

## ***Interactive comment on “Monitoring offshore wind farm power performance with SCADA data and advanced wake model” by N. Mittelmeier et al.***

### **Anonymous Referee #1**

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#### General comments

I think that the subject in general is interesting as wind farm underperformance is an important issue that we sometimes do not want to discuss much in wind energy. Therefore, I started to read with interest the manuscript but at about the second page I became really bored of the continuous issues/typos/grammatical problems that the text has. It is not that the English is generally bad; it is more about the way the authors write sentences and connect the ideas. It is generally “very weird” the way they write. In the specific comments, I list a number of issues but as I said I became so bored of these things so I just did it for the first pages; in case the authors have the chance to resubmit, the manuscript has to pass many hands including some English technical experts before resubmitting. More important, the manuscript in its actual form reads more like a technical report describing a method rather than a scientific paper. The

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authors need to make clear what the contribution to science is (if any) and write the manuscript to establish that the method they suggest is clearly novel (so far I do not see the novelty; the wake model is not new, neither the uncertainty calculation). Also they make things harder to digest by their writing so the text needs some reshuffling to accomplish a good flow.

About the subject: There is a clear shift of the direction of the wake even for the single wake case. The authors provide some arguments but in the single wake case the maximum wake deficit should simply be a 0 deg. The authors use a nacelle-based vane for the wind direction so why not checking if there is a systematic turbine misalignment by looking at the nacelle position signal in the SCADA data? The authors also refer to the study of Vollmer, but in that study, the wake is deflected intentionally by misaligning the turbines. So the most plausible explanation it is simple yaw misalignment unless the authors discard this by showing that the turbines are indeed not misaligned (but they do not do that).

There is a general problem with the way the authors make references in the text and the reference list itself at the last section. You should write refs. in the text as: “A power curve is given for each turbine (Smith, 2001). However, Jonas (2010) described another method. Such method was also shown in some previous studies (Klinsmann, 2006; Pauli, 2010)”. In the specific comments I select some specific cases but most of the references are wrongly made. And the references in the reference list should be made consistently: Names, title (non-capital all refs. or all capital), etc. Such type of reference list makes me wonder about the quality of the whole study. The reference list should be made with consistency. Also you have a problem with the equations; they are part of the text and should not disrupt it! The dot symbol does not mean multiplication, it means dot product but you don’t have such products. The “same” symbols are sometimes in italics and sometimes in normal text; if they are the symbol of the same thing then they should be written in the same way.

Specific comments:

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1. Page 1 line 16 "...technical solutions." This type of statements are very general and not precise and specific. What do you mean by this? Turbines, models, methods?
2. Page 1 line 18 "...definition (...) defines..." that the system is ready to operate" this is redundant. Why not "...definition (...) is that related to a system ready to operate"
3. Page 1 line 20 "... quality and quantity." Of what? In the next paragraph you kind of explain it but you cannot simply say this here and expect that the reader finds the answer later. If this is the case then that sentence can be removed.
4. Page 1 line 21 Replace "...much SCADA" by "lots of" or "a good amount of"
5. Page 1 lines 27-28 "Work on... of 2016". You don't need this reference and does not help the paper so remove it
6. Page 1 lines 28- Page 2 line 1 "For most turbines... wake effects" You make it sound as it was only a problem for offshore turbines and it is not so replace by e.g. "For most turbines in a typical wind farm, verification of the performance by comparison with the power curve is not suitable..." then "... maintenance of a met mast is very expensive particularly offshore."
7. Page 2 line 3 Replace "accounts" by "account"
8. Page 2 line 6 "Incorrect parameter settings" you mean "turbine parameter"?
9. Page 2 line 9 "turbine has a limited power output which has been externally applied" You want to refer to the limit but with the use of the "which" you mean the limited power output but surely this is not what is externally applied because one cannot apply a limited power output... that is a consequence of limiting something else.
10. Page 2 lines 11-16 this is a very weird paragraph. "Upwind turbines influencing the free flow for downwind turbines". This is a weird sentence because the flow is not free for the downwind turbines. Why not just removing the "free" word. Then it is also weird because you have "... , wake effects;" so with this construction you say the wake

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effects are turbines! Then you have these references to Albers (all wrongly made; see my major comment). Then you say "Albers has also looked...flow models": this is a personal communication or is in one of his studies? Then comes "But at that time..." what time? Which year or which study in particular? There is also a "to be further development" that should be "to be further developed"

11. Page 2 line 18 "...which proposed" so the standard stopped at some point proposing this?
12. Page 2 line 19-20 "...could not be established," So it is not a standard, it is a working group trying to come up with a standard. Also delete the part "...and the support... crumbled." It is not scientific knowledge
13. From line 22 in page 2 onwards you talk about "matrices" but what you mean is "look-up-tables (LUT)" Use that term. There is an unnecessary comma in line 22 after "method". Also in that line you talk about detection of "curtailment". Perhaps your method is able to detect curtailment but curtailment is generally artificially imposed or used and so it is/should be recorded in the turbine status of the SCADA.
14. Page 2 lines 23-27 "Mittelmeier et al. (2013) presented... environmental conditions." I am not sure this is a new method. In many other studies, authors used wake-model-based LUTs to estimate the efficiency of the wind farm. So the authors need to explicitly say what exactly is new.
15. Page 2 lines 27-28 "Especially... available." Already mentioned so remove it
16. Page 2 lines 31-33 Replace "this" by "the", add "of" after "method" and use "Mittelmeier et al. (2013)" instead of "(Mittelmeier et al., 2013). Replace "condition" by "conditions"
17. Page 3 line 1-2 "Hence the presented... LiDAR". Based on what you have already mentioned one can inferred what is written here so it is not necessary
18. Page 3 line 4 it should be change to "...of the method by Mittelmeier et al. (2013)

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is recalled”.

