Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2018-51-RC2, 2018

WIND ENERGY SCIENCE DISCUSSIONS

WESD

Interactive comment

Interactive comment on "Advanced CFD-MBS coupling to assess low-frequency emissions from wind turbines" *by* Levin Klein et al.

Anonymous Referee #2

Received and published: 6 August 2018

In the paper entitled "Advanced CFD-MBS coupling to assess low-frequency emissions from wind turbines" the intention is to evaluate the emission of aeroacoustic and seismic noise at low frequency from wind turbines. To do this, a coupling between a high-fidelity CFD RANS solver (FLOWer) and a commercial multibody solver (SIMPACK) is proposed. SIMPACK runs on a local windows machine, while FLOWer runs on a linux cluster. The communication between the two systems is done via SSH. For each timestep t, the configuration at the following step t+1 is computed by SIMPACK with loads given by FLOWer for the timestep t. From SIMPACK, at the time instant t+1 deformations that are used to modify FLOWer mesh are extracted. Now new aerodynamic loads can be computed, and the next iteration can start. Regarding aeroacoustic noise propagation, a FW-H formulation is used. Here authors use pressures and velocities on all surfaces of the turbine taking into account only monopoles and dipoles. The quadropole term is neglected and this is reasonable for wind turbine applications. The presented framework is exercised on a modified NREL 5MW, operated at rated conditions.

I find the work of very good quality and to start I'd like to acknowledge the large amount of work behind the paper. The actual results are most likely not revolutionary, as on one side, these simply confirm the importance of the blade/tower interference for the low frequency emissions and on the other, given the fact that a conceptual wind turbine has been used, no validation can be performed with the current set of results. Nonetheless, the high fidelity CFD-MBS framework has been topic of development for years and it is useful to present it to the scientific community. In terms of writing, the paper is fairly well written. However, I find several paragraphs too verbose. It takes very long to go through the text and as side effect the main findings of the work do not emerge clearly. Several paragraphs look more of a technical report than from an actual scientific publication. Below I list some examples. Overall, my suggestion is to shrink the text as well as improve its readability. The paper could however be published with only a few adjustments.

First, I expose four main areas of possible improvements. After that, I list several other notes that I spotted while going through the paper. I indicate the former with page and line number.

1. Paper length

I personally find the paper too long. It takes several hours to go through it and I had to read it multiple times to capture all the aspects. In my opinion the paper has several nice findings, which however currently do not emerge clearly. Several paragraphs look more from a technical report than from an actual scientific publication. A first example consists of the way the overall goal of the work is presented. This does not stand up in the text and it is only embedded in the text at page 3-line 3. This should to me be isolated in a well identified paragraph, so that readers (even quick readers) cannot miss it. A second example consists of paragraph 2.5.6 (with Figure 5). Does it improve readability to use almost one full page to discuss about numerical setups to decrease the CPU time? It has been certainly useful during the work, but I don't find this paragraph very useful. My suggestion is to shrink the overall paper, focusing on the strength of the computational setup and better highlighting the important findings about low-frequency emissions of WTs.

2. Comparisons

The whole section 3 is also in my opinion too long, with the focus that is more biased towards unrealistic setups (Sect. 3.1) than the realistic ones (3.3). I would consider reducing the number of comparisons, focusing on maybe 3 cases: rigid-steady state inflow, elastic-steady state inflow, elastic-turbulent. I understand that the current structure of the paper aims at distinguishing each and every single phenomenon. However I see the risk of focusing on numerical artifacts more than on actual results and realistic phenomena.

3. Appearance

The paper is generally well prepared and several nice plots help the understanding of the reader. However I suggest to eliminate some of the plots and enlarge others. Figure 1 is for example to me not needed, as well as all diagrams showing Fz and Mz. As expected, Fz and Mz never show anything interesting. Some other figures also don't add much to the discussion, see for instance Figure 10 as well as Figure 16. All plots containing the spectra could instead be enlarged to the full size of the page. Please be aware that when printed black/white all spectra are not easily readable.

