Response to the anonymous referee #3:

Thanks a lot for the review. Here our response to the reviewer's comments. The response is given within XXX--- ---XXX

Regards,
The authors

General comments:
The authors conducted a large number of simulations using a wide variety of models, and compared simulated values with observations from SCADA. These results can be of use to the scientific community, particularly in regards to the coupling of WRF and wake models, and to the effect of the nearby continent on the wind farm production. However, the abstract, methods, results, and conclusions are not well organized and the reader is left wondering what the real contribution of the work is, and what exactly was done when it comes to specific details of the results and their relevance to the scientific community. The manuscript can be greatly improved by overhauling the organization and text, at which point it can be considered for publication.

Specific comments:
Abstract: Very scattered text. Please rewrite. This is very confusing: "*accounting for the horizontal wind-speed gradient gives nearly the same results as averaging all the wake-free wind climates at the turbines' positions or using the wind climate of a position in the middle of the wind farm*". Results of what? AEP? CF? Can you be more direct with the "take home messages" you include in the abstract?

XXX--- The abstract has largely been changed taking the suggestions of the reviewer. The changes and additions can be clearly seen in the marked-up version of the manuscript ---XXX

This does not belong in the abstract but rather in the discussion section: "*These results are specific for this wind farm, the available dataset, and the derived inflow conditions.*"

XXX--- Given that we provide quantitative results, we think that is very important to say that the numbers are specific for this wind farm, these inflow conditions and this dataset---XXX

Can you be quantitative in the abstract, e.g. the model uncertainty is on average x%? What are the relevant results for the greater scientific community?

XXX--- See our previous two responses ---XXX

The motivation on page 2, lines 20-26 should be included in a reduced manner in the abstract to give a greater context to why this work is relevant and needed. Below is a rewording that you can use as you rewrite your abstract.

In this work, a wide range of models is used to investigate wake effects at the Anholt offshore wind farm. Undisturbed atmospheric conditions are simulated with WRF for an entire year, and wake effects are simulated with two engineering models (Park and Larsen) and with a linearized Reynolds-Averaged Navier-Stokes solver (Fuga). For the engineering models, linear and quadratic approaches are considered for lateral merging of wake deficits. The effect of the horizontal wind speed gradient over the wind farm on the annual energy production and on the capacity factor is quantified by coupling the WRF and wake models and by comparing the derived predictions to SCADA. Additionally, the ability of the wake models in estimating power losses is evaluated, and the relative uncertainty of each wake model is quantified by bootstrapping the SCADA and to estimate the model-specific error distributions. We find that accounting for the horizontal wind speed gradient is important when estimating the annual energy production but not critical to estimating…? We propose methods for estimating freestream flow conditions based on SCADA, when no measurements are available upstream of the wind farm and quantify their relative performance using the turbines power curve…?

XXX--- We appreciate the suggestion of abstract by the reviewer. We now use some of the suggestion to write a revised abstract with what we consider has a better flow. We also add some of the text regarding motivation as suggested ---XXX

Similarly for the discussion and summary, be more specific with your take home messages. Even after carefully reading the entire manuscript, it is not clear to me by the end what your main results are, and what your contribution is. Results are fragmented and scattered.

XXX--- We think this was partly because of the way the abstract and introduction were written and also because of the rather `disruptive' last paragraph in the original discussion. We have removed this last paragraph. We think the abstract and conclusions provide with the important take home messages; a sentence has been added to the second paragraph of the conclusions to link the results for the individual flow cases with the overall power loss. ---XXX

"Background" is not a good title for section 2.

XXX--- We change it for "Methods" ---XXX

Please get rid of "Park1" and "Park2", "Larsen1" and "Larsen2" and choose more descriptive names such as "Park_Linear" and "Park_Quadratic", "Larsen_Linear" and "Larsen_Quadratic".

XXX--- This is now changed as suggested by the reviewers ---XXX

Remove from all figure captions where you have something like "details in main text".

