some insight.

Finally, the rotation direction of the rotor is one asymmetry that may be of relevance given that you found such a distinct difference between veering and backing. Any thoughts?

## Specific comments

1. *Section 2.4:* Do you really need a section of its own for two sentences? Furthermore you mention that you average over 10 minutes in line 16, page 7 as well.
2. *Page 15, line 13:* Mentioning Turbine A-D comes a little bit out of the blue at this point because this is the very first time the text and the only other reference is Figure

1. You should refer to Figure 1 in this context.
3. *Figure 12*: I found it confusing that there are four entries in the legend, but only three lines. You write in the text that bins with less than 30 data points are discarded, but I recommend to remove the entry for high backing. Furthermore, it is rather strange that the error bars for the low veering case are not bold and black. It is a minor issue, but your readers should not play a guessing game. I have similar issues with Figs. 11 and 13, having four lines, but only 2 legend entries (specifically referring to the median).
4. *Figure 2*: The shading in this plot style leads to three colors in the graph, while there are only two in the legend. It is only a very,very minor remark, but wouldn't a simple line plot do a better job in communicating data availability?

## Typos

1. *Page 8, Equation 1*: Full stop instead of komma after the equation.
2. *Page 15, line 7*: 'was on average' instead of 'was in average'
3. References For Rajewski et. al 2016 and Muñoz-Esparza et.al. 2017, it seems that there are some personal comments that have slipped from the .bib file into the references. The all-caps text is not part of the actual reference.
4. *Figures 11,12,13*: You are using "Wind Speedin the x-label here, but "Wind speedëverywhere else.