4. Present vs past tense

I personally prefer papers written in present tense, while this text mixes present and past tenses, sometimes in a conflicting fashion. This does not improve readability.

Printer-friendly version

Discussion paper

Please review the text for consistency.

List of additional comments:

Page 1 line 1: I would add "wind" before turbine

Page 1 line 8: I would reformulate the sentence "The tower base loads tend to be dominated by structural eigen-frequencies with increasing complexity of the model". The sentence is not clear, and when read alone is even fairly questionable.

Page 1 line 9: Although the whole paper is about low-frequency noise, I think it would not harm to add "low-frequency" before "aeroacoustic emissions"

Page 1 line 18: I'd anticipate the verb "occur" before "in a broad frequency range"

Page 1 line 19: check the "and" and the "," in the overall sentence formulations

Page 2 line 5: "Hence" may be the wrong logical connector

Page 2 line 8: The paragraph is not well connected to the previous one

Page 2 line 30: Across the text you refer to other authors as "He" or "They". I'd prefer the passive forms for the verbs, but if you like it so, you should be consistent. Li et al. should be "They"

Page 2 line 33: "A totally new ..." may not be the right set of words to describe a coupling of existing tools within a scientific publication

Page 3 line 11: What does "strong coupling" mean?

Page 4 line 1: Tenses should all be reviewed, but here "SIMPACK is" should to me be replaced by "SIMPACK has been"

Page 4 line 5: Review the term "generally" as it is probably not the right word

Page 8 line 13: Nacelle & hub are defined as rigid body, while foundation is a rigid body connected to the ground through a spring/damper system. However in table 2 (page

9) nacelle is listed among the flexible bodies and at page 10 line 8 it is written "flexible blades as well as a flexible tower and foundation". By "non-flexible foundation" does it mean that the degrees of freedom of the spring-damper are frozen? And what about nacelle? Please clarify.

Page 8 line 14: "Details" and not "Detail"

Page 8 line 15: Here "was" is used, while a few lines later (page 9 line 2) the tense is back to present

Pag 10 line 10: In the low frequency domain the wave length is high and spectra cannot be accurately measured too close to the emitter. In the work 3600 observers are placed and the closest are only 100 m from tower base. Is the time history from those observers still accurate for the frequency band of interest? Please explain.

Page 10 line 12: Please evaluate the need to include paragraph 2.5.6

Page 12: The case LC1 is without tower and nacelle. How and where are the loads computed? Even though there is uniform inflow and no tower, shouldn't you see some periodicity in the signal due to the tilt angle?

Page 13 line 8: Please better explain the sentence "Therefore, aerodynamic loads on rotor and tower were evaluated separately." How exactly? Always at tower base?

Page 13: In figure 8, I understand the general increase of amplitudes below BPF due to shedding on the tower. Fx and My have an increase of amplitudes on the band between 5-9 Hz for LC1 and LC2. For Mz this is even more noticeable. This behavior does not appear in LC2_FSC1SD. Could you please explain what happens?

Page 14: My guess is that a Strouhal number of 0.2 was chosen as it is typical for cylinders, but it isn't mentioned. Rotor is operating at rated conditions, so let's suppose an axial induction factor of 0.33, this means that the tower experiences a flow speed of 11.3*(1-0.333)= 8 m/s. Considering the asymptotic wind speed and the average diameter, a Reynolds number around 2e6 can be calculated. Is 0.2 still a typical Strouhal number even at such Reynolds number? Please discuss.

Page 14: 0.292 Hz should be the frequency where vortex shedding occurs. However, I don't clearly see a precise peak at this frequency. What I notice is that AROUND this frequency range there is a general increase in side-side Fy and Mx amplitudes, which makes sense because shedding frequency varies along the tower because of different diameter and inflow. Do I understand things right?

Page 24 line 30: "generic" or "conceptual" wind turbine?

Page 25 line 30: In my opinion stating that results are of "high quality" requires first a validation.

Interactive comment on Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2018-51, 2018.