Review: A parameterization scheme for the floating wind farm in a coupled atmosphere-wave model (COAWST v3.7)

Summary

The authors implement a floating wind turbine parameterization in a coupled atmosphere-wave model. Their parameterization accounts for changes in wave properties due to the turbine's floating structure. In their wave parameterization, the authors develop a regression model, trained using a spectral wave model (SWAN), that accounts for the turbine's floating structure. The authors also modify the momentum tendency in the surface layer of the atmosphere. A source of momentum is included in the momentum tendency equation to represent changes in the momentum flux due to the floating turbine. Finally, the authors compare their floating turbine parameterization against the Fitch parameterization for a wind farm in the South China Sea.

The manuscript addresses a very interesting topic, namely the importance of including coupled atmosphere-wave models to evaluate the effects from offshore wind turbines in the flow over large regions. However, I have major concerns that should be addressed prior to publication, mainly about their modifications to the Fitch wind farm parameterization, which adds a non-physical source of momentum across the surface layer.

Major comments:

1. Machine learning models: the manuscript lacks information about the ML models used therein. Also, there is no explanation of how the data are split into training and validation. Specifically:
    a. The authors mention four different machine learning models. However, they do not provide information about neither of these models. Please include a more thorough description of each model, perhaps as an Appendix.
    b. It seems the authors are training and validating the models using the same dataset. If so, this should be revised; otherwise, it is expected that the ML models are going to perform well. If not, please explain how you split the data for model validation.
2. Momentum source across the surface layer (section 5.1): the authors include a non-physical source of momentum at turbine heights. Specifically:
    a. I agree that changes in the momentum flux caused by variation in SWH affect winds close to the surface. However, these changes should be transmitted through modifications to the wall model (like in Jenkins et al., 2012; Paskyabi et al., 2014; Porchetta et al., 2021; Wu et al., 2020; Zou et al., 2018) rather than as an explicit source of momentum in the tendency equation over the bottom half of the turbine rotor layer.
    b. What is the reasoning behind adding non-physical sources of momentum to across the surface layer? Also, shouldn't the source of momentum decay with

    height? If this is the case, then this should be rephrased as a modified wall model.
    c. The references provided in Lines 41-43 suggest waves modify the wind profile through changes in surface stresses, not through injections of momentum across the surface layer: AlSam et al. (2015) and Yang et al. (2014) study how swell can modify wake propagation. Jenkins et al. (2012) use a coupled atmosphere-ocean model that modifies the wind field through changes in surface roughness. Kalvig et al. (2014) resolve waves with a moving mesh, thus the wind profile is effectively modified by changes in surface roughness. Paskyabi et al. (2014) develop a wall model that accounts for wave-induced momentum fluxes. Porchetta et al. (2021) and Wu et al. (2020) use an atmosphere-wave coupled model, where the winds are modified by waves through changes in surface roughness. Zou et al. (2018) also focuses on a wall model.
3. Model configuration in Section 5.2: The authors use a 12 km horizontal grid spacing for their simulations. However, Tomaszewski and Lundquist (2020) show such coarse grids can produce unrealistic impacts over a very broad region. Please explain your choice of grid spacing.
4. Section 5.4: The authors conclude that Fitch overestimates wake effects. However, the FWFP is artificially accelerating wake recovery downstream of the turbines. Thus, it is expected to have higher power production estimates and lower wake deficits in the FWFP.
    a. Lines 243-244: Adding a source to the momentum tendency is expected to accelerate wake recovery downstream of the turbines. Thus, is it reasonable to say that that Fitch underestimates power output? Rather, the momentum source in the FWFP accelerates wake recovery; thus, momentum availability increases amplifying power production.
    b. Lines 257-258: same as above.

Minor comments:

1. I recommend English language revisions throughout the manuscript.
2. Lines 22-24: What about coupled meso-microscale simulations? Coupled mesoscale-LES simulations using WRF can capture these effects, however, at a higher computational cost.
3. Line 31: Please add punctuation as: “… sink on the mean flow. Most of …”
4. Lines 27-44: I recommend splitting paragraph #2 in the introduction, perhaps at line 35.
5. Lines 43-44: I would argue that the current parameterization can be suitable for floating offshore wind farms. Rather, the atmosphere-only model in WRF does not capture changes in roughness length over the ocean caused by the presence of floating turbines.
6. Line 74: Please explain why you chose d = 20 m.
7. Captions should fully describe the figure. Please include additional information in all captions to make each figure self-explanatory. For example, include description of the different terms and symbols used in Figure 1, as well as the significance of the red contours.

8. Figure 3: It is difficult to read the information within the grey area. Please use colors with higher contrast. Also, what is the meaning of the blue curves (presumably schematic for waves) to the side of the plot?
9. Line 173: "The important point in the derivation …" implies that the source of TKE in the Fitch parameterization is not important. Please rephrase.
10. Lines 193-201 and Figure 6: Please maintain consistency in your nomenclature (e.g., the authors use $u_{*,wt}$ in Eq. 17, but ustwt in Figure 6)
11. Figures 11, 13, 14: It would be helpful to show the top and bottom of the turbine rotor layer for reference.

References:

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