Response to Reviewers

Frequency-domain modeling of floating wind arrays with shared mooring lines

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We thank the reviewers for their careful consideration of our paper and the constructive comments. We have made a number of improvements and revisions in response. Below are the compiled reviewer comments, along with our *responses in blue italics*.

Reviewer 1

RC1: 'Comment on wes-2025-58', Anonymous Referee #1, 01 Jul 2025

This work describes the new capability of the open-source frequency domain tool RAFT in modeling shared mooring lines between multiple floating offshore wind turbines (FOWTs). The study focuses on first-order wave frequency response of the system in aligned steady wind and long-crested irregular waves. The mooring system is modeled quasi-statically. A case study of two semisubmerisble FOWTs with a single shared mooring line between them was used to verify the model against time-domain simulations in FAST.Farm. A single sea state applied in 3 directions was used for the verification. Reasonable agreement was found between the two models, except for shared mooring line tension response due to unmodeled line dynamics. Additionally, the effect of the phase difference in the wave loading between the two FOWTs resulted in what the authors refer to as a “comb-like” frequency response. A phenomenon in which the spectrum of the shared line tension has multiple sharp peaks as a result of the two FOWTs moving in and out of phase at different frequencies.

The paper is generally clear, and the results are well presented. Some comments and suggestions to improve the manuscript are given in the attached PDF.

Responses to comments in the PDF

We have corrected the typos noted in lines 63, 106, and 173. Thank you for noting these.

Eq 1: I think using both the structure and substructure might be redundant (and may be a bit ambiguous) in this case, since mass, added mass, damping, and hydrostatic stiffness are all related to the substructure. I suggest using just subscript for all coefficients related to the platform.

Response: We agree with this critique, although we also want to reflect how the matrices are divided up in the code. We have revised the equation and explanation to remove the structure-vs.-substructure redundancy, and now the different terms have a "hydro" subscript for hydro-specific parts and a "structure" subscript for structure-specific parts. This new notation follows the same variable names as in the code, which we think is helpful for an open-source software.

Eq (5): *As suggested we have added explanation of each variable in the equation, corrected eta to be zeta, and indicated that zeta is also a function of x and y position.*

Line 126: *As suggested, we have expanded the explanation of the hemispherical reference volume. We have added a sentence and equation (6). We have also added equation (7) to be more clear about the axial exposed area.*

Eq (6) - now eq (8): *We have added a definition of q in the next sentence, and also added a setntence to explain the a_q term, which pertains to the side surface area of the strip.*

Sec 2.5 line 235: Can you expand on why you chose to solve the WF response for individual FOWTs first instead of solving the entire system all at once?

We have added the following sentence: "In this way, the most computationally demanding step---the iterations when linearizing quadratic drag--is done on small system matrices for computational efficiency."

We have also edited the text around line 252 to be more clear that the final step solves for "the coupled dynamic response of all FOWTs in the array to all sources of excitation"

Table 2: Can you also include the drag and added mass coefficients for the line and the clump weight that was used in the time-domain simulation in FAST.Farm? I understand they are not used in RAFT, but since you mention later that the large differences in tensions the 90-degree case are due to ignoring line dynamics, these coefficients would be of interest to quantify that effect.

We have added the mooring line hydrodynamic coefficients to Table 2 and noted that the clump weights were modeled as a point mass with no volume or hydrodynamic properties.

Line 314: *We have corrected the stated angle from 90 deg to 45 deg.*

Line 329: Please include the simulation length and the number of simulated realizations.

We have added that after the discarded startup transients "there was one hour of simulation time. A single time-domain realization was used for each case for the purpose of making comparisons with frequency-domain results."

Line 355: Just a suggestion, I think this paragraph can be rephrased in a more clear way if figure 14 is changed. Instead of having 9 plots with the magnitude, real, and imaginary parts, you can instead have 6 plots one column for the magnitude and another for the phase and plot 3 lines per plot (one for each direction). This way the phases are explicitly given and don't need to be inferred.

*We appreciate this suggestion and have explored it. Plotting the phases will show a large wrap-around effect because the phase difference exceeds many multiples of 2*pi at higher frequencies. To avoid this,* *and to ensure the in-phase surge components of turbine 2 are visible (so they can be visually compared to the tension amplitude), we prefer to keep our original presentation that shows the components.*

Conclusion: I think it would be nice to highlight the limitations of the study (no wind or difference frequency loads, and not considering line dynamics ... etc.) and also possible further future work addressing some of these limitations.

Thank you for pointing out this missing element. We have added a final paragraph to the conclusion that broadly discusses these limitations and potential future work, including citations to two papers on capabilities that could support future work (https://doi.org/10.1016/j.marstruc.2024.103768, https://doi.org/10.1016/j.oceaneng.2025.120558).

Reviewer 2

RC2: 'Comment on wes-2025-58', Anonymous Referee #2, 02 Jul 2025

In this study, the authors present a frequency-domain model for multiple floating offshore wind turbines (FOWTs), incorporating the coupling effects introduced by shared mooring line systems. The implementation is benchmarked against the widely recognized time-domain tool FAST.Farm, providing a solid foundation for verification. A clear and concise theoretical description of the model formulation is provided, and its performance is demonstrated through a case study involving two inter-connected FOWTs sharing a single mooring line.

Overall, the proposed frequency-domain model shows good agreement with FAST.Farm results, within the expected limitations of frequency-domain methods. The characteristic comb-like frequency response of the shared mooring line is effectively captured and it is aligned with the results shown in previous studies that used similar shared mooring line configurations. This study offers a more explicit treatment and deeper investigation of this phenomenon compared to prior works.

Minor comments and questions:

(Section 3.1, Table 3) – Is there a specific reason for the difference in sign for the mean yaw offset calculated using RAFT vs. FAST.Farm?

We have recently identified an error in the calculation of the aerodynamic loads in RAFT that mostly affected the yaw moment induced by the rotor. We have updated the results to reflect this bug fix, and now RAFT mean yaw offsets agree with FAST.Farm within 0.55 degrees.

(Section 3.2) – In the sentence, “The shared mooring line tensions in the 0° and 90° cases have a distinct comb-like frequency response, which we explore more in Sect. 4,” should the angles be 0° and 45° instead?

Thank you for noting this mistake—we have corrected it.

(Section 3.2) – What is the total duration of the simulated time series in FAST.Farm?

The total duration is 80 minutes. We have revised to clarify that after the discarded startup transients "there was one hour of simulation time. A single time-domain realization was used for each case for the purpose of making a comparisons with frequency-domain results."

(Section 4) – Please revise the sentence: "Because Turbine 1's reference position is at the origin, the wave elevations it experiences have nearly zero phase (appearing as real-valued complex amplitudes)."

We have rephrased the sentence to read, "Turbine 1 has a reference position at the origin, resulting in wave elevations with close to zero phase offset (the wave complex amplitudes have close to zero imaginary component)."