XXX--- Removed as suggested by the reviewer ---XXX

Be consistent with your verb tenses – either present or past. Example of inconsistency, page 14 line 1: "we use and found"

XXX--- We have gone through the paper to find such inconsistencies ---XXX

Technical corrections:

Section	Page/Line	Comment
Entire manuscript		Don't hyphenate "wind speed" and "wind direction". You also use hyphens in other various terms that do not call for it, e.g. wind-farm.
		XXX—hyphenation is a matter of style and we think that it is the editor who decides whether this is appropriate. You will not find (if you do it is a typo) two isolated words hyphenated, e.g. wind-farm but wind-farm gradients ---XXX
		Remove the figure references that are left/right and top/bottom and instead use (a), (b), …
		XXX—This is the style we use and we have used it previously in other publications in the same journal ---XXX
Introduction	2/22	"relatively close by" – be quantitative, how many km?
		XXX—We add the number as recommended ---XXX
Background	3/9	Even after being done reading your manuscript, I still don't understand what is the "ensemble" that you are using for your average. Please explain more clearly: is it an ensemble of turbines? Of grid points? Of models? Of runs?
		XXX--- Since it is not necessary that the values that we average are equally separated in a time-series form, we clarify that these averages are ensemble averages. In the particular case of Eqn. (2) of the original submission it is an average of power values ---XXX
	3/14-16	Please give range of wind turbine spacings within the farm, to make it easier for the reader to understand what your model grid spacing means later on. I was left wondering how much spatial interpolation is being done on a 2 km grid, when you place your turbines on the model grid.
		XXX--- We add "The smallest distance between the turbines is 4.9 rotor diameters"---XXX

3/21	The dataset exclude periods where "any" turbine was parked/idling/etc.? Or only where at least some *n* number of turbines was parked/idling/etc.?
	XXX--- "any" is added as suggested ---XXX
22	The ";" is confusing, please make two sentences there. I don't understand this: "power is 5% above rated power for turbines nr. 1, 36, 65, and 68."
	XXX--- We now split the sentence into two and reformulated the last part to avoid confussion ---XXX
23	How many of these 10-minute time stamps are in 2014, which is the portion you consider in your analysis?
	XXX--- If the type of analysis is performed with the filtered SCADA time series, then all the time series is considered (not only 2014) except for the results regarding the capacity factor, in which we use all non-filtered SCADA for 2014 as stated in the section "Capacity factor" ---XXX
26-27	This is really confusing. Can you have a more lengthy explanation or an equation for u_equivalent? Also, you say how the "inflow reference wind speed" is estimated but what is it defined to be? How about it is defined as … , estimated as … , and used for …?
	XXX--- We have reformulated these sentences and provided an extended explanation of the equivalent wind speed ---XXX
4/Fig. 1	Can you color the turbines that are used in those groups you define in Tables 1 and 2, to estimate the "inflow wind speed" and direction? Is this what you call the "inflow reference wind speed"? Does "reference" stand for undisturbed, freestream wind speed?
	XXX--- Colors are added as suggested. As it is stated in line 27/p 3 of the original submission, the inflow reference speed is estimated from wake-free groups of turbines, so yes, it is an undisturbed freestream speed ---XXX
4	Please explain why a group of 4 turbines is used to estimate the wind speed, and only a group of two is used to estimate wind direction? And why are the sectors defined differently? Can you please combine these two tables in one?
	XXX--- The two tables are now combined as suggested. We have extended the explanation of the computation of the inflow wind direction as suggested ---XXX
5/2-12	How long was the simulation run for?
	XXX--- The simulations were originally performed for another project and are described in detail in the reference we provide in the text. For the reviewer's knowledge, the model was run during nearly 4 months and is a 30-year mesoscale model simulation ---XXX
5/10	Is the model output linearly or logarithmically interpolated to hub height? Please explain. "(the mean wind speed is 9.23 m s−1)" over these sectors or over the entire rose? How does that compare to the "inflow reference wind direction" estimated with your method and your two turbines by region?
	XXX--- We add "The model output is logarithmically interpolated to hub height" as suggested. The mean wind speed is an all-sector mean wind speed so this information is now added. It is not important how well the simulated mean wind speed compares to that estimated by us from the SCADA since the latter is less than an ideal time series due to the filtering we apply (described in the SCADA section) ---XXX
6/1-6	Why would you do Park1/Larsen2 for quadratic, and Park2/Larsen1 for linear? Confusing! This entire paragraph is just hard to follow, please rewrite. "We consider three different wake models: the Park wake model with the commonly-used offshore value of k = 0.04; the G. C. Larsen model (Larsen, 2009); and Fuga (Ott et al., 2011). Two methods of laterally merging the wake deficits are considered in the first two models: a linear sum and a quadratic sum."
	XXX--- We have changed the names of Park 1/2 and Larsen 1/2 to linear and quadratic to avoid confusion as suggested and we also take the suggestion of the reviewer regarding the paragraph ---XXX
6/7	What is "a time series basis"? Reword.

