Journal: WES
MS No.: wes-2020-48
MS Type: Research articles
Submission Date
Date Due 15 Mars 2020
Title: "Field testing of a local wind inflow estimator and wake detector"
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General comments:

This paper is in the continuity of other studies on the same subject. The objective of this work and the previous ones is to predict the mean wind state inflows (shears and misalignments) from wind turbine loads. Previous works were dedicated on the validation of the method using an aeroelastic simulations, LES simulations and scaled wind tunnel tests .The present work extend the validation using field tests.

Having the knowledge of the flow affecting the entire rotor including its impact on the production for all wind directions/conditions is indeed not trivial with today's sensors that are generally limited spatially (a point measurements with nacelle-mounted wind lidar, some points of the vertical wind profile from a met-mast ...), limited to certain wind directions (met-mast location, scanning lidar position etc …) and limited in time (met-mast/scanning lidar are generally installed for the certain amount of time). Extract information of the wind inflow from remote sensors on the rotor blades, that can be included in the monitoring set of data (SCADA data), is therefore a very attractive solution.

The use of blade out-of-plane bending moment is demonstrated here to be an interesting quantity for wind inflow analysis. However, a sensor characterization is generally based on measurements redundancy. For this sensor this means a perfect knowledge of the spatio-temporal inflow, which is only partially available from this field test. Also, sensors need to be characterized dynamically which is a quite complex task from field measurements. In antoher hand, reproducing all the physics in wind tunnel or in simulations is still a challenging task and this first application of the method on field test is a real interesting feedback to perform further accuracy evaluations that could be completed off-line in controlled environment using wind tunnel tests, CFD or aero-elastic simulations.

I clearly recommend this paper for publication with however some corrections or more details regarding these tow points:

Mean shear trends can be retrieved after however some online calibrations:
- calibration coefficient introduced to compensate the mismatched of the bending moments on the two blades
- calibration coefficient introduced to match the rotor effective speed VTB with the velocity estimated from the bending moment measurement.
- azimuth mean biais of 11.4° is removed (using the average over 7 days).

The origin of the mismatch is not always completely evaluated. If the source of the error dependent on the rotor operation, this will limits the validation of the method to this specific rotor operating point. It would reinforce the strength of the paper to look in more details at the origin of these mismatch.

For that purpose, it would be interesting to have more informations on the available sensors (type, accuracy, calibration procedure) such as the azimuthal sensor, the sensor available on the mast, the initial strain gauge calibration … This is particularly important to help to discriminate the error from the model to the measurement and thus to have more inside on the origin of some errors/biais found by the authors.

DETAILED QUESTIONS:

Q1: Measurements used in the paper are 10min averaged data. However, it is particularly interesting to have an estimation of the wind fluctuations at the rotor location for blade load monitoring/alleviation for instance. The highest time resolution for this method/sensor is linked to the strain gauge sensor cut-off frequency, to the structural dynamic response of the blade bending moment, but also to the rotation speed of the rotor. The rotation speed of the rotor is varying with wind inflow according to the control of the turbine, so that the developed sensor has a varying sampling rate. Have you estimated the sampling rate variations ? Does it impact the wind estimation ? Do you have an estimate of the minimal/maximum time resolution for a given azimuth position (phase measurements) ?

Q2: p3L22 " (…) former yields a rotor-effective wind speed (i.e., an average quantity over the entire rotor disk), the latter is used to sample the local wind speed at the azimuth position occupied by a blade."

With strain gauge sensors only located at the root for root bending moment measurements (with the out-of-plane forces assumed to be homogeneously distributed along the blade), the estimation of the associated wind condition is necessarily averaged along the blade. This method is therefore local in azimuth, but not along the blade. I think this is an important information to be emphasized as it is more complex to install strain gauge sensors along the blade (for more local estimation) than only at the blade root location.

Q3 P6L22: "All measurements are sampled at 10Hz".
Why not using the 10Hz data, why only the 10 min average ?

Q4: p6L25: "the relative difference between the two blades can't be related to a miscalibration of sensors …"
why not a small pitch offset beween blades ?
The cross-checking of the the load calibration is given through a comparison between rotor-effective wind speed and the wind from blade loads. However, no information is available on the initial calibration of the strain gauges, which is an important point to evaluate the accuracy of these measurements and thus to discriminate between an error in measurement and a lack in the model development or other source of errors.

Q5 p8L25: "including the cases where the blade is partially or fully stalled"
CD and CL are inputs given to the aero-elastic modeling. How these cases are treated ? Is this a LUT of measured CL/CD or a Xfoil simulation ? Or aerodyn from fast ? Or CFD computations … ?