19. Page 3 line 11 I know what you mean by “deviation” but you need to be exact so change to “A deviation between  $P_{\pi}$  and  $P_{\mu}$ ”
20. Page 3 lines 14-15 “The accuracy and calculation . . . real wind farm flow” This is not true. A simple wake model can be as accurate as a complex one.
21. Page 3 line 16 First “improve the underperformance detection capabilities” This is not always true. And replace “;” by “;” before “on the other hand”
22. Page 3 line 23 Remove the first “Additional”
23. Page 3 line 25 “for this purpose” I know what you mean but you have not mention any purpose and you want to refer to the monitoring method, I guess. So be precise
24. Page 3 line 28 Replace “. . . averages of 10 minutes” by “. . . averages over 10-min periods”
25. Page 3 line 29 Replace “. . . averaging N quantities of 10 minutes time samples” by “averaging a number N of 10-min samples”
26. Page 3 line 30 Remove “the averaging”
27. Page 4 line 1 You are talking about “correlation” but this is not a correlation of power it is a only a normalization. So as this is wrong the part of “This leads” does not make sense
28. Page 4 line 4 “This is described in Eq. (1) and (2)” Well this is not described in the equations; the equations are simply the definition you are using for the normalized powers
29. Page 4 line 12 Replace “can be described with Eq. (3)” by “is defined as”
30. Page 4 lines 16-17 “where  $\eta_{ob,ref}$ . . . (ob) turbine” You already defined everything so there is no need for this

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31. Page 4 lines 26-29 So why do you have to use all the wind vanes (this is what is read from the text)? They could all have a different misalignment and so you will need to analyze each of them (in terms of wake deficits) if you want to use all of them.
32. Page 4 line 29 “complex area” what do you mean by complex area?
33. Page 5 line 1 “of the scale” what do you mean by scale?
34. Page 5 line 2 “+1.5IQR” be explicit. If the outliers removed are those outside the range +1.5IQR then say so
35. In Eq. 4 you have constants without units. If alpha is in degrees all these constants have the units of degrees and you need to state that
36. Eq. 6 is not needed
37. Page 6 line 1 “the north inconsistency need different conditions” Yes obviously
38. Page 7 lines 1-2 “In Mittelmeier et al. (2015). . . wind speeds”. Well that depends on the stability conditions. This will be true if compare unstable conditions with low wind speeds and high sigmas with neutral conditions with lower sigmas and higher wind speeds. But stable conditions will be in the low wind speed range with lower sigmas compared to neutral
39. Page 7 line 3 “no impact” you mean “little impact”
40. Page 7 lines 7-8. This seems to be quite important and you do not provide any details about the study of Vollmer et al.
41. Page 7 line 31 “usually about 4 to 6%” you need to give a reference here; otherwise show an example
42. Page 8 line 19 “is around 7%” based on what?
43. Page 9 line 3 Figure 5: please show a proper layout with north orientation and scales

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44. Page 9 line 4 “6.3D” this is between turbines in the same row (does not look like that), between rows? And important what are rows for you: the rows of turbines in a particular direction or all “rows” of turbines?
45. Page 9 line 7 Two years of “10-min” SCADA data?
46. Page 9 line 10 “The quality of the derived wind direction” It is not the quality what you show there
47. Page 9 line 16 “from Section. . .” Explicitly state which equations
48. Page 9 line 18 “binned into 2 deg” does not look like that but more like 4 deg.
49. Page 9 line 23 These correlations are very high but the outliers seem to be also quite large so I am very skeptical about these computations
50. Page 9 The wake model seems to have a systematic bias when compared to the measurements (clearly seen at the highest deficits). Why? Is the average wind direction perhaps wrong? Perhaps you should average the wind direction of the turbines in the rows where the flow is not disturbed if you want to compare it with the wake model
51. Page 10 line 1 The wake model should be presented before the results in 3.1.2!
52. Page 10 line 11 How much data you use for the calibration period?
53. Page 10 starboard and port terms are terms conventionally used in wake studies?
54. Page 10 line 17 what do you mean by “global”
55. Page 10 lines 16-22 If this phenomenon occurs in 1 single wake the a very plausible reason is simply yaw misalignment
56. Page 10 line 32 “this data has been filtered for a wind direction sector of 5 deg” Change to “These data have been..”
57. Page 11 line 2 You mean for prediction of what? AEP? Wind speed? A particular case?

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58. Page 11 line 5 Replace “has been” by “will be”
59. Page 11 line 6 what do you mean by “real data”? so before the data was not real?
60. Page 11 line 9 degradation of 8% in terms of what?
61. Page 11 line 13 Replace “in displayed” by “is shown”
62. Page 11 line 18 Why “Therefore”?
63. Page 12 line 10 “horizontal graph” you mean horizontal line?
64. Symbols in Fig. 1 are not the same symbols. . . they are not in italics
65. Figure 3: The wind direction should not be perpendicular to the rotor?  $\beta$  (which is not the wind direction) is the angle perpendicular to the rotor
66. Figure 5: scales, north, coordinates!
67. Figure 10: there should be some green points below 0.6, so perhaps it is better to degrade based on the best  $C_p$  curve

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