Interactive comment on "Performance study of the QuLAF pre-design model for a 10MW floating wind turbine" by Freddy J. Madsen et al.

Comments from Tor Anders Nygaard
Institute for Energy Technology (IFE), Norway
tor.anders.nygaard@ife.no

General comments

The article presents a comparison study of the simplified model QuLAF (Quick Load Analysis of Floating wind turbines), and a FAST model of the DTU 10MW Reference Wind Turbine mounted on the LIFES50+ OO-Star Wind Floater Semi 10MW floating substructure. The QuLAF model and application to the OO-Star Wind Floater has been presented before. This article examines more load cases, and comparisons with FAST that provides interesting and useful input for future developments of QuLAF.

The article is relevant, because computations of large load case matrices with many realizations of time-domain simulations are computationally expensive, and it can be demanding to fully integrate these simulations into a design loop. There is a need to investigate faster models, and the trade-off between accuracy and simulation throughput.

The impact of this work is a further justification of application of frequency-domain models to problems involving significant motions, such as floating wind turbines.

The quality of the article is very good. The specific comment listed below are mostly requesting clarifications and some more discussion about items not covered by the review comments RC1 and RC2.

Clarifications

Although QuLAF is well described in the references, many of the readers working on floating wind turbines have most experience with time domain models, and I think the article would benefit from some clarifications.

In the left plots of figure 2, we have several results for each wind speed. The way I read the paper, for each wind speed, three sets of Hs and Tp are generated from the joint probability distribution. Each of these three realizations are computed with six different wind and wave seeds (also realizations). If indeed the use of several wind and wave seeds for one particular combination of Vm, Hs and Tp are used for the frequency domain model, please explain why this is done. Many frequency domain models work with distributions as input and output, directly giving the results for an infinite number of realizations. Here, however, does the input to QuLAF contains phase information for the particular realization at hand? Can the QuLAF results then be transformed back to the time domain, to be directly compared with the time-domain FAST results, and post-processed with the same methods, such as rainflow counting?

Specific comments

The first comment is due to one of the main findings; the ultimate nacelle accelerations are underpredicted in QuLAF, whereas the ultimate tower-base bending moments agree well. Often, accelerations are more sensitive to higher modes than ultimate bending moments. I did not find information on the number of tower modes used in FAST for this application. If it uses more than one tower mode, the following comment may be relevant: In addition to the under-prediction of the wave excitation loads for strong sea states due to the omission of viscous hydrodynamic drag forcing, could the omission of the second tower mode in QuLAF also be part of the explanation? One way to examine this would be to turn off modes two and higher in FAST, or look at the response-spectra from FAST. Please include information on the number of tower modes used in FAST, and, under model limitations for QuLAF, mention that only first tower bending modes are used. Have any sensitivity studies on the number of tower modes ben carried out?

The aerodynamic damping model seems to be one area where changes could significantly improve the results. One possible improvement would be to perform the decay test in FAST with flexible blades, resulting in an eigen frequency closer to the coupled tower frequency in QuLAF, thereby reducing the over-prediction of aerodynamic damping. It should also be possible to have an aerodynamic damping model in QuLAF model derived directly from a linearized BEM model.

I find it quite surprising, interesting and perhaps under-communicated that an emergency stop can be successfully computed with a frequency domain model. More details, such as direct comparison of the time series of tower base bending moments and nacelle accelerations would be very welcome.

Technical corrections/questions.

Page 4, line 14: Did you check that there is no numerical damping in the decay test? One way to test this is to scale down the lift-and drag coefficients, or somehow provide an excitation of the tower top without rotor aerodynamics present.

Page 6, line 18: .. each wind speed in each load case had three realizations of the wave spectrum peak period.

Figure 9: Orient bar text as text on y axis

Page 21: ..were applied in the original …

Acknowledgments

Tor Martid Lystad and Henrik Skyvulstad at the bridge department in Norconsult (also PhD candidates at NTNU), have contributed with many good discussions on frequency plane models lately and provided inputs to the topics in this document as well.