		XXX--- This has been reworded as suggested ---XXX
	6/9	What is a "free" wind speed/direction? Reword.
		XXX--- Changed to "undisturbed" ---XXX
	6/11	"(≈160/340 and 45/235 deg)" confusing – write in words.
		XXX--- We do not really understand why is this confusing but we now use more words anyway ---XXX
	6/15	Remove this bit starting with ";for the Anholt…AEP analysis"
		XXX--- Removed as suggested ---XXX
	7/1-12	These two paragraphs are very confusing. Please rewrite the whole thing, even if you need to be more wordy and/or use equations.
		XXX--- We have rewritten both paragraphs, in particular the first one, which is the one providing the details of how we account for the horizontal wind gradient. Here it is also now defined what a gradient-based analysis is ---XXX
	7/10	What is a gradient-based AEP analysis?
		XXX--- See our previous response ---XXX
	7/10-12	I don't understand this last sentence…
		XXX--- He have also rewritten this sentence so that it is clear what we mean with calculations using pre-computed LUTs ---XXX
	7/20	I assume you can reference this pdf in a better way…
		XXX--- Corrected as suggested ---XXX
Results	7/23	Why 2014? Why is half of the year in 2013 for which you do have data, ignored here?
		XXX--- It is simply to have a complete year and not bias the AEP estimation ---XXX
	8/2	By information you mean the WRF simulated wind direction at hub height? Be specific.
		XXX--- We replace "information" by "simulated wind direction at hub height" as suggested ---XXX
	8/5-7	Be quantitative – how small is the effect of the small island relative to the Djursland effect in percentage?
		XXX--- We have added a sentence with numbers regarding the differences between the influence of both land bodies on the farm ---XXX
	8/9	Everywhere in the manuscript change "all directions" to "omnidirectional" "wind gradient" change to "wind speed gradient"
		XXX--- Corrected as suggested ---XXX
	8/10	How does the magnitude of the WRF gradients compare to those in Paul's RANS work?
		XXX--- For the reviewer's knowledge: WRF and RANS predict comparable trends of the velocity gradient with respect to wind direction. However, the gradient calculated by WRF is more wide spread with respect to the RANS results (see van der Laan et al., 2017) ---XXX
	9/1	"a effect" change to "an effect"
		XXX--- Corrected as suggested ---XXX
	9/1-4	You need to rewrite this to make it sound a bit more scientific/less speculative. It seems like you are giving a justification for the wind farm wall effect justification for this, but it is poorly worded. Also, this "similar effect" that you are using in your justification is not shown, so maybe say that?
		XXX--- We add "(not shown)" as suggested and use some rewording to sound less speculative as recommended ---XXX
	9/Fig. 5	Left panel: add small markers to points where each turbine is; Do not connect line as we move from one row to the next (e.g. turbine 30 to 31). Legend… "omnidirectional flow"
		XXX--- Changed as suggested ---XXX
	9/7	"that that" change to "that which" "assuming a **horizontally** homogeneous"
		XXX--- Changed as suggested ---XXX
	9/9	"highest impact" **of** what **on** what?
		XXX--- Changed to "difference" and so it is self-explanatory ---XXX
	9/6-9	This sentence is long and confusing.
		XXX--- We slightly reword and shorten the sentence as suggested ---XXX

