Reply to the Reviewer #3

This manuscript presents an investigation of aerodynamic noise emission of a small vertical-axis wind turbine in different configurations designed to alter and reduce noise emissions.

For the most part, the article is clearly written. However, the study of aeroacoustics is conducted with tools that are not well suited for the refined analysis required for estimating noise emission reductions in details and consequent environmental impact. The paper also suffers a number of deficiencies that are addressed following the sections' order below.

The introduction starts with generalities about wind turbine noise. The literature review appears a bit random and disorganized.
Reply: We have reorganized the introduction and paper review in the revised paper based on reviewer's comment.

In Section 2, the numerical models are presented. The flow solution is based on a commercial software solving the compressible Navier-Stokes equations, with a standard RANS approach for turbulence modelling. In this respect, the unsteady term is missing in Eq.(2). The acoustic part is based on an integral acoustic analogy derived from Curle analogy. The integration surfaces for the acoustic calculations are on the blade surfaces. Note here, that strictly speaking, Curle's analogy is only valid for non-moving surfaces. To the authors' credit, in the present case, it may be a valid approximation though. A "correlation area" is introduced as a multiplicative factor in Eq.(11), but it is never numerically defined. Since this factor is related to wall-pressure correlation lengths, its value has a direct and significant impact on the noise emission levels. The accuracy of the overall model can then be questioned if it is not properly defined based on some physical considerations. In addition, the overall methodology for acoustic predictions seriously lacks qualitative validations, or at least references to it.
Reply: We changed the eq (2) and defined the A_c in eq (13) in the revised paper based on reviewer's comment. We also defined the overall model on some physical considerations. We added some references in section 1 and 2 based on reviewer's comment.

Furthermore, as shown in the results, the model provides only an overall (frequency-integrated) sound power level. There is no indication on how this energy is distributed over frequencies, which is a crucial aspect for environmental impact of wind turbines (or any other industrial facility for that matter). Not even an indication on A-weighted noise power levels can be obtained.

Reply: The main objective of this paper is to address how to reduce the magnitude of noise, focusing primarily on the overall (frequency-integrated) sound power level, which is also a concern for wind turbine operators. In the next stage, our research team will undertake a related study and noise analysis focusing on parameters such as noise energy vs frequency. Thanks for the reviewer's suggestions.

To make things worse, the model as it is, can most probably not capture scattering effects, which should be the dominant noise source in this context (at least in the audible frequency range). It may be that the present model can capture vortex-blade interaction noise. However, the use of a URANS strategy will limit the size of the vortices to the very large ones, resulting in sound emissions that would probably be in the infrasound range. It can be expected that this has little relevance in the present context.

Reply: URAN models may underestimate the size of vortices, potentially leading to an underestimation of noise in the infrasound range. LES model may provide a more accurate understanding of these phenomena. However, LES model requires significant computational resources. For industrial applications, the SST k-ω model currently offers sufficient accuracy with an appropriate computational load, making it a good choice. Additionally, this study primarily focuses on the modification of wind turbine blades to reduce noise. Even if the noise in the infrasound range cannot be accurately estimated, as shown in Figures 6-9, the SST k-ω model can still be used to identify methods for noise reduction, making it applicable for industrial assessments.

In Section 2.4, the numerical implementation and discretization of the CFD model is presented. It is classical for these type of calculations to provide the size of the cells at the surface (for assessing mesh refinement) in term of y+ (as mentioned by the author in the introduction). But, this is never done here. Only cell sizes in meter are provided in Table 1.

Reply: SST k–ω model has a higher tolerance for y+, therefore y+ has no impact on the results. To ensure the computational validity of realizable k–ε, maximum y+ value less than 80 in this paper. We added the information in section 2.4 based on reviewer’s comment.

Section 3 starts with a mesh convergence analysis which appears satisfying. The

remaining of the investigation concentrates on noise emissions which is lacking a number of information to make it valuable. The comparisons concentrates on the impact of the geometry for noise reduction on torque and acoustic power. This is indeed a suitable approach as indeed, acoustic reduction should affect overall aerodynamic performances to a minimum, which should be addressed in the design phase. Nevertheless, the lack of physics in the noise modelling (see earlier comment about Section 2) does not permit to draw firm conclusions on the impact of the different designs, as the noise reduction (or increase) may occur at frequencies that are not relevant for environmental purposes.
Reply: Reviewer is correct. This paper acknowledges that the noise reduction design may not be applicable to conditions that are not relevant for environmental purposes. However, the main objective of this paper is to improve the design of wind turbine to reduce the impact of turbine blade rotation on environmental noise. Therefore, the conclusions of this paper can still be considered as an important reference.

As an additional comment, the authors use a very unusual metric for displaying the noise levels, namely watts. Note values up to 10^5 W in Fig.3 which is of the order of the noise emission of a turbojet engine....
Reply: The values are around 10^{-4} W in Fig 3. in the revised paper.

To conclude, the paper presents an analysis of VAWT noise emissions which is questionable regarding its relevance for assessing environmental impact. Nonetheless, if interested in very qualitative acoustic results, that may be satisfying, e.g. if one is mainly interested in aerodynamic performances of the acoustic reduction devices. In the reviewer's opinion, the acoustic model strategy should be improved/enhanced, and noise spectra should be provided as a result, before this article can be considered for publication.
Reply: This paper primarily employs CFD method to investigate the enhancement of VAWT design with the purpose of reducing noise. Therefore, the focus is on the overall (frequency-integrated) sound power level, which is of particular concern to wind turbine operators. As for the impact of improving blade design on aerodynamic performances, an investigation is required into its relationship with the energy vs frequency of noise (rather than only calculating the overall power level). This is the next research topic for our team.

Thanks for the valuable comments.