

# ***Interactive comment on “Correlations of power output fluctuations in an offshore wind farm using high-resolution SCADA data” by Janna K. Seifert et al.***

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## **General comments**

The analysis of power output correlations across a wind farm can certainly be relevant within wind energy.

This is certainly a challenging task given the data analyzed and its limitations; the latter has been only partly addressed.

The abstract does not appear to include motivation for the study, and the introduction also lacks clear motivation and/or justification; why/how is this work relevant?

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Unfortunately there are a number of issues with the submitted draft, such that it requires at least major revisions. A number of plots showing pair-wise power output correlation versus normalized lag are shown; but their statistical significance is not evident, nor argued thoroughly, nor put within any context of the scales of atmospheric inflow fluctuations. (One can see by the repeated trends, of course, that the plotted  $R(\tau_{norm})$  are not simply noise, despite being at most  $\sim 0.1$ – $0.4$  depending on the data selection.) The methods used are not explained in sufficient detail, with references to such also lacking. As currently reported, the study would not be reproducible by a reader. The results need to be more clearly presented, and also interpreted, by the authors—in addition to the inclusion of relevant details, motivation, and significance of the study.

There are errors in language throughout; I have included some correction examples in the last section below, but suggest that the next version be proofread by somebody with near-native level fluency.

### Specific comments

I.8: what is meant by ‘correlation states’? Lines 7–9, starting with ‘Most importantly’, should be reworded. To be more direct: you are using a clustering algorithm (k-means clustering) to group similarly correlated turbine pairs, in order to examine the spatial variation of correlations between turbines and determine the key parameters affecting such correlations.

I.9–10: The phrase ‘next to’ isn’t appropriate here; it seems you’re wanting to say ‘in addition to’ or similar. Also, do you mean the location of a turbine pair is most important, or the relative locations/distance?

I.38: in terms of correlations, the wind farm was not “infinitely large”, was it? I.e., were there not periodic boundary conditions used in the LES?

I.40: by ‘variance of the wind velocity’, do you not mean strength of turbulence in the

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prescribed inflow?

I.55,I.64 and elsewhere: you haven't (yet) defined "correlation state"

I.71: why "non-axisymmetric"? Do you mean asymmetric?

I.74-76 and afterward: How did you calculate the wind direction and U? What transfer function(s) were used, and how was this blended with speed implied by measured power?

I.77: do you mean that the yaw error was not used in the nacelle wind speed transfer function/correction?

I.87-89: did you consider the across-farm variation in wind direction, with suitable averages of upwind turbines?

I.111 and Table 1: how did you determine the pitch threshold?

I.112-116 and Table 1: what is the yaw misalignment threshold? What about  $\varphi$  change per 600s?

I.120-121: why not report the variation of angles, instead of only the mean with 10-degree tolerance?

I.155-159: mention the use of Taylor's hypothesis here—and the assumption you're thus using over the entire range of  $\tau_{norm}$ . There are several references you should check (and cite) regarding this.

I.163-166: Your statement about  $\tau_{norm} > 1$  has an implication: if you used the average speed between turbines A and B (instead of  $U_B$ ), then wouldn't  $\tau_{norm}=1$ , unless the propagation speed is somehow otherwise affected? It's difficult to defend using just  $U_B$ .

I.181: why 20deg interval? How does this compare to the variation of  $\varphi$  across all turbines for a 10-minute periods? The latter is likely important to describe the inflow

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state and variability of the wind field (not to mention yaw error).

p.8/l.201–203: Indeed  $\rho=0.2$  is not generally considered to be statistically significant. Have you tried windows of different lengths (other than 300s)? Have you considered the integral timescale of the incoming turbulence? What about the wake turbulence?

Table 3: is it reasonable to include 3 significant digits in the correlations listed? (or 5 in the power?) Such second-order statistics do not converge so easily within 10 minutes...

l.253–255: While this reviewer has some familiarity with k-means clustering, how is a reader supposed to be able to understand (let alone repeat) the analysis reported here? Please include appropriate references and details.

l.293 and elsewhere: instead of just ‘filtering’, perhaps you should use a term like ‘data selection process’; recall that in the spectral sense a *filter* means something else, and such filtering could be expected for the kind of analysis you do here.

l.296: “Deviations from the 90° and 270° wind directions result in a decreased correlation” is out of context here; this and the statement after it do not make sense as written.

l.299–300: pairs within the first (upwind) row of turbines have little correlation not simply because of the ‘free-stream’ inflow, but because their spacing is greater than the transverse integral length scale of the turbulence.

l.308–309: simply using ‘previously defined’ or ‘chosen statistics’ is somewhat obfuscatory and not really appropriate in a conclusion/summary; it does not explain to the reader which ‘statistics’ you are considering.

l.309–311: why not just use joint distributions, and conditional statistics? How is k-means more helpful?

l.311–312: this statement is not understandable without more context; please help the reader, and interpret it also.

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I.320–323: why were no details about this given in section 4?

### Technical corrections

I.6: ‘correlation is’ should be ‘power correlations are’; ‘towards’ is not appropriate

I.15: second ‘and’ should be ‘while’ or similar.

I.23: ‘the respective’ should be ‘a respective’

I.27–29: need to re-word run-on sentence, including e.g. appropriate commas

I.33: remove ‘a’ before ‘high’

I.46: ‘of’ should be ‘between’

I.81: reference missing year

I.400: incorrect journal and doi for Valdecabres reference

I.403–404: the WindEurope reports appear to be missing some identifying information (e.g. doi, report number, etc.).

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