9/13	"larger than 1%" – by how much?
	XXX--- We provide later (line 14 page 9 of the original submission) the AEP reference value
9/14	"significant" may be not the best term – is this statistical significant? I'm guessing not.
	XXX--- Changed to "large" in two instances as suggested---XXX
9/12-17	In Section 2 (which may be best called "Methodology") please explain the choices of these turbines #1, #54, #65 in your analysis, as it seems very arbitrary.
	XXX--- We do not think that it seems arbitrary. As the original submission states in lines 13, 15 and 17 page 9, these turbines are chosen either because of their strategic location or because in case of 1 the wind speed is the lowest observed---XXX
10/1	Change to "although accounting for the wind farm gradient is important, it does not"
	XXX--- Changed as suggested ---XXX
10/3-4	This sentence doesn't belong here?
	XXX--- This value is here provided so that the reader can see how different the wind of turbines nr. 1, 54 and 65 is compared to the average homogenous wind ---XXX
10/5	This sentence is too informal, please use scientific writing practices.
	XXX--- We have rewritten the sentence as suggested ---XXX
10/8	By "simulated wind climate" you mean the WRF simulated wind climate? Since you are using so many models, please be very specific when referencing your results.
	XXX--- We have added "WRF" as suggested ---XXX
10/15-18	So confusing! Reword.
	XXX--- The sentence has been split into two and reworded ---XXX
10/footnote	I still don't understand what your ensemble is… time series at each wind turbine location? At all the WRF grid points in the innermost domain?
	XXX--- The footnote has been removed---XXX
11/Fig. 6	Don't use these abbreviations "grad" and "homo" – just spell out the entire term, there is space. What is the SCADA standard "error"? I assume this is the same as "standard deviation" but the term "error" is not usually used in this context, especially when error means something else here (simulations-observations).
	XXX--- We changed to "standard error of the mean" which is equal to sigma/\sqrt{n}, with n being the number of samples. We also avoid the abbreviations as suggested ---XXX
11/1-2	Why, if the flow is from the west? I don't understand the P3<P31. Is this circling back to your blockage comment earlier on? If so, please remind the reader.
	XXX--- There are couple of possible reasons: first it is a large wind sector, second distances are large between these two archs and so wakes are small , third the wake meanders, and fourth the inflow is not uniform ---XXX
11/5	Why this weird number, 168.7? Explain. Be more specific on which information from Table 1 is used, which group? I still don't understand your entire process of estimating these "reference" inflows, when they are used and what for.
	XXX--- We now add ", which is the direction where turbines nr. 45 and 46 are aligned". We also rephrased the text so that it reads "that are derived from the SCADA of turbines nr. 45 and 67—68 (Table 1)" to be more explicit---XXX
12/3	Yes you do, you can use WRF output to estimate stability. Please comment on why not do it?
	XXX--- We do not have observations of atmospheric stability. We add "We have atmospheric stability measures from the WRF simulations but `instantaneous' WRF stability measures are highly uncertain (Peña and Hahmann, 2012)" ---XXX
12/4	Why is this interesting? Why are the differences so large?
	XXX--- We delete "interesting" from the sentence. As we mention, the period is different from that used by Nygaard (2014) ---XXX
12/15	"performing the best" – reword this.
	XXX--- See next response ---XXX

	12/15-17	Confusing, reword. Why is it not "fair"? Maybe "fair" is not an adequate word here?
		XXX--- We reword the sentences as suggested: "However, it is important to note that wind turbines are not always working and underperform when compared to the manufacturer's power curve. The predicted AEP/capacity factor of a combined mesoscale-wake model is typically lower than the observed value; however, we want to know the capacity factor of a wind farm regardless of the operating conditions."---XXX
	13/3	Instead of having these numbers in the text can you add them as another column to Table 4, just noting that for PL estimation WRF is not used just the wake models?
		XXX--- We think that this will be confusing as WRF is not used for the PL estimations and because these are two different datasets --- XXX
	13/7-13	I'm not sure about this paragraph – it sounds like a justification of your methodology and not really a result. Does it belong elsewhere, maybe Section 2?
		XXX--- In section 2 we do not show any results that involve the analysis of SCADA so we choose this place as the power loss is directly dependent on the derived undisturbed inflow conditions ---XXX
	13/17-20	What does this mean for your analysis?
		XXX--- We respond to this question in the first paragraph of the original discussion ---XXX
	14/2-3	It is counter-intuitive to say that positive values mean under-estimation, so reword this a bit: "where positive ε values denote a model that overestimates the power (i.e. underestimates the wake loss)"
		XXX--- Changed as suggested ---XXX
	14/3	"mean $<\varepsilon>$ and standard deviation σ_ε of the distributions"
		XXX--- Changed to "The mean and standard deviation of the distributions of ϵ, $<epsilon>$ and σ_{ϵ}" ---XXX
	14/Table 5	Get rid of this table and add these numbers to Fig. 9.
		XXX--- Corrected as suggested ---XXX
	16/1-5	This paragraph is completely irrelevant.
		XXX--- Removed as suggested ---XXX
Conclusions	16/7	We "confirm" or "reiterate" – you don't really "show" since previous work had already shown this.
		XXX--- Changed to "confirm" as suggested ---XXX

References:

Peña A. and Hahmann A.N. (2012) Atmospheric stability and turbulence fluxes at Horns Rev – an intercomparison of sonic, bulk and WRF model data. Wind Energ. 15:717—73

van der Laan M.P., Peña A, Volker P., Hansen K.S., Sørensen N.N., Ott S., and Hasager C.B. (2017) Challenges in simulating coastal effects on an offshore wind farm. J. Phys.: Conf. Series 854, 012046