Wind Energ. Sci. Discuss., author comment AC1
https://doi.org/10.5194/wes-2021-12-AC1, 2021

Reply on RC1

Alessandro Fontanella et al.

Author comment on "UNAFLOW: a holistic wind tunnel experiment about the aerodynamic response of floating wind turbines under imposed surge motion" by Alessandro Fontanella et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-12-AC1, 2021

Dear Refree,

Thank you for taking the time to review our manuscript and for the valuable comments you made.
Below are our answers to you comments and suggestions.

1. Scientific findings the paper is trying to uncover and broader impact of these findings

Refree noticed that the paper aim is not clearly addressed in the manuscript introduction, that should also point out the main findings and their impact. We agree with Refree's comment, and we would like to replace line 48 to line 59 of the manuscript with the text below.

The unsteady response of FOWTs is still an open question. In this respect, this article presents the wind-tunnel scale-model experiment that was carried out as part of the IRPWind UNAFLOW project.
The goal of the experiment is to study the aerodynamic response and wake for an FOWT subjected to large surge (i.e. translational) motion, as it normally occurs in operation. The main contributions of this work are as follows:

- A preliminary 2D experiment is performed to characterize the airfoil used for the scaled turbine blades. Unlike previous study, knowledge of unsteady aerodynamic response of blade airfoil is leveraged to select the wind and motion conditions of full-turbine experiments. In addition, knowledge of the airfoil response is available to be used for calibrating numerical tools.
- Thrust force measurements from full-turbine experiments are compared to predictions of a quasi-steady actuator-disk model. This model is often relied on when building reduced-order FOWT models for control applications (e.g. [https://doi.org/10.1007/s11044-020-09729-x][https://doi.org/10.1088/1742-6596/1618/2/022038]), and assessing its prediction capabilities is therefore crucial for developing effective controllers. It is found the thrust force follows the quasi-steady theory for reduced frequency below 0.5.
- The wind turbine wake is measured with hotwire probes to describe and quantify the

effect of surge motion on its energy content. PIV measurements are utilized to assess the influence of surge motion on the position of tip-vortex inside the wake. The wake energy is increased in correspondence of the surge-motion frequency.

The impact this paper and the UNAFLOW experiment have on research about FOWT unsteady aerodynamics is:

- additional knowledge about the unsteady aerodynamics of an FOWT. In particular, the analysis is carried out with a system engineering vision of the problem, that considers the response of the entire floating system. Its findings may have an impact on blade design, wind turbine control, wake interaction and wind farm control.
- experimental methodology. The UNAFLOW experiment is the result of a joint effort of different research groups, some expert in numerical simulations and some in scale-model experiments. The experiment followed an integrated approach: results of numerical computations and 2D experiments were utilized to design full-turbine experiments, which results were in turn used for validation of numerical tools. Because of these aspects, the experiment can be considered as the most advanced wind tunnel test about FOWT unsteady aerodynamics to date.
- database. The experiment generated a comprehensive database, that covers the unsteady aerodynamics of the wind turbine blade, rotor forces and near wake, which is freely available for further studies. Thanks to the systematic approach of the experiment, data are especially useful for validating numerical tools. In Cormier et al. (2018), measurements were compared to a BEM, free-vortex and fully-resolved CFD model. A second comparison with numerical tools was recently carried out in Mancini et al. (2020). The UNAFLOW dataset is currently used for the validation of numerical tools in the IEA Wind Task 30 OC6 project.

2. The coordinate system used in the manuscript is not clear.

As pointed out by Refree's comments, the coordinate system used in the results of the manuscript is not very clear. A clear statement is currently lacking. Moreover an error in the y-axis label of Fig. 14 contributes to increase confusion about the reference frame. To solve this issue, we intend to replace Fig. 6 of the manuscript with the attached figure, that shows the coordinate system of the paper results. We will correct the y-axis label of Fig.14 accordingly ("y/R [-]" --> "z/R [-]").

3. Technical comments

Page 2 Line (29-31): Unclear sentence

Even though the importance of the aerodynamics of FOWTs is widely recognized, few are the experiments that tried to shed light into this topic.

We agree that this sentence is unclear and we would like to replace it with: "To date, the aerodynamics of FOWTs was studied in a restricted number of experiments."

Page 3 Line 69: because the flow (check). We would rewrite the sentence at line 69 as: "FOWTs undergo large rigid-body motions that are permitted by the high-compliance of the floating foundation and wave forcing. As a consequence, the rotor of an FOWT often operates in strong unsteady-flow conditions."

Page 3 Line 82: The second condition. (which one the second condition, please clarify).

Here "second" is mistaken for "third". To improve clarity, we would rewrite the sentence as: "In the ABOVE condition, the TSR is lower and the collective pitch angle is increased, to get a lower power coefficient."

Page 3 Line 83: what is the turbulence index?

Misspelled, it is turbulence intensity that was computed as the ratio between the standard-deviation of the turbulent velocity fluctuations and the mean velocity

Please also note the supplement to this comment:
https://wes.copernicus.org/preprints/wes-2021-12/wes-2021-12-AC1-supplement.pdf