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WIND ENERGY SCIENCE DISCUSSIONS

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Interactive comment

Interactive comment on "Free flow wind speed from a blade-mounted flow sensor" *by* Mads Mølgaard Pedersen et al.

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Thank you very much for your review, questions and comments.

- Taylor's hypothesis is not valid near the rotor and the blades where the turbulence is considerably affected. The current method, however, does not rely on Taylor's hypothesis as it estimates the free-inflow velocity at its actual position. In the HAWC2 simulations, the simulated flow velocity, which is used as input for the current method, is different from the velocity that would have been measured in real flow due to the application of Taylor's hypothesis. It is, however, not expected to influence the verification significantly. Furthermore, the turbulence that hits the sensor in the HAWC2 simulations is identical to the free-inflow turbulence except for the induced velocities.

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Discussion paper

In real flow, this turbulence would be somewhere else if the turbine was absent. Nevertheless, both effects are included in the ElllipSys3D/Flex5 simulations, which do not rely on Taylor's hypothesis.

- The method can be applied to measurements from multiple sensors as well. The average free-inflow velocity from sensors on all blades, for instance, will provide a much better estimate of the instant rotor-average velocity. In this context, however, we are only considering the inflow velocity at the rotating position of the sensor.

- The estimated free-inflow velocities can easily be binned on the azimuthal sensor position to provide the vertical and horizontal shear profile. We will add a description of possible applications of the estimated free-inflow velocity in the paper.

- The problem about measuring the free wind upstream is that the upstream flow velocity is different from the velocity at the rotor. If the flow is obeying Taylor's hypothesis, the difference is just a delay in time. In real flow, however, the upstream-measured flow will evolve and probably pass beside the sensor. A time average, e.g. 10-min mean, will in most cases provide an appropriate estimate, but the instant velocity at the rotor cannot be measured upstream.

- The sensor should not be mounted too close to the root, where it will only sweep a small part of the rotor, and not too close to the tip, where the effects of blade deflection and tip-loss are more severe. Furthermore, the load distribution along the blade should be taken into account, such that the sensor measures the inflow where the largest loads occur. In Pedersen et al. (2017), different radial positions are investigated and 50 – 67% was found to be optimal. We will add this to the manuscript.

- The effect of bound circulation is of major importance as described in Section 3.2 and illustrated in Figure 1 of the manuscript. Hence, it must be compensated before applying the current method, e.g. by the method described by Pedersen et al. (2017), which is applicable in practice. This compensation will, obviously, also introduce uncertainty, which is not considered in the current work.

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Pedersen, M. M., Larsen, T. J., Madsen, H. A. and Larsen, G. C.: Using wind speed from a blade-mounted flow sensor for power and load assessment on modern wind turbines, Wind Energy Sci., 2(2), 547–567, doi:10.5194/wes-2-547-2017, 2017.

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