Q6 p8L30: "A direct comparison between VTB and VB reveals that the latter provides … are scaled by a factor of c=0.928"

Why the model used to compute the aerodynamic coefficients is suspected to be the source of

error ? Is the model used limited ? Are the operating AoA in the stall region ?
Why not a misalignment bias of the rotor or difference of pitch angles between blades during installation ?

Q7 p10: "possible bias in the measurement of the azimuthal position of the rotor" or "no blade dynamics included in the model"

How the azimuth is measured, is the 11.4° in the error range of the sensor ?
Why you didn't include the blade dynamic model ? This would have been interesting to cross-check your hypothesis and discriminate between a sensor error or a modeling error.

Q8 p15 figure 10:
Is it possible to have the floris pictures between instant C and instant 5:00, where there is a peak increase of velocity Vs,left ?
It seems to me that the rotor orientation hasn't changed much relatively to the instant C (gama is constant ~145°) while the Vs,left peak is quite significant and the Vs,right remain constant (waked condition). This dissymmetry in the wind estimation (and therefore in load bending moments) is quite strange if the wind orientation hasn't changed. Maybe an errorbar in the measurement of the wind orientation may help ?

Q9: p15 figure 10
Another point that is remarkable is instant ~9:00. While the wind direction is back to the level found after instant C (~149°), the deficit is not as high and the dissymmetry between Vs,left and Vs,right is again present. I suspect a too fast wind direction variation for the wake to develop. In another word, apart from errors in the method, is the wind unsteadiness can be suspected.
Standard deviation of the wind direction may help to go a bit further in the analysis.
I understand that without reference this is difficult to explain, however this high sensitivity to the time duration within a wind orientation is certainly to be estimated off-line with a dynamic calibration of the sensor method in future work. It should be at minimum reported or commented in the present paper.

Q10 (figure 10): the coefficient k is interesting but not commented, why is that ?
The passage from a positive shear to a negative shear, the level of the shear at 5:00 compared to 9:00 etc ...

Q11 P17L5: "very few measurement points are available" induces "frequent shutdows of WT1"
Can you be clearer ? I don't understand this logic: even if the wind turbine is stopped you should have bending moments measurement points ?

Q12 p17L10: "Fig. 11, suggests a small bias in the met-mast wind direction measurement and/or that the wake is not developing exactly along the downstream direction."

Also suggested by figure 10 with the dissymmetry between Vs,left, Vs,right ?

Q13 P17L16: "the scatter ..."

It can also be attributed to the level of the atmospheric turbulence in the inflow, a comparison from std from met-mast and std of Vs,right / Vs,left may help to assess this point ?

Q14 p18L25: "The larger fluctuations of the vertical shear compared to the horizontal one are

probably caused by varying ambient inflow conditions.”

Depending on the mast instrumentation (sonic or vanes), this point can be assessed by the evaluation of the atmospheric stability and thus possible additional velocity fluctuations in the vertical direction.

Q15:
P19-20: “This indicates that some of the scatter ...proposed method”
P20L4: “Clearly, this is simply a feature of the flow, and not of the method tested here.”

These sentenses are very affirmative while there was no clear demonstration on that purpose.

Clearly tendencies agree well with what is expected and the method gives interesting results. However, additional measurement points are needed to have an effective measure of the method accuracy in space (more points on the mast in the vertical direction, maybe a mast in the horizontal direction, and some topological analysis of the terrain …).

Q16 p19L4: “(…) waked by a second machine. This feature of the test site has been exploited for demonstrating the ability of the proposed local wind sensing technique to detect wake impingement.”

The measurements available on field test site is not able to perform a direct validation of the method, which would consist on a direct comparison between a full spatio-temporal description of the wind inflow (at least a 2D plan) with the estimated one. The demonstration is rather based on analysis from partially available measurements (mast, SCADA, azimuth, …) completed with wake estimation from FLORIS. More specifically, there is no way to validate the horizontal shear (wake) with inflow measurements (only one point). Tendencies are clearly coherent to what we would expect, but a precise evaluation of the method accuracy (in time and space) is not feasible.

The term “demonstrating” is therefore a bit strong here, especially for the wake detection.

MINOR CORRECTIONS:

C1: In equation 1a, V should be replaced by VTB and in equation 1b, V should be replaced by Vi

C2: Usual conventions for wind roses representations are: North corresponds to *0*°/360°, East to 90°, South to 180° and West to 270°. In figure 2, 0°/360° corresponds to South.